ABSTRACT

Purpose. To assess the accuracy of templating in total hip arthroplasty (THA).

Methods. Anteroposterior pelvic radiographs of 20 men and 33 women aged 17 to 80 (mean, 60) years who underwent uncemented THA of the right (n=24) and left (n=29) sides using a single prosthesis were reviewed. A 30-mm–diameter scaling ball was placed between the patient’s legs for calculating the magnification factor (MF) of the radiographs. The planned THA was templated using computer software. The positioning of the scaling ball was measured. The preoperative MF was calculated as the size of the ball on radiograph divided by the true size of the ball times 100. The true MF was calculated as the size of the cup on radiograph divided by the true size of the cup times 100. The accuracy of the preoperative MF was calculated as the preoperative MF divided by the true MF times 100.

Results. The cup size and stem size were predicted correctly (within one size error) in 87% and 92% of the patients, respectively; no template size was greater than 3 size errors. The overall mean pre-and post-operative MFs differed significantly (122% vs. 127%, p<0.001), as did the mean postoperative MFs between males and females (126% vs. 128%, p=0.006). Assuming the MF was constant, and the postoperative measurement was the most accurate, the mean accuracy of preoperative MF was 96% (range, 89.6–99.9%), whereas the relative mean height of the scaling ball was 30 (range, 1–90) mm away from the correct height. The accuracy of the preoperative MF did not correlate with body mass index, the scaling ball position, and the accuracy of cup and stem templates.

Conclusion. If the MF of 127% is constant across different patients, using a MF of 127% is more accurate than using the scaling ball technique.

Key words: arthroplasty, replacement, hip; radiographic magnification

INTRODUCTION

Preoperative templating in total hip arthroplasty (THA) enables estimation of implant size to prevent
offset mismatch and non-availability of non-standard implant sizes and thus to reduce intra-operative complications.\textsuperscript{1–4} The actual implants used should be within one size error of those templated.\textsuperscript{1,3–7} Traditionally, templating is done using acetate overlays on radiographs, with magnification of 115\% to 120\%.\textsuperscript{3,8} Digital templating requires an accurate magnification factor (MF).\textsuperscript{8–12} This study aimed to assess the accuracy of templating in THA.

**MATERIALS AND METHODS**

Pre- and post-operative templated radiographs of 20 men and 33 women aged 17 to 80 (mean, 60) years who underwent uncemented THA of the right (n=24) and left (n=29) sides using a single prosthesis (Profemur-Z stem and Procotyl acetabular components; Wright Medical, Arlington [TN], USA) between September 2009 and September 2010 under the supervision of the senior author were reviewed. The mean body mass index of patients was 28.6 (range, 18–45) kg/m\textsuperscript{2}.

Anteroposterior pelvic radiographs were taken with the legs in approximately 15\° of internal rotation, with the X-ray centred on the symphysis pubis and the X-ray source situated 1 m above the detection plate. A 30-mm-diameter steel scaling ball was placed between the patient’s legs at the height of the greater trochanter for calculating the MF of the radiograph. The planned THA was templated using computer software (MediCAD; HECTEC, Germany).

The distance from the superior border of the symphysis pubis to the scaling ball was measured to determine the relevant positioning of the scaling ball (Figs. 1 and 2). With the true size of the scaling ball being 30 mm, the preoperative MF was calculated as the size of the ball on radiograph divided by the true size of the ball times 100 (Fig. 1). Using postoperative radiographs, the true MF was calculated as the size of the cup on radiograph divided by the true size of the cup times 100 (Fig. 1). The accuracy of the preoperative MF was calculated as the preoperative

\begin{IEEEeqnarray*}{rcl}
\tan \alpha &=& \frac{d}{1000} \\
X &=& \frac{15}{\tan \alpha} \\
X &=& 15 \left( \frac{d}{1000} \right) \\
d &=& \frac{1}{2} \text{measured scaling ball size (mm)}
\end{IEEEeqnarray*}

**Figure 1** (a) Pre- and (b) post-operative radiographs for calculation of preoperative and true magnification factors, respectively.

**Figure 2** Calculation of the relative height of the scaling ball.
MF divided by the true MF times 100.

The Student’s t-test was used for comparing paired, normally distributed data, whereas the Pearson correlation coefficient was used to determine the linear association of independent variables. A p value of <0.05 was considered statistically significant.

RESULTS

The cup size and stem size were predicted correctly (within one size error) in 87% and 92% of the patients, respectively; no template size was greater than 3 size errors (Table 1).

The overall mean pre- and post-operative MFs differed significantly (122±2.9 vs. 127±2.8, p<0.001, paired t-test, Table 2), as were the mean postoperative MFs between males and females (126±2.8 vs. 128±2.6, p=0.006, t-test, Table 2). Assuming the MF was constant, and the postoperative measurement was the most accurate, the mean accuracy of preoperative MF was 96% (range, 89.6–99.9%), whereas the relative mean height of the scaling ball was 30 (range, 1–90) mm away from the correct height, relative to the detector plate.

The accuracy of the preoperative MF did not correlate with body mass index, the scaling ball position, and the accuracy of cup and stem templates, although the actual preoperative MF correlated with the scaling ball position (r=0.34, p=0.01, Pearson correlation test, Table 3).

DISCUSSION

It may be assumed that the larger the patient, the further the patient’s hips are from the X-ray receiver and therefore the larger the MF. However, in our study the radiographic MF did not correlate with body mass index of the patient. The template was considered accurate within one size error. The mean acetabular cup size was 52 mm, and the accuracy for the acetabular cup and stem was 87% and 92%, respectively, which is comparable with that in other studies.6,7 One cup size difference is ±2 mm, which is approximately 4% of the cup size. Therefore, a ±4% error in MF is acceptable, which equals ±33.5 mm out of positioning of the scaling ball. In our study, the mean positioning error of the scaling ball was 30 mm, which was within acceptable tolerances. There was no correlation between the preoperatively measured variables and the accuracy of templating. Therefore, the discrepancies may have been due to human error in the templating process, which is unavoidable.

In this study, the mean MF of post-operative radiographs was 127%, which was identical to that in another study in the same hospital using a separate cohort of patients.2 If all our patients were assumed to have a MF of 127%, the accuracy would be 98%
which is higher than the 96% accuracy (range, 89.6–99.9%) when using the scaling ball. However, it is unknown whether the MF of 127% is constant across different hospitals. If that is the case, using a MF of 127% is more accurate than using the scaling ball technique. Further studies in different hospitals are needed.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES