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Pre-operative digital templating in cemented hip hemiarthroplasty for neck of femur fractures

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ABSTRACT

Pre-operative digital templating allows the surgeon to foresee any anatomical anomalies which may lead to intra-operative problems, and anticipate appropriate instruments and implants required during surgery. Although its role is well-established in successful elective total hip arthroplasty, little work has been done on its use in hip hemiarthroplasty in neck of femur fractures. We describe our initial experience of digital templating in 40 consecutive patients who have undergone cemented hip hemiarthroplasty, assessing templating accuracy between templated implant sizes to actual implant sizes. 81% of implanted heads were templated to within two head sizes, and 89% of implanted stems were templated to within two sizes. Although there was a moderately strong correlation of 0.52 between templated and actual head sizes, this correlation was not demonstrated in femoral stem sizes. Mean leg length discrepancy was −2.5 mm (S.D. 8.5), and the mean difference in femoral offset between the operated and non-operated hip was −1 mm (S.D. 4.4). Digital templating is a useful adjunct to the surgeon in pre-operative planning of hip hemiarthroplasty in the restoration of leg length and femoral offset. However, its accuracy is inferior to that of elective total hip arthroplasty.

Introduction

The incidence of neck of femur fractures continues to rise globally, and the numbers are predicted to reach 6.26 million by 2050, from 1.66 million in 1990 [1]. In 2013, 64 800 neck of femur fractures were recorded in the United Kingdom alone. Approximately 50-60% of these are intracapsular fractures [2]. Cemented hip hemiarthroplasty has been shown to be the treatment of choice for displaced intracapsular neck of femur fractures in randomised trials [3,4]. The goals of performing a hip hemiarthroplasty are to regain mobility and function, and to allow weight bearing without restriction. Restoration of hip biomechanics is a one of the main aims of hip hemiarthroplasty. Successful function of the hip relies on proper muscle orientation in relation to the centre of rotation of the hip joint [5]. Restoration of equal leg lengths and femoral offset is therefore paramount.

Femoral offset determines the moment of arm of the abductor muscles, and is measured from the centre of rotation of the hip joint to the longitudinal axis of the femoral shaft [5]. A higher offset increases the moment arm of the abductors when the same force is applied. Implanting a hip prosthesis that reduces the femoral offset means that the abductors muscles have to generate an increased force. From the patient's point of view, this may lead to limping, early muscle fatigue and increased use of walking aids [6]. From a biomechanical standpoint, increased wear and premature loosing of the prosthesis may result. Laxity of the joint may also increase the risk of dislocation [5].

Pre-operative digital templating has been well-described in total hip arthroplasty [5,7,8]. It enables the surgeon to assess the need for non-standard implant sizes, predict bony resection levels, avoid potential size mismatches, and anticipate appropriate instruments and implants required intraoperatively. This has been shown to reduce the likelihood of femoral shaft fractures, and prevents unidentified anatomical variations leading to intra-operative problems. However the use of digital templating has not yet been extended to hip hemiarthroplasty to date. We have adopted the use of digital templating in our institution in hip hemiarthroplasty for intracapsular neck of femur fractures in recent years. The purpose of this study was to describe out initial experience with this technique, and assess the accuracy of pre-operative templating for implant choice in hip hemiarthroplasty.

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Patients and methods

Institutional review board approval was obtained prior to retrospective patient data collection. Between May 2014 and May 2015, 142 hip hemiarthroplasties were performed in the department. Inclusion criteria for the study included: (1) Cemented hip hemiarthroplasty performed for intracapsular neck of femur fracture, (2) adequate pre-operative AP radiograph of the pelvis, with magnification data included, (3) evidence of pre-operative digital templating by the surgeon, (4) adequate post-operative AP radiograph of the pelvis. Exclusion criteria included: (1) Incomplete patient records, (2) Deformity of the contralateral hip, (3) poor quality post-operative AP radiograph of the pelvis (for example, significant tilting or rotation of the hip or lower limbs). Clinical data was obtained through the hospital database and implant data records. All radiographs were stored in the hospital IMPAX picture archiving and communication system (Agfa HealthCare UK, Brentford, United Kingdom).

40 hip hemiarthroplasty cases met the above criteria. All hemiarthroplasty operations were performed using an anterolateral modified Hardinge approach. These were performed by different surgeons within a single institution. All patients received a unipolar cobalt-chrome collarless, polished, tapered, cemented system (CPCS hip system; Smith & Nephew, Memphis, Tenessee.) head and stem. The CPCS head sizes available were 38–60 mm in diameter, at 2 mm increments with each size. Each head size came with a standard- and medium-head option, with a 5 mm increase in neck length in the latter. The stem sizes available were 0–5, with each stem size offering a standard- or high-offset option.

