



## Complications following young femoral neck fractures



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### ABSTRACT

**Background:** Femoral neck fractures in patients 60 years of age or younger are challenging injuries to treat because of the high-energy trauma mechanisms and the displaced fracture patterns typically found in this patient population. Understanding the burden of disease is an important first step in addressing treatment controversies in this population. The purpose of the current study is to quantitatively pool the incidence of patient important complications following internal fixation of young femoral neck fractures. **Methods:** A comprehensive search of the Medline, Embase, CINAHL, Cochrane Database of Systematic Reviews, and Central databases was completed under the direction of a biomedical librarian. Multiple outcomes of interest (complications) were collected and included: reoperation, femoral head avascular necrosis, fracture non-union, infection, implant failure, and malunion.

**Results:** 1558 fractures from 41 studies were included in the meta-analysis. An 18.0% pooled reoperation incidence was observed for isolated femoral neck fractures. The total pooled incidence of avascular necrosis (AVN) was 14.3%, and the total incidence of nonunion was 9.3%. When stratified for fracture displacement displaced fractures were more likely to undergo reoperation and to result in AVN or nonunion. The total incidence of malunion was 7.1%, implant failure was 9.7%, and surgical site infection was 5.1%. Complications associated with a femoral neck fracture treated in conjunction with an ipsilateral femoral shaft fracture were lower overall than the pooled estimates for isolated neck fractures.

**Conclusions:** The results of our analysis demonstrate that the incidence of complications experienced by young femoral neck fracture patients is relatively high. Reoperation following internal fixation of isolated femoral neck fractures occurred in nearly 20% of cases, and AVN and nonunion were the most common complications that likely contributed to repeat surgeries. These results highlight the importance of further efforts to improve the clinical outcomes in this population.

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### Introduction

Femoral neck fractures in patients 60 years of age or younger represent challenging injuries to treat because of the high-energy trauma mechanisms and the displaced fracture patterns typically found in this patient population [1]. The younger patient age and increased functional demands for work and recreational activities mandate a surgical treatment that preserves the native hip [2]. Although controversy exists surrounding methods of reduction and internal fixation, an understanding of the burden of disease is required.

The purpose of the current study is to quantitatively pool the incidence of patient important complications following internal fixation of young femoral neck fractures. This study aims to update the existing meta-analysis literature, expand previous reviews by including ipsilateral femoral neck and shaft fractures, and focus on multiple complications that impact quality of life and functional outcome.

### Methods

#### Study eligibility

Only studies that met the following criteria were considered eligible: [1] the population was comprised of non-geriatric adult patients (ages 16–60 years) with a femoral neck fracture [2], the patients were treated with any type of internal fixation [3], the authors reported original research, and [4] the study reported at

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least one complication outcome measure following fracture fixation. Only English language articles were included. Potentially eligible studies were also excluded if they focused on [1] stress fractures; [2] treatment of delayed fractures (greater than 14 days from injury) [3], management of femoral neck non-unions, or [4] management of osteonecrosis following femoral neck fractures. Studies involving combined femoral neck and femoral shaft fractures were also included based on a priori planned subgroup analyses.

#### Identification of studies

In November 2012, a comprehensive literature search was performed to identify studies involving the management of femoral neck fractures in patients age  $\leq 60$  years. Using the OVID interface, electronic searches of the following databases were performed: Medline, Embase, CINAHL, Cochrane Database of Systematic Reviews, and Central. Keywords and MeSH headings related to femoral neck fractures and surgical fixation were utilized under the direction of a biomedical librarian. A full description of the search strategy is found in Appendix A.

Following the literature searches, two investigators reviewed the references lists of all key articles for further eligible articles. Frequently cited articles were identified and a separate Science Citation Index search (SciSearch) was performed to locate potentially relevant studies. We also conducted a “related articles” search on PubMed.

#### Title review

Two reviewers independently screened the titles identified in the literature searches. Titles that clearly did not meet the eligibility criteria were excluded; in all situations, the reviewers erred on the side of inclusivity and selected the abstract to be reviewed. Since the search strategy attempts to filter out elderly fractures, any paper that mentions fixation of femoral neck fractures was selected for further review. The abstract and full-text review was performed in a similar independent and duplicate fashion with two reviewers. When consensus could not be reached on study eligibility, a third reviewer was consulted.

