

lateral), anatomical subregion (anterior horn, body, posterior horn) and flexion arc (0-60, 60-90, 90-max) on three-dimensional translation during weight-bearing knee flexion.

Materials & Methods: A cohort of 15 patients (9m; 26.5yrs range 16-52yrs), eligible for meniscal repair were recruited retrospectively. A medial meniscal tear was repaired in 1 case and a lateral meniscal tear was repaired in 15, with simultaneous ACL reconstructions in 6 cases. A postoperative MRI was performed in an open bore MRI scanner (Upright Multipositional, Fonar, USA). Both knees were secured in carbon braces and scanned in the sagittal plane (3.5mm slice, 256x256, 0.7mm in-plane resolution) at 0°, 60°, 90°, and maximum flexion with partial weight bearing (~20% body weight). The images were analysed with custom-written image-processing software (Matlab v2014b) and the three-dimensional positions of the horns and body of the medial and lateral menisci determined with manual image segmentation combined with a cubic spline fitted to the centroids of each meniscal region visible in each image. Translation was defined as the change in position between 0deg and 60deg of flexion (0_60), 60deg to 90deg (60-90) and 90deg to maximum flexion (90_max).

Results: The anterior-posterior translation of the uninjured menisci occurred mostly during 0_60, but did not move uniformly, or at a linear rate across the range of motion. Further, the uninjured menisci demonstrated different patterns of movement between medial and lateral compartments. The lateral menisci translated posteriorly on average, with the most occurring in the anterior horn between 0 and 60° (mean 6.0mm, 95%CI 2.1 – 9.9mm), whereas the anterior (3.8mm, 1.0 – 6.7mm) and posterior horn (1.9mm, 1.2 – 2.6mm) of the medial menisci translated less during the same flexion arc. The repaired menisci demonstrated different patterns of anterior-posterior translation across the knee flexion range. In particular, where the uninjured medial posterior horn translated posteriorly on average during the 60_90 arc (1.0, 0.2 – 1.8mm), the repaired medial posterior horn did not (0.6, -0.3 – 1.4mm). A similar difference was identified for the lateral body for the 90_max arc between uninjured (2.0, 0.4 – 3.7mm) and repaired knees (1.5, -0.4 – 3.5mm).

Discussion: The purpose of this study was to describe the meniscal translation of uninjured and clinically successful meniscal repairs in three dimensions during partial weight bearing knee flexion. Lateral uninjured menisci moved posteriorly on average more compared to medial menisci. These results were consistent to previous study which showed a higher posterior translation of the lateral menisci compared to the medial in a two dimensional partial weight bearing setting. Repaired menisci demonstrated different patterns of translation across the knee flexion range compared to the uninjured group, which is also consistent with previous studies. However, comparison to the available literature should be made cautiously due to differences in methodologies, image acquisition, knee position and load, as well as inconsistent referencing points used for measurements in previous studies. High variability of meniscal movement could be associated with variations in articular geometry, the loading environment, location of the injury and the characteristics of the repair. Although meniscal kinematics may not be fully restored after repair, this procedure is important to preserve menisci function and protect the chondral surfaces from inappropriate loads. Further studies with larger number of patients are necessary to better understand the kinematics of both uninjured and repaired menisci.

Conclusion: Meniscal mobility is highly specific to the individual and anatomical subregion in both healthy and repaired menisci. Possible reductions in meniscal mobility in repaired menisci may point to a reduction in its load-bearing capacity, with important consequences for cartilage health and joint longevity.

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Survival and clinical outcomes of high tibial osteotomy for medial knee osteoarthritis

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Background: Medial opening wedge high tibial osteotomy (MOWHTO) has been used successfully in the past to treat medial compartment osteoarthritis. Most previous studies however have reported on the variable survival rates with little documented on the pain relief of the procedure; one of the primary indications for doing a MOWHTO. However most previous studies have mainly reported on survival rates of the procedure which have been variable. Very little has been reported on pain relief following the procedure, although it is a primary outcome of a MOWHTO. Therefore the aims of this study were to i) Describe the patient demographics and surgical outcomes, including complications, of a case series of medial opening wedge HTOs for treatment of medial knee OA; ii) Determine the procedure survivorship up to 10years post-surgery and iii) Identify patient and surgery-related factors associated with pain relief following MOWHTO.

Materials & Methods: A cohort of medial opening wedge osteotomies (MOWHTOs) performed for the treatment of medial compartment knee osteoarthritis was extracted from a clinical research database. Patients underwent MOWHTO under tourniquet control, fixated internally and bone grafted. Concomitant procedures were performed where required (ACL, PCL reconstruction; meniscal or cartilage treatment). Patient demographics were extracted from the clinical research database and complications were identified by detailed review of clinical notes. The cohort list was submitted to the Australian Joint Replacement Registry to verify cases converted to total knee replacement (failures) and deceased patients. Survival analysis was conducted using right-censored data with Kaplan-Meier analysis. A normal distribution was fitted to the survival data and estimates of average and maximum survival were calculated. Pain relief was defined as the change in KOOS-Pain subscale between pre-operative and post-operative assessments. A partial least squares regression model was fitted with pain relief as the response variable and patient demographics, concomitant procedures and post-operative limb alignment as predictors.

