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FEMORAL COMPONENT ROTATION OF A MODERN TKA IMPLANT DOES NOT AFFECT PFJ BIOMECHANICS

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Research Summary

Patellofemoral joint (PFJ) complications, such as anterior knee pain, are a common complaint among knee arthroplasty patients and femoral rotational mal-alignment is thought to be a contributing factor. However, no studies have assessed the effect of femoral internal and external rotation on PFJ biomechanics using simulated physiological loading cycles. The present study aimed to assess the effect of surgical femoral rotational alignment errors on the forces, moment arms and contact areas within the PFJ.

Testing was carried out under physiological loading, with a quasi-static kinematic knee joint simulator, using Scorpio NRG prostheses implanted on synthetic bones. Three scenarios were simulated, to replicate the worst case in terms of surgical error; neutral placement was compared to 5° internal and 5° external femoral rotation.

External rotation caused a significant reduction in the patella moment arm. However, femoral rotational mal-alignments of ± 5° had no clinically relevant effect on the quadriceps force, patella compressive force, or PFJ contact areas. For all scenarios, the PFJ was subjected to over 65% lateral loading and consistent edge loading of the patella button. This study demonstrates that, in terms of PFJ biomechanics, the Scorpio NRG implant used was tolerant of surgically relevant levels of femoral rotational mal-alignment.

Introduction

The patellofemoral joint (PFJ) is implicated in many revision cases following total knee arthroplasty (TKA), with many patients reporting anterior knee pain (AKP). Changes in PFJ loading magnitudes and patterns are thought to contribute to AKP [1]. Femoral component rotational alignment has been demonstrated to affect the kinematics of the PFJ. However, no *in vitro* studies have assessed the effect of femoral rotational mal-alignment on PFJ biomechanics using a simulated physiological loading cycle.

This study aimed to assess whether femoral component mal-rotation, due to surgeon error, may be a significant contributor to the development of patellofemoral issues and pain following TKA.

Hypothesis

Femoral component mal-rotation will cause an increase in the forces within the PFJ and a decrease in contact areas after TKA.

Methods

Scorpio NRG PS size 7 implants (Stryker, NJ, USA), and an asymmetrical patella button, were implanted on Sawbones. Three scenarios were simulated; neutral femoral rotational placement was compared to 5° internal (IR) and 5° external rotation (ER) of the femoral component with respect to the cylindrical axis of the knee.

A quasi-static kinematic knee joint simulator, a derivative of the Oxford Knee Rig, was used to cycle the knee through flexion/extension via a single quadriceps actuator against a physiological peak flexion moment of 43 Nm. The joint was stabilised using synthetic ligaments and by two constant force springs simulating the action of the hamstrings. The quadriceps tendon load and the compressive force applied to the patella were measured using single axis load cells. The patella moment arm was measured with an optical technique, while the PFJ contact area was assessed using Prescale pressure films. Five repeats were carried out for each alignment scenario. Differences between the groups were evaluated with the Friedman test and post-hoc Wilcoxon signed ranked test; significance was assumed for $P < 0.05$.

Results

In mid flexion ER resulted in a statistically significant reduction in quadriceps and patella forces amounting in either case to no more than 20N. This finding is unlikely to be of clinical relevance given that it is comparable to the levels of variation expected between patients. No differences were observed in high flexion when the PFJ was under the highest loading condition.

ER resulted in a significant reduction in the patella moment arm throughout the flexion range compared to neutral alignment, while IR exhibited the opposite trend (Fig 1).

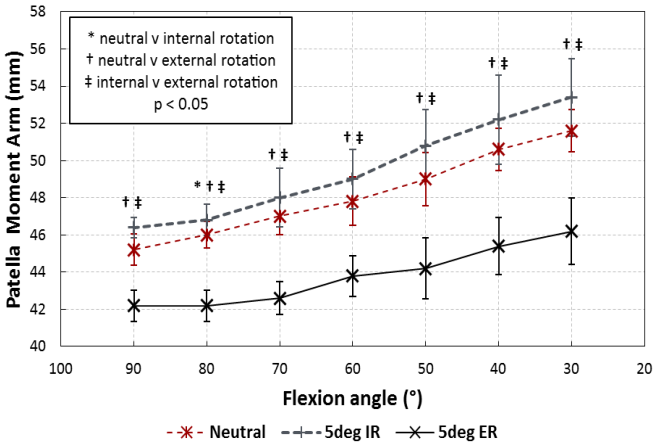

Figure 1: Variation in patella moment arm with flexion angle (mean ± standard deviation).

The joint contact area was unaffected by mal-rotation. Throughout the tested flexion range at least 65% of the loading was on the lateral side. Both lateral and medial edge loading occurred.

Discussion and Conclusion

This study demonstrated that femoral rotational mal-alignment altered the patella moment arm. This affect is attributable to changes in the Q angle as a result of induced tibial varus/valgus. However, possibly due to the geometry of the patella button used, this did not ultimately result in clinically relevant changes to the quadriceps force, PFJ compressive force, or PFJ contact area. The hypothesis can therefore be rejected.

Femoral rotational mal-alignment of ± 5° is considered the worst case in terms of surgical error, and may affect ligament forces, but has been demonstrated, with the exception of varus/valgus rotations, to have a limited effect on Scorpio tibiofemoral kinematics [3, 4]. This *in vitro* study indicates that the Scorpio implant is also tolerant of commonly reported levels of femoral rotational alignment errors with regards to PFJ biomechanics.

Significance

The results of this study suggest that the Scorpio NGR knee replacement can tolerate, in terms of PFJ biomechanics, femoral rotational mal-alignment.

Key References

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