Results of Subtrochanteric Femoral Fractures Fixation by Proximal Femoral Locking Compression Plate

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The treatments of subtrochanteric femoral fractures are a challenge. It accounts about 10.0% to 34.0% of all hip fractures with a high complication rate. This area consists of mostly cortical bone with high stress generation thus heal slowly. The fracture is too proximal to adequately control with implants for femoral shaft and too distal to control with implants for intertrochanteric fractures. The intrinsic insecurity of this fracture and forces of the muscles with comminuted medial calcar is giving the fracture a tendency to varus crumple. Extramedullary implants are associated with higher rate of implant failure while intramedullary nails are not suitable for short proximal segment and wide medullary canal. Recently proximal femoral locking compression plate (PF-LCP) has been applied in treatment of proximal femur including subtrochanteric fractures. It has an excellent result in respect of union, fewer complications and early rehabilitation. The aim of this study was to assess the rate and time taken for union of fractures by PF-LCP and determine perioperative parameters. This prospective study was conducted from March 2019 to September 2020 at Mymensingh Medical College Hospital through non randomized purposive sampling. Total 25 patients aged above 18 years irrespective of sex with closed subtrochanteric fracture were included but pathological fractures, multiple injuries were excluded from the study. Union status evaluated by Radiographic Union Score for Tibial (RUST) fracture of Whelan; where antero-posterior and lateral radiographs (X-ray) based assessment of healing of the four cortices done. The entity cortical scores were added to give an entire score; 4 being the least amount demonstrating fracture are positively not healed and 12 being the highest score representing that the fracture is positively healed. The mean age of the patients was 42.04±14.97 years with range 22-70 years. Majority of patients were male (60.0%) and most of injury (64.0%) due to road traffic accident with most fractures was Seinsheimer type III (48.0%). Average operative time was 121.92 minutes, follow up period was 41.12 weeks (24-48 weeks) and time taken for union was 14.16 weeks (11-28 weeks). According to RUST scores; fracture union rate 88.0% with delayed union 12.0% and no nonunion. There were two patients with superficial wound infection and no implant failure. This study concludes that PF-LCP is a safe and reliable implant for the treatment of subtrochanteric femoral fractures.

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Key words: Subtrochanteric femoral fractures, Proximal femoral locking compression plate

Introduction

Trauma is a growing global health concern and major cause of death and disability worldwide. Accidents involving motor vehicles are the main cause of musculoskeletal trauma[1]. By 2030, road traffic injuries alone are predicted to become the third largest contributor to the global burden of disease[2]. Subtrochanteric femoral fractures are one of the common fractures encountered in today's orthopaedic practice. This accounts for approximately 10-34% of all hip fractures with a complication rate ranging from 19.0% to 32.0%[3] is generally recognized fracture occurring at the lesser trochanter to a distance of approximately 5 cm bellow lesser trochanter[4] extending to the junction of the proximal and middle third of the femur[5]**.** They have bimodal age distribution and different mechanism of injury. Older patients typically sustain low-velocity trauma, where as in younger patients commonly result from high-energy trauma and often associated with other fractures and injuries[6]. Older age group is also susceptible to metastatic disease that can lead to pathologic fractures[7].

