THE APPLICATION OF A THREE DIMENSIONAL AUTOLOGOUS PERIOSTEAL CELL – MATRIX CONSTRUCT FOR LUMBAR SPINE Spondylodesis

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INTRODUCTION:
The objective of this study was to evaluate the suitability of cultured autologous periosteal cells embedded in a three dimensional matrix for spinal fusion in humans.

Lumbar spondylodesis is known to have a slow consolidation rate with a consecutive lengthy and costly period of absence from work and the risk of non-union (1). Hence, it is not only of medical concern to enhance the osseous bridging, but also of economical interest to expedite the healing process.
The use of tissue engineered products for various musculoskeletal impairments is the objective of numerous experimental and clinical studies at present and showing promising results in different indications (2, 3, 4).

This study evaluates the applicability of a cell-matrix construct for spinal fusion surgery using clinical and radiological parameters.

METHODS:
All experiments were approved by the university ethics committee. Anterior-posterior lumbar spondylodesis of the segments L4/5 or L5/S1 was performed in 20 otherwise healthy patients with a mean age of 45 (range 34-58) years at the time of surgery. An informed consent was obtained from each patient included in this study. Preoperative diagnosis and indication for surgery was degenerative disc disease resistant to conservative treatment.

Ten weeks before the scheduled fusion operation, a piece of periosteum with an approximate size of 2 x 2 cm was harvested from the proximal anterior tibia of the patient under sterile conditions. The obtained material was chopped into small pieces and digested with collagenase. The resulting cell suspension was washed three times before the cell number and viability were determined using a haemacytometer and trypan blue dye staining. This was repeated after each culture passage. The viability was 90 % at least before seeding. The cells were suspended in Dulbecco’s modified eagle’s medium/Ham’s F-12 1:1 supplemented with autologous serum obtained at the time of the periosteum biopsy. Reaching a confluence of 70 %, the cells were trypsinized and replaced at a density of 5000 cells/cm². After four passages, the cells were suspended in medium and mixed with human fibrinogen in a 3:1 ratio. This suspension was soaked into polymer fleeces. Polymerization was achieved by adding thrombin. These three dimensional constructs were cultured for three weeks. The form of final application were chips of 2 mm thickness and 8 mm diameter.

Anterior-posterior spondylodesis was performed using a ventral pararectal approach for implantation of 2 titanium mesh cages (Medtronic, Sofamor Danek) and a dorsal median approach for application of a transpedicular angle-stable screw-rod system (Medtronic, Sofamor Danek). In ten patients the cell-matrix chips were implanted ventrally within the cage. Eight chips were needed per cage. Twelve of them were strung on suture material for each side and attached to the ipsilateral screw heads.

Preoperative, 3, 6, 9, and 12 months after surgery a clinical examination was performed, and anterior-posterior radiographs, as well as subjective functional scores were obtained.

RESULTS:
Neither perioperative nor during the follow-up period any undesirable implant associated side effects were noted. Especially, signs of infection or allergic reaction of any kind have not been observed. The harvest sites of all patients presented healed and symptom-free at three months postoperatively.

The clinical evaluation showed a reduction of the preoperative existing neurological deficits and the muscular signs of dysbalance as well as any signs of instability.

Radiologically, the rate of consolidation was 60 % after six months and 90 % after nine months. After twelve months all patients showed consolidation of the treated segment. The group with the ventrally transplanted cell-matrix constructs showed initially a slightly higher rate of fusion at six months, whereas no differences between the two groups were found at nine and twelve months.

No clinical or radiological signs for implant failure or malpositioning were observed. No new neurological deficits were found.

90 % of the patients were completely or reasonably satisfied with the outcome of the surgery and would undergo the operation again if necessary.

DISCUSSION:
As shown in this study, in vitro cultured autologous periosteal cells in a three dimensional matrix are a suitable material for anterior as well as posterior spinal fusion in humans.

They may accelerate the rate of fusion and thus reduce the risk of non-union. The rate and velocity of osseous consolidation needs to be compared to that of patients treated with iliac crest autograft. A major advantage might be the lower rate of graft site morbidity, which is a problem concerning iliac crest biopsy. Furthermore, to obtain statistic validity, a larger number of patients needs to be included in a follow-up study.

Thus, in the near future, application of autologous cells and may become a promising way of treating patients with indication for spinal fusion.

LITERATURE:
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