PSR Press

Original Research Article

Early prediction of non union tibia from post operative follow up 3rd month radiographic union status of tibial fracture (rust) score: A systematic review and meta analysis

Govind Kumar Gupta[1],*, Subhankar Mandal[2], Sudha Rani[3], Tushar Kumar[4],*, Pancham Prasad[5] and Ratnajeet Chakraborty[5]

[1]   Department of Orthopaedics, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India, 834009.
[2]   Department of Orthopaedics, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India, 834009.
[3]   Department of Anatomy, Sheikh Bhikhari Medical College, Hazaribagh, Jharkhand. India.
[4]   Department of Anesthesiology - Trauma Rajendra Institute of Medical Sciences, Ranchi, Jharkhand, India, 834009.
[5]   Department of Orthopaedics, Rajendra Institute of Medical sciences, Ranchi, Jharkhand. India.
*   Correspondence: dr.tushar.kumar@gmail.com

Abstract: Purpose: Early prediction of the non-union tibia by the RUST score (Radiographic union score for tibia fracture) at three months postoperatively. That will help with early detection of non-union, intervene to treat the non-union and help get back to normal daily life.
Materials and method: Systematic search was done in an electronic database (Google Scholar, PubMed , Chochrane library) for articles published till 5th January 2022 investigating RUST score as a predictor for non union tibia . The new castle Ottowa scale (NOS) was used to determine risk of bias for each study.
Result: The search turned up 81 records. The final sample included three trials (2 cohorts and 1 case control study) involving 510 patients. Statistical analysis showed that if RUST score is >6 at 3rd month then there is 7.12 times more chance for union(OR -7.12, 95% CI-4.06 to 12.49). This meta analysis suggests that the RUST score at 3rd month has the potential to provide an early prediction of tibial non-union. Radiographic union scale in tibial fracture (RUST), the Newcastle ottowa scale (NOS), fracture tibia, non-union, intramedullary interlocking nail.

1. Introduction

A tibial shaft fracture is the most common long bone fracture in the human body. The annual incidence of tibial shaft fracture is 17 per 100,000 people in the world [1]. It can be managed conservatively with a reduction and plaster of Paris (pop) cast if the displacement is less than 3. Otherwise, it should be treated surgically. Road traffic accidents (RTA) are the most common cause of tibial shaft fracture in the developing world.

Most commonly, the shaft of tibia fractures is treated with intramedullary interlocking nails (ILN). The most severe complication is nonunion, characterized by pain at the fracture site and abnormal movement around the fracture. Nonunions interfere with a person's normal daily life [2]. Tibial nonunion is estimated to constitute 2-10% of all tibial fractures [3].

Various local and systemic factors lead to non-unionization. The local factors are open fracture, segmental fracture, severely comminuted fracture, inadequate fixation, poor bone contact after fixation, intact fibula, etc. Systemic factors are poor nutritional status, metabolic bone disorders, smoking, alcohol intake, etc. [4,5].

Nonunion is diagnosed clinically or radiologically when the healing process is halted for an extended period of time (more than three months) [6,7].

The RUST score is a well-known radiographic scale to assess the union status of a shaft of tibia fracture, which is treated with an interlocking nail [8]. The RUST score was determined using two radiographic views

(AP and lateral) to determine union status in all four cortices. We aimed to determine nonunion early from the RUST scores at three months postoperatively.

Despite the widespread use of the RUST score to determine tibial shaft fracture union status, no information is available that describes how the third-month postoperative RUST score will predict nonunion in the future. So, we will conduct a systemic review and meta-analysis to determine the chance of nonunion from the postoperative third-month RUST score.

2. Methods and materials

We registered Our systemic review protocol is already registered on PROSPERO (CRD42022313093). We carried out our systematic reviews and meta-analyses according to the PRISMA declaration.

2.1. Selection criteria for the study

Two authors (GKG & SM) independently searched all related articles and their attribution in two different phases, first searching the titles and abstracts and then reading the full manuscripts to search for the important parameters.

Inclusion criteria: We included 2 cohorts and 1 case control study where the 3rd month postoperative RUST score is mentioned categorical wise.

Case studies, case series, peer-reviewed articles, abstract publication, and conference presentations were not eligible.

2.2. Types of Participants

We included tibial shaft fracture patients (> 18 years) who were treated with intramedullary nails.

2.3. Exposure

RUST score at the three-month postoperative follow-up.

2.4. Outcome metrics

Union and non-union status at 12 months' follow up.

2.5. Documentation sources and retrieval strategies

We searched for all articles from PubMed, Google Scholar, and the Cochrane Library that were published before February 18, 2022. There was no language barrier. We also searched all articles from the references of the most relatable articles to make sure that we did not miss an article. Our search key words are: i) Non-union Tibia, ii) RUST score.

