INTERNATIONAL SOCIETY FOR PROSTHETICS AND ORTHOTICS

INTERNATIONAL CENTRAL EUROPEAN ISPO CONFERENCE 2018

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WELCOME ADDRESS

It is a great pleasure to welcome you to the International Central European ISPO Conference taking place in Portorož, Slovenia, from 20 to 22 September 2018.

The International Central European ISPO Conference is an event which draws professionals engaged in prosthetics and orthotics as well as other different specialists in the field of rehabilitation medicine to share their experience and expertise in service delivery, research, education, and training.

The Congress Scientific Committee has chosen a great number of different topics, with the aim of looking at a broader perspective of the overall health of people with disabilities. We invite a number of world recognized experts to present the latest achievements and combine them with presentations of professionals working in the region and Europe. We hope to prepare a balanced and interesting programme for all.

We would like to thank all the sponsors and exhibitors who made this conference possible.

Warmly welcome,

Helena Burger

President of the Scientific Committee
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PLENARY SESSION I
INTRODUCTION: Understanding of Human Performance combined with advances in medical science has enabled creation of new pioneering equipment for physically disabled people. This is through discovery of the underlying science of the unmet need, and technology to meet an engineering challenge.

AIMS: The bridge between academic innovation and industry is demonstrated in providing novel solutions on few cases and through clinical application for many has enriched the role of multidisciplinary team of engineers, designers, therapists and support staff.

METHODS: With increased complexity due to availability of advanced technology, an optimum integrated model based on system thinking is emerging. The future medical innovation requires open partnership of Industry, Academia and Healthcare providers. The application of rehabilitation robotics and autonomous care systems will extend this collaboration to social services.

Gait analysis has helped in design and development of assistive technologies for mobility. The advance prosthesis and orthosis are enabling independence and social participation for lower limb amputees and real living for people with neuromuscular conditions has been the focus of our effort. The reward has been witnessing a renaissance in application of technology that has transform lives. Despite the challenging health conditions, the principle of “patient comes first” has enabled us to improve quality of life and independence for all, ranging from service men with complex injury, to vascular diabetic, trauma and complexity of aging population. Use of science and technology is linked directly to outcome benefit data related to quality of life which is back bone of the Health Economic solution for investment in long term health care. It is time to join all the dots.

RESULTS AND CONCLUSIONS: The smart prosthetics requires a different engineering focus, as the challenge in developing an intelligent integrated lower limb devices that mimics the functional characteristics of a human limb, requires application of biomimetic principle of lower limb joints and segments as well as their mimicking the effect of neuro muscular connectivity. The impact of integration on users’ control and reduced compensation, increase comfort at interface, and increase confidence in dealing with expanding activities of daily living. The potential for future development of smart supply chain of new technology to match with society’s views of physical disability and perceives users’ capability due to limb loss expectation is real possibility. This evolution of technology and expectation has the potential of imagining superior human performance. Balancing the users need, with user acceptability accounts for a holistic view of user experiences. Hence the look and feel of the device is as important as the functionality. The impacts on public perception of prosthetics also related to future funding allocation by the government, and payers who demand quantification of outcome.

The digital Industry 4.0 revolution and internet of limbs will ensure progress of rehabilitation to full restoration of function. This vision as set out by first application of engineering in medicine over 50 years ago, is now rapidly manifesting as affordable customised bespoke devices for all, with increased accessibility by all, to provide a benefit for all.
BACKGROUND AND OBJECTIVES: With rising levels of diabetic patients, smoking and lengthening of their life expectancy the number of patients who will experience diabetic complications will increase greatly in the following years. The consequences of diabetes can be seen on all levels of the arterial system and frequently these patients need an amputation of gangrenous foot digits or parts of the foot. In diabetes an occlusion of distal crural arteries is a common occurrence. Amputations in borderline ischemic tissue is very challenging and produces poor results. Angiosomal magistral revascularization is ideal to promote good healing. However, major amputation is a common end result of our efforts. In Slovenia the number of major amputations in 2014 was 326/per million. In selected patients it is possible to perform a Knee exarticulation as an alternative to non-healing below Knee amputation, to avoid above knee amputation and provide better rehabilitating potential.

RESULTS AND CONCLUSION: Due to patient bias, different treatments prior to major amputation surgery and different technical factors, no conclusions can be made. However, in selected patients with lower limb ischemia a Knee exarticulation can be a bailout procedure to prevent a non-healing below knee stump.
Focusing on the psychosocial aspects of limb loss and prosthesis use places an important emphasis on and brings to the fore the individual’s experience of limb loss and prosthesis use, the relevance of personally meaningful gains and outcome assessment, and the inclusion of these personal perspectives across all stages of care to optimise outcomes in a personally meaningful way. This presentation will discuss findings from a state-of-the-art research programme that applies psychological knowledge and theory to enable and support individuals with limb loss to achieve optimal physical, psychological and social functioning and outcomes. It will examine the personal impact of limb loss and prosthetic devices (e.g. emotional responses, quality of life, body image, identity, adjustment, rehabilitation engagement, participation in life activities); the conceptualisations of successful outcomes from the perspective of the person using or wanting to use a prosthesis; individual differences impacting on prosthesis use (e.g. cognition, pain, self-regulation and goals, coping); and psychometrically sound outcomes measurement. Being aware of these varied and complex needs and outcomes alongside the physical sequelae, knowing how to appropriately measure them, and identifying appropriate psychosocial interventions may enable the multidisciplinary team to contribute more holistically to the person living well with limb loss.
There is increasing interest in psychometrically-sound outcome measures able to accurately monitor the impact of therapeutic interventions, such as prosthetic trials, in people with amputation. Some recent reviews of the metric properties of the outcome instruments suitable for clinical use in prosthetic practice have been able to recommend very few specific tools (with good psychometric properties, and a limited number of items able to cover a wide range of subjects’ ability). Most of them have been created or validated through advanced psychometric techniques, such as Rasch analysis.

These tools can be organized by level of amputation – lower (LLA) vs. upper limb (ULA) - and by construct measured (here we will mainly discuss about mobility and function, quality of life, and patient satisfaction).

Among the LLA-specific functional instruments, the Prosthesis Evaluation Questionnaire–Mobility Scale in its revised version (PEQ-MS 12/5), the modified versions of the Locomotor Capabilities Index (LCI-5, LCI10-4) and the Prosthetic Limb Users Survey of Mobility (PLUS-M) represent interesting self-report measures. Regarding ULA-specific instruments, the Activities Measure for Upper Limb Amputees (AM-ULA: a clinician-rated assessment of multistep tasks) and the Assessment of Capacity for Myoelectric Control (ACMC version 2.0: an observational ratings of movements during a client-chosen activity) are promising performance-based tools. In addition, a reliable assessment of manual dexterity can be performed with the Box and Block Test and the modified Jebsen-Taylor Test of Hand Function.

Furthermore, two patient-reported measures - the Orthotics and Prosthetics Users’ Survey (OPUS) and the Prosthetic Mobility Questionnaire, both created through Rasch analysis - needs further psychometric validation.

For paediatric amputees, the University of New Brunswick Test of Prosthetic Function and the Prosthetic Upper Extremity Functional Index (PUFI) are probably the most studied measures.

Finally, in people with amputation the most analyzed tools for examining “Patient Satisfaction with prosthesis/orthosis” are: a) the OPUS – Client Satisfaction with Device and Services module, and b) the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0); and for studying “Quality of Life”: a) the Amputee Body Image Scale (ABIS) and b) the Trinity Amputation and Prosthesis Experience Scales (TAPES 2.0).
EVIDENCE BASED PROSTHETICS AND ORTHOTICS - NOT JUST OUTCOMES MEASURES

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INTRODUCTION: The goal of P&O care is to increase the function of the individual. For the lower extremity that means enhancing the way that the individual moves from one place to another; for the upper extremity that means enhancing the way the individual grasps an object and moves it from one place to another.

AIMS: P&O cannot use the same standard measurements to support the effectiveness of intervention. The individualization of P&O care requires that each devise be judged on its own. The uniqueness of each amputee or person with physical disability creates a subject base of one and therefore the “N” of the research subjects will always be low.

METHODS: A review of United States’ patents for braces and limbs prior to 1945 shows the lack of biomechanical or physiological basis for the designs. In 1945 the National Research Council was given the task of bringing the Academic, Military and Industrial worlds together to improve the outcome of what was to become “prosthetics” and “orthotics” as a science.

The original biomechanics studies at the University of California – Berkley are still the basis for our understanding of how we are able to walk. The principles developed then for prosthetics were relevant for orthotics. Newer analysis systems have not disproved the original concepts. Prostheses and orthoses that are designed to achieve those goals are more likely to improve the function of the individual and allow for safer walking on varied surfaces and topography.

Work by researchers in motion analysis has given us an understanding of the physiological basis of both normal and pathological gait. We now know how the limbs move, when the muscles are contracting, and what makes an effective and efficient way of walking, running, and grasping. Designers of prostheses and orthoses have more than just their gross observation of the body. They now know when controls are needed to limit unwanted motion, how to stabilize the body without restricting functions, and other adaptations that improve the abilities of the individual.

By combining the biomechanical and physiological basis for the advancement of prostheses and orthoses, the amputee or person with physical disabilities should be able to ambulate safely with a more efficient gait and minimal pain.

To verify that is the case both self-reporting measures and performance measures have been validated for their use in P&O. Self-reporting questionnaires are subjective, but give feedback to the clinician on how the patient feels about the care that they have received. Performance measures give the practitioner a validated “point in time” objective measure on how the patient is functioning with or without the prosthesis or orthosis.

RESULTS AND CONCLUSIONS: By using biomechanical and physiological basis for the design of prostheses and orthoses there will be evidence that P&O has come closer to the “normal” function we are trying to achieve. The self-reporting and performance measures only record how effective we have become. But a final, positive outcome will always be reached when individuals have an improvement in their function.
PSYCHOLOGICAL ISSUES AND PAIN AFTER AMPUTATION
RISK OF DEPRESSION FOLLOWING TRAUMATIC LIMB AMPUTATION—A GENERAL POPULATION-BASED COHORT STUDY

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INTRODUCTION: Traumatic limb amputation (TLA) is a sudden event that accompanies life changes in physical functioning, body image and challenges in daily lives. Amputees may experience significant levels of distress and be at risk of depression may be at risk of depression. However, evidence for depression risk after TLA has been limited because of the use of cross-sectional study design of a small or selected sample and the lack of a comparison with non-amputees. Confounding from pre-amputated occupational and individual characteristics was possible but no study has controlled for these.

AIMS: We aimed to examine whether amputation may be associated with an increased risk of depression required inpatient and outpatient hospital treatment.

METHODS: Our study population was drawn from a cohort of men (n=284,257) who underwent a compulsory conscription assessment for between 1969 and 1976. Complete data were available for 189,220 men. We followed these men from 1st January 1985, when these men were between age 29 and 34 years until the date of depression. We used the ICD codes in Swedish patient register to identify TLA (primary and secondary diagnosis) and depression after TLA (primary diagnosis). Cox regression was used to calculate hazard ratios and 95% confidence intervals [CI] for the association of amputation with depression. Age was used as the underlying time scale, and the diagnosis of amputation was included as a time-dependent exposure status, with the value zero before amputation and one after the date of amputation. Birth year, region, occupation, cognitive and physical function and stress resilience in adolescence were considered as potential confounding factors and adjusted for in the analysis.

RESULTS: In total 401 men experienced amputation between 1985 and 2009, with the mean age of amputation was age 42.5 years (SD 7.4). Those who experience amputation were more likely to have low stress resilience and cognitive function in adolescence and engaged in farming and manual work in 1985.

Cox regression produced unadjusted hazard ratio 2.61 (CI 1.62-4.21, p<0.001), i.e. 2.61 times risk of subsequent depression diagnosis for risk of subsequent depression compared with amputation-free individuals. Moderate and low cognitive function, physical fitness and stress resilience were associated with elevated risk of depression. Working for farms and manual work was also associated with higher depression risk. When the analysis was adjusted for these factors, the risk of depression after amputation changed little, 2.53 (CI 1.57-4.08, p <0.001) times risk of depression remained compared with amputation-free individuals.

CONCLUSIONS: As we hypothesized, TLA was associated with an increased risk of depression over more than two decades of follow-up of men from age 29 to 57 years. Higher levels of depressive symptoms were noted among working age amputees and our study group also comprised of working age amputees.

Future research may benefit from investigating potential influence of different amputation sites, degree, and prosthesis use involved in order to set intervention target.
RELATIONSHIP BETWEEN BRIEF COGNITIVE SCREENING AND FUNCTIONAL OUTCOMES AFTER LOWER EXTREMITY AMPUTATION

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INTRODUCTION: Cognitive impairment is negatively associated with mobility, prosthesis use, and maintenance of independence following amputation. Mini–Mental State Examination (MMSE) is often used as a screening measure but some studies suggest that MMSE underestimates cognitive impairment compared to Montreal Cognitive Assessment (MoCA) test that is also used as a cognitive screening tool.

AIMS: To evaluate how two brief cognitive screens, MoCA and MMSE, associate with functional outcomes at the end of rehabilitation after lower extremity amputation.

METHODS: The study included cohort of 167 patients that finished rehabilitation at URI Soča between September 2017 and February 2018. The complete data was collected from 125 patients. Until November 2017 patients were tested with MMSE (75 patients) and after November with MoCA (50 patients). The other measures included demographic/health information, prosthetic use, and Functional Independence Measure (FIM) scales Transfers - bed/chair/wheelchair, Dressing of upper body, Dressing of lower body. MMSE group of patients significantly (at α < ,05) differed from MoCA group on age (67,4 vs. 72,5 years) and FIM - Dressing - lower body (score of 5,42 vs. 5,06), results of other measures were similar. Because of non-normally distributed data Spearman’s coefficient was used for correlations between cognitive measures and rehabilitation outcomes. We also checked how different cut-offs of cognitive screening predict fitting with prosthesis.

RESULTS AND CONCLUSIONS: Better performance on MMSE was significantly (at α < ,05) associated with better outcomes of rehabilitation on FIM – Dressing of upper body (r = ,276), donning of prosthesis (r = ,353), stairs’ walking (r = ,403), and performance of 6-minute walk test (r = ,478). Other associations were small and non-significant: fitting with prosthesis (r = ,154), FIM - Dressing of lower body (r = 0,144) and Transfers (r = ,122) and also FIM altogether (r = ,188). Better performance on MoCA was significantly (at α < 0,05) associated with fitting with prosthesis (r = ,385), FIM - Transfers (r = ,365) and FIM altogether (r = ,306), whereas FIM - Dressing of upper body (r = ,212) and Dressing of lower body (r = 259) and donning of prosthesis (r = ,105), stairs’ walking (r = ,225), and performance of 6 minute walk test (r = ,276). We also looked if the cutoff scores of cognitive measures predict fitting with prosthesis. MMSE was significantly associated with prosthesis fitting at cutoff for mild cognitive impairment ($\chi^2 (1) = 5,63$, p=,018) and also at cutoff for moderate cognitive impairment ($\chi^2 (1) = 6,23$, p=,013). MoCA wasn’t significantly associated with prosthesis fitting at cutoff for mild cognitive impairment ($\chi^2 (1) = 2,88$, p=,090), but was significantly associated at cutoff for moderate cognitive impairment ($\chi^2 (1) = 6,03$, p=,014).

The associations of both cognitive screens with outcomes are small to moderate; MoCA was slightly better associated with main outcomes of rehabilitation (fitting with prosthesis and maintenance of independence) but MMSE was better in predicting prosthesis use. The possibility of using a cognitive screening for ascertaining appropriate goals is discussed.

INTRODUCTION: Cognitive impairment is negatively associated with mobility, prosthesis use, and maintenance of independence following amputation. Mini–Mental State Examination (MMSE) is often used as a screening measure but some studies suggest that MMSE underestimates cognitive impairment compared to Montreal Cognitive Assessment (MoCA) test that is also used as a cognitive screening tool.
ADAPTATION TO LOWER-LIMB AMPUTATION AND SATISFACTION WITH PROSTHESIS

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INTRODUCTION: People after lower limb amputation have impairments of body functions (stump and phantom limb pain, decreased muscle strength and range of movement), several activity and participation limitations, as well as several psychological problems, including problems with accepting new body image and decreased quality of life (QoL) (1). With interdisciplinary and multi-professional rehabilitation, we try to decrease impairments and limitations, and improve acceptance of body image and QoL.

AIMS: The aim of our study was to assess psychosocial adaptation, activity limitation, functional and aesthetic satisfaction with the prosthesis, the presence of phantom pain, stump pain, and other health conditions not associated with amputation, in people after lower-limb amputation.

METHODS: Twenty-three patients who were admitted to our Institute for primary inpatient rehabilitation and provision of first prosthesis between 2015 and 2017 were included in the study. There were 20 men and 3 women, aged 40-88 years (average 71 years). We computed six subscale scores as recommended by the TAPES-R guide (2). Overall satisfaction rating (on 0-10 scale) was also analysed. We used Spearman correlation (rho) and independent-samples t-test for testing the associations of prosthesis satisfaction with patient characteristics.

RESULTS AND CONCLUSIONS: Adjustment to Limitation score was positively associated with time since amputation (rho=0.51, p=0.013). There was no statistically significant difference in mean value on any subscale, or regarding overall satisfaction rating, between genders (p-values 0.347 to 0.880) or between amputation levels (below-knee vs. through-knee or above-knee; p-values 0.354 to 0.881). Overall satisfaction rating was higher on average for patients who had amputation because of PAD or DM as opposed to other causes (mean 7.2 vs. 5.2; p=0.041). The difference in mean Functional Satisfaction score was also close to statistical significance (mean 10.2 for amputation caused by PAD or DM vs. 8.0 for other causes; p=0.067); other differences in mean subscale scores with respect to cause of amputation were not statistically significant (p-values 0.290 to 0.950).

In the included people after lower-limb amputation, a major factor for adjustments to limitation was time since amputation, followed by cause of amputation.
ALTERATION OF PAIN IN LOWER LIMB AMPUTEES EFFECTED BY DIFFERENT ANAESTHESIC METHODS

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INTRODUCTION: The rehabilitation of lower limb amputees is highly affected by postoperative pain. Our objective was to compare effect of the spinal anaesthetic (S) and peripheral nerve blocking anaesthesia (P) in the presence and intensity of stump pain and phantom pain felt by dysvascular major lower limb amputees in the postoperative period. Elaborating on the extent of change in the pain felt in the first month.

RESEARCH METHOD: Three examinations on each of the 10 amputees was treated with spinal anaesthetic and the 10 was treated with peripheral nerve blocking anaesthesia was compared. (6 females, 14 males, median age 70,65 (53-80)) The extent and complexion of stump and phantom pain in the postoperative first day and in the second and fourth week using the Visual Analog Scale (VAS), the Present Pain Intensity (PPI) questionnaire, and the shortened McGill questionnaire methods was examined. The differences between the groups at the different time intervals was compared. The change in the level of pain felt between these intervals was also compared. The same physiotherapeutic method was performed by every patient and there was no extraordinary occasion during the research.

RESULTS: Results indicate that the stump pain felt by the patients treated with peripheral nerve blocking is significantly lower compared to the other group. VAS: S: 5,3±1,70 (average ± SD), P: 2,3±1, p= 0,0046., PPI: S: 2,40±0,97, P: 1,20±1,03. p=0,0438. McGill: S: 31,00±7,27, P:15,80±13,07 p=0,0168. This difference however does not exist anymore on the second and fourth week. In case of phantom pain, there is not much difference related to the 2 anaesthetic methods, but it clearly shows that this kind of sensation cannot fully form in the first few days after the operation. It usually peaks 1,5-2 weeks after the amputation. (VAS:3,15, PPI: 1,59, McGill: 21.) It can be concluded that the pain felt by the patient shows a tendency to significantly decrease in the first month of the postoperative period.

CONCLUSION: Both the characteristics and the extent of stump pain and phantom pain shows significant difference, so it would be important to separate them during anamnesis. Patients treated with peripheral nerve blocking anaesthesia do not feel pain in the first few days of the postoperative period, so it would be an appropriate time to start early rehabilitation. Hospitals and other rehabilitation institutions should focus on properly timed regular and thorough physiotherapy, since it may have a great effect on lowering the extent of pain felt by the patients.
NEUROREHABILITATION OF PAIN AND FUNCTIONAL RECOVERY VIA PROMOTION OF MOTOR EXECUTION

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INTRODUCTION: A successful rehabilitation is crucial to reintegrate patients into society after traumatic events leading to amputations or motor impairments. In addition to functional loss, these patients often develop chronic neuropathic pain that further hinders their family’s quality of life as well as their own. Similarly, children with congenital malformation face functional challenges to alleviate what otherwise are life-permanent handicaps.

AIMS: Volitional activation of the motor neural circuitry along with real-time sensory feedback can relieve chronic neuropathic pain caused by motor impairment, as well as increase neural drive for motor recovery. In order to achieve this, my group is taking advantage of the synergistic activation of proximal muscles to predict movement of more distal joints (missing or immobilized). Once motor intention has been decoded, it can be used to intuitively control virtual and prosthetic limbs, while providing appropriate visual feedback for an engaging therapy to relief pain or lead to functional recovery.

METHODS: We employ surface electromyography to feed machine learning algorithms to decode motor intention, commonly known as myoelectric pattern recognition (MPR). Environments on virtual and augmented reality (VR-AR) are used to exercise motor tasks following a serious gaming (SG) approach.

RESULTS AND CONCLUSIONS: My research laboratory has implemented MPR, VR/AR, and SG technology for the treatment of phantom limb pain, and neuropathic pain after motor impairment (spinal cord injury and stroke). This approach has shown successful results in patients with chronic intractable PLP and a double-blind, randomized controlled clinical trial is currently ongoing. Patients suffering from neuropathic pain after motor impairment (spinal cord injury and stroke) are currently treat and the preliminary results are promising. In this lecture, the latest results on the use of this technology will be presented.
INTRODUCTION: Phantom limb pain (PLP) is a chronic condition that greatly diminishes quality of life. Control over the phantom limb and exercise of such control have been hypothesized to play a role in the reduction of PLP. Preliminary investigations have shown that decoding motor volition using myoelectric pattern recognition, while providing real-time feedback via virtual and augmented reality (VR-AR), facilitates phantom motor execution (PME).

AIMS: Here we present the study protocol for an international (seven countries), multicentre (nine clinics), double-blind, randomized, controlled clinical trial to assess the effectiveness of PME in alleviating PLP.

METHODS: Sixty-seven subjects suffering from PLP in upper or lower limbs are randomly assigned to PME or Phantom Motor Imagery (PMI) interventions. Subjects allocated to either treatment receive 15 interventions and are exposed to the same VR-AR environments using the same device. The only difference between interventions is whether phantom movements are actually performed (PME) or just imagined (PMI). Complete evaluations are conducted at baseline and at intervention completion, as well as 1, 3 and 6 months later using an intention to treat approach. Changes in PLP measured using the Pain Rating Index between the first and last session are the primary measure of efficacy. Secondary outcomes include: frequency, duration, quality of pain, intrusion of pain in activities of daily living and sleep, disability associated to pain, pain self-efficacy, frequency of depressed mood, presence of catastrophizing thinking, health-related quality of life and clinically significant change as patient’s own impression.

RESULTS AND CONCLUSIONS: At the time of writing (March 2018) 32 patients have been enrolled of which three have completed the treatment and follow up assessments 12 have undergone 15 treatment sessions and are currently being followed up and three have dropped out. The study involves a large number of participants with upper and lower limb amputations and thus can provide sufficient power to draw clinically meaningful conclusions. The design (double-blinded, randomized, and conducted in geographically different locations) enhances generalizability. Finally, the choice of the comparator allows controlling in a stringent manner for the effect of the key factor hypothesized as the cause of pain reduction, namely, the execution of phantom limb movements. On the other hand, the treatment is limited to 15 sessions, which might not be enough to alleviate pain in all participants. Also, the nature of the experimental treatment (PME) does not allow inclusion of individuals from which myoelectric signals cannot be recorded from the muscles in their residual limbs.

Registration: NCT03112928 ClinicalTrials.gov.
MECHANICAL TESTING OF DIFFERENT LAMINATED COMPOSITE MATERIALS FOR PROSTHETIC SOCKETS

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INTRODUCTION: In orthotics and prosthetics, composites are known as fibre-reinforced plastic. Differences between them depend on the applied material and the lamination technology. Achieving top quality of lamination process requires a wide knowledge of composite technology and the ability to predict the main forces that appear during the usage of the product. The goal is to devise a technology that is easy to apply, cost effective and standardised. Unfortunately, there is very little published literature about this topic.

AIMS: We compared our existing laminated composite technology for prosthetic sockets (A) with three potential new technologies, whereby higher sub-pressure and degassing of lamination resin was added as the first alternative (B1), higher sub-pressure, degassing of lamination resin and use of spiral tube for disposing the flow of the resin (B2) as the second alternative, and higher sub-pressure, degassing of lamination resin, mesh layer and peel ply were used as the third alternative (B3).

METHODS: An industrial experiment was performed. Samples of equal length and width were from each material produced and submitted to standard laboratory strength testing (bending, tensile and compressive strength). We analysed the data using one-way analysis of covariance (ANCOVA, adjusting for thickness when comparing strength, because sample thickness is strongly negatively correlated with all three types of strength) with post-hoc comparisons.

RESULTS AND CONCLUSIONS: Material A had the highest bending strength on average, but there were no statistically significant differences in bending strength between the materials when adjusted for sample thickness (p=0.941). Materials B1 and B2 had statistically significantly lower average tensile strength than material A (p<0.001); B3 had the lowest average tensile strength, but it could not be statistically distinguished from the others because of significantly larger average thickness. Compressive strength was only tested for materials B1, B2 and B3; their averages did not differ statistically significantly (p=0.291).

Laboratory stress testing provided important insight into the differences between different laminate technologies of prosthetic sockets. Our initial attempt to produce a better material was not successful, but we will continue research and development in this field.
INTRODUCTION: The global goal of the CYBERLEGs Plus Plus project is to validate the technical and economic viability of the powered robotic ortho-prosthesis developed within the framework of the FP7-ICT-CYBERLEGs project as a means to enhance/restore the mobility of transfemoral amputees and to enable them to perform locomotion tasks such as ground-level walking, walking up and down slopes, climbing/descending stairs, standing up, sitting down and turning in scenarios of real life. Restored mobility will allow amputees to perform physical activity thus counteracting physical decline and improving the overall health status and quality of life.

AIMS: The objectives of CYBERLEGs Plus Plus Wearable Sensors Apparatus (WSA) are (i) to further develop the WSA hardware (HW), WSA firmware (FW), and the algorithms to identify his/her intended movement, with the objective of enhancing their reliable use in a real-life scenario, (ii) to review 1st-generation of the HW/FW design of Inertial measuring units (IMU) and shoes instrumented with pressure-sensitive insoles, (iii) to develop an algorithm (SW) to use the orthotic modules, and other locomotion-related tasks i.e., stairs ascending/descending).

METHODS: The set of IMUs implements a new 9-DOF single chip device (3D accelerometer, 3D gyroscope, 3D magnetometer) and fast 32-bit Microprocessor Cortex-M4F (with floating point unit for on board calculation). The Insole Control Units and IMUs are also equipped with new RF module based on MAC layer of IEEE 802.15.4-2011 (Ultra-wide Band) standard interface for offering more robust real-time transfer of sensors data. With the objective of satisfying the technical and functional requirements set for the CLs++ intention detection algorithm, we investigated suitable strategies to reduce the number of IMUs and to achieve continuous transitions between different locomotion modes.

RESULTS: Moreover, as a main innovative step with respect to the CLs background, the proposed algorithm does not rely on full lower-limb kinematics, therefore simple sensory fusion processing is needed to perform intended movement recognition. In the developed solution, the number of sensors was reduced from 7 to 4.

CONCLUSION: This project focuses on the demonstration in an operational environment from both the technical and economic viability viewpoint of a modular robotics technology for healthcare, with the ultimate goal of fostering its market exploitation. The project involves players from academia, end users, as well as robotics and healthcare industry. Therefore, CYBERLEGs Plus Plus fits the specific challenge of the scope c (namely Technology Transfer – Robotics use cases) of the call H2020-ICT-24-2015.
THE EFFICACY OF THE ANKLE MIMICKING PROSTHETIC FOOT PROTOTYPE 4.0 DURING WALKING: PHYSIOLOGICAL DETERMINANTS

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INTRODUCTION: Lower-limb amputees depend on assistive devices to cope with daily activities. Recently, a novel quasi-passive lower-limb prosthesis, named Ankle Mimicking Prosthetic foot or AMPfoot 4.0 was developed by robotic engineers from VUB. The prosthesis contains an actuator, which is responsible for the coupling-decoupling mechanism in which a spring set stores and releases energy at the correct moment during walking. The resultant lift of the prosthetic forefoot should simulate walking of able-bodied individuals. Evaluating the effectiveness of a novel prosthetic device during walking is an important step in product development.

AIMS: The goal of the current experiment is to evaluate AMPfoot 4.0 during walking at different speeds. Comparisons were made with the current prosthesis in transtibial (TTA) and transfemoral amputees (TFA) using physiological measures. Able-bodied individuals were included to investigate walking performance differences between amputees and able-bodied individuals.

METHODS: 6 able-bodied subjects, 6 unilateral TTA and 6 unilateral TFA conducted a 6 min walk test at normal speed, followed by series of 2 min walking at slow, normal and fast speed. The intensity of effort was determined using heart rate (HR), Rating of Perceived Exertion (RPE) and the respiratory quotient (RQ). Furthermore, subjective measures were gathered using the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). An additional question was asked from the prospect of marketing the novel device: ‘Would you like to have the AMPfoot if the product is available on the market?’ Amputees performed all walking tests on a treadmill with current and novel prostheses. Shapiro-Wilk normality tests, parametric and non-parametric tests were conducted (p<0.05).

RESULTS AND CONCLUSIONS: Ten (out of 12) participants responded positive regarding buying the device if it is available on the market. Only in the TFA group significant lower values for the questions 1 and 2 (of the QUEST questionnaire) related to the satisfaction of the dimensions and the weight of AMPfoot compared to the current prosthetic device were observed (p=0.038 and p=0.042, respectively). Compared to able-bodied individuals RPE levels were significantly elevated in TTA and TFA for both prostheses (p≤0.016). Compared to able-bodied individuals TFA also showed significantly elevated HR for both prostheses at normal speed (p≤0.043). Within-group comparisons demonstrated that walking with AMPfoot significantly increased HR in TFA and TTA compared to the current prosthesis (p=0.002). Furthermore, TFA reached significantly higher RPE levels. At normal speed, in TTA significant higher RQ values were found with AMPfoot compared to the current prosthesis (p=0.017).

To conclude, walking with AMPfoot increases the intensity of effort compared to current existing passive prostheses. Especially for TFA a redesign of AMPfoot is required. All TTA and TFA encourage to further explore the prosthetic technology used in AMPfoot.
INTRODUCTION: A new perspective sheds new light to fully understand the advantages new technologies can have on the field of orthotics.

A Slovenian based company invented and patented a new approach to design and manufacture orthotics. Evolving from parent’s desire to help their son diagnosed with cerebral palsy mixed version and developmental delay, with walking. Individually designed orthoses with this new approach improved his stability, medial arch position, bowed Achilles tendon, weight distribution on the feet and gate while having a perfect first fit and no skin irritation. The approach invented helped not only their son, but was successfully tested with other symptoms and diagnoses.

CASE: The patient described in this case is an 11 years old girl who had been diagnosed with Charcot-Marie-Tooth disease.

An individual approach to the patient starts with an assessment of the symptoms and conditions while walking barefoot. Engineer of orthotics and prosthetics, physiotherapist and a 3D designer of orthoses is present at the appointment. High medial arch bowed Achilles tendon, insecure walking and a general lack of muscle tone in the whole skeleton were observed. While standing, a physiotherapist approach found the weak spots that had to be supported for correct posture of the feet and the body. One of the innovative parts of the process involves setting the feet in the corrected position in a medium that allow shaping the support areas and positioning the feet at full weight bearing or half weight bearing. Her feet were 3D scanned in this corrected position and the gathered data was imported into 3D modelling software. The approach uses the benefits of pre-set feet and during the process of designing the orthoses does not change the patient’s feet in any way but instead only designs an orthoses around the feet. Taking into the account the minimalistic approach and advantages of additive manufacturing (3D printing) the orthoses is designed to cover only symptom affected parts of the feet. The possibility to use free form design and ability to print a single piece of orthoses with different thickness gave the patient and opportunity for a minimalized solution of AFO.

The design focused on correcting the bowed Achilles tendon, the position of navicular bone, the whole ankle area was supported as high as the midfoot thus improving the overall position of the body and minimized the load on the bones.

Utilizing the new technology of 3D printing and the materials available the designed orthoses were printed at 100µm layer height forming a smooth surface that does not need any post processing. A smart design enables a waist free production.

