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Plate Augmentation for Fracture Nonunion over Existing Intramedullary Nail

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1. Abstract

1.1. Introduction

Intramedullary nailing (IMN) is the gold standard of treating femoral and tibial shaft fracture with excellent healing rates in most cases. However, as indications for nailing expand and the mechanism of trauma tends to be more severe, more nonunion cases are encountered. Many methods for treating these challenging cases were described including exchange nailing, conversion to plating and external fixation. In cases were stability is an issue, addition of a plate with retention of nail is a valid option. We present our initial experience with this technique.

1.2. Patients and Methods

Between 2005-2019, eight patients with diaphyseal fracture nonunions previously treated with IMNs were studied. These included 5 femoral and 3 tibiae. Mean time from index procedure to revision was 12 months (range 12-16).

1.3. Surgical Technique

An incision was made at the fracture site; previous locking screws were removed to dynamize the nail and either a 4.5 or 3.5mm long locking plate was applied while the first two screws were inserted in compression mode followed by locking screws. Iliac crest bone graft (ICBG) was harvested and placed in the fracture site following debridement of all fibrous tissues. Immediate full weight bearing was prescribed. Patients were followed in the outpatient clinic.

1.4. Results

All fractured healed completely. The time for union was 7-12 weeks (mean 9 weeks). All patients reported painless weight bearing. No major complication or implant failure were encountered.

Discussion: Plate augmentation with bone grafting over retained nail shows promising results both in the tibia and femur nonunions. it is considered a safe and reliable procedure which also allows immediate weight bearing and earlier mobilization.

2. Introduction

Fracture of the lower extremity long bones (femur and tibia) is considered a common injury in orthopedic trauma practice, often caused by high energy trauma [1]. Intramedullary nailing (IMN) in excellent treatment for most of these fractures evident by high union rate [2]. The introduction of interlocking has expanded the indication for nailing, especially for open fractures, as well as for more proximal and distal femoral and tibial fractures. Thus, the incidence of nonunion is reported to be higher than that reported and may reach 8-10% in modern antegrade nailing of the femoral shaft [3-4]. For tibial shaft fractures, an overall nonunion rate of 3.7% was reported [5]. The latter may range from 1% for closed fractures to 26% for high grade open tibial fractures [6-7]. Unlike the primary treatment of lower extremity fractures, the approach for nonunion is far more controversial with less predictable results. Several treatment options have been proposed for these conditions. These can start from minor procedures such as dynamization and my end up in complex surgery such as double plating, open plating, application of ring fixators etc. These options are often associated with extensive surgery, technical problems of previous nail removal and blood loss due to large exposures and medullary canal reaming [9-20]. Few authors suggested the solution of plate augmentation with bone-graft while retaining the existing nail [21].

This option carries the potential of increasing mechanical stability by neutralizing rotation while addressing biological issues with the application of autogenous bone graft. We present our experience of plate augmentation leaving the nail in situ for non-union of long bone shaft fracture.

3. Materials and Methods

Study design: retrospective study, in an Academic Level I trauma center. Between 2005-2019 eight cases (five femora and three tibiae) of lower extremity nonunion after IMN's were treated using lateral plating and bone grafting. Average time from index surgery to revision was 12 months (range 12-16). All initial fractures were closed. Patients demographics, comorbidities, mechanism of injury, AO/OTA classification and previous implants are specified in (Table 1). Nonunion was defined by painful weight-bearing, lack of bony healing based on radiographs and CT scans. Patients were operated by fellowship trained trauma surgeons using the technique described below. Clinical and radiographic follow-up was done at our patient clinic at 6 weeks, 12 weeks, 6 months and one year postoperatively. Definition of bony union was painless weight bearing and bridging of 3 out of four cortices on plain films. In this series we have operated seven patients with augmentation plate and bone graft, one patient without bone graft.

Table 1: Patients demographics, comorbidities, mechanism of injury, AO/OTA classification and previous implants are specified in (Table 1).

