

Closed reduction and fixation of high-energy femoral neck fractures: Still a viable surgical treatment option.

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Abstract

Background: Femoral neck fracture causes disability if not treated properly and high-energy fractures usually have increased complication rates. Does closed reduction and internal fixation of femoral neck high energy fractures have increased complication rates?

Methods: We used closed reduction and internal fixation using 3 cannulated cancellous screws. There were 67 patients (39 male, 28 female) included in the study. Mean age was 46.5 years (18-75). All femoral neck fractures were secondary to high energy trauma. There were 12 type I, 18 type II, 32 type III, 5 type IV fractures according to Garden classification.

Results: Complications were as 1 long screw penetrating through the joint, changed with a shorter one, 1 initial failure, 3 nonunion and 3 avascular necrosis, converted to hemiarthroplasty.

Conclusions: Closed reduction and internal fixation is not inferior to open reduction and internal fixation with low complication rates.

Keywords: Femoral neck fractures, Closed reduction and internal fixation, Cannulated cancellous screw.

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Introduction

Femoral neck fractures (FNF) comprise a significant portion of hip fractures [1,2]. The majority are due to low-energy trauma in the osteoporotic elderly patient population. However, high energy trauma may cause FNFs in all age groups. FNF treatment is still controversial, yet there is increased tendency of fracture fixation over hemiarthroplasty in all age groups, including elderly patients in recent years. However increased rate of internal fixation failure is seen with increased age due to decreased bone density. Also increased rates of avascular necrosis (AVN) and nonunion are seen with displaced FNFs [2]. Open reduction and internal fixation (ORIF) as early as possible with intracapsular pressure decompression by aspiration of hematoma is suggested in literature for perfect reduction to prevent non-union & avascular necrosis (AVN) complications [3]. However closed reduction and internal fixation (CRIF) is also an option in suitable patients [4]. We looked for the AVN, nonunion, and malunion complication rate of CRIF compared to complication rates of ORIF in literature in high-energy trauma related femur neck fractures.

Materials and Methods

After obtaining institutional review board approval, a tertiary hospital database system was used to conduct a retrospective case-series study of patients who underwent CRIF of FNFs

from 2010 to 2014. Patient registry was reviewed for general demographics, mechanism of injury, fracture pattern, surgical procedure, and follow-up of patients. All patients ≥ 18 years old with high-energy trauma related FNFs were included in the study. All patients had closed fracture. Patients younger than 18 years, open fractures, low-energy fractures, multi-trauma patients, and concomitant systemic diseases, such as diabetes mellitus were excluded.

There were 67 patients (39 male, 28 female) treated with 3 cannulated screws in the study (31 right, 36 left hips). Mean follow-up time is 24.5 months (13 to 36 months). Mean age is 46.5 years (18 to 75 years). All patients were admitted to emergency department, mean admittance time is 2.5 h (1 to 4 h) after trauma. They had pelvis AP views for diagnosis, except 3 patients, whom needed computerized tomography (CT) for diagnosis. After diagnosis of FNF, skin traction with 3 kg's was applied until operation. Low molecular weight heparin was given subcutaneously. Antibiotic prophylaxis was done 1 h before operation. Surgery was done in less than 8 hours after admittance to emergency department in all patients. Operation time interval after trauma was between 7-10 h. Hematoma was drained with a needle under fluoroscopy guidance. Closed reduction was done in displaced fractures. Garden alignment index (GAI) was evaluated on fluoroscopy check after closed reduction maneuver. Displacement less than 2 mm, angle of compression trabeculae between 160-180

degrees on both AP and lateral views were accepted and fixation with 3 cannulated cancellous screws was done in all patients.

Isometric quadriceps exercises were begun routinely. Patients were mobilized toe touch with 2 crutches or a walker at postoperative 1st day. Suture removal was done at 2nd week. Low molecular weight heparin was continued until 2nd week control. X-ray control was done at 1st, 2nd, and 3rd, 6th, 12th months, then annually. Weight bearing as tolerated was allowed after 3rd month. Pain, range of motion, and limb shortening were controlled at follow ups. Fracture healing, reduction loss, malunion, fracture collapse, and avascular necrosis were controlled radiologically. University of California, Los Angeles (UCLA) activity score was done.

