

Clinical results of treatment of garden type 1 and 2 femoral neck fractures in patients over 70-year old

S. K. Han¹ · H. S. Song¹ · R. Kim¹ · S. H. Kang¹

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Abstract

Introduction We retrospectively analyzed the clinical results of treatment of impacted or undisplaced femoral neck fractures (Garden types 1 and 2) by osteosynthesis in elderly patients >70-year old.

Materials and methods We retrospectively reviewed the radiological results of 52 patients who were followed up for at least 6 months from April 2002 to December 2008. The average age of the patients was 77.6 years (range 70–97 years), and 38 patients were females. The mean follow-up period was 11.7 months (range 6–19 months). Thirteen cases were Garden type 1 fractures, and 39 were Garden type 2 fractures. We assessed the relationships between the occurrence of complications and age, sex, Garden stage, bone mineral density (BMD), history of contralateral hip fracture, and any additional hip injury.

Results Major complications occurred in 18 cases (34.6 %), including nonunion (8 cases), osteonecrosis (6 cases), stress fracture of the subtrochanter (2 cases), excessive pull-out of a screw (1 case), and deep infection (1 case). The development of complications was associated with Garden stage 2, BMD, and additional hip injury. However, other factors were not associated with complications. Reoperations were performed in 16 cases (30.1 %), and 2 of the patients died during follow-up.

Conclusion A relatively high rate of complications or reoperations developed after treatment of Garden 2 femoral neck fractures in senile patients >70 years of age with

osteoporosis. Although internal fixation has been recommended in the literature for undisplaced femoral neck fractures, primary arthroplasty may be a better option for treatment of Garden type 2 fractures in elderly patients.

Keywords Femoral neck fracture · Garden type 1 and 2 · Elderly

Introduction

Fractures of the femoral neck in elderly patients are common and rarely managed nonoperatively. Surgical management options for femoral neck fractures include osteosynthesis, hemiarthroplasty, and total hip arthroplasty [1, 2]. The degree of displacement, age, level of activity, and the surgeon's preference are factors in deciding surgical options. However, there are no established clinical guidelines for indications or choice of surgical procedures for patients with femoral neck fractures.

Most surgeons prefer internal fixation in younger patients (<60 years old), regardless of fracture displacement [1, 3]. In elderly patients (>70 years of age) with displaced femoral neck fractures, superior clinical results—including short-term functional recovery, lower reoperation rate and greater cost–benefit ratio, and patient satisfaction—have been reported after primary arthroplasty compared to internal fixation [4–8], although the risk of complications such as infection, dislocation, and periprosthetic fracture threatens the survival of a prosthesis [9]. Therefore, primary arthroplasty is considered the preferred option for treatment of displaced femoral neck fractures (Garden types III or IV) in elderly patients [1, 3–9].

While optimal treatment for displaced femoral neck fractures in older patients remains controversial, the procedure

✉ S. H. Kang
gamjang@medimail.co.kr

¹ Department of Orthopaedic Surgery, St. Paul's Hospital, College of Medicine, The Catholic University of Korea, Dongdaemun-gu, Seoul 130-709, Republic of Korea

for impacted or undisplaced femoral neck fractures is clear. Internal fixation is the preferred treatment for Garden type I and II fractures, even in the elderly [3, 10, 11]. However, several studies have been reported that the clinical results of undisplaced fractures treated by osteosynthesis are not so satisfactory in the elderly patients due to osteonecrosis, nonunion, or residual pain [12, 13].

The aim of this study was to investigate the clinical results after surgical treatment of undisplaced femoral neck fractures. We retrospectively evaluated the factors that influence the clinical outcomes of in situ osteosynthesis in elderly patients with Garden stage I and II femoral neck fractures.

