Comparative study between InterTAN and Trochanteric femoral nailing (TFN) in Inter-trochanteric fractures: A prospective study of functional and radiological outcomes

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Abstract

Introduction: A prospective study was done in the Department of Orthopedics in Dr. D.Y. Patil Hospital, Navi Mumbai from January 2015 to March 2017 to Compare between Inter-Tan and trochanteric femoral nailing in Inter-trochanteric fractures and study functional and radiological outcomes.

Methods: All the patients attending OPD and emergency with inter trochanteric fracture without any sub trochanteric extension were admitted in our hospital and operated over a period of 2 year and 3 months. A total of 40 patients were included in our study of age group 40 to 70 years and divided in two groups (n^1=20) and (n^2=20). AO classification for fractures was used and 31-A1 and 31-A2 whereas 31-A3 variant was excluded from study. Patients were operated with two nailing systems i.e., n1= Inter-tan nailing system and n2=trochanteric nailing system. Follow-up assessments were performed at 2, 4, 6 weeks and every 6 months thereafter. Radiological assessment was done at each follow up and all associated implant position changes were also noted simultaneously. Functional outcomes were evaluated using Harris hip score.

Results: InterTAN had better outcomes in terms of varus collapse of the neck (InterTAN, n = 1 vs. TFN, n = 3), anterior thigh pain (InterTAN, n = 1 vs. TFN, n = 4), femoral neck shortening (InterTAN, 4.2 mm vs. TFN, 5.4 mm), fracture healing time (InterTAN, 13 weeks vs. TFN, 15 weeks), femoral shaft fractures (InterTAN, n = 0 vs. TFN, n = 1), screw back out (InterTAN, n = 0 vs. TFN, n = 3), lateral cortex fractures of the proximal femur (InterTAN, n = 3 vs. TFN, n = 2), operative time (InterTAN-65 min vs. TFN-50 min), fluoroscopy time (InterTAN, 4.0 min vs. TFN, 3 min), hospital stay (InterTAN, 7 days vs. TFN, 7 days), cut-out (InterTAN, n = 0 vs. TFN, n = 3). Harris Hip score (InterTAN-82, TFN 78).

Conclusion: The results of our study shows that the incidence of varus collapse of the head/neck, hip and anterior thigh pain, implant cut-outs, and femoral neck shortening and femoral shaft fractures at distal tip of implant, rotational loss of reduction were comparatively less in InterTAN subjects comparing with TFN subjects. The time for surgical procedure and fluoroscopy time was more as compared to TFN which can be reduced if procedure is done more frequently. Better radiological and functional outcomes with less degree of complications makes InterTAN a better option for fixation of Intertrochanteric fractures.

Keywords: Intertrochanteric fractures, InterTAN, TFN, AO classification, Harris Hip Score.

Introduction

The incidence of intertrochanteric fracture is rising because of the increase in number of elderly population who are simultaneously osteoporotic. More than 50% of inter trochanteric fractures are unstable[1] in which there is variable communition and poster medial defect with sub-trochanteric extension. Worldwide, it has been estimated that the total number of hip fractures could reach 2.6 million by 2025 and 4.5 million by 2050.[(2)] Unstable patterns occur more commonly with increased age and with low bone mineral density. With the rapid increase in the elderly population, the morbidity of intertrochanteric femoral fractures is also displaying a rising trend.[(3-5)] Intertrochanteric femoral fractures account for approximately half the hip fractures in elderly patients[(6)] and Incidence is higher among post-menopausal women and the mechanism of injury is usually due to low-energy trauma like a simple fall at home or working place. Complications due to bed ridden condition and delay in anesthetic fitness due to associated medical problem like diabetes, hypertension, and cardiovascular diseases add to morbidity and mortality. In order to achieve faster rehabilitation and return to pre-injury status, surgical treatment with intramedullary fixations or extramedullary fixations[(7)] is advocated. Intramedullary fixations have advantages over extramedullary fixations techniques like minimum soft tissue trauma, less bleeding, less duration of anesthesia, earlier union after surgery, but as various literature extramedullary fixation with Dynamic hip screw is still considered as the best choice in the treatment of simple Intertrochanteric fractures. However, for unstable Intertrochanteric fractures, the failure rate is higher, and intramedullary fixation devices PFN (Proximal femoral nail), TFN (Trochanteric femoral nail), PFNA-II (Proximal femoral nail-anti-rotation Asia), InterTAN is generally preferred. We have used InterTAN and TFN intramedullary nails as it provides better stability has less failure rate and better biomechanical advantage which allows for immediate mobilization initially non weight bearing and within 1 to 2 month postoperative full-weight bearing of the hip, thus decreasing hospital stay and need of antibiotic and over all increasing patient's compliance. TFN with on lag screw and other derotation screw achieves compression a fracture site

