

## Is nail dynamization beneficial after twelve weeks – An analysis of 37 cases



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### ABSTRACT

**Purpose:** Although nail dynamization in femoral and tibial fractures is an effective method of promoting healing, its role beyond twelve weeks is still not clear. It is usually done two to three months following interlocking nailing. This study was done to evaluate the efficacy of late dynamization (after 12 weeks) and factors affecting union.

**Materials and methods:** In this retrospective study, thirty seven patients who underwent dynamization for reamed intramedullary interlocking nails of femur (18) and tibia (20) after twelve weeks from index surgery and with a minimum followup of six months were included. Fracture healing index was calculated using predynamization radiographs. Radiographic union was defined as osseous bridging of three cortices on followup radiographs. Dynamization failure was defined as fractures not showing progressive increase in callus on followup radiographs and those that required secondary intervention. **Results:** Mean age of patients at time of injury was 35.92 years (range: 16–63) with males (86.8%) predominating. Mean time to dynamization from index surgery was 19.11 weeks (range-12–36). Thirty one fractures (81.5%) went onto union after dynamization of which twelve were femoral and nineteen were tibial fractures. Mean time to union after dynamization was 6 months. Communitated fractures (6–21) showed poor results with delayed dynamization compared to other anatomical types which was statistically significant ( $P = 0.05$ ). Predynamization FHI of more than 1.18 had 83% sensitivity and 72% specificity in predicting fracture healing after dynamization.

**Conclusion:** Late dynamization is still beneficial in promoting healing in femoral and tibial fractures. Communitated fractures showed poor results with dynamization. Predynamization FHI was an important predictor of fracture healing.

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## 1. Introduction

Intramedullary interlocking nailing has become the standard treatment for femoral and tibial diaphyseal fractures. Reported union rates range from 90 to 100%.<sup>1,2</sup> However some fractures cause problems leading to delayed union and nonunion. Inadequate stability, insufficient blood supply and infection are the main reasons for nonunion.<sup>3</sup> Dynamization, exchange nailing, compression plating with bone grafting, distraction osteogenesis and

vascularized fibular transfers are the available techniques to promote union in such cases.<sup>3,4</sup>

Of all the modalities described above dynamization is a simple and costeffective procedure which involves removal of proximal or distal statically locked screws from the intramedullary nail thereby causing collapse at fracture site and promoting union.<sup>5</sup> This is usually done two to three months following interlocking nailing.<sup>6–8</sup> However experimental and clinical studies could not show success with routine nail dynamization.<sup>9,10</sup> Previous reports on nail dynamization for femoral and tibial shaft fractures showed varying results ranging from 19% to 82% success rate.<sup>10–13</sup>

There were very few studies which evaluated the role of late dynamization in diaphyseal fractures.<sup>10,11,13</sup> Most of them had a small sample size which made interpretation difficult. The purpose of our study was to evaluate the efficacy of delayed dynamization

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(after 12 weeks) in femoral and tibial diaphyseal fractures and to assess factors affecting union.

## 2. Materials and methods

From January 2014 to August 2016, thirty seven patients who underwent dynamization for reamed intramedullary interlocking nails of femur (18) and tibia (20) after twelve weeks from index surgery and with a minimum followup of six months were included in this study. Patient records from the medical records department of our hospital were reviewed retrospectively to identify demographic parameters, type of fracture, classification, time to nailing, associated injury, medical comorbidities, smoking status, details of index surgery, time to dynamization from index

surgery and secondary procedures. Institutional ethical clearance was obtained before starting the study.

Patients with pathological fractures, infection, type 3 open fractures and those who underwent interlocking nails for delayed union and nonunion were excluded from this study. Fractures which failed to show progressive signs of callus formation on two successive visits underwent dynamization. Dynamization was performed as an outpatient procedure by removing single static screw from longer fracture segment under local anaesthesia and patients were allowed to fully weight bear immediately. They were followed up at one, three, six months and till union.

