



Measured Resection and Gap Balancing Techniques Result in Similar Femoral Component Rotations Regardless of Preoperative Coronal Deformity: A Database Analysis of 3922 Cases

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Abstract

A common goal in total knee arthroplasty (TKA) is to obtain collateral ligament balance in both flexion and extension while maintaining neutral overall coronal alignment. Femoral component rotation is a key variable in achieving this goal. There are two prominent techniques used in TKA to determine implant orientation, measured resection and gap balancing, but there is some controversy over which technique is superior. At our institution, we regularly use both techniques over a wide range of patients with varying degrees of preoperative coronal deformity. We therefore asked, using intraoperative measurements from a surgical navigation system, can we detect significant differences in external rotation of the femoral component between measured resection and gap balancing techniques, and do any such differences occur more frequently or at higher levels at particular values of preoperative coronal deformity?

We analysed 3922 navigated TKA cases undertaken at our institution which had complete measurements of preoperative overall coronal alignment and external rotation of the femoral component relative to the dorsal condyles line. We then compared cases using measured resection to those using the gap balancing technique, stratifying patients by degree of preoperative coronal deformity and applying a two-sample t-test.

A total of 1969 cases that used measured resection and 1953 cases that used the gap balancing techniques were identified. We found no significant differences between the

two techniques across most of the preoperative coronal deformity groupings, though small differences were detected in two specific subgroups: the femoral component was slightly more externally rotated in the measured resection cohort when the preoperative coronal deformity was between neutral and 5° valgus (mean \pm standard deviation - measured resection: $3.6^\circ \pm 1.1^\circ$, gap balancing: $3.0^\circ \pm 1.1^\circ$, $p < 0.00625$) and between 5° valgus and 10° valgus (measured resection: $4.3^\circ \pm 1.4^\circ$, gap balancing: $3.7^\circ \pm 1.3^\circ$, $p < 0.00625$).

This study has shown that there were essentially no substantial differences between the external rotation of the femoral component between the gap balancing and measured resection techniques regardless of the degree of preoperative coronal deformity. Overall, we feel that surgical decisions regarding which technique to use should be based more on any correlations with other patient outcome measures that may be better elucidated in future studies.

1 Introduction

A common goal in total knee arthroplasty (TKA) is to obtain collateral ligament balance in both flexion and extension while maintaining neutral overall coronal alignment. Femoral component rotation is an important key variable which affects the symmetry of the flexion gap and patella tracking [1]. There are two prominent techniques used in TKA to determine implant orientation, but there is some controversy over which technique should be more widely used. The measured resection technique uses bony landmarks to determine bone resections, and the femoral component rotation is chosen relative to one or more of these landmarks (typically the trans-epicondylar axis, posterior condylar axis (PCA) or Whiteside line). In contrast, gap balancing aims to maintain collateral ligament balance in both flexion and extension, and femoral component rotation is adjusted to achieve this goal [2]. There has been concern expressed over the higher incidence of ligament releases required to balance the knee during the measured resection technique which has been shown in some studies to be linked to reduced functional scores while still exhibiting small differences in femoral component rotation when compared to gap balancing [3, 4]. At our institution, we regularly use both techniques, utilizing surgical navigation to resect bone and balance the knee joint over a wide range of patients with varying degrees of preoperative coronal deformity. We therefore asked, using intraoperative measurements from a surgical navigation system, can we detect significant differences in external rotation of the femoral component between measured resection and gap balancing techniques, and do any such differences occur more frequently or at higher levels at particular values of preoperative coronal deformity?

2 Methods

We analysed 3922 navigated TKA cases undertaken at our institution between March 2007 and October 2022 which had complete measurements of preoperative overall coronal alignment and external rotation of the femoral component relative to the dorsal condyles line. We then compared cases using measured resection to gap balancing technique. Within each group, patients were stratified by degree of preoperative coronal deformity. We then applied a two-sample t-test and applied a Bonferroni correction to account for multiple comparisons, adjusting the threshold for statistical significance to $\alpha = 0.00625$.

3 Results

A total of 1969 cases which used measured resection and 1953 cases which used the gap balancing technique (Figure 1). Broadly speaking, we found no significant differences between the two surgical techniques across most of the preoperative coronal deformity groupings, though small differences were detected in two specific subgroups: the femoral component was slightly more externally rotated in the measured resection cohort when the preoperative coronal deformity was between neutral and 5° valgus (mean \pm standard deviation - measured resection: $3.6^\circ \pm 1.1^\circ$, gap balancing: $3.0^\circ \pm 1.1^\circ$, $p < 0.00625$) and between 5° valgus and 10° valgus (measured resection: $4.3^\circ \pm 1.4^\circ$, gap balancing: $3.7^\circ \pm 1.3^\circ$, $p < 0.00625$).