CONCLUSION: The patient had a successful first fit and immediate changes were observed during first 4 weeks. Walking was overall improved as stability and balance were improved. She uses much less energy when walking. The approach also allowed her to use regular shoes.

With limitless design possibilities and affordable 3D work space this approach offers new individualized solutions that were simply not available with the use of current solutions.
INTRODUCTION: Pre-fabricated composite Ankle-Foot Orthoses (AFOs) have been used for many years to help treat end-users with a primary presentation loosely referred to as "Drop-Foot". These orthoses often ignore any primary biomechanical requirements and instead focus on the application of secondary force couples to provide correction. This approach often fails to fully address the advantages and disadvantages of the base composite construction materials and, hence, the potential functional benefits these can offer the end-user and their wide-ranging activities of daily living.

A limitation in macro-geometric optimisation leads to designs which attain their function through compromised methods of manipulating swing-phase and stance phase kinetic chains, which can unnecessarily block segmental motion and reduce access to the potential benefits of neuroplastic habilitation.

This approach may also lead to accelerated wear rates or structural failure. Consensus also intimates that many of these people arrive with much more complex presentations than isolated “Drop-Foot”.

CASE: Two end-users referred as suffering from “Drop-Foot” were clinically assessed, treated and tested at a university facility in the UK. Both had a history of failed treatment with Pre-Fabricated and Bespoke orthoses and it was quickly ascertained that both presented with much more complex clinical pictures. However, a risk assessment suggested that it was safe, in a controlled environment, to test and treat these individuals in two ways:
1. To satisfy the referral requirements; Drop-Foot.
2. To address the functional requirements seen during a full assessment; Complex multi-planar insufficiencies.

Datasets were recorded pre and post-treatment as a clinical validation tool for both end-users and treatment goals.

Each was treated with a Pre-Fabricated AFO with helical spring unit and trimmable footplate to satisfy condition 1.

Each was then treated with a bespoke AFO with helical spring strut and multiplanar control elements to satisfy those requirements seen in condition 2.

We will also present a dataset that adheres closely to an isolated “Drop-Foot”.

During this talk reference will be made to optimised designs and the compromises often required due to patient wishes and co-morbidity.

CONCLUSION: Pre-Fabricated AFOs are an incredibly useful tool that enable prompt and cost/clinically effective treatment of “Drop-Foot” and other, non-isolated, lower limb pathologies or symptoms. But it is imperative that a suitably in-depth assessment is completed and documented. Orthosis design should satisfy the primary biomechanical presentation by utilising the elegant application of geometric shaping, macro-geometry and design to ensure that optimised functional and neurological benefit is realised by the end-user during their daily living.
VISUAL FLOW WITH AN IMMERSIVE VIRTUAL REALITY SYSTEM REDUCES GAIT VARIABILITY IN STEADY WALKING: A SELF-PACED TREADMILL STUDY

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Visual flow is crucial for human locomotion control, while the effects of visual flow on gait stability remain an important open question. Previous studies have investigated this question by using a computer-simulated virtual reality (VR) system to manipulate visual flow in a fixed-speed treadmill (TM) environment. However, they showed that the presence of VR increased walking speed variability and step width variability, suggesting that adding VR in a fixed-speed TM environment induced lower gait stability. Recently, feedback-controlled treadmills that allow the subjects to adjust the belt speed in real-time, so called self-paced (SP) walking with an immersive VR environment, have been developed. This environment gives subjects more natural and efficient visual cues, which are perceptually consistent with self-controlled gait speed. However, it remains unclear whether adding VR to SP TM walking affects the kinematic changes, especially gait stability. The purpose of the present study was to investigate the effects of visual flow with an immersive VR system on the gait-related kinematic variabilities during steady SP TM walking. A total of 23 participants were asked to walk over 90 s in an SP TM environment with and without a VR system in a randomized order. Gait stability was evaluated in each VR condition after SP TM walking reached steady state. Gait stability was measured by calculating mean values and coefficients of variation (CVs) of gait-related kinematic parameters (gait speed, step length, step width, and displacements of the center of pressure (COP)) in both the anterior-posterior (AP) and medial-lateral (ML) directions. It was found that the presence of VR did not affect the values of these gait-related kinematic parameters. Instead, the CVs of gait speed, step length, and AP COP displacements were significantly decreased in steady SP walking plus visual flow with a VR environment. Moreover, the CVs of these kinematic parameters (i.e. gait speed, step length, and AP COP displacements) were significantly correlated with each other. These results suggest that visual flow with an immersive VR system may contribute to increasing gait stability in SP TM walking.
A NEW METHOD FOR DETERMINING THE LEG LENGTH DISCREPANCY

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INTRODUCTION: Determining the length of the lower extremities is an important part of orthosis practice. Although there are a number of methods existing, no one yields enough reliable results. A special problem lies in the fact that the common discrepancy measurement methods do not consider the load distribution, which should be expected to be symmetric. In patients with Leg Length Discrepancy (LLD) the center of mass (CoM) always deviates from the expected position. Impossibility to determine CoM position prevents the implementation of appropriate measures to compensate difference in height. For this purpose, a special device is developed to precisely determine this parameter.

AIMS: LLD is an condition that involves a difference in length between the lower extremities. Patients with LLD have a displaced centre of mass, which causes pain and inefficient and energy-consuming gait. The accuracy and reliability of LLD estimation is essential for determining the required treatment of compensating for LLD. The existing methods of LLD estimation, are not reliable. Furthermore, they may subject patients to radiation and do not account for the displacement of CoM of the human body. For these reasons, we developed a digital system that would precisely measure and determine the difference in the length of the lower extremities.

METHODS: The system for compensating for LLD based on the estimation of CoM of the human body has been developed. This system consists of two 3-RPS (Revolute-Prismatic-Spherical) parallel manipulators with moving force plates. A patient with LLD stands on the left and right force plate. Sensors measure the center of pressure (CoP) of the foot and the total force that the foot exerts on the force plate. The patient’s shorter leg creates a greater load for the force plate. LLD compensation is performed by increasing the height of the force plate below the shorter leg by means of a manipulator. The height of the force plate is increased up to the moment when the measured forces of the left and right force plate become equal. The difference in height of the force plates represent the amount of LLD and may be used for producing the insole or sole lift for compensating for LLD.

RESULTS: Experimental measurements show that the manipulator can be used to move the CoM to a position indicating that the human body is in balance.

CONCLUSION: A prototype of the system for compensating for LLD was made. It includes two 3-RPS parallel manipulators with a moving force plate. Experimental results indicate that LLD may be compensated by balancing the human body, which sets CoM in the correct position. Future work on the system for compensating for LLD will include automated human body balancing using a visual feedback.
INTRODUCTION: The World Health Organization has published Standards for Prosthetics and Orthotics in 2017. This publication brings promise, by ensuring that everyone in need, everywhere, has access to prostheses and orthoses: that no one is left behind.

AIMS: The standards aim to:
- Support countries in implementing objective two of the WHO Global disability action plan 2014–2021, to strengthen and extend rehabilitation, habilitation, assistive products, support services and community-based rehabilitation.
- Support stakeholders in their work to achieve the eight recommended areas of rehabilitation in health systems and the subsequent Rehabilitation 2030: Call for action for coordinated, concerted global action towards strengthening rehabilitation in health systems.
- Contribute to the goal of WHO’s GATE initiative, which is to improve access to high-quality, affordable assistive products globally.
- Contribute to realizing universal health coverage to ensure that all people can use the promotive, preventive, curative, rehabilitative, assistive and palliative health services they need, which are of sufficient quality to be effective, and also ensuring that use of these services does not impose financial hardship on the user.
- Support countries in implementing the CRPD, in particular Article 20 (Personal mobility), which includes facilitating access to high-quality mobility aids, devices and assistive technologies, and Article 26 (Habilitation and rehabilitation).

METHODS: In consultation with the WHO regional offices, three groups were formed to prepare the standards: the WHO Steering Group, the Standards Development Group and the External Review Group. Two systematic reviews of the literature were commissioned to answer the PICO questions and retrieve evidence from the databases of medical, health and policy-related publications. The objective of the first was to find information on the effectiveness and cost-effectiveness of prosthetics and orthotics services, and the second was to find which skills are required to deliver and manage high-quality services (standards and models. Representatives of the review teams joined a consensus meeting of the Standards Development Group where they presented their findings. The meeting determined the scope of the standards and set directions for the development of the document. Furthermore, WHO commissioned two authors to write the document in close consultation with representatives of the WHO Steering Group.

RESULTS AND CONCLUSIONS: 60 standards in four areas were developed and described in a two part publication; a standards document and an implementation manual. Both parts cover four areas of the health system:
- policy (governance, financing and information);
- products (prostheses and orthoses);
- personnel (workforce); and
- provision of services.

Implementation of these standards will support Member States in fulfilling their obligations under the Convention on the Rights of Persons with Disabilities and in meeting the Sustainable Development Goals. With these standards, any government can develop national policies, plans and programmes for prosthetics and orthotics services of the highest standard.

References

MOVAID - INTEGRATION OF ORTHOPAEDIC PRODUCT AND SERVICE PROVISION

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INTRODUCTION: Orthotics service provision faces challenges due to demographic changes, rising costs of social services/health care provision and lack of qualified personnel. #ISPOWER advocates empowerment and social inclusion of people with impaired mobility through improved access to P&O and AHT care, however there are many obstacles to overcome to improve access to P&O care. The Horizon 2020 research project MovAiD investigates how technology and additive manufacturing can address some of these.

AIMS: MovAiD aims to develop technologies for manufacturing passive and highly-personalized wearable equipment (Movement Assistive Devices) to assist disabled children, the elderly and workers in their everyday lives.

METHODS:
The MovAiD framework consists of the following elements:
• Automated design tools allowing creation of personalised devices (compliance to body contour and kineto-dynamic parts)
• Integration platform managing the full data flow from body scan to delivery of the device
• Embedded sensors assisting with assessment and monitoring of the device
• Investigation and development of additive materials for personalised devices
• Additive manufacturing on local and central level to support device fabrication
• Intelligent supply chain management from device ordering to service support

RESULTS AND CONCLUSIONS: A progress update of the technology elements will be provided with the clear vision to facilitate an exemplary future orthotic service provision flow.
INTRODUCTION: Research on the use of Computer Aided Design, 3D printing and tele-rehabilitation technologies are carried out in various African and Middle Eastern settings, in order to improve interventions efficiency and deliver prostheses and orthoses in areas with difficult access.

AIMS: In the face of major issues in terms of availability, regarding skilled human resources and well-equipped facilities in the majority of countries where Humanity & Inclusion Programs intervene, it is proposed to delocalize the expertise and means of production, in order to answer to the needs for orthopedic devices.

METHODS: Following a pilot project conducted in 2016, which used digital technologies (CAD, Information and Communication Technologies, 3D printing) to supply of transtibial prostheses in Togo, Madagascar and Syria, Humanity & Inclusion (HI) has developed various subsequent projects aimed at pursuing the research on a larger amount of people and proposing to diversify the range of orthopedic devices being offered. Through scientific studies and evidence-based results, the new projects intend to demonstrate that the use of innovative solutions allows for better access to services, while meeting quality requirements. Thus, clinical and technological trials on orthopaedic devices provision are conducted in various settings, via some partnerships with universities and private companies specializing in new technologies:

- In West Africa (Togo, Mali, Niger) a university research plans to compare the effects of conventional orthotic equipment, against a 3D orthosis printed for 100 devices.
- In Syria, the equipment of 50 people in wait of a transtibial prosthesis is currently being remotely performed by intermediate level rehabilitation professionals and specialists, via digital technologies and 3D printing.
- In Madagascar, technological research about prosthetics components seeks to provide 3D printed tibial prostheses at much lower costs than those proposed during the 2016 pilot project.

RESULTS AND CONCLUSIONS: The projects are still in progress so far. As such, reliable data will be available by the middle of this year.

The expected outcomes are:

- Efficiency in costs, and in implementation processes
- Conformity with orthopaedic standards and efficient tele-rehabilitation systems
- Adaptability to different settings
- Appropriateness by local practitioners and users

As an essential part of the universal access to care, technology research in the fields of medical equipment, assistive technology and connected health is promoted by WHO for an expansion in low-income countries.

The various projects above offer a unique opportunity to develop these innovative technologies on the African continent, and to serve countries in conflict such as Syria.

The stakes are tremendous and can only be achieved through operational research projects involving complementary structures of the humanitarian, academic and industrial sectors.

The complementary nature of the projects will provide comprehensive and coherent responses for the benefits of the populations; who currently do not have access to rehabilitation services. The publication of research and test results will be used on a larger scale, by all stakeholders interested in improving practices and developing appropriate solutions, made accessible to all.
Although the first prosthetic artefacts survived from the Egyptian era and the first a specialized book on the subject was written in the 16th century, memories of the history of Hungarian prosthetics are available from the middle of the 19th century. The purpose of our presentation is to give an overview about this story through the relics, to the present.

The first written artefact is an illustrated prize list by Peter Fisher and Co. imperial and royal court suppliers. The book contains then it’s modern type drawings, the names of the materials used, drawings about accurate measurement methods and information on how to practice the prosthetic gait. Gyula Dollinger orthopaedic physician (1849-1937) had a pioneer role in the artificial limb manufacturing organization in Hungary. In 1915, he has established with the full powers the Prosthetic Factory of the Hungarian Royal Disability Affairs Office, where were fitted soldiers amputated in the First World War. He organized courses and published scientific articles on the details of prosthesis production and the elements of rehabilitation.

The main purpose of rehabilitation was to restore the working ability of amputated soldiers. During the war, several major cities such as Pozsony (Bratislava), Arad (Oradea), Kolozsvár (Cluj Napoca), Sátoraljaújhely and Kassa (Kosice) organized similar production. During the First World War, until 1917, 19000 prostheses were made in the Industrial School’s workshops. The most of disabled soldiers were provided with prosthesis and if needed, they also received special prosthesis for work. The gait training was conducted by gym teachers. The orthopaedic technician training started in 1920. A collection of prostheses from this time is available at the Semmelweis Medical History Museum in Budapest. The “Factory” had been known as the “Gyógyászati Segédeszközök Gyára” until 1993 and was the centre of production. After the change of regime, private companies have appeared, and the state-owned production was partially then completely privatized.

Nowadays, the artificial limb production is made by Hungarian and foreign-owned private enterprises and it can be said that the modern prosthetic fitting and rehabilitation facilities are present in Hungary. Technical and healthcare professionals are collaborating in developer research. The training of professionals involved in the production is at a mid-level, the development professionals are at BSC and MSC level. Our goal is to adapt the education system to ISPO training standards.
INTRODUCTION: State-of-the-art technologies empower people with motor disabilities to carry out activities of daily living, thus enabling a better quality of life. Personal mobility is crucial for the well-being of individuals with motor impairments and wheelchairs allow practical and efficient mobility.

AIMS: Powered wheelchairs enable efficient mobility also for severely disabled persons. A prototype of a hybrid robotic wheelchair that allows the user to traverse obstacles, such as stairs and ramps commonly found in urban and rural environments, by utilizing both wheeled and tracked propulsion, was developed and validated.

METHODS: The wheelchair prototype incorporates a four-wheel-drive system designed for comfort and enhanced maneuverability in indoor and outdoor spaces. Each wheel is individually actuated and steered. In addition to wheels, rubber tracks are mounted below the wheelchair to assist in overcoming of steep obstacles. The inclination of the user’s chair can be actively controlled to keep the user leveled at all times. The wheelchair is controlled through a joystick and a touch screen display. Other interfaces can be easily connected to the device. The wheelchair ergonomic characteristics and user interfaces were validated in a case study with paraplegic persons. The overall performance of the system was compared to other similar devices during the Cybathlon competition (Zurich, Switzerland).

RESULTS AND CONCLUSIONS: The wheelchair met the competition requirements, such as safety regulations, maximum mass, and dimension limitations. The paraplegic person controlling the wheelchair was able to overcome all competition obstacles consisting of the most common barriers found in everyday lives: driving with thighs under a table, a slalom course, driving up and down a ramp with the door opening and closing, driving over rough terrain, driving over a tilted path, and up-down traversing stairs. The wheelchair and the driver won a bronze medal.

The ergonomic design was validated in relation to the chair and user interface. The comfort of the chair was measured with a pressure mat. The results of the measurements indicate that the increase of the seat inclination significantly reduced the pressure on the body. Without the cushion and with inclination above 30° average pressure decreased below 60 mmHg, which is considered safe. When using additional inflatable cushion, the average pressure was below 40 mmHg for all chair inclinations.

The ergonomics and size of the user interface were found appropriate. At low speeds the responsiveness and mobility of the wheelchair was satisfactory, while at higher speeds user’s adaptation was required. Sitting in and out of the wheelchair was found challenging and several recommendations were provided in this regard.

The wheelchair enables efficient mobility and maneuverability using large-diameter wheels with independent steering. Tracks enable climbing of an arbitrary number of steps. The ergonomic characteristics of the chair and the user interface were found adequate. Improvements are required for easier sitting in and out of the wheelchair. This will be considered in the new wheelchair prototype.
FUNCTIONAL ABILITY OF PATIENTS AFTER STROKE AND PRESCRIPTION OF WHEELCHAIRS

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INTRODUCTION: Stroke is a worldwide problem and is a leading cause of adult disability. Consequences are limited functional abilities, namely 25-74 % of them need partial or total support in daily living activities and mobility. Many patients after stroke need to be equipped with adequate wheelchairs.

AIMS: The aim of this study was to collect and analyze data of functional ability of patients after stroke and investigate association with prescribed wheelchairs. The results will be used to improve planning and treatments of patients after stroke at University Rehabilitation Institute, Republic of Slovenia (URI-Soca).

METHODS: A retrospective analysis was used on the data from the URI-Soca medical documentation regarding the prescriptions of medical devices (wheelchair categories), that were performed in 2017 for patients after stroke in correlation with the FIM value. Out of 1341 patients included in the analysis, 294 inpatients and 1047 outpatients, wheelchairs were prescribed to 231 patients. There are nine categories of wheelchairs: manual standard wheelchair, electric scooter, manual active wheelchair, manual wheelchair for moderate motor impairment, manual wheelchair for severe motor impairment, powered wheelchair, powered wheelchair for severe motor impairment, powered wheelchair for very severe motor impairment and resting wheelchair. Functional Independence Measure (FIM) was performed when the wheelchair was prescribed. Classification by Garraway in 1981 was used to determinate levels of disability after stroke into Mild (FIM > 80), Moderate (FIM 40-80) and Severe (FIM < 40). Somers’ D was used to calculate association between FIM score level and wheelchair category.

RESULTS: Out of 231 patients after stroke to whom the wheelchairs were prescribed, 127 were male and 104 female with average age 68.0 years. Main conditions were (coded by The International Statistical Classification of Diseases and Related Health Problems): 56.28% I63 – cerebral infarction; 21.65% I61 – cerebral hemorrhage; 4.33% I60 – nontraumatic subarachnoid hemorrhage; 17.75% – stroke, not specified. Regarding FIM, there were 89 patients in the Severe level, 108 in the Moderate level and 34 in the Mild level. The most patients were prescribed a manual active wheelchair (41%), followed by resting wheelchair (25%), manual standard wheelchair (21%), manual wheelchair for moderate motor impairment (8%) and others. There was strong and highly statistically significant association between FIM category and wheelchair category (symmetric association: Somers’ D=0.57, p<0.001; wheelchair category predicted from FIM category: Somers’ D=0.61, p<0.001). However, the association was far from perfect; there was very little difference in the categories of wheelchairs between moderate and mild FIM category.

CONCLUSIONS: We observed possible association of wheelchair selection and Functional Independence Measure (FIM) level and realized that the score of FIM is only one of the factors that influence selection and prescription of a wheelchair. We obviously consider other factors as well, such as age, family status, comorbidity, environmental requirements, motivation and others when prescribing an adequate wheelchair. Further research is needed to clarify the influence of contextual factors.
INTRODUCTION: Amyotrophic lateral sclerosis (ALS) also known as motor neuron disease (MND) is a rapidly progressive neuromuscular disorder, which leads to death. The degeneration of the motor neurons causes a variety of symptoms including atrophy, spasticity, dysarthria, dysphagia, progressive muscular weakness and respiratory compromise. The rapid progression of symptoms in the extremities creates a need for almost all patients to use wheelchair. In earlier phases it is possible to use power wheelchair (PWC). Mobility is essential aspect of health status, quality of life, activity and participation and wheelchair selection, ordering and updating becomes extremely important process.

AIMS: New technology has increased wheelchair and wheelchair seating options, but this made the selection process more difficult for the prescribers and their clients and more expensive for funding agencies. So we evaluated how many and which wheelchairs are prescribed to ALS patients in Slovenia.

METHODS: In retrospective study were included all patients with ALS which were treated in infirmary for technical aids in University Rehabilitation Institute Soča (URI-Soča) in years 2015, 2016 and 2017. The available documentation on wheelchair prescription and their upgrade was scoped.

RESULTS AND CONCLUSIONS: In year 2015 32 patients were managed (22 male), in 2016 30 patients (21 male), in 2017 19 patients (12 male). In year 2015 three standard manual wheelchairs (MWC) were prescribed, 5 PWC for heavy mobility handicap, two PWC for very heavy mobility handicap, one manual wheelchair for very heavy mobility handicap and one electrical scooter. In 2016 2 standard MWC, 8 MWC for very heavy mobility handicap, 6 PWC for heavy mobility handicap and 5 PWC for very heavy mobility handicap. In 2017 9 MWC for very heavy mobility handicap, one MWC for heavy mobility handicap, 2 PWC for heavy mobility handicap and 2 PWC for very heavy mobility handicap. In five cases MWC were prescribed because of environmental barriers or patient declined PWC. Two patients after a year wanted a special device for PWC control, which needed substantial payment and was declined by insurance company.

In almost half of patients PWCs are prescribed in a phase of disease, when controlling of PWC is still possible. Since patients are familiar with wheelchair providing service many times do not seek for upgrades of PWC. Many times MWCs are prescribed because of environmental barriers. The system of wheelchair prescription for ALS patients needs to be flexible and organized in a way, that updates and changes throughout the course of the disease are possible.
HOW ARE PARENTS OF CHRONICALLY ILL CHILDREN SATISFIED WITH THE USE OF WHEELCHAIRS, PROCESSES OF DELIVERY AND MAINTENANCE OF WHEELCHAIRS

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INTRODUCTION: All children with severe mobility dysfunction need appropriate sitting positioning and transport on wheelchairs. In Slovenia, those children are referred to University Rehabilitation Institute (URI-Soča), and assessed by physical and rehabilitation medicine specialist, occupational therapist and technician with appropriate knowledge on wheelchairs and supporting technology. This team of professionals suggest appropriate models of wheelchairs, while the final selection and decision is done in cooperation with parents and child (in case the child is able to cooperate). The national Slovene insurance company is covering the costs up to a certain limit, which means, that most of children get the appropriate model of wheelchair free of charge. Preschool children are fitted with wheelchairs that should fit for five years. When they enter the school program, they are allowed to get a new wheelchair after three years. In case of deterioration of functional abilities of when the outgrow the wheelchair, the team of URI-Soča is able to send a prescription with the request for a new wheelchair or the request for the adaptation of the existing one to the national insurance company before the period of three or five years. The wheelchair suppliers are available for children and parents to do all repairs and adaptations of their wheelchairs.

AIMS: We wanted to find out, how parents are satisfied with prescribed wheelchairs and the services, provided by suppliers.

METHODS: We invited all parents whose children were as outpatients involved in wheelchair test in the period from January 2015 to January 2018 at URI-Soča. They were invited to fill in The Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0). It is an outcome measurement instrument to evaluate person’s satisfaction with the wide range of assistive technology and was intended as a clinical and research instrument. Each item can be scored on the scale from 1 to 5, later meaning the best score.

RESULTS AND CONCLUSIONS: We included 136 parents of children with severe mobility dysfunction, aged from one to 15 years. They all filled in the QUEST 2.0. By the model of wheelchair, there were 55 children who needed the individually adjusted wheelchair, 29 children needed more simple transport wheelchair, 26 children active wheelchair and 26 children electric powered wheelchairs. Those wheelchairs were delivered by seven different suppliers. Mean values for specific items of QUEST 2.0. are reported in brackets. Parents were very satisfied with the dimension of wheelchair (4.2), its safety characteristics (4.2), simplicity to use (4.2), comfort (4.2) and efficiency in transport (4.1). They were less satisfied with the weight of wheelchairs (3.4), adjustments (3.9) and durability (3.9). They were also quite satisfied with delivery of wheelchair ((mean 3.9), repairs of wheelchair (4.2), professional service (4.3) and follow-up (4.2).

Data analysis showed that parents are satisfied by the characteristics, delivery and later support in use of wheelchairs. There are some domains that could be improved, such as weight and durability. Those are inevitably connected with the price and the financial constraints based on national insurance company rules.
PLENARY SESSION III
ORTHOTIC TREATMENT OF DIABETIC FOOT

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INTRODUCTION: According to estimates, nowadays 366 million diabetics are living in the world and this number is rising steadily. This number expected to be more than half a billion by 2030. Diabetes is the most common cause of lower limb amputation in Europe and the United States, it cause increasing health problem and economic burden, and it is projected to deteriorate in the future.

AIMS: The term of „diabetic foot” includes pathological and clinical signs, sensory, motoric and autonomic symptoms of the foot. Distinguish the angiopathic and neuropathic forms are necessary, different ethiopathogenic processes require different strategy of the treatment. The most common complication on diabetic neuropathic foot is the evolution of trophic ulcers. Skin, soft tissue and bone infections of the foot, either with systemic symptoms or without the most common causes of the hospitalization of diabetic patients with high morbidity and mortality. Deformity of the foot construction, development of pathological pressure points, severe neuropathy (absence of pain sensations) and chronic local irritation all play together an important role in the evolution of the ulcer.

METHODS: In severe cases of diabetic foot disorders the destruction of the bones and joints can often be observed showing the typical clinical and radiological image of osteoarthropathy (Charcot-foot) The normal bone-structure practically „disappers”. The incidence and prevalence of Charcot arthropathy are relatively low, but it has significantly higher morbidity and mortality than other diabetic conditions. The mortality rate is estimated to reach 25-30%.

RESULTS AND CONCLUSIONS: Plaster cast or plastic and custom made orthoses (AFO) use to be a treatment for the external fixation of the ankle and the foot during 3-6 month or more. The foot and ankle will be stable and weight bearing as a result of bone remodelling after several months without any pain and pathological movement. The affected limb will be total weight bearing and the operation leads total plantar surface during walking.

Total contact cast is the "gold standard" for treatment of diabetic foot ulcers and neuropathic foot deformity if there are no severe ischemia, osteomyelitis or large infected wound. The cast reduces the mechanical tension and edema in the bones, joints and soft tissues, ensures smooth distribution of the plantar pressure and keep the neutral position of the ankle and the foot. Adaptive or custom made orthoses make total contact fixation or ensure off-loading of the foot and ankle. Achillotomy can further increases the chance of healing. These orthoses are lightweight, easy to clean, can be removed during the bath or wound dressing. The duration of remodelling is 12 to 36 weeks. Neuropathic (diabetic) shoes can use as a prevention or for the treatment of trophic ulcer and foot deformity. These shoes are made from soft leather with special soft lining and extra deep design to accommodate the deformed foot and toes.

CONCLUSION: The clinical and radiological characteristics and the diagnostic steps of the diabetic neuropathic foot disorders are not widely known, that’s why it leads very often to maior amputation. Due to neuropathy, the lack of pain sensation which normally acts as a defence mechanism, these kind of severe foot disorders are recognised too late.

Diabetic neuropathy has good prognosis, but recovering time is very long, can be more than 3-12 months. It involves a lot of patience from the patient’s and the doctor’ side also. AFO can protect the ankle, provides medial and lateral support for the ankle joint and provides total immobilization for the foot joints.
EVIDENCE BASED REHABILITATION OF PEOPLE AFTER LOWER LIMB AMPUTATION: FOCUS ON NEW DEVELOPMENTS

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INTRODUCTION: Over the last decades considerable efforts have been made to improve functionality of prosthetic components. These advancements have led to the introduction of microprocessor-controlled prosthetic knees (MPK) for individuals with a transfemoral amputation or knee disarticulation. Despite several attempts have been made to study the potential added value of a MPK when compared to the use of a non-microprocessor-controlled prosthetic knee (NMPK), there is substantial ambiguity in the published results.

AIMS: To increase our understanding about how a user-adaptive prosthetic knee influences gait adaptations in several gait related activities and to critically review the additive value of these prosthesis components.

METHODS: We conducted several randomised clinical cross-over trials in which 10 individuals with a TFA/TKA were assessed during gait related activities using a Rheo knee II (MPK) in comparison to a NMPK after an 8 week acclimatisation period. Assessments included level walking at three walking speeds with special focus on prosthetic knee kinematics and compensatory movements, gait initiation (generating forces) and gait termination (absorbing forces). In addition, we assessed balance recovery strategies after evoked balance perturbations during treadmill walking. Finally, we quantified the effect of the Rheo Knee II on prosthesis-related quality of life, balance confidence, and functional status.

RESULTS AND CONCLUSIONS: The influence of the Rheo Knee II on compensatory movements during level walking at different speeds, gait initiation [1] and gait termination was limited. No major significant differences were found. We found that the use of the Rheo Knee II enabled participants to use the same strategies that non-amputees use to cope with platform perturbations during walking. This was not seen in the non-microprocessor-controlled prosthetic knee condition. The Rheo Knee II led to increased backward margins of stability during perturbed walking which is thought to be reflective of increased gait stability. The Rheo Knee II had a limited effect on functional status, balance confidence and prosthesis-related quality of life.

The results of level walking, quality of life, balance confidence and functional status are both in line and in contrast with the results that are described in previously conducted trials. Reason for this ambiguity in outcomes may be related to differences between MPK’s, variability in indication settings for prescription of MPK’s, the minor influence of the knee complex on gait adaptations, and in limitations in the current assessment procedures. The fact that we found differences on complex tasks where this was not the case on tasks with less complexity leads us to believe that future research on the additive value of new prosthesis components should focus more on tasks that are more in line with activities of daily living. Also we believe that actuated prosthesis components could be more discriminating in effects on functional tasks and energy efficiencies compared to non-actuated prosthesis.
Is the rehabilitation of people with an upper limb amputation or a congenital deficiency based on scientific evidence and what is the level of such evidence? How can we integrate scientific evidence and clinical practice? These questions will be addressed in the presentation. If we talk about evidence, the terms Evidence Based Medicine (EBM) and Evidence Based Practice (EBP) should be taken into account. EBM is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. EBP includes the integration of best available research, clinical expertise, and patient values and circumstances. EBM and EBP are both based on best and not on perfect evidence, which not always acknowledged nowadays. In the hierarchy of establishing the level of evidence a Randomized Controlled Trial (RCT) is seen as one of the study designs that produces the highest level of evidence. However, rehabilitation research has to deal often with circumstances interfering with the execution of an RCT. Rehabilitation research mostly concerns studies on a small number of subjects, which is especially applicable to research in people with upper limb amputations or congenital deficiencies due to the low prevalence of their disorders. Furthermore, the interventions of interest are complex: e.g. research into learning to control a myoelectric prosthesis is confronted with several influencing factors, such as motivation, motor skills, type of feedback, individual learning strategies. Blinding clinicians is difficult or even impossible in many research projects, e.g. in comparing two different treatments to diminish phantom limb pain. Undoing treatment outcomes is mostly impossible, for example if the treatment to decrease phantom limb pain has been effective. All these factors hamper the execution of RCTs and therefore mostly studies with lower level of evidence are published in scientific literature. As a consequence, high quality systematic reviews on rehabilitation related topics are also scarce. Clinical decisions on the most suitable interventions for individual patients, are not only based on evidence from literature, but also on clinical expertise and patient preferences. Although clinical experience is regarded to be of the lowest level of evidence, it is a very important ingredient of clinical decision making. The value of clinical experience and patient preferences should be integrated with scientific evidence. An example of such an integration is the institution of an EBP-team in our local university hospital. This team answers research questions from health care professionals by making factsheets. Integration of clinical practice and science can also be established by involving the target population from the beginning when designing a new study, by applying different types of study designs for different research stages, by using theories to develop new interventions and by using clear implementation strategies. In the presentation the debate on the integration of scientific evidence and clinical practice will be further elaborated and illustrated.
ORTHOPAEDIC FOOTWEAR AND LOWER LIMB ORTHOTICS
A COMPARISON OF EFFECTIVENESS OF STANDARD AND CAD/CAM-PRODUCED FOOT ORTHOSES

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INTRODUCTION: Approximately one-quarter of the population are affected by foot pain at any given time. It is often disabling and can impair mood, behaviour, self-care ability and overall quality of life. For some problems, such as painful pes cavus, rheumatoid arthritis and hallux valgus, there is strong evidence that custom-made foot orthoses can alleviate foot pain (1). Computer-aided design and computer-aided manufacturing (CAD/CAM) technology is increasingly used in the field of prosthetics and orthotics. After the initial investment, it greatly reduces production time and hence also production costs. To our knowledge, no randomised double-blinded controlled study comparing CAD/CAM-produced foot orthoses with standard (manually produced) ones has been conducted.

