



Original Article

Femoral neck fracture in end-stage renal disease treated with osteosynthesis

Kin Weng Wong, Wei-Ting Lin*, Chi-Sheng Chien, Chung-Da Wu

Department of Orthopaedics, Chi-Mei Medical Center, Tainan, Taiwan

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ABSTRACT

Background: Treatment of femoral neck fracture is well documented in the literature. Femoral neck fractures in patients aged < 65 years are generally treated using closed reduction and internal fixation, while hemiarthroplasty is the treatment of choice for patients > 65 years. In specific populations, such as patients with end-stage renal disease (ESRD), this protocol is usually observed. However, unsatisfactory results and a large number of complications have been reported. It is questionable whether this protocol is the appropriate treatment and it may require modification for use in ESRD patients.

Materials and methods: The results of this study are in regard to the treatment of a consecutive series of 20 patients with femoral neck fractures and ESRD over a 7-year period. All of the patients were treated using closed reduction and internal fixation.

Results: Eight of 13 (61.5%) patients developed nonunion (of which 5 were classified as displaced fractures). Six of these eight patients were subsequently treated with hemiarthroplasty (75%). Five of these 13 patients (38.4%) achieved union; all of these were classified as nondisplaced fractures. In patients < 70 years, five of 11 patients demonstrated nonunion (45.5%), of which all were classified as displaced fractures. The mortality rate of this series was 33.3% (5 of 15 patients).

Conclusion: We determined that a femoral neck fracture in an ESRD patient is a unique case and should be treated differently from general treatment protocols. It is suggested that regardless of patient age, nondisplaced fractures should be treated with osteosynthesis, while hemiarthroplasty is a better treatment for displaced fractures.

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1. Introduction

The number of patients with end-stage renal disease (ESRD) is increasing. Metabolic bone disease is observed in 75–100% of patients with ESRD, and this leads to an increased incidence of fractures in this population.¹ The relative risk of hip fracture in ESRD patients on dialysis has been estimated to be 4.4 times that of the general population.^{2,3} Operative treatment is the currently the preferred method for treating hip fractures in ESRD patients.⁴ Surgical treatment can be successful, assuming a thorough preoperative medical evaluation and meticulous postoperative follow-up examination are performed.⁵ Despite best efforts, hip fractures in ESRD patients are associated with a high risk of morbidity and mortality.^{5,6} Rates of nonunion and avascular necrosis (AVN) as high as 83.3% were reported by Kalra et al⁷ in

comparison with 20–36% observed in the general population.² In the series reported by Karaeminogullari et al, treatment with osteosynthesis resulted in nonunion in all nine hips with a displaced femoral neck fracture.⁵

Femoral neck fractures in ESRD patients treated with osteosynthesis appear to exhibit higher nonunion rates than the general population. This study assesses the results and complications that arose from internally fixed femoral neck fractures in ESRD patients who were treated at our study center. A modified treatment, philosophy, and protocol were established in order to reduce the rate of complications.

2. Patients and methods

The hospital's clinical coding system was searched from December 2002 through December 2009 using the key words “hip fractures” and “end-stage renal disease.” Patients were included in this study if they demonstrated radiographic proof of a femoral neck fracture and were currently on dialysis.

One independent investigator reviewed the medical records and details of each patient. The age at the time of fracture, sex,

* Corresponding author. Chi-Mei Medical Center, 901 Chung Hwa Road, Yung Kang City, Tainan 710, Taiwan. Tel.: +886 6 2812811; fax: +886 6 2828928.

E-mail address: kinwengw@yahoo.com (W.-T. Lin).

mechanism of injury, fracture pattern, type of initial and secondary surgical procedures, mortality, and complications were recorded.

The femoral neck fracture patterns were classified using Garden's classification.⁸ Garden 1 and 2 were classified as non-displaced fractures, while Garden 3 and 4 were classified as displaced fractures (Fig. 1). Adequate internal fixation was defined as the contacted fracture site and screw tip being within two of three sectors of the femoral head in both the AP and lateral views and the tip apex distance being < 10 mm.

Treatment involved internal fixation of both displaced and nondisplaced fractures in younger patients (age: ≤ 65 years) and nondisplaced fractures in more elderly patients (age: > 65 years). For displaced fractures in the more elderly patients, primary hemiarthroplasty was performed and these cases were excluded from this series. Dynamic hip screws (DHS) or AO system cannulated screws of 6.5 mm or 8.0 mm were used, depending on the size of the bone. A fracture table was used to perform reduction (Fig. 2). Before fixation, adequate reduction was first achieved under fluoroscopy.

