

The prognostic value of tip-to-apex distance (TAD index) in intertrochanteric fractures fixed by dynamic hip screw

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Abstract

Intertrochanteric fractures (ITFs) are the most common type of fractures requiring surgical intervention. They also have the highest surgical mortality among orthopedic operations. Among the many different techniques used for fixation of this type of fracture, use of the Dynamic Hip Screw (DHS) has gained wide acceptance. This current study was designed to assess positive predictive value of tip-to-apex distance (TAD) index in the prognosis of patients treated with DHS. The study was designed according to a descriptive-analytic protocol, made up of 100 cases of ITFs caused by falling, treated in the Shohada Orthopedic Center, Tabriz, Iran. All patients underwent lateral and antero-posterior hip X-ray to measure TAD index. The cohort was followed for three months after DHS placement. Of a total of 100 cases (53 male, 47 female) with a mean age of 76.7 years (range 29-100 years), 43% had grade 4, 29% grade 3, 21% grade 5, 5% grade 2 and 2% grade 6 osteoporosis. The screw position was postero-inferior in 57%, central in 40% and superior in 3% of patients. Minimum and maximum TAD index were 20 and 28 mm, respectively. Mean TAD was 23.5 mm. There were no post-operative complications in 84% of cases. Screw failure was the most common complication in the remaining 16% of patients. The study shows a statistically significant correlation between TAD index and cut-off rate in patients with intertrochanteric fractures of femoral bone treated by DHS. This validates the use of TAD index in determining the prognosis of patients treated by DHS.

Introduction

Intertrochanteric fractures (ITFs) are among the most common type of fractures requiring surgical intervention. They also have the highest rate of post-operative morbidity and mortality among orthopedic operations.

Briefly, ITFs include fractures occurring in the region of the extracapsular part of femoral neck and lesser trochanter. Due to incomplete and often unacceptable post-operative functional recovery in most patients, and also to the cumbersome surgical techniques and equipment, ITFs usually impose excessive costs both on patients and on health care systems. Methods used to treat ITFs include surgical and non-surgical options. The non-surgical treatment is best suited for patients with end-stage dementia, uncontrollable pain unresponsive to full-dose analgesics, and those patients with estimated survival of less than six weeks.¹ Those with none of these indications are ideally treated by a surgical approach. Surgical treatment accelerates fracture repair, reduces time to ambulation and, finally, improves long-term functional outcomes. There has been a long history of devices used for ITF fixation. One of the most popular technologies used for fixation of these fractures include plaques and intramedullary nails. Sliding hip screws are composed of a lag screw and a side plate with 2 or 4 holes. The sliding movement of the compression screw into the barrel space causes the compression of fracture sites. The best position for the lag screw is the head and neck of central femur or slightly inferior to it. In addition, the screw head should be placed into the subchondral part of femoral head to prevent cut off of the screw.² Tip-to-apex distance (TAD) is defined as the distance between screw tip and apex of femoral head in the antero-posterior (AP) and lateral X-ray views. This study was designed to assess positive predictive value of TAD in determining prognosis of patients treated with internal fixation with Dynamic Hip Screw (DHS). Other prognostic factors include age, sex, screw position in femoral head and neck, and osteoporosis severity. The main goal of the current investigation was to obtain the best possible operative results with non-expensive equipment and with minimal trade off.

Materials and Methods

A descriptive-analytic study was conducted to evaluate 100 cases of ITFs treated by DHS technique in Shohada Orthopedic Center, Tabriz, Iran in 2010. All cases were caused by falling. Demographic features of all patients were recorded using a check list. Written consent was obtained from all participants. AP and lateral X-ray was performed on all patients and TAD index was calculated using the following equation:

$$TAD=A+B$$

where A is defined as distance between tip of

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lag screw and apex of femoral head on AP X-ray and B is defined as distance between the tip of lag screw and apex of femoral head in lateral projection.

