SpineFX
Initial Training Network

November 2010 Volume 1, Issue 2

Special points of interest:

Update on Work Packages at TUWien

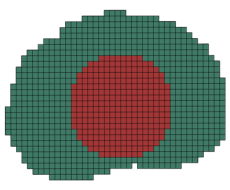
Ghislain Maquer and Hadi Hosseini began to work on the SpineFX project as Early Stage Researchers (ESRs) at the Technical University of Vienna in January 2010.

Ghislain (**work package 6**) developed a constitutive law to model the mechanical behavior of the disc (Holzapfel 2000 and Moramarco et al. 2010). The annulus fibrosus being an anisotropic soft tissue, a hyperelastic fibre-reinforced model with two families of fibres has been implemented. The fibres simulate collagen fibres so they are not subjected to compressive strains and the fibre angle from the circumferential position is set to 30 and -30 degrees while their orientation is following the outer contour of the disc. A Mooney-Rivlin material is used for the nucleus.

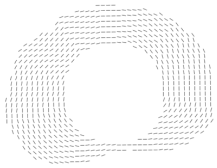
Hadi (**work package 1**) is improving the trabecular bone model developed by Charlebois to make it appropriate for large strain compression. Using the three-dimensional morphological data provided by computed tomography, finite element models can be generated and used to compute the stiffness and strength of whole bones. Three-dimensional bone images obtained from computed tomography provide input for patient-specific numerical models that can be used in clinical studies and treatment evaluation. A general description and framework for elastoplasticity coupled with damage and densification is used to simulate the behaviour of trabecular bone in large strain compression.

Now, the two ESRs are combining their results to create a complete model of the vertebra using the features developed in the frame of their work-package: Ghislain is working on spinal unit models from CT scans, his disc model and the BVTV based constitutive law programmed by Hadi for bone are used for simulations.

Ghislain Maquer &
Hadi Hosseini
TU Wien



(a)



(b)

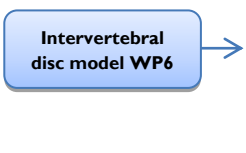
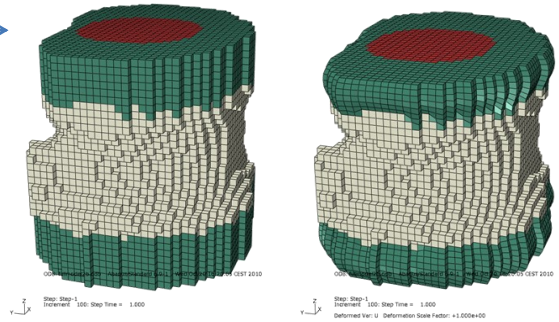


Fig1. Features of the computational model of the disc: (a) finite element mesh:nucleus pulposus (red) and annulus fibrosus (green); (b) collagen fibers of the annulus fibrosus.



(a) (b)

Fig2. Spinal unit under axial compression: (a) initial shape ; (b) deformed

Further Researchers Appointed to SpineFX

Five more researchers have been appointed to the SpineFX project.

Five more researchers have now been appointed to the SpineFX project.

Miklós Iviscisc, from Budapest, Hungary, began work on 16th September 2010 at TUHH Hamburg University of Technology as an **Early Stage Researcher**.

Miklós finished his studies in 2008 at the Technical University of Budapest (M.Sc.). While in Budapest he studied mechanical engineering and also performed research in the field of fluid-dynamics by investigating fluid-flow in a cyclone. Afterwards he spent two years in the industry getting experience in engine development, first as a CFD Engineer, then as a Lead Engineer for Measurement Systems.

Rebecca Kueny, from Boonville, MO, USA started work at TUHH on October 18th 2010 as an **Early Stage Researcher**.
Rebecca finished her B.S. in Ceramic Engineering while studying at Missouri University of Science and Technology in Rolla, MO, USA in 2008. While in Rolla she participated in research on novel types of bioactive glasses for use as a scaffold or as a coating for titanium Implants. In 2009 Rebecca received her Masters in Biomedical Engineering from the University of Oxford (M.Sc.). At Oxford she completed a FEA study on the effects of notching during hip resurfacing. She spent this past year at Pfeiffer Engineering where she took part in studies to test the fixation of pedicle screws in osteoporotic vertebrae.