Results: The patient cohort (N = 211) was predominantly male (84%) with a median age of 51yrs (IQR 44 – 55yrs) and median BMI of 28.9 kg/m² (IQR 26 – 32 kg/m²). In addition,

14.8% of patients indicated that they had smoked regularly at some point in their lives and 5.4% were treated through workers compensation. The patients were administered the KOOS questionnaire at a median follow up period post-operatively of 2.1 years (IQR 1.1-3.5yrs). At the latest post-operative follow-up, significant (P<0.01) improvements were observed for all KOOS sub-scales, however none returned to the level of age-matched normative scores. Complications requiring medical or surgical intervention (superficial infection; delayed union; deep vein thrombosis and adverse medication reaction) were documented in 8 patients (3.9%). A total of 13 conversions to total knee replacement (6.3%) occurred. Median time to failure was 7.7 years (IQR 5.4-8.6). Kaplan-Meier analysis revealed 97.7% survival at 5yrs (95%CI 95 – 100%) and 80% at 10years (95%CI 69-92%). Parametric analysis allowed for extrapolation of the survival curve and indicated that the estimated mean time to failure was 12.5yrs (95%CI 10.5-14.6yrs) and few would be expected to survive past 21 years (99th percentile 20.6yrs; 95% CI 15.7-25.6yrs). The model of pain relief was significant (P < 0.01) and provided a reasonable fit (R² = 57%). The period between surgery and the KOOS follow-up was most associated with poorer pain relief compared to the sample average (standardized β = -0.36), followed by the KOOS-Pain score recorded preoperatively (standardized β = -0.32) and male gender (standardized β = -0.21). Factors associated with higher pain relief included increased post-operative valgus (standardized β = 0.21), increased pre-operative BMI (standardized β = 0.21) and whether concomitant cartilage treatment was performed (standardized β = 0.21).

Discussion: The purpose of this paper was to describe the demographics, procedure survival and pain relief of patients undergoing MOWHTO for the treatment of medial compartment knee osteoarthritis. Survival rates at 5 and 10yrs follow-up are consistent with previous reports, however this is the first study to estimate projected average and maximum survival and provides important guidance to surgeons counselling patients contemplating the procedure for the indication described. The low complication rate and significant improvement in KOOS scores suggests that MOWHTO is a safe and effective procedure for treatment of significant medial knee osteoarthritis that has a finite longevity. The present study is the first to investigate pain relief in this patient population and the results suggests that increased frontal correction, increased BMI and concomitant cartilage treatment afford greater pain relief in the sample studied. Whether this coincides with improved survival remains to be seen and future work should be directed toward improving patient selection for this procedure.

Conclusion: MOWHTO is a relatively safe procedure with excellent 5 year survivorship in patients with predominantly medial compartment knee osteoarthritis. Surgeons contemplating the procedure for this indication can counsel patients that the average longevity is 12.5years and the maximum may be as high as 21yrs. Furthermore, patients that present with increased post operative valgus, higher BMI and receive a concomitant cartilage procedure can be expected to report above-average pain relief.

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Regression modelling combining MRI measurements and patient anthropometry to predict graft diameter in ACL reconstruction

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Background: Graft diameter has been shown to influence the risk of graft failure. Graft preparation techniques used in anterior cruciate ligament reconstruction (ACLR) are variable and may affect graft diameter. Previous studies have correlated anthropometric data and MRI tendon measurements to intraoperative graft diameter and suggested that these singular factors can be used to predict graft diameter. However, none have investigated these together in an integrated model. Our study aimed to investigate the prediction of intraoperative graft diameter in quadrupled semitendinosus (4-ST) and doubled semitendinosus-gracilis (4-STG) graft constructs, using anthropometry and MRI measurements, with a goal of providing practical guidelines for orthopaedic surgeons.

Materials & Methods: Hamstring autograft, arthroscopic ACL reconstructions using four-strand gracilis+semitendinosus (4-STG) and quadrupled semitendinosus grafts (4-ST) between April 2009 and June 2015 were retrospectively reviewed. Cross-sectional areas (XSA) of the semitendinosus and gracilis tendons were measured in the axial slice of a T2 weighted MRI image using a region-of-interest tool. Measurements were taken at the slice with the widest trans-epicondylar distance, and repeated at one slice above and below. The median was recorded. Patient anthropometric data (height, weight and gender) were extracted from patient clinical notes. Pearson's correlation coefficients with 95% prediction intervals (PI) were used to replicate previously reported correlations. Ordinal logistic regression models were established using all data, as well as sub-group models of those receiving 4STG grafts and 4ST grafts with graft diameter categorised into an ordinal response variable (>8mm, 8mm, <8mm). Partial least squares regression (PLSR) using the nonlinear iterative algorithm (NIPALS) was used to develop a refined predictive model for graft diameter. The model was validated using leave-one-out cross validation (LOOCV).

Results: A cohort of 108 ACL reconstructions in 107 patients was examined, 75 of which were performed with the 4-STG construct, and 33 which employed the 4-ST construct. The mean graft diameter in the 4-ST group (8.6±0.8 mm) was significantly (p < 0.001) greater than the 4-STG group (7.9±0.7mm). Intra-observer reliability was high for MRI measurements. MRI XSA sum of ST and gracilis tendons and height demonstrated statistically significant correlations with graft diameter in both 4-STG (r = 0.48, r = 0.45 respectively) and 4-ST (r = 0.71, r = 0.67 respectively) constructs. Ordinal logistic regression of the overall cohort showed that female gender and the 4-STGT preparation technique were associated with increased odds of receiving grafts <8mm, while every 1mm² increase in ST XSA reduced the log odds of receiving a graft