2.6. Extraction and quality control of data

Two authors (GKG and SM) independently extracted the data using a predesigned data extraction form. The two-tier approach was first used to solve any conflict between two authors through discussion. If it became inconclusive, we asked another author (third author) (SS) to extract data individually. Every study collected the following information: study type, authors, year of publication, country, RUST score at the third post-operative month, and union and nonunion status at the 12th postoperative month.

We used the New Castle Ottawa scale (NOS) to independently determine the bias of those studies. On this scale, a study can have a maximum of nine stars. One star can be given for each numbered item within the selection and outcome groups, and a maximum of two stars can be given for the comparability group.

2.7. Statistical evaluation

The meta-analysis was conducted using RevMan 5.3 software. A three-month follow-up is performed for categorical data such as the RUST score. The odds ratio, along with a 95% confidence interval (95% CI) were recorded, and a p-value below 0.025 was taken as statistically significant.

3. Results

3.1. Study characteristics and search results

Initially, a total of 41 titles and abstracts were preliminarily reviewed. Nine full-text articles were finally taken for final screening after removing irrelevant articles. We are trying to contact the authors of relevant articles through email, but those authors did not respond. Finally, two retrospective cohort studies and one case-control study including 510 patients were considered for analysis Figure 1 to determine the non-union from the third-month postoperative follow-up RUST score.

The demographic characteristics are summarised in Table 1. 510 patients are eligible for inclusion in the study. Two studies were performed in the USA and one in Canada. All of the included studies fulfilled the eligibility criteria. The sample size ranged from 32 to 323 people.

The statistical analysis shows that if the RUST score at the third month postoperative follow-up is > 6, there is a 7.12 times higher chance of union (OR-7.12, 95% CI-4.06-12.49), as shown in Figure 2.

4. Discussion

This systematic review and meta-analysis were carried out after a thorough literature search, pre-registration in PROSPERO, and a primary focus on the RUST score of each patient at the third month of follow-up, which predicts early nonunion. The New Castle, Ottowa Scale is used to assess the study bias. Many recent trials suggest that the RUST score is a good predictor of early detection of nonunion. No meta-analysis on the RUST score is available now which can determine early nonunion. This would be the first meta-analysis on the RUST score for early prediction of nonunion in tibial shaft fractures treated with interlocking nails.

The nonunion of the tibial shaft fracture hampers the patient's daily life. Many studies have been documented to evaluate the risk factors for nonunion [9–12]. There are some systemic factors or some local factors that affect the healing process.

Most nonunion patients need reintervention to enhance bone healing, like exchange nailing, bone grafting, or dynamization. Despite this type of intervention, the third-month RUST score remains highly effective for the early detection of nonunion cases. Most studies showed that if no callus formation is seen on the radiograph (RUST score 6) at the third month follow-up, there is a high risk of nonunion in the future.

RUST score was invented in 2010. Since then, multiple studies have shown excellent intra and inter-rater reliability to assess the union status of the shaft of tibia fracture [13]. It has been shown that the RUST score also correlates with clinical outcomes like tenderness at the fracture site, mobility at the fracture site, weight-bearing status, and the patient's functional recovery.

Other scoring systems, in addition to the RUST score, can predict tibial nonunion, such as the Leeds-Genoa nonunion index (LEG-NUT), nonunion determination score (NURD), and tibial fracture healing score (TFHS). However, these scoring systems could be more reliable.

O'Halloran et al. analyzed a cohort study of 382 patients, but the author did not mention the RUST score as a predictive device for nonunions. It was used as a device to determine the union.

There is no such cut-off value for the RUST score that will predict nonunion early on. Our meta-analysis shows that if the RUST score is > 6 in the third month, there is a 7.12 times more chance of nonunion. This score will be beneficial for the patient and the surgeon to predict the nonunion early. Early detection of nonunion may help to intervene in the condition, like reoperation, to promote bone healing.

This meta-analysis suggests that the RUST score in the third month has the potential to provide an early prediction of tibial nonunion. However, this study is only based on three studies. Several more studies are needed to predict nonunion from the RUST score accurately.