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The difficulties encountered in the treatment of subtrochanteric fractures are related to the anatomic and biomechanical features unique to this area. Anatomically it consists of mostly cortical bone and tends to heal more slowly than metaphyseal bone. Just proximal, the canal widens in the intertrochanteric area, which leads to less optimal fixation because of the wide canal and short segment proximally. Biomechanically the subtrochanteric area is an area of high stress concentration, and the muscle attachments lead to strong deforming forces that can make fracture reduction difficult[8]. This fracture has significantly higher rates of malunion and nonunion than other femoral fracture[9]. During the past 30 years, there has been a near-complete elimination of non-operative treatment in adults and a corresponding increase in operative treatment[10]**.** The aim of the surgery is to achieve initial stability and early mobilization of the patients to avoid complications, such as deep vein thrombosis, thrombophlebitis, pulmonary embolism, urinary and lung infection and ulcers[11]. A number of issues concerning the best treatment options for each proximal femoral fracture and optimal aftercare are still to be answered[12]. Open reduction and internal fixation (ORIF) is an important method for treatment and success depends on achievement of stable fixation. In account of this requirement, a diverse methods for internal fixations emerged[3]. It demands special consideration on reduction technique and implant selection before intervention to achieve accurate reduction of length, rotation, and angular alignment of the fracture[5]. The inherent instability of fracture and forces of the muscles with comminuted medial calcar is giving the fracture a tendency to varus collapse. This makes closed reduction difficult and pushes the proximal fragment into a malreduced position[4]. Implants used currently include Intramedullary and Extramedullary devices. Intramedullary nailing has been successful in treating subtrochanteric fractures and allowed for nail insertion via a small access incision. But disadvantages are- significant insertion site morbidity, trochanteric pain, abductor weakness and heterotrophic bone formation, less optimal fixation and risk of varus malunion[13]. Widely use intramedullary nail like proxomal femoral nail antirotation (PFNA) and cephalomedullary nails have complications such as poor reduction, lag screw cutout and varus deformity of the hip when used in unstable fractures[14]. Extramedullary devices suitable for treatment include the 95º condylar blade plate, dynamic condylar screw (DCS) and dynamic hip screws (DHS)[15]. Conventional plating method has the disadvantage of extensive surgical dissection; causing periosteum and soft tissue damage and impedes the healing process[11]. However stable subtrochanteric fractures can be treated successfully with these conventional implants but comminuted and unstable fractures, fractures with extension into the piriformis fossa and combined intracapsular and extra capsular fractures are challenging which are prone to complications[16]. Proximal femoral locking compression plate (PF-LCP) has been developed recently, which merge locking screw technology with conventional plating technique[17]. Theoritically, this technique could offer optimum fixation of comminuted and highly unstable fractures that associated with more shearing and pull-out forces. Studies have reported success with PF-LCP fixation for the treatment of complex femoral fractures and for revision operation after failure of other implants[18]. The new implant, PF-LCP allows angular-stable plating for the treatment of complex comminuted and osteoporotic fractures. The overall technical complication rate for PF-LCP was only 2.7%. Breakage of the implant rated as low as 1.0% and the reoperation rate was 1.9%[19]. The PF-LCP shows promising results in comparison to the conventional plating in respect to its better strength, accuracy and surprisingly better results in infection and non-union. Bearing all these advantages of PF-LCP in mind, the present study was undertaken to evaluate for union rate and determine perioperative parameters of subtrochanteric femoral fracture fixation.

Methods

This prospective interventional study was conducted at Mymensingh Medical College Hospital over a period of May 2019 to September 2020. After taking permission from Departmental Clearance Committee of Orthopaedic Surgery and Traumatology of Mymensingh Medical College Hospital, Bangladesh, a total of 25 patients with subtrochanteric fractures were included in the study by non-randomized purposive sampling technique. Adult patients of either sex aged 18 years and above who had closed Subtrochanteric fracture within 3 weeks of fracture of any type and

side were included. Patients were excluded who had open contaminated subtrochanteric fracture, multiple fractures and poly-trauma and pathological fractures other than osteoporotic fracture. They were informed about the purpose of the study and obtained written consent. Union status evaluated by Radiographic Union Score for Tibial (RUST) fracture where antero-posterior and lateral radiographs (X-ray) based assessment of healing of the four cortices done. This is a newly developed scoring system can be applied with excellent reliability and providing a standardized method to assess healing of fracture and used by Whelan et al.[20] for tibial fracture, Morshed[21] and Bhandari et al.[22] for Hip fractures, Litrenta et al.[23] for metaphyseal fractures, Cook et al.[24] for assessment of fracture repair and Schneble et al.[25] for humeral shaft fractures. The individual cortical scores were added to give a total score; 4 being the minimum indicating fracture is definitely not healed and 12 being the maximum score indicating that the fracture is definitely healed. The data were collected in a prescribed data collection sheet with a structured questionnaire containing history, clinical examination, laboratory investigations, pre-operative and per-operative assessment and union status with time for union. Each patient was followed up to 48 weeks (at least 24 weeks) at 2nd, 6th, 12th, 18th, 24th, 36th and finally 48th week. Analysis was done by Statistical Package for Social Sciences (SPSS) for windows software and significance of the results as determined in 95.0% confidence interval.

