Human Biomechanics 2014

Pilsen, Techmania Science Center

15 – 16 September 2014

Book of Abstracts
BOOK OF ABSTRACTS
15th International Conference Human Biomechanics 2014

Published by
University of West Bohemia
Univerzitní 8, 306 14 Plzeň, Czech Republic
VAT No. 49777513

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THIS ACTION IS REALIZED BY THE PROJECT NEXLIZ – CZ.1.07/2.3.00/30.0038, WHICH IS CO-FINANCED BY THE EUROPEAN SOCIAL FUND AND THE STATE BUDGET OF THE CZECH REPUBLIC.
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PART I. INVITED LECTURES
On heterogeneity of mechanical environment of vascular walls at a cellular level

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Mechanical properties of the artery wall have been assumed to be homogenous in conventional analyses. However, it is not the case for microscopic analyses. Artery walls consist of components with various Young’s modulus such as collagen (~1 GPa), elastin (~0.6 MPa), and smooth muscle cells (SMCs, ~10 kPa). Such heterogeneity should cause complex distribution of stress and strain depending on the histological structure. Aortic media has a concentric layered structure of a lamellar unit, a pair of elastic lamina (EL) mainly composed of elastin and a smooth muscle-rich layer (SML) mainly composed of SMCs and collagen. It is well known that the ELs are corrugated in an unloaded state and become straight over physiological pressure. Recently, we found that the corrugated ELs became straight upon isolation from the surrounding tissues. This indicates that the ELs bear compressive residual stress and the SMLs tensile in the circumferential direction in an unloaded wall. We also noticed that the waviness of the ELs in the unloaded aortic walls vary widely. To reveal the reason for this heterogeneity, we observed deformation of the ELs and SMCs in thin-sliced porcine aortic wall specimens during the circumferential stretch under a microscope in detail, and found complicated deformation at a microscopic level: Rotation and shear deformation was observed in SMCs, and ELs became straightened first without significant lengthening and then become elongated. Such deformation of ELs indicates that ELs with lower waviness bear higher load than ELs with higher waviness in a physiological state. To check this hypothesis, we cut off ELs in thin-sliced specimens stretched circumferentially mimicking a physiological state with a laser ablation technique and obtained results supporting the hypothesis, i.e., the gap produced by the ablation was wider in the ELs whose waviness had been lower in the unloaded state. Similar results were obtained for SMLs: SMLs adjacent to ELs with lower waviness had wider gap following ablation. Immunohistochemical analysis shows that SMCs adjacent to straight ELs were abundant with F-actin, suggesting that cells near ELs with lower waviness received higher mechanical stimulation. The reason for such heterogeneities is not clear at this stage. They might be caused by cellular activities such as remodeling and cell division. Microscopic mechanical environment is highly heterogeneous in the aortic walls. Microscopic viewpoint is crucial to elucidate the mechanism of the mechanical adaptation and remodeling of arteries.
Experience with the Intramedullary Skeletal Kinetic Distractor for Limb Lengthening (ISKD Nail)

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Surgical limb lengthening has been performed for more than 100 years. Results from surgery prior to the development of the Ilizarov callus distracting technique were poor. The Ilizarov technique was originated in Russia in the 1960s. It achieved limb lengthening by performing an osteotomy of the bone to be lengthened and then once healing callus started to form around the osteotomy site gradually distracting the callus using a ring external fixation device. Since then many different types of external fixation devices or frames have been produced with refinements of hardware but still employing the basic Ilizarov principles of lengthening by callus distraction.

Over the last decade totally implantable limb lengthening devices have been developed and used in clinical practice. These devices utilize a telescopic nail which is inserted into the medullary canal of the bone to be lengthened. The basic Ilizarov principles still apply. An osteotomy is performed and when healing callus starts to form the bone segments are distracted by lengthening the telescopic intramedullary nail.

Since 2009 16 patients have undergone surgical limb lengthening using the ISKD telescopic nail at the Children’s Hospital at Westmead in Sydney, Australia. I have performed 14 of these limb lengthenings. 10 patients were male and 6 were female. Their age range at the time of surgery was 14 to 18 years. There were 12 femoral lengthenings and 4 tibial lengthenings. Congenital short femur was the most common cause for a short leg with 10 of the 16 patients having this diagnosis. Other diagnoses included Russell-Silver syndrome, Arthrogryposis, Perthes disease and trauma. Lengthening was achieved by gradual callus distraction. All patients achieved the planned limb lengthening. There were no cases of premature consolidation. The amount of lengthening achieved ranged from 24-50mm with an average of 38mm. In 3 cases the rate of distraction was uncontrolled “runaway nail” and in 2 of these cases the patients developed nerve palsies. There were no infections. The ISKD intramedullary nail was found to be far more tolerable than an external distraction device for limb lengthening with an acceptable complication rate.
Hybrid human model for industrial applications

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In the transportation industry, safety of the occupant is an important issue of the research and development. Production and development of safety systems is based on experiments such as crash-tests in which the human body is represented with physical models such as standard dummies. However, numerical simulations become to play more and more important role in the process supporting and sometimes substituting the physical tests. For that purpose, development of the computational model of the human body is a challenging task. Two types of the models are usually distinguished. Articulated rigid body models (ARB) are based on the multi-body structure (MBS) consisting of rigid bodies connected via joints. Finite element models (FEM), on the other hand, are fully deformable.

