

Accuracy of Digital Templating in Total Knee Arthroplasty

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Abstract

Preoperative planning is an important aspect of total joint arthroplasty. Although significant attention has been given to how total hip arthroplasty templates are magnified, total knee arthroplasty (TKA) digital templating magnification methods have not been compared.

In this study, 50 patients undergoing TKA by the same surgeon were digitally templated using 2 common digital magnification methods to determine if there is any difference in accuracy or precision. Radiographs were randomly chosen to include a 25-mm magnification marker (MM) at the level of the joint or no magnification marker with uniform 115% magnification (NM).

There was no statistical difference between templated and actual component sizes. Preoperative templating determined the exact component size in 64% of femurs and 60% of tibias using the NM technique. Femurs were slightly oversized (mean, 0.2 femur size), whereas tibias had no such trend. In MM templating, 52% of femurs and 48% of tibias were exact.

Various methods of digital templating—the new standard of preoperative templating—provide no clear advantage over one another. The benefit of templating in TKA appears to be 2-fold: the surgeon can reliably predict a range of implant sizes needed and can ascertain a reliable starting point in determining implant size and position.

Preoperative planning is an important aspect of total joint arthroplasty. It requires that the surgeon assess joint alignment and size in determining implant selection. Malalignment is inversely correlated with implant survival.¹ Accurate planning leads to precise component placement and shortens surgical time.² More accurate prediction of components ensures availability of all needed sizes. Overall, preoperative planning may lead to fewer complications.³

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Analog radiographs are the historical standard by which preoperative templating has been achieved in total hip arthroplasty (THA) and total knee arthroplasty (TKA). Recently, progression to more economical picture archiving and communication systems has shifted emphasis to electronic templating. These systems come with the added benefit of portability and image magnification ease.

Investigators have assessed the accuracy of analog templating for THA and TKA. The literature on digital templating software describes varying results that show methods at least as precise as those of analog.⁴ Attempts to achieve accurate magnification with digital templates have involved radiopaque markers placed on radiographic films or a magnification factor. Although significant attention has been given to how THA templates are magnified, TKA digital templating magnification methods have not been compared. Whether there is value in using markers for TKA templating or in simply applying a digital magnification is unknown.

In this study, we report 50 patients undergoing TKA by the same surgeon were digitally templated with use of 2 common digital magnification methods to determine if there is any difference in accuracy or precision.

MATERIALS AND METHODS

Fifty patients (30 women, 20 men) with primary TKAs (25 left knees, 25 right knees) underwent preoperative standing radiographic evaluation. Mean age was 64.3 years (range, 33-86 years). All patients were having TKA for osteoarthritis. For patients having bilateral TKAs, the first templated knee was included. Patients with previous surgery or prostheses to the ipsilateral side were excluded.

Standing anteroposterior and lateral knee images were retained for digital templating purposes during the last preoperative visit. Radiographic films were randomly chosen to include a 25-mm calibration marker (Cal) at the level of the joint or no marker (Mag). Cal films were calibrated manually in the templating software to the appropriate 25-mm marker, and Mag films were uniformly magnified to 115% in the templating software. Preoperative templating IDS5 (Systems Atlanta Inc, Kennesaw, Georgia) workstation and software from 2007 Sectra Imtec AB (Corinth, Texas) were used. One week before surgery, digital templates were assessed on anteroposterior and lateral radiographs to determine best fit using preoperative planning tech-

Table I. Accuracy of Templating

	Femur	Tibia
Mag exact size	64%	60%
Cal exact size	52%	48%
Mag \pm 1 size	100%	100%
Cal \pm 1 size	100%	96%

Abbreviations: Mag, 115% magnified films for templating; Cal, films calibrated to 25-mm marker on film

Table II. Analysis of Templated Vs. Actual Size*

	Tibia	Femur
Cal	.95	>.99
Mag	.77	.66
Cal vs. Mag	.42	.35

*Mann-Whitney test *P* values reported; no difference between implanted and template sizes.

Abbreviations: Mag, 115% magnified films for templating; Cal, films calibrated to 25-mm marker on film

Table III. Intraobserver Reliability

	Tibia		Femur	
Calibrated	0.64	(0.43-0.82)	0.72	(0.51-0.88)
Magnification	0.68	(0.47-0.85)	0.60	(0.39-0.79)
Overall	0.66	(0.51-0.79)	0.66	(0.51-0.79)

Weighted κ with 95% confidence intervals.

nique.⁵ Radiographs were templated 2 months later in the same fashion for intraobserver reliability.