Results

During surgery, guide pin of cannulated screw was broken in two patients. At regular follow-up visits, screws were backed out and nonunion was diagnosed in one of the guide-pin broken patients, converted to hemiarthroplasty. There was not any other complication with the second patient. A patient had diagnosis of femur head penetration by a screw, therefore screw change with a shorter one was done. There were 3 nonunion (two hips Garden type 3, one hip Garden type 4) and 3 avascular necrosis of femoral head (AVN, one hip Garden type 3, two hips Garden type 4). All nonunion patients were informed for possible advantages and disadvantages of bone grafting and re-fixation, and arthroplasty surgeries. All 3 patients refused nonunion surgery, and asked for arthroplasty, therefore nonunion surgeries were converted to hemiarthroplasty (Table 1).

Table 1. Distribution of patients according to Garden classification, avascular necrosis and nonunion rates.

Garden Type	Number Patients	of Percentage	Avascular Necrosis	Nonunion
1	12	17.9%	0	0
2	18	26.8%	0	1
3	32	47.7%	1	2
4	5	7.6%	2	0

There was neither infection nor thromboembolic events in any cases. There was leg length discrepancy of 1 cm in 3 patients due to collapse of the neck during healing process. UCLA activity score was excellent in 40, good in 16, medium in 5, and bad in 6 patients. Mean fracture healing time was 6.2 months (3-13 months). Fracture healing occurred in 3 months were all Garden type I patients, except 13 months in one of Garden type I patients. AVN was seen in 1 Garden type 3, and 2 Garden type 4 patients, and UCLA activity scores were bad in these patients.

Discussion

FNFs are seen mostly in women. However, there is an increased rate of FNFs in young patient population and in males due to increased rate of traffic accidents and work related trauma [5]. Mean fracture age is between 71.5 and 78 years, and female proportion is between 77.6% and 83.7% reported in literature [6,7]. Female proportion found less in our study due to young age ratio in our population, high energy trauma such as traffic accidents, and fall from height. Simple falls is the first factor in etiology of FNFs. Traffic accidents and fall from a height are second and third factors in etiology reported in literature. In a series of 108 patients, 60% are simple falls, 20% traffic accidents, 11% fall from a height, and 9% as others were reported [5]. In our series, rate of fracture etiology were as 85% traffic accidents, and 15% fall from a height, and no simple falls or other, since we evaluate the high energy trauma related fractures. Majority of nutrient vessels pass through femoral neck, and the lack of periost on intracapsular part of the neck, high forces on femoral neck area precipitate devastating complications such as AVN and nonunion. There are a couple of factors effecting prognosis. First, vascular supply of the femoral head. Vessels crossing the neck may not rupture until displacement is more than 50% of neck diameter according to Claffey [8]. This data supports the decrease of AVN rate in early fracture reduction. Intracapsular hematoma may cause AVN due to disrupted venous flow [9]. Maruende et al. reported that intracapsular pressure increase is not related to displacement rate, but increases with internal rotation of the hip, and decreases with 3 kg of skin traction [10]. We used skin traction in all cases, with early reduction, and hematoma drainage done successfully.

