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Comparison of Side Effects and Cost Effectiveness of Proximal Femur Locking Compression Plate with Intramedullary Nailing in the Treatment of Sub-Trochanteric Fractures

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Abstract

Background: *The sub-trochanteric (ST) fracture is relatively common and does not have a single treatment. It can be repaired in a variety of ways each of which has different complications as well as different treatment costs. Accordingly, the purpose of this research is comparing the side effects and cost effectiveness of proximal femur locking compression plate (PFLCP) with intramedullary nailing in the treatment of sub-trochanteric fractures*

Methods: *This cross-sectional study was performed on 56 patients with ST fracture who were referred to Firoozgar hospital between January 2014 and December 2018. Two methods were used for treatment of fractures by physicians. The method of surgery for group A was the PFLCP while for group B it was the nailing. The postoperative complications and treatment costs were evaluated and recorded in a specific sheet for each patient.*

Results: *In this study, of the 56 eligible patients examined, 49 (87.5%) of the participants were male. The mean age of the all patients was 42.7±16.2 years. The motion restriction in group A was significantly (P=0.041) milder than group B. So, the total cost of treatment in group A was significantly (P=0.045) lower than in group B. Also, the results of logistic regression model revealed that sex and age could significantly reduce the incidence of side effects with males [OR=0.851] and those younger than 30 years [OR=1.629] having fewer side effects.*

Conclusions: *Use of a PFLCP first causes fewer side effects and less motion restriction after operation. The cost of treatment is lower and it is more cost-effective.*

Keywords: PFLCP, Intramedullary nailing, Subtrochanteric fracture, Side effects, Cost effectiveness.
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Introduction

Hip fractures, looking for a snap and a simple fall, are very common and costly in young patients when compared to older people. Patients with these fractures occupy about 20% of the orthopedic beds in England. It is estimated that the number of these fractures in the world is 1.2 million cases per year and is expected to reach 2.5 million in 2025 and 4.5 million in 2050.[1]

Proximal femoral fractures are divided into femoral neck fractures, fractures of the intertrochanteric (IT) region, and subtrochanteric (ST) based on anatomical location. Each of them has unique features, different surgical treatments, and different prognoses.[1-2]

Proximal femoral bone fracture (in particular fractures of the femoral neck and intertrochanteric region) is one of the most important fractures in orthopedic surgery.[3] Meanwhile, subtrochanteric fractures (which is anatomically referred to as a part of the proximal femur bone located 5 cm below the lower edge of the lesser trochanter) are also very important due to very serious complications due to poor management and poor clinical outcomes after treatment.[4-5]

The most important factors affecting these fractures can include age, sex, smoking, dementia and psychological disorders, underlying diseases, and osteoporosis.[6]

The overall incidence of proximal femoral fractures is about 230 per 100,000 patients with approximately 5 to 10% of these fractures occurring in the ST region. The total ST incidence is estimated to be approximately 15-20/100,000. The ST fracture is present in between 10% and 35% of all fractures of the peri-trochanteric region.[7-8]

Concerning the age of patients, approximately two thirds of all ST fractures occur in patients over the age of 50 and 25% in patients aged 17 to 50 years. So, many studies have shown that femur bone fractures occur with the same distribution in both genders. However, in some studies, it has been shown that women are at a higher risk of femoral bone fractures (about 33% higher) than men.[9] In addition to age and sex, other risk factors including total bone mineral deficiency, diabetes mellitus, and bisphosphonate medications increase the risk of ST fracture.[10]

In most cases, ST fracture occurs in older patients after a low-energy traumatic event (falling) while in young patients it occurs as high-energy trauma.[1-3]

In the elderly, glide or falling, leading to direct trauma to the lateral hip, is the most common mechanism of this fracture. Nevertheless, the prognosis and results of surgical treatment of ST fractures have remained understudied. It seems that young people who usually have femoral fractures due to severe trauma and usually with other injuries have a worse prognosis for femoral insufficiency in middle-aged people.[4-5] In a patient with suspicion of ST fracture in the first step, AP and full-length femur radiography are taken. The use of more advanced