Using pre dynamization radiographs, diameter of callus and bone were calculated in both AP and lateral radiographs (Fig. 1). Fracture healing index (FHI) was obtained by taking the

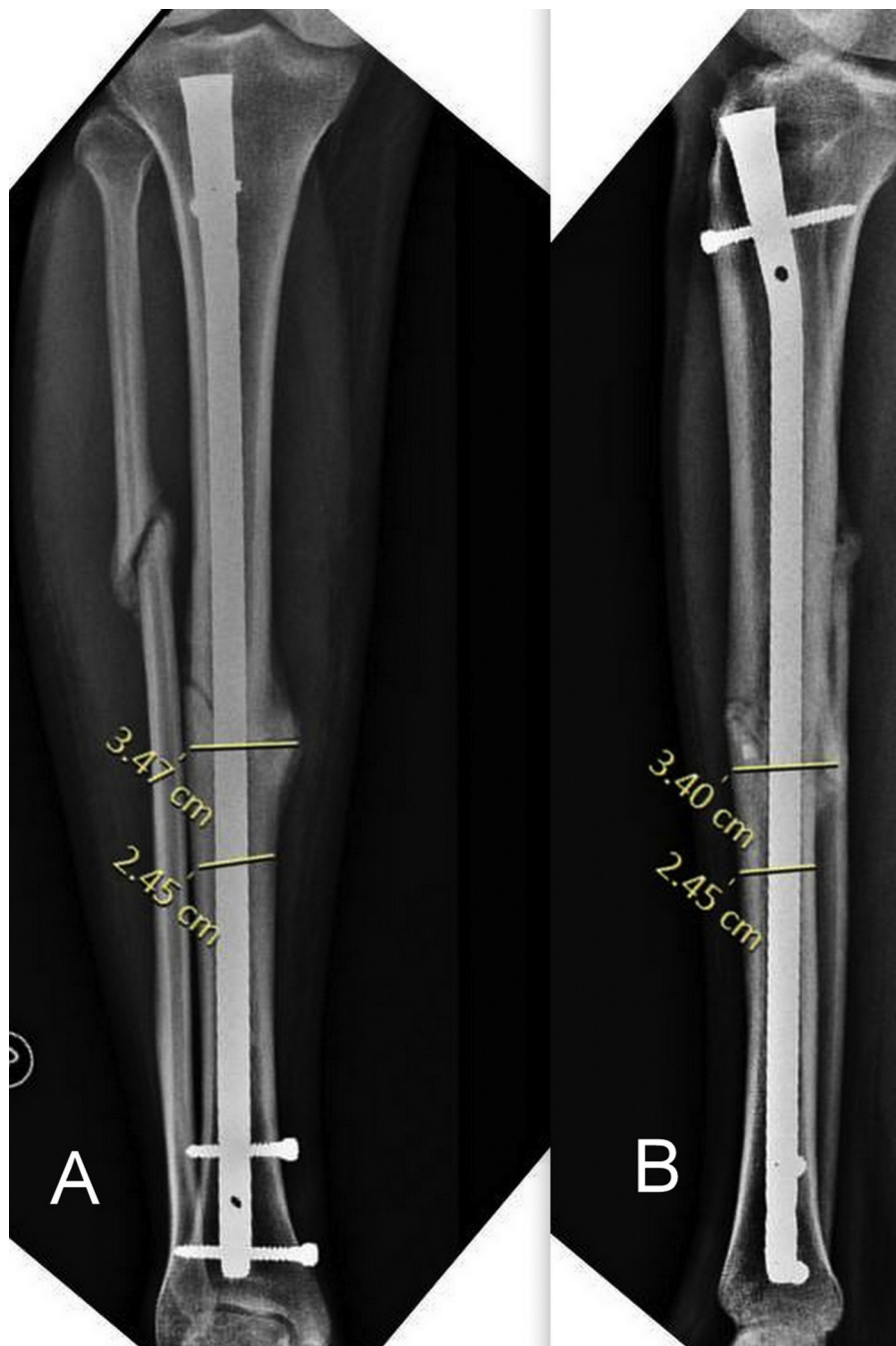
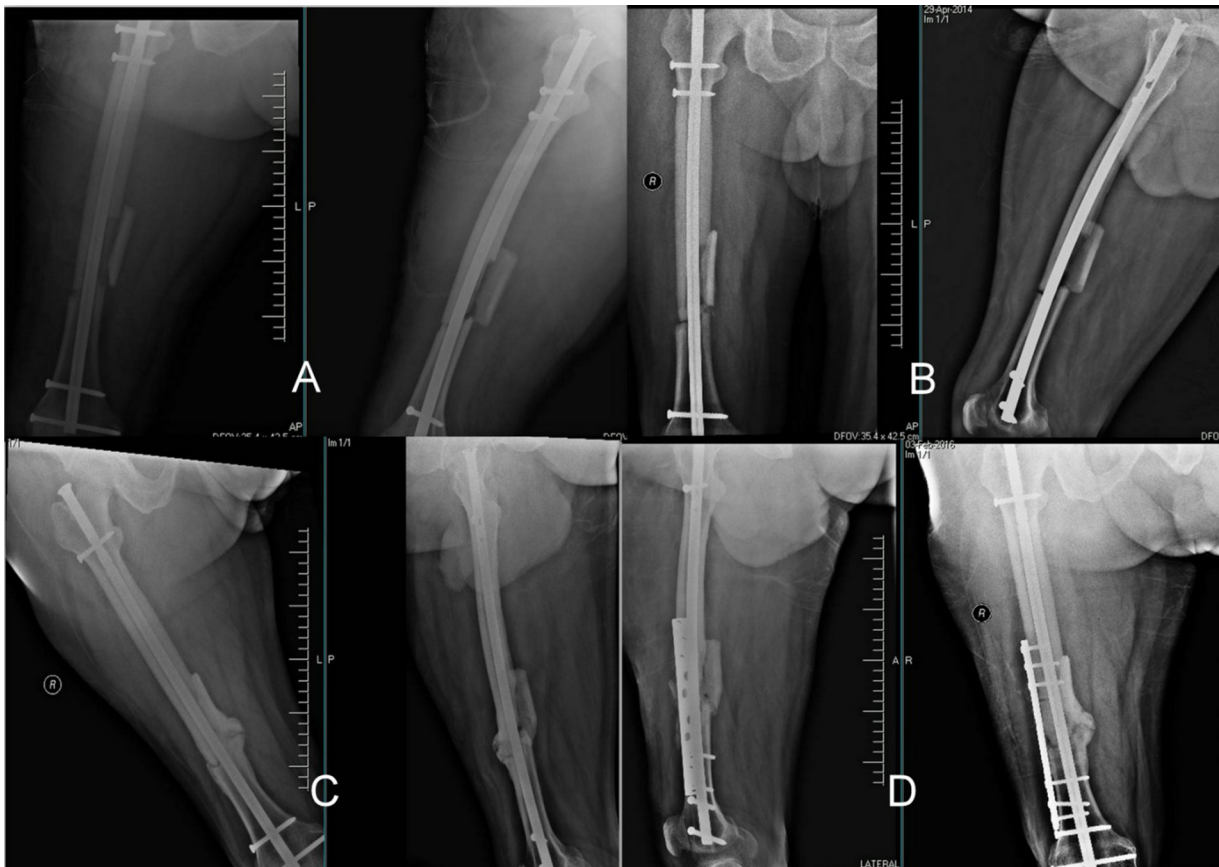