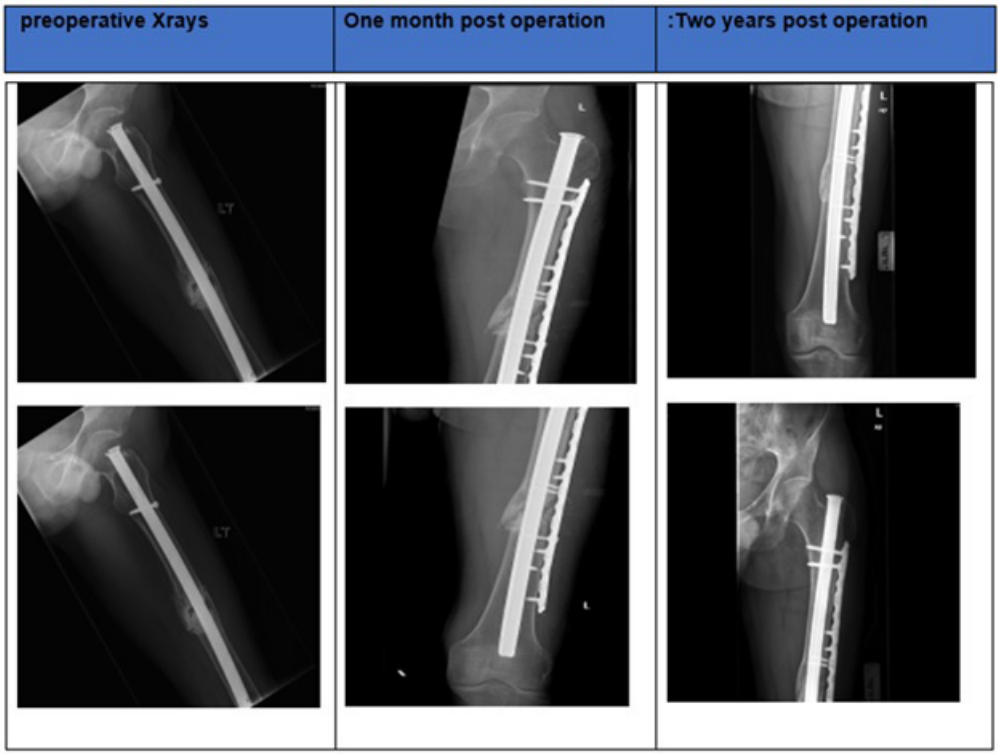
Case number:	Age	Comorbidities	Gender	AO/OTA classification	Mechanism of injury	autologous bone graft	Previous implants	Time to the address the nonunion operatively	Time to union	complication
1	44	0	M	AO32A1	MVA	yes	Femur antegrade IMN nail	24 m	9m	Wound dehiscence
2	59	Hypertension	M	AO32B2	Fall from straits	yes	Femur IMN antegrade nail	3m	12m	0
3	85	Osteoporosis Diabetes type 2, Hypertension	F	AO32A3	Fall at home	yes	PFNA and bone grafting due to bone loss.	24m	12m	0
4	21	Inflammatory bowel disease.	M	AO32A3	MVA	yes	Femur antegrade IMN	24m	9m	0
5	58	0	F	AO42A3	MVA	yes	IMN tibia	12m	24	0
6	33	0	M	AO42C2	MVA	yes	IMN tibia nail	6m	3m	0
7	24	0	M	AO42CB2	Direct trauma (heavy object)	yes	IMN tibia nail	6m	6m	0
8	63	Heavy smoker.	F	Lewis and Roraback classification type 2	Fall at home	no	Retrograde femur nail	5m	6m	0

3.1. Surgical Technique

Patients did not receive prophylactic antibiotic treatment prior to obtaining deep tissue biopsies for culture. First stage was removal of all previous locking bolts to allow fracture compression. The approach for the femoral shaft was lateral subvastus approach, in the tibial shaft an anterolateral approach was utilized. All fibrous tissues if existed were sharply excised from the fracture site until viable bone was reached. This tissues as well as bone biopsies were sent for gram stain and bacteriological cultures. In the femur, besides one case, a narrow 4.5 locking compression plate (Depuy-Synthes, Solothurn, Switzerland) while in the tibial shaft a 3.5 plate was used in most instances. One case required a wide 4.5 Plate placed on the tibia. The fractures were fixed in compression mode and locking were subsequently added. Subsequently, an Iliac crest bone graft (ICBG) was harvested and placed in the fracture site following debridement of all fibrous tissues in all patients but one. Patients were instructed to weigh bear as tolerated following fracture fixation. Patients were kept in the hospital and received intravenous antibiotics until a final cultures results, usually within 96 hours were obtained. Patients were then seen in the outpatient clinic at 2 weeks and then x-rayed at, 6 weeks, 12 weeks, 6 months and one year postoperatively.