Prophylactic antibiotic treatment (1 g cefazolin administered intravenously) was continued for 24 hours after the operation. All patients who had primary internal fixation were advised of the requirement for nonweight-bearing ambulation for 3 months after surgery, and only partial weight bearing was allowed thereafter.

The minimum follow-up period was 12 months. Nonunion was defined as a fracture line that was still visible after 12 months. AVN was defined as late segmental collapse of the femoral head.

The differences between patients with union and nonunion were studied. Correlations between age, fracture pattern, and clinical outcomes were analyzed. The Fischer exact test was used to perform the statistical analyses.

3. Results

3.1. Patient demographics

A total of 1908 femoral neck fractures were treated over the 7-year period. Twenty femoral neck fractures were identified in ESRD patients who fulfilled the criteria of this study (1.0% incidence rate). There were 11 male and nine female patients. The mean age was 64.75 ± 12 years (range: 43–85 years). Twelve nondisplaced fractures and 8 displaced fractures were identified.



Fig. 1. A 70-year-old male with a right femoral neck-displaced fracture.



Fig. 2. Femoral neck fracture was reduced and fixed using cannulated screws.

Simple falls and traffic accidents were the major causes of fracture. No pathological fractures were noted. A total of 18 fractures were fixed with cannulated screws and two were fixed with DHS.

Nineteen patients received regular hemodialysis and one patient received continuous peritoneal dialysis (CAPD). The mean postoperative follow-up period was 22 ± 4.3 months (range: 12–88 months). Five patients were lost on follow up during this period (patients 1, 9, 10, 13, and 17) and two patients died within a year (patients 7 and 11), leaving thirteen patients in the series. The patient demographics are summarized in Table 1.

3.2. Clinical outcomes

3.2.1. Fracture patterns

Of the 13 patients, eight (61.5%) demonstrated nonunion during the follow-up period (Fig. 3). Six patients in this nonunion group underwent a second operation, two of whom received cemented Austin-Moore hemiarthroplasty, two received cemented bipolar hemiarthroplasty, and two received uncemented bipolar hemiarthroplasty (Fig. 4). Of all the patients with nonunions, five were displaced fractures while three were nondisplaced fractures. The mean age was 62.4 ± 12.3 years (range: 49–85 years). In the displaced fracture group, the number of second operations was significantly higher than that of the nondisplaced group ($p = 0.005$). The mean period until the second operation was 8.8 months (range: 4–29). For those patients who underwent a second operation with hemiarthroplasty, no complications, such as stem loosening or subsidence, were noted on the last follow-up examination.

Of the 13 patients, five (38.4%) demonstrated union, two of which exhibited the appearance of AVN on the radiographs. All five unions were classified as nondisplaced fractures.

3.2.2. Age

Seven patients were < 70 years: two exhibited nondisplaced and five exhibited displaced fracture patterns. On follow-up examinations, five nonunions developed, all of which were classified as displaced fractures. All patients with nonunions underwent a second operation with hemiarthroplasty. The clinical outcomes are summarized in Table 2.

3.2.3. Morbidity and mortality

A total of five patients died on follow up, yielding a mortality rate of 33.3% (5 of 15). Two patients died within 6 months after the initial injury, the other three died within 5 years. Three patients

Table 1
The patient demographics.

