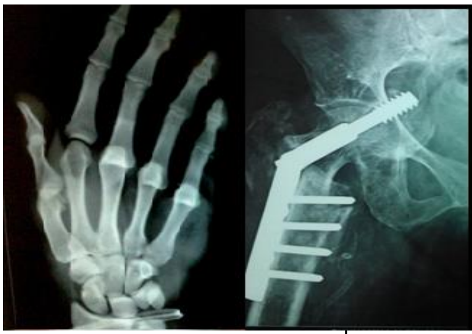

International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 273-277

https://www.orthopaper.com
Received: 27-05-2023
Accepted: 26-06-2023

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# Unstable trochanteric fractures: The role of lateral wall reconstruction using a trochanteric buttress plate with proximal femoral nailing

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**DOI:** https://doi.org/10.22271/ortho.2023.v9.i3d.3436

**Abstract**

**Background:** Intertrochanteric fractures with lateral wall involvement pose a challenge in terms of fracture stability and treatment outcomes. The use of a trochanteric buttress plate (TBP) in conjunction with a proximal femoral nail (PFN) has been proposed to address this issue. This study aims to evaluate the functional outcomes of using a TBP with PFN for unstable intertrochanteric fractures with broken lateral walls.

**Methods:** A prospective study was conducted in 30 patients with unstable intertrochanteric fractures and lateral wall fractures. The patients underwent surgery using PFN augmented with TBP. Surgical details, including duration, blood loss, and radiation exposure, were recorded. Fracture union and functional outcomes were assessed using radiological evaluation and the Harris hip score, respectively. Complications were also monitored.

**Results:** The mean age of the patients was 56±7.8 years, with 14 female and 16 male patients. Road traffic accidents were the most common cause of injury (14 cases). The mean duration of surgery was 95.5±12.8 minutes, with an intra-operative blood loss of 229±3.6 ml. Fracture union was achieved in all cases, with an average duration of 13.4 weeks. The mean Harris hip score was 94.1±7.5, indicating excellent to good outcomes in the majority of patients. Complications were minimal, with only one case of impingement observed.

**Conclusion:** The combination of TBP with PFN for the treatment of unstable intertrochanteric fractures with broken lateral walls showed favorable outcomes. The technique provided improved fracture stability, enhanced reduction, and facilitated early healing and weight bearing. The low incidence of complications highlights the effectiveness of this combined approach. Further studies with larger sample sizes and longer follow-up periods are needed to validate these findings and compare the technique with other treatment methods.

**Keywords:** Unstable intertrochanteric fracture, proximal femoral nail, trochanteric buttress plate, harris hip score

## Introduction

Intertrochanteric fractures are common fractures of elderly population with trivial trauma. It is an extracapsular fracture of proximal femur at the level of greater and lesser trochanter. It is classified into stable and unstable based on the degree of comminution. Unstable intertrochanteric fractures have severe comminution with loss of posteromedial support with breach in the lateral wall cortex. Intramedullary nailing is a common procedure used to stabilize unstable trochanteric fractures in adults. The nail provides support to the posteromedial wall of the femur and helps to prevent excessive fracture collapse. This makes the proximal femoral nail (PFN) a biomechanically superior implant for the fixation of unstable trochanteric fractures. The presence of an intact lateral wall is crucial for stabilizing trochanteric fractures when using a proximal femoral nail. A lack of lateral wall support results in fracture collapse and varus mispositionin [1, 2]. Despite having a range of modern implants, the treatment failure continues to ranges from 2% to 20% which includes lag screw migration, screw cutouts and implant breakage.

Recent studies have also shown that the integrity of the lateral wall in intertrochanteric fractures is an important predictor for failure and reoperation. In our study we hypothesize that anatomical fixation of lateral wall fractures with a lateral buttress plate added to the conventional proximal femoral nail (PFN) is essential to prevent complications. Our aim is to study the functional outcome of trochanteric buttress plate with Proximal Femoral Nail (PFN) in unstable intertrochanteric fracture.