In this work we present a development of the hybrid human model for the applications in transportation industry, namely for the safety assessment. It combines both multi-body structure and the deformable elements to profit from both approaches. For instance, it is easy to position, requires low computational time and still it allows for the deformations of individual body parts and evaluating of injury criteria. Due to the scaling algorithm implemented, it respects the variety of human population in mass, weight and age.

Important task of the model development is to ensure its biofidelity. Therefore, extensive validation has been done including impact scenarios with various impactors, impact energy levels and directions. Validation tests have been performed with individual body parts as well as whole body comparing the results with experimentally observed response of post-mortem human surrogates (PMHS).

Due to the variety of validation tests, the biofidelity of the model for the multi-purpose use is ensured. For instance, possible applications of the model in the transportation safety include accidents reconstruction, virtual prototyping and safety assessment of various transportation means.
PART II. LABORATORY PRESENTATIONS
Biomechanics at the University of West Bohemia
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The talk presents biomechanical activities at the University of West Bohemia. It concerns human body modelling (full body and segment models) for industry and medicine, joint replacement modelling, modelling of heterogeneous materials and complex structures, biological fluids (flow in aneurysm) and experimental background.

Biomechanics at Brno University of Technology
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Biomechanics at the Institute of Solid Mechanics, Mechatronics and Biomechanics has a long tradition having started in 1980’s with stress-strain analyses of some clinical problems concerning musculo-skeletal system. Later the range of investigation was enlarged to other problems with the following main achievements:

- Mechanical testing of various types of tissues, animal as well as human, and identification of their constitutive models.
- Musculo-skeletal system analyses of healthy and pathologic (hip, elbow) joints, with and without endoprostheses, simulations of various types of bone and spine fixators.
- Cardio-vascular system
  - Rupture prediction of abdominal aortic aneurysms, taking into consideration not only the undeformed geometry, but also residual stresses and intraluminal thrombus,
  - Determination of directions of collagen fibers in tissues using Fast Fourier Transformation.
- Hearing organ: computational simulations of function of human ear including ear drum.
- Vocal chords: proposal of artificial vocal chords supported by computational simulation of their function.

The division of biomechanics
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The Division of Biomechanics (http://www.biomechanics.cz) has a long history of research in biomechanics and innovation in orthopaedics going back to the pioneering work of Jaroslav Valenta in the 1970s. Research is performed in cutting-edge laboratories specializing in multi-level experimental and computational approaches. The Division of Biomechanics is involved
in a variety of multidisciplinary projects with partners ranging from orthopaedic device producers through health professionals to automotive industry. The main topics of basic and applied research involve using engineering techniques to solve orthopaedic problems and develop new orthopaedic devices, understanding mechanical properties of tissues of cardiovascular system and application of advanced experimental methods in cell mechanics. Division of Biomechanics provides education in master study program Biomechanics and medical devices and Ph.D. study program Biomechanics.

**Biomechanics research in Faculty of Physical Culture Palacký University Olomouc and Human Motion Diagnostic Center University of Ostrava**

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The biomechanical research activities of both departments deal with biomechanics of basic human motions in various groups of subjects, biomechanics of sport and physical activity. The most often used methods are: 3D kinematics (Vicon MX, Qualysis), ground reaction force measurement (Kistler), pressure distribution analysis (Footscan), electromyography (Delsys). Recently Olomouc group solve projects mainly in following topics: assessment of static and dynamic balance in various groups (young, middle age and older groups; subjects with amputations), the effect of rehabilitation on gait and balance in ballet dancers, the effect of treatment (surgery, orthotic, rehabilitation intervention) on gait in orthopaedic patients (knee, hip osteoarthrisis). Ostrava group nowadays solve, for example issues as the biomechanics of pathological running in people after Achilles tendon surgery, biomechanical risk factors for knee injury in volleyball, biomechanics of walking in people with a bionic knee after transfemoral amputation, the kinematics of vaults in gymnastics or load optimization in strength exercise.