Surgical Technique

All the patients were initially resuscitated by intravenous fluid, blood transfusion and analgesic. Then history was taken, thorough clinical examination was done and upper tibial skeletal traction was applied. Finally, diagnosis was confirmed by radiology and preoperative anesthetic fitness done for SAB. The patients were placed in supine position on fracture table. Closed reduction done on fracture table under fluoroscopy. First traction applied on involved limb in slight abduction (20º - 30°) or in neutral position. Then slight internal rotation and the limb were adducted.

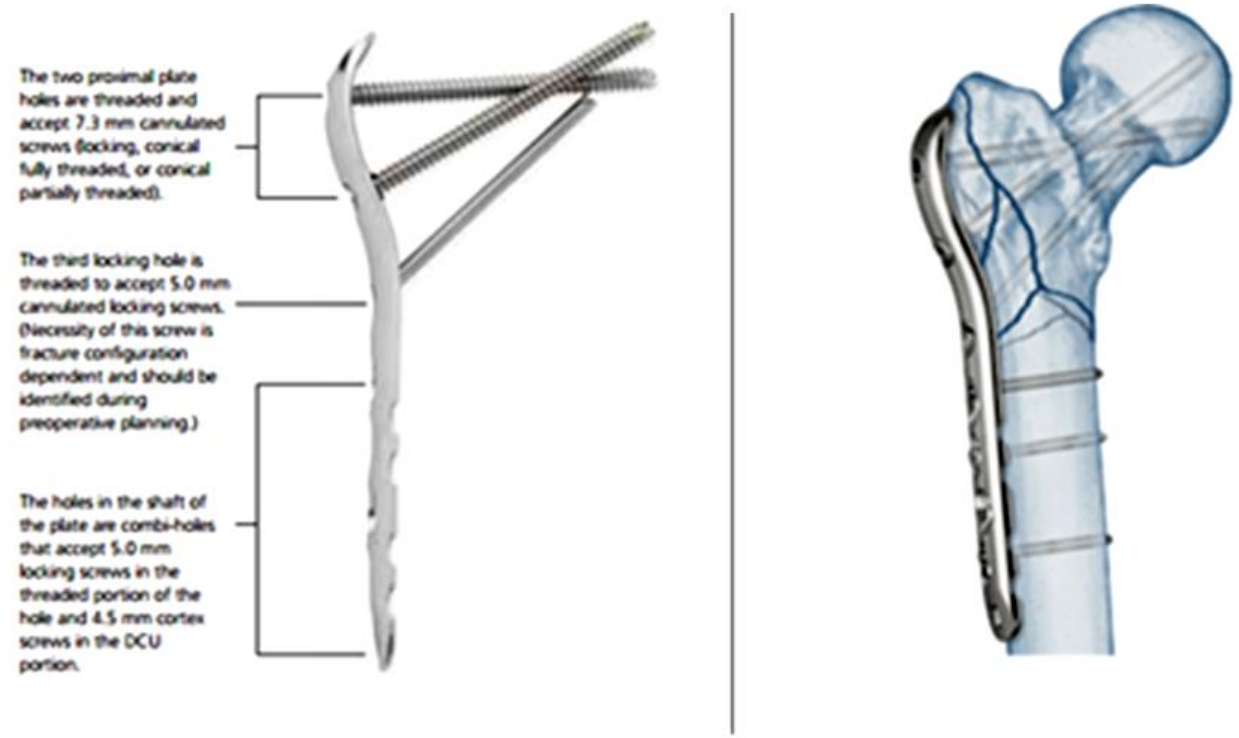

Figure 1: Features of proximal femoral locking compression plate (PF-LCP)[26]

The reduction was checked under fluoroscopy. A longitudinal straight incision about 10-15 cm was made through an imaginary line from the tip of the greater trochanter to center of lateral fermoral condyle over

fracture site. The iliotibial band was incised longitudinally along the line of skin incision and muscles were reflected anteriorly and posteriorly along the shaft of the femur to open fracture site of the lateral aspect of femur. Reduction was done with manual traction and hold in position by bone-holding forceps. The anatomically pre-contoured appropriate length of PF-LCP placed over lateral surface proximal femur and checked with C-Arm to ensure tip of plate to be flushed with tip of greater trochanter. Using drill sleeve and drill guide, 2.5mm guide wire is inserted in 95° and 120° hole and 135° hole and drilled with 4 mm drill bit using threaded sleeve. The position was checked with C-Arm to ensure guide wires were in the neck and head. The proximal 2 holes drilled with 5.0 mm cannulated drill bit and 7.3 mm cannulated screws were inserted after measurement. The 135° hole after drilling with 4.0 mm drill bit 5.0 mm locking screw inserted after measurement. Then other combi holes are drilled and at least 4 cortical locking screws of 5.0 mm are placed at the distal part of plate. After ensuring proper hemostasis a drain is placed at appropriate site and the wound closed in layers.

