Prediction of non union in diaphysis of long bones in adults

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Research Article

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Abstract

Purpose

The study was conducted to analyze the feasibility of Rust and Modified Rust score to predict non union in adult long bones.

Methods

Literature was searched using Pubmed and articles pertaining to prediction of long bones studied. In this study randomized patients were prospectively analyzed and selected for radiographic RUST and Modified Rust scores, after internal fixation of fractures of tibia, humerus and femur.

Results

64 patients were analyzed out of which 16 cases were lost in follow up. Out of 48 patients, we predicted 6 non union cases out of which 2 patients underwent dynamization and 1 pat injPRP. The remaining 3 developed non union. Rust score and Modified Rust scores are good tools for prediction on nonunion in adult long bones.

Conclusion

Our rate of non union was 6.25% which is within the nonunion rate published in the literature.

Introduction

After institutional ethics committee approval, a prospective study was done from September 1st 2020 to February 1st 2022 at a tertiary care teaching hospital. The radiographic Union Score (RUST) helps in identifying cases of fracture nonunion in adult long bones especially for tibia and Modified Radiographic Union score (mRUST) helps in predicting the same for humerus fractures. [1, 2, 3, 4, 5]

64 consecutive patients were evaluated for predicting nonunion. The treatment of fractures of long bones depends upon the type of fracture, the extent of soft tissue injury and associated systemic disease.

Variable factors play a role in fracture healing and it is difficult to treat nonunion of diaphyseal fractures, 5–33% of tibial shaft develop nonunion in 100,000 people per year. [6, 7, 8, 9, 10, 11]

The Rust score and mRust score gives a fair assessment of healing of adult long bone fractures treated surgically. It also provides some useful information to the treating surgeon for any need of adjunct procedures like dynamization, and bone grafting to enhance fracture healing. [12, 13, 14, 15, 16]
Hence in our institution, RUST score and mRUST score was used to evaluate fracture nonunion and score at 3rd month, 4th month and 5th month was crucial to predict nonunion. The purpose of this study was to determine the ability of the scoring system to predict nonunion.

**Materials And Methods**

After institutional ethics committee approval, a prospective study was conducted to find out the union of adult long bones. An inclusion criterion was closed fractures, adults in age of 20 to 70 years, fractures of diaphysis. Exclusion criteria were infected fractures, delayed presentations, and pediatric long bone fractures, nonunions and compound fractures. A total of 64 patients fulfilled the inclusion criteria and were enrolled for the study.

Patients demographics were obtained from the Electronic Patient Record system (Trak) and radiographs of the patient, AP and lateral views were reviewed using The Picture Archiving and Communication Systems (PACS). The radiographic union scale of tibia and modified union scale were used to assess the scores of each cortex.

Data was recorded in Excel sheet from follow up from 12 weeks to 46 weeks. The average mean score for fractures was calculated for 3rd, 4th, and 5th months. Patients had undergone reamed locking intra medullary fixation for tibia, femur and few cases of humerus fractures. Other cases of humerus fractures were plated.

16 patients were excluded due to loss of follow up. None of the patients had displacement more than 1 cm after nailing or open reduction and fixation, and there was no incidence of acute compartment syndrome.

All cases of tibia and femur were subjected to partial weight bearing at 6th week and fully weight bearing at 8th week.

Scoring for cortices in humerus was difficult due to plate over lap and hence that cortex not scored. In such cases we waited for consolidation.

**Results**

Out of 64 patients enrolled, 16 patients were excluded due to insufficient follow up before diagnosis of union or nonunion.

Out of 48 patients, 6 cases were predicted with nonunion out of which 3 patients underwent additional procedures, 2 were femur and 1 was tibia.

1 patient of tibia underwent dynamization at rust score of 6 at 18th week which ultimately united, 1 patient of tibia underwent injection PRP at rust score of 8. 1 case of fracture femur underwent
dynamization at Rust score 6 at 22 weeks. All 3 patients had union achieved, the duration was at 40 weeks.

In our series, 3 patients out of 48 patients went into nonunion as patients did not accept any additional procedures. Hence the nonunion rate was 6.25%.

The median time to diagnose nonunion was at 38 weeks.

The mean rust score was 7 at 16 weeks. At this score bridging callus was noted to predict union.

