



Can We Predict the Femoral and Tibial Bone Resection Depths Required to Correct Extreme Fixed Flexion Contracture in Total Knee Arthroplasty? A Database Analysis of 127 Cases

Matthew D Hickey BEng¹, Asim Khan FRCS², Joseph Baines MD FRCS²
David Allen FRCS², Findlay Welsh FRCS², Kamal Deep FRCS², Alistair
Ewen PhD², François Leitner PhD², Antony J Hodgson PhD³, Frederic Picard
MD FRCS²

¹ School of Biomedical Engineering, University of British Columbia, Vancouver, Canada

² Golden Jubilee National Hospital, Clydebank, U.K.

³ Mechanical Engineering, University of British Columbia, Vancouver, Canada
matthew.hickey@ubc.ca

Abstract

One of the goals of total knee arthroplasty (TKA) is to restore or extend the range of motion of the knee joint. A small proportion of patients who are candidates for TKA exhibit fixed flexion contracture (FFC), a condition which prevents the knee from reaching full extension and can be associated with preoperative coronal deformity. In treating FFC, surgeons have two options, either through extensive soft tissue releases or through additional resections of bone on the proximal tibia and distal femur to increase the extension gap. Usually, FFC can be corrected with just soft tissue release, however, sometimes needs to be combined with additional bone resections, especially in cases with varus or valgus coronal deformity. However, additional bone resections beyond 11mm on the femoral side can be associated with knee instability. We therefore asked, is there a relationship between preoperative coronal deformity and intraoperative bone resections required to treat patients with extreme FFC?

We analysed 3922 navigated TKA cases undertaken at our institution between March 2007 and October 2022. From this set, we identified 127 patients with extreme fixed flexion contracture (FFC) of greater than 15° and with post-operative FFC less than 5°, indicating that the FFC had been resolved. Using simple linear regression and calculating the Pearson correlation coefficients, we related the preoperative coronal deformity to the maximum femoral and tibial resection depths between the medial and lateral sides. We then calculated the statistical significance and coefficient of determination.

For the 127 cases, the coefficients of determination were calculated to be 0.19 for the proximal tibia and 0.22 for the distal femur ($p < 0.025$). The correlation coefficients for the relationship between coronal deformity and femoral or tibial resection depths were 0.47 ($p < 0.025$) and -0.43 ($p < 0.025$), respectively.

In this study, we determined there was a moderate correlation (indicated as [0.40 – 0.59]) between the tibial and femoral bone resections required to treat extreme FFC in patients with varying degrees of preoperative coronal deformity. In planning to treat extreme FFC, surgeons should pay attention to the preoperative coronal deformity of patients as this will likely be an important factor in determining the required steps in successfully treating the FCC.

1 Introduction

One of the goals of total knee arthroplasty (TKA) is to restore or extend the range of motion of the knee joint. A small proportion of patients who are candidates for TKA exhibit fixed flexion contracture (FFC), a condition which prevents the knee from reaching full extension and can be associated with preoperative coronal deformity [1]. Remaining FFC after TKA surgery has been associated with reduced functional scores and outcomes [2 - 4]. In most cases, the FFC remains permanent after TKA; therefore, it is essential to treat patients with FFC intraoperatively [2]. In treating FFC, surgeons can perform either or both of extensive soft tissue releases or additional resections of bone on the proximal tibia and distal femur to increase the extension gap. FFC can usually be corrected sufficiently with soft tissue releases alone, but sometimes additional bone resections are required, especially in cases with significant varus or valgus coronal deformity. Normally, a maximum of 9mm is resected from the distal femur to accommodate the implant, with deeper cuts (usually on the femoral side) typically only performed bone to correct an FFC. However, additional bone resections beyond 11mm on the femoral side can be associated with knee instability [5]. We therefore asked, is there a relationship between preoperative coronal deformity and intraoperative bone resections required to treat patients with extreme FFC?

2 Methods

We analysed 3922 navigated TKA cases undertaken at our institution between March 2007 and October 2022. From this set, we identified 127 patients with extreme fixed flexion contracture (FFC) of greater than 15° and with post operative FFC less than 5° , indicating that the FFC had been resolved. Using linear regression, we related the preoperative coronal deformity to the maximum femoral and tibial resection depths. Data points determined to be outliers were not used in the regression process (8 on the tibial side and 11 on the femoral side). We then calculated the coefficient of determination and the associated statistical significance. We applied a Bonferroni correction to account for multiple comparisons, adjusting the threshold for statistical significance to $\alpha = 0.025$. Finally, we calculated the Pearson correlation coefficient to test the strength of correlation between preoperative coronal deformity and tibial or femoral resection depth.

3 Results

Of the 127 FFC cases, the mean preoperative FFC was determined to be $18.8^{\circ} \pm 2.4^{\circ}$ (15.1° to 24.0°), which was corrected to $1.1^{\circ} \pm 2.1^{\circ}$ (-3.6° to 5.0°) after surgery. Coefficients of determination were 0.19 for the proximal tibia and 0.22 for the distal femur (Figure 1). Both relationships were determined to be statistically significant with $p < 0.025$. The correlation coefficients for the relationships between coronal deformity and femoral or tibial resection depths were 0.47 ($p < 0.025$) and -0.43 ($p < 0.025$), respectively.

