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Research Paper

# Assessment of the Rate and Factors Contributing to Surgical Treatment Failure in Patients With Non-displaced Femoral Neck Fractures From 2011 to 2022

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## ABSTRACT

**Background:** Femoral neck fractures present a considerable challenge for surgeons in the field. This study focuses on a critical issue in understanding the occurrence of treatment failure among individuals who underwent surgical fixation for femoral neck fractures.

**Objectives:** This study aims to evaluate the prevalence of treatment failure and identify associated risk factors in patients with non-displaced femoral neck fractures who underwent this procedure.

**Methods:** Data were gathered from individuals with non-displaced femoral neck fractures who received internal fixation from 2011 to 2022, ensuring a minimum follow-up period of one year. Treatment failure was evaluated based on these data. The gathered data were documented using SPSS software, version 22 and examined using descriptive statistics, including percentage, frequency, and Mean±SD. Statistical analysis was conducted using inferential tests, such as the t-test, chi-square test, and Fisher's exact test. $P \leq 0.05$ was considered.

**Results:** Data were analyzed on 60 individuals, with a mean age of 50.25±16.94 years. Of the total, 44 men (73.3%) participated. One individual (1.7%) experienced avascular necrosis (AVN), while 7(11.7%) experienced nonunion. Seven patients (11.7%) experienced treatment failure, including AVN, which was also associated with nonunion. Six cases (10%) were advanced to total hip replacement surgery.

**Conclusion:** The results of this study indicate that the fixation of non-displaced femoral neck fractures has a combined incidence of nonunion and AVN at around 12%. It is advisable to consistently follow-up with patients and monitor risk factors after surgery to minimize complications and enable quicker identification of those impacted.

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## Introduction

Femoral neck fractures, frequently associated with considerable complications and mortality, have consistently presented a significant challenge for surgeons in this field [1]. The results following an injury are influenced by various factors, including displacement, comminution, blood supply, proper reduction, and stable fixation [2, 3]. Excellent treatment outcomes cannot be achieved even in cases that are not displaced [4]. Recent demographic shifts have revealed a growing occurrence of hip fractures among older individuals, a pattern anticipated to escalate significantly in the years ahead [5-7]. The increase in hip fractures among older individuals is linked to factors such as an aging population, longer life expectancy, and the prevalence of osteoporosis [8]. As a result, hip fractures represent the most prevalent injury in the elderly population, accounting for approximately 20% of surgical procedures [9]. Older age is a significant risk factor for unfavorable results in femoral neck fractures [10-12]. Most cases involved women (80%), with a mean age of 80. Less than 5% of these fractures occur in individuals younger than 60 [13].

The attending surgeon makes treatment decisions by considering factors, such as biological age, comorbidities, fracture pattern, and pre-existing osteoarthritis [5]. Moreover, it has been noted that the rate of unsuccessful outcomes with internal fixation in cases of displaced femoral neck fractures can be as high as 48% [14, 15].

Considering the significance of evaluating treatment failure in individuals receiving fixation, coupled with the scarcity of research exploring the occurrence and risk factors associated with treatment failure in Iran, a notable gap exists in understanding this matter within the Iranian population. This study aims to assess the occurrence of treatment failure and associated risk factors in individuals with non-displaced femoral neck fractures treated using fixation methods.

## Methods

This study was designed as a retrospective, cross-sectional, and descriptive analysis. The study included all individuals who underwent internal fixation surgery for femoral neck fractures and were followed for a minimum of one year. The exclusion criteria included incomplete medical records, non-completion of the follow-up period, discrepancies between two evaluators regarding fracture type or failure, pre-existing medical conditions that could influence bone density or healing, and insufficient patient consent or cooperation in data provision.

After ethical approval, data were gathered from patients presenting with non-displaced femoral neck fractures at Firouzgar Hospital who received internal fixation treatment from 2011 to 2022. Non-displaced femoral neck fractures were categorized according to the garden classification system, with patients exhibiting Garden type 1 or 2 fractures on pelvic anteroposterior (AP) radiographs identified as having non-displaced femoral neck fractures. Two fellowship-trained hip specialists collaborated to review and interpret pelvic AP radiographs in this research project. Fractures identified as garden type 1 or 2 by both experts were regarded as non-displaced fractures.

Individuals who underwent treatment for fracture stabilization with either cannulated screws or dynamic hip-screw devices were selected. The follow-up duration for these individuals was subsequently assessed, and participants who attended clinical follow-ups for a minimum of one year after surgery, along with having pelvic AP radiographs accessible in the hospital's picture archiving and communication system (PACS), were incorporated into the study.

The pelvic AP radiographs were re-evaluated by the two hip fellows who analyzed the initial radiographs. Treatment failure was determined by consensus among specialists based on one or more of the following criteria: Failure of the surgical device before the fracture had united, signs of non-union, loss of reduction before union, malunion, infection at the surgical site, or avascular necrosis (AVN) of the femoral head.

The gathered information was documented using SPSS software, version 22 and examined using percentage, frequency, and Mean±SD. The outcomes were analyzed through t-tests, chi-square tests, and Fisher's exact tests for statistical evaluation. $P \leq 0.05$ was considered.

