Results of Osteochondral Mosaic Grafting in a Sheep Model

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Objective: We present the results of an experimental study in sheep on using autogenous, cylindrical osteochondral grafts for treating cartilage defects in the knee. The aim was to produce hyaline or hyaline-like cartilage on weight-bearing surfaces through autogenous osteochondral transplantation using special instrumentation and the mosaicplasty technique.
Methods: We used a sheep model – cartilage defects were made in the knees of 16 young sheep from the Tigaia breed. At 4 and 8 weeks postoperatively macroscopic, radiologic and microscopic examinations were performed on the transplanted sites and the donor sites.
Results: We found that grafts incorporated well in the recipient sites, showing good survivorship. Joint congruency was maintained, with 75 to 80% hyaline cartilage at the transplanted site.
Conclusions: Our results lead us to conclude that mosaic-like osteochondral grafting is an excellent treatment method for repairing chondral defects in major joints.

Keywords: osteochondral, knee, experimental, mosaicplasty, sheep

Introduction

Focal chondral and osteochondral defects in major joints are difficult to treat [1]. One of the treatment options for focal osteochondral lesions in the knee joint is the use of osteochondral grafts to fill the defect, with the technique called mosaicplasty. The method is believed to yield good results in the treatment of focal osteochondral defects in major joints, as other authors have demonstrated before [1,2,3,4,5,6,7].

In this experimental study we used an animal model – cartilage defects were made in the knees of 16 young sheep from the Tigaia breed – and treated them by implanting autogenous, cylindrical osteochondral grafts in the defects created. Our aim was to produce hyaline or hyaline-like cartilage on weight-bearing surfaces through autogenous osteochondral transplantation.

Methods

We used a number of 15 sheep from the Tigaia breed. The animals were 6 months old, male to female ratio was 50–50%, and their weight was 5.5 to 7kg.

Surgery was performed in general anaesthesia and consisted of a large arthrotomy of the knee to expose the femoral condyles on which we created an ostheochondral defect with a sharp dowel. The defect was then prepared for grafting by making recipient holes in it for the placement of osteochondral grafts. The recipient holes were drilled to a depth of 3 mm to 10 mm, spaced 2 to 3mm apart, covering the whole defect area [5,6]. The non-weight bearing portion at the periphery of the femoral condyle and patello-femoral joint were used as the donor sites – osteochondral grafts were obtained from these areas using special cylindrical chisels. These grafts were then press-fitted into the recipient holes to fill the defect.

After closing the wounds no external immobilization was applied. We observed no discernible limp at 3 to 5 day postoperatively. All animals were fed standard animal feed and tap water ad libitum. Animals were sacrificed at 4 and 8 weeks postoperatively (8 animals each time).

The grafted sites were first inspected macroscopically and with photo- and X-ray slides, after which samples were taken for histological examination. For histological examination we used Masson and hematoxylin and eosin stains. The donor sites were examined also, in the same manner.

Results

We found 100% graft survival of the hyaline cartilage. Macroscopic and microscopic examination demonstrated can-

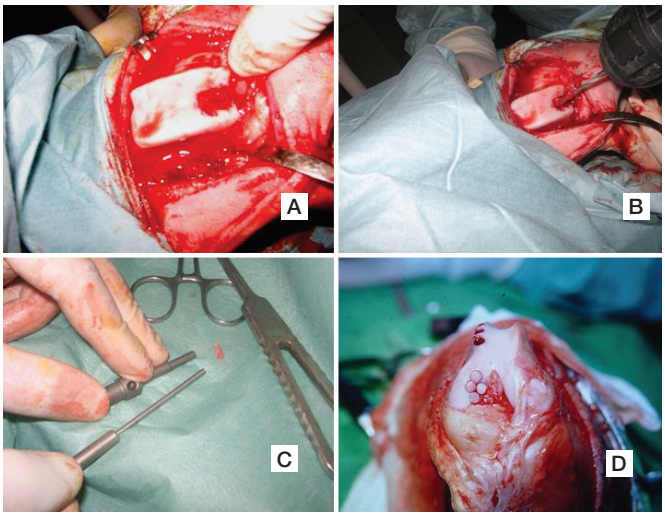

Fig. 1. The procedure of osteochondral mosaic grafting in the sheep model (A – Creating an osteochondral defect on the weight bearing surface. B – Holes drilled in the ulcerated zone. C – Special chisels used and the cylindrical grafts. D – Final aspect of the mosaicplasty.)

