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Determine the functional and radiological outcome of T3 proximal femur nail in the treatment of intertrochanteric fracture of femur

Manan B. Paneliya*, Sunil H. Shetty, Kumar Abhineet Chand, Vidur Sharma

Dr. D.Y Patil Hospital and Research Centre, Nerul, Navi Mumbai, Maharashtra, India

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***Correspondence:**
Dr. Manan B. Paneliya,
E-mail: paneliyamanan@gmail.com

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ABSTRACT

Background: T3 is the new generation nail used for fixation of intertrochanteric fractures. The lag screw is designed to transfer the load of the femoral head into the nail shaft by bridging the fracture line to allow fast and secure fracture healing. The load carrying thread design of the T3 lag screw provides large surface contact to the cancellous bone, this provides high resistance against cut out.
Methods: 30 subjects attending the study were operated with T3 proximal femur nail in the treatment of intertrochanteric fracture of femur. Prospective, randomised case-controlled study done over period of 1 year.
Results: Significant results were obtained while comparing the mean RUSH score and mean Harris hip score at different postoperative follow-up time intervals with good to excellent outcome and less operative time and low complications rate.
Conclusions: T3 is the new generation nail used for fixation of intertrochanteric fractures and is a dependable implant for the fixation. It has good to excellent outcomes and takes less operative time with low complication rates. The anatomical shape of the nail is universal for all indications involving the treatment of intertrochanteric fractures. The load carrying thread design of the T3 lag screw provides large surface contact to the cancellous bone, thus providing high resistance against cut out. The set screw prevents rotation of the lag screw. The T3 has a single screw passing into the neck of the femur and its Set Screw that is passed into the proximal part of the femoral nail sits into the groove of the Lag screw, thus providing rotational stability.

Keywords: Intertrochanteric fracture of femur, T3 proximal femur nail, Set screw

INTRODUCTION

Hip fracture contributes to both morbidity and mortality in the elderly. The demographics of world populations are set to change, with more elderly living in developing countries.[1] Gulberg et al has predicted that the total number of hip fractures will reach 2.6 million by 2025 and 4.5 million by 2050. In 1990, 26% of all hip fractures that occurred in Asia were intertrochanteric fractures whereas this figure could rise to 37% in 2025 and 45% in 2050.[2] Cooper was the first one to classify hip fractures into extracapsular (intertrochanteric) and intracapsular (femoral neck).[3] Proximal femoral fractures account for a large proportion of hospitalization among trauma cases. An overwhelming majority of these patients (>90%) are aged above 50 years. The incidence of these fractures is 2-3 times more in females as compared to male population. They are classified on basis of anatomical location of fracture into: neck of femur fracture, inter trochanteric fracture and subtrochanteric fracture. Each of these fracture types require special methods of treatment and have their own set of complications and controversies regarding the optimal method of management. These fractures occur in the region between the head of femur and inter trochanteric region.

These fractures are prone to non-union because of three reasons: Being intracapsular, hip synovial fluid impedes the healing process. Loss of blood supply to femoral head and neck due to disruption of lateral ascending cervical branches of the medial femoral circumflex artery. This also increases the risk for avascular necrosis of femoral head. Absence of cambium layer of periosteum in this region.[4] Inter trochanteric fractures of femur occur in the area between the greater and lesser trochanter and may involve these two structures. Inter trochanteric fractures make up 45% of all hip fractures. This region consists of weight bearing trabeculaes and has a good amount of cancellous bone and vascularity thus minimizing the risk of avascular necrosis and non-union. Inter trochanteric (I/T) fractures can be classified in many ways viz. Evan's classification, AO classification, Jenson's classification all of them divide this fracture into stable fractures and unstable fractures (reverse oblique and coronal split fractures).[4] In younger patients, proximal femoral fractures are usually the result of high energy physical trauma and usually occur in the absence of disease. Inter-trochanteric and femoral neck fractures account for 90% of the proximal femoral fractures occurring in elderly patients.[5] In elderly patients bones are mostly osteoporotic. Hence, minimal trauma to moderate physical trauma will lead to fracture. However pathologic fractures can occur at any age, typically these fractures result from low energy injuries and may be characterized by unusual fracture patterns.[5] Incidence of proximal femoral fractures among females is 2 to 3 times higher than males, also the risk of sustaining a proximal femoral fracture doubles every 10 years after age 50 years. Other risk factors for proximal femoral fractures include osteoporosis, maternal history of hip fractures, excessive consumption of alcohol, high caffeine intake, physical inactivity, low body weight, previous hip fractures, psychotropic medicines. Unstable inter trochanteric fractures are notorious for their complications and high failure rates following treatment with conventional DHS. The trick is to identify unstable fracture patterns and use specific design implants for their management. Unstable fracture patterns include: reverse oblique, transtrochanteric with subtrochanteric extension and with 'large' posteromedial fragment although the "large" is not well defined.[4,5]

