

Post-Operative Assessment on Gait Parameters among Intertrochanteric Femur Fracture Patients Operated by Proximal Femoral Nailing

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Abstract:

Background: Intertrochanteric fractures (ITFs) in general were clinically presented as one among the common hip fractures that is predominantly reported among elderly population especially patients suffering from osteoporosis condition and due to low-energy trauma by falls, they had been typically caused. The Proximal Femoral Nailing (PFN) was attributed as quite effective in the ITF treatment due to the recent advancements in the fixation surgery approaches. This study intends to conduct a detailed post-operative assessment on ITF patients with the prime objective of analysing the differences many patients having their treatment with proximal femoral nailing with the help of simple 3-D Gait analyser's Helen Hayes Protocol.

Methods: The study on postoperative observation in Jawaharlal Nehru Medical College, KAHER, Belagavi India was conducted among in and outpatients of orthopaedics. In order to assess the ITF spatiotemporal parameters, the study's been directed between ITF patients under examination during their post-operative with the help of 3-D Gait analyser by employing the protocol of Helen Haley between January 2021 to December 2021. Statistical analysis was conducted using SPSS (Version 19), for analysis of the data rendered.

Results: From the observed investigation, number of males was high in the sample population (56.7%) than female (43.3%). It is observed that type 3 IT fractures was presented and 18 respondents with Type 2 fracture and also 10 with severe Type 4 IT fracture. The gait parameters temporal findings had concerned that there is a rise in the single and double support phase indicatives of the impact of IT fracture on the limbs at their gait. Therefore, the difference could be observed in the gait score from the report. In the deviation of gait score, an abnormal range had been reported as $85.57 \pm 3.04 (< 100)$.

Conclusion: One of the effective diagnostic tools is 3D gait analyser that could be employed in devising the most suitable management approach as well as treatment modality post-surgery. Furthermore, PFN had been reported for exhibiting the beneficial outcome when the gait analysis is considered from the spatio-temporal findings.

Keywords: Helen Hayes protocol, Proximal Femoral Nailing, Intertrochanteric Fracture, 3D gait analyser, spatiotemporal parameters.

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Introduction

The clinical presentation of Intertrochanteric fracture as a type of hip fracture that occurs between the greater and lesser trochanters of the femur, which are the bony protrusions on the thigh bone.

This type of fracture is common among elderly patients, especially those with osteoporosis or other bone-weakening conditions. Elderly patients with intertrochanteric fractures usually experience pain in the hip or groin area, difficulty bearing weight on the affected leg, and swelling or bruising. Treatment for intertrochanteric fractures typically

involves surgery, which may include the insertion of a metal plate and screws to stabilize the bone. After surgery, patients usually require physical therapy to help regain strength, range of motion, and balance. [1] In general, the initial live treatment had been procrastinated for nearly 3-4 weeks which will lead to development of second type complications.

Several operative procedures are existed which had involved with many different described implants as modalities of treatment for the intertrochanteric fractures. In the early mobilization progress, the

primary goal governing with the particular treatment facilitates with the secondary complications' prevention that could possibly be attained from the internal fixation as well as open reduction. Through with the hip screw or trochanteric nail sliding, fractures of intertrochanteric femur could possibly be repaired. Mainly, the underlying problem in association with the sliding screws of hip are from the collapse in the leg length reduction and femoral neck that leading to hip loss offset. Although few slipping had been anticipated, some damages can be resulted by lot of falls in length to get functioned in hip region. Therefore, bringing in the intramedullary device- usage of Proximal Femoral Nail in 1996 had offered certain improvements regarding the negligible invasive surgery. [2]

On a global scale, the actual prevalence of patients who were affected by fractures near hip region had been reported with the significant digit. For trivial trauma that being the main reason, the general observations were to be intertrochanteric fractures for old age people. There are certain variations existed from one country to another which can possibly be listed for many reasons mainly for the observed occurrences due to intertrochanteric fractures. [1]