Patients and methods

We consecutively performed in situ fixation of impacted or undisplaced femoral neck fractures (Garden I and II) in 52 patients >70 years of age from April 2002 to December 2008. The average age of the patients was 77.7 years (range 70–97 years). The average body mass index of the patients was $22.2 \pm 3.5 \text{ kg/m}^2$. The mean follow-up period was 11.7 months (range 6–53 months). Exclusion criteria were patients with Pathological fractures, stress femoral neck fractures, combined shaft fractures, or had a delay of more than 48 h from injury to treatment. All radiological observations and measurements were made by two-observer agreement. There were 13 cases (25 %) of Garden type I fractures and 39 cases of type II fractures. Thirty-eight of the 52 patients (73 %) were females. The bone mineral density (BMD) T-score on the contralateral femoral neck, as measured by dual energy absorptiometry (DEXA), was taken at a mean of 6 days postoperatively. Six patients had a history of a contralateral hip fracture (four femoral neck and two intertrochanter). Patients with a history of contralateral hip fracture were excluded from the BMD measurement. Additional hip injury was considered when the patient complained of symptoms due to a slip or fall during the early postoperative period and who underwent a radiological examination. The implants used

included cannulated screws (44 cases), Dynamic hip screw (five cases), and Knowles pins (three cases). This study was approved by the institutional review board.

All operations were performed under general anesthesia. Undisplaced or impacted fractures had not been reduced before osteosyntheses were treated with multiple screws, pins, or Dynamic hip screw (DHS) on a fracture table. Capsulotomy and aspiration of fracture hematoma procedures were not used in all cases. We operated as soon as possible, and all surgeries were performed within 2 days. All patients were allowed partial weight bearing at 4 months postoperatively.

The statistical analysis was performed with Pearson's Chi-square test, analysis of variance, and Student's *t* test. All *p* values were two-tailed, and the significance level was set at 0.05. The analyses were performed using the SPSS software ver. 20.0 (SPSS Inc., Chicago, IL, USA).

Results

Major complications occurred in 18 cases (34.6 %), which included nonunion (8 cases), osteonecrosis (6 cases), stress fracture of the subtrochanter (2 cases), excessive pull-out of screw (1 case), and deep infection (1 case). The mean age of patients in the failed group was 78.1 years (range 70–84), and it was 76.5 years (range 70–97 years) in the successful group (Table 1). The proportion of male patients was 33.3 % in the failed group and 23.5 % in the successful group. Among 13 cases of Garden type I fracture, 3 cases had complications (23.1 %), including 1 nonunion and 2 AVN cases; whereas among 39 cases of Garden type II fracture, 15 cases had complications, including 7 nonunion, 4 AVN, 2 subtrochanter stress fracture, and 1 each of screw pull-out and deep infection (Table 2). A Garden type II fracture was significantly more common in the failed group (83.3 %) than in the successful group (70.1 %). The BMD T-score of the contralateral femur by DEXA was lower in the failed group (-3.22 ± 0.83) than that in the successful group (-2.80 ± 0.66). Two patients had a history of

Table 1 Factors related to failure

	Failed cases (<i>n</i> = 18)	Successful cases (<i>n</i> = 34)	<i>p</i> value
Age, years (range)	78.1 (70–84)	76.5 (7–97)	0.60
Sex (male/female)	6/12	8/26	0.15
Garden stage (I/II)	3/15	10/24	0.03
BMD (T-score, femoral neck)	-3.22 ± 0.83	-2.80 ± 0.66	<0.001
Contralateral hip fracture Hx. (%)	2 (11.1)	4 (11.8)	0.87
Hx. of additional hip trauma (%)	5 (27.7)	4 (11.8)	0.01
Type of implant (Knowles pin)	3	0	–

a contralateral hip fracture in the failed group and four patients had a previous hip fracture in the successful group. Additional hip injury developed in nine patients during the early postoperative period. The hip trauma had various causes, such as slip during crutch walking, in the toilet, careless full weight bearing, or a fall from a bed during hospitalization. Almost all implants used for fixation were cannulated hip screws (84.6 %). Among 44 cases with the usage of cannulated screws, 14 cases

developed complications. Among 5 cases with the usage of the DHS, 1 case showed the complication of deep infection and all 3 cases with Knowles pins occurred complications of 1 nonunion and 2 osteonecrosis.

