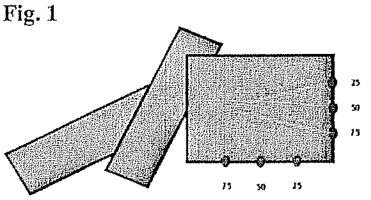
Introduction: Junctional regions of the human spine are usually difficult to judge concerning stabilisation procedures. There is a need for biomechanical knowledge if we have to deal with different types of defects and different types of surgical implants. Thus, the aim of the study was to create a model including an isolated anterior osseous defect within the cervicothoracic junction (CTJ) in which we analyse mechanics and sagittal profile following decompensation of the defect.
Material and Methods: 5 human cervicothoracic junctions were removed from fresh human cadavers. The segments C5-T2 were used, frozen until the experiment was done. Soft tissue was removed; however every discoligamentous structures were preserved. A standard computer assisted tomography (CAT) - to measure bone mineral density (BMD) within C7 and to analyse depth of spinal canal spinal-, as well as a lateral x-ray were performed. A standardized wedge-shaped-defect was created within C7 (Fig. 1). Specimen was forced in flexion -compression using a material testing machine until failure. Lateral x-ray, CAT. We checked: Correlation of load to failure versus BMD, stiffness before and after failure. Cobb's angle C6-T1, translation C6-T1, spinal encroachment at C7, each parameter before and after failure. All data are given as mean and standard deviation, significance assumed for p= 0,05. Software package used for digitizing images: Spineview 2.4, Surgiview ,Paris, France (program gives distances as pixels).
Result: Mean BMD was299 mg/cm^3, mean load to failure 1363 ± 662 N. There was no significant correlation of load to failure versus BMD. (r = 0,346, p = 0,568). Mean stiffness before failure occurred: 441 ± 237 N/mm, after: 256 ± 218 N/mm (Wilcoxon Test, p = 0,043). Sagittal profile between C6 -T1 was lordotic for intact, (2,1° ± 5,3°) kyphotic for defect (6,1° ± 6,4°), which is significant (Wilcoxon Test, p = 0,043). Translation between C6-T1: no significant change (Wilcoxon Test, p = 0,285). NO significant change in depth of spinal canal at C7 (Wilcoxon Test, p = 0,715).
Conclusion: An anterior wedge-shaped-defect with intact posterior ligaments was created in CTJ. With this defect, load to failure is not depending on BMD - which might be a sign for a massive destruction, in which the remaining bone does not contribute to stability. Failure results in significant change of stiffness and sagittal profile from lordosis to kyphosis, however does not result in translation or spinal canal encroachment.

Fig. 1



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An orthosis has only a minor effect on the loads acting on a vertebral body replacement