AIMS: We wanted to assess effectiveness of foot orthoses produced using CAD technology as opposed to the standard ones.

METHODS: Seven outpatients with foot problems were included in the study: 3 women and 4 men; weighting 70-119 kg, median 83 kg; 160-173 cm tall, median 170 cm; having used orthopaedic shoes and foot orthoses for 0-10 years, median 5 years; walking daily for 0-7 km, median 2 km. They wore the standard and CAD/CAM-produced foot orthoses for one month each, in randomised order. Plantar pressures were measured at the beginning and at the end of this period by a physician using the F-Scan system (data collected for entire sole, processed at seven spots). The patients as well as the physician were blinded to the type of foot orthoses worn. The main outcome was plantar pressure redistribution in terms of reduction of between-measurement-spots coefficient of variation (CV) (2). We also recorded the number of corrections to each pair of orthoses requested by the patient during the one-month period. In addition, the patients filled in a two-part questionnaire, with the first part (administered only at the beginning) describing walking difficulties and pain, and the second part (administered after the one-month period for each orthoses type) describing satisfaction with the orthoses. The data were statistically analyses using paired-samples t-test and exact McNemar-Bowker test.

RESULTS AND CONCLUSIONS: CV of plantar pressure decreased (in 15 instances) over the one-month period more often than it increased (9 instances) or remained unchanged (4 instances), but no change with either orthoses type on either foot was statistically significantly different from zero (p-values from 0.178 to 0.907). The average change in CV did not differ statistically significantly between the orthoses types (p=0.998 and p=0.625 for right and left foot, respectively). The number of corrections did also not differ between the orthoses types (2.7 on average for both, p=1.000). The answers to the user-satisfaction second part of the questionnaire (8 four-point scales) were identical or similar for both types of orthoses, without any statistically significant differences (p-values from 0.094 to 1.000).

We found no noteworthy differences between the two types of orthoses. The sample size war very small, but the study was randomised and double-blinded and several outcomes were assessed, so the conclusion should be sufficiently reliable. It therefore appears that CAD/CAM technology is a viable alternative to manual production of foot orthoses.
DETERMINATION OF PLANTAR PRESSURE DISTRIBUTION AND SATISFACTION IN DIFFERENT SPORT SHOES

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INTRODUCTION: In a study of 240 university students' shoes preferences and reasons, it was found that 75% of the students wore sports shoes and the first order was comfort (1). From there, four most popular and comfort-oriented brands were identified and these shoes were evaluated for plantar pressure distribution.

AIMS: The aim of our study is to determine the effects of sports shoes produced by different companies on plantar pressure distribution.

METHODS: Four of the most popular sports shoes brands in walking shoes were involved. These preferred brands are coded as A, B, C and D. Four subjects were included (2 females, 2 males; mean age 20.5 years; range 19-21) in the study who had no orthopedic problems and systemic disease. Plantar pressure distribution was determined by Walk in Sense®. An 8 different pressure areas were recorded during normal walking. One of the sensors was placed under the first toe, 4 of them under the metatarsal heads, 1 of the sensors lateral to the mid-foot, and 2 of the sensors in the medial and lateral heel. System is capable of continuous plantar pressure recording and each participant completed 3 trials consisting of between 5 and 6 steps (2). At the end of the walk, participants were asked how much they were satisfied with the shoe according to the Visual Analogue Scale (VAS) and their answers were recorded.

RESULTS: According to the results, the transverse arches parts of all the shoes was low pressure and the hindfoot plantar part pressure was moderate. The first toe plantar pressure was moderate in shoes with A and B code while high pressure in shoes with C and D code. Lateral of the midfoot pressure was very low in shoes with A and B code while low pressure in shoes with C and D code (Table1). Satisfaction level of sport shoes with code A and B received the highest scores (Table 2).

CONCLUSIONS: In our study to determine Plantar Pressure Distribution and Satisfaction in different sport shoes; all shoes are thought to have"moderate flexible" structure except for the heel and first toe part. The results show that all the shoes have a "less pressure" similar to each other in the transverse arch part. This result suggests that there is no support for transverse arch in the shoes. The fact that the midfoot and first toe part of the A and B sport shoes are less pressured than the C and D code shoes suggests that these zones of A and B code shoes may have been produced more flexibly. As a result, the A and B shoes received the highest satisfaction scores. It is believed that "midfoot" and "first toe" parts are less pressure by C and D than A and B sport shoes. It is also thought that these shoes may have been produced more consistent with the physiological pressure distribution of the soleplate. This satisfaction is thought to be influenced by the differences on sole and insole of sport shoes with other parameters.
FOOT ORTHOSES IN RHEUMATOID ARTHRITIS PATIENTS

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INTRODUCTION: Rheumatoid arthritis can cause severe impairment in foot structure and, consequently, difficulties in patients’ walking ability. Foot orthoses are an important adjunct conservative therapy. Foot pain is the main reason for rheumatoid arthritis patients’ referral to rheumatologist as well as to foot orthotics outpatient clinic. With the introduction of biological drugs and increase in their availability, the efficiency of rheumatoid arthritis treatment has improved. Fewer impairments of foot function should therefore be expected, thus reducing the demand for foot orthoses.

AIMS: The purpose of our study was to assess the rheumatoid arthritis patients’ treatment at the outpatient foot orthotics clinic at our Institute. In particular, we wanted to find out if their number has decreased due to the new treatment methods.

METHODS: Available medical documentation of rheumatoid arthritis patients treated at our outpatient foot orthotics clinic from January 2009 to June 2017 was examined. The number of different categories of prescribed foot orthoses was tabulated. Control charts were used for analysing the number of patients’ visits within 6-month and 12-month intervals. The difference in the proportion of first and repeated prescriptions between years was tested using extended Fisher’s exact test. The research was approved by the Institute’s medical ethics committee.

RESULTS: Three hundred nineteen rheumatoid arthritis patients were examined in the observed period; 146 patients were examined for the first time, 173 were readmitted. Ninety per cent were women, 10% were men; their average age was 67 years (SD 12, range 25 – 95 years). The number of patients at 6-month as well as 12-month level varied, but no systematic changes were observed over time. The proportion of first and repeated prescriptions does not differ statistically significantly between years (p=0.686). Orthopaedic shoes were prescribed to almost all patients (98%); 84 (26%) received orthopaedic shoes without special adaptation, 203 (64%) received orthopaedic shoes with individually shaped foot orthoses, 3 (1%) received individually shaped orthopaedic shoes and foot orthoses, and 23 (7%) patients received only foot orthoses.

CONCLUSIONS: Despite new treatment methods, the outpatient foot orthotics clinic at our Institute maintains its significance for comprehensive treatment of rheumatoid arthritis patients. Our findings are in concordance with the results of contemporary studies, in which the presence of foot problems in rheumatoid arthritis patients has been confirmed in the age of biological drugs and the importance of outpatient clinics for foot problems has been emphasised.

Key words: rheumatoid arthritis, foot pain, orthopaedic shoes, foot orthoses
MODIFIED ORTHOTIC CARE FOR CHILDREN WITH INFANTILE FORM OF BLOUNT’S DISEASE: PRELIMINARY RESULTS

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INTRODUCTION: Infantile Blount's disease is a developmental disorder in young children from two to five years, characterized by disordered growth of the medial aspect of the proximal physis of tibia. Blount’s disease occurs. The cause is unknown, but is very likely multifactorial, related to mechanical overload in genetically susceptible individuals (early walking, large stature, obesity). It is more frequent in male, and bilateral in 50% of cases. It results in progressive lower limb deformity (varus, procurvatum and internal rotation of the tibia). An x-ray of the knee and the lower leg confirms the diagnosis. Langenskiold classification is used for prognostic guidelines. Children who develop severe bowing before the age of three years may be treated with knee ankle foot orthoses (KAFO). Better outcomes are expected with unilateral disorder; poor results are associated with obesity and bilateral changes. If successful, improvement should occur within one year.

AIMS: We wanted to evaluate the efficiency of the KAFO in the management of a group of children with Blount’s disease.

METHODS: We included children, who were referred to Orthopaedic hospital Valdoltra or University Rehabilitation Institute of Republic Slovenia due to bilateral early infantile form of Blount's disease (the period from 2014 to 2017). The diagnosis was confirmed by x-ray (tibio-femoral angle, proximal metaphiseal-diaphiseal angle (MDA) and Levine-Drennan angle). Children were fitted with modified KAFO to decrease the tibial varus: 3-point pressure principle was applied to the proximal tibia, excluding the rest of lower limb; the knee is protected from correction forces. Mechanical parts of KAFO: TFC thermo-formed composite frame on medial side (enables good mobility, full range of knee flexion and extension; avoids the ankle and is extended to the medial longitudinal arch); above-knee ring acting as an internal centre of proximal tibial correction force (CP Copolymer, enabling the knee to move); thermoplastic supramaleolar orthosis (extending below the medial longitudinal arch); dynamic plate above the medial ankle (serves as distal tibial correction surface); elastic fabric with air cushioned plate (medially, serves as middle point correction force). Modified KAFO enables unloading of knee and ankle with correction of valgus position of foot, which is usually the consequence of tibial varus. KAFO is adjusted as the child grows; it’s light and easy to use.

RESULTS AND CONCLUSIONS: We included 6 children with Blount’s disease, four of them were girls. At the age of first referral they were in average 20 months old. The mean tibio-femoral angle was 22,5° left and 18,5° right. All children were fitted with modified KAFO. They were followed-up every four months. The mean time until significant improvement of tibio-femoral angle (average <7°) after the application of KAFO was 12,1 months. At the end of treatment, none of children had evident calcaneovalgus.

Modified KAFO was user friendly and efficient in decreasing tibio-femoral angle in children with x-ray confirmed infantile form of Blount’s disease. In addition, the valgus position of calcaneus was minimal.
THE USE OF ANKLE-FOOT ORTHOSES IN PATIENTS AFTER STROKE FOR WALKING IN HOME ENVIRONMENT

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INTRODUCTION: In patients after stroke an ankle-foot orthosis can be used to stabilize the talocrural and subtalar joints, the foot and the knee, prevent or correct deformities, as an aid to increase efficiency, control and safety of walking, and improve functional ambulation. Information on sustainability of ankle-foot orthosis use after discharged from stroke rehabilitation department and users’ opinion is however very rare.

AIMS: Of the study was to determine if patients continue to use the orthosis, which they received during rehabilitation after stroke at home environment, and if not, what the reasons are.

METHODS: All patients who were included into rehabilitation programmes in period of 21 consecutive months and received one of the foot position correction orthosis were included in the retrospective analysis. The questionnaire on use of orthosis was send to 150 patients by mail. For the parameters studied, descriptive statistics were calculated; differences between the group of patients, which were still using the orthosis (users), and the group of people, which were no longer using the orthosis (non-users), were analysed with independent sample t-test and Hi-square test.

RESULTS AND CONCLUSIONS: 96 questionnaires were included into analysis (103 returned, seven out of them were useless because of ragged answers). Sixty-six of pollee (68.8%) were users and 30 people (31.2%) were non-users. There was no significant difference between the groups in gender, age, side of hemiplegia, and Functional independence measure (FIM) and Mini mental state examination (MMSE) scores at discharge from rehabilitation. In the group of non-users, there was a significantly higher proportion of people with haemorrhagic stroke (37.7% vs. 19.7%; p = 0.028). In the group of orthosis users, 37.9% of patients received a serial ankle-foot orthosis (AFO), 47% an ankle orthosis (AO) and 15.1% a custom made AFO. In the group of orthosis non-users, patients received AO in 70%, a serial AFO in 26.7%, and custom made AFO in 3.3%. Pollees who were still using the orthosis reported that walking with orthosis is easier, safer, more certain (68.2%) and correct (57.6%). As a reason to abandonment of orthosis the non-users quoted that they did not needed it any more (46.7%), pressure/callosity (30%) and because it encumbered them during walking (23.3%). The proportion of people after stroke who continue to use an orthosis for walking at home environment after discharge from rehabilitation is expectedly high. Because the fact of higher proportion of haemorrhagic stroke and receiving mainly AO, the group which abandoned the use of orthosis probable had better recovery after discharge from the rehabilitation institution.
Contracture management can be done in different ways but they are not always effective and painless. The purpose of Low Load Prolonged Stretch (LLPS) treatment is to obtain an increase of range of motion (ROM) and so to be able to achieve fixed goals such as better gait pattern, specific daily activities, hygienic matters or personal objectives with minor inconveniences and pain. A flat coil spring gives the requested force and dynamics to work following LLPS-principles. The included patients, 2 adults, one child on which the dynamic joints were applied are mainly with a neurological background but can also be of orthopaedic nature. Each orthosis is custom made, designed following the need and is fitted at first without force to check comfort and to achieve the correct wearing time. AROM and PROM were measured with a goniometer in the beginning of the treatment and weekly after delivery of the orthoses to check the progress. In a treating time of two months (6 to 8 hrs a day, min. 5 days a week) we could determine a gain of AROM up to 14° which is a considerable improvement. This method was used complementary to the manual therapy that the patients already had before starting the LLPS treatment. Using LLPS can be an effective and painless way of treating correctable contractures. Wearing time, compliance, orthotic design and accurate follow-up is needed for a good and fast outcome.
OUTCOME MEASUREMENT IN P&O
INTRODUCTION: Substantial improvements have been perceived in surgical results following major lower limb amputation, but there remains observed variation in amputation quality for patients referred for prosthetic rehabilitation from different hospitals.

AIMS: To assess various elements that influence residual limb quality and evaluate their impact on progress through initial prosthetic rehabilitation and mobility outcome after rehabilitation.

METHODS: A revised 10-item residual limb scoring system was used to survey a succession of 95 primary amputees with transtibial and transfemoral amputations (100 residual limbs) presenting for rehabilitation.

RESULTS AND CONCLUSIONS: The majority of residual limbs scored highly, supporting the perception of generally good amputation quality. There were significant differences between in average residual limb scores between some hospitals. The overall scores showed weak or minimal correlation to progress through rehabilitation and mobility outcome but residual limbs scoring higher in seven of the items of the score showed significant advantages in key aspects of progress of mobility at discharge. There is need for continued collaboration between surgeons and rehabilitation centres to ensure consistent high standards. The revised residual limb score used in this survey needs further refinement for future use.


PHYSICAL CAPACITY AND REHABILITATION OUTCOME AFTER BILATERAL TRANSTIBIAL AMPUTATION DUE TO PERIPHERAL VASCULAR DISEASE

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AIMS: To determine the importance of exercise testing and to compare the rehabilitation outcome after uni - or bilateral transtibial (TT) amputation due to peripheral vascular disease (PVD).

SUBJECTS: Patients (17), admitted to the University Rehabilitation Institute - Soča, after bilateral TT amputation due to PVD between January 1st, 2016 and December 31st 2017, were included. The average age was 71,3 ± 8,3 years. All had hypertension, 15 diabetes, 7 ishaemic heart disease, and 2 with mild hemiparesis after stroke.

METHODS: All patients underwent testing with arm ergometry. The calculated peak oxygen uptake (VO2peak) was compared with the 6-minute walking test (6MWT) and the measured values of the VO2 during 6 MWT (Oxycon Mobile). In the second part of the study participated the patients after unilateral TT amputation, who were already walking with prosthesis before the amputation of the other leg. The results of 6MWT, FIM, independence in donning and doffing TT prosthesis, the use of walking aid, and place of patients discharge after rehabilitation after unilateral and bilateral TT amputation were compared.

RESULTS: Two groups were analysed separately. In the first, 13 patients had been walking with TT prosthesis before amputation of the other leg. The average time between first and second amputation was 36,7+ 32,8 months. In the second group, 4 patients were admitted for the first time to the rehabilitation with the average time 23 days only between both amputations. The average distance during 6MWT of the first group was 131+93,9 m, and 55,5+21,8 m of the second group. All the patients in the first group were walking with prostheses. In the second group, one patient was using prostheses for standing and transfer only. There was no important difference between VO2peak during the exercise test of both groups. The VO2peak during walking with two prostheses was between 9,5 and 14 ml/kg/min, depending on the walking speed.

There were no important differences in the results of 6MWT, FIM, independence in donning and doffing TT prosthesis, and place of patients discharge after rehabilitation in patients after one or bilateral TT amputations. The important difference was in the use of walking aid and in the speed of walking at 10m distance.

CONCLUSIONS: The patients, who had been walking with TT prosthesis before amputation of the other leg, had better outcome in all measured parameters, than those with both legs amputated one after another. Walking with two prostheses was quite different from walking with one prosthesis in the speed and the use of walking aid, ie. walker instead of crutches. The distance walked was not proportional with the results of physical capacity measured with exercise testing. For precise determination of the physical capacity needed for walking with two TT prostheses the number of patients was too small.
INTRODUCTION: Transtibial amputations are among the most frequently performed major limb amputations. Loss of a limb produces a permanent disability with an impact on patient's self-image, self-care, and mobility. The main goal of rehabilitation after an amputation is to help the patient return to the highest level of independence and function possible, while improving the overall quality of life. In pursuit of those goals, amputation rehabilitation programs may include fitting and prescribing prosthesis. However, prosthetic prescriptions vary significantly under relatively similar circumstances from centre to centre and sometimes also from team to team. Hence, standardisation of prosthesis prescription is very important. The United States' Medicare Functional Classification Level, better known as K-level, is a 0-4 scale for describing the functional abilities of persons who had undergone lower-limb amputation, with 0 indicating no ability or potential to ambulate and 4 indicating the prosthetic demands of a child, active adult or athlete. Different outcome measures are used to assess K-level, including the Six-Minute Walk Test (6MWT) and One-Leg Standing Test (OLST).

AIMS: The main goal of our study was to examine whether it is possible to predict appropriate K level of transtibial prosthesis users based on 6MWT and OLST on prosthesis.

METHODS: Patients who had been rehabilitated and fitted with transtibial prosthesis at the University Rehabilitation Institute in Ljubljana between January 2014 and December 2014 were included in a retrospective audit. We analysed 6MWT and OLST results and obtained a classification rule by visual inspection of the scatterplot, followed by receiver operating characteristic (ROC) curve analysis.

RESULTS: One-hundred-twenty patients (aged 39-90, mean 67 years; 79% men) walked on average 252 m (SD 119 m) in 6 minutes. They belonged to three K-levels: 8 to K1, 94 to K2 and 18 to K3. Sixty-one could not stand on one leg, 8 stood on the prosthesis for 1s and 5 stood on it for 2s or more. Given that a patient was able to stand on the prosthesis for at least one second, the estimated optimal thresholds of 6MWT were 125m (K1 vs. K2) and 385m (K2 vs. K3). This classification rule yielded an estimated 80% sensitivity and 88% specificity for deciding between K1 and K2, and 92% sensitivity and 74% specificity for deciding between K2 and K3.

CONCLUSIONS: 6MWT and OLST could be used as predictors for transtibial prosthesis prescription. No two amputees have the exact same general physical status, stump characteristics and occupational problems, so others factor must also be taken into account when prescribing prosthesis; nevertheless, the basic concept the our classification rule represents appears to be promising for clinical practice.
THE L TEST OF FUNCTIONAL MOBILITY: RELIABILITY AND CORRELATION WITH THE 6 MINUTE WALK TEST AND THE 10 METER WALK TEST IN PEOPLE AFTER LOWER-LIMB AMPUTATION IN EARLY REHABILITATION – PRELIMINARY RESULTS

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INTRODUCTION: The L test was designed as a modification of the timed "up and go" test. It is a clinical test for mobility assessment. Very good reliability was demonstrated in experienced prosthesis users, with average of 11.8 years since the lower-limb amputation (Deathe and Miller, 2005). The L-test measurement properties in patients after lower-limb amputation in early rehabilitation have not yet been studied.

AIMS: To establish intra and inter-rater reliability of the L-test and its correlation with the 6 minute walk test (6MWT) and the 10 meter walk test (10MWT) in early rehabilitation of patients after lower-limb amputation.

METHODS: A convenience sample of 16 subjects (15 male, 1 female, mean age 65.13 years (SD: 9.78)) amputated due to vascular disease (12 transtibial, 4 transfemoral) who underwent an inpatient rehabilitation was included in the study. They had to be able to walk with their prosthesis, five of them used crutches and 11 a walking frame. On the first assessment day the rater A conducted the L test (one test trial and two consecutive measurements), following with the 6MWT and the 10MWT (two consecutive measurements of comfortable and fast walking) in randomized order. On the following day two raters (A and B) conducted the L test in randomized order, with one hour break in between. Descriptive statistics and the intraclass correlation coefficients (ICC), and the Pearson’s correlation coefficient (r) were calculated. The study was approved by Ethics Committee of URI – Soča.

RESULTS AND CONCLUSIONS: At the first assessment the mean time of the L test was 67.9 (SD: 32.6) seconds, at the second day its score was 60.20 (SD: 36.05) seconds (ratter A) and 58.13 (SD: 32.92) seconds (rater B). The intra-rater reliability (ICC = 0.96) and inter-rater reliability (ICC = 0.98) of the L test were very good. The mean walking distance in the 6MWT was 151.6 (SD: 70.5) meters. The mean comfortable walking speed was 0.46 (SD: 0.19) m/s, and 0.68 (SD: 0.29) m/s for fast walking in the 10MWT. Correlations of the L test with the 6MWT (r = -0.81) and with the 10MWT (comfortable walking: r = 0.94; fast walking: r = 0.91) were very high and statistically significant (p<0.001).

The L test is a feasible and reliable measuring tool also in patients after lower-limb amputation during the early rehabilitation period. The result of the L test coincide with the 6 minutes walk distance and the walking speed of the individual. Studies of other measurements properties of the L test are needed, including its correlation with the sit-to-stand tests.

DEVELOPMENT OF A FREE-LIVING REHABILITATION MONITOR FOR USE WITHIN LOWER-LIMB PROSTHETIC AND ORTHOTIC POPULATIONS

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INTRODUCTION: Objective measurements, such as those obtained within the gait laboratory, provide a powerful insight into the ambulatory condition of an individual, and may be used to help monitor and target rehabilitation efforts following lower-limb amputation or hemiplegia resulting from stroke. However, such systems require substantial resources, with high costs, space, and time requirements. Furthermore, only a limited range of environments may be simulated within the laboratory. The aim of rehabilitation is the return the individual to as normal life as possible. A fundamental aspect of this is safe ambulation within the free-living environment, where environments are unconstrained. Individuals are required to ambulate at different speeds, on variable inclines, on inconsistent stairs, and on uneven surfaces, all while being exposed to different weather and crowd conditions.

AIMS: Development of a small, wireless activity monitor to allow objective measurement within this highly variable environment and capture a more realistic image of how well an individual is able to engage within their community and maintain a high-quality of living.

METHODS: The monitor utilizes a low-power triaxial accelerometer to continually capture simple use metrics such as step count and wear time. Based upon this information the device intelligently engages a 9-axial inertial motion unit, which allows temporal and spatial gait parameters to be captured throughout the day while still ensuring a battery life of several months. Additionally, the device uses a barometer to capture supporting evidence to detect slope or stair accent and decent, a fundamental activity of free-living. This information is transmitted wirelessly to the patient’s smartphone, whereby easily understandable summaries are presented for real-time feedback. Detailed data is also uploaded to cloud storage, allowing members of the patient’s clinical team to monitor the patient’s performance, and tailor their rehabilitation or device efforts.

RESULTS AND CONCLUSIONS: We report upon the development of this system and both a laboratory-based validation and free-living evaluation. The validation has been performed on seven stroke survivors with impaired gait and 20 healthy participants, wearing the device on the posterior shank. Participants performed a range of short walks involving turns and slopes within a gait lab, outside, and on a CAREN virtual-reality self-pacing treadmill. Inside walks were simultaneously captured using Vicon system with the lower-body plugin gait marker set. Ground truth for outdoor walks was obtained using a Delsys Tringo IMU system.

For free-living evaluation unimpaired, lower-limb, and stroke survival participants were recruited to use the system, with smartphone application feedback, for a period of 7 days. Quantitative and qualitative assessment of this evaluation is presented.

The system developed provides an unobtrusive method of objective ambulatory data capture in the free-living environment over an extended period of time. The system is able to present this information in an intuitive and practicable manner to the patient. Furthermore, more detailed information may be readily accessed by members of the patient’s healthcare team.
INTER-RATER RELIABILITY OF THE AMPUTEE MOBILITY PREDICTOR IN PATIENTS WITH LOWER LIMB AMPUTATIONS

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INTRODUCTION: Walking with prosthesis requires additional energy and certain motor skills. Prosthesis provision requires the patient's ability to walk and careful use to avoid other potential serious complications. The Amputee Mobility Predictor (AMP) is a measurement tool that estimates the ability to walk with prosthesis and classifies the patients with prosthesis into a single functional class. The AMP scale consists of 21 tasks requiring short administration time and little amount of equipment and space (Gailey et al., 2002).

AIMS: The aim of the study was to verify the inter-rater reliability of the AMP in the population of patients with lower limb amputations in the early rehabilitation stage.

METHODS: The study included 20 subjects (19 male, 1 female) with lower limb amputation, 70 years old on average (SD: 10 years), who underwent hospital rehabilitation at the University Rehabilitation Institute in Ljubljana. The cause of amputation was vascular disease; 7 subjects had transfemoral and 13 had transtibial amputation. The included subjects had to be able to walk with a prosthesis; 18 subjects used crutches and two subjects used a walker. The first AMP assessment was carried out by the first rater (A) in the last week before discharge from hospital; the second assessment was carried out on the following day by the second rater (B). Descriptive statistics and intraclass correlation coefficients were calculated.

RESULTS AND CONCLUSIONS: The average AMP score was 33.4 (SD: 4.1) at first (A) and 34.2 (SD: 3.6) at second (B) assessment. The estimated reliability among raters was moderate (ICC=0.61 with 95% confidence interval 0.24-0.83). Most inconsistencies between the raters occurred at the second task (sitting reach).

The estimated inter-rater reliability of the AMP is not optimal. A larger sample size should be used for obtaining stronger evidence of AMP reliability. It would be useful to estimate the comparability and correlation of the AMP with other walking tests, such as the 6-minute walk test, to facilitate and better assess the progress of walking in patients following lower limb amputation.

INTER-RATER RELIABILITY OF CLINICAL GAIT ANALYSIS IN PEOPLE AFTER TRANS-TIBIAL AMPUTATION – PRELIMINARY RESULTS

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INTRODUCTION: People after lower limb amputation fitted with prosthesis have to learn how to walk and control the prosthesis. In spite of modern prosthetic components, gait deviations in this population are frequent. The physiotherapists (PTs) performing gait training have to be able to observe different gait deviations, know their causes and try to improve them using physiotherapeutic methods. Clinical gait analysis is part of the standard procedure of fitting a new prosthesis. It is therefore important that there is inter-rater agreement between different PTs.

AIMS: The aim of our study was to find out the inter-rater reliability of clinical gait analysis.

METHODS: So far, 20 subjects after trans-tibial amputation amputated at least 1 year ago have been recruited from our outpatient clinic. They had no other neurological or musculoskeletal disorders that might influence their gait, had to be able to walk independently with their prosthesis (walking aids were allowed) and had no problems with the prosthesis. Five PTs performed gait assessment; three of them were randomly selected to observe each patient when he/she got a new prosthesis. Randomisation was balanced, so that each PT observed equal number of subjects (so far, 12). The percentage of agreement between raters was calculated for each gait parameters (which are all dichotomous).

RESULTS AND CONCLUSIONS: The subjects (16 men, 4 women) were on average 66 years old (range: 17-85, median 70 years). The mean time since amputation was 15 years (range 1-66, median 5 years); eight amputations were due to diabetes mellitus, 6 due to injury, one due to peripheral vascular disease, one due tumour and two due to other reasons. In six minutes, the subjects walked 80 to 530 meters (mean 280, median 285m).

There was 100% agreement about functionality of gait and initial contact, 95% about knee hyperextension, 90% about not loading the prosthesis and 85% about loading it. Agreement about whether there was knee valgus during stance phase was better (80%) than about knee varus (65%). The lowest agreement was about gait rhythm (45%) and equality of step lengths (50%).

Based on our previous studies we estimated that we have to include at least 50 patients after trans-tibial amputation for more reliable results, so we are continuing with data collection. Presently it seems that agreement between our PTs is satisfactory for only half of the observed gait parameters.
CONSIDERATIONS FOR DEVELOPING AN EVIDENCED-BASED PRACTICE IN ORTHOTICS AND PROSTHETICS

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INTRODUCTION: The demand placed upon clinicians to incorporate evidence-based practices into their daily routine has increased substantially over the past decades. This presentation aims to provide a critical review of the need for evidence-based practice in prosthetics and orthotics, discuss barriers for integrating evidence into clinical practice and will present a theoretical model for implementation of evidence-based practice.

DISCUSSION: Evidence-based practice (EBP) can be defined as the conscious and systematic use of best available research evidence in making decisions about the care of individual patients (Sackett et al., 2000). More recent definitions suggest that EBP should not be used in isolation but in conjunction with the clinician’s own experience and with consideration of the patients own wishes (Doherty, 2005). While the principles of EBP have been well developed in many areas of medicine, the prosthetics and orthotics profession has been slower to integrate EBP into clinical practice.

Within the field of prosthetics and orthotics, barriers to adopting EBP have specifically been identified as; time constraints, workload demands, limited relevant evidence, inadequate knowledge and demographics (Ramstrand, 2013). Other commonly cited barriers include limited access to evidence-based resources and poor organisational support.

Throughout this presentation it will be argued that successful implementation of evidence-based practice requires consideration of numerous interrelated factors. These include; the characteristics of the evidence-based topic (ie. how it is perceived by potential users), the manner in which information is communicated, the organizational context in which clinicians are working and the willingness of clinicians to alter their behavior.

CONCLUSION: Prosthetist/orthotists are generally positive to embracing the principles of evidence-based practice, however, for numerous reasons, the profession has not been as rapid to implement it into practice as other health-care professions.

There is a risk that haphazard implementation of EBP will result in clinicians failing to sustain use of its principles in the long-term. The use of a model to facilitate implementation and maximize acceptance of EBP is proposed as a beneficial means of addressing this issue.

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SILICONE PROSTHESES - MULTIDISCIPLINARY TEAM APPROACH

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INTRODUCTION: Anaplastology is a special field focused on custom-made silicone prostheses. Design, manufacturing, fitting and assessment of custom-made silicone prostheses, all that requires a multidimensional solution – a combination of medical, technical and artistic skills and experience.

AIMS: The aim of this presentation is to demonstrate the importance of the multidisciplinary team approach (MDT) in Anaplastology.

METHODS: Anaplastology is related to various areas – medical science and related fields (surgery, prosthetics, physiotherapy, biomechanics, etc.), digital technologies (3D scanning, computational modelling, 3D printing, measuring systems), material science (silicones, composites, 3D printing plastics), colour science, industrial/product design (CAD technologies), art (sculpting, colouring) etc. There will be a presentation of clinical cases of patients with both facial and somato prostheses where the MDT approach was taken by a team constituted by an anaplastologist, a surgeon, a prosthetist, a product designer/engineer, a biomechanical engineer and a researcher.

RESULTS AND CONCLUSIONS: A properly applied MDT approach can improve cosmetic appearance, function and comfort of custom made prostheses in patients with congenital abnormalities, disfigured or missing body parts due to a disease or trauma. The MDT approach brings benefits to the patient, especially if the solution requires cooperation of different medical, technical and artistic professionals. The application of the MDT approach can vary depending on the diagnosis, clinical environment and general situation of the patient.
REHABILITATION OF PEOPLE AFTER LOWER LIMB AMPUTATION
INTRODUCTION: The process of the amputation stump forming is dynamic process and influenced by many factors: surgical intervention itself, positioning, edema control, muscle and fat tissue atrophy and muscles activities of the stump itself. The knowledge about dynamics related to the stump volume changes and the influencing factors is of immense importance for the process of prosthetic fitting.

AIMS: Aim of the study is to investigate the dynamics related to the changes in stump circumferences and to define the most important factors influencing on stump volume variations and its final forming.

METHODS: The study included 43 patients (36 males and 7 females) average age 63 years (males 62, females 67), which successfully completed the program of the primary rehabilitation in the prosthetic phase in 2016. The follow up testing was done 3 months after discharge.

The measurement of the proximal and distal circumference of the amputation stump were measured at the initial assessment of the prosthetic potential, at beginning of prosthetic fitting and at follow up testing. Patients were divided in 3 groups according to the length of the pre-prosthetic phase (stump bandaging) and in 4 groups according to the daily number of hours during which they were using prosthesis.

Statistic analysis was done using nonparametric statistical tests: Friedman test, Wilcoxon test, Kruskal-Wallis Test and Mann–Whitney U test.