The development of complications was associated with Garden stage 2, BMD, and additional hip injury. However, other factors—such as age, sex, and history of contralateral hip fracture—were not related to complications. Reoperations were performed in 16 cases (30.1 %); among them, two patients died during follow-up. Total hip arthroplasties were performed in five cases of osteonecrosis at a mean of 21.2 months (range 5–49 months) after the initial operation. All nonunited cases were treated by hemi- or total hip arthroplasty (Fig. 1). Reoperations were performed for stress fractures of the subtrochanter using a bipolar hemiarthroplasty with a trochanteric cable plate (Fig. 2). Two patients (one osteonecrosis and one deep infection), who were in poor general condition for general anesthesia, died during follow-up.

Table 2 Complications according to Garden types

	Garden type I	Garden type II
Nonunion (8)	1	7
Osteonecrosis of femoral head (6)	2	4
Subtrochanter stress fracture (2)		2
Screw pull-out (1)		1
Deep infection (1)		1

Fig. 1 A 70-year-old male patient with a right femoral neck fracture due to a slip. **a** Radiograph shows complete but undisplaced femoral neck fracture (Garden type 2). **b** Postoperative anteroposterior radiograph shows that the femoral neck fracture was fixed with a Knowles pin. **c** Nonunion with collapse developed 2 months postoperatively

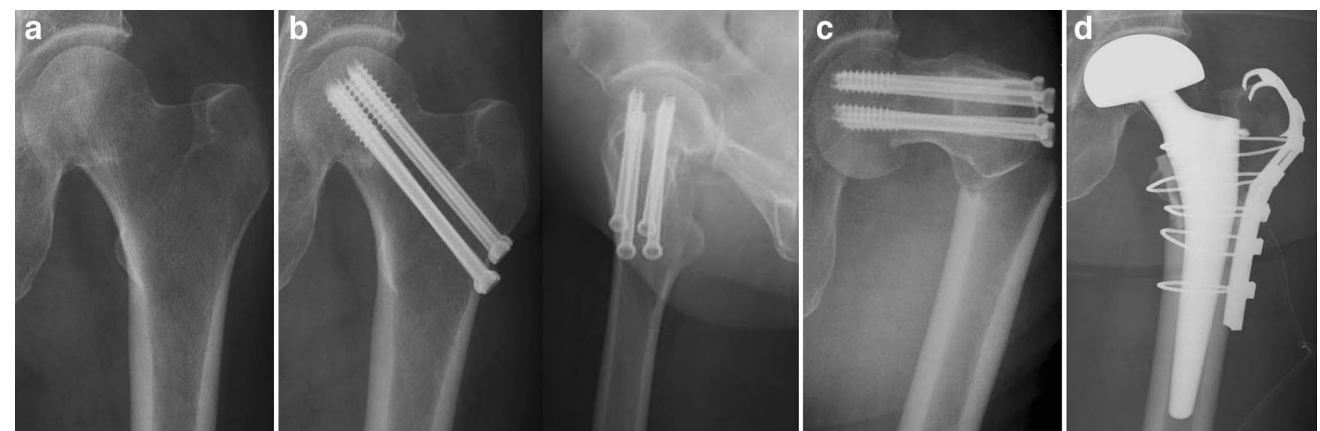
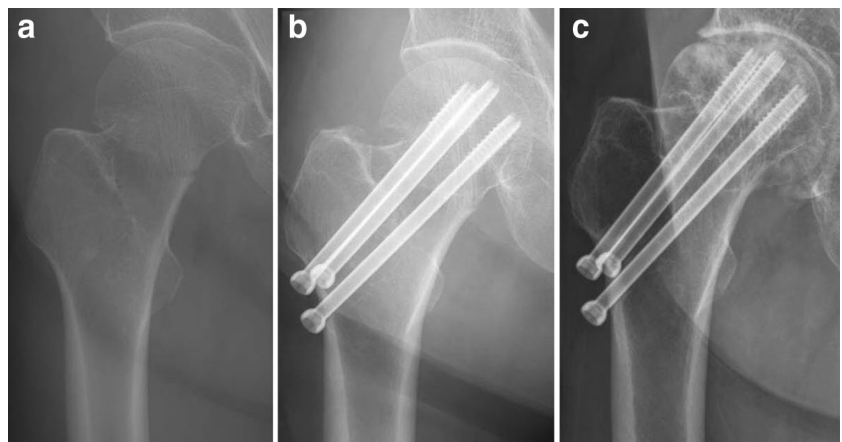


