

Factors associated to avascular necrosis of the femoral head and non-union in patients younger than 65 years old with displaced femoral neck fractures treated with reduction and internal fixation.

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ABSTRACT

Introduction: Few studies have evaluated treatment of displaced femoral neck fractures in patients younger than 65 years old, and risk factors for AVN or non-union have not been clearly delineated within this age range.

Method: To determine factors associated to avascular necrosis of the femoral head (AVN) and non-union in patients younger than 65 years old with displaced femoral neck fractures treated with reduction and internal fixation, we conducted a retrospective study of 29 displaced femoral neck fractures in 29 consecutive patients treated at a single institution. The influence of age, trauma energy, open reduction, and time from fracture to treatment on development of AVN and non-union were evaluated.

Results: Patients who developed AVN were significantly older and suffered lower energy trauma than cases without AVN. No recorded variables were associated to non-union. Logistic regression determined that only age was independently associated to AVN. Age was a good predictor for developing AVN, with a C-statistics of 0.861, and a best cut-off determined at 53.5 years.

Conclusion: Patients between 53.5 and 65 years old presented a higher risk of AVN. A primary arthroplasty should be considered in this subgroup.

KEYWORDS: femoral neck fractures; avascular necrosis of the femoral head; non-union; displaced hip fracture.

INTRODUCTION

More than 220,000 hip fractures occur each year in North America alone, with health care related costs estimated at nine billion dollars per year [1, 2]. Most cases are elderly patients, 50-62% of them being older than 80 years old, and less than 5% being younger than 60 years old [3-5]. Despite the ideal treatment for displaced femoral neck fractures (Garden types III

and IV) continues to be a source of debate [1, 6], arthroplasty is usually indicated in patients older than 65 years [3, 7-9], while in younger patients, the overall tendency is to perform reduction and internal fixation [10].

Avascular necrosis of the femoral head (AVN) and non-union are two major complications in the treatment of displaced femoral neck fractures, AVN being observed in 20-25% of patients

[10, 11], even those younger than 60 years old [12]. In addition, it has been reported that

Manuscript without author information femoral neck nonunion is increased after the age of 50 [13]. Some studies have shown their results in patients with femoral neck fractures in a specific age group between 15 to 50 years old [5, 14, 15], while the fate of patients with displaced femoral neck fractures between 50 to 65 years old has not been clearly delineated. Since displaced femoral neck fractures in patients younger than 65 years old are uncommon, risk factors for AVN or non-union have not

been clearly delineated.

The purpose of our study was to determine which factors are associated with the development of AVN and non-union in patients younger than 65 years old with a displaced femoral neck fracture treated by reduction and internal fixation.

MATERIALS AND METHOD

Institutional review board approval was obtained to perform this study.

A review of all patients younger than 65 years old admitted to a single institution with the diagnosis of a displaced femoral neck fractures between January 1995 and December 2007 was performed. All these patients underwent reduction and internal fixation with cannulated screws; only patients who had two years or longer follow up were included in this study.

The study included twenty-nine patients (22 males) with 29 fractures. In all cases, after routine radiographic examination with antero-posterior (AP) and axial views of the affected hip, a closed reduction was attempted with the patient in supine position on a fracture table.

In 5 cases (17.2%) a satisfactory closed reduction of the fracture was obtained, whereas in

the remaining 24 cases (82.8%) an open reduction was required. Then, under fluoroscopic

assistance, internal fixation with three parallel 7.0 mm cannulated screws (Synthes □) was performed. Prophylactic antibiotics were administered and low-molecular weight heparin was

started after surgery. AP and axial views of the affected hip were obtained to assess the quality of reduction. Patients underwent a monthly clinical evaluation until fracture healing

was obtained, and every 6 months afterwards. Plain radiographs were obtained in each visit to evaluate fracture healing and the presence of AVN; a CT scan was obtained for patients with bone-healing status question in plain radiographs. Weight bearing status was decided on

a patient to patient basis depending on bone healing status and concomitant injuries.

The variables recorded to determine the risk of AVN and non union were age, trauma energy required to produce the fracture, time from fracture to surgical treatment, residual displacement after reduction and internal fixation, and the need of an open reduction.

The statistical analysis was performed using SPSS™ version 17 (SPSS, Chicago, IL). All scale variables were tested for normality with the Kolmogorov-Smirnov test. The Student ttest was used to analyze parametric variables, and the Mann-Whitney U test was used for nonparametric variables and ordinal variables; categorical variables were tested with the Fisher exact test; all tests were two-tailed.

