



Comparison of outcomes following uncemented hemiarthroplasty and dynamic hip screw in the treatment of displaced subcapital hip fractures in patients aged greater than 70 years

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As health care costs increase, evaluating treatment methods in femoral neck fractures to determine the most effective treatment paradigm will become increasingly important. The current study compared two methods of treatment in similar cohorts of displaced femoral neck fractures. One hundred and twenty two patients were randomly assigned to two groups : In Group A, 62 patients were treated with a hemiarthroplasty. In group B, 60 patients were treated with dynamic screw fixation. Patients were evaluated at a minimum 3 year follow-up. Using the Matta functional hip score, 42% of group A and 70% of group B had good to excellent results. This difference was significant ($p = 0.004$). A significant agreement between physician assessment using the Matta score, and patient perception of outcome using the SF-36 scale was demonstrated ($r = 0.64$). No statistical difference between groups for revision surgery existed. Both physician based and patient based outcome scores favour retention and internal fixation of the femoral head in this cohort of patients at a short term follow-up.

INTRODUCTION

Treatment strategies for displaced subcapital hip fractures have been conflicting and uncertain as to whether internal fixation is superior to hemiarthroplasty in patients 70 years of age or older. The benefits of obtaining anatomic reduction and maintaining a femoral head are well described in patients

undergoing internal fixation. Shorter operating times, reduced hospital stays and earlier mobilisation with improved long-term mobility have all been documented (30, 40). At the same time, however, many studies have reported similarly good functional results with lower re-operation rates using the traditional Austin Moore hemiarthroplasty (38). This study was an attempt to address the discrepancy within the existing literature and to establish a future treatment algorithm for subcapital hip fractures.

PATIENTS AND METHODS

Over a four year period (1994-1998) a total of 156 patients seventy years of age or older were treated

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Fig. 1. — Uncemented hemiarthroplasty with an Austin Moore prosthesis.



Fig. 2. — Internal fixation of a subcapital fracture of the femoral neck with a dynamic hip screw (DHS).

for Garden III and IV intracapsular fractures of the femoral neck. All patients with Garden I and II injuries, pathological fractures, and mental confusion were excluded from the study cohort, as were bedridden patients. Patients were randomly allocated to either treatment groups based on their admission day to the facility. The protocol was approved by the ethical oversight committee of our institution. Patients were well matched in both groups for age, sex and degree of injury. Patients allocated to group A were treated with an uncemented hemiarthroplasty. Sixty two patients underwent hemiarthroplasty using a standard antero-lateral approach and an Austin Moore prosthesis (Howmedica, Rutherford, NJ) (fig 1). The 60 patients allocated to group B were treated with a closed reduction and fixation with a dynamic hip screw (AO Synthes) through a standard lateral approach (fig 2). Reduction was achieved using manual manipulation and maintained using the fracture table. All reductions were

considered anatomic at the time of surgery under fluoroscopic guidance.

All patients had a single suction drain removed on post operative day one and all received three doses of prophylactic second generation cephalosporin antibiotic. Patients were anticoagulated using low molecular weight heparin, which was discontinued on discharge from hospital. Physical therapy was started on the second postoperative day and ambulation progressed as tolerated until fit for discharge.

All patients were evaluated with a minimum follow-up of three years (range : 36 to 54 months). No patients were lost to follow-up, however 34 (22%) patients died of co-morbid conditions not related to the surgical intervention, within the follow-up period.

A functional and radiographic evaluation was used to determine outcome. The functional outcome of these patients was measured by physicians using the criteria of Matta *et al* (27) and by the patients using the SF-36

questionnaire. The Matta Scoring System uses three scoring parameters: pain, ambulation, and range of motion, each parameter having a highest possible score of 6 points and a lowest score of 1 point. The SF-36 was administered as a generic health assessment instrument to determine patient self-assessment outcomes. The SF-36 evaluates physical, mental and social functioning, as well as functional limitation caused by physical and emotional problems such as bodily pain, anxiety and depression, diminished energy levels and overall perceptions of health status. This questionnaire's scores have been found to be sensitive to change in the health status of patients, and have been validated as a summary outcome module in the orthopaedic literature (7, 8, 43). The incidence and nature of postoperative complications were noted, and the rate of revision surgery to a total joint arthroplasty was documented for each group. Data was analysed using a contemporary statistical package (SPSS 10, Chicago, IL, USA). Parametric comparison was performed using the Student *t* test and Chi squared test whilst non-parametric variables were evaluated using Fischer's exact test. Regression analysis was used to evaluate if independent variables could influence outcome. A power analysis of 89% was sufficient to eliminate type one and two errors.