Fig. 2 A 73-year-old female patient with a left femoral neck fracture. **a** Radiograph shows undisplaced left femoral neck fracture. **b** The fracture was fixed with four cannulated hip screws. **c** A subtrochan-

teric stress fracture occurred 3 days postoperatively when the patient fell from bed due to delirium. **d** Bipolar hemiarthroplasty was performed with a trochanteric cable plate at 5 days postoperatively

Discussion

The incidence of undisplaced femoral neck fractures is approximately half that of displaced fractures [14]. The problems after treating displaced femoral neck fractures have been investigated extensively, but less attention has been paid to undisplaced fractures. Debate exists about the need for operative management of an undisplaced femoral neck fracture. It has been suggested that elderly patients with medical comorbidities are at high risk for anesthesia, and surgery-related complications can be managed nonoperatively. However, the advantages of surgical fixation for undisplaced fractures are early patient mobilization and minimal risk of subsequent displacement of an undisplaced fracture [15].

According to the guidelines of the German Society of Trauma Surgery, the surgical treatment method for undisplaced femoral neck fractures is osteosynthesis regardless of age or bone quality [3, 10, 11, 16]. In all related literatures, no specific fixation method shows significantly better results. The most common method is internal fixation using percutaneous pinning with cannulated screws or the dynamic hip screw (DHS). DHS has the locking plate feature with plate and has the greater stability than cannulated screws, so it prevents varus displacement or rotational instability, especially in osteoporotic bone [17, 18]. On the other hand, an advantage of cannulated screws is the minimal invasive technique with shorter incision, less blood loss and a shorter operation time compared to the dynamic hip screw [19, 20]. Considering these advantages of cannulated screws including relatively quick and simple procedure, especially in elderly patients with preexisting comorbidities, we treated most of elderly patients with stable (Garden type I/II) femoral neck fractures using percutaneous cannulated screws in our study. However, some studies have reported unsatisfactory clinical results after treating undisplaced femoral neck fractures by osteosynthesis, particularly in senile patients [12, 13, 21]. So the trend in surgical management of femoral neck fractures is changing. The advantages of arthroplasty over osteosynthesis for undisplaced neck fractures are lower readmission and reoperation rates [10]. Furthermore, early arthroplasty allows for earlier weight bearing in senile patients with a femoral neck fracture compared to internal fixation. Despite the lack of published studies on this topic, some orthopedic surgeons have advocated that an undisplaced intracapsular fracture in an elderly patient should be treated with hip arthroplasty [12, 21, 22].

The rate of nonunion after internal fixation for an undisplaced femoral neck fracture was 15.4 % in our series. Although nonunion is less common in undisplaced than in displaced fractures, the rate of nonunion after internal

fixation for an undisplaced fracture varies (5.4–31.0 %) [11, 13, 22, 23]. An increased risk for intracapsular hip fractures and nonunion is observed with older age [21]. Chen et al. [24] reported a high overall failure rate (16.2 %) in patients >80 years of age with undisplaced femoral neck fractures treated with fixation and cannulated screws.

In our series, higher complication (34.6 %) and reoperation rates were noted compared to those in previous reports [10, 13, 14, 25, 26]. However, clinical results after internal fixation for undisplaced femoral neck fractures are favorable (13–33.9 %). Additionally, 1-year implant survival is 89 % after screw fixation in hip registry reports [10, 27]. Senile patients, poor bone quality, vulnerable vascular supply to the femoral head, and other difficult situations for rehabilitation in aged patients are the reasons for implant failure.