Halt of blood flow to femoral head leads to deformation due to AVN, and is the leading cause for loss of reduction due to nonunion or union delay [11-13]. Deyerle investigated blood flow of femoral neck and head, and stated that FNFs should be an emergency problem [7]. According to Massie, there is a correlation between trauma-surgery time interval and AVN rate. This rate is 24% in 12-hours, and 100% in after a week of trauma-surgery time interval [14]. Therefore, FNFs surgery is an orthopedic emergency. Swiontkowski stated that early fixation, ideal reduction, and capsule drainage are three most important factors for successful surgery, and should be done in 12 h [7]. All patients were operated in less than 12 h in our study, however we used needle aspiration instead of capsular incision for hematoma drainage. Radiologic findings of AVN are seen as early as 2nd month, mean 5th-6th months, mostly seen in 2 years, but reported as late as 17th years. In our series, mean radiologic findings of AVN was 16th months (8-24 months). Nonunion rate after FNF is reported as 0% up to 42.5% in literature, and mean AVN rate after FNF is 30% in literature. Although high energy trauma FNFs, 3 patients had nonunion and 3 patients had AVN.

Multiple screw fixation is the preferred method in FNFs. Three screws are better than 2 screws biomechanically and 4 screws is not superior to 3 screws, and may increase AVN rate. We used 3 parallel cannulated cancellous screws for fixation [2,9].

When we analyzed early postoperative x-rays of these patients, reductions were suboptimal in hemiarthroplasty patients. However, these patients were also Garden type 3 & 4 patients. We cannot determine if failure was due to injury pattern, such as ruptured vessels, or displacement or due to suboptimal reduction. AAOS guidelines for Garden 3 or 4 in elderly patients, the treatment of choice is Total Hip Arthroplasty (THA) or HA. However, AO Surgery reference suggests in elderly patients with displaced femoral neck fractures and limited life expectancy, a HA or a THA are preferred treatment options. In general, the biological rather than the chronological age should determine the surgical management of femur neck fractures. There is no strong evidence in favor of either internal fixation or arthroplasty with regard to mortality [4]. Closed reduction can usually be obtained. In addition to these, there is better range of motion (ROM) of the hip with internal fixation compared to HA or THA. During informed consent, we explain the cons and pros of CRIF/ORIF and HA surgeries, patients usually choose internal fixation over HA due to cultural differences, daily living expectancies, such as sitting, eating and, praying on the floor. Therefore, our patients usually ask for increased ROM instead of immediate walking, the reason of outweighing fixation over HA surgery.

If Garden 3 or 4 fracture type is present, with osteoporosis, then dynamic hip screw with addition of one cannulated cancellous screw fixation is recommended for decreasing the failure rate. Also, if femoral neck fracture is vertical, then a valgisation subtrochanteric osteotomy can be added to femoral neck fixation to decrease the risk of failure [3,4]. Some valgus-impacted stable fractures can be treated conservatively, but it is limited to few cases of compliant patients. We also apply preceding recommendations in our practice. Since the subject of the study is high-energy femur neck fractures, osteoporosis related, low energy femur neck fractures are not present in the study. Besides these recommendations, all femoral neck fractures can be treated with cannulated cancellous screws. In our series, not only nondisplaced FNFs, but also displaced FNFs were also treated with CRIF. Only 3 patients had AVN, 4.4% in general study population, and 8.1% in displaced fractures, which necessitated additional surgeries for reconstruction with HA. AVN rates in our series is less than AVN rates of 10-15% in nondisplaced, and 30-40% in displaced fractures after ORIF surgery in literature [2,3,15]. Operation in less than 12 h in this study has lower AVN rates [2], we think less AVN rate is related to earlier surgery.

Three patients had nonunion, which could be treated with bone grafting and subtrochanteric valgisation osteotomy, however patients refused that preference and opted for HA surgeries. Our study has some limitations. First, it is a retrospective study. Half of patients were Garden type 3. There were not enough Garden type 4 patients. Closed reduction may not be successful in displaced fractures, which obligates for open reduction, however there isn't any ORIF patients in this study, hence we could only compare with historical literature AVN rates of ORIF. Therefore, it is a limitation for unable to compare open reduction and closed reduction of such displaced fractures.

Conclusions

FNF surgery is an emergency procedure. Earlier anatomic reduction and stable fixation are essentials of surgical treatment of FNF. Surgery should be done in less than 24 h, if possible in less than 12 h. Three-screw fixation with closed reduction is safe and still preferred option with minimal complication rates in good hands.

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