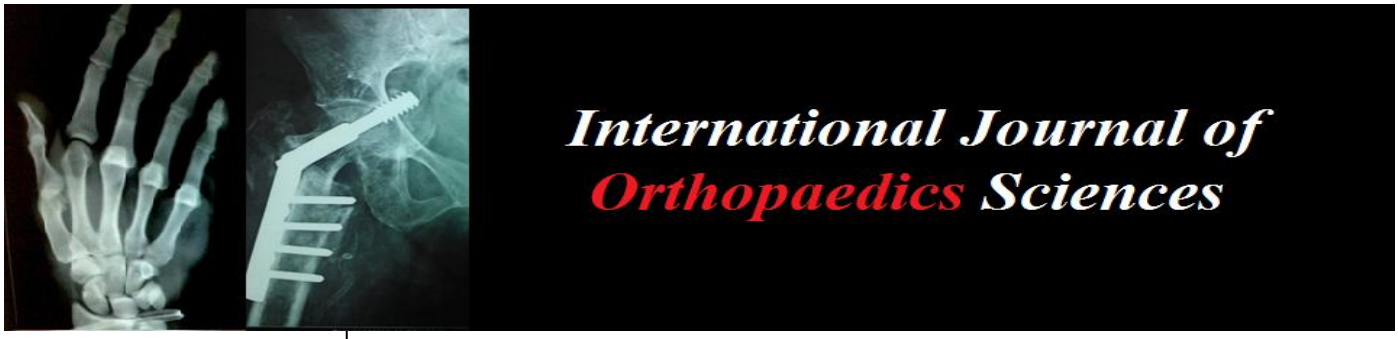

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A narrative review on functional outcome of intertrochanteric fractures treated with proximal femoral nailing

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Abstract
Introduction: Intertrochanteric fractures are the prevalent fractures in the elderly individual. Due to the unsteady design showed to be exigent demand to manage. The main aim of this study is to review the management modalities of intertrochanteric fractures and the outcome following proximal femoral nailing as reported in the literature.
Methods: Articles involving the intertrochanteric fractures and proximal femoral nailing were collected from various sources, including PubMed, Google Scholar, open-access journals excluding review articles, small studies and case reports. The modalities of treatment and outcome of proximal femoral nailing was reviewed.
Results: Early fixation and early mobilization of the patients is the mainstay goal in the treatment of intertrochanteric fractures. Intramedullary devices (PFN) offer better fixation of complex patterns of fractures and aid in early weight-bearing compared to extra-medullary devices and hence is the preferred mode of fixation.

Keywords: Intertrochanteric fractures, proximal femoral nailing, intramedullary device

Introduction
Trochanteric fractures account for half of all the hip fractures in elderly patients who have to weaken bone strength and density. More than half of all the intertrochanteric fractures are unsteady [1, 2]. The incidence increases as the age progress. The goal of treatment of any fracture is to restore mobility, safely and efficiently while reducing the risk of medical complications related to immobility and to restore to pre-injury status. Treatment methods for unstable intertrochanteric fractures have always been challenging and various methods have been described throughout the orthopedic history. The dynamic hip / condylar screws which are used for decades as a treatment option and has proven to yield good results, but complications are perennial and specifically in unsteady inter-trochanteric fracture. They require a longer incision, more soft tissue involvement, blood loss and higher operating time. Conservative management can be considered only in selected patients who are non-ambulant and the fracture has minimal impact on their daily routine.
Proximal femoral nail [PFN] was introduced in 1997 by AO/ASIF in full form as a biomechanically stronger intramedullary device. The advantage of PFN fixation is that it provides a more biomechanically stable construct by reducing the distance between the hip joint and implant.

Objective
To review treatment modalities of intertrochanteric fractures and the outcome following proximal femoral nailing as reported in the literature.

Materials and Methods
Articles involving the intertrochanteric fractures and proximal femoral nailing were collected from various sources, including PubMed, Google Scholar, open-access journals excluding

review articles, small studies and case reports. The modalities of treatment and outcome of proximal femoral nailing was reviewed.

Review of literature

Classification of fractures

Harold. B. Boyd & Lawrence. L. Griffin in 1949, treated 300 intertrochanteric fractures conservatively and came up with a classification based on prediction and steadiness of fracture patterns and arduous to reduce. They reported a mortality rate of 18% of all the 300 cases [3].

Early treatment methods and their outcome

R.C Murray & J.F.M Frew [4] from Scotland, in 1949, published a study on 100 trochanteric fractures treated conservatively between 1941 and 1947. They managed the cases with Buck's and Russel's traction methods. Counter traction was applied by raising the caudal end of the bed. They believed that internal fixation had a better prognosis. They classified trochanteric fractures into basal, intertrochanteric, oblique subtrochanteric, transverse sub trochantric and comminuted.

