NORTHWESTERN MEDICAL JOURNAL

Northwestern Med J. 2025;5(1):1-8
DOI: 10.54307/NWMJ.2025.140

RESEARCH ARTICLE

The effect of cable fixation on union time in subtrochanteric femur fractures treated with cephalomedullary nailing

Fatih İlker Can[1], **Emre Gültaç**[2], **Rabia Mihriban Kılınç**[3], **Cem Yalın Kılınç**[4]

[1]Orthopedics and Traumatology Clinic, Muğla Training and Research Hospital, Muğla, Türkiye
[2]Department of Orthopedics and Traumatology, Faculty of Medicine, Muğla Sıtkı Koçman University, Muğla, Türkiye
[3]Department of Radiology, Faculty of Medicine, Muğla Sıtkı Koçman University, Muğla, Türkiye
[4]Caria Orthopedics and Traumatology Private Clinic, Muğla, Türkiye

Cite as: Can Fİ, Gültaç E, Kılınç RM, Kılınç CY. The effect of cable fixation on union time in subtrochanteric femur fractures treated with cephalomedullary nailing. Northwestern Med J. 2025;5(1):1-8.

ABSTRACT

Aim: This study aimed to examine the effect of cable cerclage on reduction quality and union time in patients treated with cephalomedullary nails for subtrochanteric fractures.

Materials and Methods: 75 closed subtrochanteric fractures treated with cephalomedullary nails by two different surgeons with at least 10 months of follow-up were included in the study. Patients operated by Surgeon 1 were grouped as Group 1 (closed cephalomedullary nailing without cables, n=43), patients operated by Surgeon 2 with 1-2 cables as Group 2 (n=20), and those operated with 3-4 cables were grouped as Group 3 (open cephalomedullary nailing + cable fixation, n=12). Postoperative radiographs were evaluated for the presence of cables, the number of cables used, deformity, the residual gap between the fracture ends, and the union time.

Results: The cable fixation rate was calculated as 42.6%. There was a statistically significant relationship between cable use and the amount of gap (p=0.033). The average gap was 3.97 mm in patients without cables, 0.65 mm in patients with 1-2 cables, and 0.66 mm in patients with 3-4 cables. A positive correlation was found between the amount of gap and the time to union (Spearman's rho= 0.468, p=0.001). A statistically significant difference was found between Group 1 and Group 2 and also between Group 1 and Group 3 regarding the union time (p=0.007, p=0.001, respectively). The mean time to union was determined as 7.3 months in Group 1, 5.4 months in Group 2, and 5.7 months in Group 3.

Conclusion: Reducing the gap in the fracture line by using cables provides a better reduction, stability, and a shorter union time than fixation without a cable in subtrochanteric fractures treated with cephalomedullary nailing.

Keywords: subtrochanteric fractures, cephalomedullary nailing, cable fixation, residual gap, union time

Corresponding author: Fatih İlker Can **E-mail:** dr.fatihcan07@gmail.com
Received: 17.07.2024 **Accepted:** 13.12.2024 **Published:** 31.01.2025

INTRODUCTION

Intramedullary nailing is an ideal technique for the treatment of lower extremity long bone fractures because of its feasibility and high union rates (1,2). In subtrochanteric fractures, cephalomedullary nails are frequently used for treatment (3). However, reduction and fixation difficulties are frequently encountered in subtrochanteric fractures due to abduction, flexion, and external rotation deformities caused by the psoas, abductor, and gluteal muscles attached to the proximal part of the fracture (4,5). There is a literature regarding a faster and better union of subtrochanteric fractures. While some authors advocate closed reduction to not deteriorate the fracture hematoma, others emphasize the need to provide as much anatomical alignment as possible and the benefits of cerclage cables (6-10).

Due to the improper position of the proximal part of the fracture, the lateral entry point of the cephalomedullary nail causes varus deformity (11). Angular malreduction may develop in patients with the closed reduction due to strong muscle tone affecting the proximal part and the proximal medullary canal being relatively wide compared to the distal isthmus, and this may cause gap formation between the fracture ends, loss of fixation or implant failure (4,12). For these reasons, the question of which technique - hematoma-preserving closed reduction or open reduction with cable fixation - is more advantageous for subtrochanteric nailing remains unanswered. The reduction quality is of great importance to properly distribute the axial forces to the nail and femoral cortex. The aim is to prevent the entire load from getting on the nail and to allow the femoral cortex to share the axial load (13,14). Proper alignment before placing the nail reduces the possibility of complications (15-17).