and supplements calcar femorale thus ensuring earlier mobilization in both young and old patients. However compilations like screw migration, cut-outs, Z effect and Reverse Z effect and warranted an intramedullary device which can overcome these shortcomings. InterTAN comes with the unique design of two cephalocervical screws in an integrated mechanism, which allows linear intraoperative compression at fracture site also provides rotational stability of the proximal fragment. out of the two which device provides better clinical and radiographic outcomes has been a question of debate.[8-9] InterTAN being new and TFN being in practice for a decade for the treatment of intertrochanteric fractures has been brought under evaluation for management of intertrochanteric fractures in terms of functional and radiological outcomes.

Materials & Method

This prospective study was done in Dept of Orthopaedics, Dr. D.Y. Patil Hospital, Navi Mumbai and a total of 40 patients presenting with inter-trochnateric fracture in OPD and emergency without subtrochanteric extension were included and randomized in two group n^1=20 operated using InterTAN intramedullary system and second group n^2 =20 operated using trochanteric nailing system . The inclusion criteria were:

1. Patients willing to undergo procedure with explained consent.
2. AO/OTA intertrochnateric fractures with31 A1 and31 A2 subtypes.
3. Patients above 40 and up to 70 years of age.
4. Patients with other associated fractures in the upper limbs.

Patients were excluded from study who presented with

1. Compound fractures and AO/OTA 31.A3 type were not included.
2. Pathological fractures and fractures with sub-trochanteric extension and Poly trauma patients with expected delay in primary and immediate fixation were also excluded.

All the patients were evaluated clinically and radiographic examination was done. Pelvis with hip (PBH), LS spine x-ray and antero-posterior (AP) and lateral views of the affected hip were obtained .Patients were admitted and below knee skin traction was given. The radiographs were assessed on terms of site of fracture, communition, shortening, lateral wall fracture, lesser trochanteric fracture.AO/OTA classification was used and fractures with type 31A1and A2 was included and A3 was excluded. All the patients were operated on elective basis after proper pre- anesthetic Checkup.

InterTAN

Surgery was performed by same surgeon and specified protocols for the InterTAN and TFN IM nails, as described in Trigen S&N manual and Campbell. InterTAN (Fig. 1) nail comes with preloaded Cannulated Set Screw for creation of a fixed angle device and facilitates postoperative sliding. Proximally Trapezoid shaped shaft provides enhanced stability in the proximal femur and facilitates early weight bearing. 4° lateral offset for minimally invasive trochanteric entry along with 12° of built-in femoral neck anteversion for optimal screw position in the femoral neck and head with integrated Interlocking Lag and Compression Screws (Fig. 2) in figure eight formation for superior stability and linear compression. Distal locking slot allows static or dynamic locking using standard 5.0mm TRIGEN™ Internal Hex Captured Locking Screws and Clothespin distal tip reduces nail stiffness and the potential for periprosthetic fracture distal to the nail plus variable sizes of distal diameters .i.e.10mm, 11.5mm and 13mm.

Fig. 1

Fig. 2

Fig 3: IT fracture type 31A2.1


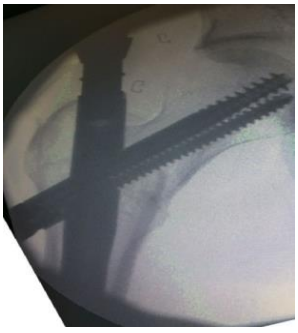


Fig. 4 **Fig. 5** **Fig. 6**

Operative procedure for InterTAN-Fig. 4 and Fig. 5 showing C-arm reduction with screws, Fig. 6 reduced IT fracture with InterTAN.

Trochanteric fixation nail (TFN): This intramedullary device consists of a Cannulated nail, Cannulated hip screws 8 mm lag screw and 6.4 mm derotation screw, distal locking bolts of 4.9 millimeters. The proximal diameter of the nail is 15 mm and length is 18cm. The diameter of nail varies from 9 to 12 millimeters depending on patient's medullary diameter. The angle between the nail and screw varies from 130^0 to 150^0. Distally there are two slots for static and dynamic locking.