Whether a sex difference is a predictive factor in the treatment of undisplaced femoral neck fracture is unclear. Parker et al. [21] reported an increased risk for intracapsular hip fractures with nonunion in females. However, no relationship between sex and fracture-healing complications was observed when undisplaced intracapsular fractures were treated by internal fixation in a large series [11]. In our study, no relationship was observed between sex and failure after treatment of an undisplaced femoral neck fracture.

Garden type I femoral neck fractures are incomplete or impacted fractures. They have intrinsic fracture stability and resist fracture displacement. Garden type II femoral neck fractures are complete but undisplaced. The difference in the clinical outcomes between Garden types I and II fractures has not been clearly defined. It has been reported that the degree of impaction of an undisplaced intracapsular fracture treated with internal fixation affects the likelihood of healing complications [11]. Among 34 cases in the successful group, 13 (38.2 %) were Garden I type fractures. Only three cases in the failed group were Garden type I fractures, and the proportion of Garden type I fractures was significantly lower in the successful group in our series.

It is generally accepted that bone quality is—at least in part—responsible for enhancing the stability of fixation and the overall healing potential. A biomechanical study in cadavers showed positive correlations between measures of proximal femoral density and fracture fixation [28]. However, clinical studies have not been definitive in terms of establishing bone quality as a critical factor. In one prospective multicenter study, no difference was found in the rates of revision arthroplasty in patients with osteoporosis or osteopenia treated with a variety of fixation methods [29]. Although age and bone quality may be related to the strength of fixation and healing potential in patients with femoral neck fractures, the relative importance of each of these factors has not been demonstrated. We obtained the

result in our study that osteoporosis has influence on the occurrence of complications. However, due to small number of each complication case and the various fixation devices used, we could not conclude the association with specific complication.

A subtrochanteric fracture occurred after femoral neck screw fixation in two cases (3.9 %). One patient was injured by a fall from bed during hospitalization, and one patient slipped after discharge. Jansen et al. [30] reported complications after screw fixation of femoral neck fractures in patients >65 years of age. The overall incidence in the literature is 2.4–4.4 %. Serious complications can be caused by high physiological stress on the subtrochanteric area, as inserting screws weakens osteoporotic bone in elderly patients. Furthermore, additional injury may worsen a stress fracture. Screw fixation with a high valgus angle and aggregated screw insertion should be avoided to prevent a subtrochanteric fracture after screw fixation for a femoral neck fracture. Additional hip injury due to a fall or slip during the early postoperative period should be prevented by careful education and protection of elderly patients.

The results of undisplaced or impacted femoral neck fractures treated with Knowles pins and cannulated screws were comparable [26]. The reoperation rate after fixation with Knowles pins was 13 %. However, in our study, when a Knowles pin was used for fixation, the failure rate was high (three of three patients). The relationship between failure after fixation of an undisplaced femoral neck fracture and the type of implant used was not significant due to the small number of cases.

The limitations of this study include the short follow-up, the small number of cases, the various fixation devices used, and the fact that there was no comparative study between internal fixation and primary arthroplasty. Additionally, we could not evaluate patient physical activities or combined medical illness, which can affect the surgical outcome.

Conclusion

In summary, the conventional treatment for undisplaced intracapsular fracture is internal fixation. However, a higher than expected rate of complications—such as nonunion and avascular necrosis of the femoral head—developed in stable femoral fractures in our series. Reoperations were necessary in patients who could ambulate before the injury. Therefore, we recommend that the primary arthroplasty is a treatment option to avoid these complication or reoperation in elderly patients with osteoporotic, undisplaced Garden type II fractures.

Conflict of interest Hyun Seok Song, Suk Ku Han, Ryul Kim, and Soo Hwan Kang declare that they have no conflict of interest.

Ethical standard All authors obey the rules of Helsinki Declaration and no ethic problem exists in the manuscript. This study was approved by the institutional review board.

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