Our aim in this study is to examine the effects of factors such as the amount of residual gap at the fracture line, the use of cables, and the number of cables on the union time of subtrochanteric fractures treated with cephalomedullary nails. We believe that the improvement in surgical technique after identification of these factors will not only be very effective in preventing complications such as delayed union, nonunion, malalignment, and implant failure, but will also provide a shorter union time.

MATERIALS AND METHODS

The study was designed in accordance with the 1995 Helsinki Declaration. Approval for this study was granted by the local ethics committee. Preoperative and postoperative radiographs of 229 patients aged 18-89 years who underwent surgery for subtrochanteric fractures at our clinic between March 2010 and February 2018 by two different surgeons were retrospectively evaluated. Patients over the age of 65 (n= 40), who had plate and screw fixation (n=43), who received bisphosphonate therapy for more than 1 year (n=11), who had insufficient postoperative follow-up (n=41), who died during the follow-up period (n =19) were excluded from the study. Seventy-five patients with a mean age of 48.3 (range 19-65) who had at least 10 months of follow-up and who had been operated on with a cephalomedullary nail were included in the study (Figure 1).

Demographic data of the patients, such as age and gender, were compiled. Fracture classification was made according to Seinsheimer's classification by evaluating preoperative anteroposterior (AP) femur roentgenograms (13). By evaluating the postoperative films, it was determined whether a titanium cable was placed and if so, how many were utilized. Patients

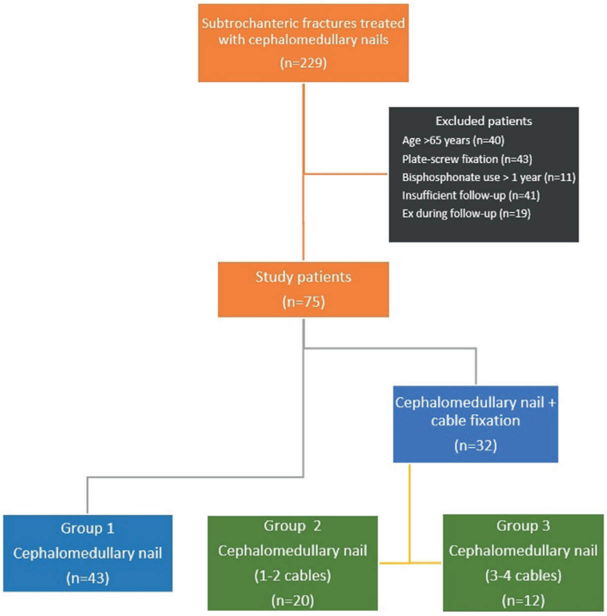

Figure 1. Flowchart of patient selection.

Figure 2. The measurement of the gap between fracture lines.

operated by Surgeon 1 were grouped as Group 1 (closed cephalomedullary nailing without cables, n=43), patients operated by Surgeon 2 with 1-2 cables as Group 2 (n=20), and those operated by Surgeon 2 with 3-4 cables were grouped as Group 3 (open cephalomedullary nailing + cable fixation, n=12). The medial or lateral gap between the fracture ends was evaluated by an experienced radiologist using the "Picture Archiving and Communication System" (PACS) and the amount of gap was measured (Figure 2). While measuring the gap between the fracture ends, the distance between the fracture ends on the medial or lateral wall with cortical discontinuity was evaluated using postoperative AP X-rays. The deformity was measured in degrees by determining the presence of varus or valgus deformity. Early postoperative x-rays and x-rays after the union were used for the measurements. The development of varus deformity was compared using early postoperative radiographs and radiographs taken after union (Figure 3 and 4). It was investigated whether there was a statistically significant difference between the groups in terms of age, gender, fracture type, union time, varus

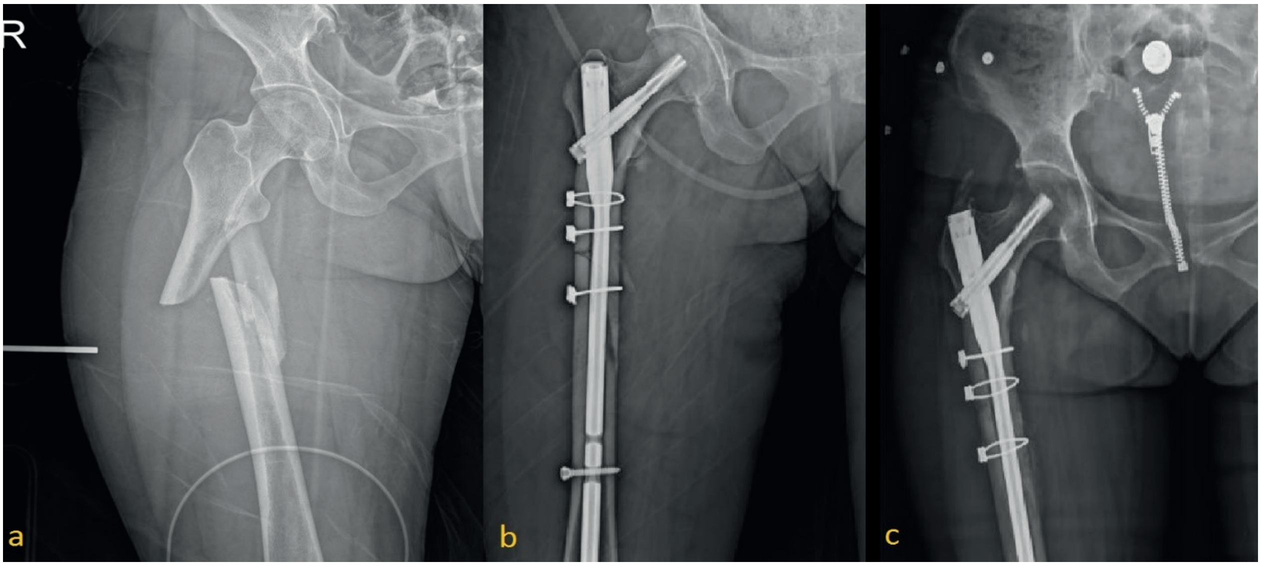

Figure 3. a) 70 years old female patient, motor vehicle accident, preoperative x-ray. **b)** Postoperative 7th month x-ray, 7mm gap laterally and 6 degrees of varus deformity. **c)** 6th month x-ray after revision surgery with cable use, complete union.

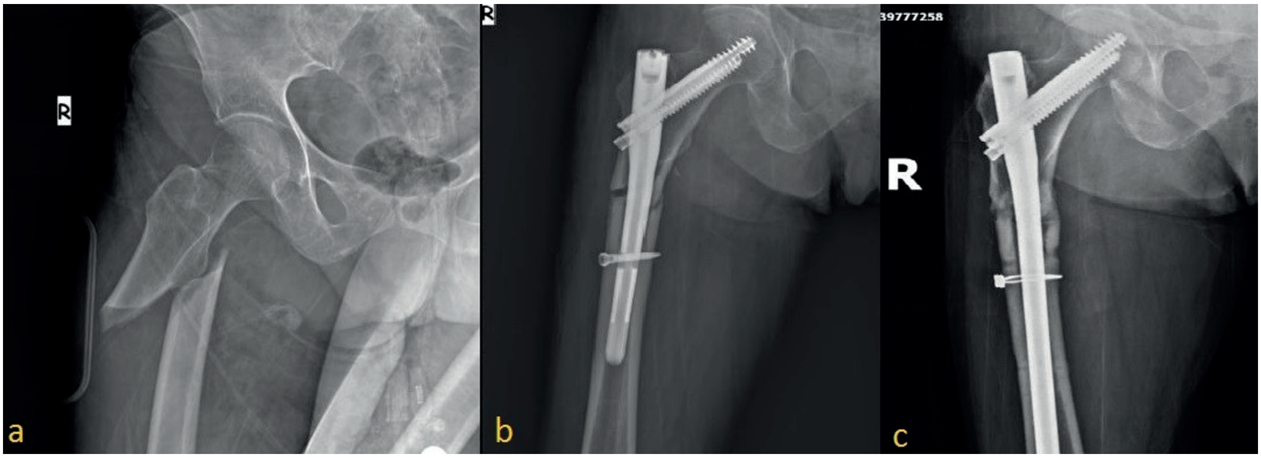

Figure 4. a) 37 years old female patient, motor vehicle accident, preoperative x-ray. **b)** Postoperative 1st month x-ray, fixation with 3 cables, 3 mm gap laterally. **c)** Postoperative 5th month, complete union.

angulation, and gap size. The need for revision surgery due to non-union was also noted.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics for Windows v.22 (IBM Corp., Armonk, NY, USA) software. Demographic data and numerical measurements were determined to be non-normally distributed according to the distribution analysis, and non-parametric tests were used. Statistical analysis between union groups was assessed using the Kruskal-Wallis test. A pairwise comparison test was used to determine which group caused the significant difference between the groups. Correlation between numerical data was analyzed with Spearman's rank correlation coefficient test. P-value <0.05 was considered statistically significant.

RESULTS

26 (34.7%) patients were female and 49 (65.3%) were male. The mean follow-up period was 12.33 months (10-17 months). There was no statistically significant difference between the groups in terms of demographic data such as age and gender (p=0.139, p=0.954, respectively).

According to the Seinsheimer's classification, the fractures were classified as Type 1 (n=6), Type 2A (n=7), Type 2B (n=4), Type 2C (n=10), Type 3A (n=9), Type 3B (n=9) Type 4 (n=15) and Type 5 (n=15). No statistically significant relationship was found between fracture types and study groups (p=0.065) (Table 1).

Cables were used in 32 of the 75 patients. There was a statistically significant relationship between cable use and the amount of residual gap (p=0.033). The average residual gap was 3.97 mm (range 0-11 mm) in patients without cables, 0.65 mm (range 0-4 mm) in patients with 1-2 cables, and 0.66 mm (range 0-3

Table 1. Distribution of fracture types according to Seinsheimer's classification

Fracture Type	Number of Cases (n)
Type 1	6
Type 2A	7
Type 2B	4
Type 2C	10
Type 3A	9
Type 3B	9
Type 4	15
Type 5	15

Table 2. The results of each group created according to cable usage

	Cable use	Patient Number	Gap Size (mm) (mean-min-max)	Mean union time (mos)	Varus deformity (n)
Group 1	0	43	3.97 - 0 - 11	7.3	9
Group 2	1-2	20	0.66 - 0 - 4	5.4	1
Group 3	3-4	12	0.65 - 0 - 3	5.7	-

min: minimum, max: maximum, mos: months, n: number.

mm) in patients with 3-4 cables (Table 2). A positive correlation was found between the amount of gap and the time to union (Spearman's rho= 0.468, p=0.001).

A statistically significant difference was found between Group 1 and Group 2 and also between Group 1 and Group 3 regarding the union time (p=0.007, p=0.001, respectively). The mean time to union was measured as 7.3 months in Group 1, 5.4 months in Group 2, and 5.7 months in Group 3 on average. No statistically significant relationship was found between study groups and gender (p=0.847).

Varus deformity (between 4-12 degrees) was detected in 10 patients. The cable was not used in 9 out of 10 patients who developed varus deformity. There was no statistically significant relationship between varus deformity and union times between the groups (p=0.201). Four patients received revision surgery due to nonunion.

DISCUSSION

Subtrochanteric fractures are generally the result of high-energy trauma in young patients and low-energy trauma due to poor bone quality in elderly patients (15). In subtrochanteric fractures, cephalomedullary nails are frequently used for treatment (3). Cephalomedullary nailing is a method with biological and biomechanical advantages due to its percutaneous application, load-sharing ability, and short-moment arm.

In subtrochanteric fracture surgery, reduction and fixation difficulties are frequently encountered due to muscle forces deforming the proximal fracture segment. The use of cable is also a highly preferred method to improve reduction quality and fixation stability (2). The possibility of damage to the nutritional vascular structures of the femur due to the pressure exerted by the cables and the occurrence of union disorders due to nutritional deficiency is a very thought-provoking problem for surgeons. A review of the literature reveals that there is no consensus among the authors about the effect of cable use on bone nutrition. Recent anatomical and histological studies have reported that the femoral arterial circulation is circular rather than longitudinal (18-21). Apivatthakakul et al. also showed that macrovascular nutrition was preserved after cable application in a cadaver study, and they reported that cerclage wiring caused minimal disruption of the femoral blood circulation (22). Kennedy et al. stated that one or two cables do not impair circulation and can be used in spiral oblique fractures due to the circular arterial placement in the bone (6). In a biomechanical study by Müller et al. on cadavers with subtrochanteric fractures, the cerclage group and the non-cerclage group were compared, and it was emphasized that the use of cables not only provides a satisfactory reduction, but also preserves the integrity of the medial cortex, and reduces the risk of nonunion and fixation loss (23). Shin et al. stated that cerclage cable fixation increases the possibility of anatomical reduction and better stability while preserving the biology around the fracture line, and emphasized that the cerclage cable method is effective in subtrochanteric fractures. In this study, in which 51 patients who underwent intramedullary nailing and percutaneous cerclage were examined, the authors recorded the postoperative angulation as a maximum of 5 degrees and reported union at a rate of 98% (24). Liu et al. In their study in which they presented the treatment of 46 subtrochanteric femur fractures with cable cerclage and intramedullary nailing, they reported the mean time of union as 3-6 months and stated that they provided good and excellent union at a rate of 86.96%. They reported that the use of cables not only provides a good alignment but also increases stability (25). In a study by Mukherjee et al., 40 composite femurs that underwent subtrochanteric osteotomy were analyzed and it was reported that cable application on the nail increases stability in subtrochanteric fractures (26). Similarly, another study that retrospectively analyzed 260 patients reported that additional cerclage application on the nail increased the possibility of anatomical reduction, contributed to the stability, and positively affected union by providing extra support to the medial cortex. It has also been stated that better clinical results are obtained in cases with cerclage compared to applications without cerclage and this application is a very useful support method in comminuted trochanteric and subtrochanteric fractures (5).

In our study, when the relationship between cable use and the union was examined, it was determined that the union time was shorter in patients with cable use compared to patients operated without cable fixation, and the amount of residual gap in the fracture line was less with the cable fixation. No study has been found in the literature showing the relationship between the amount of gap of the fracture ends and the duration of the union in patients treated with cephalomedullary nails. In our study, there was a statistically significant relationship between cable use and the amount of gap ($p=0.033$). The average gap was 3.97 mm (range 0-11 mm) in patients without cables, 0.65 mm (range 0-4 mm) in patients with 1-2 cables and 0.66 mm (range 0-3 mm) in patients with 3-4 cables. In addition, a positive correlation was found between the amount of gap and union time (Spearman's rho= 0.468, $p=0.001$). The cable fixation of the fracture fragments is more stable, the anatomical alignment of the bone is better, and ultimately less gap is formed at the fracture line during reduction. It is widely accepted in the literature that ensuring the best possible alignment and leaving less gap at the fracture line are important factors that facilitate and accelerate the union of the subtrochanteric fractures.

One of the important problems that can be seen after fixation in subtrochanteric fractures is varus deformity (13,27-29). There are many studies in the literature investigating the relationship between varus deformity and delayed union and non-union (3,30,31). In the study by Ostrum et al., excessive lateralization of the trochanter major entry point was presented as an important cause of varus deformity (11). The study by Hoskins et al. reported that there was an increase in varus deformity when anatomical reduction could not be achieved (31). In our study, we observed that 90% of the 10 varus deformities we encountered developed in patients who didn’t have cable fixation. While providing a more stable reduction of the fracture fragments, cables also help to maintain stabilization in the postoperative follow-up period. Recently, Recently, there has been debate in the literature as to whether hematoma integrity or stability is more effective for fracture union. Although our study does not allow interpretation of hematoma integrity, it is quite supportive of the importance of stability.

The most important limitation of our study is its retrospective nature. Apart from this, there are other limiting factors such as the age, gender, and trauma severity of the patients, which were not homogeneously distributed, and the use of different nails by many surgeons can be counted. Despite these shortcomings, we believe that our study provides a strong conclusion and sufficient statistical data.