Intramedullary nailing alone may not provide satisfactory reduction and buttress to the broken lateral wall in unstable IT fractures. Studies have shown that while intramedullary nails, such as the proximal femoral nail (PFN), can adequately support the medial wall, they are insufficient to provide adequate support to the lateral wall [3-7]. The failure and breakage of implants often occur at the greater trochanter or the lateral wall in these cases. Therefore, it is crucial to consider lateral wall reconstruction to address the instability caused by a broken lateral wall in IT fractures. One approach to address the challenge posed by broken lateral walls in IT fractures is the use of a trochanteric buttress plate (TBP) in addition to the PFN. The TBP provides additional support and stabilization to the lateral wall, enhancing the overall stability of the fracture construct. By combining the PFN with the TBP, the broken lateral wall can be anatomically fixed, reducing the risk of implant failure and improving clinical outcomes.

In our study we hypothesize that anatomical fixation of lateral wall fractures with a lateral buttress plate added to the conventional proximal femoral nail (PFN) is essential to prevent complications. Our aim is to study the functional and radiological outcome of trochanteric buttress plate with Proximal Femoral Nail (PFN) in unstable intertrochanteric fracture

## Methods and Materials

This prospective study was conducted in 30 patients with unstable IT factures with involvement of lateral wall treated by PFN augmented with Trochanteric Buttress Plate (TBP). Ethical approval from institutional review committee and well-informed written consent from all patients were obtained before the initiation of the study. Patients with Jenson's modification of Evans type III and IV IT fractures (broken lateral wall), aged more than 18 years, operated within one week and the satisfactory reduction achieved by closed methods without opening the fracture were included in the study. Patients with pathologic or open fractures, poly trauma, prior hip surgery, non-ambulatory prior to surgery and refusing to participate were excluded from the study. All patients were operated under similar conditions of spinal anaesthesia, in supine position on fracture table, and under c-arm. In all cases, primarily closed reduction was achieved with traction, rotation along with mild abduction/adduction, which was confirmed fluoroscopically in both anteroposterior and lateral views. To prevent the re-displacement, fracture reduction was held temporarily using K-wire passed anteriorly so that it did not hamper the passage of nails. Standard steps of intramedullary nailing were followed. A 3 cm incision proximal to the tip of greater trochanter was made, and an entry point for the nail was made with an awl just medial to the tip of greater trochanter. Under C-arm control, a flexible guide wire was passed from the entry point into the shaft of the femur without displacing the reduction of the fracture. After this, sequential reaming of the shaft of the femur was done by cannulated flexible reamers over this guide wire, up to the distal femur. This use of gradually increasing reamer sizes allowed fitting largest possible diameter nail in the canal. Nail of appropriate size and diameter mounted over the zig was inserted into the femoral canal over the guide wire, so that the proximal holes in PFN were aligned in the direction of the neck properly just above the calcar. With the help of aiming device attached to the zig, both the guide pins (8mm hip screw and 6.4mm anti-rotation screw) were passed through the guide wires. They were found to remain in lower part of the head of the femur in anteroposterior view and centrally in the neck and head of the femur in the lateral view, when checked under C-arm after confirming the position of both guide pins fluoroscopically, the detachable arm from the zig was removed, and the guide pins were kept in position. Now TBP was slid over the guide pins reaching to the bone, after enlarging the incision and gentle subperiosteal dissection up to trochanteric flare. After drilling, proper sized 8 mm hip screw and 6.4mm anti-rotation screw were passed over the guide pins, passing through the plate and Nail to the neck and head of the femur, of which the tip-apex distance was less than 20mm. Either proximal or distal cortical screws, or both were passed through the plate into the large bony piece of greater trochanter and femur along the sides of nail to fix the lateral wall or else. No further cortical screws were passed, just fixing the plate with the help of hip screw and anti-Rotation screw only, and buttressing the broken lateral wall. In case of coronal split of lateral wall, at least 2 proximal screws were passed through the plate after fixing the fragments in a reduced manner by an antero-posterior pointed reduction forceps. Finally, the hip screw and anti-rotation screw were tightened to achieve the desired buttressing effect. Distal interlocking screws were done by free hand under C-arm control.

Postoperatively, static hip, knee and ankle exercises were started on the first day, and patients were allowed to sit and move in bed. Suture removal was done at 2 weeks, and then toe touch and partial weight wearing were started. Full weight bearing was started as per patient's pain tolerance. Patients were followed up regularly both clinically and radiologically. Intraoperative details like operative time, blood loss and radiation exposure were recorded.