**Hemi-epiphysiodesis at the knee region: long - term results of Ambulant Centre for Defects of Locomotor Apparatus in Prague**

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The Ambulant Centre for Defects of Locomotor Apparatus in Prague has achieved very good results with permanent epiphysiodesis that was carried out both in cases of unequal leg length and at deformities around the knee joint. The goal of the communication is to present our last ten years of experience with anthropometric measurement of tibio-femoral angle, indication and timing of the surgery and long-term results of permanent hemi-epiphysiodesis (carried out by modified Macnicol’s method using drilling of growth physis) that was indicated to children.
with deformities around the knee joint region. Hemi-epiphysiodesis (HE) was indicated to growing children suffering from the knee joint deformities caused by idiopathic, metabolic, neuromuscular, genetic skeletal disorders. Partial permanent medial or lateral HE of distal femoral physis and/or proximal tibia one was done in a cohort of 28 patients aged 10.4 – 15.95 years. Totally were made 47 medial and 10 lateral hemi-epiphysiodesis. Average age of surgery was 13.27 ± 1.31 years. Valgosity was indicated to HE in children with both the idiopathic cases (obesity, hypermobility) and in multiple exostoses, bone dysplasias (BD), etc. In patients with valgosity the average T-F angle was 13.62° ± 4.08° measured before surgery, the angle was normalized to 4.4° ± 1.39°. The evaluation showed that intermalleolar distance was decreased from 8.1 cm ± 2.63 cm to 0.91 cm ± 1.29 cm. Varosity was indicated to HE in children with bone dysplasias (achondroplasia, pseudoachondroplasia, hypophosphatemic rickets etc.). Average T-F angle in these cases was -13.63° ± 2.29° measured before surgery, the angle was changed to -9.75° ± 2.36°. Intercondylar distance was decreased from 3.38 cm ± 1.25 cm to 2.2 cm ± 1.68 cm. In the right time indicated modified drilling HE by Macnicol results to excellent correction of tibio-femoral angle. Worse results were gained in patients with bone dysplasias and varosity of the knee joints due to difficult prediction of remaining growth and late carrying out of the HE. In BD cases we begin to use so-called „guided growth method” which uses the special 8-plates in last two years. The correction of the biomechanical axis of legs by HE is a mini-invasive surgical procedure that is indicated with the aim not only to prevent premature osteoarthritis of the knee joints but it improves the posture, walking stereotype and visual aspect, too.

**Laboratory of Biomechanics of Extreme Loading**

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Laboratory of Biomechanics of Extreme loading is a research and educational experimental place by the Department of Anatomy and Biomechanics of Faculty of Physical Education and Sports of Charles University. Since its opening in 2004, the laboratory is focused on the study of kinematic and dynamic parameters of different human movement activities, which are followed by research of rheological properties of native and artificial tissues and materials. The laboratory has at disposal devices designed by own development (rheometer, microtester, analytical work and sports equipment...) that complement and extend the capabilities of owned commercially available top-technologies (Kistler, Qualisys, Dewetron...). These technical background along with a stable staff base consisting primarily of the staff and PhD students of the Department of Anatomy and Biomechanics allows to apply an advanced biomechanical approach also in matters of forensic and injury biomechanics. An important component of the work of the lab is represented by huge grant activities and large contract research. The laboratory is also effectively used in support of Bc., Mgr. and especially of Ph.D. studies both for demonstrations in teaching process and by solving the theses topics.
PART III. TECHNICAL SESSIONS
Manual perineal protection with various sizes of fetal head

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A finite element biomechanical model is used to analyze the tension of the perineum during vaginal delivery in 10 modifications of manual perineal protection for 3 different sizes of the fetal head and compare them with the “hands off” technique. The aim of this study is to evaluate whether the most effective modification of manual perineal protection with normal fetal head size is also the most effective in cases with substantially smaller or larger fetal head.

Numerical FE analyses of the pelvic floor during childbirth

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This paper presents numerical FE analyses of the pelvic floor model during childbirth. From CT a MRI scans was created 3D FE model of pelvic floor with bones and soft tissues and organs. On this model were carried out series FE simulations of childbirth. Aims of these simulations were analyses of the loading and damage risk on some selected parts of pelvic floor model.

Enhanced computational model of the bladder tissue

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In this model are incorporated three types of cells: Smooth muscle cells, interstitial cells of Cajal and the urothelium cells. The main result of this complex nonlinear dynamical system is the time evolution of the calcium concentration in the muscle cell. This is the main control parameter for the bladder contraction. The influence of the urothelium on the behavior of bladder tissue is investigated and compared with the published experimental results.
Mathematical modeling of intraorgan circulation
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Mathematical modeling of blood circulation in the intraorgan vasculatures is important for better understanding the role of hemodynamical factors in development of the vascular pathology and diagnostics of severity of aneurisms/stenoses and other impairments. Due to complexity of the system (>1000 vessels) direct numerical computations on the whole tree are time consuming. Recently several approaches based on combination of patient-specific 3D model of larger vessels with 1D/0D models of smaller vessels have been proposed, but they also do not allow real-time computations. Here the results of numerical simulations on a combination of viscoelastic 3D geometry with axisymmetric wave propagation model in the branching system of smaller arteries are presented. It is shown the structured tree approach describes correctly wave propagation and reflection in the vasculature. Theoretical results are compared to in vivo measurements on human kidneys with/without stenoses of renal arteries. A possibility of non-invasive in silico assessment of severity of renal artery stenosis is substantiated.

