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Paper #120

Topographic Analysis of the Glenoid and Proximal Medial Tibial Articular Surfaces – A Search for the Ideal Match for Glenohumeral Resurfacing

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Summary:
This study describes a novel topographic computational model to quantify the topographic match between the medial tibial and glenoid articular surfaces, the findings of which suggest that the medial tibial articular surface provides near anatomic match to the glenoid for the purposes of glenoid resurfacing in young patients with end-stage arthritis.

Abstract:
Introduction:
Biological resurfacing is a proposed treatment for young active patients with isolated glenohumeral joint arthritis. Current knowledge of appropriate osteochondral allograft harvest sites is lacking. The objective is to match the geometry of donor tissue to native glenoid morphology. We hypothesize that the medial tibial plateau will provide the ideal site for glenoid osteochondral allografting due to its concave shape and anatomic similarity to the glenoid articular surface. The purpose of this study is three-fold: 1) To quantify the articular surface topography of the glenoid and medial tibial plateau. 2) To reconstruct 3-dimensional models to determine whether the medial tibial articular surface provides a topographic match to the articular surface of the glenoid. 3) To compare the anterior and posterior aspects of the medial tibial articular surface to determine if one zone has a more congruent topographic match.

Materials and Methods:
Computed tomography (CT) was performed on four cadaveric proximal tibias and four scapulae, allowing for 16 glenoid-tibial comparative combinations. Three-dimensional (3D) CT models were created and exported into point cloud models (Mimics Software, Materialise, Belgium). A local coordinate system was created to establish a mapping system of the glenoid and medial tibial plateau articular surfaces. Two topographic zones of the medial tibial articular surface (anterior and posterior) were quantified. The glenoid articular surface was defined as a best-fit circle of the glenoid articular surface maintaining a 2mm bony rim. This surface was virtually placed on a point on top of the tibial articular surface in 3D space. The tibial surface was segmented and its 3D surface orientation was determined by an eigenvector in the normal direction of its surface. 3D orientation of the glenoid surface was reoriented so that an eigenvector in the normal direction of the glenoid surface matched that of the tibial surface. The least distances between the point-clouds on the glenoid and tibial surfaces were calculated throughout the glenoid surface. The glenoid surface was rotated 360 degrees around the eigenvector with one degree increments and the mean least distance was determined at each rotating angle. Non-parametric Wilcoxon Signed Rank test statistical analysis was performed to compare the findings between the anterior and posterior aspects of the medial tibial articular surface.

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Results:
When the centroid of the glenoid surface was placed on the medial tibial articular surface, it covered approximately two-thirds of the anterior or posterior tibial surfaces. Overall, the mean least distance difference in articular congruity of all 16 glenoid-medial tibial surface combinations was 0.75mm (Std. Deviation +/- 0.14). The mean least distance difference of the anterior and posterior two-thirds of the medial tibial articular surface was 0.73mm (+/- 0.14) and 0.77mm (+/- 0.18), respectively. There was no statistically significant difference between and the anterior and posterior two-thirds of the tibia with regard to topographic match of the glenoid (p=0.187).

Conclusion:
We describe a novel computational model by which to quantify the topography of the tibial and glenoid articular surfaces. The findings suggest that the medial tibial articular surface provides a near anatomic match to the glenoid articular surface for the purposes of glenoid resurfacing. Both the anterior and posterior two-thirds of the medial tibial articular surface can serve as potential sites for osteochondral graft harvest in the setting of concentric glenoid articular surface wear. The above methodology can also be applied to future studies evaluating the ideal anatomic sites of graft harvest to treat zonal glenoid bone wear and/or loss.