Globally, forecasting the 2.6 million people will be impacted by hip fractures by 20252, where the lifetime risk estimate of the fracture can possibly be seen among people who are in the age of 50, where 5.6% are men and 20% are women [3]. There are certain medical ailments related to the loss of bone strength namely Cushing's syndrome, Hyperparathyroidism, Hyperthyroidism & Diabetes are in association with the increase of the hip fractures upswing. [4]

The result of higher occurrence of varus deformity and length reduction is the poor function as results. In 1950s, operations for fractures have been familiarized and lessened the constant rest' complex features on the bed with the improved function's anticipation as the predicted results. [5,6] PFN/ proximal femoral nail like intramedullary manoeuvres had been observed as more stabilized with short-lever arm, therefore the nail as well as hip joint had been made so closer than with the plate. Therefore, the malformation factors are reduced with the implant. Especially, the biomechanical devices help is significant in intramedullary in a wobbly trochanteric as well as sub- trochanteric fractures. [7,8]

Furthermore, one such assessment to see the way the body moves by running or walking from one position to other is gait analysis. As a non-invasive detection method, gait analysis has been of great value in order to identify certain medical conditions, to determine whether testing is further

required and to illuminate possible treatment options. Regarding the surgical management, the first and foremost goal in IFFs oriented surgical modality were involved in the post-operative recovery concerning with their walking ability. To re-establish every patient to the normal environment of an individual in clinical findings serves as quintessential among the older patient groups [9]. The present study mainly aims to analyse the differences among the parameters of spatiotemporal gait in 6 months had operated the case of PFN in intertrochanteric fractures by the evaluation of the gait parameters with the help of 3-D Gait analyser.

Material and Methods

Source of Data: For the study, patients who had admitted in the Orthopaedics department with post-traumatic intertrochanteric fractures at the KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre and Charitable Hospital, Belagavi between Jan 1, 2021 to Dec 31, 2021, over one year period of time were selected.

Participants and Study Design: A subset of patients was recruited by this observational study from the randomized controlled trial from the elderly ITF patients' population who had been treated with PFN. The study population were in- and out-patients of orthopaedics department in Jawaharlal Nehru Medical College, KAHER, Belagavi India. Totally 60 PFN post-surgery patients were selected for the sample. They were the ones presented with post-traumatic intertrochanteric fracture. Also, they had been post-operatively evaluated and looked into after PFN. All those patients who shown their willingness for participating in the study was comprised in the inclusion criteria. Yet, certain key inclusion criteria were assessed before they get participated. Every participant was included on the basis of Intertrochanteric fracture with postero-medial comminution, with reverse oblique pattern & sub trochanteric extension from the clinical standpoint. PFN was treated by every AO classification Intertrochanteric fracture.

On the other side, exclusion criteria had been among children with peri prosthetic fractures; associated lower limb injuries; open hip fractures; pathological fractures; poor pre-fracture walking ability; pediatric fractures [before physical closure]; and also, lower-limb pathologies such as Rheumatoid Arthritis/ Paralysis.

Gait Analysis: Assessment is mainly required for methodology that adopted for studying the Gait parameters on the spatiotemporal assessment with the help of 3D-gait parameters as the following parameters had been included in Helen Hayes method. They are- Spatial Parameters (step length (m); step width (m); stride length (m)); Temporal

Parameters (stance time (sec); cadence (steps/ min); single Support Phase (%); stride time (sec); mean Velocity (m/s); double Support Phase (%)); Gait Profile Score (Ground Reaction Force (Vertical FORCE (% body weight)).

Statistical Analysis: The gait analysis data was assessed and were assessed via, a quantitative variable both mean and the standard deviation was determined. A comparative assessment of the data was performed by certain qualitative characteristics, using unpaired t-test students, for which the continuous variables had been compared. Through medium, discrete variables had been represented. Concerning with the percentages, rates and ratios, the categorical data are expressed. By employing the Fisher's exact test, Chi-square test

or proportion test, the association were tested among the demographic characteristics, outcome and clinical characteristics. The p-value is considered as significant which is less than (0.05) 5% for all the tests.