Linear and nonlinear models for diagnostic analysis of postural sway in human
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Posturography remains one of the simplest and informative tools for examination of human biomechanics and early diagnostics of skeletal, muscular, neural, visual and other pathology. The results of the posturographic tests are time series of the center of pressure coordinates \{X(t), Y(t)\} oscillations. The linearized 3-link inverted pendulum model of human body is usually used for data analysis and interpretation. Here the non-linear n-link model with feedback control over displacement of its links due to nervous regulation is presented. Validation of the model is done on the posturographic data measured on a group of young healthy volunteers and patients with different locomotory and nervous diseases. Characteristic patterns of Y(X) curves at different 2-leg and 1-leg postures with open/closed eyes proper to osteochondrosis, arthrosis, injury and pain are revealed. Transition from regular to chaotic dynamics while disease is progressing has been detected by the largest Lyapunov exponent and fractal dimension technique. It is shown the time delay in the control function corresponds to severity of neural disease (Parkinson’s, stroke, age-related sclerosis).
Modeling of peristaltic flow of the pathological bile as Carreau's fluid in the biliary system elements
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Biliary system is responsible for bile transport to the duodenum. The system includes the gallbladder, biliary tree, and sphincter system. It is known, that physiological motion of many bio-fluids is related to wavy contraction of hollow organ walls peristalsis. Early, authors showed that pathological bile is non-Newtonian thixotropic fluid and obtained parameters of the Carreau’s fluid. The presented paper contains results of peristaltic fluid modeling of the pathological bile considered as the Carreau’s fluid in the biliary system elements (the cystic duct, the common bile duct, and ampoule of the Oddi’s sphincter with a calculus) modelled as tubes with different geometry and permeable walls to study the conditions of reflux occurring. The analytical solutions for stream function, axial velocity, and flux at small Weissenberg numbers were obtained by using of the perturbation method. The permeability parameter influence on the computational results is shown. The dependences of pressure drop on flux, time and amplitude ratio for sinusoidal wave are also presented. The values of pressures corresponding to reflux occurrence are obtained. The reported study was supported by RFBR, research project No. 14-01-31027-mol_a.

Modelling of the TCPC geometry effects on hemodynamics of the cardiovascular system with one functionally ventricle
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The numerical simulation of the total cavopulmonary connection (TCPC) geometry on the univentricular circulation offers the possibility to restore almost physiological hemodynamics conditions. The TCPC consists in a direct connection between the superior vena cava and pulmonary arteries along with the conduit connecting the inferior vena cava to these arteries. The lumped-parameter model of the single ventricle circulation has been developed with view of the modelling of the TCPC geometry influences on the cardiovascular hemodynamics and energy losses. This model represents the circulatory system as a hydraulic network encompassing a resistance, compliance and inertance elements. The mathematical formulation of the blood flow through this network is based on the laws of mass and momentum conservation and mechanical energy balance. Especial attention is devoted to prevent hydrodynamic instabilities (e.g., gas release from blood-cavitation) in the specified hemodynamics regions. The results attained by the numerical simulation show that supervised effects play a crucial role in the regulation of the pulmonary and systemic blood flow.
distribution. This work has been supported by Grant no. 101/13/23550S of the Czech Science Foundation, entitled “Experimental Research and Mathematical Modelling of Unsteady Phenomena Induced by Hydrodynamic Cavitation”.

**Inflation tests and modelling of Human Saphenous Veins**

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Inflation tests of 15 human saphenous veins were conducted to obtain data suitable for multi-axial constitutive modeling at overloading conditions (pressures up to approximately 15 kPa). The data were fitted with a hyperelastic, nonlinear and anisotropic constitutive model based on the theory of the closed thick-walled tube. It was observed that initial highly deformable behavior in the pressure circumferential stretch response is followed by progressive large strain stiffening, which is in contrast to the pressure axial stretch response where the stretches remained in the range 0.98 – 1.03 during the entire pressurization in most cases. The material parameters presented here are suitable for use in simulations describing the adaptation of the autologous vein wall after bypass surgery.