RESULTS

Of the 62 patients in group A with hemiarthroplasty, 40 patients were female and 22 were male, with a mean age of 74 years (range: 70 to 87). In group B there were 42 female patients and 18 males, with a mean age of 72 years (range: 70 to 84). All patients had a minimum time to follow-up of 36 months (range: 36 to 54). There was no statistical difference between either group with regards to age, gender, or degree of injury ($p > 0.05$ for all variables). In group A, 26 patients (42%) had excellent/good results using Matta's scoring system and 36 patients (58%) had fair/poor results. In group B, 42 patients (70%) had excellent/good results and 18 patients (30%) had fair/poor results. The overall difference in outcome between the two groups was significant ($p < 0.001$). The SF-36 mean percentile score for group A was 50 (range: 26 to 77), and group B scored 74 (range: 39 to 90). There was a significant difference between the two groups ($p = 0.002$). A significant correlation was

also found between the physician based Matta scores and patient based SF-36 scores ($r = 0.64$).

In Group A, 10 patients (16%) required conversion to total joint arthroplasty; six patients due to loose prostheses causing pain, one patient due to recurrent dislocation, one patient due to acetabular protrusion, and two patients following periprosthetic fractures. In Group B, 14 patients (23%) required conversion to total joint arthroplasty; ten patients as a result of osteonecrosis of the femoral head, two patients secondary to non-union, and two patients owing to fatigue failure of the plate. There was no statistical difference between either group with regards to failure of the index procedure and re-operation rates. The one-year mortality rate was 17%, and at the three-year follow-up, it was 22% (34 patients of the overall cohort); there was a significant difference between the two groups with regards mortality, as 22 (65%) of the deceased were assigned to Group A treated with hemiarthroplasty ($p < 0.05$). The primary functional outcome results amongst patients that expired during the study period were similar when compared to the final outcomes of both groups. Regression analysis showed there was no correlation between age, gender, degree of injury and a poor outcome within the confines of the cohort.

DISCUSSION

Treatment of displaced femoral neck fractures in patients over seventy years of age is controversial. Little has changed since Dickson described this as the unsolved fracture over 60 years ago (9). Although numerous commercial systems are available for the management of these fractures, treatment can be broadly classified into two groups: reduction with internal fixation or replacement. The literature has previously attempted to address which modality of treatment has the best outcome.

In those investigations comparing internal fixation with hemiarthroplasty, several studies have supported the continued role of head replacement in displaced femoral neck fractures. Hui *et al* reported that hemiarthroplasty resulted in lower re-operation rates than the dynamic hip screw in a group of 29 octogenarian patients (19). Lu-Yao *et al*

in a meta-analysis of 106 reports comparing the two modes of treatment found a clear trend that arthroplasty, either hemi or total, was associated with fewer secondary operations than internal fixation (24). In addition, Riley *et al*, in a review of 151 patients, demonstrated that hemiarthroplasty gave better medium-term results than internal fixation with crossed Garden screws (34).

Despite these previously reported results, excellent results have been achieved using internal fixation. The work of Parker *et al* evaluating 200 patients over sixty-nine years of age gave similar results to those of previous authors (2, 41). Their study concluded that although there was little difference between the two modes of fixation at one year, there were less complications and shorter hospital stays amongst patients treated with internal fixation. Similarly, Lu-Yao *et al* have demonstrated that internal fixation compared favourably with hemiarthroplasty, resulting in marginally lower short-term morbidity and lower rates of deep infection (24).

The present study has demonstrated a lower non-union rate than previously reported in the literature for internal fixation. Koval *et al* reported rates of non-union to range from 9 to 35% (21). Even if we include fatigue failure of fixation material as a complication arising from a non-union or a delayed union, the overall non-union rate in their study is 6%. We believe this to be due to exact reduction and judicious screw placement. The femoral head in patients greater than seventy years has lost considerable compressive and tensile strength (5, 11) and thus positioning of screws along lines of maximal compression is essential (22). Garden has demonstrated that inexact alignment and posterior comminution are the major contributing factors in non-union of the femoral neck (13). Saito *et al* (37) and Sochart *et al* (39) demonstrated that union could be predicted on the basis of radiographic criteria post reduction, and that exact medial cortical alignment was critical to osteosynthesis. The risk of this adverse outcome can be reduced therefore by judicious placement of screws along the *calcar femorale* to prevent posterior collapse (13, 22).

Similarly, the rate of osteonecrosis is related in part to anatomic reduction. Garden has demonstrat-

ed that the rate of late segmental collapse is directly related to the adequacy of reduction. When the reduction was anatomic he reported no cases of osteonecrosis. Mild deviation of post reduction alignment was associated with a 6.6% incidence of osteonecrosis, whereas moderate and severe post reduction malalignments were associated with osteonecrosis rates of 65% and 100% respectively (12, 13). In the current investigation the authors report a rate of osteonecrosis less than 17%. This compares favourably with other reports that range from 20 to 35% (6, 38). In addition to the adequacy of reduction, decompressing the joint by arthrocentesis by aspiration may have reduced the intracapsular pressure and further reduced the risk of osteonecrosis. Although this method of initial treatment of hip fractures has been substantiated by experimental data, there exists little clinical evidence to support its routine use (4, 17, 26, 35). As such the current study did not include this as part of the treatment algorithm.