Since the 1800 s, a lot has changed in the way these fractures are managed. From conservative treatment (including hip spica and pin traction) with bed rest, to the operative fixation with modern surgical techniques and implants, we have come a long way. Early attempts at surgical management were marred by poor asepsis, lack of intra operative imaging, poor implant design and quality, and incomplete understanding of fracture mechanics. Langenbeck was the first to internally fix an intertrochanteric fracture with a nail. The modern era of hip fracture fixation began in 1925 when Smith Peterson introduced a triflanged nail. The real benefit of fixation lies not in improving union rates (intertrochanteric fractures rarely go into nonunion, even when treated conservatively), but in improving functional outcome and mortality rates, which are attributed to the early mobilization and better nursing care possible after surgery.[6-8]

The goal of treatment of these fractures is stable fixation, which allows early mobilization of the patient. These fractures are associated with substantial morbidity and mortality. Associated co-morbid medical problem like diabetes, hypertension, pulmonary, renal and cardiac problems add to the insult of the fracture. Elderly patients are threatened with life threatening complications such as hypostatic pneumonia, catheter sepsis, cardio respiratory failure and decubitus ulcer. All the circumstances mentioned above require using an urgent surgical solution for early rehabilitation and mobilization of the patient.[9] They are also one of the most common fractures encountered in today's orthopaedic practice. Many treatment options are described aiming for stable fixation, which allows early mobilization of the patient as they are unable to even partially restrict weight bearing.[9] Generally, intramedullary fixation and extramedullary fixation are the 2 primary options for treatment of such fractures. Proximal femoral nail (PFN) and Gamma nail are 2 commonly used devices in the intramedullary fixation. Previous studies showed that the Gamma nail did not perform as well as DHS because it led to a relatively higher incidence of post-operative femoral shaft fracture.[10] PFN, introduced by the AO/ASIF group in 1997, has become prevalent in treatment of intertrochanteric fractures in recent years because it was improved by addition of an antirotation hip screw proximal to the main lag screw. However, both benefits and technical failures of PFN have been reported.[10] A number of studies have reported decreased blood loss and operating time with the use of intramedullary systems, but none of them report an improved functional outcome with these implants. One of the major criticisms of intramedullary systems has been the risk of femoral shaft fractures distal to the implant.[10] AO/ASIF modified the PFNA design and introduced PFNA2 to prevent the complications arising from geometrical mismatch. The PFNA2 has a decrease in the mediolateral angle of the proximal nail from 6° to 5° (to reduce the risk of lateral cortex fracture). Secondly, the proximal part of the PFNA 2 is shortened to 45 mm and the end cap length is reduced to 2.5 mm (to reduce the incidence of hip pain). Thirdly, the lateral surface of the proximal end of PFNA 2 is flattened (to reduce the chance of fracture and loss of reduction during nail insertion). Traditionally it was advocated that the lag screw be placed slightly inferiorly and posteriorly but this leads to an increased tip-apex distance. The new recommendation is to place the lag screw in the middle of neck in both planes going just 10 mm short of subchondral bone, to achieve a tip-apex distance of <25 mm. This tip apex distance holds good for PFN as well. T3 is the new generation nail used for fixation of intertrochanteric fractures.[11] The anatomical shape of the nail is universal for all indications involving the treatment of intertrochanteric fractures. A single distal locking screw is provided to stabilize the nail in the medullary canal and to help prevent rotation in complex

intertrochanteric fractures. A range of three different neck shaft angle is available for lag screw entry to accommodate variations in femoral neck anatomy. Locking in the distal part of the oblong hole creates a dynamic locking mechanism. The lag screw is designed to transfer the load of the femoral head into the nail shaft by bridging the fracture line to allow fast and secure fracture healing. The load carrying thread design of the T3 lag screw provides large surface contact to the cancellous bone, this provides high resistance against cut out.[11] The mechanical strength of the nail and less invasive procedure has made the procedure preferable.[11] Hence; under the light of above obtained data, the present study was undertaken for assessing the functional and radiological outcome of T3 proximal femur nail in the treatment of intertrochanteric fracture of femur.

