Long-Term Outcomes Following Reduction and Fixation of Displaced Subcapital Hip Fractures in the Young Elderly

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ABSTRACT: **Background:** The surgical treatment of hip fractures remains controversial especially when considering age.

Objectives: To investigate the long-term functional outcomes of displaced subcapital hip fractures that were reduced and surgically fixed using parallel cannulated screws in patients aged 60 years and younger.

Methods: During the period 1996–2005, 27 patients under age 60 with displaced subcapital hip fractures classified as Garden III or IV were treated with fracture reduction and surgical internal fixation using cannulated screws. Patient outcomes were assessed using the Harris Hip Score (HHS) and physical examination.

Results: During a follow-up period of 8–17 years 4 of the 27 patients (14.8%) developed non-union/femoral head avascular necrosis and had undergone hip arthroplasty. All reoperations were performed within the first year after fracture fixation, all in the 50–60 year old age group. The revision rate among patients 50–60 years old was significantly higher than that of patients 50 years and younger (40% vs. 0%, $P = 0.037$). Mean HHS was higher for patients not requiring revision surgery (85.4) than for patients with revision surgery (75.5), but this difference was not significant.

Conclusions: Internal fixation using fracture reduction and cannulated screw fixation is a successful treatment modality for displaced subcapital hip fractures in patients under 50 years old. Patients aged 50–60 may have a higher risk of avascular necrosis or non-union and require arthroplasty, often within the first year after fracture fixation. The long-term outcome following these fractures is good when excluding patients who had early complications.

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KEY WORDS: femoral subcapital neck fracture, cannulated screws, fixation, Harris Hip Score (HHS), young elderly

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Hip fractures are among the most commonly seen fractures in emergency departments worldwide, occurring in over 350,000 people per year in the United States alone, most of whom are over 65 years old [1]. As medicine evolves, people are living longer, leading to a rising trend in osteoporosis, a harbinger of hip fractures. By 2050 this number is expected to rise to 700,000 cases in the U.S. annually. Consequently, medical costs will peak to an estimated 15 billion dollars, imposing an intense strain on the health system [2]. There will be many hurdles to overcome as resources become scarce and demand increases. One study evaluated the effect of seasonality, weather and holidays on hip fracture incidence in an effort to divert resources towards peak incidence rates and showed significant increases in hip fractures during the winter and on holiday festivals [3]. Hip fractures are an orthopedic emergency with associated mortality rates as high as 30% at 2 years [4]. Surgical management options include internal fixation, hemiarthroplasty, or total hip arthroplasty. Hip fractures of this kind have been studied extensively; however, less research has focused on the younger, 65 and under age group, i.e., the 'young elderly'.

Patients under age 65 with a hip fracture pose a difficult dilemma as compared to their older counterparts. The orthopedic surgeon must weigh the risks and benefits of attempting to allow the patient's own native bone to heal with screws versus replacing it with prosthetic implants. Of particular concern is the limited life expectancy of an implant. Radiographic signs of wear can be seen at 10–15 years with an associated implant survival of approximately 20 years for most polyethylene-on-metal implants [5]. One recent study analyzing implant survivorship of more than 29,000 primary total hip replacements in patients younger than 55 found a 77% survivorship of implants at the 16 year follow-up [6].

These young elderly patients are therefore destined to outlive their prosthetic components. They will inevitably require a difficult surgical revision later in life at a stage when they are older and have more co-morbidities. Future surgeries such as these consequently carry higher risks of complications and are associated with poorer functional outcomes. Orthopedic surgeons therefore strive to treat these fractures using internal fixation methods, leaving arthroplasty as a last resort.

A high volume of hip fractures are intracapsular subcapital [7]. There have been several acceptable methods of classifying these fractures, including the Garden, Pauwels, and AO classifications. The Garden and Pauwels classifications are shown in Figures 1 and 2, respectively. Intracapsular hip fractures are

Figure 1. Garden Classification:
Type I: Incomplete fracture (impacted valgus fracture)
Type II: Complete fracture without displacement
Type III: Complete fracture with partial displacement
Type IV: Complete fracture with full displacement