Case	Gender	Age	Fracture Type	Primary operation	Second operation	Timing of 2nd operation (Months)	Re-operation cause	Duration of follow up (months)	Outcome
1	F	57	Displaced	Cannulated screws	-	-	-	-	Lost follow-up
2	F	52	Displaced	Cannulated screws	Autin-Moore hemiarthroplasty	4	Non-union	88	Nonunion
3	F	75	Nondisplaced	Cannulated screws	Autin-Moore hemiarthroplasty	21	Non-union	50	Death at 50 months
4	M	53	Displaced	Cannulated screws	Bipolar hemiarthroplasty	10	Non-union	19	Death at 19 months
5	F	54	Displaced	Cannulated screws	Bipolar hemiarthroplasty	3	Non-union	36	Death at 36 months
6	F	72	Nondisplaced	Cannulated screws	-	-	-	16	Nonunion
7	M	73	Nondisplaced	Cannulated screws	-	-	-	1	Death at 1 month
8	M	62	Displaced	DHS*	Bipolar hemiarthroplasty	29	Non-union	40	Nonunion
9	M	74	Nondisplaced	Cannulated screws	-	-	-	-	Lost follow-up
10	M	43	Nondisplaced	Cannulated screws	-	-	-	-	Lost follow-up
11	M	60	Nondisplaced	Cannulated screws	-	-	-	6	Death at 6 months
12	F	80	Nondisplaced	Cannulated screws	-	-	-	15	Union (AVN appearance)
13	M	71	Displaced	Cannulated screws	-	-	-	-	Lost follow-up
14	F	49	Displaced	Cannulated screws	Bipolar hemiarthroplasty	13	Non-union	20	Nonunion
15	F	77	Nondisplaced	Cannulated screws	-	-	-	19	Union
16	M	85	Nondisplaced	Cannulated screws	-	-	-	17	Nonunion, screw back out
17	M	79	Displaced	DHS* + cannulated screws	-	-	-	-	Lost follow-up
18	F	67	Nondisplaced	Cannulated screws	-	-	-	13	Union
19	M	52	Nondisplaced	Cannulated screws	-	-	-	20	Union (AVN appearance)
20	M	60	Nondisplaced	Cannulated screws	-	-	-	12	Union

* DHS = Dynamic hip screws; AVN = Avascular necrosis.

died of pneumonia, one died of intra-abdominal infection, and the other died of an acute myocardial infarction.

3.2.4. Telephone survey

For the last follow-up examination, which was performed in December 2010, only 10 of 20 patients were interviewed. Five patients demonstrated union and the other five demonstrated nonunion. Of those unions, four were not in pain and walked with support and one patient was very old and could hardly walk. Of the nonunions, three patients had undergone revision of a failed internal fixation to total hip arthroplasty. All of these patients underwent revision surgery and were not in pain and were able to walk without support. The other two nonunion patients were bedridden and in poor general condition.

4. Discussion

Recent published evidence strongly supports the use of early surgical treatment for the treatment for femoral neck fractures in patients on dialysis.⁵ Schaab et al⁹ reported that patients with chronic renal failure who had a hip fracture and were nonsurgically treated typically died within the first few years because of the lack of mobility. In a report by Tzamaloukas et al,⁴ surgical treatment of femoral neck fractures was recommended despite the high risk of perioperative and postoperative complications in ESRD patients. Early mobilization was found to reduce the number of early complications and the occurrence of early mortality.

The alternatives to surgical treatment for femoral neck fractures are osteosynthesis and arthroplasty. As far as we know, there is no



Fig. 3. A right femoral neck fracture that was fixed with screws developed nonunion and the screws backed out.

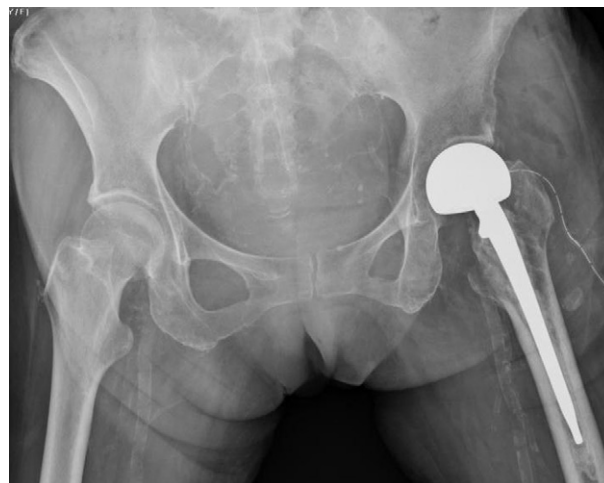


Fig. 4. Revision surgery with cemented bipolar hemiarthroplasty.

Table 2
The clinical outcome.

Patients	Fracture pattern		Age (year-old)		Second operation
	Nondisplaced	Displaced	< 65	> 65	
Union (5)	5	0	2	3	0
Nonunion (8)	3	5	4	4	6
Total (13)	8	5	6	7	6

large series in the literature that reports the results of osteosynthesis for treating femoral neck fractures in patients on long-term dialysis. In the series reported by Kalra et al,⁷ five of six femoral neck fractures treated with osteosynthesis developed nonunion or AVN and subsequently needed revision to arthroplasty. Karaeminogullari et al⁵ reported a high number of complications in their series, wherein nine of 13 femoral neck fractures treated with osteosynthesis exhibited nonunion. Similar to these findings, the results of this study show a high rate of nonunion (61.5%; 8 of 13 patients) compared with that of the general population, which ranges from 20–30%.² Of all eight nonunions observed in this study, six underwent revision surgery, providing a revision rate of 46.1% (6 of 13). The remaining two patients were conservatively treated because they were bedridden and in such poor general condition that a second operation was inadvisable. For these fractures, renal osteodystrophy and osteoporosis resulted in both biological and mechanical failure.

