61 years, with 20% having previous adolescent idiopathic scoliosis and 80% lumbar degenerative scoliosis. We used multiple level Smith-Peterson osteotomies, multisegmental screws as well as 2-3 carbon fiber composite TLIF cages at the lumbosacral area for correction and stabilization. Different pre-curved carbon fiber composite rods were used to obtain the best sagittal balance for each patient. Patient follow up ranged from 6 to 24 months.

Results: At 6 months, all patients showed fusion on plane x-ray, with a contiguous bone bridge spanning the fusion construct. The patients' average Pelvic Incidence (PI) was 58°. Average preoperative Lumbar Lordosis was 47°, postoperative 51°. Preoperative Cobb angle varied from 24° to 65°, postoperative 7° to 32° (mean correction 60% of the preoperative deformity). One single postoperative rod breakage after a patient fall was observed, with no other implant failures in the series.

Conclusion: This preliminary report shows long fiber carbon composite rod fixation may be used to treat adult scoliosis with a less stiff and more elastic implant construct and low level of early complication. Correction was comparable to the gold standard titanium instrumentation, as reported in the literature. There were almost no device related failures thus far, likely due to the carbon composite's fatigue properties.

Still, long carbon fiber composite rod may provide the means to bring the Ilizarov bone fusion principles to scoliosis surgery, allowing correction of the deformity and at the same time encourage initial bone formation with later dynamisation of the fusion construct. Further evaluation is needed.

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BIOMIMETIC POLYURETHANE SCAFFOLD FOR NUCLEUS PULPOSUS REPLACEMENT

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Question: For treatment of intervertebral disc degeneration, nucleus pulposus (NP) replacement offers a minimally invasive alternative to traditional spinal fusion or total disc replacement. Recently, a novel polyurethane (PU) scaffold with swelling capability in situ was developed. This study investigated whether the PU scaffold can achieve a mechanical and biological repair response in nucleotomized discs under dynamic load condition.

Methods: Discoid/ravioli shape PU scaffolds were manufactured with a PU hydrogel based core with swelling capacity in between two electrospun nanofiber envelope sheets (Fig. 1a). Partial nucleotomy (50 % of NP tissue) was performed through the endplate of bovine discs. After implanting dry PU scaffold into the NP cavity, the endplate defect was closed with endogenous endplate stopper and sealed with polymethyl methacrylate. Untreated nucleotomized discs served as controls. Discs were cultured within a bioreactor system with 3 h dynamic load (0–0.1 MPa, 0.1 Hz) daily for 14 days.

To assess the mechanical repair, disc height and dynamic compressive stiffness were measured. To assess the biological repair, gene expression of disc tissue was analyzed using real-time PCR. Histology was performed using Safranin O/Fast Green staining. One-way ANOVA was used to determine statistical significance.

Results: Both macroscopic and histology images demonstrated that the PU scaffold was able to swell in situ, and has completely filled the nucleotomized region (Fig. 1b, c).

After 1st day of dynamic load, a disc height loss of -9.8 ± 2.3 % was noticed in partial nucleotomized discs (Fig. 2a). Implantation of PU scaffold restored disc heights to -2.1 ± 0.5 % (Fig. 2a). This pattern was observed over 14 days of loading.

After nucleotomy, the dynamic compressive stiffness of discs dropped to 30 % compared with intact discs. After refilling the NP cavity with PU scaffold and free swelling culture overnight, the disc stiffness was restored to 73 ± 21 %. After dynamic load and free swelling recovery the stiffness of PU scaffold implanted discs further increased to 82 ± 14 % (Fig. 2b).

Compared with healthy tissue of intact disc on day 0, gene expression of MMP13 in AF tissue of nucleotomized discs increased over 130-fold after 14 days of culture with dynamic load. Implantation of PU scaffold significantly down-regulated MMP13 expression in AF tissue ($p < 0.05$).

Conclusion: The biomimetic PU scaffold with swelling capacity in situ is able to restore the mechanical property of nucleotomized discs, and shows potential to retard further degeneration of native disc tissue.

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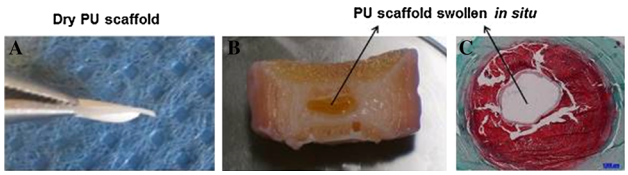

Fig. 1 **a** Dry PU scaffold. **b**, **c** Nucleotomized discs implanted with PU scaffold after culture

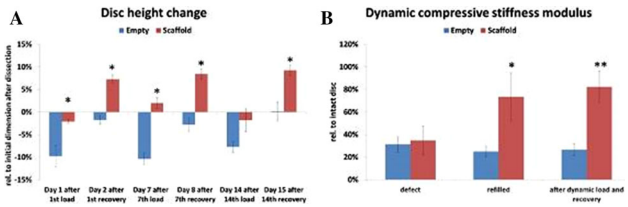

Fig. 2 **a** Disc height change and **b** dynamic compressive stiffness modulus of discs over loading period. Mean ± SEM, $n = 6$, $*p < 0.05$, $*p < 0.01$ vs Empty

