Subchondral Bone Mismatches in Osteochondral Allograft Transplants for Large Oval Defects of the Medial Femoral Condyle: Comparison of Lateral vs. Medial Femoral Condyle Donors

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INTRODUCTION: In order to improve the supply-demand mismatch of medial femoral condyle osteochondral allografts (OCA), our previous work has demonstrated that oval contralateral lateral femoral condyle (LFC) OCA can attain an acceptable cartilage surface contour match compared to an oval ipsilateral medial femoral condyle (MFC) OCA for large oval defects of the MFC. Additional prior work in the patella demonstrated that differences in the underlying subchondral bone contour between homologous and non-homologous OCA grafts may be larger than those seen on the cartilage surface. Finite element analyses in our lab have shown that these subchondral bone contour differences produce abnormal force attenuation/distribution, primarily at the graft:recipient interface, which may be a causative factor in premature failure of the allograft. The purpose of this study was to use surface contour mapping to determine if using a contralateral LFC vs an ipsilateral MFC OCA plays a role in the ability of donor subchondral bone to align with the native condyle subchondral bone when treating large oval osteochondral defects of the MFC.

METHODS:

Thirty fresh frozen human femoral condyles were matched by tibial width (±2mm) into 10 groups of three condyles each (1 MFC recipient, 1 MFC and 1 LFC donor) for 3 fellowship-trained experienced cartilage surgeons (total of 90 condyles). The recipient MFC was initially imaged using nano-CT. A 17x36mm oval “defect” was created in the recipient MFC. Donor transplant groups consisted of an ipsilateral MFC oval dowel vs a contralateral LFC oval dowel. Donor transplant order was randomized (MFC vs LFC). Following the first transplant, the recipient condyle was nano-CT imaged, digitally reconstructed, and superimposed on the initial native condyle nano-CT scan. The donor plug was then carefully removed and the process was repeated for the other donor. Dragonfly 3D and Excel were used to determine the root mean square (RMS) of both the surface height deviation (Fig. 1) and circumferential step-off height deviation (Fig. 2) between the native and donor subchondral bone surfaces for each transplant. Analyses were performed for the whole transplant and with the transplant divided into anterior, posterior, medial, and lateral quadrants. Student’s *t* tests and one-way ANOVAs with Sidak’s post-hoc testing were used to compare the RMS surface deviation and step-off heights between the two donor groups. A sample size of seven condyles was determined based on previously published work and increased to 10 condyles to ensure adequate power.

RESULTS: There was no statistically significant difference in mean subchondral bone surface deviation between contralateral LFC and ipsilateral MFC plugs (LFC = 0.87 ± 0.22mm, MFC = 0.76 ± 0.24mm, $p = 0.07$). At the interface between the donor plug and the surrounding native subchondral bone, there was no significant difference in the circumferential step-off height between the LFC and MFC plugs (LFC = 0.93 ± 0.18mm, MFC = 0.85 ± 0.21mm, $p = 0.09$). For both surface deviation (Table 1) and step-off height (Table 2), there were no statistically significant differences between the plug quadrants (anterior, posterior, medial, lateral) within each donor type (MFC or LFC) or across donor types (MFC vs LFC). There were no significant differences in outcomes between surgeons.

DISCUSSION AND CONCLUSION: Using either a contralateral LFC or ipsilateral MFC oval donor plug did not lead to statistically significant differences in subchondral bone surface height deviations or circumferential step-off height at the graft:recipient subchondral bone interface. The acceptable subchondral bone match of LFC allografts to the native MFC surface for large oval shaped lesions helps address concerns of donor tissue availability when treating these osteochondral lesions. Patient specific matching can now occur quicker to decrease patient wait times for surgery, and donor-gifted tissue can now be more completely used for patient care. Finite element analysis is now required to determine how the differences in subchondral bone surface height in the allograft compared to the surrounding native bone may affect local cartilage force distribution, especially at the interface between the native and donor tissues.

Figure 2

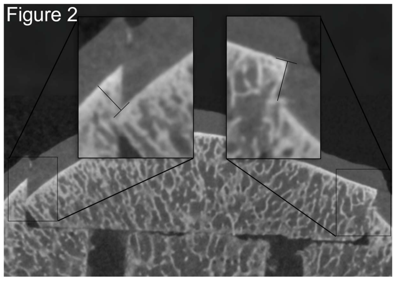

Figure 1

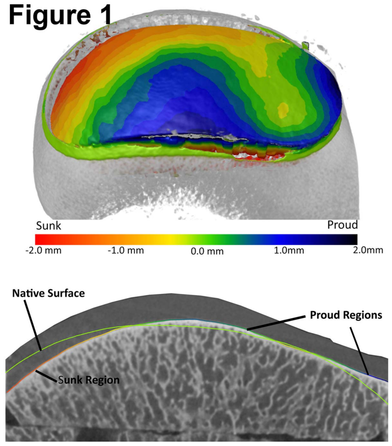

TABLE 1

Surface Deviation

	Anterior Quadrant	Posterior Quadrant	Medial Quadrant	Lateral Quadrant	Total Surface
Lateral Condyle Donor	0.86 ± 0.34	0.86 ± 0.27	0.86 ± 0.44	1.00 ± 0.41	0.87 ± 0.22*
Medial Condyle Donor	0.75 ± 0.28	0.76 ± 0.31	0.67 ± 0.33	0.86 ± 0.43	0.76 ± 0.24*

Step-off Height

	Anterior Quadrant	Posterior Quadrant	Medial Quadrant	Lateral Quadrant	Total Surface
Lateral Condyle Donor	0.93 ± 0.24	0.90 ± 0.28	0.87 ± 0.44	1.06 ± 0.39	0.93 ± 0.18^
Medial Condyle Donor	0.77 ± 0.24	0.90 ± 0.31	0.74 ± 0.43	0.87 ± 0.35	0.85 ± 0.21^