New Algorithm for Selecting Meniscal Allografts that Best Match the Size and Shape of the Damaged Meniscus

Tommy L. Haut Donahue,1 Maury L. Hull,2,3 Stephen M. Howell2

1Department of Mechanical Engineering, Michigan Technological University, Houghton, Michigan 49931
2Department of Mechanical Engineering, University of California, Davis, California 95616
3Biomedical Engineering Program, University of California, Davis, California 95616
Received 15 February 2005; accepted 8 June 2005
Published online 26 May 2006 in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/jor.20155

ABSTRACT:

Procedures used by tissue banks in selecting meniscal allografts that will best restore normal contact pressure at the time of surgical implantation into a recipient’s knee should be improved. Our objective was to develop regression equations that use dimensions measured from magnetic resonance (MR) images of the contralateral knee to predict values of important meniscal parameters of the injured knee. Another objective was to incorporate these equations into an algorithm for selecting allografts that best match the size and shape of the damaged meniscus (either medial or lateral). In each of 10 knee specimens, four transverse and six cross-sectional parameters of the medial and lateral menisci were quantified from measurements obtained using a laser-based, noncontacting, 3-D coordinate digitizing system. In each of 10 contralateral knee specimens, six transverse and 24 cross-sectional (i.e., perpendicular to transverse plane) dimensions were measured for the medial and lateral menisci from MR images of each knee specimen. Simple linear regression equations related these 10 parameters to each of 38 predictor variables determined from magnetic resonance imaging (MRI) dimensions and the best regression equation for each parameter was identified. Requiring only 9 of the 30 dimensions as predictor variables, the best regression equations predicted 8 of 10 and 10 of 10 medial and lateral meniscus parameters, respectively, with R2 values >0.500. The algorithm for selecting meniscal allografts involves: collecting an inventory of meniscal allografts and determining the 10 meniscus parameter values for all allografts in the inventory; measuring the dimensions as required from MRI scans of the uninjured knee; using the dimensions as inputs to the regression equations to predict values of meniscal parameters; and selecting the meniscal allograft from the inventory that best matches the predicted values of meniscal parameters. Selecting meniscal allografts using our new algorithm may enable allografts to better meet the clinical objectives of meniscal transplantation, which are to reduce pain in some patients following meniscal resection and to inhibit the degeneration of the articular cartilage.