EPiC Series in Health Sciences

Volume 3, 2019, Pages 376–379

CAOS 2019. The 19th Annual Meeting of the International Society for Computer Assisted Orthopaedic Surgery

Femoral Trochlear Groove Recreation Following TKA Correlates with Improved Patient Reported Outcome

Joshua G Twiggs PhD[1], Edgar A Wakelin PhD[1], Steve McMahon MD[2], Brad P Miles PhD[1]

[1]360 Knee Systems, Sydney, Australia
[2]Malabar Orthopaedic Clinic, Melbourne, Australia

joshua@kneesystems.com, brad@kneesystems.com

Abstract

Femoral component recreation of the trochlear groove is a major factor in determining post-operative patello-femoral tracking. Significant variation arises in recreation of the trochlear groove when a standardised implant design is applied to variable patient anatomy and alignment. However, the impact of variation on patient outcome is not well understood. This study sought to understand whether the accuracy of recreation of the trochlear groove drives patient outcome following total knee arthroplasty (TKA). 430 TKA patients were analysed; patients had pre- and post-operative CT scans and postoperative Knee Injury & Osteoarthritis Outcome (KOOS) scores at 6 months post-surgery. Based on the pre- and post-operative CT scans, femoral trochlear groove positioning and the post-surgery "build-up" of the medial and lateral apex either side of the groove were modeled and measured. Correlations between changes to this native morphology and KOOS scores were statistically tested. Patients who had increased implant build-up on the trochlear lateral apex had a worse outcome (correlation with KOOS Pain score: $r = -0.2$, $p = 0.03$), and this was found to be driven by impairment when straightening and pain when bending. The results suggest that reducing the proximal lateral apex of the trochlear groove post-implantation leads to improved patient outcomes when straightening the knee, with implications for both implant design and target component placement.

1 Introduction

The geometry of the femoral trochlear groove is patient specific [1, 2] and critical to understanding patella-femoral articulation. Likewise, femoral component positioning and recreation of the trochlear groove post- total knee arthroplasty (TKA) is a major factor affecting patello-femoral tracking [3, 4]. The variation in recreation of the trochlear groove when a standardised implant design is applied to variable patient anatomy and alignment strategy has been investigated [5], however, its impact on patient outcome is not well understood. This study sought to analyse the role that recreation of the trochlear groove has in driving outcome post-TKA.

2 Method

A database of TKA patients operated on by six surgeons from 1-Jan-2014 who had a pre-operative and post-operative CT scan and 6-month postoperative Knee Injury & Osteoarthritis Outcome (KOOS) scores were assessed. All knee operations were performed with the Omni Apex implant range using either CR or PS Components and a dome patella button.

Post-operative component positioning was determined by registering 3D implant and pre-operative bone models from the preoperative CT scan to the post-operative CT scan. The difference in trochlear recreation was then calculated by comparing the post-operative component position with the pre-operative bone. The offset at the medial and lateral peaks and the trough of the trochlear groove were measured at 10° intervals from full extension to 90° flexion around the patella flexion axis, see Figure 1: Example of trochlear groove measurements showing native femur and implanted geometry

. Individual and combined average trochlear groove measurements were then compared to the patient KOOS scores.

3 Results

A total of 396 patients were included in this analysis. 59% (235) were female and the average age was 69.2 years (+/- 8.1).

Implant-bone offsets were small on average for the lateral apex of the implant trochlea groove (-0.36 ± 2.43 mm) and the trough of the trochlea groove (-0.31 ± 2.18 mm). The medial apex of the groove, however, significantly increased post-implantation to 3.65 ± 2.63mm, driven primarily by the most proximal measurement (6.08 ± 2.19 mm).

A number of significant relationships with patient reported outcomes and anterior implant-bone offsets were found. Of particular interest was the trochlear lateral apex in early flexion and KOOS Pain score, with a weak but significant correlation, finding that increased implant build-up correlated with a worse outcome ($r = -0.2$, $p = 0.03$). When investigating individual questions, impairment when straightening and pain while bending were the primary drivers, with patients more than twice as likely to report difficulty straightening ($p = 0.037$) with an increased lateral apex of the implanted trochlea, see Figure 2: Patients with increased lateral trochlear offset post TKA report 2.1x risk of difficulty straightening ($p = 0.037$).

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4 Discussion

A total of 396 patients were included in this analysis. 59% (235) were female and the average age was 69.2 years (+/- 8.1).

Femoral flexion of between 0 – 3° has previously been proposed as a target alignment to minimise failure [6]. The results here indicate that a target femoral component flexion to achieve improved post-operative outcomes is patient specific and dependent upon the trochlear geometry. Rather than flexing the femoral component to prevent anterior notching, the difference between the anterior thickness of the implant relative to the anterior resection should be minimised.

The implications of this work for target alignments to recreate the diseased or pre-diseased trochlear groove are the subject of continuing work. Trochlear cartilage coverage and wear or dysplasia can vary greatly between TKA patients [7] making assumptions of the healthy trochlear difficult. The bone geometry investigated here is a recreation of the geometry observed in surgery and indicates minimising the difference pre to post TKA reduces poor outcomes.

5 Conclusions

The results suggest that reducing the proximal lateral apex of the trochlear groove post-implantation leads to improved patient outcomes when straightening the knee. This work has implications for both implant design and target component placement.

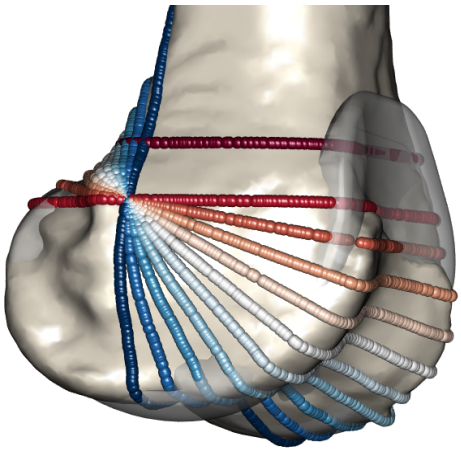

Figure 1: Example of trochlear groove measurements showing native femur and implanted geometry

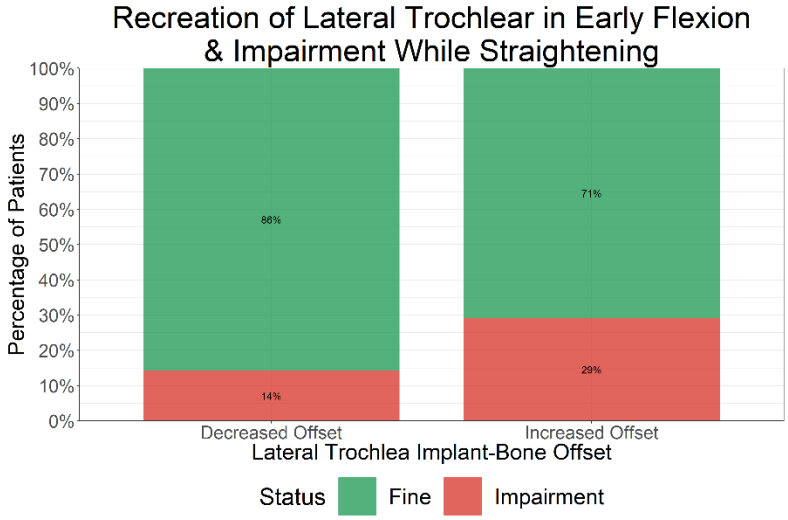

Figure 2: Patients with increased lateral trochlear offset post TKA report 2.1x risk of difficulty straightening ($p = 0.037$).

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