PERIOSTEUM INFLUENCES SUBCHONDRAL BONE FORMATION IN CARTILAGE REPAIR

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### Introduction:
Inspite of recent progress on autologous chondrocyte transplantation (ACT) [8] early deterioration of initially good clinical results remains a concern in cartilage repair surgery [3]. We hypothesized, that subchondral bone formation may be a factor in these cases [4, 6]. We further hypothesized that remodeling processes in the subchondral bone area are influenced by factors released from the cambium layer of periosteum sutured to the cartilage defects, especially in cases where the subchondral bone is affected. This is common in deep cartilage defects or may be caused by the applied repair procedure when removing fibrous tissue from the defect base.

This study focuses on subchondral bone changes 1 year after 2 different cartilage repair procedures in a sheep model.

### Material and Methods:
Chondral biopsies were taken arthroscopically from n = 10 sheep’s knees to isolate and amplify autologous chondrocytes in monolayer cultures. Four weeks later 2 standardized, full-thickness 7 mm defects were created on the femoropatellar groove (FPG) and on the medial condyle (MC) of the contralateral knee using depth gauged instruments to ensure, that the subchondral bone plate is just opened. In group A a periosteal flap was sutured to the defects with the cambium layer facing the defect and autologous cells (10⁶/defect) were injected underneath. In group B a modified ACT-technique [1] was applied by suturing a collagen type –I/III membrane (Chondro-Gide®, Geistlich, Wolhusen, Switzerland) instead of the periosteum and cells (10⁶/defect) injected underneath. Untreated defects in group C served as controls (n = 5). The operated hindlegs were immobilized in a cast for 10 days post-operatively.

One year later the animals were terminated and the defect sites processed for histology (HE, Alcian blue). On representative HE-stained specimens femoral patellar groove eluding different subchondral bone areas underneath full-thickness cartilage defect areas 1 year after treatment with autologous chondrocytes in combination with collagen I/III-membranes or periosteum or w/o any treatment (control). P-values indicate significant differences vs corresponding controls.

### Results:
While gross macroscopic appearance and overall histological scoring did not reveal significant differences in-between the repair tissues of all groups the defect sites on the medial condyle generally yielded better results in the GAG-stain sub-criterion.

However, a marked hypertrophy of the subchondral bone was seen in animals which were treated with periosteum (Fig.2). Optical density evaluation demonstrated an increase in bone formation about 71% in comparison to the control (p<0.002) and about 36% in comparison to the group treated with a collagen I/III membrane (p<0.03) in the femoropatellar groove. The effects were even more pronounced in the medial condyle areas were subchondral bone density increased about 194% (p<0.001) and 130% (p<0.001) in comparison to corresponding controls or the group treated with collagen I/III membranes. There was a slight but not significant increase in bone formation in the collagen I/III-membrane group in comparison to the control group.

### Discussion:
In a clinical setting surgeons commonly have to deal with cartilage defects where the subchondral bone is severed which is indicated by some bleeding from the defect base. Inspite of attempts to seal the defect base the applied repair procedure potentially has to compete with intrinsic repair mechanisms affecting the quality of the repair tissue [5]. The results of this study indicate that in these cases transplanted cells fail to induce a superior repair tissue when compared to the control group. Moreover, remodeling of the subchondral bone is obviously stimulated by the transplanted periosteum leading to a significant hypertrophy as shown in group A. This effect is probably linked to factors released from the cambium layer facing the defect. Since these changes in the subchondral bone are looked at as early events in osteoarthritis [2, 6], they may explain early deterioration in patients after ACT with periosteum. Using a collagen type –I/III membrane can significantly reduce subchondral bone hypertrophy.

### Conclusion:
To our knowledge this study demonstrates for the first time, that transplantation of periosteum with the cambium layer facing down induces subchondral bone hypertrophy in full-thickness cartilage defects in a sheep model.

### References:

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