ORIGINAL ARTICLE

A Study on Factors Influencing Nonunion Tibia with Failed Fixation and Its Management Outcome

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Abstract

Background: Nonunion tibia is not uncommon due to various deleterious factors. We came across a significant number of cases of nonunion owing to fallacy in primary treatment modalities. This study is to analyze and identify the preventable causes of nonunion and their outcomes after our treatment with refixation and bone grafting.

Materials and methods: It is a retrospective study of 53 patients of failed fixation resulting in nonunion tibia treated in our center between June 2018 and May 2020. All patients were treated with internal fixation and bone grafting after implant removal. The surgery was done by a single surgeon for all patients with inclusion and exclusion criteria excluding open fractures.

Results: All 53 cases of nonunion united at 3 months. As per the functional outcomes concerned using short form (SF-36) score, we found 52 cases had excellent outcomes and three had late infection necessitating implant removal. We could delineate certain preventable reasons for nonunion from this study, mostly due to treatment modalities.

Conclusion: We conclude that certain technical factors play a major role in nonunion, which could be easily averted by paying meticulous attention to surgical techniques and details.

Keywords: Factors causing nonunion tibia, Nonunion tibia, Refixation for nonunion tibia, Surgical factors influencing nonunion tibia, Treatment-dependent factors.

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Introduction

The incidence of nonunion is found to be 1.9–9% on all fractures, which varies depending on the specific region. Among these, the tibia has a high incidence of nonunion.[1] To avoid this dreadful complication, it is important to explore and address their contributing factors. On reviewing the literature, various reasons have been postulated for the cause of nonunion. These include treatment-independent and treatment-dependent factors.[2] Treatment-independent factors are medical conditions or systemic illnesses, such as diabetes mellitus, vascular disease, smoking, also the pattern of fracture, and soft tissue interposition or severe soft tissue injury.[2] The treatment-dependent factors of nonunion can also be classified into those that result from inadequate fixation or inappropriate reduction, choice of implant selection, infection, and those that result from a decrease in biological activity.[3,4] By understanding these factors, one can prevent and improve the treatment of nonunion. Even though there is a rise in the treatment modality for nonunion, we often encounter these cases in our practice. It produces significant disability, pain, stiffness of neighboring joints, deformity, limb length discrepancy, and a psychological insult to patients. By better understanding fracture fixation and fracture healing biology, we can improve the outcome in those cases.[5] There are lacunae in the literature to study the cause of nonunion due to treatment-related factors or surgical-related factors. By analyzing the treatment-dependent factors, if one can meticulously improve the technical skills or reduction maneuvers, we can prevent this dreadful complication. The main objective was to assess the vivid factors influencing tibia nonunion with failed fixation and the outcome of management by refixation and bone grafting.

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Materials and Methods

A retrospective study done on patients who presented with nonunion tibia as sequelae of failed primary treatment was studied in the last 2 years. The study group consists of 38 men and 15 women aged 25–65. Inclusion criteria include all closed tibia fractures, excluding open fractures. These patients were reviewed to find the cause of nonunion. The criteria of nonunion were framed in all cases by the presence of one or more of the following tenderness at the fracture site, 9 months from index surgery, no bridging callus in two or more cortices in anteroposterior and lateral view, no radiological progression in three consecutive X-rays taken at 3 weeks interval. The Ethics Committee of Rex Ortho Hospital approved the study.[6,7] We emphasized treatment-related factors and treatment-independent factors causing nonunion. The treatment-dependent factors such as inadequate fixation, inappropriate

reduction, implant failure, and implant selection and infection. The treatment-independent factors, such highly comminuted fractures, drug intake and nonsteroid anti-inflammatory drugs, and smoking. The inappropriate reduction was defined as a postfixation fracture gap of 3 mm or more.[8,9] Factors relating to a decline in biological activity or treatment-independent include comminution and bone loss, previous radiation therapy, alcohol abuse, diabetes mellitus, and smoking. Comminution is associated with high-energy trauma.[10] We classified nonunion into treatment-dependent and treatment-independent factors. In all cases, surgery was planned after careful evaluation of the type of nonunion, presence of infection, associated bone loss, condition of the soft tissues, and stability of the previous fixation. The surgery is done by a single surgeon for all cases. The surgical exposure was dictated by the approach during the index surgery, ease of exposure of the nonunion site, and internal fixation. The bone grafts were harvested from the iliac crest in all cases requiring grafting. The assessment of the functional outcomes by SF-36 score. Radiographs in two planes were obtained at each follow-up for evidence of healing.