METHODS

The present study was undertaken for assessing the functional and radiological outcome of T3 proximal femur nail in the treatment of intertrochanteric fracture of femur. A total of 30 patients were enrolled.

Study design, duration, location and sample size

Current study is a prospective, randomized case-controlled study conducted for 1 year from the date of obtaining approval (February 2021 to January 2022) at department of orthopaedics, Dr. D.Y. Patil School of Medicine, Navi Mumbai on 30 adults. An informed written consent was taken from each participant before being included in the study.

Inclusion criteria

Inclusion criteria for current study were; patients above 20 years of age, patients of either gender (male/female), patients with intertrochanteric fractures (classified as 31A2.1to 3 and 31A3.1 to 3 according to the AO classification for long bones), patients with closed fractures and patients who gave consent for participation in the study

Exclusion criteria

Patients below 20 years of age, patients with open fracture and polytrauma, patients with associated neurovascular injuries, patients with inability to walk before the fracture, patients with other fractures interfering with rehabilitation, pathological fractures, patients with neurological deficits, if any and patients refused to give informed consent.

Laboratory investigations

Complete blood count, BT, CT, PTI, blood grouping, blood sugar levels, blood urea, serum creatinine, viral markers, LFT, ECG, ECHO, CHEST X-ray, other lab investigations if required

Radiological investigations

Radiograph, Pelvis with both hips AP view, Full length of femur AP and lateral CT scan, when required, MRI (if needed)

Operative protocol

Informed consent was taken as per the performa. Type of anaesthesia to be used was decided by the anesthesiologist. Operations were performed on a fracture table under anaesthesia. Closed reduction performed under C-arm was considered acceptable when anatomic or a slight valgus position is achieved on anteroposterior (AP) radiographic views and slight cervical anteversion was achieved on lateral radiographic views. For both implants, the desired position of the lag screw was in the central femoral neck on the lateral view and in the central inferior femoral neck on the AP view, with the tip between 5 mm and 10 mm from the subchondral bone. Immediate postoperative radiographs were checked to determine if cortical congruence at the calcar region has been restored. All patients had suction drains for 48 hours and were given antibiotic and thromboembolic prophylaxis. Patients remained in bed for 2 days but were allowed to sit up, and then, if able, ambulation with partial weight bearing with a parallel bar or walker was allowed. Full weight bearing was allowed as tolerated and where fixation stability is thought to be adequate. Patients were discharged after primary complications were excluded. Follow up was done and radiological and functional outcome of the patient was assessed.

RESULTS

The present study was undertaken for assessing the functional and Radiological outcome of T3 proximal femur nail in the treatment of intertrochanteric fracture of femur.

Table 1: Age-wise distribution of patients.

Age group (years)	N	%
21-30	1	6.67
31-40	3	10
41-50	6	20
51-60	10	33.33
More than 60	10	33.33
Total	30	100
Mean age (years)	55.76	

A total of 30 patients were enrolled. 33.33 percent of the patients each belonged to the age group of 51 to 60 years and more than 60 years. 20 percent of the patients belonged to the age group of 41 to 50 years. Mean age of the patients was 55.76 years 66.67 percent of the patients were males while the remaining were females. Right side involvement occurred in 53.33 percent of the patients while left side involvement occurred in 46.67 percent of the patients respectively.

Table 2: Distribution of subjects according to gender.

Gender	N	%
Males	20	66.67
Females	10	33.33
Total	30	100

Table 3: Distribution of subjects according to side involved.

Side involved	N	%
Right	16	53.33
Left	14	46.67
Total	30	100

Table 4: Distribution of subjects according to AO classification.

AO classification	N	%
31-A2.1	3	10
31-A2.2	11	36.67
31-A2.3	13	43.33
31-A3.1	3	10
Total	30	100

According AO classification, 43.33 percent of the patients were of type 31-A2.3 while 36.67 percent of the patients were of 31-A2.2 respectively. 10 percent of the patients were of type 31-A3.1. 26.67 percent of the patients were hypertensive while 20 percent of the patients were diabetic. 63.33 percent of the patients, the etiology was fall while it was road traffic accident in 36.67 percent of the patients. Mean duration of surgery was 53.8 minutes. Mean duration of hospital stay was 10.2 days.