Postoperatively patients were asked to come for a review at 1, 3, 6 months and 12 months. The patients were evaluated radiologically to assess the Status of fracture union and functional assessment was done using the Harris hip score. All the follow up data and both the scoring were documented in the patient case and records. The data collected was analysed using IBM SPSS Version 22.0. A P value of less than 0.05 was considered to be statistically significant.

## Results

A total of thirty cases of intertrochanteric (IT) fractures with lateral wall fracture were included in the study. The mean age of the patients was 56±7.8 years, ranging from 38 to 71 years. There were 14 female and 16 male patients, with 16 cases affecting the right side and 14 cases affecting the left side (Table 1). The fractures were classified according to the Boyd and Griffin classification, with 11 cases classified as type 2, 12 cases as type 3, and 7 cases as type 4. The most common causes of injury were road traffic accidents (14 cases), followed by slip and fall accidents (9 cases) and falls from height (7 cases) (Figure 1).

In terms of the surgical approach, 15 cases were treated with a long proximal femoral nail (PFN), while the remaining 15 cases were treated with a short PFN. The mean duration of surgery was 95.5±12.8 minutes, ranging from 88 to 115 minutes. The intra-operative blood loss averaged 229±3.6 mL, ranging from 160 to 310 ml. The number of exposures during surgery averaged 56.6, ranging from 38 to 112.

The reduction quality of the fractures was assessed using the Chang quality reduction criterion. A score of 4 was achieved in 28 patients, indicating excellent reduction, while a score of 3 was achieved in the remaining 2 patients, indicating good reduction. Fracture union was achieved in all cases, with an average duration of 13.4 weeks ranging from 10 to 16 weeks.

The functional outcomes were assessed using the Harris hip score, which measures hip function and pain. The mean Harris hip score in the series was 94.1±7.5, ranging from 74 to 98. Excellent to good results were observed in more than 29 out of the 30 patients, accounting for 83.3% and 13.3% of the cases, respectively. None of the patients had poor results. All patients were able to resume normal gait and walk without any support (Table 2).

Complications associated with the surgical procedure were minimal. Only one patient experienced impingement, which was attributed to their extremely lean body habitus. There were no reported cases of wound infection, implant failure, Z effect (a phenomenon where the screw penetrates the femoral head), shortening of the limb, non-union, or avascular necrosis of the femoral head (Table 3).

Overall, the results of this study indicate favourable outcomes following the treatment of IT fractures with lateral wall fractures using the trochanteric buttress plate (TBP) in conjunction with the PFN. The surgical procedure demonstrated successful reduction of the fractures, achieved fracture union, and led to excellent to good functional outcomes. The low incidence of complications further emphasizes the effectiveness of this combined approach in managing IT fractures with broken lateral walls.

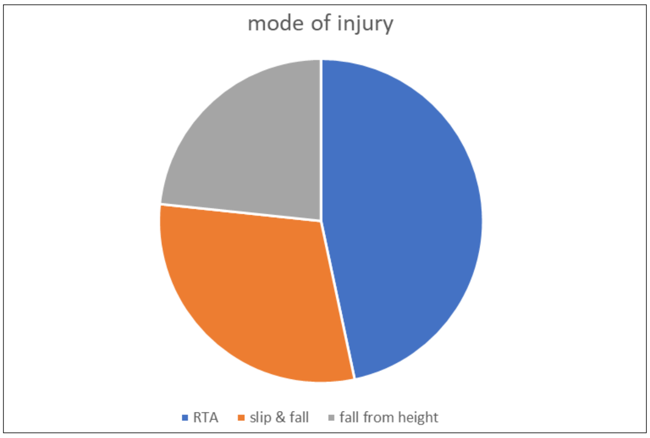


**Fig 1:** Patient's mode of injury

**Table 1:** Distribution of gender among the participants

| Gender | Participants |
|---|---|
| Male | 16 |
| Female | 14 |

**Table 2:** Results of our study

| Results |
|---|
| Patients treated with long PFN - 15 |
| Patients treated with short PFN - 15 |
| Mean duration of surgeries -95.5 ± 12.8 minutes |
| Mean intra-operative blood loss -229 ± 3.6 mL |
| Mean number of exposures - *56.6* |
| Mean harris hip score<br>• At 1-month post-op- 71.97<br>• At 3 months post-op -80.6 |