Table 1. Study details

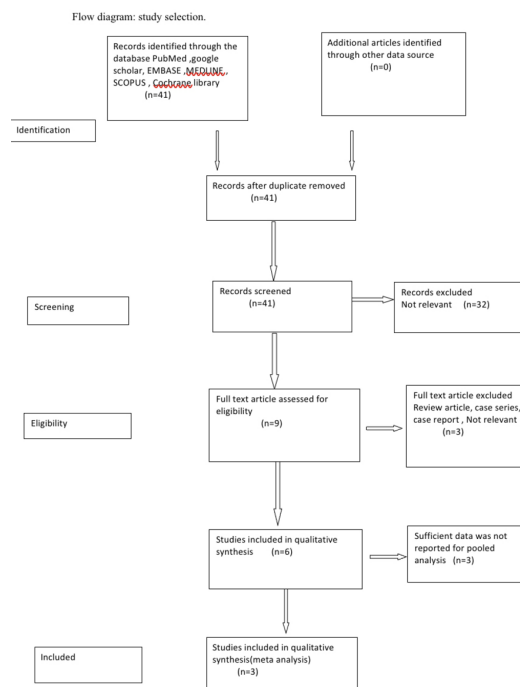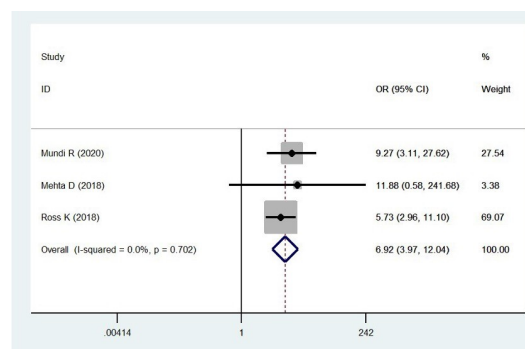| Study	Year	Country	Study Design	Sample Size
Raman mundi et al.	2020	CANADA	Retrospective cohort	155
Devan Mehta et al.	2018	USA	Retrospective cohort	32
Keir A ross	2018	USA	Case control	323

Figure 1. PRISMA flow diagram

Figure 2. forest plot

5. Highlights

1. Early prediction of non union can improve quality of life style.
2. There are no such tool available to early determine the non union.
3. In this meta analysis, it is shown that if 3rd month RUST score if less than 6, then there is 7.12 times more chance of non union

Author Contributions: All authors contributed equally to the writing of this paper. All authors read and approved the final manuscript.

Conflicts of Interest: "The authors declare that they do not have any competing interests."

References

[1] Larsen P, Elsoe R, Hansen SH, Graven-nielsen T, Laessoe U, Rasmussen S. Incidence and epidemiology of tibial shaft fractures. Injury. 2015;46(4):746e750.

[2] Brinker MR, Hanus BD, Sen M, O'Connor DP. The devastating effects of tibial nonunion on health-related quality of life. J Bone Joint Surg Am. 2013;95(24): 2170e2176.

[3] Miller NC, Askew AE. Tibia fractures. An overview of evaluation and treatment. OrthopNurs. 2007;26(4):216e223.

[4]   Fong K, Truong V, Foote CJ, et al.: Predictors of nonunion and reoperation in patients with fractures of the tibia: an observational study. BMC MusculoskeletDisord. 2013, 14:103. 10.1186/1471-2474-14-103

[5]   Tay WH, de Steiger R, Richardson M, Gruen R, Balogh ZJ: Health outcomes of delayed union and nonunion of femoral and tibial shaft fractures. Injury. 2014, 45:1653-1658. 10.1016/j.injury.2014.06.025

[6]   Chalidis BE, Petsatodis GE, Sachinis NC, Dimitriou CG, Christodoulou AG. Reamed interlocking intramedullary nailing for the treatment of tibial diaphyseal fractures and aseptic nonunions. Can we expect an optimum result? Strateg Trauma Limb Reconstr. 2009;4(2):89e94.

[7]   Singh D, Garg R, Bassi JL, Tripathi SK. Open grade III fractures of femoral shaft: outcome after early reamed intramedullary nailing. OrthopTraumatolSurg Res2011;97(5):506e511.

[8]   Whelan DB, Bhandari M, Stephen D, et al. Development of the radiographic union score for tibial fractures for the assessment of tibial fracture healing after intramedullary fixation. J Trauma. 2010;68(3):629e632.

[9]   Fong K, Truong V, Foote CJ, Petrisor B, Williams D, Ristevski B, et al. Predictors of nonunion and reoperation in patients with fractures of the tibia: an observational study. BMC MusculoskeletDisord 2013;14:103.

[10]   Bhandari M, Tornetta P III, Sprague S, Najibi S, Petrisor B, Griffith L, et al. Predictors of reoperation following operative management of fractures of the tibial shaft. J Orthop Trauma 2003;17(5):353 61

[11]   Drosos GI, Bishay M, Karnezis IA, Alegakis AK. 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 31.

[12]   Fowler J, Dubina AG, Castillo RC, Boulton CL, Nascone JW, Sciadini MF, et al. Prediction of tibial nonunions at 3 months after intramedullary nailing. Presented at the Annual Meeting of the Orthopaedic Trauma Association, Tampa, October 2014

[13]   Whelan DB, Bhandari M, Stephen D, et al. Development of the radiographic union score for tibial fractures for the assessment of tibial fracture healing after intramedullary fixation. J Trauma 2010;68:629-632