Fig 1. Predynamization AP (A) and lateral (B) radiographs showing callus diameters and normal bone diameters.



**Fig. 2.** Predynamization AP (A) and lateral (B) radiographs twenty four weeks following femur nailing showing delayed healing. Followup AP (C) and lateral (D) radiographs six months following dynamization showing complete union.



**Fig. 3.** Immediate postoperative AP and lateral radiographs (A) following nailing. Predynamization AP and lateral radiographs (B) 19 weeks following nailing. Six months followup radiographs (C) following dynamization showing no signs of union. Femur radiographs (D) three months following augmentation plating with bone grafting.

radiological ratio of the largest callus diameter in two planes and the adjacent normal bone diameter.<sup>14</sup> Radiographic union was defined as osseous bridging of three cortices on followup radiographs (Fig. 2). Dynamization failure was defined as fractures not showing progressive increase in callus on followup radiographs and those that required secondary intervention (Fig. 3).

Statistical package for social sciences software for windows version 22.0 was used for statistical analysis. Chi square test was used in analysis of factors predicting success of dynamization. Predynamization FHI and union was analysed using ROC curve.

### 3. Results

This study included thirty eight fractures in thirty seven patients who underwent delayed nail dynamization from January 2014 to August 2016. There were eighteen femur (47.3%) and twenty tibia (52.6%) fractures. Of these, nine were open (23.6%) and rest were closed injuries. Six were type 1 open and three were type 2 open injuries classified by Gustilo Anderson classification. All open injuries underwent nailing with primary skin closure. Mean age of patients at time of injury was 35.92 years (range: 16–63)

with males (86.8%) predominating. Mean time duration to index nailing was 35.4 h where twenty six fractures were nailed within twenty hours from injury. Twelve fractures underwent delayed nailing in view of polytrauma in four patients, fat embolism in one patient and delayed presentation in seven patients. Sixteen femur fractures were nailed with centromedullary nails using piriformis entry while two femurs were nailed with trochanteric entry reconstruction nails. Nineteen tibia fractures underwent fixation with standard locking nails while one was fixed using expert nail in view of proximal fracture. Average nail diameter used was 9.8 mm. Stable fracture patterns were allowed early weight bearing, while communitated fractures were made to walk non weight bearing for initial four weeks. None of the patients underwent electromagnetic or ultrasound stimulation at any point following index procedure.