Results

Patients who underwent PFN were selected for this study among which majority are men (N-34; 56.7%) and minority are women (N-26; 43.3%). This indicates that men are more vulnerable to IT fracture.

There are 18 patients between the 61 years to 70 years; above 70 years of age and also patients under the age category between 41-50 years were reported 14 from each group.

Table 1: Demographic profile of patients

Patient Demographics		Total (N)
Gender	Female	26
	Male	34
Age	Below 40 years	8
	41-50 years	14
	51-60 years	6
	61-70 years	18
	Above 70 years	14
Mode of Injury	Self-Fall	36
	RTA	24
Diagnostic representation of IT fracture	B/L IT	1
	LEFT IT	34
	RIGHT IT	25
IT fracture types	1	6
	2	18
	3	26
	4	10
Diagnostic presentation of IT fracture	B/L IT	1
	LEFT IT	34
	RIGHT IT	25

There are three cases among 51 to 60 years and eight cases among less than 40 years. Left IT fracture is the majority cases (N-34; 56.7%). Right IT fracture is the minority cases (N-25; 41.7%). Bilateral IT fracture was reported in one respondent. "Type 1", "Type 2", "Type 3" & "Type 4" are the types of fractures classified among sample population based on IT fracture & its impact. Majority of the participants in this study has type 3 IT fracture, 18 of the participants has type 2 IT fracture and 10 of the participants has type 4 IT fracture as per the observation.

Evaluation of Gait factors among the participants

Temporal parameters

Spatiotemporal factors are regarded as reliable and important method for measurement of gait. The below table provides the spatiotemporal factors and their scores of 60 participants with their estimated "mean \pm standard deviation" for stance time, mean velocity, stride time, single & double support phase, swing time, cadence of the patients.

Table 2: Observed Spatiotemporal parameters among study population

Parameter	Minimum	Maximum	Mean	Std. Deviation
Stance Time	1.030	1.180	1.137	0.0352
Stride Time	0.61	0.69	0.654	0.0148
Swing Time	0.41	0.490	0.454	0.0148
Single Support Phase	39.46	45.958	43.997	1.585
Double Support Phase	13.20	15.300	14.565	0.303

Mean Velocity	0.400	1.500	1.163	0.122
Cadence	111	118	113.35	1.68
Stride Length	1.27	1.80	1.407	0.0663
Step Length	0.5	0.660	0.630	0.0284
Step Width	0.060	0.1200000000001000	0.099570175438697	0.013904429177446

Mean stance time, swing time & stride time are within the normal range as per the findings. The impact of IT fracture on the limbs at the time of gait is indicated by the rise in the single and double support phase i.e. (43.997 ± 1.585) & (14.56 ± 0.302) respectively as per the gait parameter's findings. 1.16 ± 0.122 m/s was the mean velocity which was observed in the findings. Even though there is impact of IT fracture among the participants, there is no deviation in the mean

velocity as it is observed within the normal range. (113.35 ± 1.68) was the cadence observed in the findings which got reduced as per observation due to the IT fracture in contrast with mean normal value range. Greater correlation was exhibited by the spatial factors on IT fractures and its impact as per the findings given on the table above. 0.63 ± 0.284 m was the step length reported in this study. There was a reduction in the step length among the participants as per the observation.

Table 3: Comparative assessment of "Gait Profile score" & "Gait deviation index" from the study population

ANOVA						
	GAIT Profile Score			GAIT Deviation Index		
	Between Groups	Within Groups	Total	Between Groups	Within Groups	Total
Sum of Squares	.096	9.633	9.729	11.717	533.702	545.418
df	3	56	59	3	56	59
Mean Square	.032	.172		3.906	9.530	
F	.186			.410		
Sig.	.905			.747		

It can be concluded from the ANOVA test that there is important difference is exhibited by the factors linked with GAIT profile score & GAIT deviation score in respect to the effect of IT fracture in their factor scoring and the measures also exhibited resultant abnormal findings also.