**Table 3:** Patient demographics and data

| S. No | Age | Sex | Side | Mode of injury | Fracture classification (Boyd & Griffin) | Surgical time (mins) | Type of nail | Blood loss (ml) | Fracture union (Weeks) | Harris hip score (1 mon) | Harris hip score (3 mon) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 66 | M | R | SAF | Type 3 | 88 | Long PFN | 280 | 14 | 70 | 79 |
| 2 | 54 | M | R | RTA | Type 4 | 92 | Long PFN | 180 | 12 | 72 | 84 |
| 3 | 28 | M | L | FFH | Type 2 | 110 | Short PFN | 160 | 10 | 78 | 86 |
| 4 | 39 | F | R | RTA | Type 2 | 114 | Short PFN | 190 | 11 | 77 | 82 |
| 5 | 47 | M | L | FFH | Type 4 | 98 | Long PFN | 210 | 13 | 70 | 83 |
| 6 | 61 | F | L | SAF | Type 3 | 100 | Short PFN | 240 | 14 | 69 | 78 |
| 7 | 48 | F | R | RTA | Type 3 | 86 | Long PFN | 260 | 12 | 71 | 80 |
| 8 | 40 | M | L | FFH | Type 4 | 104 | Long PFN | 250 | 12 | 72 | 82 |
| 9 | 54 | M | R | SAF | Title 4 | 84 | Long PFN | 310 | 14 | 70 | 78 |
| 10 | 59 | F | R | RTA | Type 3 | 96 | Short PFN | 210 | 15 | 72 | 79 |
| 11 | 63 | F | L | SAF | Type 3 | 90 | Long PFN | 180 | 14 | 68 | 76 |
| 12 | 71 | F | R | SAF | Type 2 | 88 | Short PFN | 225 | 16 | 71 | 78 |
| 13 | 53 | M | R | RTA | Type 3 | 102 | Long PFN | 260 | 12 | 74 | 80 |
| 14 | 67 | M | L | SAF | Type 2 | 84 | Short PFN | 195 | 14 | 71 | 82 |
| 15 | 49 | F | R | RTA | Type 3 | 96 | Long PFN | 230 | 12 | 74 | 80 |
| 16 | 73 | M | R | SAF | Type 2 | 106 | Short PFN | 280 | 15 | 72 | 78 |
| 17 | 66 | F | L | SAF | Type 2 | 98 | Short PFN | 210 | 12 | 70 | 80 |
| 18 | 54 | F | L | FFH | Type 2 | 110 | Short PFN | 190 | 14 | 74 | 84 |
| 19 | 48 | M | R | RTA | Type 3 | 89 | Long PFN | 240 | 14 | 76 | 80 |
| 20 | 74 | F | L | SAF | Type 3 | 115 | Short PFN | 220 | 16 | 70 | 79 |
| 21 | 51 | F | R | RTA | Type 2 | 90 | Short PFN | 260 | 13 | 74 | 78 |
| 22 | 34 | M | L | RTA | Type 3 | 86 | Long PFN | 230 | 12 | 73 | 84 |
| 23 | 50 | F | R | FFH | Type 4 | 84 | Long PFN | 280 | 14 | 68 | 92 |
| 24 | 67 | M | L | SAF | Title 4 | 93 | Long PFN | 190 | 16 | 66 | 78 |
| 25 | 59 | F | R | FFH | Type 3 | 88 | Short PFN | 230 | 12 | 71 | 77 |
| 26 | 58 | M | L | RTA | Title 2 | 84 | Short PFN | 280 | 14 | 76 | 80 |
| 27 | 70 | F | R | SAF | Type 2 | 96 | Short PFN | 260 | 16 | 72 | 82 |
| 28 | 40 | M | L | FFH | Type 4 | 89 | Long PFN | 200 | 12 | 70 | 84 |
| 29 | 66 | M | R | SAF | Type 3 | 101 | Long PFN | 190 | 14 | 72 | 78 |
| 30 | 69 | M | L | SAF | Title 2 | 94 | Short PFN | 230 | 15 | 76 | 80 |

