THE HUMERAL HEAD AS A POTENTIAL DONOR SITE FOR OSTEOCHONDRAL ALLOGRAFTING TO THE ARTICULAR SURFACE OF THE FEMORAL CONDYLES

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Introduction:

Osteochondral allografts for transplant to the femoral condyles have several limitations and concerns. One key limitation of allografts is the availability of an adequate supply. Currently, cadaveric femurs serve as a source of osteochondral allografts for transplantation to distal femur osteochondral defects. If an area of the humeral head could be shown to be an acceptable topographical match, then we may double the donor pool for allograft osteochondral transplants. However, previous studies have shown that if gross mismatch is allowed, including mismatches of the curvature and cartilage thickness, poor healing and suboptimal joint function are likely to result. The purpose of this study was to examine the topography of the articular surface of the humeral head and to evaluate it as a potential donor site for osteochondral transplantation to the weight-bearing surfaces of the femoral condyles.

Materials and Methods:

Five humeral heads and five distal femur cadaveric specimens with intact articular surfaces were obtained and prepared for mounting on a customized apparatus. A laser-based coordinate measuring scanner was used to obtain a 3-D surface map of the distal femur and proximal humeral articular surfaces (figure 1a). We defined a single donor site on the center of the humeral head, after determining that the approximate hemispherical shape of the humeral surface negated the need to sample multiple donor sites.

![Image](a)

![Image](b)

Figure 1 – (a) Potential transplant locations on the humeral head. For this study, the central location (blue) was used. (b) Recipient sites located on the femur corresponding to 30 and 60 degrees of flexion.

Two recipient sites were selected on both the medial and lateral distal femoral condyles corresponding to the weight-bearing surface of the tibiofemoral joint at thirty and sixty degrees of flexion, which are thought to be areas of high cartilage wear (figure 1b).

Simulated osteochondral grafts of 1.0 cm diameter were taken from the surface map of the humeral heads using RapidForm software and superimposed on recipient sites on the femoral condyles. MatLab software was used to optimize the rotational fit and depth of graft placement, and the error of topographic mismatch between the donor and recipient sites was calculated. Measurement criteria included maximum mismatch, average mismatch, and circumferential step-off.

Results:

For 30 degrees of knee flexion, the average mismatch between the donor and recipient sites was 0.073 mm on the lateral condyle and 0.066 mm on the medial condyle (SD 0.048 mm and 0.049 mm respectively). The maximum mismatch was 0.232 mm medially and 0.243 mm laterally. The average step-off was 0.106 mm laterally and 0.079 mm medially (SD 0.059 mm and 0.051 mm respectively). The maximum step-off was 0.240 laterally and 0.220 medially.

For 60 degrees of knee flexion, the average mismatch between the donor and recipient sites was 0.074 mm on the lateral condyle and 0.079 mm on the medial condyle (SD 0.052 mm and 0.053 mm respectively). The maximum mismatch was 0.245 mm medially and 0.236 mm laterally. The average step-off was 0.088 mm laterally and 0.101 mm medially (SD 0.056 mm and 0.058 mm respectively). The maximum step-off was 0.241 laterally and 0.226 medially.

Discussion:

The humeral head may be an excellent option for additional donor sites for osteochondral allografting to the distal femoral condyles. The measurement criteria assessed in this study demonstrate that 1.0 cm osteochondral plugs from the humeral head are an excellent fit to the recipient sites of the femoral condyles. The low circumferential step-off suggests that the component acceptably blends into the overall topography of the recipient surface. The low maximum and average mismatch suggests that the curvature of each specimen does not deviate significantly from the curvature of the recipient site. All measured parameters were conceivably less than errors introduced by harvesting and implantation. Furthermore, all donor sites were acceptable to all tested recipient sites on the weight-bearing surface of the femoral condyles.

Having established the surface compatibility of such transfers, the current direction of our work aims to compare the cartilage thickness of the humeral head donor site and the femoral condyle recipient site. Furthermore, osteochondral allografts to the femoral condyles are often used in the repair of lesions larger than the 1.0 cm size examined in this study; our current work is progressing to the investigation of the fit of such larger plugs.