In as much as osteonecrosis can be regarded as an adverse outcome following internal fixation, it may be that radiographic outcome scoring systems are not relevant to patients' perception of outcome. Koval and Zuckerman report that in an analysis of four studies with 67 patients developing osteonecrosis, only 25 patients (37%) required further surgery secondary to symptoms (21). Barnes has confirmed these findings, reporting that just 30% of patients with late segmental collapse experienced significant disability (3).

The re-operation rate for the internal fixation group in the current study was 23%. This compares to previous studies (32, 36) that found a revision rate of 33% and 43% respectively in similar patient groups. It is important to emphasize that those patients requiring a second procedure following failed internal fixation tolerate the second procedure well. Parker reports one-year mortality rates for patients treated with a second procedure following failed internal fixation as 18%. In the same time period the mortality rate for re-operation secondary to failed hemiarthroplasty was 71% (30). Although the current authors did not observe the same mortality rates as Parker's study, we agree that failure of an Austin Moore hemiarthroplasty

and subsequent re-operation is a technically more demanding procedure with an associated increase in complications.

Several confounding factors can be identified in the current study. The rate of revision surgery either from loosening or from acetabular erosion may have been skewed by the choice of implant. Bipolar hemiarthroplasty systems, either cemented or uncemented, modular or conventional, may have reduced these complications as suggested by several previous investigators (9, 10, 29, 31, 35). Similarly, total hip replacement as an index procedure may have reduced the rate of subsequent revision surgery in the current study. Recent recommendations for treatment strategies in patients over 70 years suggests that total hip arthroplasty should be the treatment of choice when these patients are active and can walk greater than one mile prior to presentation (14). This recommendation has been underscored by corroborating evidence from studies showing similar excellent outcomes when total hip arthroplasty is used as a primary procedure in hip fractures and in the treatment of degenerative arthritis (1, 18). Despite this evidence that may confound the current study's outcome, there is some evidence to suggest that the Austin Moore hemiarthroplasty compares favourably with more contemporary prostheses. In a study of 173 patients comparing the Austin Moore with bipolar arthroplasty at 24 months follow-up, Marcus *et al* demonstrated that there was no significant difference between the two groups using the Harris hip score (25). Similarly, Lavernia demonstrated in a study comparing bipolar arthroplasty with Austin Moore hemiarthroplasty that operative times and hospital charges increased without a corresponding increase in functional benefit for patients treated with bipolar arthroplasty (23). Based on the finding of the aforementioned articles, this study chose the Austin Moore as a tried and tested mode of femoral head replacement, and therefore as a benchmark to which other methods could be compared (15, 16, 42).

The discrepancy in the literature regarding treatment outcomes of displaced femoral neck fractures may in part be due to methods used to determine outcome. Traditional physician based scoring systems weighted highly subjective criteria such as

range of motion and radiographic appearance. In one of the few papers looking at objective criteria, Nilsson *et al* found that patients treated with internal fixation had fewer problems with sleep and the performance of housework and generally functioned better than those patients who were treated with a primary total joint arthroplasty (28). Likewise, this study's use of the SF-36 scoring system has found that patient satisfaction is higher following internal fixation than following hemiarthroplasty. While the method of evaluating outcome may be sound, the time to follow-up in the current study may have biased reported outcome scores. At a minimum of three years of follow-up, the patients treated with internal fixation may have developed secondary osteoarthritis or late segmental collapse from osteonecrosis at a future time point. These later developments could bias the outcomes we report at a short to medium term follow-up. Similarly, in those patients treated with the Austin Moore prosthesis, acetabular erosion could be expected at a later time point, further confounding meaningful analysis at this short to medium term investigation. Despite that, the validity of reporting outcomes at a three year time point is legitimate. The early mortality following trauma related hip surgery in patients greater than 70 years is significant and evaluating outcome at long term follow-up may be redundant (20, 33).

Fifty years following Dickson declaring that the displaced femoral neck fracture was the "unsolved fracture" the current study may have helped in unravelling the controversy regarding the optimal treatment of these fractures. The Austin Moore prosthesis appears to be a satisfactory treatment for those patients with little mobility, reducing the potential for loosening and acetabular wear. Although contemporary total hip arthroplasty and hemiarthroplasty systems offer excellent outcomes in certain cases, the current study has shown that internal fixation, retaining the patient's original femoral head can give similarly excellent outcomes. With health care costs increasing and outcome analysis focussing on patient perception, attention will be directed at treating undisplaced femoral neck fractures in a cost effective and proficient fashion. Retaining the femoral head with

judicious reduction and internal fixation may satisfy these criteria.

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