INTRAOPERATIVE ERROR DURING IMPLANTATION OF THE AUSTIN
MOORE HEMIARTHROPLASTY

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ABSTRACT

Introduction: Technical inadequacy in implantation of the uncemented unipolar
Austin Moore Hemiarthroplasty has been associated with early failure of the
prosthesis by aseptic loosening and residual thigh pain requiring revision. This study
examines the frequency of technical errors experienced during implantation of the
Austin Moore prosthesis in a public hospital.

Methods: A Retrospective radiographic and chart review of 147 consecutive
uncemented Austin Moore hemiarthoplasties was conducted with particular reference
to intraoperative errors associated with early failure of the prosthesis.

Results: 48.3% patients had at least 1 error in implantation. Intraoperative fractures
were sustained in 14.3%. Registrars and Consultants had equivalent error rates.

Conclusions: The results from this study imply the uncemented Austin Moore
prosthesis is a technically demanding prosthesis that is difficult to implant well, and
greater selectivity should be exercised when considering its use for femoral neck
fractures.

KEYWORDS: Hemiarthroplasty; Hip; Uncemented; Error; Fracture
INTRODUCTION

For displaced subcapital fractures of the femoral neck, the uncemented Austin Moore is the most frequently used monoblock hemiarthroplasty in Australia. Commonly this procedure is reserved for the elderly or frail low demand patient, who represents a poor candidate for revision should the prosthesis fail. Australian Joint Registry data indicate the uncemented Austin Moore prosthesis has a three times higher rate of revision within 2.4 years when compared to the cemented Thompson prosthesis (HR 2.89; 95% C.I. 1.8 – 4.6; p<0.0001). Technical errors in implantation of the uncemented Austin Moore are common, and have been associated with early failure of the prosthesis. Inadequate calcar seating, insufficient residual femoral neck length, insufficient metaphyseal fill and errors in sizing the prosthesis are all associated with early prosthetic failure of the Austin Moore. Sharif & Parker (2002) in a review of 243 Austin Moore prostheses found at 1 year post surgery 61 patients (25.1%) had residual pain and 17 patients (7%) required revision surgery for aseptic loosening. Both residual pain and revision for aseptic loosening were strongly associated with features of the operative technique, namely caudad resection level of the femoral neck, inadequate seating of the prosthesis and inappropriate selection of prosthetic head size. Kwok & Cruess (1982) in a review of 599 Moore and Thompson hemiarthroplasty implantations concluded that dislocation of the Austin Moore prosthesis was related to inappropriate residual neck length and poor selection of prosthetic head size. Yau & Chiu (2004) in a series of 44 patients managed with the Austin Moore prosthesis for acute displaced fractures of the femoral neck at 2 – 7 year follow up found proximal metaphyseal fill of less than 70% was associated with subsidence and postoperative pain.

In public hospitals, unipolar hemiarthroplasty for femoral neck fracture is frequently performed by less experienced surgeons in difficult circumstances. This study aims to assess the technical accuracy of implantation of the uncemented Austin Moore prosthesis, with specific reference to Orthopaedic Registrars.

METHODS
All patients undergoing unipolar uncemented Austin Moore hemiathroplasty at the Cairns Base Hospital in the 6 year period from Jan 1998 to Jan 2004 for subcapital fracture of the femoral neck were identified using discharge diagnosis coding and operation logs. 147 patients were identified using these criteria, and no patients were excluded from the study. A retrospective review of all charts including operative notes was conducted and analysis of pre- and immediate post-operative radiographs was conducted. Radiographic assessment of the technical accuracy of prosthetic implantation was performed using methods described by Sharif & Parker.\textsuperscript{9,10} An error in implantation was defined as an intraoperative periprosthetic fracture, or a technical aspect of insertion known to be associated with early failure of the prosthesis.\textsuperscript{7,8,10} This study considered four potential errors in implantation (Figure 1):

1. Length of the neck remnant, measured from the superior margin of the lesser trochanter to the resection margin at the calcar femorale. Inadequate neck length was considered $\leq 12$mm. If on postoperative radiographs an inadequate neck remnant was identified, neck length on preoperative radiographs was also measured.

2. Calcar seating, measured from the medial prosthetic collar to calcar in millimetres. A collar seated flat on the calcar without intervening bone spikes was recorded as zero. Inadequate calcar seating was considered $>1$mm.

3. Prosthetic head size compared to the contralateral normal head or preoperative radiographs using circular overlays. Equal size or prosthesis up to 2mm larger to account to articular cartilage was considered satisfactory.

4. Intraoperative periprosthetic fracture. Fracture classification was conducted using the Vancouver system.\textsuperscript{5}

**RESULTS**

147 patients were treated with the unipolar uncemented Austin Moore prosthesis over the time period. 128 (87.1\%) had their surgery performed by Orthopaedic Registrar, 19 (12.9\%) by Consultant Orthopaedic Surgeon. Seniority of the registrar performing the surgery was Senior Medical Officer in 13.6\%, Training Registrar in 56.5\% and Principal House Officer in 17\% of cases.
84 errors in implantation were identified in 71 patients. Only 76 patients (51.7%) had no errors in implantation. 52 patients (35.4%) had 1 error, 17 (11.6%) had 2 errors, and 2 patients (1.4%) had 3 errors in implantation (Figure 2).