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Introduction: Severe, unstable compression fractures of a vertebral body are often stabilized posteriorly with an internal fixation device and anteriorly with a vertebral body replacement (VBR). Subsidence of the VBR associated with correction loss is one type of complication of this treatment. Some surgeons try to decrease this risk by supplying their patients with an orthosis. However, it is still unknown how much the ventral spinal column is relieved by an orthosis. The aim of this study was to measure the loads on a VBR for several activities in patients with and without an orthosis, and determine the extent to which implant loads can be reduced by an orthosis.
Material and Methods: Telemeterized VBRs were implanted into 5 patients who have suffered from a compression fracture of a vertebral body. For each patient, measurements were performed in a special session, with the patients successively wearing no orthosis and the Lumbo TriStep (LTS) brace. Four patients agreed also on measurements with the hyperextension orthosis medi 3C. Measurements were performed while the patients were standing and sitting on a stool, respectively, and included flexion, extension, lateral bending and axial rotation of the upper body as well as elevation of one or both arms with and without a weight in the hand. In addition, the loads during level walking were measured. Overall 26 different activities were studied. The median resultant forces for the various activities were calculated and the relative force changes due to an orthosis were determined.
Results: The maximum resultant forces for the situations with and without an orthosis differed strongly inter- and intra-individually. For extension during sitting with the LTS brace, for example, force reduction of 48% in one patient is accompanied by a force increase of 52% in another patient. During walking, the average maximum resultant force was 4% higher when wearing the LTS brace and 20% lower when wearing the hyperextension orthosis. The maximum resultant forces for 10 activities performed while sitting were usually lower with an orthosis than without. However, the maximum force values varied strongly for the various patients. The average resultant-force reduction for the activities while sitting was 14% for the LTS brace and 26% for the hyperextension orthosis. For the 15 activities while standing, the maximum resultant force was also usually lower with than without an orthosis. The average force reduction was 6% for the LTS brace and 14% for the hyperextension orthosis. Averaged over all 26 activities, the maximum resultant force was 9% lower when wearing the LTS brace and 19% lower when wearing the hyperextension orthosis.
Conclusion: On the average, the force reduction due to an orthosis was in most cases small. Although the force reduction was considerably for some activities, the force increase for other activities was remarkable in some patients. A hyperextension orthosis hinders upper body bending. Thus, the bending angles of the upper body were smaller with than without a hyperextension orthosis. In conclusion, the loads on a VBR and thus on the anterior column of the spine are slightly reduced when wearing a LTS brace and more pronounced due to a hyperextension orthosis. However, large inter- and intra-individual variations exist. Therefore, from the biomechanical point of view, no clear recommendation to wear an orthosis can yet be given.

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Two piece interbody fusion cage improves bone-implant alignment without compromising stability. A cadaver study

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Introduction: A novel two-piece anterior lumbar interbody fusion device allows lordotic adjustment until pedicle screws are locked to the rod. A potential benefit includes improving the bone-implant interface anteriorly with a potential positive impact on sagittal balance and clinical outcomes.
The aim of the study is to analyze the spinal segment motion and implant alignment of a two piece ALIF fusion cage compared with standard one piece ALIF cage in a 360° setting.
Material and Methods: Seven lumbosacral (L3-S1) human cadaver specimens were tested (aged 50-60, 4 males and 3 females). The intact segment and the specimen instrumented with a two piece ALIF cage (Statur-L, FBC Device ApS, Denmark) and a one piece standard ALIF (Pezo A, Ulrich, Germany) with pedicle screws were analyzed. Pure moment loads of ±7.5 Nm

were applied in flexion/extension, axial rotation and lateral bending. Fluoroscopic images were captured during motion. Three-dimensional intersegmental motion was measured using a motion analysis system (Vicon MX, Vicon, UK). Relative motion between the implant and endplate was measured from the images. Paired t-tests were performed to determine statistical significance at a p<0.05 level.
Results: No significant segment motion differences were identified between the one and two piece ALIF concepts used in a 360 set-up.
For both implant types in all three directions, the 360 constructs significantly reduced the motion of the spinal segment in comparison to the intact condition (p<0.05) (Table 1).
However, there was significantly less motion at the implant-endplate interface for the two piece device (Mean, SD) (p<0.05).
Table 1: RoM of two-piece cage and one piece cage compared with intact.

	Intact (N=7)	Two-piece cage as 360 construct (N=7)	One piece cage as 360 construct (N=7)
Flexion/Extension			
Median	8.6°	4.6°	4.2°
Range (Max, Min)	5.2° (11.2°, 6.0°)	5.6° (6.4°, 0.8°)	4.4° (5.2°, 0.8°)
Lateral Bending			
Median	6.9°	2.1°	1.6°
Range (Max, Min)	8.0° (13.3°, 5.3°)	2.3° (3.3°, 1.0°)	2.4° (3.2°, 0.8°)
Axial Rotation			
Median	4.6°	2.1°	2.0°
Range (Max, Min)	3.6° (5.5°, 1.9°)	2.5° (3.6°, 1.1°)	2.6° (3.0°, 0.4°)