The Evan's classification was used to determine the degree of stability of surgical fixation. Seventy-two percent of cases, categorized as stable fixation group, had fractures with minimal or no displacement at all allowing anatomical reduction. The medial cortex was intact in this group. Twenty-eight percent of cases were assigned to unstable fixation group which included those with displaced fractures fixed in a non-reduced position. This group also encompassed patients with reverse oblique fractures or those showing destruction of anatomical cortex. After surgical fixation of fractures using DHS, patients were followed for three months. Treatment results were evaluated and recorded. In the case of treatment failure, all possible causes were reported and recorded. After completion of the study database, the results were analyzed using SPSS-16 statistical software. Quantitative data were described using mean±standard deviation (SD). Frequency and cumulative frequency were used for assessment of qualitative data. Independent sample t-test was used for comparison of means in different groups. K² test was applied for analysis of qualitative data. Cut-off point was determined by area under the ROC curve. P<0.05 was considered statistically significant. Exclusion criteria included: i) any underlying medical condition affecting bone turnover or metabolism (e.g. CKD, primary hyperparathyroidism, metastatic bone involvement); ii) any type of fracture other than ITF; iii) treatment strategies other than DHS placement; iv) patient refusal or non-compliance.

Patients' names and medical records were not revealed according to current research protocols, and an observational, rather than interventional, approach was adopted to collect demographic and therapeutic data. No ethical issues were encountered.

Results

A total of 100 patients entered the study with a male to female ratio of 5:4. Mean age was 76.7 years (range 26-100 years); 43% of cases had grade 4, 29% grade 3, 21% grade 5, 5% grade 2 and 2% grade 6 osteoporosis. Eighty-nine percent of all reductions were stable and 80% of patients sustained full weight bearing after three months. The remaining 11% were categorized as unstable reduction. Lateral comminution was observed in 5% of patients. Screw position was posteroinferior in 57%, central in 40% and superior in 3% of fixations. TAD ranged from 20 to 28 mm (mean 23.5). No cut off was observed after termination of 3-month follow up in 92% of cases, with the remaining 8% showing early or delayed evidence of cut off. The most common complication was screw failure which occurred in 8% of patients (5 men, 3 women). There was no statistically significant difference in cut-off rate between males and females ($P=0.7$). Also, there was no meaningful correlation between cut-off rate and severity of osteoporosis ($P=0.56$). A significant correlation was observed between stability or instability of reduction and cut-off rate ($P=0.04$). In contrast, the correlation between comminution and cut off did not reach significance ($P=0.24$). In patients undergoing cut off ($n=8$), the position of the screw was posteroinferior in 2 cases, central in 3 and superior in the remaining 3. Mean age of the cut-off group was 78.2 years compared with 76.5 years in patients with no cut off. Mean TAD was 25.8 and 23.29 for patients with or without cut off respectively.

Discussion

Hip fractures are very common, especially in the elderly population.³ Consequently, enormous costs are imposed on health care systems dealing with this ever-growing age group and their problems. Crude statistics for 2010 showed an incidence of 1.26 million cases worldwide, with a projected estimation of 2.6 million cases in 2025 and 4.5 million cases in 2050.⁴ Regardless of fracture type, mortality and morbidity of hip fractures are high in this age group.⁵ For instance, in the USA, more than 90% of all proximal femoral fractures