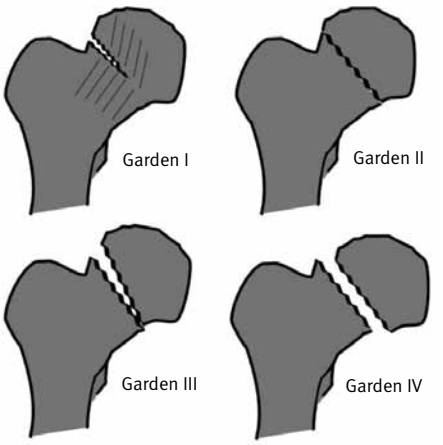
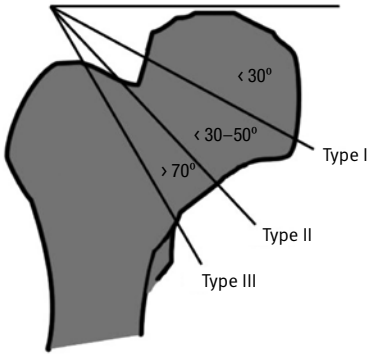


Figure 2. Pauwels Classification: Type I: < 30°, Type II: 30°–70°, Type III: > 70°



often associated with disruption of the femoral head blood supply, causing a high rate of non-union and femoral head avascular necrosis (AVN). One prospective study involving 1023 patients with hip fractures found the incidence of avascular necrosis to be 20.6% for patients under the age of 60 and 12.5% for those between 60 and 80 years old [10]. Still, numerous other studies have reported rates ranging anywhere from 12 to 86%, most likely owing to variable external factors such as time to surgery, anatomic reduction, capsular decompression, and stable internal fixation [9,11]. The main predictors of femoral head necrosis following subcapital fractures are the patient's age, the amount of fracture displacement, and the configuration of fracture fixation [9,11].

There is general agreement on the management of displaced femoral neck fractures at the age extremes: internal fixation for young patients and arthroplasty for elderly patients. An international survey showed a near consensus in management of displaced fractures in patients under 60 years old with 89% of surgeons favoring internal fixation over arthroplasty. A near consensus was also seen with patients over 80 years old with 94% favoring arthroplasty over internal fixation [12]. For patients aged 60–80 however, a discord in management was found, with 25% favoring internal fixation and 75% arthroplasty. The greatest controversy lay in the management of displaced fractures in active patients in particular, with 49% of respondents favoring internal fixation compared to 51% favoring arthroplasty [12]. Obviously, preserving the femoral head is of greater significance in the young and active than in the elderly and frail. Furthermore, the majority of respondents favored internal fixation over arthroplasty in terms of mortality, infection rate, surgical time, and blood loss [12]. Some disadvantages of internal fixation compared with arthroplasty are a slower time to mobilization, risk of femoral head necrosis, non-union, and a higher revision rate (31% vs. 8%) [13].

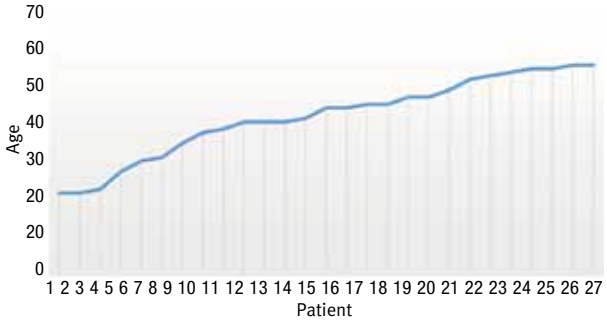
The purpose of this study was to investigate the long-term outcomes of displaced subcapital hip fractures treated with fracture reduction and internal fixation using parallel cannulated screws in the young elderly.

PATIENTS AND METHODS

A database of patients from our medical center was utilized for this study following approval from our ethics committee. Inclusion criteria were as follows: i) patients who had suffered a subcapital hip fracture during the years 1996–2005 after a mechanical fall, ii) displaced subcapital hip fracture classified as Garden III or IV, iii) age under 60, and iv) fracture reduction with parallel cannulated screw fixation. Thirty-nine patients met criteria i, ii, and iii. Of these, 12 had hemiarthroplasty, 0 had total hip arthroplasty, leaving 27 patients who fulfilled all four criteria. As evident in this data set, most of these hip fractures were treated with internal fixation as compared to arthroplasty, which is in accordance with the protocol of our medical center. Hemiarthroplasties were only performed in a minority of cases as this was based on surgeon's preference. All these fractures were classified as type 31-B according to the Orthopaedic Trauma Association classification system. Patients under age 50 were generally healthy with no preexisting co-morbidities. Two patients over age 50 had co-morbidities such as hypertension, diabetes, peripheral neuropathy, and urine incontinence.