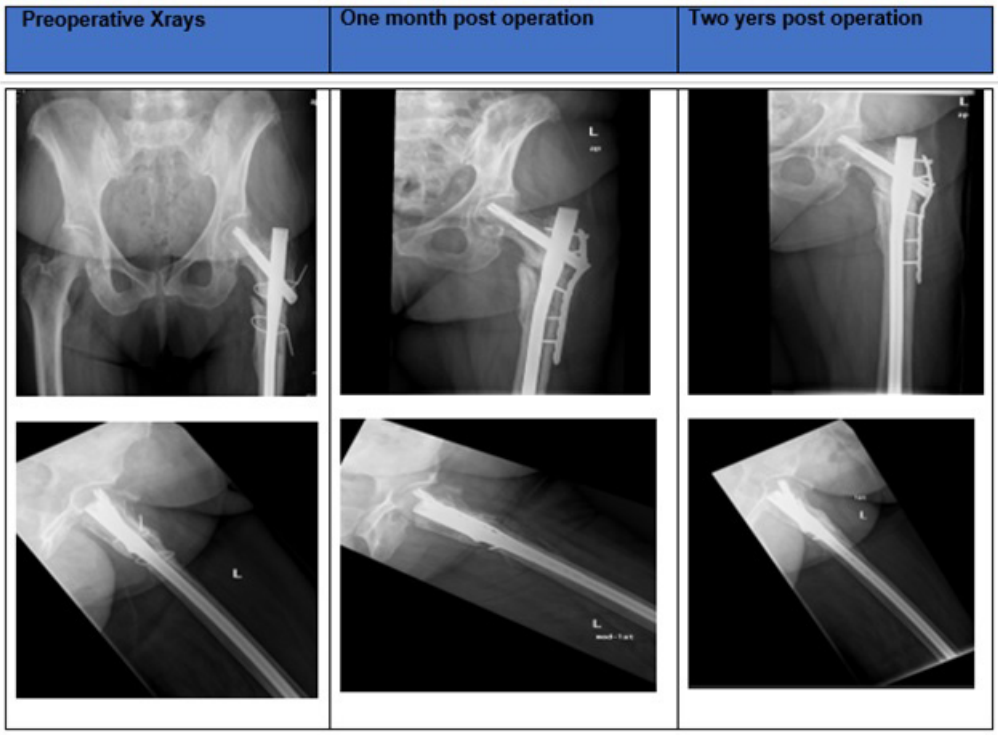
4. Results

All fractured was heal completely. The time for union 7-12 weeks (mean 9 weeks), all patients reported painless weight-bearing. Two patients out of nine patients (one femur, one tibia), required intravenous antibiotic treatment due to superficial wound infection. None of the patient required further surgical intervention. All the demonstrative cases are presented in [Figures and Cases].