Fig 7: Type 31A1.3 **Fig. 8: TFN AP view** **Fig. 9: TFN Lateral view**

All patients were given a intravenous infusion of cefuroxime sodium 1.5 gm before the skin incision was made. 4-5 cm incision was given along line of greater trochanter perpendicular to line drooped from ASIS and C-arm guided reduction was achieved and procedure was done.

Active quadriceps exercises and calf pump and ankle movements were started second day. Post op 3rd day bed side high sitting quadriceps and hamstrings were initiated. Sutures were removed on 14th day and non-weight wearing ambulation was started with help of walker. Follow-up occurred at 2 weeks, 6 weeks, and every 6 months thereafter. After 8-10 weeks x-rays were done and after clinical examination full weight-bearing was started. Plain anteroposterior and lateral radiographs were obtained at each visit. All implant position changes, complications, and fixation failures were recorded. At each follow-up, hip range of motion; pain in the hip and thigh, post fixation complications like screw pull out, screws cut outs, implant breakage, periprosthetic fracture were evaluated. The patient-related functional outcomes were evaluated using Harris hip score (HHS). The HHS was considered excellent (90–100), good (80–89), fair (70–79), or poor (<70). Operation time was measured as the interval from the incision start to the wound closure. Fluoroscopy time was determined as the number of issues exposure, read on the C-arm monitor at the end of the operation. The blood loss included number of mops used during operation and drains collection post operatively and was recorded in milliliters (mL). Bony union was defined as evidence of bridging callus or cortical continuity involving at least two cortices.

Table 1:

Variables	InterTan n=20	TFN n=20
Avg Age	63.05	62.55
Male /female	12/8	13/7
Right/Left	14/6	15/5
Mode of injury		
Trivial trauma	14	15
Fall from height	5	3
RTA	1	2
AO/OTA type		
31A1	12	11
31A2	8	9

Results

Though most of the outcomes were statically non-significant, InterTAN had better outcomes in various radiological assessments as listed below.

Table 2:

Radiological assessment	InterTAN n=20	TFN n=20
Varus collapse of the neck	1	3
Anterior thigh pain	1	4
Femoral neck shortening	4.2mm	5.4mm
Fracture healing time	13 weeks	15weeks
Femoral shaft fractures	0	1
Screw back out	0	3
Lateral cortex fractures of the proximal femur	3	2
Operative time	65 min	50 min
Fluoroscopy time	4 min	3min
Hospital stay	7	7
Cut-out	0	3
Harris hip Score	82	78

Discussion

As the life expectancy has increased so the management of Intertrochnateric fractures had also gained attention in the literatures.[10,11] Stable and secure fixation is essential to allow active and early mobilization and to minimize the risk of morbidity and mortality among the elderly population with unstable IT fractures. On the basis of stability of the fracture fixation many implants have been devised.[12] Our study focuses on intraoperative and postoperative complications and outcomes with the InterTAN and TFN nailing systems and to evaluate the outcomes. TFN nailing systems is associated with compilations like screw migration, cut-outs, Z effect and Reverse Z effect. Cutout has multi-factorial variables, including patient age, bone quality, fracture geometry, reduction adequacy, lag screw fixation in both planes, implant design, and choice of nail angle. Both systems have statistical outcomes parallel t each other's like implant failures, nonunion, malunion, delayed union, implant positions, non-anatomical reduction, improper placements of the devices, Avascular necrosis of femoral heads, severe lateral migration of the hip screw and clinical outcomes via Harris Hip score.[13-16] Though TFN remained standard for IT fractures now trend has been shifting towards InterTAN and has become a standard treatment device. Its characteristics include two integrated screws with a hybrid worm-gear mechanism, a trapezoidal proximal end, an oval footprint, a "clothes-pin" distal tip, a unique geometry and mechanism of action, and initial linear compression, which prevent uncontrolled shortening during healing and varus collapse, thus improving rotational instability. Similarly TFN with lag screw and derotation screw has excellent bone purchase in the proximal femur and also permits early non weight bearing and partial weight bearing mobilization within few days post operatively.