Figure 2: Position of patient under c-arm with traction

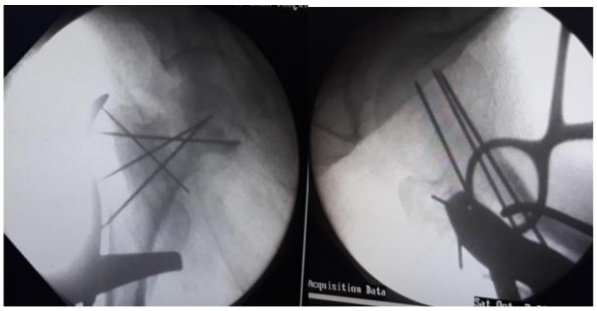

Figure 3: C-Arm view after insertion of guide wires; A/P and Lateral views.

Figure 4: Pre-operative x-ray pelvis A/P and right hip lateral views.

Figure 5: X-ray right thigh at final follow up (48th weeks)

Results

Age was ranged from 22 to 70 years and mean age 42.04±14.97 years. Maximum patients (56.0%) were in workable age (21-40 years). Majorities (60.0%) were male and male: female ratio was 1.5:1 (Table I). Common (64.0%) cause of injury was RTA (Figure 6) and Seinsheimer type III (48.0%) was most common fracture type (Table II). Maximum patients (48.0%) were operated in second week of trauma. Mean time interval was 11.24±3.45 days and range of time 6-17 days (Figure 7). Mean operative time 121.92±18.58 minutes and range of was 85-150 minutes (Table III). Main intra-operative problem was proximal screw insertion difficulty 6(24.0%) followed by reduction difficulty 5(20.0%), Maximum patient (72.0%) operated without complication (Table IV). Minimum follow up time was at least 24 weeks and range was 24-48 weeks and mean 41.12±7.11 weeks (Table V). Mean radiological union period 14.6±5.11 weeks (Table VI). According to RUST Score 88.0% fractures were

united within 24 weeks (Figure 8). There were two patients with superficial wound infection and no implant failure (Table VII).

Table I: Age-Sex distribution of study patient (n=25)

Age group (years)	Sex		Total
	Male	Female	
21-30	7	0	7
31-40	4	3	7
41-50	1	2	3
51-60	3	2	5
61-70	0	3	3
Total	15	10	25

The mean age of the patients was 42.04±14.97 years and the youngest and oldest patients were 22 and 70 years respectively. The male: female ratio was 1.5:1 (Table I)

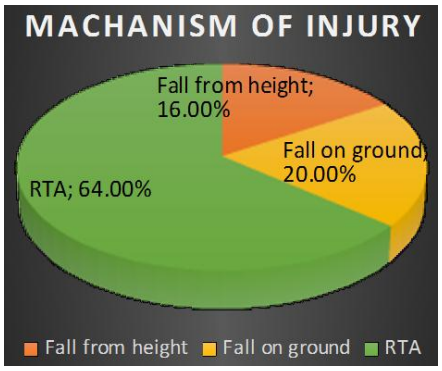

Figure 6: Pie diagram showing the mechanism of injury of patients (n=25). Most common 16 (64.0%) cause of injury was RTA

Table II: Distribution of patients by Seinsheimer classification (n=25)

Seinsheimer Type	Frequency (n)	Percentage (%)
II	06	24.0
III	12	48.0
IV	06	24.0
V	01	04.0
Total	25	100.0

Seinsheimer type III (48.0%) was most common fracture.