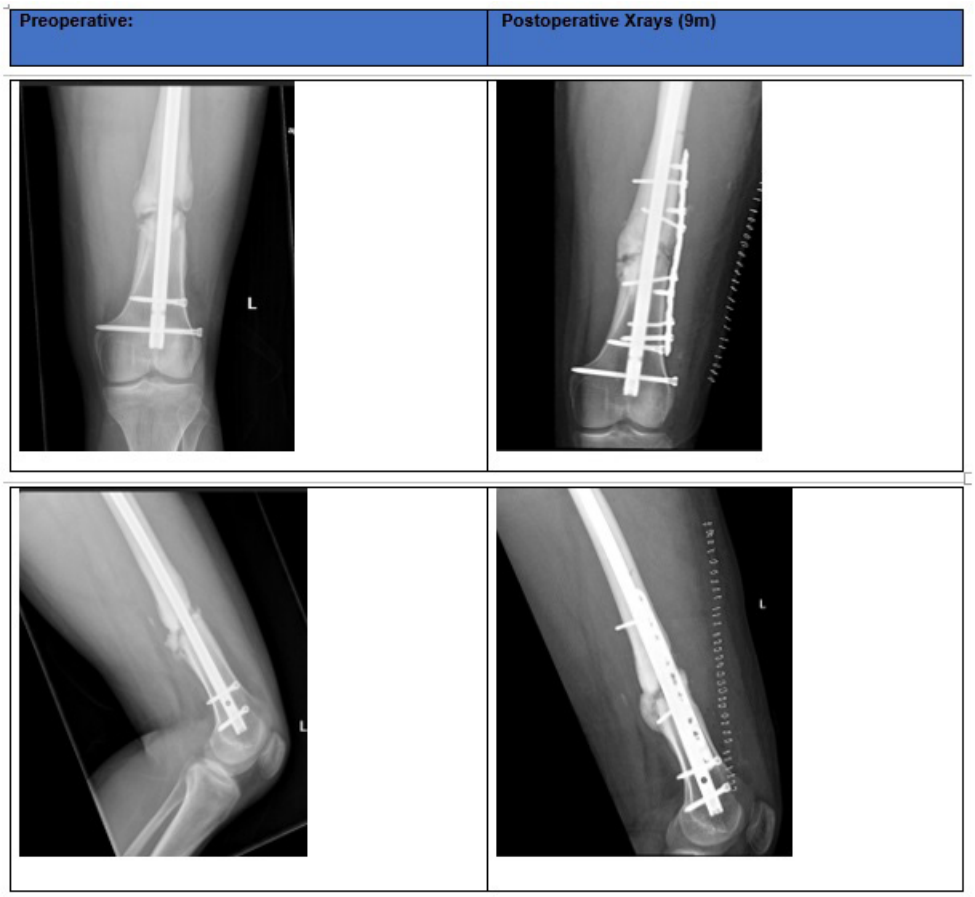


Case 1: 44 years old male after a motor vehicle accident (MVA), operated with intramedullary nail for femur shaft fracture. After one years operated again due to nonunion by exchange nail, then due to resistant nonunion after two years we operated him with leaving the intramedullary nail in situ with adding an iliac bone graft and lateral compression plate due to nonunion of the fracture. With full union after 9 months. After 3 years from the first operation he had complicated with wound dehiscence treated with antibiotics.

Case 2: 59 years old male, hypertension treated medically, after a femur shaft fracture due a fall from straits, operated with intramedullary nail, follow up after 2 months with malalignment thus operated again. after the second operation three month follow up x-ray shown nonunion fracture. thus, operated with changing the nail, iliac bone graft, Lateral compression plate was added.

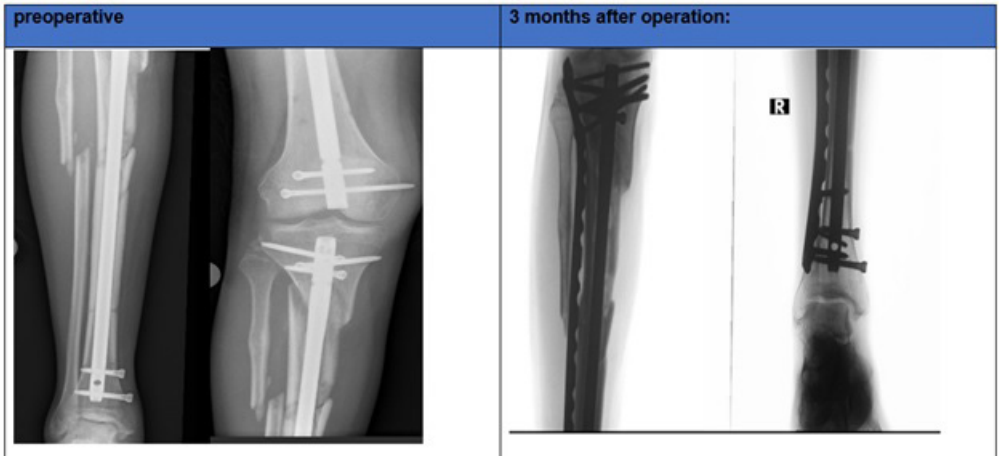


Case 3: 85 years old women, medical history including osteoporosis treated with Fosalan, first admitted with subtrochanteric femur fracture treated with PFNA, after 1 month fall again and operated with Blade Plate, after 3 months falling again treated with PFNA and bone grafting and cerclage. after 2 years of follow up continue to have hip pain, x rays show nonunion of the subtrochanteric fracture. treated with iliac bone graft and lateral compression plate, with retention of the PFNA.

