

Displaced Femoral Neck Fractures: Anatomic Reduction or Early Surgery?

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ABSTRACT

Objective: Femoral neck fractures are treated with arthroplasty options in elderly patients. In young patients, the aim of the treatment is to protect the hip joint and its functions. In this study, the effect of the timing of surgery and reduction quality on the development of avascular necrosis in patients aged 15-60 years with Garden types 3 and 4 femoral neck fractures were retrospectively analyzed.

Methods: Patients who underwent treatment in our clinic between 2009 and 2016 were retrospectively evaluated. The patients were classified into two groups, including those who underwent surgery within the first 8 hours after injury (mean time, 301 min) and those who underwent surgery 8 or more hours after injury (mean time, 1750 min). The patients were classified according to the Garden classification based on their preoperative radiographs. Reduction quality was evaluated through the Garden Alignment Index using postoperative radiographs. Postoperative radiographs were evaluated on the 1st, 2nd, 3rd, 6th, 12th, 18th, and 24th month after surgery, and the osteonecrosis classification was made using the Ficat-Arlet method.

Results: No significant differences were found among these four groups in terms of operation time, fracture reduction quality, and the development of avascular necrosis ($p>0.05$).

Conclusion: According to the this study the timing of surgery and anatomical reduction have no effect on the development of avascular necrosis in the treatment of displaced femoral neck fractures fixed with three cannulated screws.

Keywords: Femoral neck fractures, trauma, avascular necrosis, internal fixation, anatomic reduction

INTRODUCTION

Femoral neck fractures are usually treated with arthroplasty options in elderly patients. The aim of femoral neck fracture treatments in younger patients is to protect the hip joint and its functions. Internal fixation of femoral neck fractures has high complication rates, with avascular necrosis and nonunion of the femoral head being the most common complications (1-4). In the literature, it has been reported that anatomic reduction and the timing of surgery are effective in preventing the development of avascular necrosis (5, 6).

In this study, we investigated the relationship of avascular necrosis in patients with unstable (Garden grade 3 and 4) femoral neck fractures treated by internal fixation with the timing of surgery and reduction quality. We retrospectively compared avascular necrosis rates between patients who underwent early (<8 hours) and late surgery (>8 hours) with or without anatomic reduction.

METHODS

The study protocol was approved by the Scientific Research Ethics Committee of Gaziantep University Medical Faculty on November 13, 2019 (2019/443). In this study, patients who underwent treatment in our clinic between 2009 and 2016 were

retrospectively evaluated. Written consent was obtained from the patients for the surgery. Patients aged 15–60 years, treated with the closed reduction and internal fixation method, using three pieces of 7.3-mm partially grooved cannulated screws, who were followed up for at least two years, developed union, and had femoral neck fractures classified as Garden grade 3 and grade 4 were included in the study (7). Patients with multiple traumas, Garden grades 1 and 2 fractures or pathologic fractures, who underwent arthroplasty and developed nonunion, were excluded from the study. A total of 42 patients met the inclusion criteria. The mean age was 37.16 (15–60) years. Of the patients, 32 were males and 10 were females. Of the femoral neck fractures, 23 occurred in the right hip and 19 in the left hip. The mean follow-up period was 3.2 years.

Patients underwent surgery on a fracture table in the supine position. The reduction was controlled by fluoroscopy, and fixation was provided. The patients received postoperative rehabilitation, and were not load-bearing for six weeks.