occur in patients over the age of 50 years. It is also notable that the occurrence of femoral fractures doubles for each decade over 50 years.⁶ Several important factors may impact the incidence of hip fractures including, among others, older age, smoking habits, excessive alcohol consumption, high caffeine intake, physical inactivity, low body weight, dementia and, most importantly, osteoporosis.⁷ According to previous studies, 75% of all hip fractures occur in women. The estimated risk for hip fracture over the age of 50 years in a Caucasian woman approaches 16%, while for the same age group only 6% of Caucasian men will sustain a hip fracture. In the present study, however, 53% of all fractures occurred in males, exceeding the female fracture rate (47%) by 6%. Generally, in a traditional city such as Tabriz, most of the elderly women prefer to participate predominantly in housekeeping duties or indoor activities. Since physical activity plays an undeniable role in ITFs, the higher risk in male patients is probably due to more vigorous activity and exercise in osteoporotic men of the same age.⁸ The minimum and maximum age of our cohort were 29 and 100 years, respectively, with a mean of 76.7 years; these figures are comparable to similar studies conducted in Western countries. Certainly, more studies are required to deal specifically with this discrepancy between Asian and Western patterns of hip fractures. Prevalence of ITFs rises steadily with advancing age. According to our study, ITF prevalence begins to rise sharply after the seventh decade of life. In comparison with westernized Asian countries such as Turkey, the prevalence of ITFs is substantially lower in Tabriz, which is probably explained by lower physical activity among elderly population in this geographical area. Furthermore, many patients over the age of 80 years have never sought medical assistance, mainly due to a lack of attention on the part of the family or early death. In a previous study, conducted in 1388 in the heliacal Hegira calendar (coinciding with 2010 in the Georgian calendar) by Farahanchi and colleagues, the main cause of hip fracture was due to falls which accounted for 83% of ITFs (male to female ratio 2:1). In the remaining 17%, injuries such as motor vehicle accidents and falling from a height were the most common causes. In Western countries, ITFs are due to many completely different causes, mainly because of social and cultural differences. Choosing the most appropriate treatment strategy for ITFs in elderly patients has several important implications, the most important of which are the risk of non-union, malunion and loss of limb functionality.⁹ Former investigations performed in Tabriz to assess the epidemiology of low energy-hip fractures revealed an incidence of 1.75 per 1000 in a random population of people over

the age of 50 years. This rate increased to 3.5 per 1000 over the age of 60 years with almost equal prevalence in males and females. In a similar study evaluating the prevalence of hip fractures in 6 Mediterranean countries (including 5 European countries plus Turkey), male to female ratio was 3:7. Osteoporosis-associated low-energy hip fractures have a strikingly low prevalence in Tabriz compared with other areas of the world which primarily reflects a lower risk of trauma-related fractures and lower prevalence of osteoporosis in Tabriz.¹⁰ Patient or family refusal to seek medical care, especially in people over the age of 80 years, and low levels of physical activity may also contribute to this unexpectedly low prevalence. Osteoporosis-associated fractures appear about ten years earlier in Tabriz compared with European societies. This discrepancy is, at least in part, due to physical inactivity and the low-calcium diet prevalent in this area. Based on the Singh grading system, osteoporosis is divided into 6 grades with grade 6 having normal trabecular architecture and grade 1 having the most distorted trabecular formation.¹¹ This grading system is based upon AP X-ray assessment of hip joint. Grades 3, 4 and 5 osteoporosis accounted for 90% of cases in our series. After a 3-month follow up period, 84% of cases showed no evidence of post-operative complication. In the remaining 16% of patients, screw failure was the most common problem (9%). Other complications included delayed union (4%) and malunion (3%). Based on the results of the present study, there was a significant correlation between screw position and cut-off rate. There was also a significant correlation between cut-off rate and the degree of stability of reduction. No correlation was found between fracture type and complication rate. Mean age of patients in the cut-off positive and cut-off negative groups was 78.25 and 76.57, respectively. However, age difference did not reach statistical significance. Another study showed a significant correlation between rate of screw failure and TAD increment.¹² Range of TAD index was 20 to 28 mm with a mean of 23.5 mm. Mean TAD for cut-off positive and cut-off negative groups was 25.87 and 23.29 mm, respectively. Although there was a general agreement between the results of the present study and previous investigations in Iran and other countries, there are certainly some areas of discrepancy, especially regarding minor study goals. A large number of these differences are explained by cultural and social factors prevailing in the geographical areas under study. Secondly, nutritional habits may also play a marginal role in these discrepancies. Other factors that may contribute include different surgical techniques and equipment, expertise of surgeons, and patient adherence to post-operative medical instructions.

Conclusions

Treatment of intertrochanteric femoral fractures using DHS has gained wide acceptance in recent years, mainly because of the simplicity of the techniques used for its application and its lower cost. Furthermore, in agreement with our study, the rate of post-operative complications is justifiably low. According to the present study, there was a statistically significant correlation between TAD index and cut-off rate in patients with intertrochanteric fractures of femoral bone treated by DHS. This validates the use of the TAD index in determining prognosis for patients treated by DHS.

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