EFFECT OF PATELLAR RESURFACING AND PATELLOPLASTY ON QUADRICEPS TENDON FORCE AND KNEE KINEMATICS AFTER TOTAL KNEE ARTHROPLASTY

*Mountney, J; +Paice, M W; *Masri, B; *Greidanus, N; +Wilson, D R
*Orthopaedics and +Division of Orthopaedic Engineering Research, University of British Columbia and Vancouver Coastal Health Research Institute, Vancouver, British Columbia

Total knee arthroplasty (TKA) is one of the few effective treatments for severe knee osteoarthritis, with over 267,000 knee replacement surgeries performed every year in North America.1 Although the procedure is generally successful, knee prostheses can fail due to component loosening or wear. The site of failure is often the patellofemoral joint, which has been found to be involved in 45% of revision and 41% of re-revision surgeries.2

In a natural healthy knee the patella transmits 0.5 to 8 times body weight. The patella acts to increase the moment arm and maintain proper alignment of the extensor mechanism. During TKA the patella may be left intact, resurfaced with a number of different patellar designs, or resected (patelloplasty). It is not clear how these treatments affect mechanics at the patellofemoral joint. This study examined the change in quadriceps tendon force and knee kinematics during weight bearing flexion in the natural knee and for 4 different patellar treatments used during TKA.

METHODS:

Eight fresh frozen human cadaveric knees (4 right, 4 left, 5 female, 3 males; mean age 65 years) were thawed overnight at room temperature and dissected leaving the extensor mechanism and capsule intact (Figure 1a). Threaded steel rods were cemented into the intramedullary canals of both the femur and tibia using bone cement. The natural Q-angle of the specimen was measured and the joint line was identified. The quadriceps muscle was dissected, leaving sufficient soft tissue attachments to accept a clamp (Figure 1b).

Each specimen was flexed under load in a modified Oxford rig which simulates natural weight bearing flexion. A series of knee bends (0° to 60° to 0°) was performed for each condition of the patella in each specimen. Extensor mechanism force was recorded using an S-beam load cell [Ometagycle Inc.] connected between the quadriceps clamp and the test rig. Kinematic data were collected by placing infrared markers on each segment of the knee (femur, tibia, and patella) that were tracked using an optoelectronic camera system [Optotrak 3020]. Knee kinematics were determined using a custom Matlab (The Mathworks, Natick, MA) program.

Testing was initially done using the natural unaltered knee (NORM). A TKA was then performed using a Zimmer Legacy Posterior Stabilized knee prosthesis and subsequent testing was carried out using four different patellar treatments: TKA with unresurfaced patella (TKA), TKA with resurfaced patella (TKAP), TKA with patelloplasty (TKAP) and TKA with augmentation patella (TKAT). The augmentation patella (Zimmer, Austin, TX, USA) is designed for resurfacing patella when there are significant defects such as loss of bone stock.

Statistical analysis was performed using a two-way ANOVA with two repeated measures (patellar condition and flexion angle).

RESULTS:

The quadriceps tendon (QT) force for each of the patellar treatments used in TKA was significantly greater (p < 0.019) than those seen in the natural knee. However, between the different patellar treatments, the only significant difference in QT force was found in the case of the patelloplasty (p < 0.023). In extension, the QT force for TKAP was on average 29.3% higher than the other treatments (Figure 2).

The patella was shifted medially after TKA relative to its position in the natural knee (p<0.032). However, between the TKA treatments, the only significant difference (p<0.0032) was seen in the case of the patelloplasty where the patella’s position was significantly more medial than the other three treatments (Figure 3). No significant differences in patellar tilt and spin were seen between any of the cases.

DISCUSSION:

This study was performed to evaluate the differences in quadriceps tendon force and patellar kinematics between the natural knee and four different patellar treatments used in TKA. The increase in QT force may be attributed to changes in patellar thickness. For both the unresurfaced and resurfaced patellae after TKA, the thickness of the patella was maintained to close to that in the natural knee, which suggests that the moment arm was not affected much. However, the patelloplasty procedure removed all but a thin bony shell of the patella, which likely reduced the moment arm of the quadriceps tendon and subsequently increased the resulting force.

Tracking differences between the patelloplasty case and all other patellar treatments are likely due to differences in the surface that articulates against the femoral component of the prosthesis. After patelloplasty, the bony shell of the patella articulates against the medial and lateral condyles of the femoral component instead of in the patellar surface between the two condyles.

These results suggest that patelloplasty compromises the mechanics of the patellofemoral joint after TKA, and that resurfacing the patella should be attempted when possible.

REFERENCES:


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