The Dorr type and cortical thickness index of the proximal femur for predicting peri-operative complications during hemiarthroplasty

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ABSTRACT

**Purpose.** To assess the Dorr proximal femoral types and the cortical thickness index for predicting peri-operative complications during hemiarthroplasty.

**Methods.** Records of 53 male and 147 female elderly who underwent cemented or uncemented monopolar hemiarthroplasty for displaced intracapsular femoral neck fractures were reviewed. Any intra-operative fracture and postoperative dislocation within 30 days was recorded. The cortical thickness index was defined as the ratio of cortical width minus endosteal width to cortical width at a level of 100 mm below the tip of the lesser trochanter. Higher values indicated thicker cortices. The Dorr proximal femur morphology was classified into types A, B, and C.

**Results.** 28 patients were excluded. The proximal femurs of the remaining 172 patients (mean age, 85 years) were categorised as Dorr type A (n=29), type B (n=75), and type C (n=68). The respective mean cortical thickness indices were 1.10, 0.79, and 0.65. Lower cortical thickness indices correlated with worse Dorr types (p<0.05). There were 18 intra-operative fractures; 8 and 10 occurred in Dorr types B and C femurs versus none in Dorr type A femurs (p=0.046). There were 5 postoperative dislocations; 3 and 2 occurred in Dorr types B and C femurs versus none in Dorr type A femurs (p=0.591). The mean cortical thickness index was significantly lower in those with a fracture (n=18) than those without a fracture (n=154) [0.59 vs. 0.81, p=0.0003].

**Conclusion.** Dorr types B and C proximal femurs were at greater risk of intra-operative fracture.

**Key words:** arthroplasty, replacement, hip; femoral neck fractures

INTRODUCTION

Femoral neck fractures in the elderly are associated with high mortality, morbidity, and social dependence. Its incidence is predicted to rise owing to ageing populations.1 Surgical delay increases short- and long-term mortality.2,3 Treatment options for intracapsular femoral neck fractures include
internal fixation, hemiarthroplasty, and total hip arthroplasty (THA). Outcomes after THA are superior, although hemiarthroplasty enables shorter operation time and earlier mobilisation, but has inferior functional outcomes and greater liability to warrant revision later. It is therefore reserved for patients less able to tolerate surgery and anaesthesia and have limited life expectancy and exercise tolerance. Monopolar hemiarthroplasty has one articulation of the metal head onto the acetabulum, whereas bipolar hemiarthroplasty has 2 articulations that the metal femoral head is separated from the metal stem by a polyethylene cup, with the outer metal head articulating with the acetabulum. Both confer similar mortality and functional outcomes. Hemiarthroplasty can be cemented or uncemented. Cemented hemiarthroplasty achieves better functional outcome, but has higher dislocation rates.

Complications during or after hemiarthroplasty include periprosthetic fracture, dislocation, deep infection, venous thromboembolism, respiratory complications, and death. Inadequate calcar seating, insufficient residual femoral neck length, insufficient metaphyseal fill, and errors in sizing the prosthesis are all associated with early failure of the Austin Moore hemiarthroplasty. Intra-operative fracture results in poorer Harris hip scores and mobility. This study assessed the Dorr proximal femoral types and the cortical thickness index for predicting peri-operative complications during hemiarthroplasty.

MATERIALS AND METHODS

Records of 53 male and 147 female elderly who underwent monopolar hemiarthroplasty for displaced intracapsular femoral neck fractures between August 2009 and 2010 were reviewed. The Austin-Moore or Muller prosthesis was used with or without cementation, depending on surgeon’s choice, pre-morbid function, and co-morbidity. Any intra-operative fracture and postoperative dislocation within 30 days was recorded.

The cortical thickness index was defined as the ratio of cortical width minus endosteal width to cortical width at a level of 100 mm below the tip of the lesser trochanter on anteroposterior radiographs. Higher values indicate thicker cortices (Fig. 1). According to the Dorr description of the proximal femoral morphology (Fig. 2), type A exhibited thick cortices that begin at the distal end of the lesser trochanter and thicken quickly, producing a funnel shape and a narrow diaphyseal canal. Type B exhibited bone loss proximally and widening of the diaphyseal canal. Type C exhibited considerable loss of the thickness of the cortices resulting in a very wide intramedullary canal and a fuzzy appearance to the bone cortices. The Tukey-Kramer minimal significant distance was used to compare categorical data, whereas the Wilcoxon rank-sum test was used to compare non-normally distributed samples.