CT scan and MRI modalities is indicated in more complex cases based on examination and radiological evidence.[2]

The Russell-Taylor classification is the most reliable method for categorizing the fractures of the ST, which is based on the presence of lesser trochanter commination and fracture extension to the priformis fossa. According to this classification, fracture type 1 does not involve piriformis fossa. They are divided into two categories: 1A (small fractures of the small trochanters) and 1B (fractures including small trochanter). Fracture type 2 involves piriformis fossa. Two types of 2A (with a stable medial buttress) and 2B (without medial femoral cortex).[1, 11]

Treatment of ST fractures is very challenging for orthopedic surgeons. Open reduction sometimes damages vascular nutrition, weakens the components and damages soft tissues. It can also increase the risk of non-union and implant insufficiency.[7-8] Also, these techniques can cause complications and problems in some patients.[9] One of the other techniques used is closed reduction and biologic plating. Here, a lateral femur locking compression plate (PFLCP) can be used as a protective shield next to the trochanter's side wall for preventing the movement of proximal parts.[10] Due to the lack of sufficient information on ST fracture repair by PFLCP method, as well as the constraints for insertion of various implants into the country, this study was conducted to compare the PFLCP with intramedullary nailing in the treatment of sub-trochanteric fractures in Firoozgar Hospital in Tehran in 2014 until 2018.

Materials and Methods

In this comparative study, 56 patients with ST fractures admitted to the Firoozgar Hospital in Tehran during January 2014 and December 2018 were recruited. The patients were subdivided in two groups: group A with open reduction and internal fixation using a proximal femur locking compression plate and group B with intramedullary nailing for treatment of fractures

Inclusion criteria: patients requiring one of the surgical procedures, the ability to visit for a specified period, follow up on the treatment and consent to participate in the research. Exclusion criteria: mental or physical disability, underlying disease affecting the healing process, fracture due to underlying disease or malignancy, and refusal to participate in the research.

In this study, eligible patients were selected by reviewing the archives of medical records. Group A included patients for whom PFLCP was used to treat the ST fracture and Group B included patients who received intramedullary nailing to treat their ST fractures. In group A, after the patient's prep and drep, they were placed in the lateral position. Then, an incision of a greater trochanter was made to distal length of approximately 15 cm.[12] After separating the origin of the vastus lateralis muscle, it was first placed and then a plaque was placed on the bone. Three proximal screws were fitted to fix the plate. Then, at the fracture site, an incision was made on the distal femur of approximately 15 cm in the vastus laterals.[12-13] Distal plaque was fixed with 5 screws to the bone. Then, for each patient, the drain was used for discharging the blood and secretions, after which the fascia was sutured to the skin and subcutaneous layer, and then the wound was dressed. For group B patients, standard intramedullary nailing surgery was performed. These problems included: the need for a special fracture bed, the need for C-Arm imaging, far more X-rays, the patient's harder position for surgery, more tools and being more time-consuming. On the other hand, the PFLCP method uses a usual operation bed, the patient takes a lateral position which is easier to operate, and imaging is done routinely. Side effects of femoral neck fracture, including motion restriction at different angles, deformity, severity of pain, difficulty in walking, delay in recovery, and the need for re-operation was investigated for all patients within 12 months. Also, all treatment costs including prosthesis and hospital costs, rehabilitation such physiotherapy and recovery costs were calculated for all patients. All clinical and cost data of patients in both groups were recorded in each patient's special sheet.

Descriptive statistics including mean and standard deviation, as well as relative frequency were used to describe the data. To examine the relationships and comparisons between the two groups, the chi-square test was used and multivariate logistic regression was employed to evaluate the odds of each of the variables. All analyses were performed using SPSS software version 16 with significance level of $P<0.05$. This study has an ethics code number (IR.IUMS. FMD.REC. 1396.9411242003) from research deputy of Iran University of Medical Sciences. The essential information and the objectives of the study were explained to the patients, and written consent was obtained for participation in the plan.