Mean time to dynamization from index surgery was 19.11 weeks (range-12–36). Fractures were classified based on anatomical pattern (Table 1) and OTA classification (Table 2). Majority of the fractures in this series were either communitated or transverse.

Thirty one fractures (81.5%) went onto union after dynamization of which twelve were femoral and nineteen were tibial fractures. Mean time to union after dynamization was 6 months. One tibial and six femoral fractures did not show signs of union after dynamization and were termed dynamization failures. Of these seven nonunions, four underwent augmentation plating with bone grafting and went onto complete union. Remaining three patients were asymptomatic and not willing for further procedures.

Twenty six fractures were dynamized within twenty weeks from index surgery and twelve were dynamized after twenty weeks. Age, sex, smoking status, open fractures and time of dynamization were not statistically significant in predicting dynamization success or failure ( $P > 0.05$ ). Communitated fractures showed poor results with delayed dynamization compared to other anatomical types which was statistically significant ( $P = 0.05$ ). Three type B fractures and four type C fractures failed to unite whereas all type A fractures united. All transverse fracture patterns went onto complete union (Table 3).

Predynamization FHI of more than 1.18 had 83% sensitivity and 72% specificity in predicting fracture healing after dynamization. Fractures with FHI less than 1.18 had successful union in only 50% (5 of 10) cases, whereas fractures with FHI more than 1.18 had successful union in 92.8% (26 of 28) cases (Fig. 4).

#### 4. Discussion

Nail dynamization is a simple and costeffective method for enhancing union in femoral and tibial fractures. It works by improving contact area at the fracture site thereby shortening time to union.<sup>5</sup> Usually dynamization is done two to three months following nailing so that sufficient callus is present to prevent excess mobility at fracture site.<sup>6–8</sup> The main disadvantage of dynamization is shortening leading to limb length discrepancy especially in communitated and long oblique fracture patterns. It is

**Table 1**  
Anatomical classification.

Anatomy	Frequency	Percent
Communitated	21	55.26
Oblique	1	2.63
Segmental	1	2.63
Spiral	1	2.63
Transverse	14	36.84
Total	38	100.00

**Table 2**  
AO classification.

OTA type	Frequency	Percent
A	16	42.1
B	12	31.5
C	10	26.3

**Table 3**  
Fracture types and union rates.

Anatomy	Union from dynamization				Total	Chi square	p
	No		Yes				
	N	%	N	%			
Communitated	6	28.57	15	71.43	21	9.48	<b>0.050*</b>
Oblique			1	100.00	1		
Segmental	1	100.00			1		
Spiral			1	100.00	1		
Transverse			14	100.00	14		
Total	7	18.42	31	81.58	38		

Bold values indicate statistical significance with  $P = 0.050$ .

usually preferred in transverse, wedge and short oblique fractures.<sup>15</sup>

Success rate following delayed nail dynamization (>12 weeks) in our study was 81.5% which was comparable to studies by Chalidis et al,<sup>16</sup> Kempf et al<sup>6</sup> and Pihajamashi et al.<sup>17</sup> However in these studies, dynamization was performed at a mean duration of twelve weeks whereas in our study mean time to dynamization was 19.11 weeks (range- 12–36 weeks). In studies by Wu and Shi et al<sup>10</sup> (30 weeks), Wu and Chen et al<sup>11</sup> (16 weeks) and Wu et al<sup>13</sup> (24 weeks) fracture union occurred in 50–60% of cases.

Wu and Shi in their series of twenty two cases of femur and tibia fractures obtained a success rate of 54% following dynamization. The mean dynamization time from nailing was thirty weeks. They found no correlation between time to dynamization and fracture union<sup>10</sup>. In a similar study of twenty four femoral fractures that were dynamized at a mean duration of six months, only 54% of fractures achieved union. Mean time to union was  $5.2 \pm 2$  months.<sup>13</sup> In our study the mean time to union from dynamization was six months.