**Discussion**

The key to successful treatment of IT fractures lies in comprehending the fracture type – distinguishing between stable and unstable fractures, selecting the appropriate implant, adequate reduction and ensuring correct placement of the implant. These critical steps are necessary for securing stable, thereby facilitating early weight-bearing and minimizing potential complications. Stable inter trochanteric fractures refer to two-part fractures where the posterior-medial buttress remains intact, offering resistance to displacement following adequate reduction. Such fractures can be effectively managed using either sliding hip screw (SHS) or intramedullary nails. On the other hand, unstable IT fractures exhibit comminution in the posteromedial region, along with reverse oblique and sub trochanteric extension. Opting for SHS treatment in unstable cases may lead to substantial medial displacement, excessive sliding, shortening, and a higher occurrence of screw cut-out. Hence, the biomechanically superior option of intramedullary nailing becomes necessary for addressing unstable fractures. It provides enhanced support to the posteromedial wall and effectively resists excessive collapse. Recent studies have brought attention to the previously overlooked prognostic factor in the management of intertrochanteric (IT) fractures: The status of the lateral trochanteric wall. The intact lateral trochanteric wall has emerged as a critical element in improving the stability of IT fractures by providing a lateral buttress for the proximal fractured fragment. Loss of this lateral support, whether occurring before or during surgery, can have detrimental effects such as excessive collapse, varus mal-reduction, medialization of the shaft, shortening, instability, increased reoperation rates, and the transformation of stable IT fractures into the reverse oblique variant. To optimize outcomes, minimize complications, enhance stability, and preserve fracture reduction, it is of utmost importance to reconstruct the lateral wall of IT fractures, regardless of the chosen fixation method-whether it is intramedullary nailing or extramedullary sliding hip screw. Recognizing and addressing the significance of the lateral trochanteric wall is crucial in achieving successful management of IT fractures. Reconstruction of the fractured lateral wall has been explored using various methods, including both extramedullary and intramedullary devices. However, extramedullary implants like sliding hip screws (SHS) with trochanteric stabilization plates, condylar blade plates, dynamic condylar plates, and proximal femoral locking compression plates alone are not sufficient for fixing or providing support to the entire broken wall, particularly due to its limited superior extension. Moreover, these extramedullary implants are not suitable for all types of IT fractures, especially unstable fractures, as their application requires larger incisions, extensive dissection, and results in increased blood loss. Studies by Haq *et al*. And Han *et al*. [8, 9] have demonstrated that reverse femoral locking compression plates and proximal femoral locking compression plates are inadequate in treating IT fractures with compromised lateral walls compared to using proximal femoral nails alone. Intramedullary nails alone can adequately support the posteromedial wall but fail to restore the integrity of the fractured lateral wall. To address this, cerclage wires or screws are often used in conjunction with both intramedullary and extramedullary devices to reconstruct the lateral wall. However, the use of cerclage wire carries risks such as increased exposure, additional dissection, infection, difficulties in hardware application, the need for specific instruments, potential damage to blood vessels, and delayed healing at the fracture site. Placing additional screws with the intramedullary nail for lateral wall reconstruction requires precision, a learning curve, and expertise to ensure they do not interfere with the existing nail. Additionally, both cerclage wires and screws are relatively weak structures, especially in cases of osteoporosis or comminuted fractures, which pose a high risk of mal-reduction, breakage, loosening, impingement, and back out.

In our study, we utilized trochanteric buttress plate (TBP) in combination with proximal femoral nail (PFN) to address unstable intertrochanteric (IT) fractures with a broken lateral wall. The PFN was fixed to the proximal femur using a hip screw and an anti-rotation screw, which passed through the plate first, then through the nail, and finally into the neck and head of the femur. We assessed the outcomes of 30 patients with unstable IT fractures and broken lateral walls who underwent PFN with TBP. The TBP used in our study featured an anatomically contoured plate with two oblique holes, angled at 130° or 135°, for passing a 6.4 mm anti-rotation screw and an 8 mm hip screw of the intramedullary nail. Additional holes were present proximally for fixation in the greater trochanter and distally for fixation in the shaft of the femur. By compressing the hip and anti-rotation screws, the plate was able to align flush with the lateral surface without obstructing controlled collapse, effectively creating a single assembled structure that reinforced the fixation of the bone with PFN and TBP. This technique did not require extensive exposure or dissection as the plate was passed over the guide pins of the hip screw and anti-rotation screw. The longer plate with multiple optional holes provided effective buttressing of the entire lateral wall, even in cases of coronal split and comminuted fractures. The overall assembly offered rigid fixation and a buttress effect on the lateral wall, resulting in improved bone contact between the proximal and lateral walls, enhanced reduction, and facilitated early healing and weight bearing, while maintaining appropriate lever arm and abduction function.

