



Audit

Effect of introduction of digital radiographic techniques on pre-operative templating in orthopaedic practice

SP White, DL Shardlow

Department of Orthopaedics, Yeovil District Hospital, Yeovil, Somerset, UK

Aim: To assess whether the introduction of digital radiographic acquisition has altered the magnification of pelvic radiographs compared to standard acquisition techniques, and whether this influences preoperative implant templating for total hip arthroplasty.

Setting: District general hospital orthopaedic out-patient department.

Patients and Methods: 51 sets of patient radiographs were studied, where digital and standard radiographic techniques had been used for each patient. Key bony landmarks were measured, the scaled ruler analysed and the femur templated to gauge the most appropriate implant size of implant.

Results: Introduction of digital techniques has resulted in a mean magnification of 97%, whereas most manufacturers' templates assume a magnification of 115–120%. For the Exeter femoral component, the templated size showed only moderate correlation with that templated from a standard radiograph (kappa index 0.46), although the offset templated showed good correlation (kappa index 0.89).

Conclusions: Surgeons should be aware that introduction of digital techniques of radiograph acquisition may reduce the magnification of the film and, therefore, reduce the accuracy of pre-operative templates supplied by the manufacturers of implants, resulting in incorrect selection of implants.

Key words: Digital radiography – Pre-operative templating – Orthopaedics

Orthopaedic surgeons often template radiographs as part of pre-operative planning in order to gauge the suitability and correct size of a particular implant. This is becoming increasingly important due to the large range of implants available and the limitations of any one hospital unit in stocking large inventories of implants.

Specifically for the femoral component of cemented total hip arthroplasty, templating allows the surgeon to choose the most appropriate offset of implant to restore correct soft tissue balance and forces around the hip, and also to decide which size of implant will allow an acceptable surrounding cement mantle.

Digital radiographs were introduced in this department in 2000. Currently, due to demands for plain radiographs and gradual introduction of newer machines, patients could have pelvic films taken by either a digital or standard technique, and this has allowed a cohort of patients who have films available for review taken with each method.

Patients and Methods

A total of 51 patients attending pre-operative assessment clinics in a district general hospital in preparation for total hip arthroplasty were included who had both digital and

Correspondence to: Mr Simon White, 34 Glebe Road, Long Ashton, Bristol BS41 9LH, UK
Tel: +44 (0)1275 540195; E-mail: simonpwhite@blueyonder.co.uk

Table 1 Mean (mode) values

Radiograph technique	Standard	Digital
Offset	44 (44)	44 (44)
Size	3 (4)	2 (1)

standard pelvic radiographs taken within a year apart. Patients who had marked disease progression such as femoral head collapse were excluded.

Measurements were taken and compared of readily identifiable landmark points along the sacrum and sacro-iliac joints from both radiographs. The sealed ruler printed on each digital radiograph was analysed. Both radiographs were templated using Exeter (Stryker Howmedica Osteonics) femoral templates and the most suitable offset and size of stem to allow a circumferential cement mantle of 2 mm was determined.

Results were analysed using paired Student's *t*-test and kappa correlation.

Results

Fifty-one patients with radiographs taken between June 1999 and September 2002 were studied. The mean age was 70 years (range, 43–88 years). The mean difference in fixed sacro-iliac joint distance was 4.24% (range, 0–17%) which was statistically significant ($P < 0.002$). Where different, the digital radiographic measurement was always smaller (46/51 patients).

The mean magnification for digital radiographs was 97% (range, 81–98%). Table 1 shows the mean and mode values for Exeter stem templated.

The average size measured from the digital radiograph was one size smaller than from the standard radiograph. For 18 patients, the size templated from the digital radiograph was one size smaller, in 2 patients it was two sizes smaller, and in one patient, three sizes smaller. The kappa correlation index was 0.46.

For offset, there was perfect agreement in 49 out of 51 patients (kappa index 0.89).

Discussion

The standard Exeter templates provided by the manufacturer assume a radiographic magnification factor of 20%, meaning that a radiograph should represent 120% of original proportions. A previous study of standard

radiographs showed a mean magnification factor of 18%.¹ In this study, the introduction of a digital technique of acquiring radiographs has produced a mean of 97% of original proportions. Analysis of distances between fixed bony landmarks has shown a statistically significant discrepancy in measurements with the digital technique yielding smaller measurements. Similar work on dental radiographs following introduction of digital techniques also showed a statistically significant difference in measurements between sets of films.²

Pre-operative templating for Exeter femoral stems has shown good agreement in offset from both sets of radiographs, but only moderate agreement in size of stem templated with 21 of 51 measurements predicting a smaller size of implant from the digital radiograph.

With the increasing utilisation of uncemented implants, templating has become more critical. With a higher risk of intra-operative fracture during insertion, it is re-assuring for the surgeon when the pre-operative prediction matches the intra-operative choice of implant. In this study with the newer radiographic technique commonly producing smaller measurements, the situation could and has arisen where it is felt that a femoral canal is too small for a particular choice of implant, when in reality it would have been appropriate.

The difference in magnification could have implications throughout orthopaedic practice, for instance when sizing for intramedullary nails pre-operatively.³ Other examples where we have experienced difficulty in chronological comparison have been in follow-up radiographic evaluation of bone cysts or tumours.

Surgeons working in other departments that have introduced digital radiographic techniques should be aware that the manufacturers' templates may not correlate with the magnification produced by their radiology department and should account for this in their pre-operative planning.

References

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