RESULTS AND CONCLUSIONS: Statistical analysis of the entire sample confirmed the statistically significant difference between proximal circumferences measured during the first assessment and beginning of prosthetic fitting, as well as between proximal circumferences measured during the first assessment and follow up assessment (p< 0.01). Also there is statistically significant difference between the distal circumferences measured during the first assessment and follow up assessment (p< 0.01). No statistically significant difference was found in changes of distal circumferences measured during the first assessment compared to distal circumferences measured at the beginning of prosthetic fitting.

In relation to the period without prosthesis, there was no statistically significant difference in the circumference reduction between the observed groups, measured both proximally and distally, during the first assessment and beginning of prosthetic fitting.

Further analysis among all groups revealed the statistically significant difference in circumference changes proximally, at beginning of prosthetic fitting compared to follow up measuring between groups n1 and n4 (p< 0.05), although out clinical observation showed significant reduction in both, proximal and distal, circumferences in patients who used prosthesis 6 and more hours a day, in comparison to those who used prosthesis up to 4 hours a day.

We can conclude that the process of primary prosthetic fitting should start as early as possible after the amputation as the prolonged bandaging time does not lead to the significant volume reduction and better forming of the amputation stump. More significant circumference reduction of the stump starts only after the prosthetic fitting and with active use of prosthetic limb.
EDUCATION AS AN IMPORTANT FACTOR IN PREVENTING LOWER LIMB AMPUTATIONS DUE TO VASCULAR DISEASE

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INTRODUCTION: Peripheral arterial disease was identified as a key cause of amputations of the lower limb. With the education patients can widen their knowledge about the care of their feet. With knowledge and consistent care for limb at risk they can avoid potential problems that lead to limb amputation.

AIMS: The aim of this study was to determine whether there is a difference in knowledge about the care of the residual limb between patients with different causes of amputation and whether there is a difference in knowledge before and after the education.

METHODS: The quantitative nonexperimental study was carried out. The longitudinal design was used. A closed-ended questionnaire was used. The research was conducted from January 2014 to December 2014. The study included patients with unilateral lower limb amputation, regardless of the level of amputation. Included were 102 patients, 75 men and 28 women. Patients were asked to respond the questions using Likert scale, where 1 means disagree and 5 means totally agree.

RESULTS AND CONCLUSIONS: Factorial analysis by the method of main axis and bivariant linear regression. Assessment of reliability in terms of internal consistency was 0.88. Bivariate linear regression shows that knowledge is significantly related to the following characteristics of patients: smoking (p = 0.027), diabetes (p = 0.024) instructions regarding the supply leg (p = 0.002), more frequent screening feet (p = 0.050) and impairment (p = <0.001). Comparison of knowledge before and after training shows a statistically significant improvement in education (p< = 0.001 for each item).

Research has shown that patients gain knowledge that will be useful in maintaining the good condition of the remaining legs. It is important that after finishing the program they had more knowledge that will help them in identifying dangers and in deciding on changing the risk behavior on their health.
FUNCTIONAL TRAINING OF PATIENTS WITH LOWER LIMB AMPUTATION WITH MUSIC (DMT)

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INTRODUCTION: The DMT (dance-movement therapy) approach is based on the bio-psycho-social model of the International Classification of Functioning, Disability and Health and therapeutic approaches that are aimed at restoring physical functioning, activity and cooperation. DMT is a group activity consisting of three parts: preparation for dance, sitting dance and upright dance for patients already fitted with prosthesis. The contents of each part are specifically tailored, therapeutic approaches are considered and activity elements are determined.

Music has an important role in DMT. Music is a therapeutic medium that influences emotional stability, helps gaining control and reduces stress level and anxiety through the power of its melody and rhythm. The authors of the DMT programme have not found any details of similar activity in the published literature; hence this activity is considered as innovative.

AIMS: The aim of our study was to gain information on the advantages and deficiencies of DMT. We applied a non-standardised questionnaire, which was given to the patients taking part in DMT. The study focused on the influence of music on functional activity and the activity of dancing.

METHODS: Patients after unilateral lower limb amputation hospitalized at the University Rehabilitation Institute in Ljubljana were included in the study. Attending DMT was voluntary; the patients were informed about the study and their rights during the study. DMT was led by an occupational therapist and a physiotherapist twice a week; each patient attended the group eight times, with 4-6 patients per group. The inclusion criteria were: 25 points scored on the Mini Mental State Examination (MMSE), that the patients liked music and were younger than 75 years of age.

Patient satisfaction with DMT was assessed during their last participation in the activity. The questionnaire had 21 statements describing the difficulty of DMT, the role of music in DMT, the group format of DMT; the patients were asked to mark their level of agreement with each statement.

RESULTS AND CONCLUSIONS: Thirteen patients participated in the study, 9 men and 4 women, 52 to 74 years old (mean 65 years). Seven patients had trans-tibial amputation and 6 had trans-femoral amputation.

The included patients reported no deficiencies of the programme. All of the patients rated the following statements with the maximum of four points (i.e., entirely agreeing with the statement): group therapy fits me; I like to participate in group therapy; I find DMT a useful part of the rehabilitation programme. The following statements were given mainly (5 out of 13 patients) 3 points (i.e., I am not entirely sure): music encourages me to exercise; the three parts of DMT have different difficulty levels; DMT may help me dance again.

We can conclude that the patients see the advantages of the programme, they notice different difficulty levels and they find DMT to be useful in the rehabilitation process. Minority of patients is not sure if the music is helping them in participating in the activity and they are not convinced that they will be able to dance again because of participation in DMT.
INTRODUCTION: Motor imagery can be described as a dynamic process in which a person mentally stimulates the given motor movement without any physical motion. The impairment in motor imagery ability after the changes occurred in the neural system has been studied for many years by researchers. Similarly, the changes in motor imagery ability in patients with amputation have recently begun to be wondered. However, there is a limited number of studies about the topic in the literature.

AIMS: The aim of this study is to evaluate motor imagery ability in patients with unilateral lower limb amputation and compare with healthy controls.

METHODS: Patients were evaluated by a physical therapist to determine whether they met the following inclusion criteria: a) men or women between the age of 18 and 80 years with unilateral lower limb amputation, b) a score higher than 23/30 in Mini-Mental State Examination. 11 amputee patients (mean age 55.36 ± 15.53 years; 90.9% men) and 12 healthy controls (mean age 50.83 ± 13.95 years; 33.3% men) participated in the study. Psychometric and chronometric tests were performed to evaluate the motor imagery ability of patients. Participants’ visual (internal and external) and kinesthetic imagery abilities were evaluated with Movement Imagery Questionnaire-3 (MIQ-3). Temporal Congruence Test of stepping movement was performed in each lower limb to measure mental chronometry and the ratio of mental imaging time to physical execution time was taken as final score. Finally, the mental rotation scores of the participants were assessed with a mobile application called “Orientate”. 25 photographs of left and right feet were presented to the participants in a random order and their accuracy ratios and response times recorded.

RESULTS AND CONCLUSIONS: The mean duration of time since amputation was 48.45 ± 106.90 months. 6 of the patients were amputated on the right side and 5 had on the left side. Amputation levels were trans-tibial in 9 patients and trans-femoral in 2 patients. As a result, physical execution time of the control group in Temporal Congruence Test on the right side was shorter and faster at a statistically significant level compared to the patient group (p=0.03). However, there was no significant difference in imaging durations and final mental chronometry scores between the groups. Only the internal imagery score of MIQ-3 was significantly different and higher in the amputated group (p=0.02). There was no difference between the groups in external imagery (p=0.3) and kinesthetic imagery (p=0.1) scores. Accuracy (p=0.3) and time (p=0.4) of mental rotation were not significantly different between the groups. In conclusion, the motor imagery ability of patients with lower limb amputation was not affected in terms of the chronometry and mental rotation parameters while the vividness parameter was found to be higher. We think that the reason of higher score in vividness is due to self-scored structure of MIQ-3. For future studies, it is suggested to select movements specific to the amputated side while assessing the ability of motor imagery in patients with lower limb amputation.

Keywords: Imagery, Amputation, Mobile Applications
BALANCE CONFIDENCE AND FALLS OF COMMUNITY-DWELLING PATIENTS WITH LOWER-LIMB AMPUTATION

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INTRODUCTION: Falls pose a significant risk to persons after lower-limb amputation and may be related to physical and psychological factors. Balance confidence has been positively correlated to community-based physical activity level in non-fallers. Activities-specific Balance Confidence (ABC) scale (1,2) has been used in several studies as an outcome measure of balance confidence. Prosthetic Mobility Questionnaire (PMQ) (3) is a more recent outcome measure of mobility in lower-limb amputees.

AIMS: The purpose of study was to compare balance confidence and mobility among community-dwelling lower-limb amputee fallers and non-fallers.

METHODS: Community-dwelling lower-limb amputees visiting outpatient clinic in January and February 2018 were included. Information about limb loss, fall history and basic demographic data were collected. Subjects completed ABC scale and PMQ. Subjects were divided into 2 groups according to falls history in last 6 months. Statistical analysis was carried out with SPSS using Mann-Whitney U test.

RESULTS: Data on 37 subjects (24 men), 18 to 84 years old (mean 60.7 years) were collected. 34 (91.9 %) had unilateral amputation, 24 (64.9 %) at transtibial and 9 (24.3 %) at transfemoral level. The cause of amputation was in 26 (70.3 %) non-vascular. 11 (30 %) reported a fall in last 6 months. 7 amputees fell more than once, 4 of those had an amputation at transfemoral level. All other fallers (7) had amputation at lower level. In only 2 cases a fall was related to a prosthesis. Mean value of ABC scale for non-fallers is 71.7±27.8 and for fallers 49.3±24.0. Subjects with history of falls had significantly lower ABC (z=2.39; p<0.017). Mean value of PMQ for non-fallers is 32.96±11.22 and for fallers 20.80±9.58. Subjects with history of falls had significantly lower PMQ (z=2.67; p<0.008).

CONCLUSION: Results suggest that fallers among community-dwelling lower-limb prosthetic users have lower balance confidence and are less mobile. Prosthesis was rarely the cause of a fall. Study limitations include a small sample size and fall classification based on retrospective data that may suffer from recall bias.

INTRODUCTION: Maintaining dynamic balance during walking is immanent to movement of humans. However, there has been little research into dynamic relationship between centre-of-mass (CoM), centre-of-pressure (CoP), ground reaction forces (GRF) and base-of-support (BoS) during walking under perturbed conditions. Consequently, our knowledge on neurophysiological and biomechanical processes underlying efficient balancing during walking is limited. This has considerable implications on limited success of rehabilitation of walking following various impairments. We have developed an innovative perturbing apparatus named Balance Assessment Robot (BAR) that enables unhindered movement of pelvis in all six degrees-of-freedom (DoF) during walking. We have performed several experimental studies recently, applying perturbing pushes to the pelvis of healthy intact subjects walking on an instrumented treadmill. The results have shown that balancing reactions to perturbations in general require well-coordinated responses. At lower speeds of walking control of horizontal component of ground-reaction-force (GRF), achieved predominantly by the action of hip abductor muscles (”hip strategy”) and control of COP achieved predominantly by the action of ankle musculature (”ankle strategy”), are the main balancing strategies. At higher speeds of walking predominant response consists of adequate stepping following perturbing pushes. Little is however known about the coping strategies of people after amputation when being subjected to perturbations during walking.

CASE: A 44-years old male after left trans-tibial amputation (21 years ago) able to walk several kilometres per day on all terrains with different walking speeds and without additional walking aid participated in this case study. The subject was walking on the instrumented treadmill while being in contact with the BAR device. After initial warm-up period where magnitude of perturbations was experimentally determined a period of perturbed walking followed where perturbations were delivered randomly in forward, backward, left and right directions at either left or right heel contact. Seven repetitions of each perturbation were delivered. Speed of treadmill was set to 0.5 m/s. Responses that occurred at the non-amputated, right side were very much similar to responses observed in healthy individuals. However, responses to perturbations that occurred when the amputated limb entered stance have shown lack of both “ankle” and “hip” strategies while the subject relied solely on the stepping strategy meaning that the appropriate activity to decelerate movement of COM started only after the non-amputated side entered next stance. The consequence of such delayed responses was much larger excursion of COM as compared to the responses on the opposite limb.

CONCLUSION: This case study has objectively shown that the capacity to successfully recover from loss of balance during walking in person after trans-tibial amputation is very much reduced when perturbation commences on the amputated side, thus showing that this type of perturbations is much more fall-threatening and should be adequately addressed by appropriate training.
TECHNOLOGY USE AMONG OLDER PEOPLE AFTER LOWER LIMB AMPUTATION IN SLOVENIA – PRELIMINARY RESULTS FROM SAAM PROJECT

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INTRODUCTION: There is not much known about technology use among older people after lower limb amputation (LLA). New technologies, supported with artificial intelligence may enable elderly to stay at home, instead of going to a nursing home. In order to develop technology specifically targeting the elderly, technology use among elderly (including people after LLA) needs to be analyzed. This analysis is part of a Horizon2020 project, called Supporting Active Ageing through Multimodal coaching (SAAM), whose goal is to support the aging population living at home with a novel and practical emphasis on ambient sensing and learning of user needs and preferences, and effective coaching by leveraging the user’s social support networks.

AIMS: The aim of this study was to collect and analyze data of technology use among elderly after LLA to enable them active aging and in this way to stay at home as long as possible.

METHODS: For the purpose of this study, partners developed a questionnaire with 27 questions regarding demographic information, occupation, activities and technology use, which was sent by conventional postal delivery services together with informed consent form to the sample of 296 patients after LLA that were rehabilitated at University Rehabilitation Institute, in 2017. Descriptive statistics are used to present the preliminary results.

RESULTS: We received 63 questionnaires (21% response rate) from which 56 amputees were over 60 years old. Average age was 73.63 (SD 7.96; 43 male and 13 female). Most of them were married (59%), some were widowed (21%), 7% divorced, 5% were single, and 7% in domestic partnership. More of half amputees lived in a rural area and were retired, a third of them was unemployed. A third had primary level of education, and the majority secondary level. Two thirds of them agreed or strongly agreed that social relations are important for them. Two thirds reported diabetes. Regarding technology, less than a third agreed that they enjoy learning and hearing about new technologies. Almost all owned a basic mobile phone and only a quarter owned a smartphone. A third of amputees owned and used a computer on a weekly basis. A very small percentage of amputees (9%) used a tablet. However, use of TV and radio is for most of them on a daily basis. Health monitors were used by almost half of amputees, of which majority had diabetes or other chronic health issue. The use of Internet, e-mail, Facebook and instant messaging was rather low (less than a quarter).

CONCLUSION: Based on these preliminary results on very small number of people it seems that more older amputees live in a rural area and majority does not have a high education and use television, radio and basic mobile phone. Not many are eager to learn about new technologies, which seems to be in association with the education level. Future studies will involve in-depth interviews with older people after amputation about technologies.
REHABILITATION OF PEOPLE AFTER UPPER LIMB AMPUTATION
Being somehow different than others is often difficult and quite a challenge for everyone who has to deal with it. Sadly, there is still a hint of negativity about being disabled nowadays and that is why a lot of disabled people suffer from anxiety, feeling misunderstood or not accepted. I was born without my left hand, so I can say that I know how it feels to be different. But thanks to my family, doctors and my passion for sports, I somehow never really felt very different.

Being without an arm may seem a big handicap for other people but I always say that I am lucky to have been born with my disability. It definitely is easier not knowing how life is with two hands than to lose one in an accident for example. And since I got my first hand prosthesis when I was about 4 months old, I can actually do most of the things using “both hands”. I got my first esthetic prosthesis in order to assure healthier physical development, but later I got the electric prosthesis as well. That made a lot of things easier for me. Suddenly I could do daily things like grabbing and carrying things with both hands, driving a bike and later also a car, tying my shoes and cutting food without any help and with much less effort. That is why I really got used to wearing it and I still do every day. I believe wearing hand prosthesis has – besides more obvious physical advantages – also psychological advantages. I was, especially in adolescence, much more confident whenever I was wearing. That is why I am very happy to have been encouraged by my parents and doctors to wear it even when I was a child. Because of that I have automatized my moves while using electric hand. Some things are easier done with a hand prosthesis, and some without it. But in fact, I have never liked doing anything the easy way. Maybe that is why my life story is somehow special. I have loved sports ever since I was a child and that is why today I am a good skier, snow boarder, bike rider, runner, swimmer etc. Nevertheless, at the end I decided to choose volleyball as my main sport. Kind of strange choice for a person without a hand, I agree, but as I said – I like tough challenges and having my hand prosthesis playing volleyball did not seem so impossible. I started playing with my electric hand, which turned out not to be a very good idea. Therefore, the doctors made me special hand prosthesis just for sports and playing volleyball became much easier with it.

Today I am a member and a captain of Slovenian sitting volleyball national team and being an “amputee” almost seems like a gift to me, because so many incredible things that most of people cannot even dream of, have happened to me.
DESIGNING A NEW TRAINING METHOD FOR ADVANCED HAND PROSTHESES

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INTRODUCTION: New prosthetic hands with advanced technology making it possible to perform many different grasps and positions are now available on the market. This new advanced technology is also difficult for users to control, and studies have shown that the new hand functions are not used to the extent expected (1).

The Örebro Centre for Limb Deficiency and Arm Prostheses has a long experience of prosthetic fitting for both children and adults. About 80% of the adults report daily prosthesis use (2). Today, many prosthesis users find the advanced prosthetic hands interesting and wish to have one. However, when introducing a new prosthetic hand with questionable merits, the reasons for these results need to be considered. In light of our experience from fittings in Örebro, we decided that the training programs for the new hand models were not comprehensive enough, and there was a need for the development of a new method for training.

AIMS: To design a training method for advanced hand prosthetic hands.

METHODS: We performed a review of existing training programs for advanced myoelectric prosthetic hands and combined this with a structured training program, and a treatment philosophy with early fitting and regular follow-up used in Örebro.

RESULTS AND CONCLUSIONS: The training method comprises control training and performance of ADL’s. It follows a structured program based on the 14 steps described in the Skills Index Ranking Scale. The control training focuses on control of all different grasps available with the body in different positions: sitting, standing; with and without support of the arm. The ADL’s are chosen individually through a Canadian Occupational Performance Measure interview. The capacity to use different grasps and integrating the new prosthesis when performing ADL’s is evaluated through the Assessment of Capacity for Myoelectric Control. The method is based on regular support and feedback from an occupational therapist, with follow-ups weekly the first month and then monthly the following 3-6 months. The method has been used on patients with good results.

CONCLUSION: A new method is designed to fit the new multifunctional prosthetic hands. The method can be applied upon prescription of advanced multifunctional prosthetic hands to enhance the functional use of the hands.

REFERENCES:
OCCUPATIONAL THERAPY WITH CHILDREN AFTER CONGENITAL AND ACQUIRED AMPUTATION OF HAND

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INTRODUCTION: Like with adults, occupational therapist (OT) is an important member of rehabilitation team in children after congenital or acquired amputation. The OT has to assess the child’s abilities for various activities and participation, teach them how to perform activities with one hand and made devices and splints that may help them perform activities. When the child is fitted with prosthesis, the OT has to teach the child how to use it.

AIMS AND METHODS: The aim of our study was to review medical and OT records of all children who have visited our Clinic for rehabilitation of children with congenital or acquired amputation after 1996, specially the activities of OT team members.

RESULTS AND CONCLUSIONS: Since 1996, we have treated 20 children (12 boys, 8 girls) after amputation (16 congenital, 4 acquired) of part of their hand (three had amputation just distal to the wrist joint, five had part of the palm, six had thumb and six had two fingers amputated). At the first visit to our clinic, they were 11 months to 15 years old; half of them visited us for the first time before they started school. Ten children were fitted with prosthesis (4 with passive, 3 myoelectric and 3 with silicone one). Eight children got one to three different devices for activities (three for cycling, two for playing a musical instrument – one drums and one violin, one for eating, typing, writing, phone and skiing). Those fitted with myoelectric prosthesis had regular checks and OT treatment; the others received explanation about the possibilities and various advices, including coming back if the child encounters problems at any age with an activity or would like to have prosthesis.

Children after congenital and acquired amputation at the hand level can perform most activities without prosthesis; for some activities, they need special devices made by the OT. Hence, the two main roles of the OT were teaching the children how to use the prosthesis and making devices for different activities.
INTRODUCTION: In the past decade, the relationship between parents, families and health service providers has changed. Parents are being increasingly involved in decision-making and treatment processes. A family-centered approach indicates the importance of providers to understand family belief systems with respect to the involvement of family members. Parents to children with congenital limb deficiency are facing many decisions related to their ideological standpoints and their child during the child’s first years; decisions about e.g. when or if to start interventions. Usually the interventions concern surgical and/or prosthetic treatment.

AIM: The aim of this study was to describe parent’s experiences of their role in decision-making and treatment for children with congenital limb deficiency.

METHOD: A descriptive, qualitative design was used. Data were collected through semi-structured individual interviews. We used a convenience sample to comprise parents from a variety of geographical settings within Sweden. Parents to children from 1 to 10 years, with upper and/or lower limb deficiency were included. Interviews were conducted with 17 parents, including 12 mothers and 5 fathers. Mean age of their child was 5.9 years. Data was analyzed using qualitative content analysis with inductive approach.

RESULTS AND CONCLUSIONS: The resulting categories are showing parents’ experiences from raising a child with limb deficiency. Categories related to the role in making decisions were feelings about and resources in decision making process, facing unwanted decisions, and, trust to the experts. Categories related to the treatment were being a collaborator within the family and between health care providers and family, being a constant supporter for challenges in everyday life, and, handling a variety of needs based on psychosocial issues.

The results contribute to new knowledge and understanding of parents’ as individual persons handling their role in decision-making process in different ways. The parental role in treatment shows satisfaction in collaboration with health care providers but indicate need of psychosocial support as their child grows. The results may improve family centered health service and enhance the care for children with congenital limb deficiency.
**BILATERAL TRANSHUMERAL AMPUTATION – BODY-POWERED OR ELECTRIC PROSTHESES?**

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**INTRODUCTION:** Bilateral transhumeral amputations are rare, mainly caused by high voltage injuries. After such injury, the patients are completely dependent and need a prosthesis or adaptive equipment.

**CASE:** The 34-year old electrician sustained a work related electrical burn injury of both upper limbs that resulted in bilateral transhumeral amputation. Stump healing was delayed (it took 5.5 months). Two months after amputation the patients visited our outpatient clinic for the first time. The occupational therapist demonstrated him the adaptive equipment for activity of daily leaving (ADL), he visited our smart home, we explained him the prosthetic options.

The occupational therapist designed some adaptive equipment and suggested some other solutions for ADL. Many were produced by his father and they are fixed to walls and furniture at his home.

We also fitted him with a body-powered prosthesis. He used them in his workshop for welding and soldering. Two years later he bought a myoelectric prosthesis with electric elbows and bionic hands.

We sent him a Standardised five-level (1=not satisfied at all, 5=very satisfied) questionnaire Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) to assess both types of prosthesis.

Average device subscale score for body powered prosthesis was 4.1, average service subscale score was 4.75 and total QUEST score was 4.3.

For electric prosthesis average device subscale score was 3.1, average service subscale score was 4.25 and total QUEST score was 3.5.

The biggest score differences were in the questions about the satisfaction with weight, the ease and adjusting the parts of device, safe and security, durability, ease to use the device and service delivery program. The scores for body powered prostheses were higher.

**CONCLUSION:** For experts who work in clinical practice, it is very difficult to justify the value of expensive prosthetic components if the difference is not clear and provable. It is even more difficult when patients decide to buy and later find that more expensive components are not as useful as they expected.
DIRECT SKELETAL FIXATION (DSF) IN TRANSFEMORAL AMPUTATION: EVIDENCE REVIEW

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INTRODUCTION: There has been a considerable surge of interest in direct skeletal fixation of prosthesis to enhance prosthetic rehabilitation outcome. DSF is now perceived as a viable alternative to conventional socket prosthesis for carefully chosen patients. We have seen an increase in publications on the methodology and outcome of different surgical techniques. This presentation is a summary of an evidence review presented at the workshop on transfemoral DSF organised by ISPO UK in January 2018.

AIMS: DSF – surgical technique, implant material and rehabilitation duration, vary widely between the different methods practiced at present. The aim of this literature review is to provide an overview of the different methods and published outcome for the benefit of the clinicians managing transfemoral amputees.

METHODS: A literature search was carried out personally and through the St George’s Hospital library. The publications relevant to clinical practice were selected and the material on basic science was omitted.

RESULTS AND CONCLUSIONS: At present there is no Cochrane collaboration or meta-analysis on DSF available. The reviews carried out by a group of orthopaedic surgeons in the US, rehabilitation medicine clinicians in Canada and Bazian, a UK based company commissioned by NHSEng all drew similar conclusions. The hierarchy of evidence being low, mostly retrospective with design limitation and publication bias. Subject to these limitations they concluded that DSF improved quality of life and is safe.

National Institute of Clinical Excellence (NICE) UK provides 4 categories for surgical innovations. The current recommendation is for DSF to be carried out with special arrangements in place. Similarly FDA in the US has granted a limited approval for DSF.

Based on the present evidence, a multi-centre, prospective research, comparing DSF with socket use aiming for a higher level of evidence would be recommended.

REFERENCES: A list of the published references will be made available during presentation.
18 YEARS FOLLOW-UP OF PATIENTS WITH TRANSFEMORAL AMPUTATION TREATED WITH THE OPRA IMPLANT SYSTEM IN SWEDEN - A DESCRIPTION OF IMPLANT MECHANICAL COMPLICATIONS

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INTRODUCTION: Bone-anchored prosthesis (osseointegrated; OI) is an alternative treatment for patients with transfemoral amputation (TFA) with problems wearing socket-suspended prostheses. The OI-prosthesis has been shown to increase quality of life, improve sitting comfort and increase the amount of use of the prosthesis. In Sweden the OPRA implant system has been used since 1999. The OPRA consists of three main components: a cylindrical titanium fixture (the inner component), an abutment and an abutment screw (two outer components). The treatment requires two surgeries. At the first surgery (S1) the fixture is inserted into the residual femur and about six months later at the second surgery (S2) the abutment and abutment screw are inserted and connected into the fixture. The design of the implant allows changing the abutment and/or the abutment screw leaving the osseointegrated fixture untouched.

It is important to survey and identify possible reasons for complications in the implant system in terms of biological failure between the bone and the fixture causing aseptic or septic loosening and mechanical failure caused by complications between the components e.g. fractured components, wear in-between the components or bended components.

AIMS: The main purpose was to describe the mechanical complications in the OPRA implant system.

METHODS: All 124 individuals (mean age 44 years (17-70) at treatment) treated for the first time with OPRA at the Sahlgrenska University hospital in Sweden between January 1999 and December 2017 were included (n=134 implants; 10 individuals with bilateral TFA were treated bilaterally). Time since S2 varied between 0.5–18 years. Data regarding any actual event that led to a change of the abutment or abutment screw was considered as a complication and was collected retrospectively on individual level from the hospital medical records.

RESULTS AND CONCLUSIONS: There were 384 mechanical complications registered in 73 individuals (59%). Fifty-one individuals (41%) had not experienced any mechanical complication, thus no change of any component was registered. Patients with unilateral TFA had 95% of all complications (n=363). The time from S2 until the first event of a mechanical complication varied between 301 days - 13.4 years. Seventeen percent (21/124) of the patients had had more than 5 complications each (6-27) and this group accounted for 71% (274/384) of all complications. The most common mechanical complication was a fracture of the abutment screw.

More than half of the patients treated with OPRA in Sweden had experienced at least one implant mechanical complication that resulted in the need to change one or both of the outer components. Reducing the amount of these complications is of high importance and further research is needed to identify possible reasons for repeated mechanical complications.
DESCRIPTION OF PROSTHETIC ACTIVITY LEVEL AND IMPLANT MECHANICAL COMPLICATIONS IN PATIENTS WITH UNILATERAL TRANSFEMORAL AMPUTATION TREATED WITH THE OPRA IMPLANT SYSTEM IN SWEDEN – A RETROSPECTIVE COHORT STUDY

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INTRODUCTION: The OPRA system for attachment of transfemoral (TFA) bone-anchored prostheses has been used since 1999. Treated patients are followed at defined time-points including answering the Questionnaire for Persons with a Transfemoral amputation (Q-TFA). Patient-reported results include more prosthetic use, improved prosthetic mobility, fewer problems and an improved general situation as compared to before treatment. Mechanical complications in terms of bent, fractured or wear of the outer implant parts (Abutment and Abutment Screw) have been shown to increase between 2- and 5-years follow-up. The relation between these mechanical complications and prosthetic activity level needs to be investigated.

AIMS: To describe prosthetic activity level and to study its relation to number of implant mechanical complications among patients treated with OPRA in Sweden.

METHODS: In this retrospective study all patients with a unilateral TFA treated in Sweden year 1999-2017 were included. Patients not followed for one year and those with an early implant failure were excluded. An activity level score (0-4) was developed and assigned retrospectively for each patient at five time points; preoperatively, at 2-, 5-, 7- and 10-years follow-up. The activity score is based on hospital records and answers in Q-TFA and combines the amount of prosthetic use, use of walking-aids, walking habits and other prosthetic activities (i.e. biking, gym training etc.). Zero means no prosthetic activity and a higher score means a larger amount of demanding prosthetic activities. Mechanical complications enforcing a change of any of the outer implant parts were taken from medical records. The Spearman’s correlation coefficient (rs) was used to assess the relationship between number of complications, demographic variables and the activity score at each time-point.

RESULTS AND CONCLUSIONS: One hundred patients with a medium follow-up time of 7 years (1-15) were included (69% men, 31% women; mean age at treatment 45 (Sd 12.7) years, amputation cause: 69% trauma, 19% tumor, 12% other). At each time-point the activity score was higher as compared to preoperative. Thirty-nine percent of the patients had not had any mechanical complication and 69% had experienced at least one complication. In total 363 mechanical complications were recorded (mean 3.6, Sd 5.8, n=100). A positive significant correlation was demonstrated between number of complications and number of follow-up years (n=100 rs 0.511) and number of complications and a higher activity score at each time point (2-year (n=85) rs 0.440; 5-year (n=63) rs 0.490; 7-year (n=55) rs 0.558 and 10-year (n=32) rs 0.503, respectively). There were no relationship between number of complications and gender, BMI or residual limb length, respectively. The group of patients with any mechanical complication had a significantly higher activity score at each time-point as compared to those with no complication.

CONCLUSION: The relation between prosthetic activity level and number of implant mechanical complications in patients with unilateral TFA treated with OPRA in Sweden is demonstrated. This study is a first step to assess this relationship. The activity level score needs further investigation. To fully understand how mechanical complications can be avoided more detailed studies are needed.
INTRODUCTION: A survey conducted in 2001 indicated that over 66% of respondents with a transfemoral amputation fell at least once in the past year. It is therefore of clinical importance to understand the responses of individuals with an amputation to balance perturbations and how interventions can affect these responses. One potential intervention is the use of an auto-adaptive prosthetic knee (AAK) which has been associated with a reduced number of self-reported falls and stumbles. A biomechanical explanation for this finding, however, is lacking.

AIMS: The aim of this study was to compare the use of a non-microprocessor-controlled prosthetic knee (NMPK) and an AAK (the Rheo Knee II) on responses to anteroposterior platform perturbations during walking.

METHODS: Participants were measured twice: once with their own NMPK and once with the Rheo Knee II. Data were collected using a CAREN system consisting of an instrumented treadmill and a 12-camera VICON system. We measured perturbed and non-perturbed walking, both at preferred walking speed. A control group was included for reference purposes. Anteroposterior platform perturbations (magnitude 0.2m, speed 0.2 m/s) were applied during the single stance phase on the prosthetic leg and during the end of the swing phase of the prosthetic leg. The primary outcome measure was the backward margin of stability (BMoS), which is the distance between the extrapolated center of mass and the base of support. A increased BMoS has been associated with an decreased risk of falling.

RESULTS AND CONCLUSIONS:
MPK vs NMPK condition: The BMoS of the steps after the stance phase perturbations in the Rheo Knee II condition was significantly increased when compared to NMPK condition. This is explained by a smaller foot forward placement and step length in the Rheo Knee II condition when compared to the NMPK condition. For the BMoS of the steps after the swing phase perturbations no differences were found.
Perturbed vs non-perturbed condition: In the Rheo Knee II condition, the BMoS of the steps after the stance phase perturbation was significantly increased when compared to non-perturbed walking. This was also seen in the controls. This was achieved by decreasing the step length and foot forward placement during perturbed walking. In the NMPK condition, the BMoS of perturbed walking was comparable to the BMoS of non-perturbed walking.
These results suggest that the Rheo Knee II enabled the use of strategies that are also used by non-amputees where this was not the case for the NMPK condition. This study provides initial findings that might explain the decrease of self-reported falls and stumbles that have been associated with the use of AAKs.
COGNITIVE PERFORMANCE AND BRAIN DYNAMICS DURING WALKING WITH CURRENT AND NOVEL PROSTHETIC DEVICES

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INTRODUCTION: An issue of bionic feet in general is the control of propulsive forces during walking. It is known that the brain plays a central role in human gait. Therefore, one of the solutions to optimize the control of bionic feet is neuroprosthetics, meaning that the prosthetic device is controlled by electrical signals from the muscle or the brain. The acquired electrical signal is then used to optimize the movement of an artificial limb. A first step towards non-invasive brain-computer interfaces of lower-limb prostheses is determining the supraspinal control of human locomotion.