The patients were classified into two groups: those who underwent surgery within the first 8 hours after injury (mean time, 301 min) and those who underwent surgery 8 or more hours

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after injury (mean time, 1750 min). The patients were classified according to the Garden classification based on their preoperative radiographs (7). Reduction quality was evaluated with the Garden Alignment Index using postoperative radiographs (8). Postoperative radiographs were evaluated on the 1st, 2nd, 3rd, 6th, 12th, 18th, and 24th month after surgery, and the osteonecrosis classification was made using the Ficat-Arlet method (9). Radiological follow-up was continued for patients who developed avascular necrosis. During this evaluation, the patients were divided into four groups. The first group included patients who underwent surgery in the first 8 hours after injury and whose fractures were anatomically reduced; the second group included patients who underwent surgery in the first 8 hours and whose fractures could not be anatomically reduced; the third group included patients who underwent surgery 8 or more hours after the injury and whose fractures were anatomically reduced; and the fourth group included patients who underwent surgery 8 or more hours after the injury and whose fractures could not be anatomically reduced. The development of osteonecrosis was statistically analyzed among the groups. Pearson chi-square tests were used as the statistical method.

Statistical Analysis

Continuous variables are presented as mean and standard deviation, and categorical variables are presented as absolute numbers and percentages. The Shapiro-Wilk test was used for testing the normality of numerical data. Mann Whitney U test was used to compare numerical variables that were not normally distributed in two groups. The relationship between categorical variables was analyzed by the Chi-square test. The SPSS 22.0 (IBM SPSS Corp.; Armonk, NY, USA) software package was used for the analyses. For all analyses, a p value of <0.05 was considered statistically significant.

RESULTS

Forty-two patients (32 males, 10 females) who met the inclusion criteria and had at least two years of follow-up data were included in the study, and their radiographies were evaluated. Among the postoperative controls, the rate of avascular necrosis in the femoral head was determined to be 52.38%. The duration of avascular necrosis development in the patients was 1.67 years (621.22 days). Avascular necrosis was seen in 45.75% of the patients who underwent surgery before 8 hours and whose fracture was reduced anatomically (Figure 1–8). Avascular necrosis

was seen in 63.63% of patients who underwent surgery before 8 hours and whose fracture could not be reduced anatomically (Table 1a, 1b). Avascular necrosis was seen in 58.33% of patients who underwent surgery after 8 hours and whose fracture was reduced anatomically. Avascular necrosis was seen in 8.50% of pa-

Figure 1. Preop anteroposterior (AP) x-ray



Figure 2. Preop lateral (LAT) x-ray



Main Points:

- As we have shown in our study, in 52% of the patients, avascular necrosis can develop after an average of 1.67 years, although postoperative union is provided for displaced femoral neck fractures.
- According to this study the timing of surgery and anatomical reduction have no effect on the development of avascular necrosis in the treatment of displaced femoral neck fractures fixed with three cannulated screws.
- In the treatment of these patients, we believe that changing the treatment method or turning to new treatment methods may increase the success rate.



tients who underwent surgery after 8 hours and whose fracture could not be reduced anatomically (Table 2a, 2b). After statistical analysis, no significant differences were found among these four groups in terms of operation time, fracture reduction quality, and development of avascular necrosis ($p > 0.05$).

DISCUSSION

Avascular necrosis of the femoral head and nonunion after femoral neck fractures are the most common complications (1-4). Due to these complications, total hip arthroplasty may be a solution in elderly patients; however, this method is not



Table 1a. Group of Patients Who Underwent Surgery in the First 8 Hours and Whose Fractures Reduced Anatomically

Group of Patients Who Underwent Surgery in the First 8 Hours and Whose Fractures Reduced Anatomically:

Patient No:	Age	Gender	Side	Classification (Garden Classification)	Time To Operation (minute)	AP Reduction Quality (Garden Alignment Index)	LAT Reduction Quality (Garden Alignment Index)	Development of Avascular Necrosis (Ficat Arlet Classification)	Follow-Up Period (day)	Development of Avascular Necrosis (day)
1	60	e	Right	3	143	GR	GR	3	734	517
2	58	k	Left	4	150	GR	GR	1	1227	-
3	28	e	Left	3	188	GR	GR	2	1404	815
4	15	e	Left	4	189	GR	GR	3	770	287
5	50	e	Right	3	274	GR	GR	1	1884	-
6	32	e	Right	3	314	GR	GR	3	1025	816
7	16	k	Right	4	323	GR	GR	1	1001	-
8	43	e	Left	3	351	GR	GR	3	1189	759
9	15	e	Right	3	389	GR	GR	1	898	-
10	56	e	Left	3	396	GR	GR	1	987	-
11	35	e	Left	3	476	GR	GR	1	1038	-