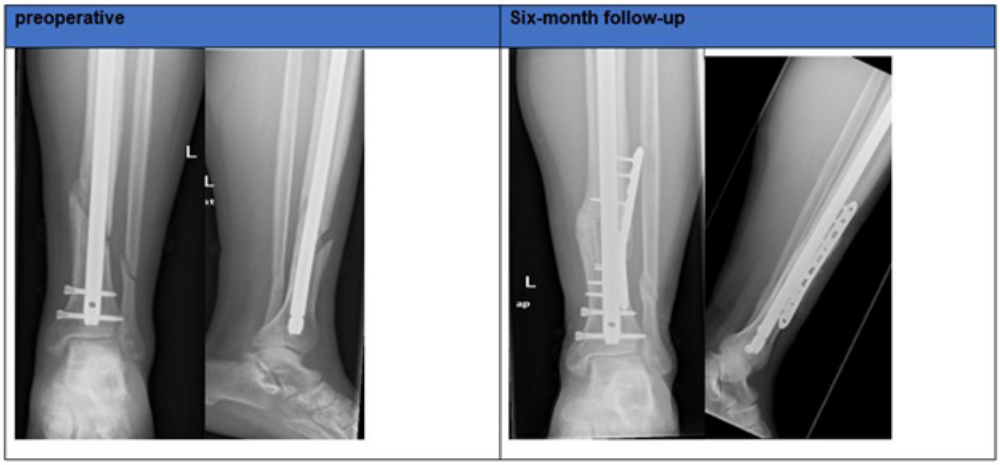


Case 4: 21 years old medical history with IBD using prednisone, after a motor vehicle accident, admitted with a femur shaft fracture operated using an intramedullary nail, after 1 year passed dynamization and IGNITE injection. 1 year follow up shows nonunion, thus operated with adding lateral compression plate and iliac bone graft.

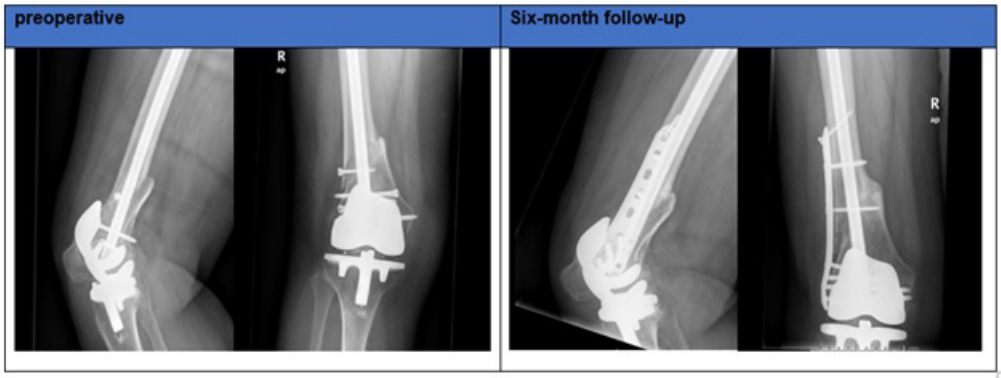
Case 5: 58 years old female, after motor vehicle accident, admitted for nonunion of tibia shaft after 9 months, treated with augmentation medial shaft plate and iliac bone graft.



Case 6: 33-year-old healthy male. After a motor vehicle accident, suffer from multi fragment tibia shaft fracture, operated first using Intramedullary nail. After six months of follow-up still nonunion of the fracture site. We decided to re-operate with using an iliac bone graft and augmentation plate with retention of the nail.



Case 7: 24 years' healthy male, first admission due tibia shaft fracture after a heavy object fall on his leg, he passed intramedullary nail, at the 6-month follow-up the fracture site didn't union, we decide to re-operate him with iliac bone graft and augmentation plate with retention of the nail.



Case 8: A 63 years old female, heavy smoker, s/p total knee replacement, fall down at home and broken her distal femur shaft. Underwent a retrograde nail through the total knee, after 5 months in the routine clinical visit she still has pain and difficulty to ambulated. We rule out infection, her x-ray shows a nonunion.

So, we decide to keep the nail and to add an anatomical plate augmentation. With successful union after that.