The same experienced surgeon performed all TKAs. All implants were cemented to the distal femur and the proximal tibia with applied tourniquet. A conventional femoral component sizer and Depuy P.F.C Sigma Knee System (DePuy Orthopaedics, Warsaw, Indiana) components were used. Posterior referencing of the femur and a tibial cutting guide were used in surgical component sizing.

Medians were calculated for tibial and femoral component size differences from surgically implanted components and were compared with the Mann-Whitney test. An exact match size percentage and within one size (+1) percentage were calculated. Finally, weighted κ was used for intraobserver reliability between measurements taken 1 week before and 2 months after surgery by the same surgeon. Reliability values were categorized according to strength of association between measurements, with strength of agreement, with scores of 0.20 or less considered poor; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, good; and 0.81 to 1.00, very good.⁶

RESULTS

Preoperative templating determined the exact component size in 64% of femurs and 60% of tibias using the Mag technique. Femurs were slightly oversized (mean, 0.2 femur sizes), whereas tibias had no such trend. In Cal templating, 52% of femurs and 48% of tibias were exact. There were no trends of oversizing or undersizing in this group. All measurements were within 1 component size, except a single calibrated tibial measurement (Table I). There was no statistical difference between templated and actual component sizes or between the Cal and Mag

Table IV. Templating Studies

Reference	Patients	Exact Femur (%)	Exact Tibia (%)	\pm 1 Femur (%)	\pm 1 Tibia (%)	Digital	Templating Technique
Del Gaizo et al ⁸	200	82.5	79.5	97.0	92.5	No	No magnification
Unnanuntana et al ¹⁰	113	50.4	55.8	N/A	N/A	No	No magnification
Aslam et al ⁷	25	49.0	67.0	89.0	92.0	No	No magnification
Specht et al ⁵	50	48.0	37.0	94.0	89.0	No	110% magnification
Howcroft et al ⁹	30	40.0	55.0	97.0	97.0	No	No magnification
The et al ⁴	65	8.0	14.0	64.0	69.0	No	110% magnification
Miller	25	64.0	60.0	100	100	Yes	115% Magnification
The et al ⁴	65	55.0	52.0	92.0	94.0	Yes	Unknown calibration method
Miller	25	52.0	48.0	100	96.0	Yes	Calibrated with reference object
Specht et al ⁵	50	48.0	52.0	92.0	94.0	Yes	110% Magnification
Trickett et al ¹¹	40	48.0	55.0	98.0	100	Yes	Calibrated with reference object

Abbreviation: N/A, not available

techniques (Table II). Intraobserver reliability was tested with weighted κ scores, which all fell in the good range (Table III). These intraobserver measurements were also similar across Mag and Cal templating. These results are compared against previous TKA templating studies in Table IV.^{4,5,7-11}

DISCUSSION

Planning for TKA is crucial. Comorbidities are identified, perioperative issues addressed, and appropriate surgical planning done. Other investigators (Table IV) have studied analog and digital templating methods and have found none to be clearly superior.⁵ Furthermore, the methods have shown equivocal efficacy in accurately predicting exact sizes of implemented components.⁹ In the present study, we tried to determine the benefit of using one digital templating method over another. To this point, use of markers in determining radiograph magnification has not been questioned.

Heinert and colleagues¹² compared 2 different digital templating methods for THA using markers and a magnification factor. The results showed no statistical difference between the methods. Similarly, there appeared to be no statistical difference for TKA templating between markers and digital magnification to a constant percentage. In fact, Mag results showed more exact templates than Cal (Table I). This was true for both distal femur and proximal tibia templating. Trickett and colleagues¹¹ questioned the clinical benefit, considering the outcomes and accuracy of preoperative templating, and suggested that TKA templating should be used only for estimates.

Our results suggest similar findings. Although almost all templated knees were within 1 size difference (1 tibia templated was 1.5 sizes less than the implanted component) only 40% of the time were both components templated exactly the same as implanted on the same knee.

Preoperative templating is an aspect of surgical planning. The benefit of templating in TKA appears to be 2-fold. First, the surgeon potentially can predict a range of implant sizes that need to be available in the operating

room. Second, templating provides the surgeon with a starting point in determining implant size and position. Both benefits may decrease surgical time and therefore decrease complications; however, these benefits are limited by templating accuracy. Preferably a more accurate method of implant size prediction could be used. Templating can be used only for rough estimates at this time. Various methods of digital templating—the new standard of preoperative templating—are just as accurate as analog methods.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.