Table 5: Distribution of patients according to co-morbidities.

Co-morbidities	N	%
Diabetes	6	20
Hypertension	8	26.67
Total	30	100

Table 6: Distribution of subjects according to etiology.

Etiology	N	%
Road traffic accident	11	36.67
Fall	19	63.33
Total	30	100

After 10 weeks, minimal union was observed in 90 percent of the patients while no union was observed in 10 percent of the patients. At 14 weeks follow-up, union was observed in 73.33 percent of the patients while minimal union was observed in 26.67 percent of the patients. After 18 weeks, complete radiological union was seen in 100 percent of the patients. Mean radiological union time was 14.2 weeks. Mean RUSH score at preoperative time, postoperative 2 months, 4 months and 6 months was 10.5, 16.4, 30 and 30 respectively.

Table 7: Duration of surgery.

Duration of surgery (minutes)	N
Mean	53.8
SD	5.4

Table 8: Duration of hospital stay (days).

Duration of hospital stay (days)	N
Mean	10.2
SD	1.78

Figure1: a) Surgical markings of the operative site; b) Incision site; c) Intraoperative C-arm image-AP views; d) intraoperative C-arm image-Lat view; e) C-arm image showing set screw insertion; f) T3 implants with set screw ; g) PFNA2 with helical blade; h) pre-operative X-ray images; i) post-operative X-ray images.

Significant results were obtained while comparing the mean RUSH score at different postoperative follow-up time intervals. Mean Harris hip score at preoperative time, postoperative 2 months, 4 months and 6 months was 49.2, 67.1, 72.9 and 85.8 respectively. Significant results were obtained while comparing the mean Harris hip score at different postoperative follow-up time intervals. According to Harris hip score grading, excellent, good, fair and poor outcome was seen in 23.33 percent, 43.33 percent, 30 percent and 3.33 percent of the patients

respectively. Superficial infection, deep infection and thigh pain were seen in 6.67 percent, 3.33 percent and 16.67 percent of the patients respectively.

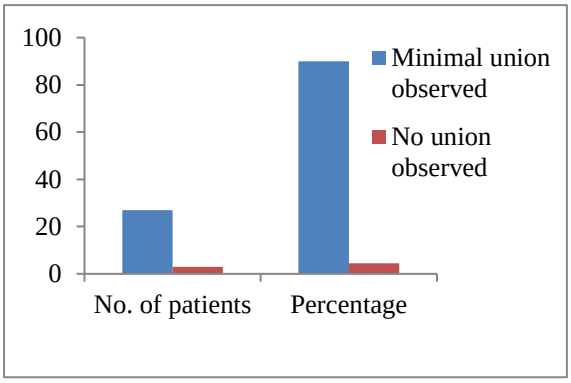

Figure 2: Distribution of patients according to radiological union after 10 weeks.

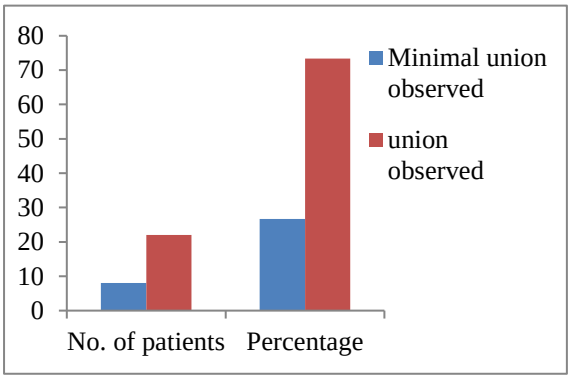

Figure 3: Distribution of patients according to radiological union after 14 weeks.

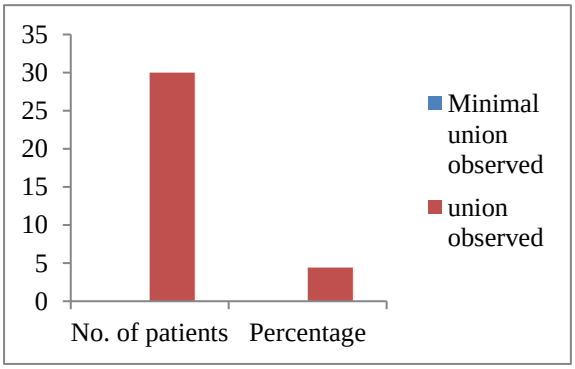

Figure 4: Distribution of patients according to radiological union after 18 weeks.