Young elderly adults (< 60) who sustained a subcapital hip fracture and were found generally healthy and active were operated on within 8 hours of admission. An attempt at closed reduction was performed, under fluoroscopy guidance. If fracture reduction was not achieved, an open reduction through an antero-lateral approach was performed. Capsulotomy was not conducted routinely. Fractures were then fixed using three 7.3 mm cannulated screws through the femoral neck in an inverted triangle configuration.

Figure 3. Age Distribution



All patients were assessed for any postoperative complications, revision surgery or re-admission using the patient's electronic medical record as well as a scheduled patient interview. The Harris Hip Score (HHS) was used to assess functional outcome. Categories of the score included pain, limping, support, distance walked, sitting, ability to enter public transportation, climbing up or down stairs, putting on shoes and socks, absence of deformity, and range of motion [14]. Scores range from 0 to 100 with a grading scale of < 70 indicating poor, 70–79 fair, 80–89 good, and 90–100 excellent [15]. Patients were also examined by an orthopedic surgeon for any signs of arthritis, limited range of motion, and leg length discrepancy. Follow up hip X-rays (antero-posterior and axial) were obtained to evaluate fracture healing and to rule out radiographic signs of arthritis such as joint space narrowing, subchondral sclerosis, and osteophyte formation.

RESULTS

Of the 27 patients, 20 were male and 7 were female. At the time of evaluation we had follow-up data on 27 patients. However, since 7 of them were either deceased or refused to be seen and examined again, we could not obtain their final HHS scores but still included them in our survival analysis.

The mean age at the time of initial fracture was 44 years (range 23–59, median age 47, and interquartile range 15 years) [Figure 3]. There were 11 Garden IV fractures and 16 Garden III fractures. Mean duration of follow-up was 12.5 years (range 8–17); 17 patients were < 50 and 10 patients were > age 50.

The files of the seven patients lost to follow-up were scanned for reoperation. Of these, two were deceased due to other comorbid conditions, one of whom had a total hip replacement 8 months after fracture fixation. Another patient had undergone total hip replacement as well, and the other 5 did not. All 27 patients were included in the reoperative rate analysis. In total there were 4/27 reoperations (14.8%) (2 Garden III and 2 Garden IV fractures), all in patients 50–60 years old. These reoperations were due to either AVN or non-union. Three of these had a total hip arthroplasty; one had a hemiarthroplasty.

Figure 4. De-identified sample postoperative antero-posterior and axial X-rays of one of our patients at a follow-up visit, showing complete fracture site healing with good alignment and no signs of avascular necrosis or arthritis

All reoperations took place within the first year after fracture fixation. All reoperations were performed on patients older than 50 years (40% for patients 50 years and older vs. 0% for patients younger than 50, $P = 0.037$, confidence interval 3.06–76.9).

The distribution of Harris Hip Scores varied, with 3 patients having 'poor' functional outcomes, 4 patients 'fair', 3 patients 'good' and 10 patients 'excellent'. The mean score was 84 ± 16. No significant differences were found between patients younger (mean HHS 87.5) and older (mean HHS 80) than 50 years. Functional scores were available for only two of the patients who necessitated reoperations, with a mean HHS of 75.5, compared to 85.4 for those who were not reoperated; however, this difference was not found to be significant ($P = 0.336$).

X-rays showed complete fracture healing with none to mild arthritic changes [Figure 4]. One of the patients with a total hip replacement showed minor lucencies between the cement and prosthesis along with minor acetabular wear. The patient with hemiarthroplasty showed no signs of loosening.

DISCUSSION

The management of displaced subcapital hip fractures in young patients remains controversial. While arthroplasty provides predictable good outcomes, it is not recommended in young adults with a life expectancy that could outlive the prosthesis. Research of hip fractures in young patients has not been studied as extensively as in the older population. Previous reports on this age group showed relatively short-term follow-up [16-19], the longest being a mean 6.6 years as compared to 12.5 years in the present study. The purpose of our study was to report the long-term outcome of reduction and fixation of displaced subcapital hip fractures in patients younger than 60 years old.