21 patients (14.3%) sustained intraoperative fractures (Figure 3). The fracture rate for Registrars was 14.8%, for Consultants 10.5% (p=0.73). 20 fractures were sustained to the proximal femur; all Vancouver Classification Type A.\(^5\) All femoral fractures were identified during the procedure. 15 fractures were managed with circlage wire, 2 fractures with both circlage wiring and cementing of the prosthesis. 2 fractures were considered stable and did not require specific management and 1 fracture was treated by cementing the prosthesis alone.

1 patient sustained a non-displaced fracture acetabulum, located outside of the weight-bearing dome. This fracture was not identified during surgery and was associated with oversizing of the prosthetic head by 3mm.

36/135 patients (26.7%) had inadequate length of the neck remnant on postoperative radiographs (Figure 4). 12 patients (8.2%) were excluded from assessment of neck remnant length as postoperative radiographs were either unsuitable for unavailable for analysis. Registrars were found to have insufficient neck remnant remaining in 26.2% of cases, and Consultants in 29.4% (p=0.66). Of those patients with insufficient neck remnant remaining postoperatively, 29/36 had preoperative radiographs suitable for comparison. 13/29 (44.8%) of patients were found to have insufficient neck remnant available prior to surgery due to the pattern of fracture sustained.

26/120 patients (21.7%) had inadequate calcar seating on postoperative radiographs (Figure 1). 27 patients (18.4%) were excluded from assessment of calcar seating, as postoperative radiographs were either unsuitable or unavailable. Registrars were found to inadequately seat the prosthesis in 23.8% of cases, Consultants in 6.7% (p=0.09). 13 prostheses were demonstrated to be proud by >3mm on postoperative radiographs, all of these were implanted by Registrars. 3 were found to be >10mm proud.

Incorrect prosthetic head size was identified in 2 patients. 1 patient sustained an intraoperative acetabular fracture associated with implantation of a 3mm oversized prosthesis.

**DISCUSSION**
The technical error rate for the Austin Moore prosthesis when performed by Registrars is high, but not significantly different to Consultants within this study or rates previously reported in the literature.\textsuperscript{6-8,10}

Inadequate residual neck remnant was the most common error identified. Both increased rates of residual thigh pain and early revision due to loosening have been associated with short neck remnants.\textsuperscript{10} Almost half of patients with inadequate residual neck remnant had insufficient length available due to the fracture pattern and was observable on preoperative radiographs. Failure to maintain sufficient neck length in these cases represents not an intraoperative technical surgical error, but inappropriate prosthesis selection and preoperative planning. Given the inferior results of the uncemented Austin Moore implanted with short neck remnant, the use of this prosthesis in low-neck fractures is questionable, and an alternative should be considered.

Intraoperative periprosthetic fractures sustained during the procedure were common (14.3%), with an equivalent fracture rate between Registrars and Consultants. From review of the operative notes and discussion with the surgeons involved, most fractures were sustained either during impaction of the prosthesis after broaching or during reduction of the prosthesis. Underbroaching and relative oversizing of the stem with intent to provide interference fit of the prosthesis in osteoporotic bone may result in fracture during prosthesis insertion. Also of note in this regard is the high rate of implantation without adequate seating, implying that surgeons not infrequently experience difficulty due to the size and proximal geometry of the prosthesis. To assist with adequate prosthetic seating without excessive impaction the routine use of narrow stem Austin Moore could be considered a solution, however Yau and Chiu (2004) have demonstrated that proximal metaphyseal fill of greater than 70% is required to reduce the risk of early postoperative subsidence and loosening of the Austin Moore prosthesis.\textsuperscript{12} Both narrow and standard stem Austin Moore prostheses should be available to the surgeon to allow an intraoperative assessment of the stem most appropriate to enable appropriate metaphyseal fill providing stability without excessive risk of fracture or inadequate calcar seating.

A loose stem with inadequate rotational stability may predispose to intraoperative fracture during reduction of the prosthesis, particularly if the leg has been lengthened and capsule preserved. Should the rotational stability of the prosthesis after impaction remain questionable, reduction should not be attempted.
Options available in this situation include an alternative prosthesis or cementing the Austin Moore.

All surgeons regardless of experience using sterile circular sizing rings reliably accomplished selection of correct prosthetic head size.

The results of this study and literature review suggest intraoperative error during implantation of the uncemented Austin Moore prosthesis is relatively common. Equivalent results between Registrars and Consultants indicate inadequate training does not explain the error rate. Based on this information the Austin Moore appears to be a technically demanding prosthesis, which is difficult to implant well, and greater selectivity should be exercised when considering use of this prosthesis for management of femoral neck fractures.

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REFERENCES
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**Figure 1:** Prosthesis inadequately seated on femoral calcar, demonstrating measurements used for radiographic analysis of intraoperative errors.

1: Length of neck remnant 2: Calcar seating distance 3. Prosthetic head size (see text).
Figure 2: Errors per patient

Figure 3: Intraoperative periprosthetic fracture of the proximal femur managed with cerclage wire.
Figure 4: Femoral neck resection inappropriately distal with insufficient neck remnant remaining.