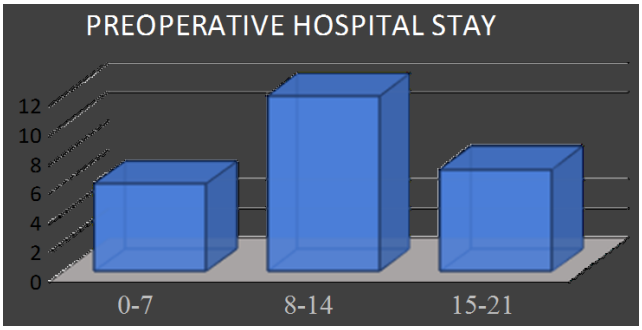

Figure 7: Bar chart showing time interval of injury and operation (n=25)

Maximum patients (48.0%) were operated in second week of trauma. Mean time interval was 11.24±3.45 days.

Table III: Operative procedure duration of study patients (n=25)

Duration of operation (minutes)	Frequency (n)	Percentage (%)	p value
<90	03	12.0	
91-120	14	56.0	0.002
>120	08	32.0	
Total	25	100.0	

Regarding duration of surgery, most of patient (56.0%) operating time was 90-120 min. Mean operative time 121.92±18.58 minutes.

Table IV: Intra-operative technical problem of study patients (n=25)

Intra-operative problem	Frequency (n)	Percentage (%)
Reduction difficulty	05	20.0
Proximal screw insertion difficulty	06	24.0
Plate position difficulty	02	08.0
Broken hardwire (Guide wire)	01	04.0
No	11	44.0

Main intra-operative problem was proximal screw insertion difficulty 6(24.0%). Maximum patients (44.0%) operated without complication.

Table V: Follow up period of study patients (n=25)

Follow Up (weeks)	Frequency (n)	Percentage (%)
24-32	04	12.0
33-40	07	28.0
41-48	14	56.0
Total	25	100.0

Mean±SD = (41.12±7.11) weeks; Range = (24-48) weeks. Maximum patients (56.0%) complete their last follow up in between 41-48 weeks.

Table VI: Radiological union time according to RUST criteria (n=25)

Radiological Union Time (weeks)	Frequency (n)	Percentage (%)
<12	13	52.0
13-18	08	32.0
19-24	02	08.0
>24	02	08.0
Total	25	100.0

Mean±SD = (14.6±5.11) weeks; Range = (10-28) weeks. Mean radiological union period 14.6±5.11 weeks. Co-relation test significant (CO=0.008) in type of fracture and union time.

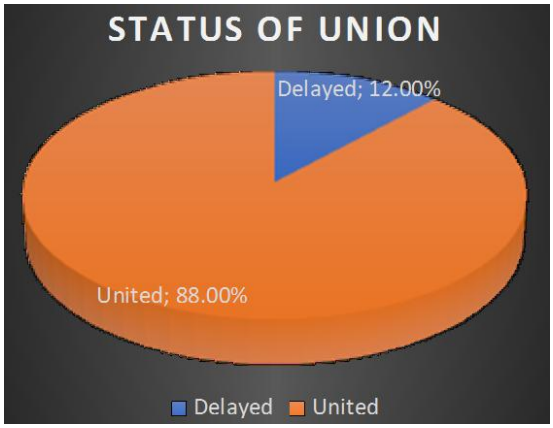

Figure 8: Pie diagram showing union at final follow up (n = 25)

Satisfactory union occurs in 88.0% patients within expected duration of healing and 12.0% patients show delayed union.

Table VII: Complications of study patients (n=25)

Complication	Frequency (n)	Percentage (%)
Knee ROM	04	16.0
Hip ROM	02	08.0
Superficial infection	02	08.0
Deep Infection	00	00.0
Implant failure	00	00.0
No complication	18	72.0

Table showing the complications of study patients, 4(16.0%) patients had restricted knee ROM, 2(8.0%) patients had restricted hip ROM or superficial infection and maximum patients (72.0%) had no complications.