Surgical Technique

All the patients had undergone resurgery, and surgery was done by a single surgeon. All patients had surgery under spinal anesthesia, and prophylactic antibiotic was given. Most of the patients had a single-stage procedure, except for infection. In infection staged procedure has been carried out, that is, implant removal followed by definitive fixation with the interval of 6–8 weeks. Iliac bone graft has been harvested for bone grafting. After the debridement of the fracture site, most of the fracture was fixed with plating and bone grafting. All the patients had postoperative immobilization, intravenous antibiotics, and analgesics. Serial radiographs have been carried out in the postoperative period at an interval of 3–6 weeks and 3–6 months. All the patients had been assessed by SF-36 score postoperatively.

Results

Results were classified based on nonunion due to treatment-dependent and treatment-independent.

Treatment-independent Factors of Nonunion (Table 1)

The group of patients in whom the nonunion was found to be treatment-independent consisted of three patients. In one patient, the nonunion was strongly associated with the patient's smoking, drug abuse, addiction, as well as poor compliance, while the primary treatment of the fracture was appropriate. In two patients from the group, tibia nonunion was due to the extensiveness of the primary injury (high-velocity injury), resulting in comminution and gross displacement and soft tissue damage.

Treatment-dependent Factors of Nonunion (Table 2)

In the remaining 50 patients, the nonunion was directly related to the surgical treatment. Inadequate fixation, improper reduction, improper implant selection, fixation in distraction, infection, implant breakage, and wound breakdown were the causes of nonunion in surgically managed patients. Among these, inadequate fixation is the main cause of nonunion with 22 patients. It includes a number of locking screws used and inappropriate nail sizes. Four patients had nonunion due to infection, eight patients had nonunion due to improper reduction, seven patients had distraction at the fracture site, four patients had implant breakage, and two patients had wound breakage.

We treated all these patients with open reduction, refixation, and bone grafting.

Fifty-three cases had a satisfactory reduction in the immediate postoperative X-ray. Osseous union was achieved in 53 cases with an average healing time of 16 months. Three cases had a late infection and necessitated implant removal. As per the functional outcomes

Table 1: Treatment-independent factors

Factors	*No. of patients*
Smoking/drug abuse/addictions	1
Extensive primary injury	2
Total	3

Table 2: Treatment-dependent factors

Factors	*No. of patients*
Inadequate fixation	22
Improper reduction	7
Improper implant selection	4
Fixation in distraction	7
Infection	4
Implant breakage	4
Wound breakage	2
Total	50

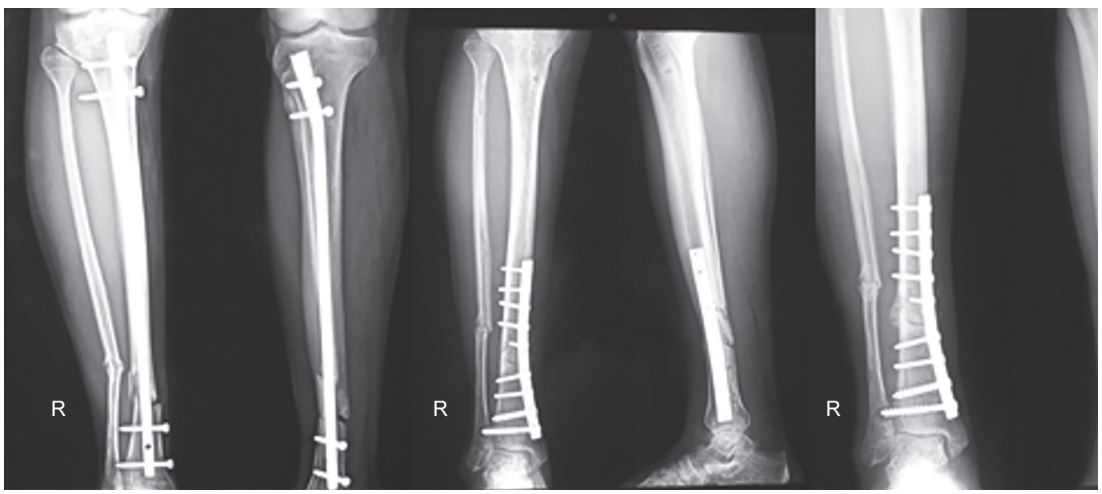
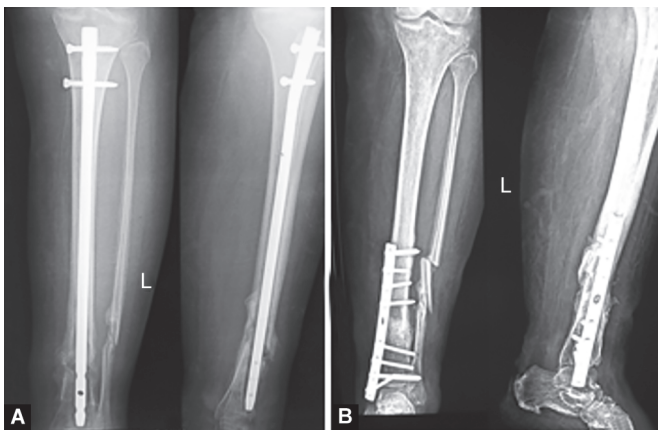


Fig. 1: Nonunion tibia due to inappropriate reduction and treated with plating and bone grafting

were concerned, according to the SF-36 score, 52 patients had an excellent score and one had a good score.