CONCLUSION

Our study demonstrated that in subtrochanteric fractures treated with cephalomedullary nailing, reducing the gap in the fracture line by using cable wires provides a better reduction, stability, and a shorter union time than fixation without using cable(s).

Ethical approval

This study has been approved by Muğla Sıtkı Koçman University Ethical Commitee (approval date 21/07/2020, number 158). Written informed consent was obtained from the participants.

Author contribution

Surgical and Medical Practices: CYK; Concept: CYK; Design: FİC; Data Collection or Processing: EG; Analysis or Interpretation: RMK; Literature Search: FİC; Writing: FİC. All authors reviewed the results and approved the final version of the article.

Source of funding

The authors declare the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Winquist R. Locked Femoral Nailing. J Am Acad Orthop Surg. 1993; 1(2): 95-105. [Crossref]
2. Canadian Orthopaedic Trauma Society. Nonunion following intramedullary nailing of the femur with and without reaming. Results of a multicenter randomized clinical trial. J Bone Joint Surg Am. 2003; 85(11): 2093-6.
3. Afsari A, Liporace F, Lindvall E, Infante A, Sagi HC, Haidukewych GJ. Clamp-assisted reduction of high subtrochanteric fractures of the femur. J Bone Joint Surg Am. 2009; 91(8): 1913-8. [Crossref]
4. Lundy DW. Subtrochanteric femoral fractures. J Am Acad Orthop Surg. 2007; 15(11): 663-71. [Crossref]
5. Beingessner DM, Scolaro JA, Orec RJ, Nork SE, Barei DP. Open reduction and intramedullary stabilisation of subtrochanteric femur fractures: A retrospective study of 56 cases. Injury. 2013; 44(12): 1910-5. [Crossref]
6. Kennedy MT, Mitra A, Hierlihy TG, Harty JA, Reidy D, Dolan M. Subtrochanteric hip fractures treated with cerclage cables and long cephalomedullary nails: a review of 17 consecutive cases over 2 years. Injury. 2011; 42(11): 1317-21. [Crossref]
7. Babalola OM, Ibraheem GH, Ahmed BA, Olawepo A, Agaja SB, Adeniyi A. Open Intramedullary Nailing for Segmental Long Bone Fractures: An Effective Alternative in a Resource-restricted Environment. Niger J Surg. 2016; 22(2): 90-5. [Crossref]
8. Grundnes O, Reikerås O. The importance of the hematoma for fracture healing in rats. Acta Orthop Scand. 1993; 64(3): 340-2. [Crossref]
9. Grundnes O, Reikerås O. The role of hematoma and periosteal sealing for fracture healing in rats. Acta Orthop Scand. 1993; 64(1): 47-9. [Crossref]
10. Mizuno K, Mineo K, Tachibana T, Sumi M, Matsubara T, Hirohata K. The osteogenetic potential of fracture haematoma. Subperiosteal and intramuscular transplantation of the haematoma. J Bone Joint Surg Br. 1990; 72(5): 822-9. [Crossref]
11. Ostrum RF, Marcantonio A, Marburger R. A critical analysis of the eccentric starting point for trochanteric intramedullary femoral nailing. J Orthop Trauma. 2005; 19(10): 681-6. [Crossref]
12. Wiss DA, Brien WW. Subtrochanteric fractures of the femur. Results of treatment by interlocking nailing. Clin Orthop Relat Res. 1992; 283: 231-6.
13. Shukla S, Johnston P, Ahmad MA, Wynn-Jones H, Patel AD, Walton NP. Outcome of traumatic subtrochanteric femoral fractures fixed using cephalo-medullary nails. Injury. 2007; 38(11): 1286-93. [Crossref]
14. Perry JJ, Winter B, Mast JW. Managing bone deficiency and nonunions of the proximal femur. Orthop Clin North Am. 2010; 41(1): 105-8. [Crossref]
15. Nieves JW, Bilezikian JP, Lane JM, et al. Fragility fractures of the hip and femur: incidence and patient characteristics. Osteoporos Int. 2010; 21(3): 399-408. [Crossref]
16. Kilinc BE, Oc Y, Kara A, Erturer RE. The effect of the cerclage wire in the treatment of subtrochanteric femur fracture with the long proximal femoral nail: A review of 52 cases. Int J Surg. 2018; 56: 250-5. [Crossref]
17. Blatter G, Janssen M. Treatment of subtrochanteric fractures of the femur: reduction on the traction table and fixation with dynamic condylar screw. Arch Orthop Trauma Surg. 1994; 113(3): 138-41. [Crossref]
18. Pazzaglia UE, Congiu T, Raspanti M, Ranchetti F, Quacci D. Anatomy of the intracortical canal system: scanning electron microscopy study in rabbit femur. Clin Orthop Relat Res. 2009; 467(9): 2446-56. [Crossref]
19. Lenz M, Perren SM, Richards RG, et al. Biomechanical performance of different cable and wire cerclage configurations. Int Orthop. 2013; 37(1): 125-30. [Crossref]
20. Lenz M, Perren SM, Gueorguiev B, et al. Underneath the cerclage: an ex vivo study on the cerclage-bone interface mechanics. Arch Orthop Trauma Surg. 2012; 132(10): 1467-72. [Crossref]
21. Kulkarni SG, Babhulkar SS, Kulkarni SM, Kulkarni GS, Kulkarni MS, Patil R. Augmentation of intramedullary nailing in unstable intertrochanteric fractures using cerclage wire and lag screws: a comparative study. Injury. 2017; 48(Suppl 2): S18-22. [Crossref]
22. Apivatthakakul T, Phaliphot J, Leuvitoonvechkit S. Percutaneous cerclage wiring, does it disrupt femoral blood supply? A cadaveric injection study. Injury. 2013; 44(2): 168-74. [Crossref]
23. Müller T, Topp T, Kühne CA, Gebhart G, Ruchholtz S, Zettl R. The benefit of wire cerclage stabilisation of the medial hinge in intramedullary nailing for the treatment of subtrochanteric femoral fractures: a biomechanical study. Int Orthop. 2011; 35(8): 1237-43. [Crossref]
24. Shin WC, Moon NH, Jang JH, Jeong JY, Suh KT. Technical note and surgical outcomes of percutaneous cable fixation in subtrochanteric fracture: A review of 51 consecutive cases over 4 years in two institutions. Injury. 2019; 50(2): 409-14. [Crossref]
25. Liu ZD, Xu TM, Dang Y, Zhang DY, Fu ZG. Clinical effectiveness of less invasive intramedullary nail fixation combined with titanium cable cerclage for subtrochanteric fractures. Beijing Da Xue Xue Bao Yi Xue Ban. 2020; 52(6): 1102-6. [Crossref]

