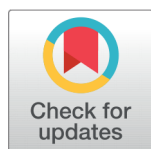


RESEARCH ARTICLE



OPEN ACCESS

Received: 18.01.2020

Accepted: 29.01.2020

Published: 05.02.2020

Editor: Dr. D. R. Galfat

Citation: Singh BG, Chandrasekharan A (2020) Various factors influencing the outcome in DHS fixation of Intertrochanteric fractures. International Journal of Orthopaedics Traumatology & Surgical Sciences 6(1): 5-10. <https://doi.org/10.47618/IJOTSS/v6i1.2>

*Corresponding author.

Funding: None

Competing Interests: None

Copyright: © 2020 Singh & Chandrasekharan. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Published By Society of
Orthopaedics, Surgical and Dental
Sciences

ISSN

Print: 2455-0809

Electronic: 2454-4167

Various factors influencing the outcome in DHS fixation of Intertrochanteric fractures

Bhandari Gaurav Singh^{1*}, A Chandrasekharan²

¹ Assistant Professor, Department of Orthopaedics, Sri Guru Ram Das Institute of Medical sciences & Research, Vallah, Sri Amritsar (Pb.)

² Professor of Orthopaedics, Sri Ramachandra University, Porur, Chennai

Abstract

Background: Dynamic hip screw (DHS) is a standard device for intertrochanteric fractures (ITF). Implant failure in form of screw cut out leading to varus collapse of neck shaft angle is associated with various factors like bone quality, fracture pattern, fracture reduction, lateral femoral wall thickness (LFWT), screw position and tip-apex distance (TAD). But there has been no clear consensus to the relative importance of each factor. The purpose of our study is to assess individual factors for a favorable outcome in DHS fixation of ITF.

Materials and methods: 121 hips sustaining ITF treated with DHS between-June 2014 and July 2016 were reviewed in our prospective study with a mean period of 12 months. Factors under study were bone quality, fracture pattern, fracture reduction, LFWT, screw position and TAD, which were recorded and used for statistical analysis using SPSS. Chi-square test, Independent t-test and Paired t-test were used to evaluate the significance of the differences. Final analysis involved clinical and radiological assessment using Harris Hip Score (HHS) and radiographs respectively. **Results and Analysis:** The mean age of patient at the time of surgery was 65.27 ± 3.21 years (range 24-85) with 80 males and 41 females. There was no statistical significant relation found between implant failure and osteoporosis even though cases of failure were found in weak osteoporotic bones. Implant failure in relation to unstable fracture pattern, non-anatomical fracture reduction, $LFWT < 21.77$ mm, screw placement in position apart from centre-centre or centre-inferior and TAD greater than 25mm was found to be statistically significant ($p < 0.05$). The final functional and radiological assessment revealed 68.85% and 86.88% of hips respectively in good to excellent category. **Conclusion:** DHS is a well-accepted implant for ITF with lower rate of complications only if proper surgical technique is followed. Good fracture reduction, adequate LFWT, ideal screw position and TAD less than 25mm are must to prevent implant failure. **Level of Evidence:** Level IV

Keywords: Intertrochanteric fractures; DHS; factors of failure

1 Introduction

Nearly one-half of proximal femur fractures are intertrochanteric fractures (ITF) out of which one-third are unstable. Elderly population tends to suffer from a trivial fall due to decline in bone density whereas road traffic accidents (RTA) are the leading cause in the younger ones⁽¹⁾. The Dynamic Hip Screw (DHS) introduced by Clawson in 1964⁽²⁾ provides rigid fixation^(3,4) and encourages fracture impaction. Stable fixation is the keystone for a successful union of trochanteric fractures, thus aiming to achieve early mobility and restoring the patient's walking ability to pre-injury level. The mechanism of failure has been the cut-out of lag screw from the femoral head leading to varus collapse of the neck-shaft angle, loss of reduction caused by excessive sliding of the lag screw, non-union, shortening of the affected limb and pain⁽⁵⁾. There are various factors responsible for the same such as age of the patient, bone quality, fracture pattern, stability of reduction, lateral femoral wall thickness (LFWT), lag screw position and tip-apex distance (TAD). But there has been no clear consensus on the relative importance of these factors. Therefore, this study was conducted to assess the importance of individual factors for a favorable outcome in DHS fixation of ITF.