DISCUSSION

The treatment of intertrochanteric fractures, especially unstable fractures in the elderly remains a challenge for orthopaedists. There is no consensus on the ideal implant for its treatment. The main goal of treatment is a stable fixation that promotes early postoperative mobilisation and better healing. Evidence indicates that intramedullary nail is one of the best implants available for its fixation and hence, better clinical outcomes.

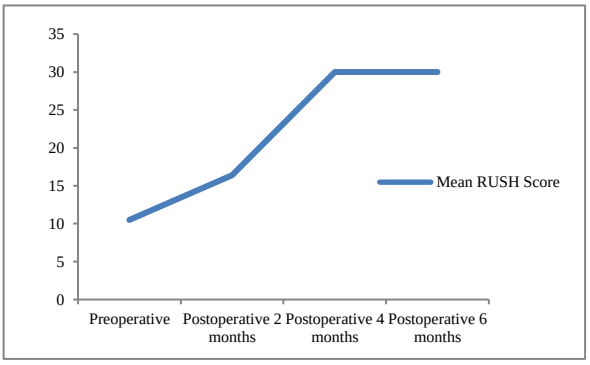

Figure 5: Radiological outcome according to RUSH Score at different time intervals.

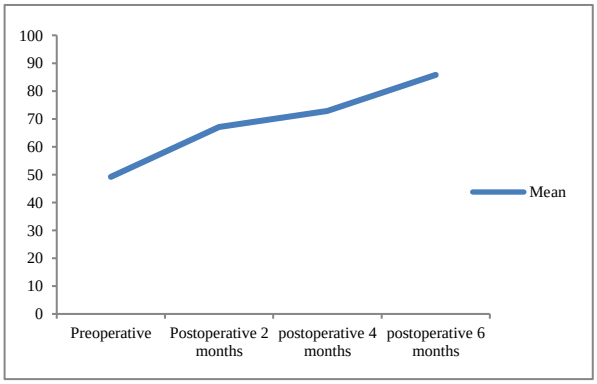

Figure 6: Harris hip score at different follow-up time intervals.

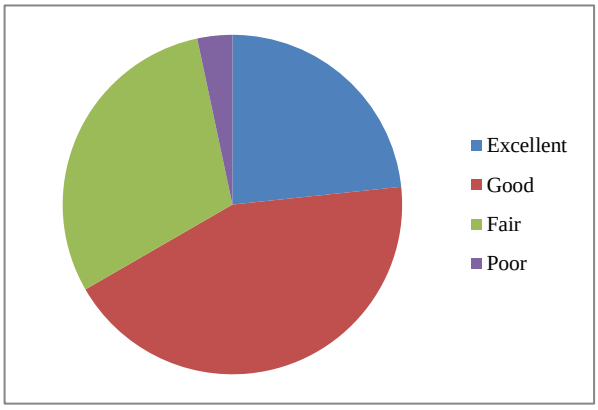

Figure 7: Final functional outcome according to Harris hip score.

Intertrochanteric fractures are relatively common among the elderly, 90% of such fractures occurring in those aged over 65 years. Most elderly patients with intertrochanteric fractures have osteoporosis. This type of geriatric fracture has relatively high mortality and causes severe impairment of function. So, the main aim of surgery is early mobilisation of the patient. Unstable intertrochanteric fractures are those with significant disruption of the

posteromedial cortex due to comminution, reverse oblique fractures or those with the subtrochanteric extension.[13-16]

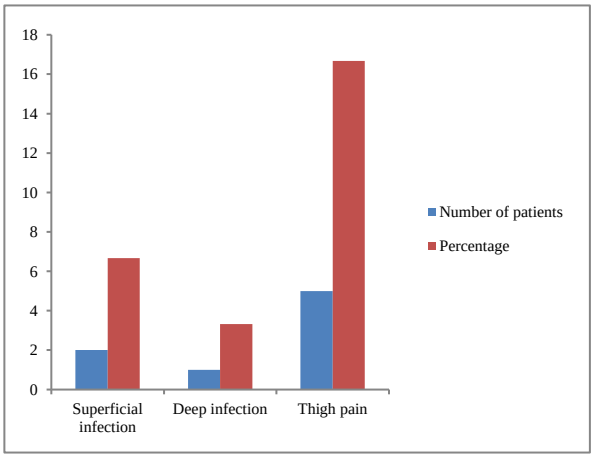

Figure 8: Complications.