Augusto sarmiento (1963) [5], treated 100 cases with 150 degree angle nail plate and early mobilisation. He observed that loss of fixation of fractures, or migration of the nail, or both resulted in a delay in rehabilitation.

Dynamic hip screws

Ecker Malcolm *et al.* (1975), reviewed 62 cases of trochanteric fractures treated with dynamic hip screws. 22 patients in both stable and unstable fracture groups were allowed to bear weight as tolerated, as early as possible (average of 14 days). He observed a failure rate of 6.4% [6].

Jacob *et al.* (1976), noted that using a sliding compression screw with a fixed angle device decreased the incidence of joint penetration [7].

R.Ganz, R.J Thomos & C.P. Hammerle [8] in 1979, statistically reviewed 1376 cases of trochanteric fractures, excluding sub trochanteric type, of which 70% were female and 30% male. The average age was 60 years & 75 years in males and females respectively. 70% had a trivial domestic accident reflecting that the elderly group is affected much. Road Traffic accidents accounted for only 10%. The mortality rate was 10% S.P Mohanty and V. Chacko [9] in Manipal, India, in 1984, made a comparative analysis of the outcome of operative and conservative management of trochanteric fractures in 135 cases. 63 cases were conservatively managed and 53 cases were operated, the remaining 19 were not included for several reasons. The total number included 65 males and 51 females with an average age of 61.7 years. Modified Russell traction was employed in the conservative management group in which the limb was immobilized by an upper tibial Steinmann pin incorporated in a below knee plaster cast. Traction was applied along the axis of the femur by a system of pulleys. The average hospital stay was 49 days. 6 deaths were observed in the conservative and 5 in the surgical group within 1 year of management. The outcome was graded as excellent, good, fair and bad considering pain, deformity, ability to squat and sit cross-legged, daily activities, range of knee movements and walking distances. They found that operative management was superior to conservative management.

Gutler Jacobs reported a biomechanical evaluation of the fixation of unsteady intertrochanteric fractures with dynamic hip screws and with condylo-cephalic nails in 1986. The dynamic hip screw was proven to be 5 times more sturdy compared to condylo-cephalic nails [10].

Bannister *et al.* (1990) did a prospective comparative study of 155 patients with dynamic hip screw and Jewet nail. The DHS showed significantly less mechanical failure and a lower incidence of resurgery [11].

Anil Dhal, M Varghese, and V B Bhasin *et al.* (1991), studied external fixation in 154 intertrochanteric fractures over the years by employing early mobilisation. The average time of the union was 16 weeks [12].

Baumgaertner *et al.* (1995), reported that a simple, reproducible method of re-reduction and re-direction of the guide was more helpful in intra-operative estimation of tip apex distance [13].

Proximal femoral nailing

Simmermacher RK *et al.* (1999) reviewed 191 proximal femoral fractures treated by proximal femoral nailing in 1 year. Anatomical fracture reduction was achieved in 86% of cases. A short term follow up of 4 months showed a drastic reduction in technical failures (4.6% of the cases) [14].

Christian Boldin, Franz J. Seibert, Florian Fankhauser, Gerolf Peicha, Wolfgang Grechenig, *et al.*, in 2000 did a prospective study on 55 patients with proximal femoral fractures managed with a proximal femoral nail. A good outcome with the least complications at 12-month follow-up was achieved in most patients [15].

Friedl W, Clausen J., in 2001, performed an experimental examination for improving the stabilization of trochanteric femur fractures with intra or extramedullary implant [16]. The outcome of the DHS, Gamma Nail and the PFN, were tested in unstable trochanteric fractures. The weight bearing capacity was tested using static and dynamic loading. The intra medullary devices showed to be several times stronger than the DHS, with less or no deformity at maximum loads. This concluded that the biomechanically stronger intramedullary devices provided uncompromised mobilisation in complete weight bearing cases

Bhatti, Arshad *et al.* (2003) showed similar results in both proximal femur nail and DHS at six months after fixation [17].

Kulkarni GS *et al.* (2006) reviewed the current concepts of Intertrochanteric fracture treatment. They concluded that the unstable Intertrochanteric fractures can be better helped by intramedullary fixation as the Dynamic hip screw had more failure rates [18].

Reska M. *et al.* (2006) concluded that a careful surgical approach and a stable Osteosynthesis have remarkably contributed to the rapid mobilization of patients with the help of proximal femoral nail [19].

Pavelka T. *et al.* (2007) [20] conducted a study of 79 patients with ipsilateral hip and femoral shaft fractures managed with a long proximal femoral nail. Bone union was achieved in all patients. The outcome was graded as excellent (64%), good (28%) and satisfactory (8%).