The goals in treating subcapital hip fractures are to minimize patient discomfort, restore hip function and allow rapid

mobilization. Operative treatment options include open/closed internal fixation, hemiarthroplasty, or total hip arthroplasty.

Internal fixation involves the use of screws and/or plates to facilitate native bone healing. This option is indicated in younger patients with milder fracture patterns, whose fracture site has a high likelihood of healing. Hemiarthroplasty, also known as a "partial hip replacement," involves replacing the femoral head with a prosthetic implant. This is usually chosen with higher grade fracture patterns where the femoral blood supply has been disrupted, resulting in a low probability of fracture site healing. Hemiarthroplasty can either be unipolar or bipolar. Bipolar hemiarthroplasties have an articulating femoral head composed of two components whose shell moves within the acetabulum, designed in an effort to reduce acetabular cartilage wear and tear. Outcomes of unipolar vs. bipolar hemiarthroplasties have largely been controversial. One recent meta-analysis of over 1100 patients showed no statistical significant difference in functional score, dislocation rate, infection rate, acetabular erosion, operating time, blood loss, and length of stay [21].

Total hip arthroplasty involves replacing the acetabulum in addition to the femoral head. Also known as a "total hip replacement," this final option is indicated when a patient has concomitant severe acetabular pathology. This may be due to degenerative joint disease, rheumatoid arthritis, traumatic arthritis, developmental hip dysplasia, protrusio acetabuli, or malignant bone tumors affecting the acetabulum. Ultimately, management depends on a variety of factors including the patient's age, severity of fracture, and co-morbidities. Non-operative treatment is reserved for patients who are either demented non-ambulators or who pose a critical medical risk for surgery [7].

The rate of non-union and AVN leading to reoperation in this study was 14.7%, which is well within the 10% to 30% reported prevalence in the literature [16-20]. Interestingly, all reoperations were performed on patients older than 50 years, within the first year after the fracture. The long-term outcome for patients who did not need a reoperation was good to excellent in 72% of cases.

Prognostic factors affecting hip fracture outcome have been studied extensively. According to an American Academy of Orthopaedic Surgeons instructional course by Ly et al. [10], the key factors in the treatment of femoral neck fractures are time to diagnosis/surgery, anatomic reduction, capsular decompression, and stable internal fixation. Stable internal fixation is achieved by compression at the fracture site, effectively neutralizing the forces acting on the hip. According to a report by Asnis et al. [20], the purpose of fixation is to prevent posterior and varus migration of the femoral head, optimized by using small diameter guide-pins to determine screw position and length accurately, as well as the use of parallel screws which provide an atraumatic lag screw effect.

In a recent study by Yang and colleagues [11] of 202 patients, mean age 65, with both displaced and non-displaced subcapital fractures treated with three cannulated screws, the factors found to be significantly correlated with poor outcome included the degree of displacement of fracture, screw fixation with a triangle configuration (as opposed to inverted), increased screw-shaft subchondral purchase over the femoral neck, and borderline or unacceptable reduction. In another study, Gurusamy et al. [22] found that reduced spread of screws on a lateral X-ray was associated with increased risk of non-union.

Wongwai and co-scientists [23], however, showed that delayed reduction and fixation of these fractures also brings good results, so the timing of surgery is a matter of debate. Similar conclusions were drawn in other studies which showed no difference in outcome between immediate and delayed treatment of subcapital hip fractures in young adults [24,25]. One cause for this discrepancy may be a better optimization protocol for patients who have more co-morbidities and require additional time for medical clearance prior to surgery.

The main limitation of this study is the small number of patients. Furthermore, retrospective evaluation and a significant number of patients lost to follow-up diminish the quality of our evaluation. However, a major effort was made to locate all patients on the list, and in the case of lost to follow-up, medical records including those in other hospitals within the area were searched. As a result, we are confident that our reported reoperation rate is fairly accurate and reflects the reality of these cases.

CONCLUSIONS

Internal fixation using fracture reduction and cannulated screw fixation is a successful treatment modality for displaced subcapital hip fractures in patients younger than 50 years old. Patients aged 50–60 may have a higher risk of avascular necrosis or non-union and may require arthroplasty, often within the first year after fracture fixation. The long-term outcome following these fractures is good when patients who had early complications are excluded. More research with larger cohorts focusing on the "young elderly" population would be beneficial to confirm the findings of this study.

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