Discussion (Figs 1 to 4)

Among the treatment-independent factors, extensive primary injury (grossly displaced or comminution) is the main cause of nonunion tibia. We also advise the patients to avoid smoking as it is important and should be part of the treatment protocol to prevent nonunion. Fifty patients had nonunion due to treatment-dependent factors. Many of these factors can be improved upon. Twenty-two cases (nearly 42% of the cases) had the factor of inadequate fixation (number of locking screws and inappropriate nail size).[11] Seven patients had distraction at the fracture site after fixation. Seven patients had an improper reduction. Inadequate surgeries performed by surgeons who lack a basic knowledge of fracture management were considered to be the causes of a considerable number of the nonunion tibia. To decrease the number of inadequate surgeries, systematic education in fracture management is needed. In this series, there were four cases that sustained implant breakage that may be of nonunion. Broken implants can be a cause of early failures.[12,13] Inadequate mechanical stability or reduction can cause implant breakage. On the other hand, broken implants also lead to additional instability and may become a cause of nonunion. Fixation by plating and bone grafting has been a standard treatment for the nonunion of the tibia.[5,14] Two-stage procedures are required in the presence of infection and poor local conditions.[15] Treatment of diaphyseal nonunion of the tibia is a difficult problem. A treating surgeon should think about the various modalities to treat the nonunion.



Figs 2A and B: Nonunion tibia due to infection, staged procedure was done

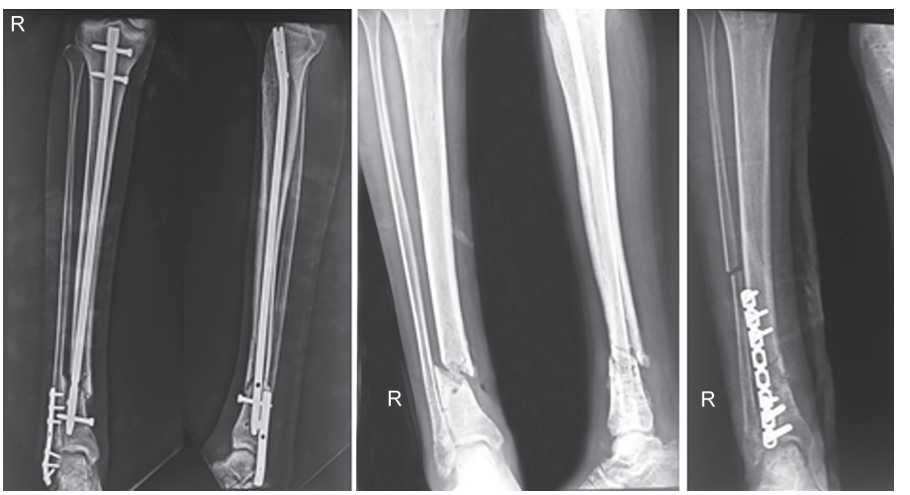


Fig. 3: Nonunion tibia due to inappropriate reduction and infection, treated with plating and bone grafting

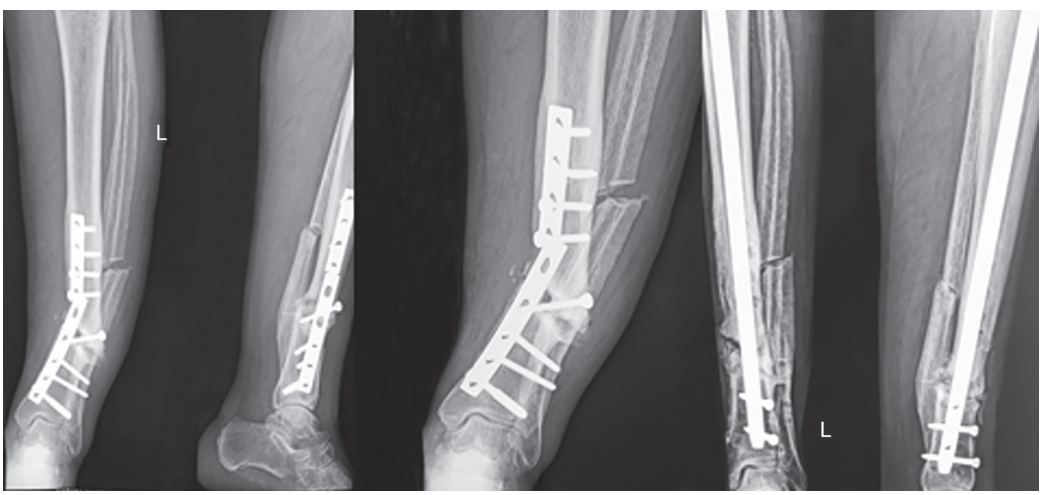


Fig. 4: Nonunion tibia due to implant failure treated with nailing and grafting

Understanding the fracture healing biology and improving the reduction maneuvers and technical skills can improve the outcomes in these patients.