Discussion

The current examination was done to examine the patients with many various intertrochanteric fractures' kinds that cured with proximal nailing of femoral with the help of simple 3-D Gait analyzer's Helen Hayes Protocol. The impact of IT fracture on the limbs at the time of gait is indicated by the rise in the single and double support phase i.e. (43.997 ± 1.585) & (14.56 ± 0.302) respectively as per the gait parameter's findings. 1.16 ± 0.122 m/s was the mean velocity which was observed in the findings.

Even though there is impact of IT fracture among the participants, there is no deviation in the mean velocity as it is observed within the normal range. (113.35 ± 1.68) was the cadence observed in the findings which got reduced as per observation. 0.63 ± 0.284 m was the step length reported in this study. There was a reduction in the step length among the participants as per the observation. 7.76 ± 4.06 was the mean range reported in this study. A deviation in the gait score among the participants is indicated by this mean range as the normal range is less than seven. 85.57 ± 3.04 was the gait deviation score

reported in this study. It indicates abnormal range as it deviates from the normal range among participants who had IT fracture. Also, for the majority cases of the sample population presented with important connection with respect to the gait parameters (IT fracture) in the following examination [10,11]. Based on the available literature, it is recommended that the postoperative functional goals for elderly and vulnerable patients include achieving a similar level of independence and ambulation as prior to their fracture [12,13,14].

Our study showed significant improvement in hip power generation & external hip abduction instant at the time of development of torso over the limb which is supporting to create forward thrust. At the time of thrust phase of single limb stance, ITF patients exhibited important deficiencies in ankle & hip power generation, hip abduction and ankle plantar flexion when compared to elderly participants. The risk of fall is high in the elderly participants when there is less peak hip abduction, hip power generation & ankle dorsiflexion. The rise in the gait speed is contributed by rise in the power generation and ankle plantar flexion which is indicated by existing studies. This may result in the decreased gait speed which is reported in patients who have fracture. To maintain functional following ITF, an important step is to reduce the decline in power generation and high range of motion as per suggestion. The overall efficacy in

the surgical method which involves the usage of PFN [15,16] was studied in detail by the meta-analysis examination with also provides evidence for this. When compared to other methods of fixation, this usage of PFN is regarded as superior due to its increased effectiveness. It requires only less surgery duration. The other important positives are less fixation failure rates, reduce intra operative blood loss and less complications related to the post-op outcome as per the gait analysis [17,18]. It is indicated from the reports that the less functional outcome score and less ADLs [11,18] are linked with the functional independence. Post-op of ITF is still unexplored, when changes in gait biomechanics are considered. The more weightage is given for the functional outcomes and the gait parameters and possible tools regarding functional deficiencies & the way its stems from are provided by the vast data. The Gait analyser findings indicated an overall enhancement of knee, hip, ankle biomechanics at the time of post-operative for ITF patients.

Conclusion

From the post-operative assessment, it could be inferred that from resultant spatiotemporal outcomes indicated an overall enhancement of knee, hip, ankle biomechanics at the time of post-operative for ITF patients. This reflects the feasibility governing with the PFN treatment modality in terms of positive outcomes in regards to the patients exhibiting important enhancements in gait biomechanics during six months period after the surgery.

Limitations and scope of the study

It is important to acknowledge several limitations when interpreting these results. At first, less patients were included in the analysis as there was complexity involved in the demographic profile of patients related to age & comorbidities. This created challenge in terms of attendance & the patients who are available for analysis.

These measures come with a degree of uncertainty, and further research is needed to fully discover “the effects of femoral nail positioning and the geometry of the bone-implant construct on gait biomechanics in ITF patients”. Therefore, future studies should focus on investigating these factors to provide a more understanding of the biomechanical changes which happen in ITF patients and improve the clinical outcomes of these patients.

Author's contribution

Both the authors and the co-authors were responsible for developing and conducting the collection of data, musculoskeletal modelling and examination of the result. All authors' contribution is present in structuring the study, data gathering &

analysis, and interpretation of results and provided feedback to improve the quality of the study.

