Predictive Value of Preoperative Digital Templating in THA Depends on the Surgical Experience of the Performing Physician

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**abstract**

Digital preoperative templating is increasingly used to predict the correct component size in total hip arthroplasty (THA). Experienced surgeons could avoid the new technique and rely on a digital template done by a younger colleague. We compared the accuracy of preoperative templating between orthopedic residents (group A) and an experienced orthopedic surgeon (group B).

In 106 cases, the software-predicted component sizes of both groups were compared with component sizes placed surgically. An accurate prediction of the acetabular component was achieved in 63% of cases in group A compared with 88% of cases in group B ($P=0.001$). Concerning the femoral component, accurate prediction was achieved in 89% in group A and 97% in group B ($P=0.021$).

If performed by an experienced orthopedic surgeon, digital templating is an accurate method to predict the prosthetic component size in THA.

**Figure:** Anteroposterior view of the pelvis with calibration ball (30 mm) between the legs, used for determining leg-length inequality and templating the right acetabulum and femur (A). Postoperative digital image with component sizes as predicted (58 mm acetabular; 13.75 mm femoral) (B).
Preoperative templating is commonly used to predict the correct component size in total hip arthroplasty (THA). Accurate planning lowers the risks of peri- and postoperative complications, such as periprosthetic fracture, luxation, early aseptic loosening, and abnormal wear due to malpositioned implants. A major aim is to restore femoral offset and leg length.

Conventional hard-copy radiography is usually used for preoperative templating in THA. Inaccurate determination of magnification is one of its main problems. The greater distance between the radiograph and the hips of obese patients causes an increased magnification and can lead to inaccurate preoperative templating. Magnification errors are decreased by scaling the radiograph using a reference object of known size. The reference object is normally placed at the same distance from the detector as the center of rotation of the hip.

Over the past 2 decades, digital imaging has been established. The conversion to picture archiving and communication systems (PACS) affected all fields of medical imaging. Digital images can be displayed on a screen of any size without reference of true dimension. Therefore, accurate calibration and scaling of radiographs and templates became even more important.

Whether digital templating in THA is at least as precise as analog templating is still controversial. With the introduction of digital templating in THA in connection with PACS, surgically inexperienced residents increasingly come in contact with the software because templating can be performed from any computer station that has the software uploaded. Furthermore, experienced surgeons could avoid the new technique and rely on a digital template done by a colleague. In the current study, we compared the accuracy of preoperative templating in THA between orthopedic residents and an experienced orthopedic surgeon. The software-predicted component sizes were compared with component sizes placed surgically.

**MATERIALS AND METHODS**

We retrospectively reviewed 106 patients with primary osteoarthritis who underwent THA at our institution. In accordance with the regulations of a retrospective study, informed consent was not required.

The study group comprised 54 women and 52 men. An uncemented acetabular component (Allofit; Zimmer, Warsaw, Indiana) was implanted in 84 patients, and a cemented component (Durasul; Zimmer) was implanted in 22 patients. Implanted femoral components were cemented (Müller straight stem; Zimmer) in 90 patients and uncemented (M/L Taper; Zimmer) in 16 patients.

For accurate calibration and scaling, a 30-mm calibration ball was placed between the patient’s legs at the level of the greater trochanter (approximately the center of rotation of the hip) when taking standard preoperative anteroposterior digital radiographs. For digital templating, we used EndoMap software (Siemens AG, Erlangen, Germany). After magnification adjustment with the 30-mm calibration ball, digital component templates were moved over the acetabular or femoral region. Size and orientation of components can be changed until the result is satisfactory (Figure 1A).

Preoperatively, digital templating of all 106 cases was performed by an orthopedic resident between the first and sixth year of residency (F.M., I.I., R.S.) (group A). The operating surgeon usually performed his own preoperative templating. Prior to the study, all residents received and passed training on using the templating hardware and software. All 106 cases were also digitally templated by an experienced orthopedic surgeon (U.L.) (group B). The surgeon knew neither the results of the original templating (performed by the residents) nor the implanted component sizes. He was blinded to any other patient identifiers. The predicted component sizes (acetabular and femoral) of both groups were compared with the component sizes as documented in the operative report (Figure 1B). No additional clinical information was evaluated. According to the literature, the templating results were considered accurate if the implanted component size was exact or within 1 size of the predicted component size.

Statistical analysis was performed in cooperation with the Department of Medical Biometry, Tübingen, Germany. Paired t-test and Pearson’s chi-square test were used. Significance was set at \( P < .05 \).