4 Discussion

This study has shown that overall there were essentially no substantial differences between the external rotation of the femoral component between the gap balancing and measured resection techniques regardless of the degree of preoperative coronal deformity, though we did find statistically detectable differences for patients with preoperative coronal deformities between neutral and 5° valgus and between 5° valgus and 10° valgus. This finding may reflect some minor effect related to increased challenges in obtaining knee balance in valgus knees compared to other knees. However, since the mean differences in these two groupings were each less than 1°, we do not feel that these small differences will be clinically significant.

One limitation of this work is that we did not evaluate whether or not patient outcomes differed between the measured resection and gap balancing techniques. In previous works, the measured resection technique exhibited a lower Knee Society Function Score [3, 4]. We are planning a follow-up study aiming to assess differences in component placement, functional scores and patient satisfaction. The other limitation is that the measured resection technique was in general performed by high-volume surgeons who may have not adhered strictly to any particular protocol for determining which landmarks to use or how much to rotate the femoral component and likely used their clinical experience and judgement to make adjustments to the original plan. Nonetheless, finding no or minimal differences in femoral component rotation between these techniques is concordant with other similar works [3,5].

Overall, in this study, we have found that broad application of the measured resection and gap balancing techniques does not result in significantly different femoral component rotations, except possibly for a small difference in pre-operatively valgus knees that have a coronal angle between neutral and 10° valgus. In these cases, therefore, surgeons may consider that using the measured resection technique may lead to a slightly more externally rotated femoral component than if they used the gap balancing technique. However, overall, we feel that surgical decisions regarding which technique to use should be based more on any correlations with other patient outcome measures that may be better elucidated in future studies.

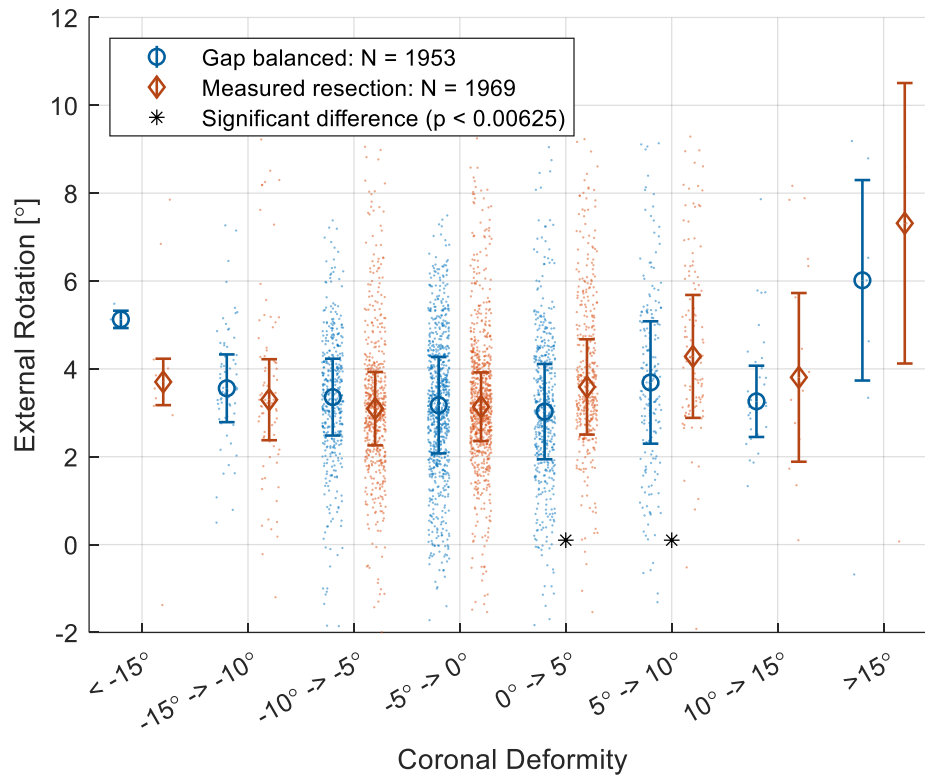


Figure 1: Femoral component external rotation for gap balancing (blue) and measured resection (orange) techniques, grouped into different preoperative coronal deformities. The hollow circles and diamonds show the median measurement while the bars indicate the interquartile range. The * indicates a detectable statistical difference between the two techniques at the listed preoperative coronal deformity.

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