Results

In this study, of the 56 eligible patients examined, 49 (87.5%) of the participants were male and the rest were female. The mean age of the all patients was 42.7±16.2 years (16-85 years). Regarding the variables studied in all patients, the extent of the motion restriction after operation was significantly lower in group A ($P=0.041$), while in other variables, there was no significant difference between the two groups. The results of clinical side effects of patients in the two groups are presented in table 1.

The costs of treatment and healing of femoral bone fractures for all patients are reported in table 2. As can be seen, the total cost of treatment in group A is significantly ($P=0.045$) lower than in group B.

In this study, independent variables with side effects were investigated in multivariate regression model. As observed in table 3, the results of logistic regression model indicated that sex and age could significantly reduce the incidence of side effects such that male gender reduced the odds ratio [OR=0.851 (95% Confidence: 1.083-0.525)] while age older than 60 years increased the odds ratio [OR=1.629 (95% Confidence: 1.908-1.3612)] of side effects. Note that there was no significant relationship with other variables.

Table 1. Comparision of side effects and recovery in two groups

Side effects	A group Number (%)	B group Number (%)	Total Number (%)	P.V
Motion restriction				
– Without restriction	17 (60.7)	15 (53.6)	32 (57.1)	0.04
– Mild restriction	10 (35.7)	11 (39.2)	21 (37.5)	
– Moderate restriction	1 (3.6)	2 (7.2)	3 (5.4)	
Severity of pain				
– Low	20 (71.4)	18 (64.2)	38 (67.9)	0.09
– Moderate	6 (21.4)	5 (17.9)	11 (19.6)	
– High	2 (7.2)	5 (17.9)	7 (12.5)	
Deformity				
– Positive	11 (39.3)	10 (35.7)	21 (37.5)	0.11
– Negative	17 (60.7)	18 (64.3)	35 (62.5)	
Difficulty in walking				
– Not	17 (60.7)	18 (64.3)	35 (62.5)	0.07
– Mild	7 (25.0)	7 (25.0)	14 (25.0)	
– Moderate	4 (14.3)	3 (10.7)	7 (12.5)	
Delay in recovery				
– Not	21 (75.0)	18 (64.3)	39 (69.6)	
– One month's delay	5 (17.9)	3 (10.7)	8 (14.3)	0.08
– Delay of two to three months	2 (7.1)	5 (17.9)	7 (12.5)	
– Delay more than three months	0 (0.0)	2 (7.1)	2 (3.6)	
Need to re-operation				
– Positive	6 (21.4)	8 (28.6)	14 (25.0)	0.06
– Negative	22 (78.6)	22 (71.4)	44 (75.0)	

Table 2. comparison between hospital procedure cost of two treatment approaches using t test

Costs	A group (Rials)	B group (Rials)	Total (Rials)	P.V
Mean cost of prosthesis	32.000.000	29.000.000	30.000.000	0.058
Mean hospital costs *	8.300.000	11.000.000	9.900.000	0.048
Mean cost of recovery	5.500.000	9.000.000	7.300.000	0.043
Mean cost of physiotherapy	4.800.000	5.900.000	5.300.000	0.081
Mean total cost of treatment	50.300.000	54.900.000	52.500.000	0.045

*. Mean duration of patient`s hospitalization in A group was 4.±1.5 days and in B group was 5.5±1.9 days.