In several studies InterTAN shows less inferior head displacement, sustains higher loads to failure, and longer survival under physiological loads compared to the TFN which can be attributed to fact that two screws of the InterTAN are placed closer to the inferior femoral neck along calcar femorale[18] Huang et al.[21] also reported that the InterTAN nail was approximately 30 % stronger than the TFN in the proximal femoral region.

Unstable Inter trochanteric Fractures with lateral wall deficit and lesser trochanteric fractures treated with an IM device is commonly associated with mild thigh pain. Lag screw cut through or lateral protrusion may cause the long-term pain of the operated limb. Though cut-out of lag screws in TFN results from the improper positioning of the screws and surgeon incompetency to achieve anatomical reduction rather than being implant-related. Controlled collapse is a matter of concern can be prevented by the anti-rotation of the head and neck of the femur. Excessive collapse can lead to unacceptable shortening of the head[22] and excessive shortening of the neck (>5 mm) will alter the lever arm mechanism resulting in compromised gluteus medius abductory action and limit the movement of the hip joint.[23] The InterTAN device, with a hybrid worm-gear mechanism converts the rotational forces into linear compression providing controlled collapse and prevents unacceptable shortening. Overall effect is decreased union time, better anatomical reduction and stable construct.

Conclusions

In summary, the results of our study show that the incidence of varus collapse of the head/neck, hip and anterior thigh pan, implant cut-outs, and femoral neck shortening and femoral shaft fractures at distal tip of implant, rotational loss of reduction were decreased in group InterTAN comparing with group TFN. The time for surgical procedure and fluoroscopy time was more as compared to TFN which can be reduced if procedure is done more frequently. Better radiological and functional outcomes with less degree of complications makes InterTAN a better option for fixation of Intertrochanteric fractures.

Conflict of Interest: The authors affirm that there are no conflicts of interest.

Funding: There was no funding or grants for the study.

Informed consent: All patients were explained about the study and a written informed consent in patient's native language was obtained. Patients were all also informed about the usage of his/her data for educational and publication purposes.