5. Discussion

We presented a surgical technique of retaining a previous intramedullary nail while augmenting it with a side plate and bone graft. All our cases healed with just two minor complications. In most cases fracture types were simple (AO/OTA A types and one B type). Therefore, theoretically if a fracture gap persists, a high strain situation may impede fracture healing according to Perren's strain theory [22]. An addition of a rigid fixation such as a plate in conjunction with fracture compression or with filling of the gap with bone grafting may significantly reduce to strain across the fracture site and therefore progress to healing.

the use of intramedullary interlocking nail for the femoral/tibia shaft fracture is the treatment of choice, the known causes of failure include comminuted fracture pattern or significant displacement of fragments and mechanical factors (like small diameter of nail, insufficient locking) and malalignment of fragments.

Traditionally, they are various methods commonly used to treat nonunion after intramedullary nail that will be describe briefly below: Exchange nail is knowns to be the most acceptable and a common method of treatment for femoral nonunion [23]. The thicker nail provides better bending and rotational stability and the reaming of the canal promotes osteogenesis [24].one of the advantages of this procedure that's is closed and with fewer blood loss, but one of the limitation of this is we need a larger nail diameters that it's hard to achieve.However, the results of the union after exchange nailing vary, and high failure have been reported [25], and sometimes the technique is harder especially with titanium nail removal is more difficult, resulting in more longer surgical operation and more intraoperative bleeding . Also, the exchange nailing in comminuted and distal femur fractures is not advised as the nail does not provide adequate stability in the wide distal fragment [26].

1. Double plating approach is also a technique to approach the nonunion, but this approach also with high blood loss and technically more complicated surgery [27].

2. ilizarov's ring also described as a treatment with good results, however it is a long-time consuming surgery and associated with pin tract infection and malrotation [28].

3. Dynamization is more routinely done as it is simple, however the results unreliable. Also, it may lead to further instability of the fragment [29].

4. Removal of the nail and reduction of the fragments followed by fixation by conventional plate requires a long incision, extensive approach with significant soft tissue and vascular compromise, also its delays the rehabilitation as the removal of the nail causes increased bending forces on the plate with may lead to failure of the plate thus the weight bearing has to be protected [30]. One of the major advantages of the plate augmentation is that equally effective for proximal/middle/distal third long bones fractures. also plate augmentation allows additional rotational stability at the fracture site, where the plate holds the fragments in place thus preventing their macro motion, it is important to notice that our plating technique was at the tension side because if the plate is applied to the compression (or concave) side of the bone it is highly likely to bend, fatigue and fail [31]. The advantage of leaving the nail in situ is that it helps in neutralizing the bending forces on the plate and maintaining alignment the fracture fragments furthermore, by these approaches we have changed a major difficult surgery and time consuming to a simpler surgery by retaining the nail. We published this series to publish our surgical technique in operating difficult nonunion long bones fracture, further research must be done to understand the exact mechanism and treatment.

References

1. Neumann MV, Südkamp NP, Strohm PC. Management of femoral shaft fractures. Acta Chir Orthop Traumatol Cech. 2015; 82(1): 22-32.
2. Winquist RA, Hansen ST, Jr, Clawson DK, Closed intramedullary nailing of femoral fractures. A report of five hundred and twenty cases. J Bone Joint Surg Am. 1984; 66(4): 529-539.
3. Lambiris E, Panagopoulos A, Zouboulis P. Current concepts: aseptic nonunion of femoral shaft diaphysis. Eur J Trauma Emerg Surg. 2007; 33(2): 120-134.
4. Finkemeier C, Chapman M. Treatment of femoral diaphyseal nonunions. Clin Orthop. 2002; 398: 223-34.
5. George W. intramedullary nailing in the treatment of femoral and tibial shaft fractures. Journal of orthopedic science. 2006; 11(6): 657-669.
6. Court-Brown C M, McQueen M M, Tornetta P. Trauma. Lippincott Williams & Willkins: Philadelphia. 2006.
7. Court-Brown C, Aitken S A, Forward D, O'Toole R. The epidemiology of adult fractures In: Rockwood and Green's fractures in adults. (Eds. Bucholz RW, Court-Brown C, Heckman JD, Tornetta P): Philidelphia, Lippincott Williams & Wilkins. 2009; 53-84.
8. Furlong AJ, Giannoudis PV, DeBoer P. Exchange nailing for femoral shafts aseptic non-union. Injury. 1999; 30: 245-9.
9. Banaszkiewicz P, Sabboubeh A, McLeod I. Femoral exchange nailing for aseptic non-union: not the end to all problems. Injury. 2003; 1812: 1-8.
10. Wu CC, Shih C, Chen W. Effect of reaming bone grafting on treating femoral shaft aseptic nonunion after plating. Arch Orthop Trauma Surg. 1999; 119:303-7.
11. Bellabarba C, Ricci W, Bolhofne rB. Results of indirect reduction and plating of femoral shaft nonunions after intramedullary nailing. J Orthop Trauma. 2001; 15: 254-63.
12. Smith WR,Morgan SJ. Failure of internal fixation of the femoral shaft. Tech Orthop. 2003; 17: 448-57.
13. Pihlajamaki HK, Salminen ST, Bostman OM. The treatment of nonunions following intramedullary nailing of femoral shaft fractures. J Orthop Trauma. 2002; 16(6): 394-402.

