COMPUTERIZED MATCHING OF AUTOLOGOUS GRAFTS FOR THE TREATMENT OF MEDIAL TALAR OCD LESIONS BY OSTEOCHONDRAL TRANSPLANTATION

Introduction:
A standard treatment for osteochondral lesions of the talus is debridement and drilling of the lesion. This technique stimulates a fibrocartilagenous ingrowth into the defect. Short-term results have been good but a long-term study has shown less favorable results over time. Recently, osteochondral transplantation of an autologous femoral graft to the talar lesion has been reported. With any transplantation, the restoration and congruency of the articular surface is paramount. However, the compatibility of the topographical surface of the femur compared to the talus has not been investigated. The purpose of this study is to match the topographical articular surface of selected femoral condyle donor sites to medial talar recipient sites to determine the areas of the best articular contour and fit for osteochondral transplantation.

Methods:
Five matched cadaver tali and distal femurs were utilized. Each bone was imaged using magnetic resonance imaging at 1.5mm slices in the coronal plane. The articular surface was reconstructed using segmentation software (Mimics, Belgium). Using the 3D reconstructed surfaces of both bones; circular 10mm donor and recipient graft sites were selected (Metris, Belgium). Six potential donor sites were selected from the non-weight bearing medial and lateral condylar flares of the trochlea. Three sequential medial and lateral grafts were selected from the inferior to superior margin starting at the apex of the notch (Figure 2). Three recipient sites were selected on the medial talar surface: anterior, middle, and posterior. The recipient sites were also 10mm in diameter and placed so that the medial most articular edge did not violate the medial vertical plane. Each donor site was matched to each recipient site to determine the best donor site for each recipient site. Using customized software (Matlab, USA) the donor site was rotated and translated in space (four degrees of freedom) until the discrepancy between the outer 1mm annular ring was minimized (Figure 1). The optimization procedure was repeated utilizing the entire surface of the donor and recipient sites.

Results:
1) The average circumferential step-off was 0.24mm ± 0.07 mm (range: 0.13-0.60mm).
2) The average deviation of the surface contour was 0.32mm ± 0.11mm (range: 0.14-0.78mm).
3) For all medial lesions, there was a trend to improve the circumferential step-off from the inferior to superior donor site but this was not statistically significant (p=0.13).
4) Better circumferential fits are obtained in the transplantation to posterior medial lesions than the middle and anterior lesions (p<0.042).
5) The deviation of the surface contours before and after grafting varied significantly with the location of the donor site but not with the location of the recipient site.
6) The best restoration of the surface contour for all recipient sites was obtained from the superior lateral donor site (p=0.021).

Conclusions:
Our study shows that when repairing lesions on the talus using autologous femoral condylar grafts the greatest success can be expected if the lesion is located on the posterior medial region of the talus. Our measurements show that the talar posterior medial region is the “best recipient” site. Similarly, we have shown that the “best donor” site is the superior lateral femoral condylar surface. In conclusion, we have demonstrated that there are significant differences in articular surface reconstruction quality based on both the location of the lesion as well as the graft donor site. When repairing articular lesions, topographical matching must be taken into consideration to improve the overall success of the transplantation.

Figure 1. Illustration of Femoral and Talar donor/recipient sites.

Figure 2. Illustration of optimization degrees of freedom and measurement sites.

In the optimized position, the average mismatch, or step-off, in the 1 mm annular ring step-off between the donor and recipient sites was calculated. The average mismatch across the entire surface, as well as the maximum mismatch was calculated (Figure 2). Two-way ANOVA (P <0.05) was used to analyze the data.