AIMS: The aim was to investigate the attentional demand and electro-physiological brain measures during walking at normal speed in able-bodied individuals (CON), transtibial (TTA) and transfemoral amputees (TFA). The latter two subject groups conducted experiments with current and novel prostheses.

METHODS: 6 CON conducted one experimental trial, and 6 unilateral TTA and 6 unilateral TFA performed 2 experimental trials; the first with the current and the second with a novel prosthesis, i.e. the Ankle Mimicking Prosthetic foot or AMPfoot 4.0. Each experimental trial comprised 2 walking tasks; 6 and 2 min treadmill walking at normal speed interspersed by 5 min of rest. During 6 min walking the sustained attention to response (go-no go) task, with measures reaction time (RT) and accuracy (ACC), was performed. Electro-encephalographic data were gathered when subjects walked 2min. Motor-related cortical potentials (MRCPs) and brain sources of MRCPs during gait were examined. Normality and (non-)parametric tests were conducted (p<0.05).

RESULTS AND CONCLUSIONS: In contrast to TTA, TFA required more attentional demands during walking with AMPfoot compared to the current passive prosthetic device and CON (RT and ACC: ps0.028). This emphasizes that AMPfoot is not suitable for TFA. Since no significant differences were observed in MRCP amplitude and latency of any peak deflection, these measures might be used to optimize the control of lower-limb prostheses. The first positive electro-physiological deflection showed higher activity within the underlying brain sources in TTA walking with AMPfoot compared to CON, possibly due to the limited acclimation period to the novel device and consequently increased afferent sensory feedback for postural control.

To conclude, TTA did not alter the attentional demand during walking with AMPfoot compared to the current prosthesis and CON, in contrast to TFA. Electro-physiological signaling at electrode site Cz during walking is similar between TTA and CON. TTA showed higher activity within underlying brain sources of the first positive electro-physiological deflection during a gait cycle, which is probably due to increased afferent sensory feedback signaling related to maintaining postural control.
TAKE THE EXTRA STEPS: VARIABILITY OF SPATIOTEMPORAL AND KINEMATIC VARIABLES OF INDIVIDUALS WITH A TRANSFEMORAL AMPUTATION

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INTRODUCTION: The gait pattern of individuals with an amputation is usually quantified using a limited amount of steps. However, it is unknown whether collecting, for instance, 10 steps provides a gait pattern that is reflective of everyday walking. In addition, it is unknown what the variability of the gait pattern is between measurement sessions. Because this variability is unknown, it is hard to understand whether differences between prosthetic interventions are true differences or fall within day-to-day variations.

AIMS: The aim of the current study was to quantify the within-session and between-session variability of spatiotemporal and kinematic variables of individuals with a transfemoral amputation.

METHODS: A total of three participants were included: age etc. A total of 5 or 6 gait analysis sessions were performed on different days and different time of days (morning, early afternoon and late afternoon). No changes were made in prosthetic configuration and participants wore the same shoes during all measurement sessions. Data were collected using a six-camera Vicon system. We placed markers according to the lower-body plug-in-gait model. All markers were placed by the same researcher. A total of 150 steps were collected and analyzed using Vicon nexus and custom-build Matlab 2011b software.

RESULTS AND CONCLUSIONS: Differences in spatiotemporal and kinematic variables between sessions were substantial, especially for walking speed and peak prosthetic knee flexion during swing. Differences on these outcome measures can be up to 10% especially when analyzing less than 30 steps. Of the four presented variables, only peak hip extension during stance appeared to have a low variability between sessions.

The results indicate that the gait pattern of individuals with a transfemoral amputation can have substantial variability. This has to be taken into account when describing differences between, for instance, prosthetic knees. The presented results also seem to indicate that incorporating 15 steps or less does not necessarily reflect a gait pattern that is seen during longer-distance walking. Authors should clearly state the number of steps that they have analyzed so that the legitimacy of their results can be assessed.
VALIDATION OF THE CYBERLEGs ACTIVE TRANSFEMORAL PROSTHESIS (ATP) DURING VARIED AMBULATION TASKS

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INTRODUCTION: The global goal of the CYBERLEGs Plus Plus project is to validate the technical the powered robotic ortho-prosthesis developed within the framework of the FP7-ICT-CYBERLEGs project as a means to enhance/ restore the mobility of transfemoral amputees and to enable them to perform locomotion tasks such as ground-level walking, walking up and down slopes, climbing/descending stairs, standing up, sitting down and turning in scenarios of real life. Restored mobility will allow amputees to perform physical activity thus counteracting physical decline and improving the overall health status and quality of life. A major part of accomplishing this goal has been the development of a new powered transfemoral prosthesis, the CYBERLEGs ATP. By assisting the user with actively powered joints, it is hoped that this new prosthesis is able to assist those who may not be able to use other current prosthesis technologies due to weakness.

AIMS: CYBERLEGs Plus Plus aims to investigate a new powered transfemoral prosthesis which is paired with a wearable sensory apparatus to attempt to fluidly detect gait events and react accordingly. This wearable sensory apparatus consists of IMUs and instrumented insoles developed by partners within the consortium. The prosthesis has both a powered knee and ankle that are capable of approximating natural joint behaviors through the use of series elastic actuation. The newest CYBERLEGs ATP is a fully self contained system including the ability to communicate directly with the sensor system, an improvement over earlier versions which had tethered control electronics. The device intends to assist the user in accomplishing the tasks of ground-level walking, walking up and down slopes, climbing/descending stairs step over step, standing up, sitting down, and turning with greater ease and stability than current prosthesis technology.

METHODS: Amputees have been tested in the lab environment in each of the different target tasks (6 minute walking test, Stair climbing, Timed get-up and go). After an extended training period, the performance of the ATP will then compared to the behavior of the subject's own prosthesis during the same tasks. Performance is then assessed based on user capability, user effort as determined through metabolic consumption and qualitative questionnaire, and measured joint kinematics.

RESULTS AND CONCLUSIONS: As of submission, the device has proven to be able to assist one user for the actions of treadmill and level ground walking, sit to stand and stand to sit movements, and stair climbing/decent actions. Further improvement of the system and measurements on a number of test subjects is ongoing to prove efficacy of the system in gait detection, assistance, and metabolic effort when compared to current prescribed devices.
INNOVATIVE MECHATRONICS DEVICE FOR UPPER LIMB REHABILITATION

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INTRODUCTION: Impaired arm movements, a frequent consequence of stroke as the leading cause of disability in the developed countries, but also of muscle atrophy and dystrophy conditions, imply an increasing need for physical rehabilitation. The insufficient number of physical therapists coupled to the time-intensive traditional therapeutic procedures, whose progress and efficiency is often hard to follow and assess, are a limiting factor in this regard. This has recently prompted the development of mechatronics rehabilitation devices that not only enable the achievement of a large number of adaptively assisted movements, but also allow a single therapist to assist concurrently three patients. However, the commercially available devices are expensive and capacious, while their adaptability to the personalised rehabilitation needs is limited.

AIMS: The aim of this works is to design an advanced mechatronics arms’ rehabilitation device that is versatile and allows an increased range of assisted arms’ movements, but also portable, efficient and cost-effective, providing high intensity and frequency treatments. The device will enable coordinated arms’ movements assisted by actuating devices whose power contribution depends on the level of the autonomous effort provided by the patient, as well as on suitable sensing elements and a complementing control architecture.

METHODS: A crucial task in designing versatile rehabilitation devices is the study of the anatomy and kinematics of arms’ movements. In recent literature, it was shown that a structure with seven degrees-of-freedom (DOFs) can assure a good combination of motion accuracy and acceptable device complexity. The coordinated use of the DOFs of the designed assistive mechatronics device is hence based on inverse arms’ kinematics, i.e., on the conversion of the position and orientation of manipulator’s end-effector from Cartesian space to the DOFs of the used servo actuators. A geometric approach based on the rotation matrices in Euclidean space and the Denavit-Hartenberg parameters, which allow simplifying the considered kinematics via coordinate transformations in a single homogeneous transformation matrix, is hence employed and implemented in the Matlab/Simulink environment. Based on these considerations, electronics components (actuators with power supplies and feedback sensors) fitting the characteristics of the resulting mechanism are chosen, while an appropriate simultaneous real-time control system is being developed. What is more, the device will be mainly based on 3D printing passive components that enable its easy reconfiguration according to the needs of the single patients, while assuring its reduced weight and space requirements.

RESULTS AND CONCLUSIONS: The design of all the elements of the prototype of the innovative mechatronics device presented in this work will enable a highly efficient rehabilitation of the patients with reduced functionality of upper limbs. The concept will enable the control and insight in the active recovery process of the patients with an explicit reduction of the waiting times for the recovery procedures. What’s more, a further development expanding its architecture with a virtual reality interface, will allow boosting the patients’ motivation, which should lead to an even faster and more efficient recovery, i.e., the fast return to everyday activities.

Keywords: arm rehabilitation, mechatronics device, innovative design, inverse kinematics parameters
INTRODUCTION: There are many different clinical tests to assess movement parameters of people with disabilities, e.g. the Southampton Hand Assessment Procedure (SHAP), Action Research Arm Test (ARAT) or Functional Gait Assessment. All tests require special knowledge of the examiner to obtain representative assessment of the performance.

AIMS: We would like to present possibility of upgrading standard movement tests by implementing non-visual, visual, and mechanical measurement systems. With additional sensors new information about task performance can be obtained. In addition to the desired parameters measurement systems can provide details about kinematics (e.g. joint angles, travelled path, work area), task segmentation and descriptive events that enable the examiner more detailed analysis of the performed test.

METHODS: Movements can be assessed with laboratory grade measuring equipment (e.g. Optotrak, Vicon, force plates, force/torque sensors, measuring mattresses) or low-cost wearable systems (e.g. inertial measurement units, Kinect, pressure measuring insoles). Presented equipment was implemented in different experiments performed in the Laboratory of Robotics, FE UL.

RESULTS AND CONCLUSIONS: Optoelectronic measurement system Optotrak has high accuracy and it is used as a reference system for any validation procedures. Wearable system comprised of inertial measurement units (IMUs) and measuring insoles is used for whole body awareness to access kinematic and kinetic parameters (joint angles, travelled path of individual limbs, segments’ velocity, interaction forces, joint torques), phase segmentation of different movements (gait, sit-to-stand, stand-to-sit, stairs negotiation) and intention detection. As the IMUs are very small and unobtrusive can be used for monitoring infant movements, spine movement analysis, and even for assessing stability parameters. While examining parameters during performance tests, IMUs serve as a support sensors for integration with used objects to provide information about object interaction. Knowledge about kinematics obtained via stationary or wearable measurement systems can be used for detailed analysis and identification of e.g. compensatory movements.

Different force/torque sensors are used for assessing interaction forces during grasping or reaction forces during different movements. Pressure measuring mattress is used for providing information about pressure distribution while sitting in the wheelchair at different seat inclinations or performing task while sitting. From directly measured quantities indirect parameter, e.g. human joint torques, centre-of-pressure, centre-of-mass, or zero-moment-point, can be derived.

By integrating additional sensors into existing movement tests examiners get additional valuable information about the performance of the examined tasks. New parameters can provide insight knowledge about tasks execution and thus improving the overall results of the performed studies.
INTRODUCTION: At the end of 25 years, there have been fundamental changes in the approach of the production of orthoses and prostheses. Soon after the implementation of the first numerical production systems, with all the disadvantages and high price, it was noted that their application in O&P practice has a future. In this sense, our team, with its own ideas, contributed in development of the CAD/CAM and robot based production systems.

AIMS: Orthoses and prostheses are often supplied to people with limited working ability and low income. Now days, we are witnessing increased needs for such products. Population in developed countries is getting older and more active, and we are faced with an increased incidence of metabolic diseases, such as diabetes, which requires adequate orthoses. Besides, orthopedic aids are often the target of cuts in health budgets due to high demand and prices. Digital production systems exist, but significant problems are still associated with them, for which their application in practice has still not reached an appropriate level. The goal is therefore to achieve such production systems that will fully meet the technical requirements for mold production at an affordable price, and to be affordable and easy to implement.

METHODS: In designing the methodology to problem solving, we were lead by the guidelines that such a machine must be:

• affordable
• made of standard components
• suitable fast and functional
• of small dimensions
• easy to use
• quiet
• safe

Although it is difficult to satisfy the stated criteria completely, it is possible to define the set of characteristics that would achieve the optimal design of the machine and its performance. This approach has proved to be effective in practice.

RESULTS: A number of conceptual and fully functional solutions have been realized which have found their application in practice, where they fully meet the purpose. These are manufacturing systems for the production of orthoses and molds for orthoses and prostheses based on numerical components in the form of 3, 4, 5 and 7 axis milling machines. Also, systems based on standard industrial robotic arms have been developed, along with all the necessary software support.

CONCLUSIONS: A working group was formed with the aim of defining a new approach that would allow faster and easier implementation of CAD/CAM technologies in O&P practice, for the purpose of advanced and cheaper manufacturing of these products. For this purpose, a methodological approach with the guidelines was defined, whose adoption within the technical and financial possibilities made possible optimal design of a functional machine. This approach has proved to be effective, and results have been achieved through the implementation of CAD/CAM technology in O&P practice.

RELIABILITY OF MODIFIED SENSORY INTERACTION SINGLE-LEG STANCE TEST USING A FORCE PLATFORM
INTRODUCTION: In addition to standing on both feet, it is important for people to successfully maintain posture and balance on one leg as well. Since, in quiet stand, the projection of the center of pressure is never still, the measurement of the various variables of center of pressure movement enables the evaluation of the ability for single leg stance without support. Purpose: The purpose of this study was to determine the reliability of the modified sensory interaction single leg stance test using a force platform in young and healthy subjects.

METHODS: The study involved 12 young (18-23 years old) and healthy females. The test was performed standing on the dominant leg on the force platform for three sensory conditions: standing on a firm surface with eyes open and closed and on compliant surface with eyes open. Each measurement lasted 60 seconds at a sampling frequency of 200 Hz. To determine the reliability, the measurements were repeated after seven days, 30 seconds of each measurement was used for the analysis. Nine variables of the center of pressure movement were observed: medio-lateral and antero-posterior displacements, total path length, velocity, medio-lateral and antero-posterior path length, sway area from principal components, sway area calculated by Fourier coefficients and sway area calculated by Fourier coefficients divided by sway area from principal components. Results: The most reliable variable for standing on a firm surface with eyes open was medio-lateral path length (intraclass correlation coefficient = 0.848). For eyes closed, the most reliable variable was sway area calculated by Fourier coefficients divided by sway area from principal components (intraclass correlation coefficient = 0.644). As well as for standing on the firm surface with eyes open, medio-lateral path length was the most reliable variable also for standing on the compliant surface with eyes open (intraclass correlation coefficient = 0.877).

DISCUSSION AND CONCLUSION: When applied the modified sensory interaction single leg stance test on the force platform with healthy, young subjects the results varied from excellent reliability to not being reliable. Although some variables have shown poor reliability, those with excellent reliability can still be used for evaluating the abilities to maintain posture and balance. The most (six out of nine) observed variables proved excellent reliability during single leg stance on a compliant surface with eyes open.

Key words: test, sensory interaction, single leg stance, stabilometry, reliability
LOWER LIMB PROSTHETICS
INTRODUCTION: Additive manufacturing technologies have allowed the fabrication of personalized designs, principally for prototyping. However, Carbon fiber reinforced polymer parts fabricated by AM technologies allow the fabrication of composite parts with high strength sufficient for end-use parts.

AIMS: The main aim of this research is focus on develop a 3D printed prosthetic pylon, and evaluate by FEA the mechanical performance of it under critical loads of gait cycle.

METHODS: An FEA model was developed in order to evaluate the structural performance of a prosthetic pylon prototype, following the ISO 10328-2016 standard. The FDA design control guidance for medical device manufacturers was used to develop an additive manufactured prosthetic pylon. Compressive and flexural mechanical properties of a 3D printed carbon fiber reinforced material have been analyzed from a previous study in order to establish the mechanical property constants for the FEA model. Four different CAD prototypes have been designed and evaluated under a 2D model. Then, a joining mechanism of pylon to a standard prosthetic union system was studied by 3D structural simulation, analyzing the strongest prototype design from the 2D models. The simulation analyzed critical points of the gait cycle, specifically at the heel strike (4130 N) and toe off (3623 N) walking phases according to P4 level of ISO 10328-2016 standard.

RESULTS AND CONCLUSIONS: The FEA study demonstrated that the joining mechanism of nut attachments has a higher risk of failure than the plate mechanism, because stress concentrations on the nut system are higher than the yield stress of material. The final prototype evaluated under heel strike and toe off walking phases have lower maximum stress than the stress at proportional limit of the material. Structural FEA of a final pylon prototype fabricated by AM has demonstrated that the prototype resists loads of K3 level patients under the most critical loads of walking cycle.
DESIGN OF A NOVEL FOOT DEVICE FOR PROSTHETIC APPLICATIONS FABRICATED WITH FIBER REINFORCEMENT ADDITIVE MANUFACTURING TECHNOLOGY

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INTRODUCTION: The emergence of new additive manufacturing technologies has driven the research and development of custom devices at lower cost and meeting with the functional needs of patients. This possibility of functional personalization at a lower cost encourages the development of this research focused on the design, fabrication and preliminary computational validation of a novel foot device for lower limb amputee patients, implementing continuous filament fabrication (CFF) additive manufacturing technology.

AIMS: (1) To evaluate CFF technology mechanical properties to be used in the fabrication of a novel prosthetic foot design and (2) validate the foot design stiffness and structural integrity by using finite element analysis (FEA).

METHODS: A mechanical characterization of CFF technology was performed by three-point flexural testing to study the effect of reinforcement material (carbon fiber and fiberglass) and volume ratio on flexural properties. FEA is employed to verify prosthetic foot stiffness and structural integrity. Boundary and loading conditions for the design validation were defined according to standard ISO 22675. An iterative design process was developed to optimize variable stiffness of the prosthetic foot design.

RESULTS AND CONCLUSIONS: Three-point flexural tests results show a non-linear increase of mechanical properties with the increase of reinforcement volume ratio. CFF technology achieved maximum flexural modulus of 8.42 GPa and a proportional limit of 135.72 MPa with the parameters defined in this study. Fiberglass was selected as the reinforcement material for the foot prototype due to its stiffness, proportional limit and the possibility to absorb more energy when it is deformed elastically as well its low cost compare to carbon fiber. Simulation results confirms the possibility of developing a low-cost customized prosthetic foot device fabricated with CFF technology that replicates ESAR stiffness and structural integrity. The prosthetic foot was designed with optimized variable stiffness (from 38.34 to 60.78 N/mm) for heel-strike and toe-off stances. Further mechanical and biomechanical studies will be developed to validate the foot design.
MODERN FIRST PROSTHETIC FITTING OF A MOTORCYCLIST FOLLOWING TRAUMATIC BELOW-KNEE AMPUTATION

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**INTRODUCTION:** Traumatic amputation caused by motorcycle accident represents a sudden and unexpected cause of amputation in young patients. Traumatic amputations make 15% of the total number of amputations.

**CASE:** The patient SF, born in 1989, was injured as a motorcycle rider. During the accident, he suffered a left below-knee posterior tibial artery transection. Revascularization was attempted, however, due to the lack of perfusion distal to the site of injury, the patient underwent a left below-knee amputation with wound debridement. The stump infection postponed the hospital admission and initiation of the prosthetic rehabilitation. Polytrauma is the most common consequence of motorcycle accidents. Besides extensive injuries of the soft tissues of the left knee, a patient also suffered injury to the pelvis, which was treated by repositioning. After his stump infection has been cured, the patient was admitted to the Special Hospital for Rehabilitation and Orthopedic Prosthetics in Belgrade. The phase of preprosthetic preparation included general conditioning exercises, continuing skin care, prevention of contractures and the use of shrinkers until the stabilization of the stump volume was achieved. The device was fabricated according to the prescription: a below-knee prosthesis with a test socket, skeletal construction, Tritton prosthetic foot and a silicone sleeve. During the gait training with a test socket, the patient complained of the pain occurring in the left lateral aspect of the left knee. Painful sensations were eliminated by extirpation of the remaining fibula by an orthopedic surgeon. Upon wound healing, stabilization of the stump volume and improvement of the skin quality, the patient obtained the second test socket. After further stabilization of the stump volume, a definitive socket was fabricated and then completed with attachment of the Tritton prosthetic foot. The gait school was continued. The patient could walk successfully without any assistive devices. Occasional occurrence of bullae at the surgical incision site across the anterior portion of the stump caused interruptions to the gait school.

**CONCLUSION:** Prosthetic rehabilitation of a young man, a motorcyclist, requires going faster through the training phases, but, traumatized skin urges for patience and tolerance. After stabilization of the stump volume and fabrication of a definitive socket, the liner alleviated stump changes and painful phases. Stump perspiration required better hygiene and more frequent doffing of the liner. All gait phases passed without extension of time for their performance. Since the National Health Insurance Fund does not cover procurement of the prosthetic components such as a liner, Tritton foot and a silicone sleeve, the patient has to rely on sponsors and personal resources. This type of prosthesis represents a standard in prosthetic rehabilitation of young people and children, although weaknesses of the Rulebook can negatively affect it. Further activity is necessary to confirm recommendations of this work and start thinking about corrections of the Rulebook on the fabrication of orthopedic devices.
FITTING HYBRID SOFT SOCKET ON DIFFERENT LOWER LIMB AMPUTATION LEVELS AND MANAGING VOLUME CHANGES

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INTRODUCTION: There is an increasing awareness around the importance of including quality of life as an outcome measure in ensuring substantial amputee rehabilitation. Finding outstanding solutions for patient stability, safety, comfort, stump volume management as well as a cosmetic appearance of a prosthetic device are all part of our continual efforts in successful patient management. They all are imperative factors that are considered during the development of prosthetic devices for our patients, regardless of amputation levels, age or gender. Throughout the course of our experience, we have established a set of procedures for supplying prosthetic care to our patients, which involve: consultations, taking measurements, developing prosthetic devices, trials, device fittings as well as ensuring overall patient satisfaction with the end results.

CASE: The aim of this case study is to present different solutions for patients of various genders, age and amputation levels, whose common denominator was their dissatisfaction with their previous prosthetic devices. Their biggest distressing issues were managing stump volume changes and maintaining stability while ensuring socket comfort. Previously, they had used rigid conventional prosthetic sockets, which didn’t adapt to their stump volume changes throughout the day thus causing worse suspension, skin irritations and overall discomfort. In order to address these issues, we fitted the patients with hybrid soft sockets with integrated volume managing aids. All sockets were designed to ensure maximum bone stabilization and at the same time enable maximum range of motion. We will present the different approaches we’ve put to use in order to handle changing stump volumes in the socket during the day and with that maintaining good stability, comfort as well as good suspension.

CONCLUSION: All amputees involved in this case study have reported improved stability, comfort and reduced energy consumption throughout the day, which has resulted in increased quality of life and more fitting everyday use of prosthetic devices. We strongly believe that it is of great importance to ensure all our patients are fitted with state of the art sockets that are customized to fit their needs and constantly adapt to daily stump volume variations. This goal is attainable through the use of latest materials and technologies and the advancement of prosthetic development methods.
INTRODUCTION: The prosthesis for hip disarticulation and transpelvic amputees are rare and most prosthetist have limited experience fitting these patients. The main problems are high energy requirements, uncomfortable sockets and bad control of the prosthesis, so the level of rejection is high. How is fit the socket is critical because it determines comfort, functional capabilities of the prosthesis and acceptance of the amputees.

CASE: The 53-year-old teacher lost her leg at age 15 due to osteosarcoma at hip disarticulation level. She used classical (Canadian) type prosthesis socket, 7E7 hip joint (Otto Bock), 3R45 knee joint (Otto Bock) and Elation foot (Ossur).

Because of negative consequences of long-term usage of the prosthesis she wanted more comfortable socket, less energy requirements of the prosthesis and more safety during walking with prosthesis.

We made classical style (Canadian) socket with Helix hip joint (Otto Bock), C-Leg electronic knee (Otto Bock), 1C63 Triton LP carbon foot (Otto Bock). She walked more secure, but we still had problems with comfort of the socket and control of the prosthesis.

For this reason we looked for new design of the socket. Bikini style socket incorporates ischial containment which prevents the tuberosity from slipping out of the socket and improves control over the prosthesis. The pubic ramus is also contained within the socket, but it must not cause discomfort. Together with iliac crest stabilizers, ischial containment stabilizes the prosthesis in the coronal and sagittal planes (A-P movement).

The result is a lighter prosthetic socket, superior comfort and control of the socket, easier to fabricate and fit, accommodate weight changes to some degree, less restriction of body movements, better cosmetic appearance.

CONCLUSION: Well-fitting, comfortable socket with proper selection of remaining components is a difficult task for prosthetists who work with hip disarticulation amputees. With good communication between the prosthetist and hip disarticulation amputee, proper attention to details in material selection and socket configuration that goal can be achieved.
REHABILITATION OF PEOPLE AFTER LOWER LIMB AMPUTATION
INTRODUCTION: Rehabilitation of patients after lower limb amputation is a complex process, additionally complicated with following comorbidity.

The goal of this paper is to represent the complexity of primary rehabilitation in the prosthetic phase in patients that require multidisciplinary approach, and the importance of each and every team member, in this case a vascular surgeon because of advanced pathological changes on blood vessels of lower limbs and neck.

The cause of the right below-the-knee amputation is a progressing ischemia caused by an aneurism of the right popliteal artery.

CASE: Aside from advanced pathological changes on blood vessels of both legs and neck that disrupt the vascular status (CT angiography confirmed), it is also important to note that this is the patient with additional comorbidities that significantly complicate primary prosthetic rehabilitation:
- cardiovascular status (cardiomyopathy and hypertension)
- degenerative changes of both hips and knees

Surgical treatment of left popliteal artery aneurism and pre-prosthetic preparation preceded the process of primary rehabilitation in the prosthetic phase. Before the beginning of the rehabilitation process, the assessment of prosthetic potential was made – level of activity K2 (classification system), AMP no PRO 27.

Level of success of applied process of primary rehabilitation in the prosthetic phase is measured by the level of mobility (AMP Pro and LCI scale (locomotor index scale), two-minute walk test, Time up and go, Barthel index) and K levels classification system.

RESULTS: The success of completed primary rehabilitation in the prosthetic phase was as following:
Level of activity K2, AMP PRO 36, 2 minute walk test 92m, Time up and go test 15 seconds, LCI scale 21/15, Barthel index admission/discharge 26/92.

3 month after primary rehabilitation in the prosthetic phase and surgical treatment of left carotid artery follow-up: Level of activity K3, AMP PRO 38, LCI scale 23/19.

CONCLUSION: The success of primary rehabilitation in the prosthetic phase depends on the level of individual investment of every member on the rehabilitation team and team approach, meaning multidisciplinary approach to the rehabilitation. This means that this is the complex form of rehabilitation medicine, particularly considering the fact that these are the patients with severe comorbidities that require constant care and evaluation of an extended rehabilitation team.
INTRODUCTION: The Institute for the Physical Medicine and Rehabilitation “Dr Miroslav Zotović” Banja Luka is a referral center for primary prosthetic rehabilitation of patients with lower limb amputation in Republic of Srpska, but also admits patients for the secondary prosthetic fitting.

The aim of the study is to analyze the structure of the patient population admitted for primary prosthetic rehabilitation in period 2015 - 2017.

MATERIAL AND METHODS: The retrospective study included set of data on all patients with lower limb amputations who were admitted for primary prosthetic rehabilitation in period 2015 - 2017. Data were analyzed using descriptive statistics to determine age, sex, amputation cause and level of amputation.

RESULTS: The number of patients admitted for primary prosthetic rehabilitation was as follows – 2015 – 189; 2016 – 156; 2017 – 153. The number and percentage of males vs. females was: 2015 144 (76%) vs. 45 (24%); 2016 - 127 (81%) vs. 29 (19%); 2017 - 123 (80%) vs. 30 (20%). The average age in 2015 and 2016 was 64, and in 2017 it was 65,4 years.

The most common cause of lower limb amputation were occlusive peripheral vascular diseases, developed as a late complication of diabetes mellitus. The number and percentage of amputations caused by trauma is as follows: 2015 – 14 (7%); 2016 – 4 (3%); 2017 - 13 (9%).

As for the level of amputations, the most common are bellow knee amputations: in 2015 – 125 (66%); in 2016 - 93 (60%), in 2017 - 79 (52%); above knee: in 2015 - 56 (30%), in 2016 - 44 (28%), in 2017 -55 (36%); bilateral amputations: in 2015 - 6 (3%), in 2016 - 11 (7%) and in 2017 - 13 (8%); the other levels: in 2015- 2 (1%) partial foot amputation: in 2016 - 8 (5%) and in 2017 - 6 (4%).

CONCLUSION: The number of patients admitted for primary prosthetic rehabilitation in 2015 and 2016 showed a significant decrease. Male patients admitted for primary prosthetic rehabilitation are largely prevailing (up to four times). As expected, diabetes mellitus is primary cause leading to a lower limb amputation. In 2017 there is significant number of posttraumatic amputations. There is an increasing trend in number of patients admitted with above knee amputations which may indicate the need for prevention and adequate evaluation of vascular status.
6-MINUTE WALK TEST IN PATIENTS AFTER LOWER LIMB AMPUTATION AT DISCHARGE AND AT THE FIRST CONTROL AFTER HOSPITALISATION

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INTRODUCTION: The walked distance in six minutes is a good indicator of patient's submaximal functional performance, reflecting the level of daily physical activity. The 6-minute walk test (6MWT) is also used to assess walking capacity and endurance of gait in subjects with lower limb amputation. Patients use their self-selected pace during the test, so the 6MWT is safe even for patients with elevated risk of complications. Objective: The aim of the study was to determine the difference in the outcome of the 6MWT performed by patients with unilateral lower limb amputations between the discharge day and the first control after hospitalisation.

METHODS: A retrospective quantitative study was conducted. The data on the 6MWT and other characteristics of all inpatients after unilateral lower limb amputation at the University Rehabilitation Institute in Ljubljana were collected from medical documentation for the time-period from January 2017 to December 2017. Results: Twenty-two subjects (19 males, 3 females) were included in the study; 82% of them had trans-tibial amputation and 18% had trans-femoral amputation. They were 21 to 86 years old, 63 years on average. Crutches (45%) were the most commonly used walking aid. On average, 210 days (SD: 81 days) passed between the two tests. The distance walked in 6 minutes improved by an average of 57m (95% confidence interval for mean: from 6m to 107m). We found that the number of days between the two tests was not statistically significantly associated with the improvement in walking distance. The age and change in walking distance were negative correlated, meaning that older patients achieved less improvement in walking distance on average.

CONCLUSION: We observed improvement in the walking distance between the two tests, where by older subjects improved less.

Key words: amputees, 6-minute walk test, lower limbs, walking.
INTRODUCTION: One of the main cause of lower limb amputations is in most cases affected by the peripheral arterial disease (PAD), because of atherosclerosis affecting the various parts of the arterial vessels. The most common diseases following circulatory disorders are diabetes and PAD. In patients with diabetes occurs earlier, than patients with PAD and progresses faster. Blood circulation problems cause prolonged ulcer healing. In addition to ulcers on the stamp, patients of the lower limb amputation also often have other types of ulcers such as, pressure ulcer, abrasions of various sources, fistula on surgical scar and ulcers on the remaining leg. As a result of an aggravated circulation or diabetic foot. In the case of increasing body weight after lower limb amputation, patients are further exposed to the risk of developing ulcers on the amputation stump.

AIMS: In this study, we wanted to determine the number of patients who had ulcers and type of ulcers. We were also interested in the degree of ulceration and whether we were successful in their treatment.

METHODS: A retrospective survey was carried out, and the documentation review was made. In the study were included all patients hospitalized in URI-Soča in the department after lower limb amputation hospitalized from January 1st 2017 to December 31th 2017. The Ethics commission of URI-Soča approved the research. We derived descriptive statistics, Spearman’s correlation coefficient and t-test.