**Finite element analysis of whole human mandible**

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A FEA model of human mandible was created from CT scans of young woman. It consists of the three parts – bone, periodontal ligaments and teeth. Mechanical properties of bone were found out from CT scans. It was assumed that mechanical behavior of bone is dependent on the bone density. The bone was modeled with non-homogenous structure – each finite element had various material properties. We were supposed that the bone has elasto-plastic deformation generally. The FEA model of human mandible was loaded from muscles physiologically. This model will be used to simulation of a response of bone to insert retainers.
FE analysis of aortoiliac bifurcation
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Many cardiovascular diseases occur at bifurcations and branchings of large arteries. Atherosclerosis and arteriosclerosis are two of them. The geometrical configuration of a bifurcation has a major influence on the intramural stress distribution within arterial wall and the stress concentration factor at both the apex and the sides of bifurcation. High value of the intramural stress is one of risk factors for disease development. This article deals with aortoiliac bifurcations. Its geometry was parameterized to create FEM models. The Influence of aortic diameter, wall thickness, bifurcation angle, non-planarity angle and apex radius on the Misses stresses was evaluated. Regression model predicting Misses stresses from geometry is presented.

Approximation solution of 0D pulsatile flow within a capillary
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This paper deals with weak solution of the momentum balance equations. Different shapes of velocity profile are taken into account for description of pulsatile flow. The flow is assumed incompressible within the rigid capillary tube with constant diameter. The results of approximated solution of flow are compared with exact solution for various Womersley numbers. The same analysis was performed for a different type of weight functions and weighted residual methods. The assumption of Hagen-Poiseuille velocity profile causes error of flow rate in tens of per cent in the range of Womersley numbers 1-12 while the error of flow rate computed from fourth order polynomial velocity profile is only a few percents. The analysis proved that the integration of the residual and weight over the cross-section of pipe provides results of flow rate closer to the exact solution then the integration over radius. The integration over the area set the importance on wall function and back flow rate near the wall. It was revealed that the Galerkin method is the appropriate method for formulation of the weak solution of the pulsatile flow then the least square method and expert estimation of weighted function.
Biomechanics of nanoparticles self-assembly in lipid bilayer
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Nanoparticles aggregation in lipid bilayer depends on the method of preparation: forming distributed monolayer if prepared by extrusion process or forming hybrid vesicles with nanoparticles segregated into hemispherical domains if prepared by dialysis. The aim of the study was to explain two forms of nanoparticles configuration by assuming changes in biomembrane bending and stretching energy. Monte Carlo simulation of membrane mechanics shows that an energetical barrier exists between condensed and distributed configuration of membrane particles. We propose that two distinct forms of nanoparticles configuration corresponds to two energetically stable states.

Biomechanical comparison of two selected methods of patient handling in rehabilitation and nursing
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The highest risk factor in causing the discomfort and injuries in the locomotor system is transferring patients. According to the rehabilitation and nursing practice, there are several different approaches in the patient lifting and handling. Basically, it is necessary to know the biomechanics, as well as the body mechanics, and later to implement that knowledge into applied ergonomics in the working environment. Biomechanical analyses of two different approaches in sitting to standing (one, when the therapist/nurse is standing at the side of the patient, and the other when the therapist/nurse is standing in front of the patient) has been made, mainly with measurement of pressure distribution (Novel Pedar) in feet and a 3D analysis of differences in gait and posture (QualiSys). The observed factors were “Closer to the load”, “Increase the support base”, “Reduce the centre of gravity according to the load” and “Head position”. Results present differences in the balance, stability and performance of the process between two selected approaches. The approach “Standing at the side” is found to be more appropriate than “Standing in front”. Results support the need of implementation of the program “Methods of handling and lifting with acquired competencies” and the call for use of mechanical lifting, because lifting people is a dangerous manual work.
Monitoring of orthotics applications
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There are produced a lot of types orthoses for correction, stabilization or other function on human body. Children and adolescent age is a season for effective treatment by corrective orthoses. Usually there is a problem with a discipline of using orthoses by children. All data of treatment have been given only by patients as non-provable information, sometimes as subjective or intentional. Some monitoring systems have been developed. After applications it is possible to read data of treatment season usually in 15' steps. It is accurately enough. During some years we could have more objective information of orthotics applications to compare therapeutic effect to real time of application. It will be possible to determine more optimal regimes of therapy.

Uniaxial tensile test of perivascular adipose tissue
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Biomechanics of elastic arteries is widely studied at present time. In contrast to the constitutive modeling of the aortic wall, little attention has been paid to mechanical properties of surrounding tissue. To fill this gap, uniaxial tensile tests with adipose tissue surrounding human abdominal aorta were conducted. Strongly nonlinear stress-strain relationship was observed. It was found that highly compliant response characterized with the initial elastic modulus about 2.16 kPa is exhibited approximately to engineering strain of 0.03. Initial linear response is followed by gradual stiffening. Tangential elastic modulus of about 500 kPa was observed at engineering strain of 0.11.