We also found that communitated fractures showed poor results compared with transverse and oblique fractures after delayed nail dynamization ( $P = 0.05$ ) with 71.4% success rate. This is in accordance with literature that dynamization in communitated femoral fracture causes loss of reduction and shortening.<sup>16,18</sup> All transverse fractures united in our series. One segmental fracture failed to unite highlighting the poor results of dynamization in communitated and segmental fractures.<sup>11</sup>

Another factor which was important in predicting successful union was predynamization FHI. In our study predynamization FHI > 1.18 resulted in 92.8% union rates. This was comparable to a study by Vaughan et al. (93% union rates with FHI > 1.17).<sup>19</sup> Predynamization FHI of more than 1.18 had 83% sensitivity and 72% specificity in predicting fracture healing after dynamization. This shows that some amount of callus must be present at the fracture site before proceeding with dynamization. The callus prevents excess mobility at the fracture site.

We did not find any statistical significance between age, sex, smoking status, time of dynamization and fracture union. The limitation of this study is the small sample size and no comparison group. Further prospective studies with proper randomization are needed. All patients who undergo dynamization must also be

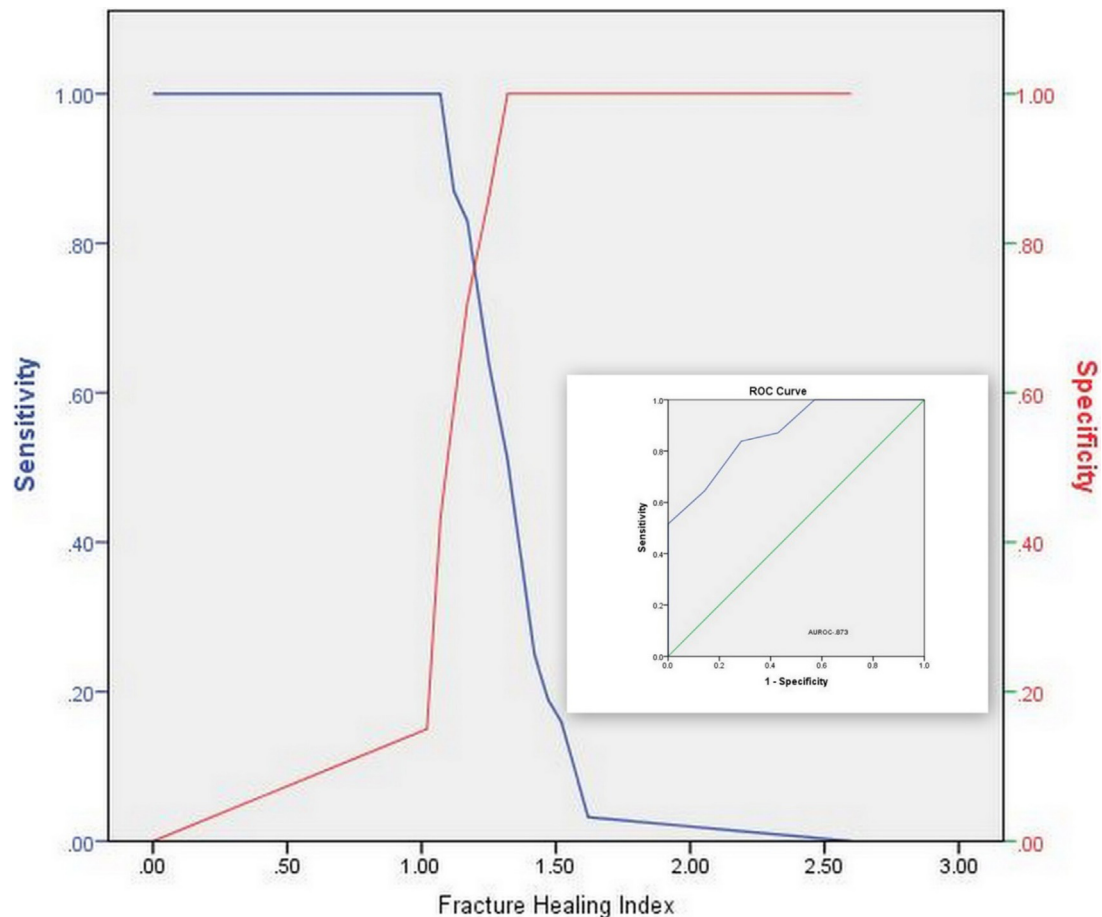


Fig. 4. Sensitivity/specificity plots and ROC curve demonstrating fracture healing index optimized at 1.18.

explained regarding need for secondary procedures especially in comminuted fracture patterns.