RESULTS AND CONCLUSIONS: In the year 2017 305 patients were hospitalized in URI-Soča, in the Department for rehabilitation after amputation. Various types of ulcers were present in 134 patients. Average age of the patient was 68.3 years According to the sex, various ulcers were present in 107 men and 27 women. Those patients had in total 162 ulcers. The main reason was that 53 patients had two ulcers. At the admission, 90 different ulcers were recorded, and later on, during the hospitalization, 44 patients had ulcerations. The main cause was abrasion on the stump due walking with the prostheses (34 patients), 4 patients received an ulcer due to blow with the wheelchair, other acquired ulcers had other causes for their arising. There was a statistically significant correlation between the formation of ulcers because of walking with the prosthesis and with increased body mass index (BMI) higher than 30 kg/m2 (p=0.001). In the bilateral below knee amputation there was a significant correlation with BMI (p=0.029). There was a statistically significant correlation between allergy caused by the various materials such as prosthesis components or elastic bandage too (p = 0.033).

The number of ulcers in patients who were present at the admission is high and can be an obstacle for the duration of hospitalization. There is also a high number of ulcers on the stump, which also prolonged time of hospitalization. The average age of patients who received ulcer in the hospital was quite high.
INTRODUCTION: Most patients after lower-limb amputation due to peripheral arterial disease (PAD) have changes in the vessels of the remaining limb. Interval training is recommended for treatment of claudication pain. However, this is not possible in patients who have recently undergone amputation, due to their limited mobility. Therefore, other physical therapy methods are used during this period, such as electrostimulation, vacuum therapy, intermittent compression therapy and hyperbaric therapy. The use of elastic adhesive tapes is beneficial for reduction of pain and greater flexibility of joints, reduction of oedema, and some pilot studies have shown that they also increase the flow at the level of microcirculation in healthy subjects. No study about the effects of long-term use of elastic adhesive tapes on blood circulation in patients with PAD has been published.

AIMS: The aim of our study was to determine the effects of elastic adhesive tapes on the improvement of blood circulation in the remaining limb in patients after lower limb amputation.

METHODS: So far, we have included four patients after lower limb amputation and diagnosed PAD in the remaining leg (ankle index above 1.4 or under 0.7; Fontain IIb); our plan is to include ten patients. The subjects were randomly assigned to two groups (3 in experimental, 1 in control group). In the experimental group, the patients had elastic adhesive tape applied over the popliteal fossa onto the m. gastrocnemius and a group of knee flexors. A disburdening technique was used. Patients in the control group will not have tapes. The tapes were applied for a period of 4 days, followed by a 2-day break, and repeated for a total period of 4 weeks. The patients in both groups will continue to participate in the conventional post-amputation rehabilitation program. The following measurements were carried out prior to the inclusion in the study and repeated after 2 and 4 weeks:
- transcutaneous oxygen measurement (TcPO2);
- volume (V) of the calf in accordance with the lymphedema definition protocol;
- 6-minute walk test (6MWT) with the determination of claudication pain and number of repetitions of standing heel-raise.

RESULTS AND CONCLUSIONS: The median value of TcPO2-10min was 21.0 mmHg and of TcPO2-20min it was 32.5 mmHg. The average volume of the lower limb below the knee was 1567 cm³. There were no differences in TcPO2 and in the volume of the lower limb below the knee in the 1st, 2nd and 3rd assessment. The results of both functional tests in the 1st and 3rd tests improved (standing heel-raise test: median: 29.5, 6MWT: median 45 m).

It seems that adhesive taping may improve functional tests and have no influence on TcPO2. A much larger sample size is needed to obtain reliable results.
INTRODUCTION: Many people after lower limb amputation are not entirely independent due to seriously compromised basic activities of daily living (ADL). A short and pre-prosthetic ADL intervention is an effective method for an early recovery of functional independence in self-care activities and promotes home adaptation. Age is an important determinant of functional recovery, and most subjects can achieve independence in basic ADLs regardless of the level of amputation. A pre-prosthetic ADL program should be included in rehabilitation strategies for adults with lower-limb amputation.

Aim of the study was to find out the most frequently suggested assistive devices to patients after lower limb amputation during their inpatient rehabilitation at our Institute.

METHODS: We revived medical and occupational therapists’ documentation of all patients admitted to inpatient rehabilitation at our Institute between June and December 2017, and checked which and how many assistive devices that are reimbursed by the Health Insurance Institute of Slovenia (ZZZS) have been prescribed to our patients.

RESULTS AND CONCLUSIONS: During the studied period we admitted 160 patients (78% men; 37% after trans-tibial, 49% after trans-femoral and 14% after bilateral amputation), 21 to 92 years old (mean and median 69 years); 131 lived at home, 29 in nursing homes. Assistive devices other than cushions for wheelchairs were prescribed only to patients living at home; 62 received a bath seat or shower stool and 33 received a raised toilet seat. Patients who were issued assistive devices were 2.5 (commode) to 5 years (raise for toilet) older than those who did not on average, but the difference was not statistically significant.

Occupational therapist is an important team member in rehabilitation of patients after lower limb amputation. Different assistive devices can improve patient’s independence.
INTRODUCTION: Social work is part of comprehensive rehabilitation. It entails help to the patients who have found themselves in psychosocial difficulties because of health problems or disability. The starting point of social treatment is recognition that each individual is part of a social network and community. We follow the principle of individualised planning involving the client and their social system, exploring their life experience and needs, set goals and define the strategy for goal attainment, empower them and seek power sources throughout the rehabilitation process. The precise form of social treatment depends on the psychophysical status of the patient, duration and outcome of rehabilitation and the patient’s social-support network.

AIMS: Our aim was to find out which are the most frequent social problems of people after lower limb-amputation.

METHODS: We performed a retrospective quantitative study by gathering the data from social treatment records of 180 patients included in inpatient rehabilitation at our Institute during 2017. We collected data and calculated descriptive statistics on gender, age, socioeconomic status, family members and caregivers, prosthetic fitting and the types of assistance offered within social treatment.

RESULTS AND CONCLUSIONS: There were 78% retired patients, 7% were still employed and 15% had low socioeconomic status (as defined by receiving welfare payments). Sixty-six per cent of the patients were living with their family, relatives or friends, 22% were living alone and 12% were in institutionalised care. After the rehabilitation, 83% returned home and 17% into institutionalised care or a hospital. Information and counselling on entering or re-entering the labour market, help with contacting the employer, co-operation with our Occupational Rehabilitation Centre and/or support for presenting themselves to the Disability Commission was provided to 15% of the patients. Sixty-two per cent of the patients required information on examination at the outpatient clinic for drivers with special needs and legislation on disabled driving. At the end of the rehabilitation, 42% of the patients needed information or help with receiving the service of home assistance, and 25% of the patients needed information on arranging meals to be delivered to their home. In general, information counselling and support were required by all the patients and 65% of their family members. Social treatment was more intensive in patients who were not fitted with prosthesis (18%) and those living alone (22%). In those cases, social treatment was focused on finding appropriate forms of help and services for enabling the patient’s return to their home environment, on connecting them with other institutions, and on helping them seeking and obtaining social security rights (72%) and pension and disability insurance-based rights (89%).

The results indicate that the majority of patients after lower-limb amputation and their relatives are poorly informed about the possibilities for help at home and the rights arising from disability, as well as with the possibilities and procedures of obtaining the rights arising from social, health and disability insurance. The patients were facing difficulties in care and support at home, social inclusion into the community, car driving, socioeconomic status and administrative procedures.
UPPER LIMB PROSTHETICS
INTRODUCTION: The main goal of having prosthesis is to provide the opportunity to perform those daily activities that are most important for every individual, but for now none upper limb prosthesis can fully replace the lost limb. Purpose: Purpose is the review of literature in the field of affordable 3D printed prosthesis and to create an electrical open source prosthesis with a 3D printer brand Zortrax M200.

METHODS: A descriptive method was used. Search was conducted from March to May 2017, through databases such as Google Scholar, Web of Science and Medline. After a quick review, was followed a contraction of articles on those from 2014 or younger. Used literature was from the first three pages of results. Literature from chapters of the anatomy and prosthesis for the upper limbs, with associated sub-sections, is obtained from the library of Health Sciences Faculty in Ljubljana. In addition to the descriptive methods is also used the method of evaluation work, which presents the production of affordable prosthesis using Zortrax 3D printer, its advantages and disadvantages. Results: Most of the freely accessible 3D printed prosthesis works on the principle of voluntary closing, with the help of elastic bands and cords. Weight ranges from 70 grams to 2000 grams, with the prices of manufacturing below $500. The main drawback of most prostheses available on market is noise and weak grip.

DISCUSSION AND CONCLUSION: Cost of making own upper limb prosthesis is 85 euros without batteries and myoelectrical sensors. The maximum grip strength was 1.02 N. The sum of range of motion of the fingers healthy hands, according to the literature was 260 °, and the sum of the value own-manufactured prosthesis is 237 °. 3D printing is the future, however development must eliminate the deficiencies that prevents full integration of individuals into society.

Keywords: 3D, printing, affordability, technology
INTRODUCTION: There are a number of possible benefits to arm swinging. Suggested effects include reduced vertical displacement of the centre of mass (Umbarger 2008), and reduction of angular momentum (Herr & Popovic 2008), angular displacement (Pontzer et al. 2009) or ground reaction moment, all about the vertical axis. Other possible effects include prevention of uncontrolled arm motions and arm swing plays a stabilizing role that reduces the metabolic cost of walking (Ortega et al. 2008). Arm swing has also been purported as the motion that is useful in counteracting the trunk rotation in gait.

Collins et al., study emphasized that arm swinging can reduce ground reaction moment requirements, leading to overall decreased energy expenditure, perhaps in the muscles of the lower limbs. In our study, we investigated the effects of upper-limb prosthetic usage on kinetic parameters in gait cycle with transradial and transhumeral amputees.

AIMS: Aim of study compared the Hip Powers kinetic parameters of both upper limb amputees sound and amputee side with wear prostheses and not wearing prosthetic results of gait analysis.

METHODS: Two upper-limb amputees participated in this study. One transradial (TR) prosthesis user was male and adult (Age: 20 yrs-old, Height: 170 cms, Mass: 68 kgs, Stump length: 80%, amputation cause trauma). One transhumeral (TH) prosthesis user was a male and adult (Age: 24 years-old, Height: 170 cms, Mass: 63 kgs, amputation cause trauma). Two persons used body-powered arms with cable driven terminal devices.

Three dimensional gait analyses were done in Motion Analysis Laboratory via Vicon motion analysis system (Vicon Nexus, UK) with six infrared cameras at 240 Hz. Gait records were obtained when the patient was with prosthesis and not wearing prosthesis. Kinetics analyses were done in order to analyze the influence of prosthesis on amputee gait. We used Helen Hayes marker protokol in gait analysis.

RESULTS AND CONCLUSIONS: In our study, we compared the Hip Powers kinetic parameters of both cases sound and amputee side with wear prostheses and not wearing prosthetic results of gait analysis. As a results, Transhumeral amputee sound side peak power hip generation H2 (Eccentric Iliopsoas) is higher than amptee side with prosthesis and without prosthesis gait results. H2 hip power generation not changed with or without prothesis results of gait analysis in TH amputee. Transhumeral amputee sound side peak hip power H1(Concentric Gluteus max\Hamstring) generation increased with prosthetic using. Transradial amputes amputeated side peak hip power generation H1(Concentric Gluteus max\Hamstring) was a decrease with wearing prosthesis gait and but increased H2 hip power.

CONCLUSION: As the upper extremity amputation level increases, the hip power values are affected. Peak hip power H1 generation is the most affected value. As the component number and weight of the prosthesis increases, the sound side may have caused an increase in power during walking. In addition, the rotation in the trunk may have compensated with hip muscle group contraction during H1 phase was higher.
USER SATISFACTION WITH UPPER LIMB PROSTHESIS AND SERVICE AT THE CENTRE FOR ORTHOTICS AND PROSTHETICS

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INTRODUCTION: The rehabilitation of persons after upper limb amputation, prosthetic care is one of the possible goals. If the person accepts the prosthesis and uses it, the goal is achieved in its entirety. The data on the acceptance rate of upper limbs prosthesis vary from 5% to 61%. In general amputees prefer a comfortable prosthesis. In addition, the prosthesis must also be functional and light and donning and doffing of the prosthesis must be simple. Not many questionnaires are available for assessing satisfaction with prosthesis. We decided to use the Slovenian version of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST).

AIM: The aim of our study was to assess the state of customer satisfaction that as a basis for the decision-making for introducing changes in production and service protocol.

METHODS: Slovenian version of the standardised five-level (1=not satisfied at all, 5=very satisfied) QUEST questionnaire was used. We sent the questionnaire to all adult persons (18 years and more) who received the upper limb prosthesis from January 2014 to June 2017 at the Centre for Orthotics and prosthetics of the University Rehabilitation Institute, Republic of Slovenia.

RESULTS: Questionnaires were sent to 159 users. We got 63 (40%) fully completed questionnaires, 3 were incomplete. Average device subscale score was 4.0, average service subscale score was 4.3 and average total QUEST score was 4.2. The most important satisfaction items as identified by the users were comfort, durability/endurance and ease of use. The users mainly commented on durability and quick staining of the cosmetic gloves, problems with impact of the weather features on the temperatures in the socket, and not enough sustainable prosthetic components for heavy duties and sport. Many also highlighted that the administrative process is long and unclear.

DISCUSSION: The results of our study show that the users of upper limb prosthesis are quite satisfied with their prosthesis and our service. Frequent comments on durability and quick staining of the cosmetic gloves are understandable because the cosmetic glove is the most noticeable part of the upper limb prosthesis. We will notify the producers of the cosmetic gloves about the problems.
The number of malignances, occupational injuries and congenital malformation among active older population increases every year. Aesthetic silicone prosthesis and epithesis are one of the possibilities of prosthetic care of such patients. The result is shown as partially functional, aesthetic and psychological rehabilitation for the patient.

In the following cases the author displays three patients with this type of care.

Key words: silicone prosthesis; epithesis; prosthetic care; psychological rehabilitation.
IMPROVEMENT IN HAND FUNCTION WITH PROSTHETIC FINGER EXTENSION IN PATIENT AFTER POLYTRAUMA AND STROKE

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INTRODUCTION: Rehabilitation of severe polytrauma patient with concomitantly ischemic stroke with consequent left-hand hemiparesis is presented. A successful cooperation between occupational therapy and prosthetic intervention for improving function of his left hand is described.

CASE: 49 years right-handed locksmith was admitted to our department for rehabilitation after polytrauma due to motorcycle injury. Beside several bone fractures (right femur and tibia, right radius, left 2nd metacarpal bone) he concomitantly suffered ischemic stroke with consequent left side hemiparesis. During the acute treatment, osteosynthesis of femur, tibia and radius were performed, whereas metacarpal bone was treated conservatively. A comprehensive rehabilitation program comprising nursing, physiotherapy, occupational therapy, cognitive training and psychological support as well as social counselling.

In first semi-structure interview, Canadian Occupational Performance Measure (COPM), the patient stressed the importance of performing activities of daily living. Self-evaluation of performance was 5,33pts (out of 10pts) and satisfaction of performance 3,33pts (10pts). At initial assessment, severe impairment of his left hand was noted. The Southampton Hand Assessment Procedure (SHAP) test overall score presented very low left-hand effectiveness – 32pts (norm >= 95pts). The performance of Nine Hole Peg with left hand was inexecutable. The patient didn’t include left hand index finger when performing Box and Blocks test, scoring 18pcs (age and gender norm: 75,8pcs).

Despite significant overall improvement with intensive rehabilitation and bone healing, impairments in his left-hand function remained, as a combination of hemiparesis and deformation of his hand due to 2nd metatarsal bone shortening after fracture with consequent functional shortening of index finger. In COPM, he pointed out activities, where the index finger has to be included. Self-evaluation of performance, as well as satisfaction of performance was 2pts. Overall SHAP test score rise to 72pts. Problems with positioning of the index finger were observed. During performance of Nine Hole Peg Test (67,10sec (age and gender norm: 20,7sec)) and Box and Block Test (48pcs), he unsuccessfully tried to use the index finger.

A certified orthotic and prosthetic engineer, specialized in silicon technology, was therefore counselled to overcome the problem of shortened finger. Prosthetic finger extension was individually designed according to patient's right-hand index finger shape. Prosthesis was manufactured from medical silicon Chlorosil shore 35 (Otto Bock) with direct sculpting technology based on plaster finger model.

With application of prosthesis and some additional training, function of index finger and patient’s ability to perform left-hand activities improved. Self-evaluation of performance and satisfaction of performance raised to 6,5 pts (for 4,5 pts). Overall points of the SHAP was 86pts (rise for 54pts) and he used the index finger when performing the Nine Hole Peg (61 sec) and Box and Blocks (58 pcs).

CONCLUSION: With application of silicon partial index finger prosthesis, patient’s left-hand function improved.
COMPARISON OF DIFFERENT SPLINT MATERIALS FOR TREATING TRIGGER THUMB

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INTRODUCTION: Trigger thumb is a common and debilitating condition. Trigger finger occurs when the pulley becomes too thick, so the tendon cannot glide easily through it. The tendons in thumb and fingers are covered in a tunnel like structure of tissues that are called sheaths. Because of inflammation or swelling the tendons are no longer properly gliding through sheaths. Having a finger that locks up, then pops straight out suddenly or even worse, remains curled permanently can make any work or daily activities impossible and very painful. Common treatments include night splints, anti-inflammatory and steroid injection. If non-surgical treatments do not relieve the symptoms, surgery may be recommended. The goal of surgery is to open the pulley at the base of the finger so that the tendon can glide more freely. The clicking or popping goes away first. Finger motion can return quickly. Sometimes there can be some stiffness after surgery. Occasionally, occupational therapy is required after surgery to regain better use. For pain relief we produced various splints for desired activities from different materials. Splints and immobilization as a treatment is only a partially successful method, but it can reduce pain and thus enable the user to perform the desired activities. We should not neglect exercise and strengthening of the affected finger, as well as providing regular ice massage.

CASE: The case study is an occupational therapist who evaluated and compared the splints from different materials over the period of eight months when the problem of the thumb occurred and all the way through till the operation. As occupational therapist she was interested in how the material can easy be designed. What is the comfort of wearing the splint from different material? How does the material behave during the activity? Is it easy to clean it and how does the material behave in the water?

We made two splints for the thumb. One in the acute phase and the other postoperatively. We produced three small thumb splints from various materials that prevented flection of the IP joint, which enabled uninterrupted work for the occupational therapist. The usability was compared within different activities.

The best material for making small finger splints is the orfit, which is suitable to use in a variety of situations, but sometimes too flexible for small splints. The most comfortable one is the orficast, which behaves poorly in water. For small splints, woodcast may be the roughest but with suitable firmness.

CONCLUSION: Splints improve the quality of the activity of the trigger finger, especially if it is the thumb of the dominant arm. They prevent triggering and pain. The material and shape of the splints are selected according to the activities that the user performs. A recommendation for an overnight splint, a small thumb splint should be made of orficast, and for daily activities either orfit or woodcast should be used, because they are harder and easier to clean.
INTRODUCTION: The poster focuses on custom orthoses fabricated from 3 mm neoprene. They are designed to allow patients with total or partial finger amputations and those with reduced grip strength to carry out many of the activities they would otherwise be unable to perform.

CASE: Such orthoses are used to affix the afflicted hand to various tools, crutches, walking sticks, sports equipment etc. They are custom-made, designed to suit the individual needs of each patient.

CONCLUSION: By allowing patients the use of the aforementioned tools and equipment they play a crucial role in improving their quality of life, reducing psychological problems and building their self-esteem.
INTRODUCTION: Although there are many investigations which show that people with limb loss are dissatisfied with the prostheses they use, the research around people’s preferences towards prostheses is limited.

AIMS: By dividing prostheses in three categories; those of realistic (RP), functional (FP), and expressive (EP), the aim of the study was to investigate users’ preferences towards prostheses in order to understand possible factors that drive these preferences. The objectives were:

• To critically analyse prior knowledge about issues surrounding users’ satisfaction towards prostheses.
• To gather insights regarding the prostheses participants own, as well as demographic and disability related variables.
• To explore the reasons which led participants to their choices.
• To establish key criteria which drive users’ preference based on demographic and disability related characteristics and compare them with previous investigations in order to evaluate which variables influence their choices.

METHODS: An online survey, based on questionnaires with nominal questions, was used in order to gather a large number of data and determine relationships. Non-probability sampling methods were used (snowball and volunteer) in order to approach people with limb loss by contacting 136 private companies, support groups, private clinics etc. All participants met the inclusion criteria: being over 18 years old and own prosthetic limb(s).

RESULTS AND CONCLUSIONS: By the 157 people who completed the questionnaires, only 136 responses (87%) were valid; the majority of those were men (65%) and over 45 years old. Regarding the prostheses participants own, RP and FP present the same percentages (47% and 48% respectively); EP is the least popular among prosthetic users. However, the hierarchy of participants’ preferences differs as first is FP (65%), EP comes second (19%) and last is RP (16%). Various demographic and disability related variables were tested; the analysis shows association between participants’ preferences and sex, cause of amputation, years since amputation and years wear prostheses, whilst there is no association between their preferences and educational level. Although the analyses of Chi-square tests regarding age, level of annual income, area of residence, area and level of limb loss are mentioned in the Results, they cannot be considered as reliable due to the unevenly spread of the sample and they need further investigation. The analysis of the reasons participants chose their preferable prostheses shows functional as the most important reason.

The design of prosthetic limbs is continuously changing; however, the level of people’s satisfaction with their prostheses remains low. The objectives of the study have been met, and half of the participants answered they would like to use a different type of prostheses as they are not satisfied with the one they have. The transitions of their preferences show that the majority of the participants who own RP and are not satisfied chose FP, while the majority of the participants who own FP and are not satisfied chose EP.
Satisfaction of Very Active User with Lower Limb Prosthesis at a Centre for Orthotics and Prosthetics

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Introduction: The goal of rehabilitating a person after amputation is to achieve their better functioning and inclusion in society. Most people after lower limb amputation want to use the prosthesis for walking. The effectiveness of prosthetic care is influenced by individual psychophysical condition, amputation level, selected prosthetic components, and their regulation, learning of the use of the prosthesis and rehabilitation program. Not many questionnaires are available for assessing satisfaction with prosthesis. We decided to use the Slovenian version of the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST).

Aims: The aim of our study was to assess the state of customer satisfaction as a basis for the introducing changes to the service and to the manufacturing of the prosthetic devices.

Methods: Slovenian version of the standardised five-level (1=not satisfied at all, 5=very satisfied) QUEST questionnaire was used. We sent the questionnaire to all very active users who received lower limb prosthesis from January 2016 to October 2017 at the Centre for Orthotics and prosthetics of the University Rehabilitation Institute, Republic of Slovenia.

Results and Conclusions: Questionnaires were sent to 188 users. We got 76 (40%) fully completed questioners, two of the users died and one questionnaire was incomplete. Average device subscale score of all users who answered the questionnaire was 4.2, average service subscale score was 4.1, and average total QUEST score was 4.3. The most important satisfaction items, as identified by the users were comfort, security and durability/endurance. They mainly commented on durability of the cosmetic parts of the prosthesis.
PROSTHESIS SATISFACTION AND SELF-PERCEPTION IN THE LOWER LIMB AMPUTEE

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INTRODUCTION: Providing a satisfactory, functional prosthesis following lower limb amputation is a primary goal of prosthetic rehabilitation.

AIMS: This study examines the relationship between prosthesis satisfaction and aesthetic experience of cosmetic prosthesis, and the variations within these relationships with respect to gender of the subject.

METHODS: In the period from April 2015 to April 2018 the study was performed on 60 patients of the Clinical Institute for Rehabilitation and Orthopaedic Aids, KBC Zagreb. The subjects of the study, chronological age 54-82 years, undergoing their lower limb amputation because of vascular disease and/or diabetes, were given primary and secondary prosthetic supply, either transtibial (TT) or transfemoral (TF) prosthesis. The Trinity Amputation and Prosthesis Experience Scales-Revised was used as an instrument of assessment. The data were processed and statistically analyzed using t-test and Pearson correlation.

RESULTS AND CONCLUSIONS: The difference in satisfaction with prosthesis in patients with TT and TF prosthesis is not statistically significant. According to assessment of significance and value of t-test there is a significantly higher level of satisfaction with TT prosthesis as well as TF prosthesis in regard to secondary prosthetic supply. Amputation can have a significant psychological impact on self-perception and body image. The main reasons for the lower levels of satisfaction with aesthetics of prosthesis in primary supply are voluminous stump, badly repaired stump, presence of contractures and postural changes due to non-use of the prosthesis, and yet insufficient experience to adapt, overcome and integrate prosthesis into the activities of everyday life. Functional self-perception of people with lower limb amputation is correlated with the aesthetic experience of cosmetic prosthesis.

KEY WORDS: prosthesis satisfaction, self-perception, amputation, lower limb
INTRODUCTION: Due to the rapid development of advanced assistive technology (AT), its integration is becoming increasingly important in supporting health and social care globally. AT includes powered devices, software and settings that allow persons with disabilities to have more control in their environments and have potential to increase independence and therefore their satisfaction.

CASE: This case presents a 36 years old male with tetraplegia (p. fract. C3-C4) and impact on his satisfaction of the advanced AT he uses. We used a case study design with quantitative method – repeated measures with Canadian Occupational Performance Measure (COPM) and qualitative method with standardized five-level Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) for the satisfaction with his wheelchair.

In the first COPM he exposed two main problems of occupation as controlling environment (doors, lights, windows) and making phone calls. After 12 months the visual analysis revealed gains in self-determination and in performance and satisfaction in the COPM, since the grades for performance raised for nine and satisfaction for five points, which means clinically significant improvements. During the semi-structured interview, he emphasized satisfaction with his inclusion in the information society, which he performs with the help of advanced AT as well. He uses infrared interface to operate the computer, and Bluetooth (BT) for his smart phone through his special wheelchair chin control. His smartphone is with the help of application also a remote control for TV. He wears a wireless BT Headset during the day. When he is not sitting on a wheelchair, he uses hands-free mouse solution to operate a computer with his head and with help of software that enables clicking by dwelling. He also uses an on-screen keyboard with word prediction in his native language and settings that enable him to use single click instead of double click.

Satisfaction with his current powered wheelchair (with chin control) was evaluated with QUEST, with device subscale score 4.4 and services 4.5, total QUEST score 4.4, meaning that he was quite satisfied to very satisfied. The most important satisfaction items for him were safety and security, effectiveness and repairs and servicing (maintenance).

CONCLUSION: This case study shows the benefits and positive impact of advanced AT on satisfaction of the individual user with high tetraplegia.
COMPARISON OF EFFECTS OF THREE CUSTOM-MADE ANKLE-FOOT ORTHOSES ON GAIT PATTERN AND SPEED IN PATIENTS AFTER STROKE: MULTIPLE CASE REPORT

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INTRODUCTION: In patients after stroke, walking ability is commonly affected because of lower-limb muscle weakness, increased muscle tone and/or contractures, impaired proprioception and motor control. Within their interdisciplinary rehabilitation at the University Rehabilitation Institute in Ljubljana, we applied three types of individually-made ankle-foot orthoses (AFO): without joints (two different trimlines – behind and in front of malleoli) and with joints.

AIMS: To establish the advantages of different types of custom-made AFO in three patients after stroke.

METHODS: Three patients in subacute phase after stroke with left-sided hemiparesis, who were able to walk 30m with assistance of one person, were included. At the hemiparetic side, they were unable to actively perform dorsal flexion and foot eversion, had moderately increased tone of triceps surae and tibialis posterior muscles, with plantar contracture less than 20° and were able to passively correct the calcaneus to neutral position. Three types of AFOs described above were made individually per each patient. Ten-meter-walk test and clinical gait analysis were performed without orthosis and with each type of AFO in random order. PT performed clinical gait analysis by observation of videotape.

RESULTS AND CONCLUSIONS: First case, 64-year old woman. Without orthosis (10m-walk test time: 69.8s), her gait was with first contact on lateral side of the foot, severe hyperextension of the knee and less flexion in swing phase. The anomalies were corrected similarly with use of all three AFOs. She gained initial heel contact, control of the knee in stance phase and control of the hip in swing phase. Walking speed with AFO trimlined in front of maleoli increased by 31%, AFO with joints by 24% and AFO trimlined behind maleoli for 14%.

Second case, 75 years old man. Without orthosis (10 m-walk test time 25.2s), his gait was with first contact on lateral side of the foot, concurrent clonus, valgus of the knee and insufficient weight transfer. The anomalies were corrected with all three AFOs; the largest increase of certainty and quality of gait was with AFO with joints. With this orthosis, the increase in walking speed was the largest (28%), followed by AFO trimlined behind malleoli (25%) and AFO trimlined in front of maleoli (24%).

Third case, 66 years old man. Without orthosis (10m-walk test time 34.1s), his gait was with first contact on the front foot and severe hyperextension of the knee. With all three AFOs the correction was small, with first contact at foot flat. The largest increase of certainty, quality of gait and speed (25%) was with the AFO with joints; walking speed with AFO trimlined behind maleoli increased by 17%, and trimlined before maleoli AFO by 12%.

With each of the three custom-made AFOs, the gait pattern and walking speed improved in all three patients, the most with the AFO with joints.
STABILOMETRIC ANALYSIS IN PATIENTS SUPPLIED WITH ANKLE AND FOOT ORTHOSIS

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INTRODUCTION: Ankle and foot orthoses are rarely a subject in clinical studies, but they have a significant clinical effect, they can improve stability in standing and walking, and reduce the risk of falling. The objective assessment of balance in patients with foot drop is inherent in setting the indication for orthotic intervention and taking into account that the level of balance depends on whether or not the eyes are open or closed, the stabilometric platform represents a validated and safe instrument of evaluation.

AIMS: The aim of the paper is to present the possibility of objective evaluation of balance in persons with unilateral foot drop with analysis of changes in postural parameters during orthotic supply.

METHODS: After reviewing the literature and processing of available data, in the Clinical Institute for Rehabilitation and Orthopedic Aids, in the period from April to May 2017, an analytical study of measurement outcomes was conducted on a sample of 10 patients, involved in ambulatory rehabilitation. The criteria for inclusion in the evaluation were: patients with unilateral foot drop, supplied with ankle and foot orthosis, able to stand alone on a 60x60 cm evaluation platform with eyes open and closed with no risk of falling, able to understand instructions and perform tasks placed. Evaluation of balance and postural parameters in subjects was performed using a stabilometric platform "Cosmogamma" with or without ankle and foot orthosis. The postural parameters (center of gravity path length, center of gravity path surface) were collected through center of gravity projection with eyes open then closed, through a 30-second static test and with the automatic calculation of the Romberg's coefficient. For statistics processing of numeric data, SPSS - v17 program was used.

RESULTS AND CONCLUSIONS: The results of the static balance test, despite the initial difference in the arithmetic mean; center of gravity path length with eyes open (542.42 mm vs. 492.54 mm) and closed (783.53 mm vs. 758.75 mm), center of gravity path surface with eyes open (7.66 cm2 vs. 5.81 cm2) and closed (11.14 cm2 vs. 9.28 cm2), in favor of the orthosis, ultimately do not show statistically significant differences in the observed parameters in patients with or without orthosis. Between the Romberg's coefficient with or without the orthosis, no statistically significant differences were found.

The data from the literature demonstrates that ankle and foot orthoses have a positive effect on maintaining balance in patient with foot drop, while the results of the study do not show a statistically significant difference in the observed parameters in patients with or without orthosis, which is a direct consequence of a small sample and does not reflect the actual effects we find in the literature. With the aim of a more extensive analysis and obtaining evidence of high level of significance, it is necessary to increase the sample of respondents with the use of the existing balance evaluation methods.

KEY WORDS: ankle and foot orthosis, stabilometric platform, balance
COMPARISON OF DIFFERENT ANKLE-FOOT ORTHOSES IN PATIENTS AFTER A STROKE: THE EFFECTS ON FUNCTIONAL MOBILITY AND PATIENTS’ OPINION: A PILOT STUDY

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INTRODUCTION: Ankle-Foot orthoses (AFO) or ankle orthoses (AO) are frequently prescribed to improve mobility and dropped foot, and to compensate for biomechanical deficits. Integration of clinical and biomedical research findings with better understanding of patients’ views and wishes can lead to selection of the optimal orthosis.

AIMS: The aim of this study was to establish how a certain serial made orthosis affect performance of various functional activities.

METHODS: 8 patients after a first stroke, scored with FAC 4-6, participated in the single blind study. In the second week of the rehabilitation, 10-meter walk test, 6-minute walk test, timed up and down stairs and five times sit to stand test were performed randomly in 3 consecutive days with a serial AFO, one of the serial elastic AO and without orthosis. At discharge, patients performed tests only with the selected orthosis and without it. During the tests, type of orthosis was covered to the tester with a protection above the footwear. Another investigator interviewed the patients about subjective feelings and satisfaction with each orthosis.