**RESULTS**

An accurate prediction of the acetabular component was achieved in 63% (n=67) of cases in group A and 88% (n=93) in group B \( (P=.001) \) (Figure 2A). Further classification in cemented and uncemented acetabular components showed similar results: 61% (group A) vs 87% (group B) for cemented components and 94% (group A) vs 100% (group B) for uncemented components.
(group B) in uncemented components ($P = .001$) and 73% vs 91% in cemented components ($P = .16$), respectively (Table 1).

Mean implanted acetabular component size was 54 mm (range, 48-62 mm; 2-mm step to next size). Group A predicted a mean size of 56 mm (range, 48-62 mm), and group B predicted a mean size of 54 mm (range, 48-62 mm).

Concerning the femoral component, accurate estimation was achieved in 89% ($n = 95$) of patients in group A and in 97% ($n = 103$) of patients in group B ($P = .02$) (Figure 2B). In cemented stems, group A predicted 94% vs 98% in group B ($P = .26$). In uncemented stems, results were 63% vs 94%, respectively ($P = .03$) (Table 1).

Mean implanted femoral size was 11.5 mm (range, 7-20 mm). Groups A and B predicted almost the same mean size (11.4 vs 11.7 mm, respectively).

**DISCUSSION**

Approximately 88% of the acetabular components and 97% of the stem components were predicted by the experienced surgeon (group B) with an accuracy of 1 size. According to the literature, similar values were achieved with different digital planning software (Table 2).

However, statistically significant differences were found between the surgically experienced and inexperienced colleagues. Compared with the average of the residents, the experienced surgeon achieved significantly better results. The acetabular components were predicted more accurately (especially uncemented components). Interestingly, the resident-predicted average size of the acetabular components was 1 size above the size predicted by the experienced surgeon. Therefore, surgically inexperienced colleagues tend to predict larger acetabular components. Concerning the femoral area, a difference existed be-

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**Table 1**

<table>
<thead>
<tr>
<th>Accurate Templated Prosthesis Components</th>
<th>% Within ±1 Size (n)</th>
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</thead>
<tbody>
<tr>
<td><strong>Acetabular</strong></td>
<td><strong>Femoral</strong></td>
</tr>
<tr>
<td>Cemented</td>
<td>Uncemented</td>
</tr>
<tr>
<td>Group A</td>
<td>73 (16)</td>
</tr>
<tr>
<td>Group B</td>
<td>91 (20)</td>
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</tbody>
</table>

* $p < .05$.

* Orthopedic residents.

* Experienced surgeons.

**Table 2**

<table>
<thead>
<tr>
<th>Published Digital Templating Results</th>
<th>% Within ±1 Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td><strong>Acetabular</strong></td>
</tr>
<tr>
<td></td>
<td>Cemented</td>
</tr>
<tr>
<td>Crooijmans et al</td>
<td>81</td>
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<tr>
<td>Davila et al</td>
<td>86</td>
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<tr>
<td>Gamble et al</td>
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<td>Goldstein et al</td>
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<tr>
<td>Iorio et al</td>
<td>60</td>
</tr>
<tr>
<td>Kosashvili et al</td>
<td>83</td>
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<td>The et al</td>
<td>72</td>
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* Type of prosthesis (cemented/uncemented) not published.
tween groups A and B in the uncemented components: the experienced surgeon was more accurate (note the relatively small number of 16 patients).

To our knowledge, this is the first study investigating the influence of surgical training in digital templating in THA. In a similar study design using hard-copy radiographs in templating, Carter et al.\(^5\) achieved comparable results. The accuracy of templating increased with the level of surgical training.\(^5\) Further studies investigated the reproducibility and accuracy of different software on digital images, but the relationship between surgical experience and quality of templating in THA was not examined (Table 2).\(^6,15,17\)

The current study had several limitations. Group B consisted of only 1 experienced surgeon with a higher accuracy than the mean of the less experienced colleagues. Adding more experienced surgeons may have made this a more significant study. In general, implant size is of less interest to the patient and is merely a surrogate for reconstruction of patient anatomy. The reason for performing the preoperative planning is to plan how to reconstruct the hip. Other important parameters such as leg length and offset were not measured in our study. Despite technological advances and training in preoperative templating, the need for intraoperative verification is essential to ensure optimal implant selection in THA.

**CONCLUSION**

Digital templating in THA is easy to use and cost effective. Compared with surgically inexperienced colleagues, an experienced surgeon achieved significantly better results. Therefore, the operating surgeon should perform digital templating in THA by him- or herself, or it should be performed by another experienced orthopedic surgeon.

**REFERENCES**