#### Data extraction

Two reviewers independently performed the data extraction. Study characteristics, patient demographics, fracture patterns, and surgical details were recorded for each included study. Multiple outcomes of interest (complications) were collected and included: femoral head avascular necrosis, fracture non-union, reoperation, infection, implant failure, and malunion. The malunion outcome included any case described as malaligned, malreduced, malrotated, or malunited.

#### Data analysis

A random-effects model of DerSimonian and Laird was used to provide pooled estimates of the incidence of complications within the young femoral neck fracture literature [3]. This model assumes that the studies included in this review represent a random sample of all of the potentially available studies. While we are confident that our search strategy identified all relevant studies in this population, it remains plausible that not every study ever conducted was identified. The random-effects model accounts for this fact and assumes that we have a representative sample of all existing studies (published, non-published, and in progress). For each complication of interest we calculated the pooled incidence and 95% confidence interval (CI). The  $I^2$  statistic was reported for

each pooled estimate as a measure of study heterogeneity; values greater than 50% represent substantial study heterogeneity [4]. Subgroup analyses were performed based on fracture displacement as well as the presence of an ipsilateral femoral shaft fracture.

## Results

Fig. 1 outlines the search results and selection of eligible studies. 41 articles were included in our analysis: 27 studies involved patients with femoral neck fractures only and 14 publications included femoral neck fractures associated with ipsilateral femoral shaft fractures [5–46]. Table 1 summarizes the outcomes reported by the included studies. Briefly, 1558 fractures were included. The mean sample size of included studies was  $39.43 \pm 33.8$  patients. The mean of the average age and duration of follow-up reported in each study was  $39.4 \pm 5.6$  years and  $35.2 \pm 16.6$  months, respectively. All research was published between 1964 and 2012. 60% of included studies were retrospective case series; only two studies were prospective randomised control trials. Table 2 presents the pooled results of isolated femoral neck fractures, combined neck–shaft fractures, and the overall incidence of complications when all results are combined.

#### Reoperation

28 studies reported reoperation events within their study population. A total of 181 event in 1061 included patients. There was an overall 18.0% reoperation incidence for isolated femoral neck fractures (95% CI 13.1–24.2%,  $I^2 = 19.8\%$ ; Fig. 2). When the pooled results were stratified for fracture displacement, similar reoperation estimates were obtained for displaced fractures (17.8%, 95% CI 12.4–24.9) and much lower estimates were observed for undisplaced fractures (6.9%, 95% CI 2.6–17.1%). Although a large difference in the point estimates between the subgroups is reported, the confidence intervals overlap and fail to demonstrate statistical significance.

#### Femoral head avascular necrosis

39 studies reported femoral head avascular necrosis occurring in their study population. A total of 184 events in 1552 patients were included. The total pooled incidence of avascular necrosis for isolated femoral neck fractures was 14.3% (95% CI, 12.5–24.2%,  $I^2 = 0\%$ ; Fig. 3). Similar to reoperation events, displaced fractures were associated with a statistically higher incidence of avascular necrosis than undisplaced fractures (14.7%, 95% CI 12.3–17.5% versus 6.4%, 95% CI 3.4–11.8%).

#### Nonunion

Fracture nonunion events were pooled from 35 studies. A total of 109 events in 1328 patients were included. The pooled incidence of nonunion after internal fixation for isolated fractures was 9.3% (95% CI 6.6–13.0%; Fig. 4). The point estimate for displaced fractures (10.0%) was nearly double the incidence of undisplaced fractures (5.2%), however, the confidence intervals were too wide to demonstrate significance (displaced 95% CI 6.9–14.3%; undisplaced 95% CI 2.0–13.1%).

#### Malunion, implant failure, and infection

Malunion, implant failure, and infection outcomes were less commonly reported by the included studies (Table 1). The pooled incidence of reported femoral neck malunion was 7.1% (95% CI 2.7–17.5%). The incidence of implant failure was 9.7% (95% CI 5.4–16.7%), and the incidence of surgical site infection was 5.1% (95% CI 3.2–8.0%). Pooled analyses comparing these outcomes for displaced and

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