2 Materials and Methods

This is a prospective study of 127 patients with 127 consecutive ITF in adults treated by DHS admitted to the Sri Ramachandra University Hospital, Chennai between the period of June 2014 to July 2016. Following approval by institutional review board, all 127 hips were included in the initial evaluation of prospective study. The hips lost to follow-up and died before fracture union were 2 and 4 respectively. The remaining 121 hips were included in the final evaluation with a mean period of 12 months. Pathological fractures except osteoporotic fractures, trochanteric fractures with extension into proximal shaft, intracapsular neck femur fractures, medical and anesthesiologically unfit patients, fractures treated by other methods and fracture associated visceral injuries were excluded from this study. Patients who were bedbound prior to fracture were also excluded.

In our study, all the reported injuries were fresh appearing to the ER within 48 hours. All patients underwent routine hematological and clinical assessment. The pre-injury walking ability was recorded as per history. Following the pelvis radiograph, the contralateral side Neck-shaft angle was measured and found to be in the range of 132 ± 6 degrees. The fractures were classified as per Boyd and Griffin classification (I & II) and Evan's classification-stable and unstable. The bone quality was assessed using Singh's index and also the pre-operative Lateral femoral wall integrity (LFWI) was assessed based on AO/OTA classification 31-A1(A1) & 31-A2 (A2)⁽⁶⁾. LFWT defined as the distance in mm from a reference point

3cm below the innominate tubercle of the greater trochanter, angled at 135 degrees upward to the fracture line (the mid-line between the two cortex line) on antero-posterior radiograph (Figure. 1).



Figure 1

All the patients were taken up for surgery in form of closed reduction and fixation with 135-degree angle AO DHS plate after obtaining anesthetist clearance. There was a strict relationship followed between lag screw length and type of barrel used i.e. short barrel for screw length below 85mm⁽⁷⁾. The length of incision, duration of surgery and fluoroscopy time was variable.

3 Surgical procedure

In our study, all the patients were positioned supine on fracture table under spinal anesthesia for adequate reduction of fracture. The reduction was achieved using traction and internal rotation. The unaffected lower limb was flexed and abducted to allow easy access for the image intensifier. The objective of reduction was to confer alignment of neck shaft angle, weight bearing stability and correct varus and rotational deformities. In stable fractures, this is achieved by reduction of calcar femorale. However, in comminuted fracture anatomic reduction does not confer stability. Following a straight lateral incision 5 cm below the trochanteric ridge, vastus lateralis was cut in a 'L' shaped way, 1 cm anterior to linea aspera. Using the angle guide, a point of entry at the trochanteric flare is chosen by a thumb placed beneath the inferior ridge of greater trochanter (GT) under radiographic control, which is confirmed to lie opposite to the lesser trochanter if it is intact. A 2.5mm tipped threaded guidewire is inserted into the centre or inferior portion of the neck and head of femur in antero-posterior (AP) view and midway between anterior and posterior cortices in lateral view, to lie within 10mm from the subchondral bone on

either view. Triple reaming and tapping was performed and a lag screw of appropriate length was inserted. Four or five hole side plate were used in all of the cases.

4 Post-operative assessment

Based on assessment of post-operative radiographs, fractures were graded as good or poor. A good reduction has normal to 10° valgus neck-shaft angle alignment in the AP view, less than 20 degrees of anterior angulation in the lateral view and displacement of less than 4mm on either view. Otherwise, the reduction was graded as poor. Furthermore, the femoral head was divided into nine separate zones on AP and lateral view to locate the screw position. These were superior, central and inferior thirds in AP view and anterior, central and posterior thirds on lateral view. The implant position was considered optimal if the lag screw of DHS was placed in the centre-centre or centre-inferior position of the femoral head. Tip-Apex Distance (TAD) was measured by method as described by Baumgaertner et al. which is the sum of the distance from the tip of the screw to the apex of the femoral head on antero-posterior (AP) and lateral radiographs⁽⁸⁾. These above parameters were used to compare between patients with uneventful fracture healing and patients with implant failure in form of screw cut-out.