All of the fractures in this study were fixed with cannulated screws, except for two patients (patients 8 and 17) who were fixed using DHS with or without an antirotation screw. DHS was chosen because the fracture patterns were similar to that of a basal neck fracture when examined using intraoperative fluoroscopy.

Kalra et al⁷ suggested that primary arthroplasty be used to treat such fractures despite any displacement of the fracture pattern. Sano et al¹⁰ preferred arthroplasty with the hope of treating the patients once and for all, without resorting to revision. Osteosynthesis takes time to achieve bone union and is likely to result in nonunion. In this study, five out of eight nondisplaced fractures (62.5%) exhibited union, while the fractures in the remaining three patients exhibited nonunion (37.5%; 3 of 8 patients). The rate of complications in this study is higher than that of the general population. Rogmark et al¹¹ reported that 15% of the patients in the series that they studied required a subsequent operation; 11% were considered failures (mostly due to avascular necrosis) and 9% required a secondary arthroplasty. Nevertheless, the revision rate was not as high as the rate reported by Kalra et al (83.8%; 5 of 6).¹² Because of the small number of patients in this study, it is impossible to conclude whether primary arthroplasty should be the treatment of choice for nondisplaced fractures in ESRD patients. However, it appears that nondisplaced femoral neck fractures in ESRD patients can heal, albeit with a lower tendency to produce union. Moreover, osteosynthesis requires a shorter operation time and is less invasive than arthroplasty.

In the displaced fracture group, all five patients (100%) exhibited nonunion on follow up. All of these patients underwent revision surgery. Arthroplasty, using either Austin-Moore or a bipolar prosthesis, was performed depending on the patient's age. Patients < 65 years were treated with bipolar hemiarthroplasty, while older patients were treated with Austin-Moore hemiarthroplasty. Uncemented arthroplasty has become increasingly popular for treating a variety of hip diseases, but it is not widely used in patients who are undergoing dialysis because of concerns that poor bone stock in association with chronic renal failure would make it less possible to achieve a secure and reproducible initial press fitting to the uncemented device.¹³ However, Nagoya et al¹⁴ reported good results for uncemented, extensively porous-coated implants in patients who

were undergoing hemodialysis. Nevertheless, the debate continues. For this study, the choice between cemented or uncemented bipolar hemiarthroplasty was made according to the surgeon's preference. In this series, no stem loosening or sinking was noted in any of the revision hemiarthroplasties at the last follow-up examination.

The overall mortality rate of this series was 33.3% (5 of 15 patients). This is comparable to the documented rate of patients without renal failure who have femoral neck fractures and are treated with osteosynthesis.^{11,15}

Femoral neck fractures in the general population aged < 65 years are generally treated with osteosynthesis.¹⁶ Lu-Yao et al² showed that although internal fixation is associated with a higher rate of failure, it offers patients a long-term chance of regaining normal hip function. Mataliotasis et al¹⁷ used similar strategies for treating femoral neck fractures in younger patients with renal osteodystrophy. All fracture patterns, except those of patients who developed coxarthrosis, were treated with osteosynthesis. Revision osteosynthesis using vascularized fibula grafts has been proposed for the treatment of cases of femoral neck fracture that resulted in osteonecrosis.¹⁸ The use of endoprosthesis has been performed when osteosynthesis failed. In this series, it was noted that five out of 11 patients < 65 years developed nonunion. All nonunions developed from initially displaced fractures. Secondary revision surgery was subsequently performed, but three patients died on follow-up. In view of the high risk of nonunion or AVN following osteosynthesis, we believe that primary arthroplasty should first be considered for treating displaced femoral neck fractures in ESRD patients, even in younger patients. Nondisplaced fractures should be treated with osteosynthesis.

This study is limited, however, because of its small sample size ($n = 20$). Five patients were lost on follow up and two died within 6 months of the initial operation. These dropouts might have affected the results. Larger series are required to allow the specific assessment of the current protocol for treating femoral neck fracture in patients with renal failure.

5. Conclusion

The results of this study suggest that nondisplaced femoral neck fractures in ESRD patients should be treated using osteosynthesis. Primary arthroplasty is recommended for displaced fracture patterns, regardless of the patient's age.

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