Kuzyk, Paul *et al.* (2009) in biomechanically evaluated extramedullary and intramedullary fixation in inter-trochanteric fractures of reverse obliquity type and concluded that there was no significant difference between both methods [21].

W. M. Gadegone & Y. S. Salphale (2006) [22], conducted an analytic study on 100 cases of proximal femoral fractures management with Proximal femoral nail with an average of 1 year follow up. Postoperatively 90% of patients their radiographs showed a very close anatomical fracture reduction. The fracture consolidated in 4 months.

Metin Uzun *et al.* (2010) [23] conducted a study in 40 patients to evaluate the functional outcome of unstable intertrochanteric femoral fractures with the proximal femoral nail. The complete union was achieved in 37 patients with a mean Harris hip score of 84.

Deepinderjit Singh *et al.* (2012) studied 25 patients with sub trochanteric fractures treated with PFN. They reported that PFN is the implant of choice for stabilizing subtrochanteric fractures as it facilitates early rehabilitation and weight-bearing [24].

Pajarinen J *et al.* (2005), in a randomized clinical trial, compared the functional outcomes of Dynamic hip screw and proximal femoral nail in patients with per trochanteric fractures. After four months of review, patients treated with PFN returned to pre-injury walking status, while a shortening of the femoral neck was observed in patients treated with DHS [25].

Minos Tyllianakis & Andreas Panagopoulo, in Greece (2004), published a retrospective analysis of 51 intertrochanteric cases treated with PFN. They observed a re-surgery rate of 28.8%. They found a positive result in the outcome following PFN. There were mechanical & technical complications observed in 41% of cases. They related the complications to the fracture pattern, surgical technique and timing of mobilization than the PFN system per se [26].

Steinberg *et al.* (2005), studied the biomechanics of proximal femur nail in subtrochanteric fractures and concluded that proximal femur nail was more effective in the management of such complex fractures. It was reported that the fluting tip of the nail reduced the stress fractures in the shaft of the femur [27].

A retrospective mortality study comparing the death rates in PFN and hemiarthroplasty in 202 cases of intertrochanteric fractures conducted at Turkey by U.H.Golge, Ozhan Pazarci [28], established that PFN is significant fruitful in intertrochanteric fractures management compared to hemiarthroplasty in elderly cases even the mortality rate was 5.1 times significantly high than PFN. The life span of the patients managed with PFN were much longer than that of hemiarthroplasty.

B. L. Chopra, Krishan Kumar, Bikaner, Rajastan, India studied the outcome and complications in 125 cases of proximal femur fractures treated by proximal femoral nailing (2017). They observed radiological union in 123 cases by the 6th month. Functional assessment was done with Salvati and Wilson Score and showed excellent and good results in 82% of cases. Failure of fixation was observed in 2% of cases. They concluded that proximal femoral nailing is a suitable implant to use in proximal femur fractures [29].

Dr. Punit J. Tank, Dr. Rajesh A. Solanki, Ahmedabad, India (2016), prospectively studied 70 patients with inter trochanteric fractures and published the results of using Proximal Femoral Nail in the treatment of Intertrochanteric Fracture. The majority of the patients in their study were elderly female with a low velocity trauma showing the incidence of fracture similar to international studies. They observed excellent outcome in 51% of cases and implant failure in 3% of cases. They concluded that unstable fracture patterns can be quickly fixed with lesser soft tissue dissection using proximal femoral nailing and hence recommend it to be used as the implant of choice [30].

Choy *et al.* (2010) conducted a study by using cementless bipolar hemiarthroplasty as management in 40 patients with unstable intertrochanteric fractures. They found the hemiarthroplasty to be a stable and viable option, with 60% of patients reporting no loss of ambulation. All the prosthesis were found stable without any significant loss of alignment [31].

Table 1: Show the sample size treatment outcome complications

Study	Sample size	Treatment	Outcome	Complications
Punit J. Tank *et al.* [30]	70	Proximal femoral nailing	Excellent 51%	Implant failure 3%
B. L. Chopra [29]	125	Proximal femoral nailing	Excellent 36%	Failiure of fixation 2%
Choy *et al.* [31]	40	Cementless bipolar hemiarthroplasty	Excellent 60%	
Simmermacher RK *et al.* [14]	191	Proximal femoral nailing	Excellent 86%	Implant failure 4.6%
Ecker Malcolm *et al.* [6]	62	Dynamic hip screw		Failure of fixation 6.4%

Conclusion

Intertrochanteric fractures are the prevalent fractures in the elderly individual. In our review of literature, various management methods have been described. The dynamic hip screw offers a stable and effective fixation in stable patterns, but in unstable fractures with mediolateral communition, intramedullary devices prove to be the effective method of fixation with minimal soft tissue handling and early mobilization. Early fixation and return to pre-injury status was better achieved in intramedullary devices and is hence recommended for unstable intertrochanteric fractures.

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