RESULTS AND CONCLUSIONS: The most commonly selected orthoses were AO. At the first evaluation results of all clinical tests were superior for the selected AO: 10-meter fast walk test (12,2±4,9 s), 6-minute walk test (269,4±137,8 m), the timed up and down stairs test (32,3±18,8 s) and for the five times sit to stand test (19,1±10,7 s). Results were worse for walking with a serial AFO / or without it: 10-meter fast walk test (13,5±5,9 / 12,3±4,5 s), 6-minute walk test (252,1±125,6 / 257,4±123,2 m), the timed up and down stairs test (38,2±30,6 / 35,9±25,5 s) and for the five times sit to stand test (21,0±12,4 / 19,1±7,8 s). At the final evaluation test results were better for the selected AO (compared to walking without it): 10-meter fast walk test 9,5±4,3 (10,7±4,7 s), 6-minute walk test 317,0±157,8 (296,9±159,0 m), the timed up and down stairs test 31,5±28,2 (35,3±32,8 s) and for the five times sit to stand test 14,0±3,1 (18,6±9,3 s). Most of the patients while wearing a selected AO felt more secure, their walking was better and their leg has stuck less often. More of the patients would wear it throughout the day compared with a serial AFO.

The selected AO has a positive effect on the walking speed and distance. Similarly, the measured times in all other activities were the best when using a serial AO, compared to serial AFO or without using an orthosis. A serial AFO reduced walking speed and distance. With the selected AO patients were more satisfied compared with a serial AFO. They felt that when walking with the selected AO their confidence and safety during walking improved. Study with larger sample size is needed for statistical analysis of the tests performance with different types of orthoses and without it. The research will continue, with the aim to gather a larger sample size.
FOLLOW-UP ON USAGE OF SERIAL ANKLE-FOOT ORTHOSES AND ANKLE ORTHOSES – RESULTS OF A SURVEY

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INTRODUCTION: Ankle-foot orthoses and/or ankle orthoses are frequently prescribed for patients with foot-drop, which is usually a sign of an underlying neurological, muscular or anatomical problem. Little is known about the experience of patients wearing those orthoses.

AIMS: The purpose of the study was to determine whether persons who have been issued with serial ankle-foot orthoses or ankle orthoses at the Pharmacy of the University Rehabilitation Institute in Ljubljana are still using the orthoses after 30 and 90 days after receiving them. We also assessed their satisfaction with the orthoses using a survey.

METHODS: Twenty-four people who had visited the Pharmacy of the University Rehabilitation Institute in Ljubljana because to receive prescribed ankle-foot orthoses or ankle orthoses were willing to participate and were included in the study. We used a questionnaire to follow-up the usage of, and satisfaction with, serial ankle-foot orthoses or ankle orthoses. The questionnaire, which consisted of three parts, was administered with a telephone interview. The first part contained demographic information, information about the received orthosis and the potential use of other medical devices. The second and third part of the questionnaire described the use of the received orthosis and user satisfaction. The telephone interview lasted for 10 to 15 minutes; it was performed 30 and 90 days after receiving the orthosis.

RESULTS AND CONCLUSIONS: The participants used the orthosis for 5.9 days per week and 4.8 hours per day on average after 30 days since receiving it, for average 5.2 days per week and 5.2 hours per day on average after 90 days since receiving it. The majority of complains from the participants regarding the orthoses were about the fitting procedure, unbreathable material (plastic) and poor durability of the straps. Dissatisfaction with the fitting procedure significantly increased over time – from 20% (30 days after receiving the orthosis) to 50% (90 days after receiving the orthosis).

The results of the study will be of great help in our further work, as we will be able to focus on the causes of potential non-use and anticipate possible user concerns in advance, which should lead to better rehabilitation outcome of each individual.
INTRODUCTION: Cerebral palsy (CP) is caused by impairment of brain in very early childhood and joint contractures are frequent secondary impairments. In hemiplegic form of CP children are usually able walk, but with different range of difficulties. There are several different gait patterns recognized in hemiplegic CP. In a gait pattern with equinus, child is not able to lift the foot and is in a long term developing the ankle contracture. It is already known that hemiplegic CP children, fitted with hinged ankle foot orthosis (hAFO), have a potential to improve the gait pattern, but they can still develop the ankle contracture due to the lack of push off and insufficient foot lift. Recently, there is a new type of AFO with double spring ankle joint available (dsAFO). It maintains the neutral foot position in order to ensure the heel strike at the initial floor contact. The joint of dsAFO enables more dorsal flexion since it enables the eccentric power generation of the pretibial muscles. The heel rocker is actively supported. The foot drops are controlled against the spring force. The aim of our study was to compare gait pattern with HAFO and dsAFO in child with hemiplegic CP.

CASE: A 5,5 years old girl with hemiplegic CP (GMFCS level I) voluntarily participated in the study in the study. In the past, she was already fitted with hAFO. At the time of the study, she was fitted with both, new hAFO and new dsAFO. Gait patterns with both AFOs were analysed and compared with biomechanical computer gait analysis using Vicon MX system. The walking performance was assessed with Six-Minutes Walk Test (6mWT) and timed 10-Meter Walk Test (10mWT). Both tests and computer gait analysis were repeated after 6 months.

CONCLUSION: The dsAFO improved the gait pattern and gait spatio-temporal parameters in hemiplegic child with cerebral palsy.
INTRODUCTION: Persons with weakened quadriceps muscle are usually fitted with knee-ankle-foot orthosis (KAFO). In Slovenia, we use knee-joints with locked extension position as the standard. Hence, the user has to change the walking pattern and also compensate movements in the hip and the lumbo-sacral part of the spine. According to the literature, the newest type of KAFO with a knee-joint with free range of motion in the swing phase and the staible lock in the stance phase (stance-control KAFO) improves the biomechanics of walking, reduces energy consumption and reduces compensatory movements in the hip and pelvis.

CASE: The 44-year old lady with unexplained degenerative disease of central nerve system has weakened left quadriceps muscle. We fitted her with a stance-control KAFO in February 2017. We tested her with Timed 10-meter Walking Test (10MWT) and Two-minute Walk Test (2MWT) when she received the orthosis. After using the orthosis for walking for 11 months, we tested her again. The result of the 10MWT without the orthosis in February 2017 was 20.6 s and with the orthosis it was 17.6 s. In two minutes (2MWT), she could walk 71 m without the orthosis and 90 m with the orthosis. One year later, the results of the 10MWT were 20.1 s without the orthosis and 13.2 s with the orthosis; in two minutes (2MWT), she could walk 73 m without the orthosis and 98 m with the orthosis. The lady has never used any other knee-ankle-foot orthosis, so we cannot compare her results with a different type of orthosis.

CONCLUSION: Our first experiences and assessments of the stance-control knee-ankle-foot orthosis are very positive. In the future, we want to compare our standardly designed and stance-control KAFO to verify the differences between them stated in the literature.
THE IMPACT OF STATIC PROGRESSIVE STRETCH ON THE RANGE OF MOTION IN HEAMOPHILIC PATIENTS AFTER TOTAL KNEE REPLACEMENT

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INTRODUCTION: Hemophilic arthropathy is one of the conditions most associated with loss of range of motion. Total knee arthroplasty (TKA) is an effective treatment option for patients with end-stage hemophilic arthropathy of the knee. However, despite the arthroplasty, range of motion is sometimes still not sufficient. Static progressive stretch using joint active system (JAS) is an adjunct technique to traditional physiotherapy, with the goal to restore functional range of motion and decrease knee stiffness and pain.

AIMS: The purpose of this study was to evaluate static progressive stretch as a treatment method for hemophilic patients with decreased range of motion after TKA.

METHODS: Six hemophilic patients (eight knees) (6 male; mean ± SD age, 54.1 ± 7.8), at an average age of 54.1 years, with decreased range of motion (knee flexion less than 80 degrees and/or lack of extension more than 10 degrees) after TKA were treated with patient-directed orthosis (JAS) that utilized the principles of static progressive stretch. The outcome was measured by using the Knee Injury and Osteoarthritis Outcome Score and the Knee Society Score. At each visit the range of motion was measured with a goniometer.

RESULTS AND CONCLUSIONS: The study is in progress.

We expect improvement in range of flexion, range of extension and total range of motion. We also believe that treatment with static progressive stretch will help to achieve better function and mobility of the knee in hemophilic patients after TKA.
APPLICATION OF BOTULINUM TOXINE AND ORTHOSIS IN TREATMENT OF SPASTICITY IN CHILDREN WITH CEREBRAL PALSY- CASE REPORT

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INTRODUCTION: Cerebral palsy is marked by a neuromotor disorder of the control of the position and movement of the body and the changed tone from the earliest age of the baby. Simplified classification of cerebral is divided into three basic types (spastic, dyskinetic and atactic), and on subtypes (bilateral and unilateral spastic, dystonia and choreoatetotic dyskinetic). Functional gradient of gross motor functions is defined for the lower extremities, i.e. GMFCS (Gross Motor Function Classification System) and fine motor mechanics, i.e. BFMF (Bimanual Fine Motor Function) 2.4. A spastic type, which affects 75% of children, is defined as an increased speed-dependent tonus and associated with damage to the upper motor neurons that includes an enhanced muscle contraction, Babinski reflex, and weakness, coordination difficulties. Spasticity is estimated by Ashworth scale and determines four degrees of elevated tone. Botulinum toxin type A is effective in improving the range of motion and reducing tonus, and also has potential positive effects on improving motor control. The principle of the action of botulinum toxin is the blocking of the release of acetylcholine from the collinear nerve endings and the result is a decrease in tone of spastic muscles over a certain period of time. The neurotoxin activity is at least three months, which is the minimum interval between injecting into the muscle. The improvement is visible after two weeks, and the best effect occurs six weeks after the application. The best effect of this therapy is achieved in children older than two years with dynamic contractures. After the application of botulinum toxin, orthoses are prescribed, which, after relaxation of the treated muscle group, provide stability to the joints, passively stretch muscles, thereby preventing the development of the contracture in the joint and maintaining the acquired mobility of the joint. More frequent is the supply of orthoses to the lower extremities, mainly KAFO and AFO, stabilization and dynamic. They are carried inside the shoes and contribute to the stabilization of the foot, ankle and lower legs to allow firm contact with the ground when walking or standing.

CASE: we showed a patient with cerebral palsy and a clinical manifestation of spastic tetraparesis, GMFCS II level, BFMF 1, Ashworth scales 2/3 for the lower extremities in which we used botulinum toxin in both m. Triceps surae, appropriate orthoses and orthopedic shoes.

CONCLUSION: in patient we used botulinum toxin and the corresponding dynamic orthoses, we obtained a favorable foot position and a smooth weight transfer while walking, reducing the tone, stretching the muscles and stabilizing the joints.
ORTHOPAEDIC FOOTWEAR
COMPARISON OF FOOT PLANTAR PRESSURE MEASUREMENT WITH FOOTPRINT METHOD

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INTRODUCTION: The footprint method is a practical and frequently used method in the clinic for the determination of foot disorders. Plantar pressure measurement is an objective evaluation method which can give numerical data in units of kg/cm² and can be done with different devices. Walk in sense® is a plantar pressure evaluation device that demonstrates its validity and reliability.

AIMS: To compare the two methods of determining the plantar pressure distribution by Walk inSense® of individuals whose feet were evaluated by footprint method.

METHODS: The dominant legs of 7 subjects (5 females, 2 males; mean age 19 years; range 18-22) who were randomly selected from the university students and who had no known foot health problem and who had no surgery. They were analyzed by Footprint method followed by Walk in Sense. For footprint analysis, the individual was asked to perform knee flexion three times on the dominant foot rubber while standing. Plantar pressure distribution was determined by Walk in Sense®. Foot pressures from 8 different points were determined by the position and method used in the footprint. One of the sensors was placed under the first toe, 4 of them under the metatarsal heads, 1 of the sensors lateral to the mid-foot, and 2 of the sensors in the medial and lateral heel.

RESULTS AND CONCLUSIONS: Footprint analysis showed that the result of 6 individuals was more dominant in certain regions (1.metatars head, heel medial-lateral, transverse arch, 5.metatars head). In one individual it was seen that the load distribution was equal. The result of plantar pressure analysis was the same as those in the footprint analysis of the regions with overprinting in 6 individuals (1st metatars head, heel medial-lateral, transverse arch, 5th metatars head). It was seen that distribution was close to each other in plantar pressure analysis in an individual.

When we compared the two methods by determining the plantar pressure distribution with Walk inSense® and Footprint, the two methods were found to give similar results about the pressure distribution. Walk in Sense is considered as an advantage of this method because it is an objective evaluation method by obtaining numerical data with kg / cm² unit. On the other hand, the ease of use and accessibility of Footprint analysis in clinics and the low cost are considered as advantages of this method. In the insert design, both values can be combined as the data out by Footprint and the pressure values which determined by the Walk in Sense. The boundaries of "supportive" and "relief" areas can be specified and insert layers (sandwich structure) are created. It is thought that more accurate results can be achieved by increasing the number of individuals included in the study and by working with different evaluation methods.
APPLICATION OF SPINAL ORTHOSIS IN TREATMENT OF PATIENTS WITH IDIOPATHIC SCOLIOSIS

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INTRODUCTION: Outcome of treatment for idiopathic scoliosis depends on timely and comprehensive treatment as well as on the cooperation of child and family with multidisciplinary Team for Scoliosis. Team for Scoliosis in our Institute is founded in 1987 and ever since, the Team continuously develops following the evidence based medical knowledge.

AIMS: Based on the SOSORT Guideline for treatment of idiopathic scoliosis, the Team improved its organization and developed protocols which are used in daily clinical work. Every doctor in the Team weekly assesses at least 50 patients with scoliosis (2250 cases a year) and prescribes 7 orthoses a week (315 orthosis a year).

Joint efforts of Team for Scoliosis, Ministry of Health and Social Welfare and Health Insurance Fund in the Republic of Srpska resulted in legislation harmonized with SOSORT recommendations. By-law on orthopedic aids stipulates that processes of prescription, production and application of spinal orthoses are under the exclusive control of the Team for Scoliosis in the referral health facility – our Institute.

METHODS: The assessment of every child includes mandatory data which are stored in special software program. A standing X-ray of the entire spine and pelvis is done with obligatory protection for breast and gonads. Radiographic analysis includes measurement of parameters necessary for treatment evaluation (Cobb’s curve degree Cobb, Raimondi’s rotation degree, coronal balance, clavicular angle, C7-S1 distance, Risser sign).

Clinical and radiological parameters are used to define the scoliosis and brace pattern according to Bad Sobernheim classification, based on functional types by Schroth. Every child with prescribed orthosis is also prescribed physiotherapy in our Institute. As recommended by SOSORT, the first step in treatment of idiopathic scoliosis are specific therapeutic exercises. In the Institute our team we follow the exercises by Schroth and SEAS. Integral part of treatment is ADL without orthosis and with orthosis. Children and parents are taught home exercises and procedures.

CAD/CAM technology is used in production of orthoses. In this phase, special emphasis is placed on team work - joint work of doctor, orthotists and physiotherapist.

After application of orthosis, the child starts the process of adaptation to orthosis with several corrections under the constant supervision of the Team. Parallel to this, children are taught therapeutic procedures and ADL in orthosis. After a month, the child is seen for the follow up X-ray in orthosis to evaluate its functionality.

There are further regular follow ups for individual adjustment to specific needs of every patient. When Risser sign is 4/5, gradual weaning of orthosis begins.

RESULTS AND CONCLUSIONS: Multidisciplinary team approach, adopted Protocol based on SOSORT guideline, continuing education, use of modern methods in medicine and orthopedic technique, along with the high technical standard of CAD/CAM technology, are all guarantee for successful application of orthoses in children with idiopathic adolescent scoliosis.
TREATMENT WITH SEAS SCOLIOSIS-SPECIFIC EXERCISES AND BRACING IN THREE GIRLS WITH AIS

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INTRODUCTION: Complete conservative treatment of adolescent idiopathic scoliosis (AIS) in the high-risk group includes bracing and exercises. SEAS scoliosis-specific exercise program, which has been proven to be able to increase correction at first brace wearing and to reduce the correction loss during brace weaning, can be used as a complementary measure to bracing in medium-high degree curves during growth.

The goal is to present the examples of outpatient physical therapy program and effectiveness of SEAS scoliosis-specific exercises and bracing in three girls with AIS.

CASE: A 19-year old girl was first diagnosed for AIS in 2012. X-ray showed right thoracic curve, Cobb angle 27° and left lumbar curve, Cobb angle 30°, Risser sign 0. Since 2012 till 2014 she was wearing a Lyon brace for 16 hours per day. Four evaluations were performed, first in May 2012 last in October 2017.

A 10-year old girl was first diagnosed for AIS in 2016. At x-ray in February 2017, the Cobb angle of right thoracic curve was 25° and left lumbar 9°, Risser sign 0. Since March 2017, she has been wearing a Cheneau Rigo orthosis. Three evaluations were performed, first in April 2017 and third in February 2018.

An 18-year old girl with left lumbar curve, Cobb angle 20°, Risser 5, was in a brace weaning period after two years of wearing a brace. Three evaluations were performed, first in February 2017 and third in October 2017.

In all cases evaluations according to the SEAS approach (including angle of trunk rotation – ATR, plumbline distances, Trunk Aesthetic Clinical Evaluation – TRACE, muscles restriction, range of motion – ROM – of spine, Fukuda test, Romberg tests, and hand-eye coordination) were performed, at the beginning of the treatment, in the course of the individual sessions and at the end of the treatment.

According to the findings at the first evaluation, an exercise plan using Scoliosis Manager was made. The plan included required active self-corrections in thoracic and lumbar spine, exercises to improve spine stabilisation, balance and proprioception, neuro-motor integration, co-ordination, stretching of shortened muscles and exercises to increase the mobility of spine.

Girls received at least five individual outpatient physical therapy sessions lasting for one hour in order to learn active self-correction, exercises according to the SEAS approach and a recorded plan of exercises. Between the outpatient physical therapy sessions, they were performing exercises at home and once a week in a group of patients with AIS controlled by a trained physiotherapist. They were wearing the brace for required time per day.

Evaluation at the end of the treatment showed, that one girl improved in ATR, all three in aesthetic appearance and in ROM of the spine, two girls in Fukuda vertical and Romberg tests and one in hand-eye co-ordination.

CONCLUSION: With performing SEAS scoliosis-specific exercises and wearing a brace, girls improved some parameters of scoliosis evaluation and were able to perform correct active self-correction of the spine and maintained it during performing different activities.
BRACING FOR CHRONIC LOW BACK PAIN IN ADULTS WITH SPINAL DEFORMITIES: RESULTS OF A NEW MODULAR PREFabricATED BRACE

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INTRODUCTION: Bracing adults with spinal pathologies is quite complicated. The custom-made braces are quite rigid and often not so comfortable, while the available prefabricated braces are mainly focused on the sagittal alignment and not enough on the frontal plane problem. Recently, a new modular prefabricated brace called BJM (Body Jacket Modular) to treat adults with spinal problems including scoliosis, hyperkyphosis, vertebral fractures and postural collapse.

The aim of the present study is to report the results on pain, spinal alignment and satisfaction of the first two patients with spinal pathologies fitted with the new BJM Brace.

CASE: Patient one: an 84 years old woman suffering from Hyperkyphosis and thoracolumbar scoliosis. She complained for a Chronic Low Back Pain with a VAS score of 9.

Patient two: an 73 years old woman suffering from Hyperkyphosis and thoracolumbar scoliosis secondary to L1, L2 and T6 osteoporotic vertebral fractures. She complained for a Chronic Low Back Pain with a VAS score of 8.

Both were braced with a BJM Brace that was fitted by an expert orthotist. The patients were instructed to wear the brace as much as possible during the day.

Patient one: she wore the brace only during the morning and when she needed more passive support to her back. After one month of treatment she reported a significant improvement in pain, with scoring VAS 3 without the brace and 2 with the brace on.

Patient two: she wore the brace all day long. After one month of treatment she reported a significant improvement in pain, with scoring VAS 3 without the brace and 0 with the brace on.

Both were much more straight with a better sagittal and coronal alignment while wearing the brace with a postural improvement that lasted for some hours after the brace removal. Both reported to be very happy with the treatment.

CONCLUSION: The new modular prefabricated brace showed to be very effective in improving pain in patients with Hyperkyphosis and scoliosis. These initial results are very promising and make it worth to design a prospective study to better evaluate the benefit achievable.
USER SATISFACTION WITH CUSTOM-MADE ABDOMINAL HERNIA BELTS

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INTRODUCTION: Custom-made abdominal hernia belts are prescribed to the persons with very pronounced abdominal hernia when serially made abdominal hernia belts do not fit because of the size or position of hernia, or the person is oversized. These belts are used before or after hernia surgery, or if surgical treatment of the hernia is not possible. Scientific evidence supporting the use of abdominal hernia belts, including patient experience, is lacking. Not many questionnaires are available for assessing satisfaction with custom-made medical devices. We decided to use the Slovenian version of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST).

AIMS: The aim of our study was to investigate patient experience of wearing custom-made abdominal hernia belts.

METHODS: Slovenian version of the standardised five-level (1=not satisfied at all, 5=very satisfied) QUEST questionnaire was used. All customers who received custom made abdominal hernia belts in September and October 2017 at the Pharmacy of the University Rehabilitation Institute in Ljubljana received the questionnaire.

RESULTS AND CONCLUSIONS: The questionnaire was returned by 14 users, 9 women and 5 men. Average device subscale score was 4.3, average service subscale score was 3.8 and average total QUEST score was 4.5. The most important satisfaction items as identified by the users were comfort, adjustments and dimensions. The users mainly commented on high temperature of the belt, especially in the summer time, and the users with a lot of soft tissue reported difficulties with swinging of the edges of the belt.
WHEELCHAIRS
CUSTOM MADE SEATING UNIT

Gregor Hočevar

INTRODUCTION: Prescription of most sophisticated wheelchairs requires a team approach. Solutions and application are made for each user individually, and members of the team need a lot of medical and technical knowledge. Goals for a wheelchair and seating system are to maximize functional independence with activities of daily living, minimize the risk of secondary injuries, correct or accommodate for skeletal deformities, ensure comfort and promote positive and unobtrusive self-image. Especially correcting or accommodating for skeletal deformities and ensuring of comfort are the most important for wheelchair user which have many skeletal deformities and cannot correct the sitting position for themselves.

AIMS: Description of prescription and manufacturing process of custom made seating unit.

METHODS: In our institution for about 25 wheelchair users yearly it is necessary to make the seating unit by imprint which is mounted on a special frame. The members of the team determine make thorough physical assessment, determine characteristics of seating unit and describe the level of impairment of body functions and structures.

RESULTS AND CONCLUSIONS: For custom made seating unit we usually decide with those users who have besides mental disorders many additional problems such as contractures of the joints, deformities of spine and chest, movement disorder, epilepsy, problems with perception, behavioural disorders. Most of these clients come from social institutions and the therapists who work there emphasize active participation of their clients in activities of daily living according to their capability.

User`s physical assessment bases on diagnosis, description of disease if it is static or progressive, secondary conditions and complications, and the level of impairment of body functions and structures which includes joint movement and range, sitting balance, alignment and flexibility of the spinal column including the head and neck. Into consideration must be taken also vision, eating, toileting, breathing, transfer, communication and other factors that affect patients’ positioning. We are also interested in patients’ living situation and what kind of activities he is involved in.

During wheelchair prescription we determine the type of seating unit, headrest, footrests, fixation belts and other accessories and the type of frame. The ideal posture as agreed by the team must then be modelled within the moulding bags. An impression of the client’s ideal posture is taken. Seating unit is then made from various polyurethane materials.

At probation of the seat we check position of pelvis, trunk, head, legs and arWe check the areas where increased pressure is expected and mark possible corrections. Precise observation and use the pressure mapping system is needed. Materials for the seat are carefully chosen. The seating unit is finalized when we are sure that it is appropriate.

Testing and prescribing wheelchair with custom made seating unit is a set of compromises. We should focus on appropriate seating which stimulates participation in everyday activities. The best seating position for the wheelchair user can not be described by a single static or fixed position, but it should be described as a dynamic state that uses a lot of different positions.
USABILITY OF USERS ASSESSMENT OF SATISFACTION WITH WHEELCHAIR AND RELATED SERVICES BASED ON QUEST 2.0 (QUEBEC USER EVALUATION OF SATISFACTION WITH ASSISTIVE TECHNOLOGY - VERSION 2.0)

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INTRODUCTION: Wheelchair is one of the most complex aids of assistive technologies (AT) for ensuring independent mobility of individuals with walking impairments. The quality of the wheelchair and its suitability affect the user’s independence in mobility and in other activities, as well as satisfaction and quality of life.

AIMS: Our aim was to determine users’ satisfaction with wheelchairs and related services, using standardized QUEST 2.0 and classify different models of wheelchairs and producers based on user satisfaction. The information attained could help us to plan better testing of wheelchairs in the future.

METHODS: The study included users that came to Rehabilitation engineering at University Rehabilitation Institute, Republic of Slovenia, during year 2017 for testing a new wheelchair. Including criteria was that already had a wheelchair. They completed standardized questionnaire QUEST by themselves or with a help of an assistant. Each item is ranged on five-level scale (1 = not satisfied at all, 5 = very satisfied). They assessed the wheelchair they have used mostly five years (three years for employed and students) until the prescription of a new one.

RESULTS: QUEST was completed by 94 users. 83 questionnaires were completed properly, 11 were not valid due missing data. The average users’ satisfaction with wheelchair was 4.37, the average score of satisfaction with services was 4.45, and the overall rating of QUEST was 4.40. The most often chosen satisfaction factors were safety, security and comfort, as well as repair and servicing of wheelchair in part of services; followed by adaptability and durability. Most comments were made on the dimensions and durability of the wheelchair. The durability (endurance), and efficiency of wheelchair obtained the lowest score (4.25 and 4.28). The best scores were assigned to easy use of wheelchairs and to the quality of professional services (4.55 and 4.58).

Results of our study show that users are in average quite satisfied to very satisfied with both wheelchair and its services but the scores between different suppliers have some variations. The low scores of durability and frequent comments about repairs and servicing are partially understandable, because of specific population, which mostly receive high equipped wheelchairs which are in use a big part of the day. Their independence and functioning depends of good conditions of the wheelchairs.

While collecting and monitoring data of questionnaires, some weaknesses arouse. Evaluation after five years of receiving a wheelchair is questionable, since the reliability of data is poor. It is difficult to know how long user was waiting for a new wheelchair and how many service interventions were done. We will try to introduce a questionnaire already in the second year after obtaining the wheelchair. We found also a low sensitivity of the questionnaires in Slovenian language. In future, we also intend to upgrade the questionnaire with more specific quality indicators.

CONCLUSIONS: Results show, that users in Slovenia are mostly satisfied with their wheelchairs. Continuous monitoring of users’ satisfaction will help to improve quality of wheelchair testing and enable to evaluate the reliability of different suppliers of wheelchairs.
FUNCTIONS OF POWERED WHEELCHAIRS FOR VERY HEAVY MOVEMENT HANDICAP IN SLOVENIA

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INTRODUCTION: The wheelchair or seating system should enable individuals to perform the activities of daily living that are important to them with minimal to no assistance and with the least amount of energy expenditure. Types of activities can include transfers, personal needs (e.g., bathing, toileting), working, preparing meals, cleaning, and shopping. Around the world there are different models of wheelchair provision. Health insurance in Slovenia made a system in year 2007 and since then it was not changed. Since wheelchair technology greatly changed in last ten years we are challenging with questions what new functions wheelchairs nowadays allow and if they can be prescribed to our patients.

AIMS: Find out how many most sophisticated powered wheelchairs were prescribed in University rehabilitation institute Soča (URI-Soča) in year 2017, what additional functions they allowed and how many of them were out of standard prescription based to Slovenian health insurance provision.

METHODS: We scoped testing lists of wheelchairs prescribed in URI-Soča in year 2017 and get data about functions which enabled prescribed powered wheelchairs for very heavy movement handicap.

RESULTS AND CONCLUSIONS: In Year 2017 in URI-Soča 91 powered wheelchairs for very heavy movement handicap were prescribed. Sixty-six (72.5%) of them provided additional functions, which are not in standard provided for that category of wheelchairs by health insurance. In 54.5% of cases additional function were power elevating seat and power foot rest elevation. In 37.8% wheelchair allowed movement of back and hand rest together with user in 34.8% were prescribed integrated controls, in 19.7% wheelchairs which allow powered transition to standing position and 13.6% special controls of wheelchair.

Results show that most of the prescribed powered wheelchairs for very heavy movement handicap had additional functions, which in year 2007, when the provision system was set, were not in regular use. Health insurance allows provision of such sophisticated even though they are out of so called standard. Additional functions prescribed allowed patients independent control of wheelchair, independent changing of seating or even standing position and independent environment control, useful at home, work or in school. Those functions are needed for better functioning and maintenance of health condition. Since there are so many prescribed wheelchairs out of standard, system of provision need to be changed and new rules set.
FITTING AN ELECTRICAL POWERED WHEELCHAIR FOR A YOUNGER HIGH COMPLETE CERVICAL SPINAL CORD INJURY PATIENT

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INTRODUCTION: A patient after high cervical spinal cord injury needs electrical powered wheelchair (EPW) with many individual adaptations. It is important to align the needs of an individual in his environment with the available technical possibilities. For planning and implementation of wheelchair adaptation a multidisciplinary team should cooperate with a patient and also with his relatives and/or caregivers.

CASE: A male patient, aged 21 suffered a high cervical spinal cord injury (neurological level C4, AIS A, six months post injury, tracheotomy tube impedimented speech). His remaining locomotor skills, absent sensory input below the level of injury and demands of the new environment after discharge were considered for proper adaptation of the EPW. With appropriate base structure (middle wheeldrive offers more stable, safe, agile mobility) and different sitting and lying positions the patient was able to drive the wheelchair independently for several hours per day, simultaneously preventing the development of possible complications (deformations, pressure ulcers). He could use only his head movements to operate switches, mounted on his headrest which provided appropriate head support. EPW enabled vertical positioning which he could control, suspenders for the ventilator were added, additional controls for information and communication technology (smartphone and laptop) enabled him to better communicate, play games and engage in information society. EPW was fitted with adaptations for car access and safe driving as passenger.

CONCLUSION: Highly demanding process of choosing and fitting an EPW enabled the patient to independently use information and communication technology and better manage his environment so he could integrate into information society and increase his quality of life.
INTRODUCTION: This paper is a representation of series of procedures in occupational therapy at Prosthetic rehabilitation ward of Institute for physical medicine and rehabilitation “Dr Miroslav Zotović”, used for assessment and training for wheelchair use in patients with lower limb amputation. Before the beginning of prosthetic rehabilitation every patient with lower limb amputation, whether its unilateral or bilateral, transfemoral, transtibial or combined, undergoes the process of prosthetic potential evaluation. If the assessment shows that a patient does not have adequate potential for prosthetics, the use of wheelchairs is recommended, both for transportation and every-day activities.

AIMS: Representing the protocol for assessment and training for wheelchair use and the way such protocol simplifies the process of assessment and training in wheelchair use, reduces the time needed for evaluation and training and reduces potential mistakes during physical and occupational intervention

METHODS: Procedures used for assessment in wheelchair use are a series of steps documented in a file named “Wheelchair use assessment” which is in official use at Institute for physical medicine and rehabilitation “Dr Miroslav Zotović” since 2013. This document includes interview, aka. data given by the patients himself, or the patient’s family. The second part consists of data collected by observing a patient with amputation in completing the given tasks. Collected data are documented in the aforementioned file and by analyzing the data the proper wheelchair is prescribed. The assessment is followed by the training in wheelchair use. The training for wheelchair use is also a process including the series of steps as documented in a file named “Revision of handling and managing wheelchairs”, which is a document in official use at Institute for physical medicine and rehabilitation “Dr Miroslav Zotović” since 2013.

RESULTS AND CONCLUSIONS: The protocol of assessment and training for wheelchair use in not just a reminder of skills that a person with amputation must overcome in order to successfully and safely use a wheelchair, but also a list that gives us the insight in skills that a patient has successfully overcome and skills in which a person with amputation needs assistance.
INTRODUCTION: People after lower limb amputation have problems walking, climbing stairs and with some other activities and participation. Not all people after lower limb amputation can be fitted with prosthesis and many amputated due to vascular reasons abandon their prosthesis (1). To be able to move in their environment, they need an appropriate wheelchair. When deciding about the most appropriate wheelchair, we have to take into consideration that the centre of mass after lower limb amputation moves higher due to the loss of lower limb mass. To prevent tipping over, we use safety wheels and we move the rear wheels farther back.

In Slovenia, the Health Insurance Institute of Slovenia (ZZS) divide wheelchairs into two main categories: basic and advanced ones. The prescription criterion is the level of functional disability (motor impairment) of the user. The main difference between the two categories is in the number of possible adjustments and accessories.

AIMS: The aim of our study was to find out which type of wheelchairs are most frequently used for people after lower limb amputation, and whether age and amputation level influence wheelchair selection.