## 5. Conclusion

Delayed nail dynamization is a simple and effective method of promoting healing in femoral and tibial fractures with 81.5% success rate in our study. Comminuted fractures showed poor results with dynamization. Predynamization FHI was an important predictor of fracture healing. Patients have to be explained regarding nonunion and need for secondary procedures beforehand.

## Conflict of interest

None.

## References

1. Winkquist RA, Hansen Jr 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.
2. Wolinsky PR, McCarty E, Shyr Y, Johnson K. Reamed intramedullary nailing of the femur: 551 cases. *J Trauma.* 1999;46(3):392–399.
3. Gelalis ID, Politis AN, Arnaoutoglou CM, et al. Diagnostic and treatment modalities in nonunions of the femoral shaft: a review. *Injury.* 2012;43(7):980–988.
4. Lai D, Chen CM, Chiu FY, Chang MC, Chen TH. Reconstruction of juxta-articular huge defects of distal femur with vascularized fibular bone graft and Ilizarov's distraction osteogenesis. *J Trauma Acute Care Surg.* 2007;62(January 1 (1)):166–173.
5. Wu CC, Shih CH. A small effect of weight bearing in promoting fracture healing. *Arch Orthop Trauma Surg.* 1992;112(December 1 (1)):28–32.
6. Kempf I, Grosse A, Beck G. Closed locked intramedullary nailing: its application to comminuted fractures of the femur. *J Bone Joint Surg Am.* 1985;67(5):709–720.
7. Klemm KW, Börner M. Interlocking nailing of complex fractures of the femur and tibia. *ClinOrthopRelat Res.* 1986;212:89–100.
8. Brumback RJ. The rationale of interlocking nailing of the femur, tibia and humerus. An overview. *ClinOrthop.* 1996;324:292–320.
9. Dagrenat D, Moncade N, Cordey J, Rahn BA, Kempf I, Perren SM. Effects of the dynamization of static bolt nailing: in vivo experimentation. *Revue de chirurgie orthopedique et reparatrice de l'appareilmoteur.* 1988;74:100.
10. Wu CC, Shih CH. Effect of dynamization of a static interlocking nail on fracture healing. *Can J Surg.* 1993;36(4):302–306.
11. Wu CC, Chen WJ. Healing of 56 segmental femoral shaft fractures after locked nailing: poor results of dynamization. *Acta Orthop Scand.* 1997;68(6):537–540.
12. Vécsei V, Häupl J. The value of dynamic adjustment in locking intramedullary nailing [in German]. *AktuelleTraumatol.* 1989;19(4):162–168.
13. Wu CC. The effect of dynamization on slowing the healing of femur shaft fractures after interlocking nailing. *J Trauma.* 1997;43(2):263–267.
14. Giannoudis PV, Mushtaq S, Harwood P, et al. Accelerated bone healing and excessive callus formation in patients with femoral fracture and head injury. *Injury.* 2006;37(September 30 (3)):S18–S24.
15. Krettek C, Schandelmaier P, Tscherner H. Nonreamed interlocking nailing of closed tibial fractures with severe soft tissue injury. *Clin Orthop.* 1995;1(June (315)):34–47.
16. Chalidis BE, Petsatodis GE, Sachinis NC, Dimitriou CG, Christodoulou AG. Reamed interlocking intramedullary nailing for the treatment of tibialdiaphyseal fractures and aseptic nonunions: can we expect an optimum result? *Strategies Trauma Limb Reconstr.* 2009;4(2):89–94.
17. Pihlajamäki HK, Salminen ST, Böstman OM. The treatment of nonunions following intramedullary nailing of femoral shaft fractures. *J Orthop Trauma.* 2002;16(6):394–402.
18. Lynch JR, Taitsman LA, Barei DP, Nork SE. Femoral nonunion: risk factors and treatment options. *J Am Acad Orthop Surg.* 2008;16(2):88–97.
19. Vaughn J, Gotha H, Cohen E, et al. Nail dynamization for delayed union and nonunion in femur and tibia fractures. *Orthopedics.* 2016;39(November 29 (6)):e1117–23.