## Results

The research examined information from 60 individuals, with a mean age of 50.25±16.94 years (19 to 87 years). In the patient group, 44 men (73.3%) and 16 women (26.7%) participated. Of the total, five individuals (8.3%) were diagnosed with diabetes, while 18 individuals (30%) were smokers. One patient (1.7%) developed AVN, and seven patients (11.7%) experienced non-union. Seven instances of treatment failure were observed, accounting for 11.7% of cases. The patient

**Table 1.** Analysis of the relationship between AVN and gender, diabetes, rheumatoid arthritis, smoking, and type of fixation

| Variables | Subgroup | No. (%) | | No. | P |
|---|---|---|---|---|---|
| | | AVN-free | AVN | Total | |
| Gender | Female | 15(25.4) | 1(100) | 16 | 0.267 |
| | Male | 44(74.6) | 0(0) | 44 | |
| Diabetes | Yes | 5(8.5) | 0(0) | 5 | 1.000 |
| | No | 54(91.5) | 1(100) | 55 | |
| Rheumatoid arthritis | Yes | 2(3.4) | 0(0) | 2 | 1.000 |
| | No | 57(96.6) | 1(100) | 58 | |
| Smoking | Yes | 17(28.8) | 1(100) | 18 | 0.300 |
| | No | 42(71.2) | 0(0) | 42 | |
| Fixation type | Screws | 53(89.8) | 0(0) | 53 | 0.117 |
| | DHS | 6(10.2) | 1(100) | 7 | |
| Fixation type | Two screws | 4(6.8) | 0(0) | 4 | 0.021 |
| | Three screws | 49(83.1) | 0(0) | 49 | |
| | DHS | 6(10.2) | 1(100) | 7 | |

AVN: Avascular necrosis; DHS: Dynamic hip screw.

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with AVN also had non-union. Additionally, six patients (10%) required a transition to total hip arthroplasty. No significant correlation was identified between AVN and factors, such as sex, diabetes, rheumatoid arthritis, or smoking (Table 1).

No significant correlation was observed between bone healing and factors, such as sex, diabetes, rheumatoid arthritis, smoking, or fixation method used. While smoking is a possible risk factor for non-union (57% compared to 43%), this relationship did not achieve statistical significance (P=0.182) (Table 2).

The mean age of patients in the union group was 50.30±17.46 years, whereas in the non-union group, it was 49.85±13.47 years, showing no statistically significant difference between the groups (P=0.949).

## Discussion

Femoral neck fractures are currently considered one of the leading contributors to disability. In older adults, most femoral neck fractures occur due to low-energy falls. In contrast, fractures of the femoral neck in younger individuals are usually the result of high-energy trauma [16].

The mean age in this study was 50.25±16.94 years, and 73.3% of patients were men. It appears that more men were observed in the younger demographic, while more women were observed in the older demographic. Nonetheless, considering that a significant proportion of the elderly population is women, it can be inferred that most patients with femoral neck fractures are women. This aligns with the results of other studies indicating that women constitute 80% of these patients [13].

In a study conducted by Moghtadaei et al. in Tehran City, Iran [17], 19 patients (23.8%) were diagnosed with AVN, while 12(15%) experienced nonunion. In this study, one patient (1.7%) developed AVN, while seven (11.7%) experienced nonunion. Seven instances of treatment failure were observed, accounting for 11.7% of cases. Individuals with AVN also experience simultaneous nonunion. The surgical technique employed by Moghtadaei et al. [17] differed markedly from that of the current study. In the referenced study, 83.8% of patients received open reduction; in the current investigation, every patient was treated with closed reduction. Additionally, the study found that patients with non-displaced fractures experienced no complications.

**Table 2.** Analysis of the relationship between union and gender, diabetes, rheumatoid arthritis, smoking, and type of fixation

| Variables | Subgroup | No. (%) | | No. | P |
|---|---|---|---|---|---|
| | | Union Present | Union Absent | Total | |
| Gender | Female | 14(26.4) | 2(28.4) | 16 | 1.000 |
| | Male | 39(73.6) | 5(71.4) | 44 | |
| Diabetes | Yes | 3(5.7) | 2(28.6) | 5 | 0.099 |
| | No | 50(93.3) | 5(71.4) | 55 | |
| Rheumatoid Arthritis | Yes | 2(3.8) | 0(0) | 2 | 1.000 |
| | No | 51(96.2) | 7(100) | 58 | |
| Smoking | Yes | 14(26.4) | 4(57.1) | 18 | 0.182 |
| | No | 39(73.6) | 3(42.9) | 42 | |
| Fixation type | Screws | 47(88.7) | 6(85.7) | 53 | 1.000 |
| | DHS | 6(11.3) | 1(14.3) | 7 | |
| Fixation type | Two screws | 4(7.5) | 0(0) | 4 | 0.744 |
| | Three screws | 43(81.1) | 6(85.7) | 49 | |
| | DHS | 6(11.3) | 1(14.3) | 7 | |

DHS: Dynamic hip screw.