The presence of bridging callus at 4th month and 5th month is variable and its absence predicted that some additional procedures need to be carried out. In our series all patients with fracture of humerus who had undergone ORIF with plating or underwent interlocking nailing through their mRUST scores were less went on to heal but beyond 6 months.

Due to plate fixation the cortices with bridging callus is difficult to visualize and we scored leaving one cortex out.

Fracture healing is variable and our results are comparable with other studies.

No patient whose fracture was deemed to have united was later diagnosed with implant failure or required any additional procedures for healing related complications.

**Discussion**

This study demonstrated significant help from the use of RUST and mRUST scores in predicting union or nonunion in fractures of adult long bone.

Long term outcomes of diaphyseal fractures by scoring by formation of callus, bridging of callus and obliteration of fracture line gives a clue on progression of healing state.\(^{[17,18,19,20,21,22]}\)

Collection of scores: For medial, lateral, anterior and posterior cortices we analyzed whether there was fracture line, callus, and whether the callus was bridging the cortices and finally obliteration of fracture line. The RUST score and mRUST scoring method was used and data entered in Excel sheet.

The data reflected in the study denote prospective prediction of nonunion by using mRUST score due to the fact that the plate obscures the cortices and also since open internal fixation is done absolute stability, little of callus could be visualized.\(^{[23,24,25,26,27,28]}\)

Hence in our data sheet we retrained scoring for the cortices involved and recorded lower mRUST scores for humerus. A RUST score of 10 indicated 2 cortices united and remodeled. The score of 6–9 is ideal for the time intervention by dynamization.\(^{[29]}\)
In our study, 1 patient of tibia underwent dynamization at Rust score 6 at 18 weeks. 1 patient of tibia underwent injection PRP at rust score of 8 at 12th week, both fractures of tibia united the RUST scores for one tibia was 12 at 28 weeks and the Rust score for another tibia was 12 at 40 weeks (this patient had injection PRP when Rust score was 8 at 12th week).

1 patient of femur underwent dynamization at RUST score 6 at 22 weeks, the femur united with Rust score 12 at 48 weeks.

The Rust score and mRust score should not be used at 6 weeks and 12 weeks due to inability to accurately predict fracture healing.

The overall rate of nonunion was 6.25% due to 3 patients not willing for additional procedures despite predicting nonunion. In our series to achieve tricostical bridging was beyond 5 months except one case where fracture united within 5 months.

The mean Rust score was 4.8 in a study by Mundi et al. [30] In our study, it was 5.6 at higher rate. The overall mean Rust score was 6.3 and in our study, the Rust score was 7.3.

Thus a numerical value by Rust score and mRust score to fractures which are healing after operative fixation can have sensitivity and specificity to predict nonunion.

While using the mRust score, we hereby caution that despite lower scores in earlier months based on our findings all humeral fractures united at 38–40 weeks.

The 3 month Rust score remains effective for fractures of femur and a Rust score of 4 or 6 are having 48% risk of nonunion.

The only limiting factor in our study which was prospective proper radiographic sequences is variable due to non adherence of strict follow up by patients.

**Conclusion**

Our rate of non union was 6.25% which is within the nonunion rate published in the literature. The RUST Score and Modified RUST Score helps the surgeons to note the progression of bone union in fracture of diaphysis of long bones.

**Declarations**

CONFLICTS OF INTERESTS: The authors declare that there are no conflicts of interests

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ETHICS: Approval Obtained
References


Tables

Table-1: RUST score

<table>
<thead>
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<th>Cortex score</th>
<th>Callus</th>
<th>Fracture line</th>
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</tr>
<tr>
<td>2</td>
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<tr>
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Table-2: Modified Rust score

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</tr>
<tr>
<td>3</td>
<td>Bridging</td>
<td>Visible</td>
</tr>
<tr>
<td>4</td>
<td>Remodeled</td>
<td>Invisible</td>
</tr>
</tbody>
</table>

Figures
Figure 1

Fracture Humerus
Figure 2

At 14 weeks mRUST score 6 of Humerus
Figure 3

At 40 weeks mRUST score 14 of Humerus
Figure 4

Fracture right tibia AP and lateral views
Figure 5

Fracture tibia at 16 and 28 weeks
Figure 6

Rust score 11 of Tibia at 32 weeks