It is crucial to use a less invasive implant which allows early weight-bearing and has low complication rates. The selection of an implant is mainly decided by the fracture pattern (stable or unstable). Though there are many implant designs for the fixation of these types of fractures, most of them have many demerits such as mechanical disadvantages, less hold on the osteoporotic bone and early failures. PFNA devices have been introduced recently as an intramedullary option and PFNA-2 is its newer design. These devices were developed to achieve better fixation strength, particularly in the presence of osteoporosis. PFNA has many advantages such as shorter operative time, minimal fluoroscopy time, minimal blood loss and early weight-bearing. Other advantages are fewer chances of implant failure, easier helical blade insertion (compared with a cumbersome lag screw and derotation screw insertion in PFN), lesser chances of postoperative hip pain, and better performance than any other implant.[17-20] The previously used A1 construct had 2 proximal screws. Sometimes it was difficult to negotiate 2 screws in individuals with a smaller neck diameter. The T3 has a single screw passing into the neck of the femur and its Set Screw that is passed into the proximal part of the femoral nail sits into the groove of the Lag screw, thus providing rotational stability. The above study was based on a series of 30 patients; however, we feel that a larger study (series) would provide us a more conclusive and better understanding of PFN T3 implant.

CONCLUSION

The present study was undertaken for assessing the functional and Radiological outcome of T3 proximal femur nail in the treatment of intertrochanteric fracture of femur. A total of 30 patients were enrolled. Following results were obtained: 33.33 percent of the patients each belonged to the age group of 51 to 60 years and more than 60 years. 20 percent of the patients belonged to the age group of 41 to 50 years. Mean age of the patients was 55.76 years. 66.67 percent of the patients were males while the remaining were females. Right side involvement occurred in 53.33 percent of the patients while left side involvement occurred in 46.67 percent of the patients respectively. According AO classification, 43.33 percent of the patients were of type 31-A2.3 while 36.67 percent of the patients were of 31-A2.2 respectively. 10 percent of the patients were of type 31-A3.1. 26.67 percent of the patients were hypertensive while 20 percent of the patients were diabetic. 63.33 percent of the patients, the etiology was fall while it was road traffic accident in 36.67 percent of the patients. Mean duration of surgery was 53.8 minutes. Mean duration of hospital stay was 10.2 days. After 10 weeks, minimal union was observed in 90 percent of the patients while no union was observed in 10 percent of the patients. At 14 weeks follow-up, union was observed in 73.33 percent of the patients while minimal union was observed in 26.67 percent of the patients. After 18 weeks, complete radiological union was seen in 100 percent of the patients. Mean radiological union time was 14.2 weeks. Mean RUSH score at preoperative time, postoperative 2 months, 4 months and 6 months was 10.5, 16.4, 30 and 30 respectively. Significant results were obtained while comparing the mean RUSH score at different postoperative follow-up time intervals. Mean Harris hip score at preoperative time, postoperative 2 months, 4 months and 6 months was 49.2, 67.1, 72.9 and 85.8 respectively. Significant results were obtained while comparing the mean Harris hip score at different postoperative follow-up time intervals**.** According to Harris hip score grading, excellent, good, fair and poor outcome was seen in 23.33 percent, 43.33 percent, 30 percent and 3.33 percent of the patients respectively**.** Superficial infection, deep infection and thigh pain were seen in 6.67 percent, 3.33 percent and 16.67 percent of the patients respectively. Under the light of above obtained results, we have concluded that: T3 is the new generation nail used for fixation of intertrochanteric fractures and is a dependable implant for the fixation. It has good to excellent outcomes and takes less operative time with low complication rates. The anatomical shape of the nail is universal for all indications involving the treatment of intertrochanteric fractures. The load carrying thread design of the T3 lag screw provides large surface contact to the cancellous bone, thus providing high resistance against cut out. The set screw prevents rotation of the lag screw.

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Ethical approval: The study was approved by the institutional ethics committee

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