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A study conducted by Dashtbozorg et al. [2] in Ahvaz City, Iran, revealed that the AVN age of the participants was 37 years. Open reduction was performed in 76.2% of cases. In this group of patients, 28.6% had nonunion and 16.7% had femoral head necrosis. All instances of nonunion were observed in patients who underwent open reduction treatment.

A systematic review and meta-analysis by Overmann et al. [18] reported a reoperation rate of 14.1% and a one-year mortality rate of 14.6%. This study concentrated on non-displaced femoral neck fractures in individuals aged >60 years, and its results are quite similar to those of the current study. It revealed an 11.7% treatment failure rate that resulted in the need for reoperation. The observed 2.2% difference may be associated with the disparity in the mean age of the patients across the two studies.

In a study conducted by Biz et al. [9], which included patients with non-displaced femoral neck fractures averaging 81.44 years of age who underwent treatment with cannulated screw fixation, the treatment failure rate was 9.7%. In this study, the treatment failure rate for cases fixed with cannulated screws was 10%, corresponding to 6 cases.

In a systematic review conducted by Xu et al. [19], it was found that among patients over 65 with non-displaced femoral neck fractures, the union rate for those who underwent surgical treatment was 92.6%. Conversely, this group's incidence rate of AVN was 7.7%.

In a systematic review conducted by Kim et al. [7], the focus was on complications arising from internal fixation with screws in non-displaced femoral neck fractures among patients aged >60 years. The results revealed that the most prevalent complication post-surgery was nonunion, occurring at a rate of 39.2%. At the same time, osteonecrosis emerged as the second most frequent reason for reoperation, with an incidence of 31.9%. The rate of reoperations resulting from surgical complications was 15.2%, with conversion to hip arthroplasty noted in 12.4% of cases after the initial fixation procedure. In this study, 10% of treatment failures (6 cases) led to total hip arthroplasty.

In a study conducted by Duckworth et al. [20], which focused on individuals aged 60 years or younger with displaced femoral neck fractures classified as Garden types 3 and 4, the observed nonunion rate was 7.4%. At the same time, the incidence of AVN was 11.5%. In conclusion, displacement of femoral neck fractures significantly increases the risk of AVN.

Furthermore, according to a meta-analysis conducted by Slobogean et al. [21], the total incidence of nonunion was 9.3% after internal fixation in cases of femoral neck fractures. The incidence was elevated in patients with displaced femoral neck fractures.

In a study conducted by Chen et al. [22], 16.1% of individuals with femoral neck fractures, with a mean age of 56 years (age range: 20-93 years), experienced failure. Similarly, a retrospective cohort study conducted by Sjöholm et al. [23] involving patients with non-displaced femoral neck fractures who underwent internal fixation revealed an overall treatment failure rate of 17%.

Walsum et al. [24] conducted a study to explore the failure rate associated with a dynamic locking blade plate in individuals with non-displaced femoral neck fractures. A total of 149 patients were analyzed, revealing a failure rate of 4%, which corresponds to 6 cases, including two instances of nonunion.

The research conducted by Xu et al. [19] focused on individuals aged 65 and older with non-displaced femoral neck fractures. The results indicated that opting for surgical intervention improved union rates and a reduced likelihood of AVN compared to non-surgical approaches. Moghtadaei et al. [17] highlighted the significance of achieving accurate alignment and ensuring high standards in fixation techniques. In a study conducted by Kim et al. [7], the rate of complications associated with non-displaced femoral neck fractures in individuals aged >60 years who received treatment with internal fixation screws was significant. Consequently, they proposed that hemiarthroplasty is a viable treatment option for certain patients.

According to the research conducted by Duckworth et al. [20], arthroplasty may be regarded as a viable alternative treatment option for patients with a background of alcohol abuse, kidney disease, or respiratory issues. Additionally, Sjöholm et al. [23] suggested that before addressing non-displaced femoral neck fractures in older patients, a thorough lateral pelvic radiographic evaluation should be conducted to identify those who would gain more from arthroplasty instead of internal fixation.

## Conclusion

The study's results and a review of earlier research indicate that fixing non-displaced femoral neck fractures carries an approximately 12% risk of complications, including nonunion and AVN. While this rate may be lower than that of displaced fractures, it is advisable to perform regular follow-up of patients and address risk factors after surgery to reduce the likelihood of complications. Furthermore, identifying patients who are at risk at an early stage is essential for achieving improved results.

This research faced certain constraints, notably a limited number of participants. Consequently, it is advisable to conduct more extensive studies with larger sample sizes to better identify risk factors. The retrospective nature of this study makes it impractical to implement preoperative differences or random selection of patients. Therefore, it is advisable to conduct future randomized clinical trials to improve the management of this condition.

## Ethical Considerations

### Compliance with ethical guidelines

This study was approved by the Ethics Committee of Iran University of Medical Sciences, Tehran, Iran (Code: IR.IUMS.FMD.REC.1402.454)

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### Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

### Conflict of interest

The authors declared no conflict of interest.

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