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REPAIR OF ANNULUS FIBROSUS REPAIR WITH GENIPIN-ENHANCED FIBRIN HYDROGEL AND SILK MEMBRANE-FLEECE

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Introduction: Low back pain is often caused by a trauma causing disc herniation and/or disc degeneration. Although there are some promising approaches for nucleus pulposus repair, the inner tissue of the intervertebral disc (IVD) so far no treatment or repair is available for annulus fibrosus (AF) injuries. Here we aimed to develop a new method to seal and repair AF injuries by using a silk fleece composite and a genipin enhanced hydrogel.
Methods: Bovine (b) IVDs were harvested under aseptic conditions and kept in free swelling conditions for 24 h in high-glucose DMEM containing 5 % bovine serum for equilibration (1). A circular 2 mm biopsy punch (Polymed, Switzerland) was used to form a reproducible defect in the AF. For filling the defect and keeping the silk composite in place a human-derived fibrin gel (Baxter Tisseel, Switzerland) enhanced with 4.2 mg/ml of the cross linker genipin (Wako Chemicals GmbH, Germany) was used. The silk composite consists of a mesh- and a membrane side (Spintec Engineering GmbH, Germany); the membrane is facing outwards to form a seal. bIVDs were cultured in vitro for 14 days either under dynamic load in a custom-built bioreactor under physiological conditions (0.2 MPa load and ± 2° torsion at 0.2 Hz for 8 h/day) or static diurnal load of 0.2 MPa (2). At the end of culture discs were checked for seal failure, disc height, metabolic activity, cell death by necrosis (LDH assay), DNA content and glycosaminoglycan content.
Results: Silk composite maintained its position throughout the 14 days of culture under loaded conditions. Although repaired discs performed slightly lower in cell activity, DNA and GAG content were in the range of the control. Also LDH resulted in similar values compared to control discs (Fig. 1). Height loss in repaired discs was in the same range as for static diurnal loaded control samples. For dynamically loaded samples the decrease was comparable to the injured, unrepaired discs.
Conclusions: Silk-genipin-fibrin reinforced hydrogel is a promising approach to close AF defects as tested by two degree of freedom loading. In further experiments cytocompatibility of genipin has to be investigated.
Acknowledgments: This project is funded by the Gerbert Rüf Stiftung project # GRS-028/13 and the Swiss National Science Project SNF #310030_153411.
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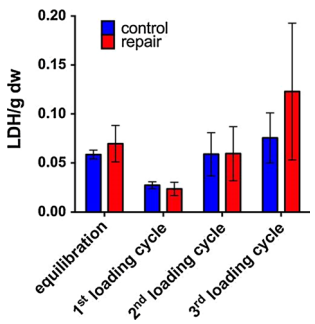

Fig. 1 LDH of repaired discs compared to control disc after 24 h in free swelling conditions for equilibration and first three loading cycles

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A NEW ALTERNATIVE TO EXPANDABLE SCREWS: EXPANDABLE PEEK SHELL

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Question: Screw pullout is a very common problem on the fixation of sacrum with pedicle screws. The main reason behind this is the higher value of vibrations on the sacrum limits the osteo-integration between bone and screw. In addition the bone quality is very poor at sacrum region. This study investigated a possible solution to the pullout problem without the Expandable screws' handicaps.
Methods: Newly designed PEEK made expandable shell and Classical pedicle screws were compared. Torsion test, pullout tests, fatigue tests, Flexion/extension moment test, axial gripping capacity tests and torsional gripping capacity tests were conducted in accordance with ASTM F543, F1798 and F1717. Standard Polyurethane foam and Calf vertebrae were used at pullout tests.
Results: Classical pedicle screw pullout with 564.8 N loads on Polyurethane Foam and the failure load for calf vertebrae was 1,264 N. For the same test conditions expandable shell used system pulled out with 1,196.3 and 1,890 N loads from Polyurethane foam and Calf vertebrae, respectively. The pullout values for expandable shell was 33 and 53 % higher than classical pedicle screw on PU Foam and Calf vertebrae, respectively. The PEEK shell exhibited the endurance on its 90 % of yield load. Contrary to PEEK Shell Classical Pedicle Screw exhibited endurance on 70 % of its yield load.
Conclusion: This study covers the standard ASTM tests on a newly designed expandable PEEK shell and classical pedicle screws. Pullout tests were conducted to EPEEKS and CPS on synthetic foams and cadaveric calf vertebrae. EPEEKS and CPS were also compared on fatigue performances. EPEEKS exhibited much higher pullout performance than CPS. Fatigue performance of EPEEKS is also higher than CPS due to shock absorption capacity of the PEEK. EPEEKS is a safe alternative to all those expandable pedicle screw systems on mechanical perspective.

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IN-SITU PHOTOPOLYMERIZED COMPOSITE-HYDROGEL FOR MINIMALLY-INVASIVE NUCLEUS PULPOSUS REPLACEMENT

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