Modelling the effect of bone resection and soft tissue releases in correcting flexion contractures in total knee arthroplasty

CHANGULANI M¹, DEAKIN AH¹, PICARD F¹

Department of Orthopaedics, Golden Jubilee National Hospital, Clydebank, UK

angela.deakin@gjnh.scot.nhs.uk

Introduction: Many patients with osteoarthritis of the knee present with a fixed flexion contracture (FFC). FFC can be caused by soft tissue contracture and tightness around the joint as well as abnormalities in bony anatomy [1]. Post-operative function and satisfaction are linked in part to post-operative range of movement and post-operative FFC is a recognised complication of TKA [2]. FFC creates abnormal loading of the affected knee joint [1] causing quadriceps muscle fatigue,[3] anterior knee pain, altered gait mechanics and ultimately lower knee outcome scores and patient dissatisfaction with the arthroplasty [2, 3]. Therefore an important aim of TKA is to correct any pre-operative FFC. Theoretically FFC deformity can be corrected during TKA by a combination of cutting more bone from the distal femur and proximal tibia to increase the extension gap, soft tissue release and precise component positioning [4]. However distal femur resection for correction of FFC in TKA can lead to joint line elevation, abnormal knee kinematics and patellofemoral problems. The aim of this retrospective study was to establish the contribution of soft tissue releases and bony cuts in the change in maximum knee extension in TKA.

Methods: Data were available for 209 navigated TKAs performed by a single surgeon using a medial approach. All patients had the same cemented implant, either CR or PS, which both required a minimum thickness of 10 mm for the tibial and 9mm for the femoral component. Intra-operatively pre- and post-implant extension angles and the size of bone resection were collected using a commercial navigation system. The thickness of polyethylene insert and the extent of soft tissue release performed (no release, moderate and extensive release) were collected from the patient record. A univariate linear regression model was used to predict change in maximum extension from pre- to post-implant.

Results: The mean bone resection was 19mm (15 to 28 mm) (Figure 1).79% of polyethylene inserts were 10mm thick (10 to 16 mm). 71% of knees had no soft tissue release. The mean increase in extension was 5° (11° decrease to 23° increase) (Figure 1). The analysis showed that bone cuts (p<0.001), soft tissue release (p=0.001) and insert thickness (p=0.010) were all significant terms in the model (r² adj=0.170). This model predicted that carrying out a TKA with 19mm bone cuts, 10mm

![Figure 1: Regression between bone cuts and flexion contracture correction for different soft tissue releases](image-url)
insert and no soft tissue release would give 4.2° increase in extension. It predicted that a moderate release would give a 2.8° increase in extension compared to no release, with an extensive release giving 3.9° increase over no release. For each mm increase in bone cuts the model predicted a 0.8° increase in extension and for each mm increase in insert size a decrease extension by 1.1°.

**Discussion:** Correction of FFC is crucial to improve patient functional outcome and satisfaction. FFC is still a difficult issue to tackle intraoperatively with the ultimate goal to increase knee gap in extension with the prosthesis in place. The two common surgical options to solve FFC, which have been extensively debated in the literature, are resecting more bone from femur and/or tibia or releasing soft tissue envelope around the knee or doing both. This study analysed our own navigated computer data to identify the contributions of these two options and therefore which one of might be more suitable to correct FFC.

Our data confirmed that both increasing bone resection and soft tissue release are relevant to increasing the knee extension gap. The modelling results show that in general to increase maximum extension by the same as an extensive soft tissue release that bone cuts would have to be increased by 4-5mm. Bellemans et al. [5] advised additional 2 mm, 4mm and more than 6 mm bone cuts to correct preoperative FFC successively between 5 and 15°, for moderate (15 to 30°) and severe (more than 30°). Our model predicted that for similar preoperative FFC with standard bone cuts and poly the use of a moderate release of the knee would correct the flexion by 7° and if an extensive release was performed this would be 8.1°. In severe FFC it is obvious that soft tissue release might not be enough to correct the deformity whereas disproportionate bone cuts would be too much. Indeed any unnecessary bone cuts modify the joint line and consequently the knee kinematics. This is the reason why some authors are eager to first control the preoperative FFC using soft tissue release and afterwards proceed for further bone resection.

This study has some limitations. Although all computer data were accurately collected and more reliable than clinical measurements the classification of releases into three categories may not be completely describing the range of alterations to the soft tissues and so may be masking the true contribution. Secondly the number of severe FFC knees is small, making the analysis more difficult. In addition there are some limitations in the application of the results. The measurements were taken intraoperatively with the knee open and so may not represent the true clinical in vivo FFC angle either pre- or post-operatively. The model only accounted for 17% of the variation in change in extension pre- to post-implant so is poor at predicting outcomes for specific patients. Therefore this model gives an indication but could not be applied fully as an algorithm.

Preoperative FFC contracture is a frequent condition in TKA that the surgeon has to address either by resecting more bone or by extending soft tissue release to increase the extension gap to fit the knee implant. This analysis of 209 navigated knee arthroplasty showed that both options are suitable to increase the extension gap. However the large variation in actual FFC correction indicates that this relies on factors other than bone cuts and soft tissue releases.

**References**