Single cells compression testing
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Mechanical properties of a cytoskeleton or a cell itself are considered to be a quantitative parameter for cell diversification or disease. A nanoindenter or an atomic force microscope is usually used for the assessment of the mechanical properties of a single cell. Appropriate testing probes as well as mechanical models must be chosen, in order to correctly interpret the
mechanical loading and derive the intrinsic material characteristic of a cell. In this case, the compression tests of a single cell were performed by a Hysitron TI 950 TriboIndenter® [Hysitron, Inc., Minneapolis, USA] nanomechanical test instrument with a 100 um diamond flat end probe (90° fluid cell conical). However, a clear visualization of the living cell needs to be established in order to precisely position the probe with the X and Y coordinates of the cell. There are two microscopy regimes available for the TriboIndenter bright field and fluorescence, both top-down. Based on previous experiences, COS-1 cells [ATCC code: CRL-1650] were used due to their long viability and good adhesion properties. The cell line was derived from an African green monkey kidney; the cells grow attached to the base (adherent) and have the same morphology as fibroblasts [ATCC, USA]. The practical use of green fluorescence of EGFP modified cells exposed to a blue light applied by the TriboIndenter microscope will be discussed and compared to standard bright field microscopy also available for cell localization. Compressive load-displacement data demonstrating a critical bursting force of a cell membrane will be presented. This research was supported by Grant Agency of the Czech Technical University in Prague, grant No. SGS13/176/OHK2/3T/12.

An investigation of the influence of cartilaginous tissue microstructure on its local mechanical properties

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The research on mechanical properties of a cartilaginous endplate (CEP) seems to be more actual in current biomechanics of a spine. Mechanical properties of the cartilaginous endplate are presented with large range of values in the literature. Elastic moduli are given in the range from 5 MPa to 10 GPa. Which raises the following questions: What causes this large range of values? Is it an erroneously performed experiment? Is it a poorly identified endplate? Is it an inner microstructure of the endplate that causes large range of measured values? We decided to investigate mechanical properties depending on inner microstructure of CEP and thereby detect possible source of scattering of results. A fresh porcine spine was used for an experiment. The lumbar spine motion segments were immediately dissected and ten millimeter thick plates of vertebral body, CEP and annulus fibrosis were cut and polished under running water conditions. The specimen was kept in saline solution for protection from drying out during tests. Second Harmonic Generation imaging method (SHG) was used to identify CEP area and its inner structure. Nanoscale Dynamic Mechanical Analysis (nanoDMA) was used to investigate structural dependent mechanical properties afterwards. This work presents combination of a nanoindentation technique and SHG imaging to determine an influence of the cartilaginous endplate microstructure on its local mechanical
properties. Acknowledgement: This research was supported by Grant Agency of the Czech Technical University in Prague, grant No. SGS13/176/OHK2/3T/12.

The dependence of viscoelastic parameters of hair on its structure
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Hair is a polymer with a composite structure; that’s why its dependence of the total viscoelastic properties on its physical sizes is not surprising. Cross dependencies of the viscoelastic parameters, especially their dependence on the diameter of the hair, allows construction of a viscoelastic model of the hair structure and identify its elements with the anatomical structural parts of the hair, then find the characteristic viscoelastic parameters for these parts. We measured parameters such as activation energy, the work necessary to break the hair, relaxation times, the Young's modulus, the ultimate strength and elasticity. 600 samples of Caucasian women’s hair have been measured. The demonstration of dependence between these parameters is itself a valuable finding of this pilot study.

Experimental test machine for durability evaluation of bifurcated endovascular stent-grafts: verification of testing conditions
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Bifurcated endovascular stent-grafts are crucial medical devices for mini-invasive treatment of abdominal aortic aneurysm (AAA). After deployment of stent-grafts into the vessel, it is subjected not only to strongly corrosive environment but also to fatigue. This is due to the cyclic alteration of systolic and diastolic blood pressure in an artery. Proposed paper deals with construction and verification of a machine which is able to simulate conditions in the aorta and thus verify durability of the stent-grafts as a whole. Special attention is dedicated to measurement of the pressure development in a silicone model of the aorta.

The ability of vibrational technique to assess initial fixation of implant
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Initial fixation of implant plays a crucial role for long term survival of implant and the overall success of the surgical procedure. The main objective of proposed paper is a preliminary study of ability of the vibrational technique for assessing the initial fixation of implant. The experimental results show a correlation between status of initial fixation of implant and evaluation of frequency response of bone - implant structure. The vibrational method has a potential to assess the initial fixation of implant, but the feasibility, repeatability and sensitivity testing are required.

The values of viscoelastic parameters of hair at different places on the head surface
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Most works do not even consider the dependence of mechanical and viscoelastic parameters on the sampling places on the surface of the head, but it shows that these parameters significantly depend on the sampling places, as has been shown in our work (Šimková et al., 2013). This paper deals with describing this dependence on other viscoelastic parameters such as activation energy, the work necessary to break the hair, relaxation times, the Young's modulus, the ultimate strength and elasticity. The samples were taken from 40 women and the values determined for 600 hair. In addition to the previously found dependence of the hair diameter on the sampling places, dependence of two other parameters has been found.