14. Hak DJ, Lee SS, Goulet J. A Success of exchange reamed intramedullary nailing for femoral shaft nonunion or delayed union. J Orthop Trauma. 2000; 14(3): 178-182.
15. Somford MP, Bekerom MP, Kloen P. Operative treatment for femoral shaft nonunions, a systematic review of the literature. Strategy Limb Reconstr. 2013; 8(2): 77-88.
16. Weresh MJ, Hakanson R, Stover MD. Failure of exchange reamed intramedullary nails for ununited femoral shaft fractures. J Orthop Trauma. 2000; 14(5): 335-338.
17. Brian P. Fracture healing: A review of clinical, imaging and laboratory diagnostic options, Injury, Int. J. Care Injured. 2017; 48S: S69-S75.
18. Julius A. Bishop. Assessment of Compromised Fracture Healing, J Am Acad Orthop Surg. 2012; 20: 273-282.
19. Bellabarba C, Ricci W, Bolhofner B. Results of indirect reduction and plating of femoral shaft nonunions after intramedullary nailing. J Orthop Trauma. 2001; 15: 254-63.
20. Park K, Kim K, Choi YS. Comparison of mechanical rigidity between plate augmentation leaving the nail in situ and interlocking nail using cadaveric fracture model of the femur. Int Orthop. 2011; 35: 581-585.
21. Perren SM. Evolution of the internal fixation of long bone fractures. The scientific basis of biological internal fixation: choosing a new balance between stability and biology. J Bone Joint Surg Br. 2022; 84(8): 1093-110.
22. Brinker MR, O'Connor DP. Exchange nailing of ununited fractures. J Bone Joint Surg Am. 2007; 89(1): 177-188.
23. Somford MP, Bekerom MP, Kloen P. Operative treatment for femoral shaft nonunions, a systematic review of the literature. Strateg Limb Reconstr. 2013; 8(2): 77-88.
24. Shroeder JE. The outcome of closed, intramedullary exchange nailing with reamed insertion in the treatment of femoral shaft nonunions.J Orthop Trauma. 2009; 23(9): 653-7.
25. Weresh MJ, Hakanson R, Stover MD. Failure of exchange reamed intramedullary nails for ununited femoral shaft fractures. J Orthop Trauma. 2000; 14(5): 335-338.
26. Seyhan M. Complications during removal of stainless steel versus titanium nails used for intramedullary nailing of diaphyseal fractures of the tibia ,Ann Med Surg (Lond). 2018; 26: 38-42.
27. El Haj M, Khoury A, Mosheiff R, Liebergall M, Weil YA. Orthogonal double plate fixation for long bone fracture nonunion.Acta Chir Orthop Traumatol Cech. 2013; 80(2): 131-7.
28. Menon DK, Dougall TW, Pool RD. Augmentative Ilizarov external fixation after failure of diaphyseal union with intramedullary nailing. J Orthop Trauma. 2002; 16(7): 491-497.
29. Jung HG, Kim DJ, Kim BH Treatment of the femoral shaft nonunion occurred after intramedullary nailing. J Korean Orthop Assoc. 2007; 42(5): 653-658.
30. Vaishya R. Plate augmentation with retention of intramedullary nail is effective for resistant femoral shaft non-union. Journal of Orthopaedics. 2016; 13(4): 242-245.
31. Tooms RE. Amputations of Lower Extremity, in Campbell's Operative Orthopaedics, A.H. Crenshaw, Editor. 1992; 740-760.