Variables were examined using univariate analysis to determine predictors of non-union and

AVN; significant or near-significant factors ($p < 0.10$) on univariate analysis underwent multivariate logistic regression analysis to assess their independent relationship with AVN and non-union. A $p < 0.05$ was considered to be a statistically significant difference.

For variables with an independent statistical significance, a ROC curve (Receiver Operating Characteristics) was performed in pursuit of the C-statistics, and we also determined the best cut-off value.

RESULTS

The mean age of our population was 46.45 ± 11.59 years. The median time between the accident and surgery was 8 hours (range 4-96); 20 patients (68.9%) were treated within 12 hours after injury, 12 of them (41.3%) within 6 hours. Anatomic reduction (defined as no residual displacement) was obtained in 7 patients (24.1%), while a satisfactory reduction (defined as less than 3mm of residual displacement in both antero-posterior and axial planes)

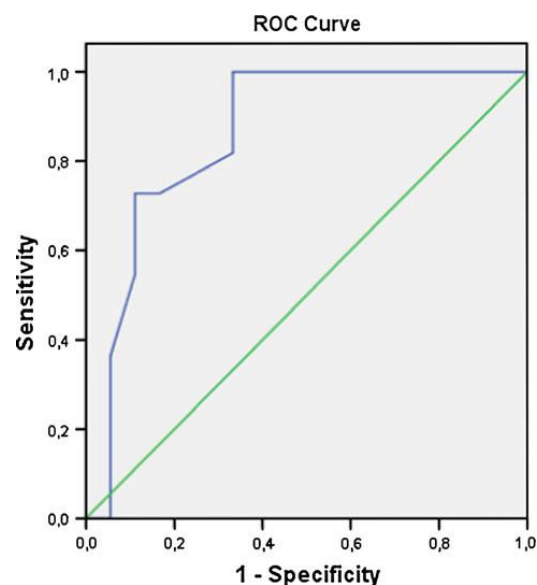


Fig. 1 ROC curve for age. The discrimination capacity of the curve was 86%

was obtained in 22 patients (75.8%). Only one case had a residual displacement of more than 3 mm. As only one patient did not obtain an anatomic or satisfactory reduction, quality of reduction was not evaluated to determine association to AVN or non-union.

The median follow up period was 28 months (range 24-144 months). Eleven patients (37.9%)

obtained an adequate healing, without evidence of AVN during the follow-up period. In this group, the median time to obtain bone healing was 4 months (range 2-6 months). Eleven of 29 patients (37.9%) developed AVN, 10 of them requiring conversion to THA.

Non-union was observed in a total of 7 (24.1%) cases; none of these patients concomitantly developed AVN. One of the patients with non-union required a THA, while the other 6 were successfully treated with valgus osteotomy.

The mean age of patients who presented AVN was 55.55 ± 5.63 years, while those that did not developed AVN had a mean age of 40.89 ± 10.79 years ($p < 0.01$). The mean age of patients who presented non-union was 43.43 ± 10.48 years, while those that healed had a mean age of 47.41 ± 11.99 years ($p = 0.488$).

Twelve patients presented their fracture associated to a low energy trauma, 9 of them developing AVN (75%), whereas only 2 of the 17 patients (11.8%) who had a femoral neck fracture secondary to a high energy trauma developed AVN ($p < 0.01$). Two of the 12 patients

with a low energy trauma (16.7%) developed non-union, while 5 of the 17 patients with a high

energy trauma (29.4%) developed a non-union ($p = 0.66$).

Time from fracture to surgery was not significantly different in patients who developed AVN

compared to cases without AVN ($p = 0.55$); also, there was no difference in time from injury to surgical treatment in patients that obtained bone healing compared to those that developed non-union ($p = 0.18$).

Ten of twenty four patients (41.7%) that underwent an open reduction developed AVN, while

one of the five patients (20%) of the cases treated by a closed reduction developed AVN ($p =$

0.62). Likewise, no significant difference in non-union rate was observed comparing patients treated with an open reduction (20.8%) to patients treated with a closed reduction (40%), $p =$ 0.60.

Logistic regression analysis was performed to evaluate whether age, time from fracture to surgery and trauma energy, independently determined the presence of AVN; only age was independently associated to AVN ($p = 0.04$), but not time from fracture to surgery ($p = 0.5$) or trauma energy ($p = 0.055$).

The discrimination capacity for age was determined using the area under the ROC curve,

obtaining a C-statistics of 0.861 (Figure). The best cut-off point was defined with 73% sensitivity and 89% specificity, finding it to be 53.5 years.