GR: Good Reduction

suitable for younger patients. Studies have shown the importance of anatomic reduction, stable fixation, and the timing of surgery to prevent complications and achieve successful treatment results (5, 6). In our study, since we aimed to investigate the effect of the reduction quality and early surgery on the development of avascular necrosis in displaced femoral neck

fractures, we included patients with bony union and excluded patients with nonunion.

The blood supply to the femoral head is mainly from the medial femoral circumflex artery (10). The terminal branches of this artery are intracapsular and are at risk in displaced femoral neck

Table 1b. Group of Patients Who Underwent Surgery in the First 8 Hours and Whose Fractures Not Reduced

Group of Patients Who Underwent Surgery in the First 8 Hours and Whose Fractures Reduced Anatomically:

Patient No:	Age	Gender	Side	Classification (Garden Classification)	Time To Operation (minute)	AP Reduction Quality (Garden Alignment Index)	LAT Reduction Quality (Garden Alignment Index)	Development of Avascular Necrosis (Ficat Arlet Classification)	Follow-Up Period (day)	Development of Avascular Necrosis (day)
1	45	e	Right	3	33	AR	AR	3	928	928
2	52	e	Left	3	241	AR	AR	2	740	181
3	33	k	Left	4	282	AR	AR	3	923	575
4	29	e	Right	3	291	AR	AR	3	924	538
5	46	e	Right	4	306	AR	AR	3	1236	399
6	18	e	Left	4	318	AR	AR	1	732	-
7	19	e	Right	3	352	AR	AR	4	786	264
8	16	e	Right	3	357	AR	AR	1	804	-
9	58	k	Left	3	396	AR	AR	4	1255	775
10	26	e	Right	3	411	AR	AR	1	990	-
11	16	e	Right	3	444	AR	AR	1	804	-

Anatomically
AR:Acceptable Reduction

Table 2a. Group of Patients Who Underwent Surgery After 8 Hours and Whose Fractures Reduced Anatomically

Group of Patients Who Underwent Surgery After 8 Hours and Whose Fractures Reduced Anatomically

Patient No:	Age	Gender	Side	Classification (Garden Classification)	Time To Operation (minute)	AP Reduction Quality (Garden Alignment Index)	LAT Reduction Quality (Garden Alignment Index)	Development of Avascular Necrosis (Ficat Arlet Classification)	Follow-Up Period (day)	Development of Avascular Necrosis (day)
1	17	e	Left	3	510	GR	GR	3	1822	228
2	54	e	Left	3	718	GR	GR	1	754	-
3	49	k	Left	3	962	GR	GR	1	765	-
4	60	e	Right	3	1170	GR	GR	1	1004	-
5	60	k	Right	3	1266	GR	GR	3	977	400
6	52	e	Right	3	1267	GR	GR	1	1810	-
7	61	k	Left	4	1433	GR	GR	3	738	553
8	51	e	Right	3	2481	GR	GR	3	1167	783
9	40	e	Left	4	3996	GR	GR	3	832	625
10	35	e	Left	4	3291	GR	GR	3	2352	697
11	60	e	Right	3	2122	GR	GR	1	1875	-
12	30	e	Right	4	1440	GR	GR	4	1056	394

GR:Good Reduction

fractures. This may be the most important factor for the development of osteonecrosis (11). Providing anatomic reduction and stable fixation as early as possible will protect these arteries that supply blood to the femoral head (12-14). It is widely accepted

that anatomic reduction and stable fixation in femoral neck fractures reduce the risk of femoral head avascular necrosis (15-17). Treatment of femoral neck fractures is a traditionally urgent surgery. Swiontkowski et al. (18) reported successful results in pa-