Antony Francis, from Canada, has begun work on 27th September 2010 as an **Early Stage Researcher** at University of Leeds.

Antony graduated in 2009 from Dalhousie University, Canada (M.A.Sc.). This thesis project focused on developing a standardized radiostereometric analysis bead placement protocol for studying thoracic spinal fusion in scoliosis patients. During his studies, he worked at the IWK Health Centre as a Research Engineer mapping the pressure distribution of spinal deformity patients on different operating room beds.

Argyrios (Argiris) **Kasioptas**, from Greece, began work on 1st November 2010 as an **Experienced Researcher** at BONESUPPORT AB.

Argiris has a diploma in Chemical Engineering from the University of Patras (Greece). His diploma thesis was focused on the crystallization of apatite on both apatite and polymeric substrates (PHEMA, PMMA) used for the fabrication of intraocular lenses for cataract surgery. After doctoral studies in the Institute of Mineralogy of the University of Münster (Germany) he completed his Ph.D. in August this year. The Ph.D. work concerned the hydrothermal transformation of calcium carbonate structures to apatite, a method used for fabrication of bone implants.

Il-Soo Koh, from New Zealand, has begun work on 4th November 2010 as an **Early Stage Researcher** at the University of Bern.

Il-Soo received her BE in Biomedical Engineering at the University of Auckland in 2007. During her Bachelor's study, she conducted a project to develop a mathematical model for the deformation of fibrous composite materials. Il-Soo then worked at the Auckland Bioengineering Institute (ABI), developing a methodology to create cubic bone specimens to observe the mechanical responses of trabecular bone under compression in three orthogonal directions. This project was further developed into her masters thesis topic, an experimental protocol to create an atlas of the mechanical properties of human knee bones, which was completed in 2010.

Screw augmentation with BONESUPPORT's biological cement

On the 2nd of July this year, Malin Nilsson, inventor of BONESUPPORT's biological cement Cerament™, presented interesting data at the EORS conference in Davis, Switzerland.

The work with the title "Biomechanical evaluation of a biological alternative to PMMA cement for transpedicular screw augmentation in osteoporosis" was done in collaboration with Dr Becker in Vienna and showed that Cerament™ may be used in screw augmentation where PMMA cement is contraindicated.

In the study, the pull-out strength of PMMA cemented screws in cadavers was statistically higher ($p=0.01$) than that of the Cerament™ augmented screws but the single case analysis showed that 3 out of 5 screws in the Cerament™ group had the same stability as in the PMMA group.

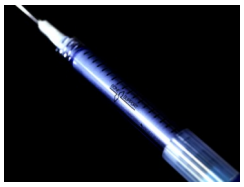
The spread of the cements inside the vertebrae were similar for both groups, no leakage was recorded in the Cerament™ group while the PMMA group had 2 cases of epidural leakage. The injection of Cerament™ was easier to perform since the force needed to extrude it from the syringe was significantly lower than the injection force needed for PMMA.

The combination of easy injection, no leakage and a stability comparable to PMMA in several cases may justify the use of Cerament™ in screw augmentation where PMMA cement is contraindicated.

Malin Nilsson
BONESUPPORT AB

Company Profile: BONESUPPORT AB

One of the industrial members in the SpineFX project is the Swedish medical technology company BONESUPPORT AB. BONESUPPORT's main business is the development of injectable bone-like materials for the treatment of various bone-defects, including fragility fractures caused by osteoporosis. The company was founded in 1999 as a result of research conducted at the University of Lund in the field of biological bone cements. The key product of BONESUPPORT AB - CERAMENT™ | SPINE SUPPORT - received EU approval



in 2008 for vertebral body augmentation. Until today more than 500 patients have been treated with this new resorbable ceramic bone cement, which has been developed to mimic the properties of cancellous bone. CERAMENT™ SPINE SUPPORT is a safe and efficacious biologic alternative to PMMA in the treatment of vertebral compression fractures. In the SpineFX project, BONESUPPORT AB will mainly work with further development of biological bone cements (Work Package 7).

