

TRANSVERSE PLANE KNEE MECHANICS FOLLOWING TOTAL KNEE ARTHROPLASTY WITH AN ASYMMETRIC PROSTHESIS

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INTRODUCTION

Our understating of the *in vivo* biomechanics of the knee in the transverse plane are limited, particularly during functional tasks such as gait. Techniques such as dynamic fluoroscopy have been used to describe some characteristics of transverse plane rotation following total knee arthroplasty (TKA) [1], however there remains limited information on this topic. Cadaveric and patient based studies of ACL deficient knees have suggested that the transverse plane biomechanics of the tibiofemoral joint are associated with two key factors; 1) femoral condyle geometry and 2) the 'winding up' of the anterior cruciate ligament [2,3]. There are many groups who still debate the role of the ACL in control of transverse plane rotation. Currently only a single study has described the transverse plane biomechanics of the tibiofemoral joint following total knee arthroplasty, this identified that 60% of PCL retaining TKA procedures resulted in a 'reverse screw home' [1]. This is of particular importance when considering the variation in prosthesis design as some are specifically designed to recreate 'normal' screw home mechanics through asymmetric geometry of the medial and lateral femoral condyles.

METHODS

In a repeated measures cohort study, fourteen patients were recruited all of whom were scheduled for TKA with OA graded 2-4 on the K-L scale. Knee biomechanics were measured during steady state gait prior to TKA and subsequently during the early stages of recovery following TKA. Postoperative assessments were at six weeks, three months and six months following the procedure. At each assessment five successful gait trials were recorded using 10 infra-red cameras (Qualisys Medical AB), 3 force platforms (AMTI) with a marker set described by Thewlis *et al.* [4]. From these the ensemble mean was calculated. All of the patients underwent the same procedure (Zimmer NexGen CR) conducted by a single consultant orthopedic surgeon (SS). The segments of the lower limb were modelled in six degrees of freedom based on the calibrated anatomical systems technique [5]. Knee joint kinematics were calculated based on the ZYX Cardan sequence, external net joint moments were calculated using standard inverse dynamic methods. Knee joint kinematics were calculated at initial contact, the peak external rotation during loading, peak internal rotation during terminal stance and the peak internal rotation during swing phase. Peak knee joint moments were calculated during loading, at mid stance and during terminal stance. Repeated measures ANOVA with posthoc pairwise comparisons (adjusted with Bonferroni correction) were run on all of the data sets.

RESULTS AND DISCUSSION

No significant differences were identified in the transverse plane tibiofemoral kinematics ($p < 0.05$). The transverse plane kinematics indicated directionally normal screw home mechanism. Significant reductions were identified in the peak transverse plane tibiofemoral external net joint moments during terminal stance between pre operative and six weeks post operative ($p = 0.03$), three months ($p = 0.01$) and six months ($p = 0.01$). During swing phase of gait the maximum sagittal plane knee flexion angle did not differ significantly between assessments ($p > 0.05$), and at six months post surgery the maximum knee flexion was only three degrees greater than pre surgery. These findings indicate that the Zimmer NexGen CR prosthesis results in transverse plane joint kinematics comparable to the arthritic knee, this may be due to the asymmetric geometry of the femoral component and the amount tibiofemoral flexion during swing phase of gait. The reduction in the transverse plane external net joint moments is more complex in its nature. A possible contributing factor which may influence the reduction in the transverse plane moment during terminal stance is a reduced coefficient of friction within the joint when compared to the OA joint.

Table 1: Transverse plane knee joint moments (Nm/kg) during stance

	Loading	Mid stance	Terminal stance
Pre op	0.02 ±0.02	0.08 ±0.05	0.16 ±0.07
6wk post	0.02 ±0.01	0.03 ±0.04	0.08 ±0.05
3mth post	0.02 ±0.02	0.04 ±0.03	0.10 ±0.05
6mth post	0.02 ±0.01	0.04 ±0.02	0.11 ±0.05

CONCLUSIONS

It is apparent that the Zimmer NexGen CR TKA results in transverse plane kinematics equal to the preoperative level despite the removal of the ACL. However the transverse plane knee moments appear to be significantly reduced following the TKA. There is potential that the transverse plane knee external joint moment could be used as an early indicator of potential component failure if the moment is shown not to reduce following the TKA following the TKA, further longitudinal studies are required to explore this.

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