RESULTS

28 patients were excluded: 13 and 15 lacked adequate pre- and post-operative radiographs, respectively. The proximal femurs of the remaining 172 patients (mean age, 85 years) were categorised as Dorr type
A (n=29, 17%), type B (n=75, 44%), and type C (n=68, 40%). For the respective types, the male-to-female ratios were 0.30, 0.44, and 0.30, whereas the mean cortical thickness indices were 1.10 (95% confidence interval [CI], 0.40–1.80), 0.79 (95% CI, 0.38–1.23), and 0.65 (95% CI, 0.17–1.12). Lower cortical thickness indices correlated with worse Dorr proximal femoral types (p<0.05 for all 3 pairs, Tukey-Kramer minimal significant difference). The correlation remained significant when men and women were analysed separately.

There were 18 (11%) intra-operative fractures; 8 and 10 occurred in Dorr types B and C femurs versus none in Dorr type A femurs (p=0.046, Fisher’s exact test, Table). There were 5 (3%) postoperative dislocations; 3 and 2 occurred in Dorr types B and C femurs versus none in Dorr type A femurs (p=0.591, Fisher’s exact test, Table). After combining both complications, the difference between Dorr type A and Dorr types B and C remained significant (p=0.015, Fisher’s exact test, Table).

The mean cortical thickness index was significantly lower in those with a fracture (n=18) than those without a non-fracture (n=154) [0.59 (95% CI, 0.23–0.96) vs. 0.81 (95% CI, 0.22–1.37), p=0.0003, Wilcoxon rank test]. Patient age was not significantly different in the fracture and non-fracture groups (85.0 vs. 84.6 years, p=0.962).

There was no significant difference between cemented (n=33) and uncemented (n=139) hemiarthroplasties in terms of intra-operative fracture (2 vs. 16, p=0.531), postoperative dislocation (0 vs. 5, p=0.585), or both (p=0.255).

### DISCUSSION

Worse Dorr proximal femoral types are associated with more severe osteoporosis and higher risk of intra-operative fracture. Dorr type C femurs are found predominantly in older women with lower body weight. These femurs have structural and cellular compromise and are less favourable for implant fixation. Worse Dorr proximal femoral types correlated with lower cortical thickness indices. In patients with femoral neck fractures, standard anteroposterior radiographs are difficult to obtain, as the femurs are commonly in an internally rotated position. The Dorr types are simpler and easier to measure than the cortical thickness index.

Most intra-operative fractures occurred during impaction of the prosthesis or subsequent reduction of the hip. This may be due to broaching with or without stem oversizing in order to obtain an interference fit in the proximal femur. Stem oversizing predisposes to intra-operative fracture, and thus cementation may be of benefit for elderly women or those with compromised bone quality. All these features should be taken into consideration during pre-operative planning.

The use of a cemented prosthesis may reduce the rate of intra-operative fractures. It is more appropriate to compare a tapered polished stem (that requires gentle reaming) with a press-fit stem in terms of cementation. Comparing an uncemented press-fit stem (Austin-Moore) with a cemented press-fit stem (Austin-Moore or Muller) may not have
accounted for the fracture risk associated with a tight metaphyseal fit within the proximal femur, as both prosthesis require vigorous rasping.

Asian women have smaller proximal femurs. In those with particularly small proximal femurs, even a narrow-stem Austin-Moore prosthesis may be too tight to insert and may need to rasp the femur and thus risk fractures. The Dorr types may not be as important risk factor in terms of intra-operative fractures. Routine preoperative templating of the opposite femur is another way to predict risks and difficulties and serve as a guide to the choice of fixation method. The use of the cortical thickness index and the Dorr proximal femoral types to predict patients at risk of intra-operative fracture or postoperative dislocation can serve as a guide to the choice of prosthesis and fixation method.

**DISCLOSURE**

No conflicts of interest were declared by the authors.

**REFERENCES**