Fig. 10: IT fracture 31A2.1

Fig 10.1: TFN AP view

Fig. 10.2: TFN lateral view

Fig. 11: IT fracture 31A2.1

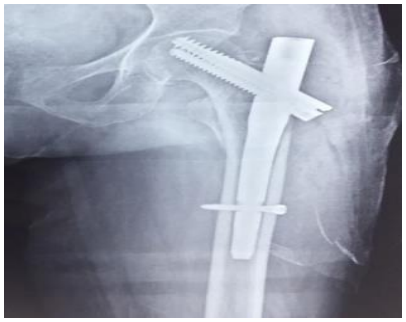

Fig. 11.1: InterTAN AP view

References

1. Rockwood and Green "Fracture in adults". 4th Edition, 1998, Vol. 2, Chapter 26. Lippincott Raven Publishers.
2. Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. *Osteoporosis Int*. 1997;7(5):407–413.
3. Shen J, Luo F, Sun D, Huang Q, Xu J, Dong S, et al. Mid-term results after treatment of intertrochanteric femoral fractures with percutaneous compression plate (PCCP). *Injury-International Journal of the Care of the Injured*. 2015;46(2):347–57.
4. Li M, Wu L, Liu Y, Wang C. Clinical evaluation of the Asian proximal femur intramedullary nail anti-rotation system (PFNA-II) for treatment of intertrochanteric fractures. *Journal of Orthopaedics Surgery and Research*. 2014;9.
5. Liu JJ, Shan LC, Deng BY, Wang JG, Zhu W, Cai ZD. Reason and treatment of failure of proximal femoral nail anti-rotation internal fixation for femoral intertrochanteric fractures of senile patients. *Genet Mol Res*. 2014;13(3):5949–56.
6. Liu X, Liu Y, Pan S, Cao H, Yu D. Does integrity of the lesser trochanter influence the surgical outcome of intertrochanteric fracture in elderly patients? *Bmc Musculoskeletal Disorders*. 2015;16.
7. Xu Z, Zhang M, Yin J, Ren L, Zeng Y. Redisplacement after reduction with intramedullary nails in surgery of intertrochanteric fracture: cause analysis and preventive measures. *Arch Orthop Trauma Surg*. 2015;135(6):751–8.
8. Ma KL, Wang X, Luan FJ, Xu HT, Fang Y, Min J, et al. Proximal femoral nails antirotation, Gamma nails, and dynamic hip screws for fixation of intertrochanteric fractures of femur: a meta-analysis. *Orthopaedics & Traumatology-Surgery & Research*. 2014;100(8):859–66.
9. Yang Y-H, Wang Y-R, Jiang S-D, Jiang L-S. Proximal femoral nail antirotation and third-generation Gamma nail: which is a better device for the treatment of intertrochanteric fractures? *Singap Med J*. 2013;54(8):446–50.
10. Ozkayin N, Okcu G, Aktuglu K. Intertrochanteric femur fractures in the elderly treated with either proximal femur nailing or hemiarthroplasty: a prospective randomized clinical study. Injury. 2015;46 Suppl2:S3–8.
11. Egol KA, Marcano AI, Lewis L, Tejwani NC, McLaurin TM, Davidovitch RI. Can the use of an evidence-based algorithm for the treatment of intertrochanteric fractures of the hip maintain quality at a reduced cost? *Bone & Joint Journal*. 2014;96B(9):1192–7.
12. Temiz A, Durak A, Atici T. Unstable intertrochanteric femur fractures in geriatric patients treated with the DLT trochanteric nail. Injury. 2015;46 Suppl 2:S41–6.
13. Raviraj A, Anand A, Chakravarthy M, Pai S. Proximal femoral nail antirotation (PFNA) for treatment of osteoporotic proximal femoral fractures. Eur *J Orthop Surg Traumatol*. 2012;22(4):301-5.
14. Hwang J-H, Garg AK, Oh J-K, Oh C-W, Lee S-J, Myung-Rae C, et al. A biomechanical evaluation of proximal femoral nail antirotation with respect to helical blade position in femoral head: a cadaveric study. *Indian Journal of Orthopaedics*. 2012; 46(6):627–32.
15. Yaozeng X, Dechun G, Huilin Y, Guangming Z, Xianbin W. Comparative study of trochanteric fracture treated with the proximal femoral nail anti-rotation and the third generation of gamma nail. Injury. 2010;41(12):1234–8.
16. Sahin S, Erturer E, Ozturk I, Toker S, Seckin F, Akman S. Radiographic and functional results of osteosynthesis using the proximal femoral nail antirotation (PFNA) in the treatment of unstable intertrochanteric femoral

fractures. *Acta Orthopaedica Et Traumatologica Turcica.* 2010;44(2):127–34.

17. Wu D, Ren G, Peng C, Zheng X, Mao F, Zhang Y. InterTan nail versus Gamma3 nail for intramedullary nailing of unstable trochanteric fractures.
18. Rupprecht M, Grossterlinden L, Sellenschloh K, Hoffmann M, Pueschel K, Morlock M, et al. Internal fixation of femoral neck fractures with posterior comminution: a biomechanical comparison of DHS (R) and Intertan nail (R). *Int Orthop*. 2011;35(11):1695–701.
19. Kreder HJ. Principles and evidence: the optimal treatment of pertrochanteric hip fractures: commentary on an article by Kjell Matre, MD, et al.: "TRIGEN INTERTAN intramedullary nail versus sliding hip screw. A prospective, randomized multicenter study on pain, function, and complications in 684 patients with an intertrochanteric or subtrochanteric fracture and one year of follow-up". *The Journal of bone and joint surgery American.* 2013;95(3):e16.
20. Collinge CA, Beltran CPTMJ. Does modern nail geometry affect positioning in the distal femur of elderly patients with hip fractures? A comparison of otherwise identical intramedullary nails with a 200 versus 150 cm radius of curvature. *J Orthop Trauma*. 2013;27(6):299–302.
21. Huang Y, Zhang C, Luo Y. A comparative biomechanical study of proximal femoral nail (InterTAN) and proximal femoral nail antirotation for intertrochanteric fractures. *Int Orthop*. 2013;37(12):2465-73.
22. Zhang S, Zhang K, Jia Y, Yu B, Feng W. InterTan nail versus proximal femoral nail antirotation-Asia in the treatment of unstable trochanteric fractures. *J. Orthopedics*. 2013;36(3):E288.
23. Zehir S, Zehir R, Zehir S, Azboy I, Haykir N. Proximal femoral nail antirotation against dynamic hip screw for unstable trochanteric fractures; a prospective randomized comparison. Eur *J Trauma Emerg Surg.* 2015;41(4):393–400.