All patients were given post-operative intravenous antibiotics for 48-72 hours. In-bed mobilization and static quadriceps were started on post-operative day 1. Partial weight bearing with walker support was commenced in all patients on day 2 till four weeks and full weight bearing after four weeks depending on individual clinical and radiological condition. Suture removal was done after 10 to 14 days. When there was pain, single elbow crutch or walking stick was used^(9,10). All patients were assessed post-operatively at regular defined period of 6 weeks, 3 months, 6 months, 9 months and 1 year. During the follow-up period, all the patients were assessed clinically and radiologically using Harris Hip Score (HHS) and x-ray of the operated side respectively. According to HHS, the score 90 and above suggested of excellent outcome, between 80 to 90 suggested of good outcome, 70 to 79 fair outcome and below 70 means a poor outcome. The radiological post-operative outcome was assessed using a plain radiograph of the operated hip in which the neck shaft angle was measured and also any signs of implant failure were looked for. Failure of treatment or implant was defined when there is penetration of screw into the hip joint or loosening within femoral head, breakage of plate-barrel junction or screws, side plate pullout, non-union, infection or re-operation.

5 Statistical Analysis

The statistical software used was SPSS. The study material was processed and analyzed using SPSS for windows⁽¹¹⁾. Chi-square test, Independent t-test and Paired t-test were used to

evaluate the significance of the differences. A difference was considered to be statistically significant when $p < 0.05$.

6 Results & Analysis

Table 1

Age group (years)	
<30	5
31-40	25
>40	91
Mean age	65.27± 3.21
Sex :	
Male	80
Female	41
Affected by	
Trivial fall	94
RTA	27
Boyd & Griffin classification	
Type I	68
Type II	53
Evan's classification	
Stable	80
Unstable	41
AO/OTA classification	
A1	40
A2	81
Osteoporosis	92

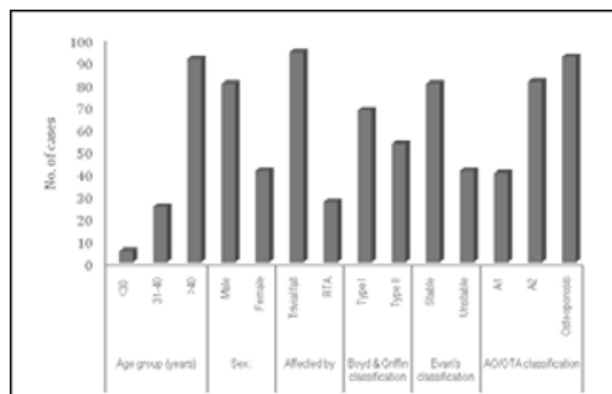


Figure 2

Table 2

Table 2			Implant failure		p-value
Osteoporosis	No.	%	No.	%	
• Yes	92	76.03	13	81.25	0.643
• No	29	23.97	3	18.75	
Fracture pattern					
• Stable	80	66.12	0	0.00	0.036
• Unstable	41	33.88	16	100.00	
Fracture reduction					
• Good	116	95.87	11	68.75	0.022
• Poor	5	4.13	5	31.25	
LFW thickness					
• A1	40	33.06	0	0.00	0.001
• A2	81	66.94	10	62.50	
Screw position					
• Centre-Centre	82	67.77	0	0.00	0.021
• Centre-Inferior	23	19.01	0	0.00	
• Other	16	13.22	16	100.00	
TAD					
• <25	115	95.04	0	0.00	0.011
• >25	6	4.96	6	37.50	

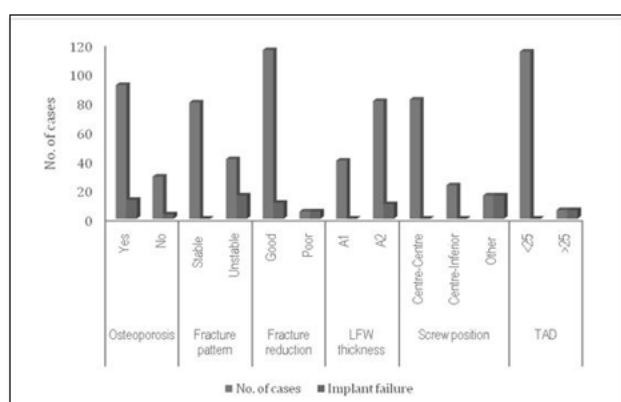


Figure 3

The mean age was 65.27 ± 3.21 years (range 24-85) with male predominance: 80 hips (66.11%). 94 hips (77.68%) were affected by trivial fall followed by RTA-27 hips (22.31%). Based on classification, Boyd & Griffin type I: 68 (56.19%), type II: 53 (43.80%), Evan's stable: 80 (66.11%) and unstable: 41 (33.88%) and A1 40 (33%) and A2 81 (67%). The bone quality assessed using Singh's Index, revealed 92 hips (76.03%) in the osteoporotic category (Table. 1 & Figure. 2).