Discussion

The ideal implants for stabilization of subtrochanteric fracture are debatable as because there are high rates of delayed union, malunion and implant failure. In literature review of proximal femoral locking compression plate (PF-LCP) allow locking plating for the treatment of subtrochanteric fractures and provide both compression and bridging techniques. It prevents varus collapse and helps in rapid bone healing with early rehabilitation. In the present study the mean age of the patients was 42.04±14.97 years and the youngest and oldest patients were 22 and 70 years respectively. Among them 28.0% were from 21-30 years or 31-40 years aged group individually with majority were male and male: female ratio was 1.5:1. Similar study was done by Vaidya et al.[27] found the mean age was 32.6 years and ranges of was 14-45 years with male predominance and most were between 20-40 years age group. Another study was done by Zhou et al.[28] and found the age range of 37-72 years; mean age 53.5 years and male: female ratio was 2.3:1. Other study by Kumar et al.[17] showed age range from 36-82 years with mean age of 65 years. From above studies including our study, most of the patients were male and early middle aged working population. This may be due to activities and traveling because of male are still main earning people in our country and need to move more frequently. The mechanism of injury in this study mostly was RTA (64.0%) after that fall on ground (20.0%) and fall from height (16.0%). According to Lee et al.[11] and Saini et al.[29] the majority of injury was caused by traffic injuries. So, high velocity injury- RTA was found the main

mechanism of injury in all above study. In this study out of 25 subtrochanteric fractures, 6(24.0%) patients were Seinsheimer type II, 12(48.0%) patients were Seinsheimer type III, 6(24.0%) patients were Seinsheimer type IV and 1 (4.0%) patient was Seinsheimer type V. Study by Zhou, et al.[28] there were 2 cases of type I, 7 type II, 15 type III, 23 type IV and 29 type V. A similar study by Saini et al.[29] where fracture IIIA 34.37%, IIIB 25%, IV 31.25%. Above all studies comminuted fractures are predominant and showed nearly similar fracture pattern. The present study revealed, the average time interval between injuries to surgery was 11.24 days, most of patients operated on second week of admission. Kayali et al.[30] observed average time from admission to surgery was 9.5±5.5 days. The current series mean operative duration was 121.92±18.58 minutes and range of time 85-150 minutes. Most of the patient (56%) operating time was 90-120 minutes. Similar studies of El-Desouky et al.[31] were observed mean operative duration 91±8 min; Lee, et al.[11] had 77.3 minutes (range: 50-105 minutes); Saini et al.[29] were 79.5 min (range 60-95min); Kumar, et al.[17] were 80 minutes. So, this study was little different with other study due to required larger incisions, newer operative techniques of PF-LCP. Intra-operative problems of this study encountered with proper placement of screws in head of the femur (24.0%), fracture reduction (20.0%), along with difficulties relating to appropriate positioning of the implant with respect to the tip of the greater trochanter (8.0%) and broken hard wire (4.0%) cases.

In present study the mean duration of follow up was 41.12±7.11 weeks (range 24-48 weeks) and minimum follow up was at least 24 weeks; according to RUST criteria of Whelan et al.[20] average time to union was 14.6±5.11 weeks (range: 10-28 weeks). Study conducted by Saini et al.[29], the mean duration of follow up was 40.25 weeks, and time to union was 15.62 weeks; Lee et al.[11] found 97.0% patients had an uneventful bone union by 24 weeks and the mean union time was 15.1 weeks (range, 12-24 weeks); Zhou et al.[28] were followed up for 24-48 weeks; Celebi et al.[32] mean duration of follow up 24.6 (12-66) months and union was achieved within a mean of 15.1 (13-22) weeks. In this study, according to RUST criteria of Whelan et al.[20] satisfactory union occurred in 88.0% within expected duration and 12.0% patients showed delayed union and no nonunion. A similar study done by Saini et al.[29], El-Desouky et al.[31] and Celebi et al.[32] individually and where union was achieved in all. Zha et al.[19], shows 98.0% union, with one case of nonunion, which were nearly similar to above said study. In this study two case of superficial infection with no deep infection, four patients had restricted knee ROM, two patients had restricted hip ROM and rest of the patients 18(72.0%) had no complication. There were no re-operations in any of the patients during the study. Infection managed by irrigation and broad-spectrum antibiotics. Study by Saini et al.[29] showed two cases of infection and one case malunion with external rotation; Zha et al.[19] to one case of implant failure, two cases superficial infection.

Conclusion

Subtrochanteric femoral fracture usually occurs in middle age people with a male preponderance and most of due to by road traffic accident. Proximal femoral locking compression plate (PF-LCP) is an effective and reliable implant for the treatment of subtrochanteric fractures with excellent result and minimal complications. However, the small number of patients and non-randomized nature of the study are its shortcomings. A long term Randomized Controlled Trial (RCT) with a large series with long follow up is recommended.

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