Table 2b. Group of Patients Who Underwent Surgery After 8 Hours and Whose Fractures Not Reduced Anatomically

Group of Patients Who Underwent Surgery After 8 Hours and Whose Fractures Not Reduced Anatomically										
Patient No:	Age	Gender	Side	Classification (Garden Classification)	Time To Operation (minute)	AP Reduction Quality (Garden Alignment Index)	LAT Reduction Quality (Garden Alignment Index)	Development of Avascular Necrosis (Ficat Arlet Classification)	Follow-Up Period (day)	Development of Avascular Necrosis (day)
1	31	e	Left	3	799	AR	AR	3	1331	473
2	35	e	Left	3	849	AR	AR	2	1961	1961
3	21	e	Right	3	976	AR	AR	1	2018	-
4	46	e	Left	3	1193	AR	AR	1	874	-
5	23	k	Right	3	2241	AR	AR	1	2329	-
6	17	k	Right	3	4022	AR	AR	1	933	-
7	25	e	Right	4	2260	AR	AR	1	1203	-
8	28	k	Right	4	2001	AR	AR	3	1677	699

AR: Acceptable Reduction

tients who underwent surgery within 8 hours after injury, and Jain et al. (19), Zetterberg et al. (20), and Bray et al. (21) showed in their studies that the timing of surgery after injury was an important factor for the results. In contrast, Karaeminoğulları et al. (22) and Gumustas et al. (23) showed no correlation between the timing of surgery and avascular necrosis of the femoral head. Papacostidis et al., in their meta-analysis, could not prove a relationship between the timing of internal fixation and the incidence of avascular necrosis (24). However, they have indicated that a delay in internal fixation of more than 24 hours may increase the probability of nonunion. While surgery can be delayed for Garden I–II nondisplaced fractures, Garden III–IV fractures may require immediate treatment (4). We included displaced femoral neck fractures (Garden III–IV) with higher complication rates in our study. We thought that this would create stronger evidence to evaluate the timing of the surgery and the effects of anatomical reduction on avascular necrosis.

In our study, no differences were found among the four groups in terms of the development of avascular necrosis. The fact that no difference was found in terms of avascular necrosis development between the patients who underwent surgery after 8 hours and whose fracture could not be reduced anatomically, which was the worst scenario, and the patients who underwent surgery within the first 8 hours and whose fracture was reduced anatomically, which were the best scenario, demonstrates that avascular necrosis develops independently of surgical timing and anatomic reduction, especially in patients with grade 3 and 4 instable femoral neck fractures. No statistically significant association was found between the rate of avascular necrosis of the femoral head and timing of surgery in our patients.

As we have shown in our study, in 52% of the patients, avascular necrosis can develop after an average of 1.67 years, although postoperative union is provided for displaced femoral neck

fractures. The development of avascular necrosis in 45% of the patients who underwent early surgery, anatomic reduction, and developed union indicates the difficulty in treating displaced femoral neck fractures. According to the results of our study, the timing of surgery and anatomical reduction have no effect on the development of avascular necrosis in the treatment of displaced femoral neck fractures fixed with three cannulated screws. In the treatment of these patients, we believe that changing the treatment method or turning to new treatment methods may increase the success rate.

A limitation of our study is the retrospective design. On the other hand, we think that evaluating a specific patient group (patients who have Garden grade III and grade IV femoral neck fracture, who develop union and who are followed up at least for two years) and having a large number of patients compared to the literature are the strengths of our study.

CONCLUSION

According to the this study the timing of surgery and anatomical reduction have no effect on the development of avascular necrosis in the treatment of displaced femoral neck fractures fixed with three cannulated screws.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University Medical Faculty (13.11.2019, 2019/443).

Informed Consent: Written consent was obtained from the patients for the surgery.

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