Our study demonstrated excellent (83.3%) to good (13.3%) outcomes in 29 out of 30 patients, with a mean Harris hip score of 83.3 after an average follow-up of 6 months. Since the lateral wall served as the buttress, the union time was shortened, averaging 14.6 weeks, and no complications such as screw back out, Z effect, or shortening were observed. Plate lateral impingement was the only complication encountered in one patient who was thin but well-tolerated. Although the use of additional plates increased surgical time, blood loss, procedure duration, and radiation exposure in our study, it provided valuable experience and expertise. With more practice, the surgical time can be minimized to an acceptable level. The procedure necessitates careful removal of the lateral part of the zig without exerting pressure on the reduction and guidewire, ensuring accurate application of TBP to the proximal femur. Key surgical steps for a successful outcome include achieving fracture reduction prior to nail insertion, meticulous removal of the detachable part of the zig, precise use of an incisional mobile window to align the plate flush with the bone, and employing appropriately sized hip and anti-rotational screws to achieve the desired buttressing effect on the broken lateral wall. The inclusion of a trochanteric buttress plate in the surgical technique and nailing instrument set for proximal femoral nailing can be beneficial in managing iatrogenic broken lateral trochanteric walls during surgery. In a study by Ganjale *et al.* 32 patients fracture union was achieved at an average of 12.6 weeks. Mean duration of surgery was 75 min in all the patients. Mean intraoperative blood loss was 180 mL, [10]. The excellent to good results are seen in 93.75% in their series.In a study by saurabh Jain *et al*. Of 30 patients, the mean duration of surgery (min), mean intra-operative blood loss (mL) and mean number of exposures were 91.86±12.8, 144.8±3.6, and 56.6, respectively. The mean union time was 11.6 weeks and the mean Harris hip score was 94.1 [11]. Gupta *et al*. study compared 2 groups with PFN and PFN with TBP where they reported excellent to good results in PFN with TBP group which was significantly better with p value of 0.011 [12]. Our study produces similar results comparable with the aforementioned studies. Our study highlights the benefits of the distinctive plate-nail combination utilized for fixing or supporting the lateral wall. Nonetheless, there are certain limitations: The sample size was small with relatively shorter follow up period and there was no comparative group included. A larger patient population with longer follow-up periods with comparative groups would be an ideal study to find the outcome of this study.

## Conclusion

Our study focused on addressing unstable intertrochanteric (IT) fractures with broken lateral walls by utilizing a trochanteric buttress plate (TBP) in combination with a proximal femoral nail (PFN). The inclusion of the TBP provided effective buttressing of the entire lateral wall, resulting in improved stability, enhanced reduction, and facilitated early healing and weight bearing. Our study demonstrated excellent to good outcomes in the majority of patients, with a high union rate and favourable Harris hip scores. The plate-nail combination technique presented in this study offers several advantages over other methods. It provides rigid fixation and a buttress effect on the lateral wall, allowing for improved bone contact between the proximal and lateral walls. The use of the TBP does not require extensive exposure or dissection, minimizing surgical trauma. The anatomically contoured plate with multiple optional holes offers versatility in addressing various fracture patterns, including comminuted and coronal split fractures. Although the use of additional plates increased surgical time, blood loss, and radiation exposure, this technique offers stability, improved fracture reduction, and facilitates early healing and weight bearing. Further investigation and long-term studies are warranted to validate our findings and determine the comparative effectiveness of this approach

## Declarations

**Funding:** None

**Conflict of Interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Ethical Approval:** Not required

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**How to Cite This Article**
Partheeswar, Navaneethakrishnan S, Subramanian RM, Athiraj ATM, Subash Y. Unstable trochanteric fractures: The role of lateral wall reconstruction using a trochanteric buttress plate with proximal femoral nailing. International Journal of Orthopaedics Sciences. 2023;9(3):273-277.