DISCUSSION

Patients younger than 65 years old with displaced femoral neck fractures represent a heterogeneous group; however, the usual recommendation for these patients is to perform a

reduction and internal fixation. Previous studies have described the outcomes for patients 50 years old or younger [5, 14, 15]; however, there is not enough data on the treatment of displaced femoral neck fractures in patients between 50 and 65 years old. Our study shows that patients in that age group present an increased rate of AVN compared to younger patients, and that age represent an independent predictor of AVN, also demonstrating a good discriminatory capacity. Conversely, we found that time elapsed between the fracture and operative treatment, as well as the need of an open reduction were not associated to an increased rate of AVN in our cohort.

Previous studies have shown that AVN is the main reason for conversion to THA in patients 50 years old or less with femoral neck fractures treated with internal fixation, either displaced or non-displaced [5]; identification of cases with an increased risk of AVN is important for an adequate treatment decision. The evidence relating risk of age and AVN has been confounding, with some studies finding an increased incidence of AVN in older patients [12,

16, 17]; nonetheless, these studies include older patients with displaced femoral neck fractures, for which primary arthroplasty is currently the recommended treatment. Few studies

have evaluated displaced femoral neck fractures in patients younger than 65 years old [5, 10, 14, 15, 18, 19]. In a retrospective review of 38 patients 60 years of age or less, Jain et al found that age did not influence the development of osteonecrosis [19]; conversely in our

study, age was the only independent predictor of AVN, with a best cut-off determined at 53.5 years. To date, most patients under 65 years old with a displaced femoral neck fracture undergo reduction and internal fixation; however, since cases between 53.5 and 65 years old

present a higher risk of AVN, a primary THA may be considered, and future studies should determine if this option is more clinically effective and cost-effective than reduction and

internal fixation within this age group, as it is in healthy older patients with a displaced intracapsular fracture of the hip [9].

Although we found that a low energy trauma was associated to a significant higher risk to develop AVN, which disagrees with previous literature [15, 20], when we adjusted for age in our logistic regression model, trauma energy was not an independent determinant of the presence of AVN. These results suggest that the higher risk of developing AVN is associated to a lower energy trauma depends on the effect of age over risk of developing AVN, since older patients usually suffer femoral neck fractures after low energy trauma.

Time from injury to surgery has remained a controversial topic and data are inconclusive. Some

studies have suggested that early surgery could reduce the risk of developing AVN [19, 21-23]. In patients 60 years old or less, Jain et al. found a significantly lower rate of AVN in cases treated with early fixation (within 12 hours after injury) [19]. Conversely, other studies have failed to demonstrate a clear relationship between timing of surgery and the risk of developing non-union or AVN [5, 14, 24, 25]. In their series of patients between 15 and 50 years old with displaced femoral neck fractures, Upadhyay et al. described an overall incidence of AVN of 16.3%; however, a delay of more than 48 hours did not influence AVN rate compared to patients undergoing surgery within 48 hours of injury [14]. In another series of young patients with femoral neck fractures, Haidukewych et al did not find differences in AVN rates in patients treated within 24 hours from diagnosis compared to those treated more than 24 hours from the diagnosis. Our study used a shorter period to differentiate early and late surgical treatment from the time of injury, without differences among the two groups, which is also in agreement with a meta-analysis that evaluated the complications after intracapsular hip fractures in young adults involving 564 fractures [24].

Our study did not demonstrate a difference in AVN rates of patients that underwent an open reduction compared to patients treated with a closed reduction; this observations also agrees with the conclusion of the meta-analysis from Damany et al.[24], which showed that after excluding one study with a very high incidence of AVN [25], no differences were observed in AVN rates comparing open and closed reduction of intracapsular hip fractures in young adults.

We could not determine any factors associated to non-union in our series. This may be

explained by the retrospective nature of our study, which allowed us to study only some variables than can influence non-union in these patients; in addition, the relatively small size of the group studied may represent a limitation, since the absence of significance may be secondary to a type II error.

Our study represents the first cohort of patients published in the international literature evaluating patients younger than 65 years old with displaced femoral neck fractures from a Latin American country. Since cultural characteristics, race and the nutritional status of patients may influence their outcomes, including the possibility to develop AVN and non-union

after suffering a displaced femoral neck fractures, our study adds information to previously

available data. Our patients 53.5 to 65 years old present an increased rate of AVN compared to younger patients, age being an independent predictor of AVN, also with a good discriminatory capacity. Future studies should determine if a THA is a more clinically effective

and cost-effective option than reduction and internal fixation for this age sub-group.

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