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Knee Replacements Have Abnormal Patella Tracking

Paul Monk, DPhil, FRCS, NEW ZEALAND
Stephen Mellon, PhD, UNITED KINGDOM
David J. Beard, MA, MSc, DPhil, FRCS(Hon), Prof., UNITED KINGDOM
Richie Gill, UNITED KINGDOM
David Murray, FRCS(Orth), UNITED KINGDOM
Minsi Chen, PhD, UNITED KINGDOM

University of Oxford
Oxford, Oxford, UNITED KINGDOM

Summary:
Our data suggests that patello-femoral tracking after knee replacement using standard modern designs is very abnormal.

Abstract:

Introduction

When problems occur following knee replacement they often relate to the patello-femoral joint (PFJ) and may be due to abnormal patella tracking. The aims were (a) to develop a system to assess functional 3D patello-femoral kinematics, (b) to compare patella tracking after knee replacement and in the normal knee and (c) to compare trochlear geometry in knee replacement and the normal knee.

Method

Patello-femoral kinematics were assessed using a combined Motion Analysis and UltraSound system (MAUS). A tracked ultrasound probe was used to identify the position of the patella and a 12-camera motion analysis system was a used to capture images of reflective markers on subjects lower limbs and the ultrasound probe. The movement of the patella relative to the femur was determined using a mapping between the ultrasound image and the motion capture system.

Patella tracking was assessed in 20 TKR (with “anatomical” femoral components), 20 PFJR and 20 normals during a squat exercise.

The bony and cartilagenous trochlea geometries from 3T MRI scans of 20 normals were compared with both “anatomical” and “symmetrical” TKR femoral components and PFJ replacement geometries. Following segmentation and standardized alignment, the path of the apex of the trochlea groove was measured using customized Matlab software.

Results

Validation studies of system error, calibration error and target acquisition showed the accuracy of MAUS in registering ultrasound images of the PFJ within the motion capture system to be 1.84 mm (2 x SD). There were no significant differences in inter and intra observer repeatability (p=0.132) in determining the coronal plane position of the patella relative to the femur (mean difference 0.83mm/90º).

In the normals the patella moved laterally with increasing flexion (12mm/90º SD 4mm). This was not recreated in the

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"anatomical" TKR (p=0.03) or PFJR (p<0.01). After engagement the patella moved medially in flexion in both TKR (3.6mm/90º SD 8mm) and PFJR (1.8mm/90º SD 7mm). There was no difference between TKR and PFJR (p=0.27).

In normal knees the trochlear groove apex was directed laterally with increasing flexion for both cartilage and bone. Both the "anatomical" TKR and PFJR had a medially orientated trochlea, whilst the "symmetrical" TKR showed a neutral straight path. The differences were significant (p<0.05).

Discussion

We present a new technique for measuring functional 3D patello-femoral kinematics in native and replaced knees. Our data suggests that patello-femoral tracking after knee replacement using standard modern designs is very abnormal. This may explain why PFJ problems are common. The abnormalities in tracking were probably due to the geometry of the trochlear and therefore could be improved by modifying the design.