Following the DHS fixation, all the hips were assessed for screw placement position, which revealed the centre-centre position to be most common: 82 hips (67.77%) followed by centre-inferior position: 23 hips (19.01%) and other positions 16 (13.22%). The mean LFWT of 40 A1 (33.05%) fractures was 26mm as compared to the mean of 22.18 mm in 81 A2 (66.95%) fractures. Post-operatively, lateral femoral wall fracture was found to be in 10 hips (62.5%) (Range 20.80-24.12, mean 21.77). TAD was found to be in the range of 17.5- 32mm (mean: 21.5mm). 6 hips (4.95%) showed cut out in which TAD was found to be greater than 25mm (Table. 2 & Figure.3).

Assessment of post-operative

reduction on radiograph revealed 116 hips (95.86%) in good and 5(4.13%) in poor category. Follow-up based on radiological outcome, 105 hips showed fracture union by 6 weeks to 3 months (mean: 68.5 days) whereas functional outcome using HHS revealed 84 hips as excellent, 18 as good, 3 as fair and 16 as poor outcome. These 16 hips were the one, which went into implant failure and therefore were evaluated further with respect to bone quality, fracture pattern, fracture reduction, LFWT, screw position and TAD.

Upon evaluation of implant failure with respect to bone quality, 13 had osteoporosis but the relationship was not statistically significant ($p > 0.05$). The relationship of implant failure and fracture pattern was statistically significant ($P < 0.05$), 16 out of 16 hips had unstable fracture pattern. Furthermore, 5 out of 16 hips had poor fracture reduction ($p < 0.05$). LFWT was inadequate in 10 out of 16 hips ($p < 0.05$). All implant failure occurred in positions other than centre-centre and centre-inferior ($p < 0.05$) (Table. 2 and figure. 3). The co-relation of TAD with implant failure was also found to be statistically significant ($p < 0.05$).

7 Discussion

The use of DHS is supported by its biomechanical properties, which helps in fracture healing. DHS is still the most widely preferred implant of choice for proximal femur fractures⁽¹²⁾. Numerous studies have reported excellent results with DHS for ITF^(13,14). Control collapse at the fracture site and shorter operating time are advantages of DHS. However, failures in form of hip pain and shortening of the affected limb occur due to cut-out of lag screw from the femoral head leading to varus collapse of the neck-shaft angle and loss of reduction. Common causes for fixation failure are osteoporosis, fracture instability⁽⁵⁾, inadequate LFWT⁽¹⁵⁾, lack of anatomic reduction, unacceptable lag screw position⁽⁴⁾ and unacceptable TAD⁽⁸⁾. These causes all together have never been studied to such an extent in any other study previously to our knowledge. In this study, we have evaluated and studied in detail all the factors leading to failure of DHS fixation of ITF. The failure rate in our study was found to be 13.22%.

Bone quality based on Singh's index for osteoporosis has a greater inter-observer variation and less diagnostic accuracy than dual energy X-ray absorptiometry and it seems to be valuable in diagnosing extreme osteoporosis⁽⁵⁾. Thus, in our study, the relationship between bone quality and implant failure was not found to be statistically significant ($p > 0.05$) even though implant failure was present in hips with poor bone quality constituting 14.13%. We applied Boyd and Griffin along with Evan's classification to classify ITF as stable and unstable based on preoperative radiograph and evaluated the relationship between fracture pattern and implant failure. Unstable fracture pattern was highly associated with rate of implant failure⁽³⁾ and the relationship between them was