Pre-operative templating

All pre-operative radiographs were stored in the hospital PACS. Digital templating was carried out using AGFA Orthoview for IMPAX software. Calibrated AP radiographs of the pelvis all had focus film distance (FFD) and focus object distance (FOD) measurements. FFD and FOD measurements were made by the radiographer when the initial radiograph was obtained. The magnification of the radiograph was calculated using the formula [9]:

Magnification = FFD/FOD

Implants were templated using the contralateral hip to the fracture. The most suitable femoral head size was chosen, based on the diameter of the contralateral native femoral head. The line of the template head should ideally lie halfway between the dome of the acetabulum and the femoral head to account for the thickness of the cartilage (Fig. 1). The femoral stem was then chosen, ensuring metaphyso-diaphyseal filling accounting for a 2 mm cement mantle, and avoidance of varus or valgus placement. Restoration of the hip offset was ensured.

Post-operative radiographic evaluation

AP radiographs of the pelvis were taken within the first week after surgery and were independently reviewed by two authors (I.K. and S.P.), neither of whom performed any of the hip hemiarthroplasties in the study. Differences in femoral offset and leg lengths (comparing the operated hip to the non-operated one) were measured and recorded for each patient.

Femoral offset was determined by measuring the distance from the centre of rotation of the femoral head to a line bisecting the long axis of the femur [10]. Leg length discrepancy (LLD) was determined by first drawing a horizontal line connecting the caudal margins of the two ischial tuberosities (bi-ischial line) as a pelvic reference. The perpendicular distances from the bi-ischial line to the tips of each of the lesser trochanters (the femoral reference) were then measured [11]. LLD was expressed as the difference in measurements between the two hips. If the leg length in the operated hip was longer than that in the non-operated hip, "+" was recorded and vice versa (Fig. 2).

The actual head and stem implant sizes were retrieved from theatre implant records in the department, and compared to the templated results. Spearman's rank correlation was used to assess the correlation between non-parametric data, i.e. templated sizes and actual implant sizes, using SPSS version 17 software package (SPSS Inc, Chicago, IL, USA). A p value ≤ 0.05 was regarded as significant. Percentage analysis of planning accuracy was also used.

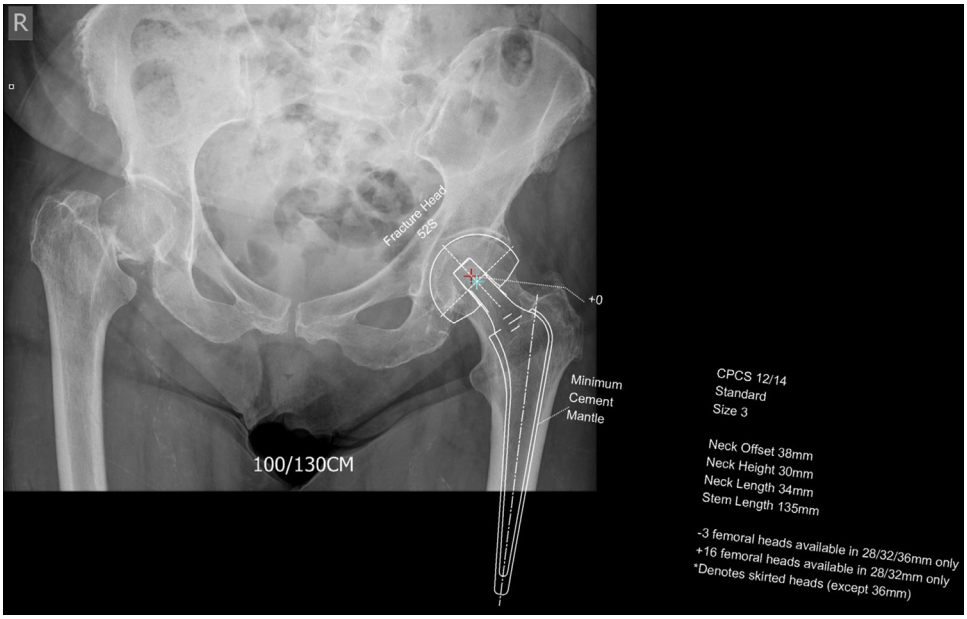

Fig. 1. Digital templating of hip hemiarthroplasty, using the contralateral hip on an AP radiograph of the pelvis. The magnification (FFD/FOD) in this radiograph is 100/130 cm. A size 3 standard offset CPCS stem was templated, with a size 52 standard head.