Risk types of landing in volleyball for ACL injury
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Anterior cruciate ligament (ACL) injuries frequently occur in landing from a jump on one or both legs near full extension (0-30° knee flexion). The aim of the study was identified the type of landings after volleyball block where knee flexion is found under critical value at the instant of first peak of resultant GRF. Subjects were required to land on force platforms using eight types of landing after performing a standing block jump movement. One-sample t-test (critical value 30°) was use for compare between types of landing and critical value 30° of
knee flexion. The One-sample t-test showed significantly lower knee flexion angle in sagittal plane than 30 degrees in go landing (p = 0.0) and reverse landing only. The reverse and go landing may be harmful for ACL due to single-leg landing in mediolateral direction with significantly lower knee flexion at instant of first peak of GRF.

**Determination of dependence of radiographs magnification on the BMI**

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X-rays are used for preoperative planning and clinical studies. X-rays have different magnification depending on the distance of the subject from a shield. The aim of the study was to determine whether there is a correlation between images magnification and the BMI. About 60 images of the standard (a ball of known diameter and constant distance from a shield) and the implanted hip joint heads from three hospitals were measured. The result of this study is that the magnification of standard is constant. The dependence of the measured hip joint head magnification on the BMI is statistically significant. Each set of images has a different magnification but the gain of magnification per unit of the BMI is similar.

**Effect of the different positioning of Proximal Femur Nail on fixation of proximal femur fracture during cyclical loading**

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The objective of this work is to compare the effect of the different positioning of Proximal Femur Nail (PFN) on fixation of proximal femur fracture during cyclical loading. The subject of analysis is an unstable fracture with large posteriomedial comminuted area. We considered five possible positions for the PFN fixation system, where one of them is known as the optimal position. We carried out a stress analysis of the bones, stress analysis of the PFN and the preservation of the proper behavior of the PFN. For this work we undertook a computational analysis using Finite Element Method.

**The effect of destabilization upright positions on human respiratory function**

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The research was focused on finding connections stabilizing function of the body on the respiratory function. The research group consisted of 14 healthy young subjects. During the measurement, which lasted 60 " (one standing on the ground and second on balancing rotating segment), the proband of the camera to assess the variability upright positions (3D trajectories C7) and also was picked Spiro record volume of exhaled air. Watching these two phenomena that have natural variability and body resolves the situation by keeping the individual functions within a certain tolerance band. The destabilization caused by standing on unstable surface, resulted in deflections increase, especially in the anteroposterior direction, the selected reference vertebra C7. Moreover, the increased frequency corrected fluctuations in the ratio of about 1:6. The role of maintaining upright positions increased variability of individual breaths, caused an increase in isolated larger tidal volumes and shorter expiratory phase of breathing and the slight increase in respiratory rate.

The biomechanic influence on vessel’s physiology and pathophysiology

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The study of biomechanical characters of vessels a them modeling cause the new information about behavior this anatomical structures. Recently discovered vessel quality, angiosynizesis and self-excited wall vessel vibration have an influence on behavior understand part of cardiovascular system. Recently discovered biomechanical vessel duality has an influence on physiology and pathophysiology vessel system in different anatomical systems of body, e.g. central nervous system area. Physiological aspects: in hemodynamic regulation - Starling resistor, in hemodynamic - combination bridging veins, any venous brain system and venous brain sinuses - primarily cavenosu sinus (physiological jewelry box) - as pulsing pump, the effect on liquorodynamic brain system - increased production(plexus chorioideus), resorbcion (basal system- arachnoithelial tissue on skull base, convexity system as standby system), the effect of movement of brain on bridging veins, exchange cross-section, influence on brain microcirculation by way oncotic and osmotic pressure during local metabolism, the effect for aim increase function selected brain part- by way physical influences on muscular vein type - the contraction and exchange microcirculation into drainage areas - influence brain part with superior function in the siame time (under exam - fMRI, MSI, SISCOM, PET, SPECT).The self-excited oscillation: cleaning wall, the effect for blood flow, the inflace of physical effect between layers - biomechanical border double layers, resolution of problem imperfect absolute smoothness innersurface vessel wall, mixing fluids, at fluid with particles reduction particle clustering, the protection before Karman vortex street. The effect of Karman vortices, vortex streets, on boundary two layers of fluid with different speed come about so-call Kelvin-Helmholtz instability, which demonstrates by form Karman vortices, whose density increases by fractals, the fluid until go to turbulence mode. Pathophysiological problems:
during trauma very gently junction between bridging veins and sinuses is gently and fragile area - venorhexis, development of hydrocephalus - influence on production and resorption of cerebrospinal fluid - hyporesoptional (influence of arachothel with combine of venous system) or hypersecrectional type - the production from plexus choririoides, problem with local brain ischemia - arterial and venous type (imbibition of tissue), the problem during surgery procedures (e.g. temprobasal areas) in train of venous connection - the influence of level brain retraction on flow rate, external compression venous wall, pseudotumor cerebri - small brain ventricles, papilloedema, on CT brain oedema, any organic pathology, our premise: impairment of brain outflow - none venous trombose or sinuses trombose - none venous brain attack, more verisimilitude effect of angiosynizesis. Self-excited oscillation. The problem nonpulsing flow at artificial pump in blood circulation, which do not form pulses, participation on development angiosynizesis, the cavitation effect into adventitia and into blood flow, the effect on collagen - piezoelectric, magneostiction etc. - electromagnetic continuum. The conclusions: very small exchange of length (ca. 1%) about bridging brain veins can go to angiosynizesis, vibration of vessel wall during physiological state, facility beginning of angiosynizesis by propagation pulsing pressure wave, structural stability of bridging veins can be restore by adequate rise in pressure in given moment. The function of flow in thin wall venous system of brain is combination of angiosynizesis and pulsing venous pump of cavernous sinus, which follow into venous system pulsing flow. Angiosynizesis - the vessel’s collapses, the spontaneous shut-off valve of vessel cross-section. The condition: pulsing flow into system minimalized to zero (prefentially in venous system), types: temporary and permanently. The time to a inception of effect is given by biomechanic vessel wall characters a flow fluid characters - rate pulsing, angiosynizesis has effect on hemodynamic and liquorodynamic system of brain and influence on brain microcirculation, angiosynizesis has effect on any pathology of brain (e.g. subdural haematoma and traction of veins - interhemispheral hematoma in the first place, the cause of idiopathic benign intracranial hypertension) and biomechanical quality of bridging veins together with biomechnical quality of connection between bridging veins and venous brain sinuses are area of injury. Self-excited oscillation - the effect of commencement of double layer border. The formation at pulsing flow too, a phenomenon on layer border, is able to form on border solid elastic, viscoelastic unit and fluid (continuum), on border layer of fluid etc.