found to be statistically significant ($p < 0.05\%$). However, these two factors are not in surgeon's hand⁽⁴⁾ but are equally important for evaluation of the results. Furthermore, out of factors that are present in surgeon's hand, good fracture reduction appears to be of paramount importance as it restores maximal bony contact at the fracture ends. In our study, the relationship between fracture reduction and implant failure was found to be statistically significant ($p < 0.05$). Anatomical reduction of the posteromedial and greater trochanteric fragments could re-establish bone-to-bone contact in treatment with DHS. Thus, for a DHS to work efficiently without excessive collapse the contact area between the ends has to be maximum and to attain that, the well-known regions are posterior medial calcar, the lateral wall and the anteromedial region. Thus, excessive fracture collapse in varus position following loss of bony support is due to severe fracture angulation, medialisation of proximal fragment and lateral wall fracture^(1,11). Anatomical reduction at the time of surgery is achieved by buttressing the lateral wall¹⁴. A significant reduction in excessive collapse and subsequent limb length discrepancy had been reported by Babst *et al.*⁽¹⁶⁾ by buttressing LFW using trochanteric stabilizing plate along with DHS. Also, in our study this relationship was found to be statistically significant ($p < 0.05$). A number of studies have already pointed out the importance of implant position on outcomes. Good implant positioning is best determined by centre-centre and centre-inferior position of the lag screw in the femoral head in the AP and lateral radiograph^{4,15}. A study conducted by Celik *et al.* in 2016⁽¹⁷⁾, reported strongest trabecular bone pattern in central and inferior region of femoral head whereby screw cut-out rate are less. The concept of TAD describes the position of lag screw within the femoral head and was shown to be highly predictive of fixation failure by screw cut out⁽¹⁸⁾. In our study, the cases of failure showed TAD more than 25mm, which was statistically significant ($p < 0.05$). However, not all incorrectly placed lag screws will cut out which indicates above-mentioned factors also need to be considered in DHS fixation of ITF. Likewise, among 16 hips, which failed 6 had TAD more than 25mm and in these the screw placement was also found to be peripheral. Also, the assessment based on functional and radiological outcome revealed 68.85% and 86.88% respectively. Both functional and radiological outcome are inter-related and functional outcome depends on radiological outcome.

8 Conclusion

DHS is a good and stable internal fixation device for ITF. To decrease the risk of implant failure, it is important to achieve good fracture reduction, placement of lag screw in the centre-centre or centre-inferior position with TAD < 25 mm along with minimum thickness of 21.77 mm of LFW.

There are limitations of our study. First, the lateral femoral wall fractures were evaluated based on radiographs, so lin-

ear/hair line fractures could have been missed. Second, the sample size is relatively small. Third, Singh's index used for osteoporosis has a high individual variation. Thus, further study with a more sample size and use of DEXA scan for osteoporosis is needed for more concrete conclusion.

Conflict of Interest: None declared.

No source of funding was received or will be received from any commercial party related directly or indirectly to the subject of this article.

List of Abbreviations

1. ITF Inter-trochanteric fractures
2. RTA Road Accidents
3. DHS Dynamic Hip Screw
4. AP Antero-posterior
5. HHS Harris Hip Score
6. LFW Lateral femoral wall
7. LFWI Lateral femoral wall
8. LFWT Lateral femoral wall thickness

Declaration

"VARIOUS FACTORS INFLUENCING THE OUTCOME IN DHS FIXATION OF INTERTROCHANTERIC FRACTURES" is based on my own work carried out during the course of my study under the supervision of Professor Chandrasekaran A.

I assert the statements made and conclusions drawn are an outcome of my research work. I further certify that:

The work contained in the report is original and was done with prior approval from the ethics committee (Institutional Review Board) of Sri Ramachandra University, Chennai. Informed and written consent form to participate in the research was obtained from each patient or their next kin and was submitted to the ethics committee for approval.

Participants involved were informed and written consent was obtained for publication.

Please contact the author for data requests.

The author declares "No competing interests".

This work has not been funded by any other third party but wholly and solely an individual work.

This project is a part of my dissertation during my post-graduation degree at Sri Ramachandra University as the first relation to pre-operative fracture stability and osteoporosis.

This research was supported by my colleagues, my wife and family who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations of this paper.