4 Discussion

In this retrospective study, we determined there was a moderate correlation (defined as being the range of 0.40 to 0.59 [6]) between the tibial and femoral bone resections required to treat extreme FFC in patients with varying degrees of preoperative coronal deformity.

One limitation of this study is that we do not currently know the degree to which ligament releases were done in these procedures. However, we do have access to intraoperative data via surgical navigation with follow-up functional scores and are planning future studies to assess the impact of strategies for treating FFC.

In general, it seems that for patients with no preoperative coronal deformity, up to 9mm should be expected to be resected from the distal tibia and up to 11mm on the proximal femur. For knees with varus preoperative coronal deformity, surgeons should expect to additionally cut 1.4mm from the tibia and spare 1.3mm from the femur per 10° of varus deformity. Conversely, for knees with valgus preoperative coronal deformity, surgeons should expect to spare 1.4mm from the tibia and additionally resect 1.3mm from the femur per 10° of valgus deformity (see linear slope coefficients in Figure 1). However, since femoral resections beyond 11mm may be associated with knee instability [4], further ligament releases for knees with valgus deformity may be more appropriate as a treatment option compared to additional resections. Nevertheless, and despite proper ligament releases, full FFC correction may still require more bone resections than usual to increase the extension gap. This recommendation is in agreement with the 4-step process presented in [1], limiting the over-resection of the femur by up to 2mm, followed by ligament releases. Only if the FFC remains should the femur then be additionally over-resected up to a maximum of 4 mm. However, there were two distal femoral resections in our series which went beyond 4 mm beyond the orange lines shown in Fig 1 (up to 5 mm). In planning to treat extreme FFC, surgeons should pay attention to the preoperative coronal deformity of patients as this will likely be an important factor in determining the required steps in successfully treating the FCC.

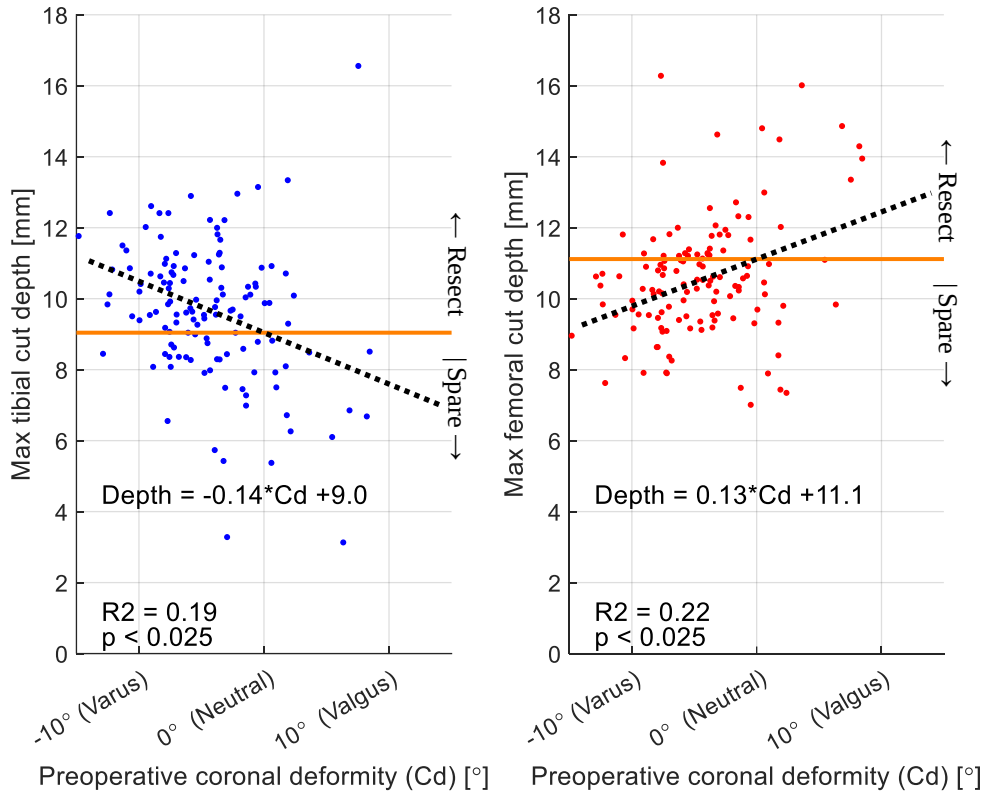


Figure 1: Scatter plots and linear regression results comparing preoperative coronal deformity (Cd) and maximum (between medial and lateral) (A) tibial and (B) femoral bone resection in 127 patients with preoperative fixed flexion contracture greater than 15°. The orange line indicates resection depths for cases with no preoperative coronal deformity.

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