The effect of velocity and slope of the ground on the lower limbs and pelvis movement during Nordic and regular walking

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Nordic walking is often considered as physical activity with many positive effects, however comprehensive assessment during various conditions is missing. The aim of this study was to
analyze the effect of Nordic walking and its velocity on the movement of the lower limbs and pelvis during level and uphill walking. Fifteen males with mean age 22.9 years walked on a treadmill with and without poles, in self-selected and increased (110 % and 120 %) velocities in level ground and slope 8 %. Kinematic data was observed by Vicon system. Statistical comparison was performed by three-way ANOVA and LSD Fisher’s post hoc test. The results indicate that the effect of poles was small. During uphill walking hip flexion increased and maximal knee extension decreased in comparison with level walking. Increased walking velocity resulted in mainly increase of hip range of movement sagittal plane and pelvis rotation in transversal plane.

The possibilities of quantitative description of nonlinear loaded characteristics of soft tissue of locomotor apparatus of man in vivo

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The goal of this study was to find out an appropriate mathematical description of nonlinear loaded characteristics of soft tissue of locomotoric apparatus in man by help of chosen deformation tests in vivo, in situ. We wanted to easy interpretate the results that we obtain from myotonometry testing. We have found out that this mathematical description of hysteresis curves may be used in clinical trials as well as in laboratory testing.

Evaluation of muscle activity during Nordic walking in different conditions

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The purpose of this study was to determine the influence of slope of the ground on muscles of lower extremities during regular walking (RW) and Nordic walking (NW). Ten healthy men (mean age 22.9 ± 1.04 years) walked at self-selected speed on a treadmill at different slopes of the ground (0% and 8%) without poles and with poles. We investigated electromyographic activities of the tibialis anterior (TA), gastrocnemius lateralis (GL), biceps femoris (BF), gluteus medius (GM), vastus medialis (VM), and rectus femoris (RF). Increased slope of the ground led to increase in activity of GL, BF, and GM during both NW and RW and RF only during NW. In comparison of RW and NW, the activity of some muscles enhanced on flat
Ballet movements influence the mobility of the lower limb joints. This altered motion is translated to performance of the gait cycle (GC). The aim of this study was to observe the effect of rehabilitation on range of movement during the GC in ballet dancers. Fourteen ballet dancers (5 males, 9 females; age 24.1 ± 3.8 years; height 170.2 ± 8.5 cm; weight 58.3 ± 11.2 kg) participated in this study. We analyzed the subjects before and after ten rehabilitation interventions. Ten trials of the GC at self-selected walking speed were obtained using the system Vicon MX (Vicon Motion Systems, London, UK). Dancers demonstrated significantly increased maximal knee flexion during the stance phase (14.8 ± 4.5) and decreased maximal extension during the swing phase (3.4 ± 4.5), as well as decreased maximal hip adduction (6.8 ± 1.5) after rehabilitation. The results confirm that rehabilitation should be a necessary part of comprehensive care about dancers to improve their dance technique and prevent injuries.