Discussion: We found a significant improved relative motion at the bone-implant interphase with the two piece fusion implant, which theoretically can reduce the risk of implant subsidence, improve bony healing and establish better sagittal balance. The study also showed that the two very different ALIF concepts significantly reduced total motion in comparison to the intact state. Further, there was no statistically significant difference between the standard ALIF and the Statur-L, when supported with pedicle screw systems.
Conclusion: The novel two piece interbody fusion cage has the potential of improving the implant-bone interface resulting in less implant subsidence and improved sagittal balance without compromising stability.

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Anatomical changes in a lumbosacral transitional vertebrae Castellvi type 2A

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Introduction: The aim of this study is to present the anatomical changes in a lumbosacral transitional vertebrae Castellvi type 2A. In this variant, a unilateral large transverse process which appears to follow the contour of the sacral ala resulting in a pseudoarthrosis.
Material and Methods: Six bone specimens with a transitional vertebrae Castellvi type 2A from pathoanatomical samples from Berlin and Vienna were morphometrically examined. Two clinical cases with extraforaminal nerve root compression in this variant will be presented.
Results: The following significant morphometric changes were observed (compared with anatomical specimens): caudal dysplastic facet joint (n=6), rudimentary caudal intervertebral disc (n=6), enlargement of the pedicle on the pathological side (n=6), and dysplastic ala sacralis on the pathological side (n=6).
On the basis of two clinical cases (0.2% of the operated lumbar root compression syndromes per year) of extraforaminal spinal nerve root compression due to pseudoarthrosis in the ala sacralis we presented the clinical relevance of this variant. Both patients were operated on via a posterior approach with nerve root decompression in microsurgical technique.
Conclusion: A lumbosacral transitional vertebrae Castellvi type 2A shows four typical bony changes. The pseudoarthrosis can lead to an extraforaminal radiculopathy.

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Adaptation of the Three-Dimensional Bone Microstructure in a Lumbar Vertebra using a Two Motion Segment Optimization Model

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Introduction: Osteoporosis is a disease, which reduces the bone mineral density. It forces the microstructure of the bone to adapt to a reduced overall mass to new configurations. This includes thinning and lost of trabeculae and continuous evolution of the microstructure that ultimately leads to severe reduction of compression strength in the vertebra. Ultimately, it may result to a subsiding and collapse of one or more vertebrae. To date, most efforts to simulate bone remodeling have been made to predict the bone density distribution of the proximal femur, both in two and three dimensional finite-element (FE) models. Similar studies on the three dimensional (3D) spine are lacking in the literature.
Material and Method: A new optimization scheme was generated using the well-known Wolff's law for bone remodeling along with 3D-FE model of a spine segment in order to study the evolution of the bone microstructure in a single vertebra. Simulations have been conducted to demonstrate the predictive character of the method on a healthy spine segment subject to global loading. The model contained three vertebrae (L2-L4), two intervertebral discs and ligaments. The load consisted in a pure compression of 1000 N applied to the superior surface of L2. The remodeling process was performed only in the middle vertebra (L3).
Results: The optimization scheme predicted a 3D trabecular microstructure in the healthy L3 vertebral body, which was similar in many aspects we know from anatomical investigations. A higher number of longitudinal trabeculae in comparison with transverse structures was predicted, coherently with published data.
Conclusion: This is the first model able to predict the 3D microstructure of vertebral trabecular bone based on an optimization numerical model, with good agreement with literature data. The new optimization scheme shows promises in the prediction of the adaptation of the vertebral microstructure in response to osteoporotic bone loss, and could be used in the future for the evaluation of possible surgical therapies for osteoporotic vertebral fractures.

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The Influence of Disc Height Reduction on the Motion Characteristics of Lumbar Functional Spine Units

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Introduction: Disc space narrowing at the lumbar spine is considered as one of the underlying factors of low back pain