Not Applicable

References

- 1) Puram C, Pradhan C, Patil A, Sodhai V, Sancheti P, Shyam A. Outcomes of dynamic hip screw augmented with trochanteric wiring for treatment of unstable type A2 intertrochanteric femur fractures. *Injury*. 2017;48(2):S72–S77. Available from: [https://dx.doi.org/10.1016/s0020-1383\(17\)30498-9](https://dx.doi.org/10.1016/s0020-1383(17)30498-9).
- 2) O'Neill F, Condon F, Mcglough-Lin T, Lenehan B, Coffey JC, Walsh M. Dynamic hip screw versus DHS blade. A BIOMECHANICAL COMPARISON OF THE FIXATION ACHIEVED BY EACH IMPLANT IN BONE. *J Bone Joint Surg (Br)*. 2011;93(5):616–637.
- 3) Tony S, Yau H, Ng CT, Lim S, Liang. Clinical outcome following treatment of stable and unstable intertrochanteric fractures with Dynamic Hip Screw. *Ann Acad Med*. 2011;40:482–487.
- 4) Hsueh KK, Fang CK, Chen CM, Su YP, Wu HF, Chiu FY. 2010.
- 5) Kim WY, Han CH, Park JJ, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. *International Orthopaedics (SICOT)*. 2001;25:360–362.
- 6) Hsu CE, Shihcm, Wang CC, Huang KC. Lateral femoral wall thickness. A reliable predictor of post-operative lateral wall fracture in intertrochanteric fractures. *Bone Joint J*. 2013;95(8):1134–1142.
- 7) Gundler R, Gargan MF, Simpson AHRW. How to minimize failures of fixation of unstable intertrochanteric fractures. *Injury*. 1995;26(9):611–614. Available from: [https://dx.doi.org/10.1016/0020-1383\(95\)00125-s](https://dx.doi.org/10.1016/0020-1383(95)00125-s). doi:10.1016/0020-1383(95)00125-s.
- 8) Baumgaertner MR, Curtin SL, Lindsog DM, Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. *The Journal of Bone & Joint Surgery*. 1995;77(7):1058–1064. Available from: <https://dx.doi.org/10.2106/00004623-199507000-00012>. doi:10.2106/00004623-199507000-00012.
- 9) Ecker ML, Joyce JJ, Kohl EJ. The treatment of trochanteric hip fractures using a compression screw. *The Journal of Bone & Joint Surgery*. 1975;57(1):23–27. Available from: <https://dx.doi.org/10.2106/00004623-197557010-00004>. doi:10.2106/00004623-197557010-00004.
- 10) Koval KJ, Friend KD, Aharonoff GB, Zuckerman JD. Weight Bearing After Hip Fracture: A Prospective Series of 596 Geriatric Hip Fracture Patients. *Journal of Orthopaedic Trauma*. 1996;10(8):526–530. Available from: <https://dx.doi.org/10.1097/00005131-199611000-00003>. doi:10.1097/00005131-199611000-00003.
- 11) Fang C, Gudushauri P, Wong TM, Lau TW, Pun T, Leung F. Increased Fracture Collapse after Intertrochanteric Fractures Treated by the Dynamic Hip Screw Adversely Affects Walking Ability but Not Survival. *BioMed Research International*. 2016;2016:1–8. Available from: <https://dx.doi.org/10.1155/2016/4175092>. doi:10.1155/2016/4175092.
- 12) El M. Fixation of subtrochanteric fractures. *Strat Traum Limb Recon*. 2009;4:65–71.
- 13) Kyle RF, Gustilo RB, Premer RF. Analysis of six hundred and twenty-two intertrochanteric hip fractures. *The Journal of Bone & Joint Surgery*. 1979;61(2):216–221. Available from: <https://dx.doi.org/10.2106/00004623-197961020-00009>. doi:10.2106/00004623-197961020-00009.
- 14) Laros GS, Moore RF. Complications of fixation in intertrochanteric fractures. *Clin Orthop Relat Res*. 1974;(101):110–119.
- 15) Gupta RK, Sangwan K, Kamboj P, Punia SS, Walecha P.
- 16) Babst R, Renner N, Biedermann M, Rosso R, Heberer M, Harder F, et al. Clinical Results Using the Trochanter Stabilizing Plate (TSP): The Modular Extension of the Dynamic Hip Screw (DHS) for Internal Fixation of Selected Unstable Intertrochanteric Fractures. *Journal of Orthopaedic Trauma*. 1998;12(6):392–399. Available from: <https://dx.doi.org/10.1097/00005131-199808000-00005>. doi:10.1097/00005131-199808000-00005.
- 17) Celik T, Mutlu I, Ozkan A, Kisioglu Y. Comparison of the Lag Screw Placements for the Treatment of Stable and Unstable Intertrochanteric Femoral Fractures regarding Trabecular Bone Failure. *Journal of Medical Engineering*. 2016;2016:1–8. Available from: <https://dx.doi.org/10.1155/2016/5470798>. doi:10.1155/2016/5470798.
- 18) Guven M, Yavuz, Kadioglu, Akman, Kilincoglu, Unay, et al. Importance of screw position in intertrochanteric femoral fractures treated by dynamic hip screw. *Orthopaedics & Traumatology: Surgery & Research*. 2010;p. 96–117.