Table 3. Relationship between independent variables with having a side effect in multivariate logistic regression model

Independent variables	Odds Ratio	95% Confidence	P.V
Age category			
– Less than 30 years	1		
– 30 to 60 years	1.29	1.51-0.097	0.05
– More than 60 years	1.63	1.91-1.36	0.04
Sex			
– Female	1.00		
– Male	0.85	1.08-0.53	0.04
GCS Glasgow Coma Scales			
– > 10	1.00		
– ≤ 10	0.94	1.25-0.81	0.09
BMI Body Mass Index			
– 18-25 kg/m2	1.00		
– < 18 kg/m2	0.92	1.13-0.76	0.06
– > 25 kg/m2	0.88	1.04-0.61	0.05
The first time referral			
– Immediately	1.00		
– With 1 to 7 days delay	0.85	1.12-0.67	0.12
– With over 7 days delay	0.72	0.96-0.67	0.09
Number of traumatic sites			
– Just femur	1.00		
– Multiple	0.87	1.14-0.51	0.05

Discussion

The results of this study suggested that effect use of PFLCP in the treatment of subtrochanteric fracture was almost similar to intramedullary nailing, but it significantly reduced the motion restriction after operation and was more cost-effective. In this study, also with the help of multivariate logistic regression model, it was found that factors such as age and sex can significantly correlate with the increase in patients' recovery, such that in patients under the age of (up to 30) and males, the rate of side effects was lower.

Treatment of sub-trochanteric fractures (especially comminuted and unstable types) due to biomechanical

properties is very challenging and there is still no single choice treatment.[13] Several methods are chosen based on the location of the fracture, the age of the patients, and the surgeon's experience.[14-15]

One of the new ways to repair the ST fracture is to use the PFLCP.[16] The success of using PFLCP depends on the correct choice of the patient, choice of a suitable length plate, presence of medial buttress at the fracture site, and use of the kickstand screw.[17] In Barquet study of 3500 cases of proximal femoral fractures, the results of using extra and intra-medullary implants were compared. They reported that mortality rate, side effects, and treatment costs were not significantly different between the two groups.[18]

In a study by Glassner et al., it was observed that use of PFLCP can be a simpler approach such as C-Arm imaging, much more X-rays, the patient's harder position for surgery, acceptable results and substitutes for other methods, especially in cases where the fracture has occurred the lateral wall as it can produce acceptable stability in the hip. The special feature of this type of implant is that once the screw is locked in the plate, it acts as an external fixator and can hold the parts together without stress and excessive force on the large trochanter. This device (PFLCP) prevents the need for subsequent surgery and thus reduces the side effects and the cost of treatment which are similar to the present study results in this regard.[19]

According to numerous studies, more than 20% of patients undergoing intra-medullary implants have several complications. Also, the protrusion of the screws from the lateral region, as well as their migration into the joint causing abnormal pain and reducing the amount of joint movements, are other complications of this treatment. Meanwhile, 20% of patients undergoing intramedullary fixation will require reoperation.[20-21] In this study, the mean age of patients was 42.7±16.2 years, suggesting that most of the sub-trochanteric fractures are caused by high energy impacts and occur in young people.

Barquet et al. compared the results after the insertion of PFLCP and intramedullary nailing in a study. However, they did not report significant differences in side effects between the two groups, which has been largely similar to the present study in this regard.[22] The only difference was the need for walking aid, which was significantly lower in patients who used the PFLCP, which may be due to the number and age of the patients participating in the two studies.

In the current study, the total treatment cost had a significant decrease in the PFLCP group. In the study of Asselineau et al., evaluating the pelvic function after the introduction of PFLCP, the average total treatment cost was less than other methods.[23] Saini et al. reviewed the repair process and postoperative complications in 45 patients with ST fracture treated with PLFCP. They evaluated hip joint performance one year after surgery, where the mean total treatment costs in these patients was similar.[15] The difference in the cost-effectiveness of this study with our study may be due to the difference in sample size in these studies.[16]

Use of a PFLCP to treat of ST fractures causes fewer side effects and is less costly. Therefore, it is recommended that surgeons use this method for the treatment of this fracture in young patients with slight complication, especially in cases of greater trochanter involvement, lateral wall damage, and comminuted sub-trochanteric fractures.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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