Eva Lidén
BONESUPPORT AB

"Cerament™ may be used in screw augmentation where PMMA cement is contraindicated"

Paper of Interest: Vertebroplasty versus Conservative Treatments

Vertebroplasty versus conservative treatment in acute osteoporotic vertebral compression fractures (Vertos II): an open-label randomised trial. Klazen et al Lancet 2010.

Following on from the previous 'Paper of Interest' reviewed by Prof Heini, this randomised trial provides further evidence of the efficacy of vertebroplasty for treating osteoporatic fractures. Klazen et al present a study that randomised 202 patients with persistent pain into two groups comprising those that received vertebroplasty and those that were recipients of conservative interventions. Those that received vertebroplasty demonstrated greater pain relief both at 1 month and 1 year when compared to the conservative cohort. This study overcomes some of the methodological issues previously noted in the papers by Buchbinder et al (2009) and Kallmes et al (2009) which compared vertebroplasty versus a sham procedure.

Prof. Richard M. Hall
University of Leeds

SpineFX is focused on providing training and research in the area of spinal biomechanics and medical engineering associated with vertebral fracture. The project is a Marie Curie Initial Training Network (ITN), Project Number 238690, and is funded by the European Commission. The network comprises of four leading research universities and three companies with a track record in innovation.

The SpineFX ITN will deliver research in three domains; basic science, oriented research and applied research whilst focusing on three underlining pathologies; osteoporosis, metastases and trauma. Training is provided by 'experience through research', network-wide workshops and local professional development provision.

SpineFX Contact:

Sophie Goodeve,
SpineFX Administrator
School of Mechanical Enginnering
Woodhouse Lane, Leeds
LS2 9JT

Phone: 0113 343 32061

E-mail: mensgo@leeds.ac.uk

WE'RE ON THE WEB!

HTTP://WWW.SPINEFX.EU/

Focus on Experienced Researcher: Galibarov

Pavel Galibarov is an Experienced Researcher on the SpineFX Project working at Anybody Technology

Pavel Galibarov, 30, was born in Syktyvar, Russia. He graduated from St. Petersburg State University, Russia (BSc & MSc Mechanical Engineering). For his theses he investigated how to apply the Finite Element Methodology to modelling of nanostructures. Pavel also received a Master's degree (IT) from Lappeenranta University of Technology, Finland. He specialized in Image Processing and his Master's thesis was: "Embedding, Extraction and Detection of Digital Watermarks in Multispectral images". After that Pavel worked as a Software Engineer in a St. Petersburg-based software development company, "C-Map Ltd.", which produces naval navigational software and electronic charts. In 2005 he decided to pursue a PhD in Bioengineering; spending four years studying at Trinity College, Dublin, Ireland, under the supervision of Prof. Patrick J. Prendergast and Dr. Alexander B. Lennon. His PhD thesis was: "Stochastic failure modelling of total hip replacement". Pavel submitted his thesis in 2009, and started work in the computational mechanobiology field as a Research Assistant in Trinity Centre for Bioengineering. In May 2010 Pavel Galibarov joined the Initial Training Network (ITN) as an Experienced Researcher based in Aalborg, Denmark, working for Anybody Technology. His current research and development activities include patient-specific modelling of the lumbar spine, investigation of the degenerated spine kinematics, modelling of the lumbar spine using Anybody Modelling System (AMS), and development of an interface between AMS and commonly used FE packages (ANSYS, Abaqus). Pavel is very happy and proud to be a part of the SpineFX project and enjoys every minute of work at Anybody Technology. Pavel finds this project an excellent opportunity to meet interesting people, helping to bring spine technologies a step forward, and develop as a professional in the bioengineering field.

In his spare time, Pavel likes to travel across Denmark by bicycle or car with his wife. Also he likes to participate in many kinds of sports, Latin dances, learn new languages, read books, and meet new people. Pavel is grateful to the ITN for giving him an opportunity to experience living in Denmark and widen his horizons.

Pavel Galibarov
Anybody Technology