METHODS: We reviewed wheelchair tests and medical records of all people after lower limb amputation who had a wheelchair test between January 2017 and December 2017.

RESULTS AND CONCLUSIONS: In the studied period we tested the wheelchair for 92 persons (60% men) after lower limb amputation (13% trans-tibial, 53% trans-femoral, 34% bilateral amputation). They were 54 to 95 years old (mean and median 76 years). About two thirds (64%) of the tested wheelchairs were basic and about one third (36%) were advanced. Age, amputation level and co-morbidities were not associated with the type of tested wheelchair. The most frequently tested accessories were body belt and table. Both seemed to be most frequently used for older people after bilateral amputation who had suffered a stroke.

Many people after lower limb amputation need advanced wheelchairs with several accessories due to advanced age and several co-morbidities.
INTRODUCTION: Sitting is a dynamic function influenced by selective motor activity and reflex motor patterns as well as the seating device. People with various disorders of nervous system and neuromuscular diseases are unable to control sitting actively or to continuously adapt their sitting posture. Powered wheelchairs are appropriate for people who cannot manually propel themselves. They are operated with a joystick or other devices that can be controlled by almost any part of the body that they can move. The prescription and the application of assistive technology such as a wheelchair can only be performed by an experienced interdisciplinary rehabilitation team. Along with mobility, comfort is reported as the most important attribute or function of wheelchair. The wheelchair or seating system should enable individuals to perform the activities of daily living that are important to them with minimal assistance and with the least amount of energy expenditure.

CASE: The 48 years old man with muscular dystrophy and respiratory support is a user of powered wheelchair for years. He lives in an environment which enables him to move with powered wheelchair and he has 24-hour assistance. He is still regularly employed. At the time of new wheelchair prescription he was using a rear-wheel drive powered wheelchair. The wheelchair was 23 years old and could not be maintained no more. Fourteen years ago he got a new electric powered wheelchair, but he did not use it because of sitting problem instead he was using the old wheelchair.

The result of the physical assessment showed scoliosis with rotated and elevated pelvis and contractures in hips, knees, ankles and elbows. Preserved was only mobility in fingers of the hand, with very low strength. The patient needed air filled cushion for seating to reduce pressure and pain and individually anatomic made cushion for back. Testing of mobility and strength of fingers movement showed, that the patient can handle only the mini joystick with very small dimensions with very little strength (<0.1N~10g) and very little joint range of motion to operate a wheelchair. He also needed additional switches for turning wheelchair on and off and to change between wheelchair functions. The position of switches had to be precise, unless he was not able to operate them.

He decided for a wheelchair with midwheel drive which allows the user to turn seemingly on center and dramatically increases indoor maneuverability. Traction is also increased. Since the wheelchair was different from current, the test of maneuvering of the wheelchair was needed.

CONCLUSION: Wheelchair is a mobility orthosis and the most common assistive technology for person with disability. A properly prescribed wheelchair can be useful device in reintegrating a person with a disability into quality day life. When choosing the most appropriate seating unit and wheelchair frame we have to take into account the impairment of body structures and functions, activity and participation of the user in activities of daily living, the environmental and personal factors and the level of the assistance to the user.
INTRODUCTION: Multidrug resistant (MDR) bacteria are well-recognized to be one of the most important current public health problems. The Infectious Diseases Society of America (IDSA) recognises antimicrobial resistance as "one of the greatest threats to human health worldwide" (1). That is why it is important that all health professionals, including prosthetists and orthotists, are aware of the threat and know how to protect themselves and their patients. Proper hand hygiene is the single most important, simplest, and least expensive means of reducing the prevalence of health-associated infections and the spread of antimicrobial resistance. Normal human skin is colonised by bacteria (2). Total bacterial counts on the hands of health care workers have ranged from $3.9 \times 10^4$ to $4.6 \times 10^6$ CFU/cm²; fingertip contamination ranged from 0 to 300 CFU when sampled by agar contact methods (2). Additional hygiene measures to prevent MDRO transmission are also important (3).

AIMS: The aim of the study was to go through the whole process from clinical examination in a clinic to final fitting of a prosthesis, define the critical moments for MDR bacteria transition and the appropriate and possible solutions for protection with main focus on hand hygiene.

METHODS: Observation certified prosthetist orthotist during his work, checking for situations when he has to disinfect his hands.

RESULTS AND CONCLUSIONS: We will present and discuss all moments when it is possible to transmit MDR bacteria, and the necessary actions in all situations when prosthetists meet and work with patients, with special emphasis on hand hygiene.

References
INTRODUCTION: The aim of this paper is to inform about the status of the Society for prosthetic and orthotic in Bosnia and Herzegovina (ISPO in Bosnia and Herzegovina) and about the priority activities for the period 2018-2020.

CASE: ISPO in Bosnia and Herzegovina was established in 2010. The same year, the First ISPO conference was held during the national Congress of Physical Medicine and Rehabilitation Tuzla. Ever since, both the activities and the membership of ISPO in B&H were very scarce. This years’ long inactivity resulted from a situation whereby ISPO in B&H was not affiliated to any organization or institution with strong prosthetic and orthotic teams and PRM doctors were almost not involved in the work of ISPO. In other words, the membership and leadership were lacking.

In October 2017, during the Annual Assembly, the team from the Institute for Physical Medicine and Rehabilitation “Dr Miroslav Zotović”, Banjaluka and the former ISPO in B&H leadership negotiated several changes in the structure and function of Organization. The main change was the relocation of ISPO in B&H headquarters – now it is in the Institute in Banjaluka. The new headquarters ensures affiliation to strong prosthetic and orthotic teams, with long tradition and good regional contacts. Also, the Institute is University hospital which is the value added for the future ISPO development.

As for the legal framework, the Statute was revised to accommodate more flexible governing structure. The new leadership includes prominent professionals: president of ISPO in B&H is Biljana Majstorović, PRM doctor, clinical leader in prosthetic rehabilitation; president of the Assembly is Predrag Stojanović, O&P technician ISPO cat II, member of the executive Board is Đurđica Stevanovic Papić, regional champion in a conservative scoliosis treatment. Secretary is Nataša Tomić, PRM doctor with extensive experience in organizational development. Two other members of the Executive Board – Damir Berberović and Mehmad Latifagić ensure the continuity in functioning of the Organization.

The Statute stipulates main activities of ISPO in B&H: promotion and organization of educational activities in fields of orthopedic aids and highly specialized rehabilitation programs requiring application of orthopedic aids; establishment of standards in education; consulting work with health insurance funds and user’s organizations.

Trainee PRM doctors are prospective members and target group for education. At recent meeting they expressed their perceived priority needs for education. Out of 20 doctors 4 opted for prosthetics, 11 for orthotics and 5 for mobility aids (wheelchairs). Asked to self-rate their perceived competence in assessing the functionality of orthopedic aids, on scale 0 to 5, vast majority opted for 1 and 2, only one for 3 (feeling moderately competent in this field). This information is valuable for the new ISPO in B&H leadership.

CONCLUSION: Current, 2018 baseline indicators of ISPO in B&H are: 10 active members, one ISPO conference (2010), scarec contacts with ISPO International.

Plan for 2018 – 2020 includes: 10-times increase in membership, organization of annual conferences (June 2018, Banjaluka), opening a dialogue with user’s organization, frequent and projects-oriented contacts with regional societies and ISPO International.
BIOMECHANICAL EVALUATION OF A VARIABLE RESISTANCE ORTHOTIC KNEE

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INTRODUCTION: The next generation of orthotics devices can benefit from microprocessor-based intelligent control and novel mechanical designs to enable better mobility in the user’s chosen environment. To address this need, a novel microprocessor controlled orthotic knee joint was developed to enable safe mobility across multiple movement tasks by dynamically adjusting knee flexion resistance, based on real-time multiple-sensor analysis at the thigh and knee. This orthotic knee combined the Ottawalk-Speed mechanical design, Endolite Elan prosthetic foot control system and valve, and a new interface manifold to produce a low profile variable stance control KAFO (VSCKAFO). This new VSCKAFO addresses size limitations of other microprocessor controlled KAFO’s (i.e., fits beneath clothing, all sensors within the device) and provides a modular design that accommodates patient-specific decisions on ankle joints and foot section.

AIMS: Evaluate the VSCKAFO biomechanical performance for level walking, stand-to-sit, and stair descent.

METHODS: Five able-bodied participants were recruited as a preliminary sample before future evaluations with KAFO users. These participants were fitted with the VSCKAFO and VSCKAFO settings were adjusted to the participant during an accommodation period. A lower body, 6 degree of freedom marker set was affixed to each participant before level walking at self-paced speed within the CAREN-Extended virtual reality environment while kinematic and kinetic data were collected (12 camera Vicon System, dual tread instrumented treadmill) were collected. Following level walking, kinematic data were collected from each participant during stair descent and sitting within a motion analysis laboratory (10 camera Vicon System, 2 force plates). Following data processing, peak values were extracted and analyzed.

RESULTS AND CONCLUSIONS: Motion analysis results confirmed that the VSCKAFO engaged and disengaged appropriately for safe walking. Further work on optimal user setup will improve walking results. The variable resistance setting provided appropriate knee flexion resistance for controlled lowering of the body during stand-to-sit and stair descent.

The VSCKAFO performed as designed by determining gait phases using the integrated sensors, rapidly adjusting knee flexion resistance during movement, resisting knee flexion during weight-bearing, and allowing free knee motion during swing. The successful biomechanical analysis supports further testing of this VSCKAFO with people with knee extensor weakness.
The world of scoliosis is gradually changing. After many years in which the so-called conservative treatment lost prestige because considered somehow outdated, the pendulum is now swinging back in the opposite direction. This is due to the raising evidence published in the last decades. Bracing is currently the primary method for treating moderate idiopathic scoliosis (IS) during the developmental phase of growth. Following a lengthy debate, during which researchers and authors questioned the role of bracing in the treatment of IS due to inconsistent evidence, the Bracing in Adolescent Idiopathic Scoliosis Trial study have provided a high level of evidence to the value of bracing and may have convinced most of those who were skeptic. However, although some guidelines have been published, there remains no standard for constructing scoliosis orthoses and no standard treatment protocol. About exercises a number of papers has been published after a 2012 Cochrane review reported no strong evidence in favor or against exercises. Some RCTs appeared with consistent results showing significant improvements of moderate curves. Finally, new guidelines have been recently published summarizing the evidence and giving an operative framework for an evidence based approach to the conservative treatment of scoliosis.
INTRODUCTION: The correction of lumbar scoliosis does not follow uniform patterns under treatment with braces; there are astonishing similarities with the model of the “Euler buckling mode”. This theory states that the curvature of a flexible column depends on how it is fixated.

AIMS: To detect pathological fixations (malformations) of the lumbosacral region according to the Castellvi classification

METHODS: 52 patients suspicious to LSTV (x-ray with bony structure suspicious to LSTV, angulation L5-S1 Cobb> 5°, rotation of L5 and rounded promontorium) were transferred to get MRI of the lumbar spine. The MRI images were assigned according to the Castellvi classification.

RESULTS AND CONCLUSIONS: Castellvi I: Castellvi I requires the height of the processus transversus with >19mm. The coronary view of many x-rays does not allow a precise measurement depending on the quality of the x-ray and angulation of the portrayed vertebra (n - 13). Also MRI is limited to enable an accurate measurement.

Castellvi II: In scoliosis, an attachment on one side between the transverse process of L5 and the body of S1 could be found in 17 patients (Castellvi II-A). An attachment on both sides could be found in 5 cases (Castellvi II-B).

Castellvi III: It was unquestionable in 5 patients if coronary image were taken in the MRI (Castellvi III-A). A connection and on both sides could be found in 4 cases (Castellvi III-B).

CONCLUSION: Castellvi I: In a conventional x-ray overlays to the transverse process prevents a required measurement (>19mm). MRI images are also not focused to the transverse process. This prevents also a precise measurement and classification. In conclusion Castellvi I is only an allusion to a pathological finding.

Castellvi II: In some scoliosis an articulation between the transverse process and the sacrum can not differentiate LSTV from a pathological junction (the rotation and angulation of the vertebra can also lead to a junction). Only if a wide pseudarthrosis can be dedected, the diagnosis of LSTV is confirmed. In the case of wide pseudarthrosis it is a malformation and cannot be corrected conservatively, while in case of a contact area a correction with the brace can be expected.

Castellvi III: It is a bony bridge and can be classified very easy. In Castellvi III-B if only pictures of the lumbar spine are taken the detection of L5 becomes difficult.

Castellvi IV: as a combination of Castellvi III and IV shows a diagnostic overlapping without therapeutic consequence.

LSTV Castellvi-classification is highly depending on the quality of conventional X-ray and MRI-images.
QUANTITATIVE ASSESSMENT OF SPINAL BRACE WEAR IN TREATMENT OF IDIOPATHIC SCOLIOSIS

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INTRODUCTION: Idiopathic scoliosis is a three-dimensional spine deformity affecting 0.3-0.5 % of children younger than 16 years of age (1). According to 2011 SOSORT guidelines (2), bracing is one of the conservative approaches to treatment when curves are greater than 20° Cobb. Corrective orthoses should be worn part-time (12-20 hours) or full-time (20-24 hours). With electronic wearing-time systems we can quantitatively assess time of brace wear and compliance. The literature overview shows that usual compliance is between 60 % and 65 % (3,4).

AIMS: We had only used subjective methods like interviews and questionnaires to assess time-of-orthosis-wear. We wanted a more objective assessment, which is possible by equipping the brace with a device that measures time-of-wear. We decided to use temperature sensors (5,6) that were imbedded inside the brace.

METHODS: Fifty-five patients aged 6-15 years with idiopathic scoliosis were prescribed a brace treatment for 18-23 hours daily. Each brace was custom made and equipped with a temperature probe imbedded inside the orthosis. The data were acquired every three months during check-ups using a wireless reading device connected to a computer via USB plug. The acquired data were analysed and graphed by the accompanying software. All the patients were notified that there is a sensor within the brace.

RESULTS AND CONCLUSIONS: From 42 (76%) of 55 activated sensors data were successfully acquired. Only 7 (7%) patients wore the brace for the prescribed time. In this group the patients wore their orthoses from 18.2 to 22.6 hours (mean: 20.4 hours). All the other patients (35 or 83%) wore their braces less than prescribed. The lowest acquired reading was 1.2 hours. We found out that the compliance of our patients is very poor in comparison to similar studies performed abroad, and that there is a lot to be done to increase it especially by better education of patients and their parents. Our aim should be positive encouragement and stimulation from all members of the rehabilitation team.

REFERENCES:
THE OUTCOME OF A MODIFIED VERSION OF THE RIGO-CHENEAU BRACE (MOOR S BRACE) IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS): A RETROSPECTIVE STUDY

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INTRODUCTION: Scoliosis is a general term comprising a heterogeneous group of conditions consisting in changes in the shape and position of the spine, thorax and trunk. By definition, idiopathic scoliosis is of unknown origin and is probably due to several causes. Bracing of patients with AIS has been controversial for a long time, with some authors reporting control of curve progression with bracing and others reporting that bracing fails to alter the natural history. To make comparisons among studies more valid and reliable, the Scoliosis Research Society (SRS) has standardized criteria for brace studies in patients with AIS. The SOSORT (Society On Scoliosis Orthopedic and Rehabilitation Treatment) proposed guidelines for an appropriate bracing treatment.

AIMS: The aim of this study was to assess the outcomes of a modified version of the Rigo-Cheneau brace – MOOR S, which we have been using since 2013 in the treatment of patients with AIS, based on SRS and SOSORT criteria.

METHODS: Study was retrospective. From 2013, patients with AIS who were newly prescribed MOOR S brace and met SRS and SOSORT criteria were studied. Inclusion criteria were: diagnosis of AIS, age ≥ 10 years, Risser Score 0-2, Cobb degrees 20-40, no previous treatment, beginning of treatment within 1 year after menarche. The study included twenty patients (18 girls and 2 boys), age 13,27 years ± SD 1,35 and 26,6±5,7 Cobb degrees at the beginning of the treatment. Outcome measures were Cobb angle at the end of the treatment. According to SRS criteria bracing outcomes were classified as follows: "improved" (reduction of the curve ≥6⁰), "unchanged" (5⁰ curve progression or reduction), "worsened" (≥6⁰ curve progression) and "over 45" (curve exceeding 45⁰ or undergone surgery). The outcomes "improved" and "unchanged" were considered as successful outcomes. The outcomes were measured at the cessation of wearing brace and not at 2-years follow up.

RESULTS: In 3 cases the curve progressed and they undergone surgery, 6 the curve improved and 11 the curve remained unchanged. Outcome after bracing treatment was successful in 85 % at efficacy analysis.

The results of the Independent T-test showed that there are statistically significant results in Cobb degrees at the end of the treatment (p=0,00) and degrees of improvement (p=0,00). The mean levels were better in the group "improvement/unchanged" than in group "over 45". There were also statistical significant differences in the same indicators, Cobb degrees at the end of the treatment (p=0,00) and degrees of improvement (p=0,00) between groups "improvement" and "unchanged".

CONCLUSIONS: This are first results of treatment with MOOR S brace. Study shows that in patients with AIS treatment with MOOR S brace is associated with high rate of successful outcomes. MOOR S brace proved to be effective conservative treatment for AIS.
INTRODUCTION: Improper backpack use (unilateral or excessive posterior loading) has led to alignment issues such as forward head posture, rounded shoulders, kyphosis, low back pain, and an asymmetrical axial skeleton (1,2). Forward head posture occurs when the head is held anterior to its neutral, balanced position and stresses the cervical vertebrae and posterior neck muscles (3).

AIMS: The purpose of the present study is evaluated cervical postural changes and functional capacity during the carriage of different loads with the same type backpacks.

METHODS: Twelve university students (10 male, 2 female) (20±0.7 years) participated in the experiment’s three standing modes: (1) unloaded standing, (2) 10% body weight (BW) load (in the form of a backpack), (3) 20% BW load. Photogrammetry was used to assess the craniovertebral angle. Craniovertebral angle formed between the line that links the seventh cervical vertebra (C7) and tragus and a horizontal line. It is used to verify the position of the head in terms of flexion and extension. All participants completed the six minutes walk test (6MWT) two modes: (1) 6MWT with 10% body weight (BW) load (in the form of a backpack), (3) 6MWT with 20% BW load.

RESULTS AND CONCLUSIONS: Statistically significant difference were found craniovertebral angle between two standing modes in photogrammetry results. In the 20% BW load significant differences compare to unloaded standing position (p<0.05). Craniovertebral angle in 10% BW load not statistically significant difference compare to 20% BW and unloaded standing. 6MWT test walking distance was found significant differences between the two conditions (p<0.05).

CONCLUSION: The results showed twenty percent BW (20% BW load) backpack causes the most significant head postural changes so it should be avoided. Craniovertebral angles in the 20% BW load decreased compared with %10 BW load and unloaded standing that showed head flexion increased in 20% BW load. Increased posterior loading backpack is adverse effect for functional capacity.
INTRODUCTION: Many patients with motor neuron diseases (such as spinal muscular atrophy, amyotrophic lateral sclerosis) or neuromuscular diseases (such as Duchenne muscular dystrophy or congenital muscular dystrophy) suffer from progressive weakening of neck muscles. As the neck muscles grow weaker, at one point in their life, it becomes very difficult for them simply to keep their head balanced against gravity and to orient the head for effective performance of activities of daily living. According to the requirements of these patients’ groups, head orthosis concept has been developed, that would help the users to move and orient their head with ease and maintain head stability.

AIMS: The aim of this study was to evaluate the effectiveness of the newly developed head orthosis concept on reduction of neck muscle activity level. Primarily, the head orthosis was tested on healthy participants to observe the efficacy of the concept.

METHODS: 10 healthy adult participants performed discrete movement of head that involved pure head flexion (-10 to 30 degrees at a step of 10 degrees). To ensure precise movement of head in subsequent repetitions, they were shown targets on a screen placed in front of them. They were then asked to move a cursor on the screen from a reference position to the target position and keep the cursor static within the target for 10 seconds by using head movements. The movements of the cursor were directly related to sagittal and frontal plane head angles of the participants, measured with inertial sensors. Surface electromyography (EMG) was recorded from neck muscles (upper trapezius and sternocleidomastoid). Data were averaged over the static phase of the tasks. The tasks were performed both with and without the orthosis to evaluate the effect of the orthosis on neck muscle activity level.

RESULTS AND CONCLUSIONS: The preliminary results show that wearing the orthosis caused reductions in neck muscle activity level. The average muscle activity level was 4%–9% of maximum voluntary contraction in the ‘without orthosis’ condition for the aforementioned neck muscles. This level was reduced to 2%–6% of maximal voluntary contraction for the ‘with orthosis’ condition. Moreover, no pain or discomfort was reported by any of the participants during the experiment. Based on these findings, it can be concluded that the current head orthosis concept has the potential to reduce the activity level of neck muscles and can potentially be beneficial for patients who are suffering from degenerative neck muscle diseases. Further study with different patients’ groups is going to be carried out to properly evaluate the effect of the head orthosis concept on its intended users.
TRUNK MOVEMENT AND MUSCLE ACTIVITY IN CHILDREN WITH DUCHENNE MUSCULAR DYSTROPHY WHEN PERFORMING SEATED DAILY ACTIVITIES

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INTRODUCTION: In performing daily activities from a seated position, besides the upper extremities, the trunk plays a crucial role. For patients with Duchenne muscular dystrophy (DMD) it becomes more difficult over time to perform such activities due to progressive muscle weakness. Supportive devices could assist these patients during daily life by reducing the required muscle force to perform these daily activities independently. For the development of a trunk supportive device, detailed information is needed about trunk movement and muscle activity in patients with DMD when performing seated daily activities.

AIMS: The aim of the study was to gain insight in trunk movement and muscle activity in patients with Duchenne muscular dystrophy in different disease stages when performing seated daily activities. Possible implications for trunk orthoses design were deducted afterwards.

METHODS: Seventeen participants with DMD (7-20 years) and twenty-five healthy participants (6-20 years) were included in this study. A 3D motion analysis system (Vicon) was used to record 23 single markers on pelvis, trunk and arSurface electromyography (EMG) signals were collected for the longissimus, iliocostalis and external oblique muscles and were normalized to EMG obtained from maximum voluntary isometric contraction (MVIC) measurements in a seated position. The maximum force was also collected during MVIC. While seated, participants performed several daily activities, like reaching forward and sideward, drinking and writing. Afterwards, trunk kinematics and normalized muscle activity were calculated.

RESULTS: First analyses showed increased trunk movement when reaching within arm length distance for DMD subjects compared to healthy controls. Differences could already be seen in patients with a relatively good arm function (Brooke scale 1). Normalized back muscle activity generally increased with Brooke scale until the task could not be performed anymore. More detailed analyses are ongoing.

CONCLUSIONS: Trunk movement is important for boys and men with DMD to perform daily activities. However, with disease progression, this requires an increase percentage of their trunk muscle strength. Clinicians should therefore take the trunk into account and not only focus on the upper extremities. For the development of supportive devices it is important to provide additional support to the trunk, to reduce the muscle load during daily life, but also to allow trunk movement so that daily activities can still be performed.
INTRODUCTION: Body powered upper-limb prostheses [bpp] have many advantages over EMG-controlled, electrically actuated ones [myo’s], including mass, reliability, and proprioceptive feedback. Despite these advantages, bpp are rejected as often as myo’s. Reasons mentioned include mass (despite being lower than myo’s), and comfort (especially of the harness). Recent research has shed even more light into why bpp are rejected: the operating forces are too high. As a result the main advantage of bpp – feedback – is secluded, and the high operating forces negatively influence the comfort.

AIMS: Current research at the Delft Institute of Prosthetics and Orthotics (DIPO) aims at improving the performance of upper-limb prostheses.

METHODS: At DIPO several ongoing projects try to improve different aspects of upper-limb prostheses. Three of them will be highlighted here:

• Natural grasping
  This project aims to design a body-powered voluntary closing hand prosthesis with adaptive fingers, a high pinch force to operating force ratio, and a low mass.

• Haptic interface for prostheses control
  This project aims to combine the advantages of externally powered prostheses (low operating effort, high pinch force) with the advantages of body-control (feedback). The idea is to measure movements of the body to control the aperture of the terminal device, and to measure pinch forces in the terminal device and feed them back to the body.

• Servo mechanisms
  This project aims to enable prosthesis operation with low operating efforts. The envisioned servo mechanism uses pneumatic energy, as electro-mechanical servo mechanisms suffer from a high mass, and are sensitive for water and dirt.

RESULTS AND CONCLUSIONS:

• Natural grasping
  A prototype hand was developed. It has four adaptive, under-actuated fingers and a stationary thumb. The hand requires less energy (50-160%) of the user compared to current bpp-hands, while its mass is only 152 grams. Clinical tests are currently performed.

• Haptic interface for prostheses control
  The designed interface utilizes skin anchors connected by sensors and an actuator to record force/displacement and to provide feedback from sensors in the terminal device. An experimental set-up showed that the system indeed is able to provide input to the terminal device and gives proper feedback to the user.

• Servo mechanisms
  A hybrid system was designed that closes a voluntary closing terminal device by a Bowden cable as usual, and automatically activates a pneumatic servo as soon as an object is grasped. The output of the servo is proportional to the cable force, with a three-fold amplification.

The current projects at DIPO all show the future promises for upper-limb prostheses. The Delft Cylinder Hand is the first hand prosthesis that fulfills most requirements of the user: low mass, low operating effort, and proprioceptive feedback. The haptic interface shows a promising way of avoiding the harness, while maintaining the proprioceptive feedback. In combination with the pneumatic servo mechanism a prosthesis that combines body-control with a low operating effort comes within reach.
NEURAL CONTROL AND DIRECT SKELETAL ATTACHMENT OF BIONIC LIMB PROSTHESSES

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INTRODUCTION: Current prosthetic devices deliver limited functionality and do not purposely provide sensory feedback, mainly due to the use of superficial skin electrodes. Implanted neuromuscular electrodes have been long thought as a solution to provide a more natural control of limb prostheses. However, their clinical utilization has been hindered by the lack of a long-term stable transcutaneous or percutaneous interface.

AIMS: We have developed long-term stable, bidirectional osseo-neuromuscular interfaces for upper and lower limb prostheses as a solution for the aforementioned long-standing problem.

METHODS: The discovery of osseointegration allowed for the first successful skeletal attachment of a limb prosthesis. We enhanced the pioneering device for skeletal attachment of limb prostheses, the OPRA implant system, to also allow for bidirectional communication between neuromuscular electrodes and the prosthetic device.

RESULTS AND CONCLUSIONS: This enhanced OPRA (e-OPRA) allowed for the first time, that a transhumeral amputee utilized implanted electrodes for the daily control of his prosthetic arm, outside of controlled environments. Furthermore, the e-OPRA also allows amputees to receive intuitive sensory feedback via direct peripheral nerve stimulation in daily life. The transhumeral e-OPRA system is continuously functional and in daily use up to date (over five years after implantation). We have now developed transradial and transfemoral versions of the e-OPRA system. These implant systems have been verified in bench experiments and the first recipients are planned to be implanted in the near future. Direct skeletal attachment of limb prostheses itself has shown to have considerable advantages and it is now a relatively established technology. We have advanced this technology further to allow bidirectional communication between the biological and mechatronic control systems, but more importantly, this technology has been proven safe and long-term stable to be used in daily life.
PERFORMING SHAP TEST WITH BODY-POWERED AND MYOELECTRIC SIMULATOR

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INTRODUCTION: Body-powered (BP) and myoelectric (Myo) prosthesis each have their advantages and disadvantages. We found no study that would compare performing the same activities or test with both of them.

AIMS: The aim of our study was to compare the results of Southampton Hand Assessment Procedure (SHAP test) performed by clinicians working with people after upper limb amputation, as well as to find out which compensatory movements are most frequent and largest with both prostheses (the second part is not presented in this abstract).

METHODS: Seven clinicians (one MD, 3 CPO, 3OT; 2 men, 5 women; 43 - 67 years old, median and mean 42 years), all working over 10 years with people after upper limb amputation, were included into the study. They performed the SHAP test with right hand first, and later with BP and Myo simulator in a random order. We calculated grip index scores.

RESULTS AND CONCLUSIONS: All indexes were significantly better with BP than with Myo prosthesis. With both prostheses the best was spherical grip (mean BP 57.14, Myo 31.57). The worst for BP was tip grip (mean 22.71) and for Myo it was power grip (mean 0.57). Five subjects found it much easier to perform the tasks with BF prosthesis, while two found no difference between the two simulators used. Age was highly negatively correlated for BP with overall (r=-0.90), spherical (r=-0.78) and tip grip index (r=-0.78), and did not correlate significantly with other results.

In spite of our belief that there would be no differences or that Myo prosthesis might be better than BP, we found out that all indexes were better with PB prosthesis. Age appears to have negative influence only on some performance aspects with BP prosthesis.
INTRODUCTION: Silicone prostheses after partial amputation of fingers or hand are mainly used and considered only as aesthetic replacements for the amputated body part. Finger amputation is a major loss for patients who play musical instruments. For them, the prosthesis is not merely an aesthetic aid, but also improves function and quality of life.

AIMS: The aim of the study was to find out if silicone finger prostheses are useful for the amputees for playing a musical instrument.

METHODS: We reviewed medical records of all patients with finger amputation who have been fitted with silicone prosthesis in the last ten years at our Institute. Fourteen of them play at least one musical instrument. So far, we have only collected data from medical records. In the future, we will send them a questionnaire about the use and usefulness of the prosthesis for playing musical instruments and about their satisfaction.

RESULTS AND CONCLUSIONS: Twelve men and three women, 14 to 79 years old (median 54 years), who were involved in the study, play one (13 subjects) to three (2 subjects) musical instruments. One had congenital upper limb deficiency of fingers, one was injured in a traffic accident, one with a textile machine; all others were injured with farm machinery. One had bilateral amputation of all five fingers; seven had amputation of only one finger. Nine had amputation of index finger and eight of ring finger, six of middle finger, 4 of thumb and 3 of little finger. Six played accordion, three played piano, guitar and violin; other instruments were played by only one person. At the moment, we know for six of them that they are regularly using silicon prosthesis for playing musical instruments.

CONCLUSION: The majority of the subjects use the standard aesthetic silicone prosthesis without additional adjustments for playing accordion or keyboard instruments (piano, organ). Most of them had only one finger amputated. For the subjects who had a finger amputated on the left hand and play accordion, a reinforcement of the prosthesis is required in order to avoid finger bending at the level of the end of the stump. For the patients playing wind instruments, a technological improvement of the prosthesis would be required in terms of a soft cushion at the distal end to imitate finger tips. For playing bowed string instruments or zither, special adjustments are also required, because it is usually not possible to play those instruments with the standard aesthetic finger prosthesis. The ability to play guitar also depends on the amputation side and which finger is amputated. Regained ability to play a musical instrument undoubtedly improves the person's quality of life and facilitates reintegration into the social environment.
SATISFACTION, ADJUSTMENT AND CONTINUED USE OF UPPER LIMB PROSTHESES IN SLOVENIA

Klara Šosterič, Helena Burger, Gaj Vidmar
Uni Soča, Ljubljana, Slovenia

INTRODUCTION: The Trinity Amputation and Prosthesis Experience Scales – Revised (TAPES) assesses satisfaction and various aspects of adjustment to prosthesis, which are important factors in the acceptance and continued use of the prosthesis.

AIMS: To investigate influence of systematics factors (gender, amputation level, prosthesis type and cause of amputation) on satisfaction with upper limb prosthesis, on the level of adjustment to it and time of its use.

METHODS: This cross-sectional study was carried out at the University Rehabilitation Institute in Ljubljana between January and December 2016 and included all (442) patients after upper limb amputation visiting our clinic. TAPES–R questionnaire and electronic health records (EHR) data were analysed with descriptive statistics, univariate analyses and multiple linear regression models.

RESULTS AND CONCLUSIONS: Forty-three per cent of included patients answered the questionnaire. The distributions of systematics factors were practically identical in the EHR and the sample; hence the sample was representative of the population. Social and general adjustment was better on average than adjustment to limitations of prosthesis, especially among long-time prosthesis users. On average, adjustment-to-limitation scores decreased with age, were higher for patients with a passive prosthesis and when the cause of amputation was accident. In general, the patients were more satisfied with aesthetic than functional aspect of prosthesis. Aesthetic satisfaction scores were lower on average for recent receivers of last prosthesis, and higher for those with fingers/palm amputation. Functional satisfaction was higher on average for women and when the cause of amputation was accident. Overall satisfaction was higher on average in women and lower in recent receivers of last prosthesis. It also turned out that women wear their prosthesis more than men and patients with finger/palm amputation less than others. There are other systematic factors and personal specifics that play a major role in the person’s adaptation to prosthesis in addition to the factors considered in our study.

Adjustment to upper limb prosthesis in Slovenia is better with long time prosthesis users, if the amputation was caused by an accident and with passive prostheses. In general, women tend to be more satisfied with their prosthesis than m
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