26. Mukherjee P, Brattgjerd JE, Niratisairak S, Nilssen JR, Strømsøe K, Steen H. The stabilising effect by a novel cable cerclage configuration in long cephalomedullary nailing of subtrochanteric fractures with a posteromedial wedge. Clin Biomech (Bristol). 2019; 68: 1-7. [Crossref]

27. Haidukewych GJ, Berry DJ. Nonunion of fractures of the subtrochanteric region of the femur. Clin Orthop Relat Res. 2004; 419: 185-8. [Crossref]

28. Giannoudis PV, Ahmad MA, Mineo GV, Tosounidis TI, Calori GM, Kanakaris NK. Subtrochanteric fracture non-unions with implant failure managed with the "Diamond" concept. Injury. 2013; 44(Suppl 1): S76-81. [Crossref]

29. Barquet A, Mayora G, Fregeiro J, López L, Rienzi D, Francescoli L. The treatment of subtrochanteric nonunions with the long gamma nail: twenty-six patients with a minimum 2-year follow-up. J Orthop Trauma. 2004; 18(6): 346-53. [Crossref]

30. Robinson CM, Houshian S, Khan LA. Trochanteric-entry long cephalomedullary nailing of subtrochanteric fractures caused by low-energy trauma. J Bone Joint Surg Am. 2005; 87(10): 2217-6. [Crossref]

31. Hoskins W, Bingham R, Joseph S, et al. Subtrochanteric fracture: the effect of cerclage wire on fracture reduction and outcome. Injury. 2015; 46(10): 1992-5. [Crossref]