References

1. Falch JA, Liebekk A, Slungaard U. Epidemiology of hip fractures in Norway. *Acta Orthop Scand* 1986; 56:12-6.
2. Simmermacher RKJ, Bosch AM, Van der Werken C. The AO/ASIF- Proximal femoral nail: a new device for the treatment of unstable proximal femoral fractures. *Injury* 1999; 30: 327-32.
3. Chaitanya M, Mittal A, Rallapalli R, Biju R, Prasad YS. Comparison of Dynamic Hip Screw and Plate with Proximal Femoral Nail in Trochanteric Fractures of Femur. *IOSR J Dent Med Sci* 2015; 14(4):73-82.
4. Gulberg B, Jhonell O, Kanis J. Worldwide projection for hip fractures Osteoporosis Int. 1997; 7:407-13.
5. Hagino H, Furukawa K, Fujiwara S, et al. Recent trends in incidents and lifetime risk of hip fracture in Tottori, Japan *Osteoporosis Int.* 2009; 20(4):543-8.
6. Jarnlo GB, Thorgren KG, Background factors to hip fractures. *Clinorthop* 1993; 287:41-49
7. Schumpelick W, Jantzen PM. A new principle in the operative treatment of trochanteric fracture of the hip, *J. Bone Joint Surg* 1988;70-A:1297-303.
8. Massie WK: Fracture of the Hip, *J.Bone Joint Surg* 1964; 46-A: 658-90.
9. Salpakoski A, Törmäkangas T, Edgren J, Sihvonen S, Pekkonen M, Heinonen A, et al. Walking recovery after a hip fracture: A prospective follow-up study among community-dwelling over 60-year old men and women. *Biomed Res Int.* 2014.
10. Menezes, Daniel FA, Gamulin A, Bruno. Is the Proximal Femoral Nail a Suitable Implant for Treatment of All Trochanteric Fractures? *Clin Orthop.* 2005; 439:221-7.
11. Kubaik E, Bong M, Park S, Kummer F, Egol K, Koval K. Intramedullary Fixation of Unstable Intertrochanteric Hip Fractures - One or Two Lag Screws. *J Orthop Trauma.* 2004; 18:12-7.
12. Pajarinen J, Lindahl J, Michelsson O, Savolainen V, Hirvensalo E. Peritrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail - A randomized study comparing post-operative rehabilitation. *J Bone Joint Surg.* 2005; 87B: 76-81.
13. Banan H, Al-Sabti A, Jimulia T, Hart AJ. The treatment of unstable, extracapsular hip fractures with the AO/ASIF proximal femoral nail (PFN) - our first 60 cases. *Injury.* 2002 Jun; 33 (5); 401-5.
14. Zeng C, Wang Y-R, Wei J, Gao S-G, Zhang F-J, Sun Z-Q, Lei G-H. Treatment of Trochanter-

- ic Fractures with Proximal Femoral Nail Antirootation or Dynamic Hip Screw Systems: a Meta- analysis. *The Journal of International Medical Research*. 2012; 40: 839 – 851.
15. Shen L, Zhang Y, Shen Y, Cui Z. Antirootation proximal femoral nail versus dynamic hip screw for intertrochanteric fractures: A meta-analysis of randomized controlled studies. *Orthopaedics & Traumatology: Surgery & Research*. 2013; 99: 377-383.
 16. Simmermacher R K J, Bosch AM, Vander Werken C. The AO/ASIF- Proximal femoral nail (PFN); a new device for the treatment of unstable proximal femoral fractures. *Injury* 1999; 30: 327-32.
 17. Zeng C, Wang Y-R, Wei J, Gao S-G, Zhang F-J, Sun Z-Q, Lei G-H: Treatment of Trochanteric Fractures with Proximal Femoral Nail Antirootation or Dynamic Hip Screw Systems: a Meta- analysis. *The Journal of International Medical Research* 2012; 40:839-51.
 18. Shen L, Zhang Y, Shen Y, Cui Z: Antirootation proximal femoral nail versus dynamic hip screw for intertrochanteric fractures: A meta-analysis of randomized controlled studies. *Orthopaedics & Traumatology: Surgery & Research* 2013; 99:377-383.