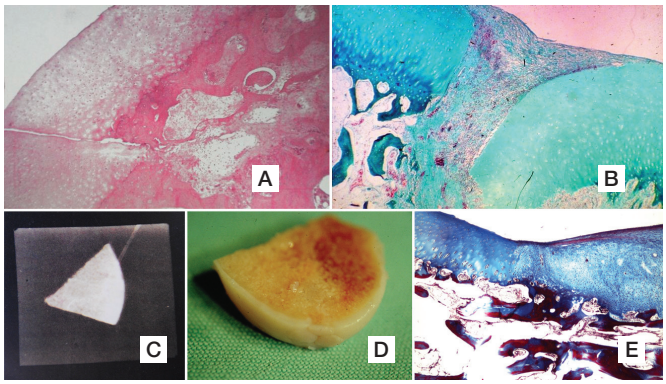

Fig. 2. Histological results (A – Excellent integration of the grafts at 4 weeks postoperatively. The hyaline cartilage survived. HE coloration. B – The space between the grafts and the recipient zone was filled with fibrocartilage. No articular incongruence was evident. Masson coloration. C – Micro X-ray, no radiolucency zones was obserwed..E – macroscopic slide, good bony integration at 8 weeks. D – the articular surface was remodelated at 8 weeks Masson coloration40x40)

cellous bony union between the graft and the surrounding recipient area. The same was observed on radiologic analysis – the grafted bone was incorporated into the recipient bone, no radiolucency lines was observed (Fig. 2C).

On histological examination the transplanted cartilage showed no signs of degeneration and it retained the morphologic characteristics of hyaline cartilage. We also carefully examined the interface between the graft and the recipient area. At 4 weeks postoperatively the microscopic examination showed a complete bony union with cancellous bone between these areas, and the presence of a fibro-cartilaginous nest at the base of the cartilage cleft. At 8 weeks postoperatively all remaining spaces between the graft and the recipient site were filled with fibro-cartilaginous tissue, but we observed no evident articular incongruence. We found uninterrupted union between the hyaline cartilage of the grafts and that of the recipient area, with fibrocartilage filling the space between these areas. In the transplanted area, 75 to 80% of the cartilaginous tissue was of the hyaline type.

We also studied the donor sites, carrying out both a macroscopic and a microscopic examination. By 4 weeks these sites filled with regenerated bone trabeculae and the surface showed congruency with the surrounding area by fibrocartilage ingrowth.

Discussion

The grafts incorporated well into the recipient site, demonstrating good survivorship. The grafting technique involves exact press-fit fixation of the grafts, which is why the specially designed instruments are essential for the success of the procedure [1,5,6]. Placing the grafts so close to each other allows for a maximum of cylindrical grafts to be inserted with minimum space left for fibrocartilage ingrowth [5,6,8,10,11].

In our study we found no evidence of necrosis of the grafted hyaline cartilage. Congruity issues at the recipient site have been solved by the use of multiple small cylindrical grafts. In the samples obtained at 4 weeks postoperatively we found good, but incomplete integration of the grafts, while at 8 weeks postoperatively we observed better maturation and integration of the grafted area (Fig. 2C–D–E) [5,6,9].

Conclusions

In this study we tested the feasibility of addressing these types of cartilage lesions by grafting, using the mosaicplasty technique, with small, fresh autogenous cylindrical osteochondral grafts in a sheep model.The follow up termen is not to long,but our findings demonstrated that the grafts was incorporated into the defects and restore both hyaline cartilage and cancellous bone integrity [5,6,8,9]. The survivalship of cilindric osteochondral grafts was very good, the cartilage maintained his hialin type, no articular incongruency was found. We found that mosaicplasty is an excellent technique for the treatment of focal osteochondral defects in major joints on the weight bearing surfaces. [7,2,11].

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