Conclusion

Though treating closed tibia fractures surgically is a common procedure, the incidence of nonunion in India is on the higher side than quoted in the literature. In this study, we found more than 90% of cases had nonunion due to faulty surgical techniques, most of the inadequate fixation. This indicates that one should have meticulous training to improve surgical technique in order to prevent this disastrous complication. This correctable surgical menace has got a direct bearing on the economical and functional outcomes. Subsequent fixation and bone grafting were done by a senior consultant, which invariably gave 100% healing with bare minimal complications. This reiterates and clarifies the same.

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References

1. Mills LA, Aitken SA, Simpson AHRW. The risk of non-union per fracture: current myths and revised figures from a population of over 4 million adults. Acta Orthop 2017;88(4):434–439. DOI: 10.1080/17453674.2017.1321351
2. Bishop JA, Palanca AA, Bellino MJ, et al. Assessment of compromised fracture healing. J Am Acad Orthop Surg 2012;20(5):273–282. DOI: 10.5435/JAAOS-20-05-273
3. Rodriguez-Merchan EC, Forriol F. Nonunion: general principles and experimental data. Clin Orthop Relat Res 2004;419(419):4–12. DOI: 10.1097/00003086-200402000-00003
4. Panagiotis M. Classification of non-union. Injury 2005;36(4):S30–S37. DOI: 10.1016/j.injury.2005.10.008
5. Bungaro P, Pascarella R, Colozza A, et al. Rigid fixation with plate and bone graft in failures of intramedullary osteosynthesis for the treatment of diaphyseal nonunion of the femur. Chir Organi Mov 1999;84(3):263–267. PMID: 11569041.
6. Frölke JP, Patka P. Definition and classification of fracture non-unions. Injury 2007;38(2):S19–S22. DOI: 10.1016/s0020-1383(07)80005-2
7. 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. DOI: 10.1016/j.injury.2011.06.030
8. Fong K, Truong V, Foote CJ, et al. Predictors of nonunion and reoperation in patients with fractures of the tibia: an observational study. BMC Musculoskelet Disord 2013;14(1):103. DOI: 10.1186/1471-2474-14-103
9. Drosos GI, Bishay M, Karnezis IA, et al. Factors affecting fracture healing after intramedullary nailing of the tibial diaphysis for closed and grade I open fractures. J Bone Joint Surg Br 2006;88(2):227–231. DOI: 10.1302/0301-620X.88B2.16456
10. Murray IR, Foster CJ, Eros A, et al. Risk factors for nonunion after nonoperative treatment of displaced midshaft fractures of the clavicle. J Bone Joint Surg Am 2013;95(13):1153–1158. DOI: 10.2106/JBJS.K.01275
11. Niikura T, Lee SY, Sakai Y, et al. Causative factors of fracture nonunion: the proportions of mechanical, biological, patient-dependent, and patient-independent factors. J Orthop Sci 2014;19(1):120–124. DOI: 10.1007/s00776-013-0472-4
12. Duckworth AD, Bennet SJ, Aderinto J, et al. Fixation of intracapsular fractures of the femoral neck in young patients: risk factors for failure. J Bone Joint Surg Br 2011;93(6):811–816. DOI: 10.1302/0301-620X.93B6.26432
13. Day SM, DeHeer DH. Reversal of the detrimental effects of chronic protein malnutrition on long bone fracture healing. J Orthop Trauma 2001;15(1):47–53. DOI: 10.1097/00005131-200101000-00009
14. Bosch U, Skutek M, Kasperczyk WJ, et al. Diaphysäre oberarmpseudarthrosen - operative und konservative behandlung [Nonunion of the humeral diaphysis - operative and nonoperative treatment]. Chirurg 1999;70(11):1202–1208. DOI: 10.1007/s001040050771
15. Ueng SW, Wei FC, Shih CH. Management of femoral diaphyseal infected nonunion with antibiotic beads local therapy, external skeletal fixation, and staged bone grafting. J Trauma 1999;46(1):97–103. DOI: 10.1097/00005373-199901000-00016