

# Validating the Modified Radiographic Union Score for Tibia and Evaluating its Correlation with Clinical and Patient-Reported Outcomes in Pediatric Patients with Femoral Shaft Fractures

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## INTRODUCTION:

The global burden of trauma has increased significantly over the years, causing particular impact on low-middle income countries (LMICs). The ability to measure bone healing and union is essential in assessing efficacy of fracture treatments and ensuring optimal patient outcomes. Historically, a successful fracture treatment was defined as radiographic union. However, the definition of union remains poorly defined. As such, the Modified Radiographic Union Score for Tibia (mRUST) was developed to quantitate radiographic findings as a means to measure and define a spectrum of radiographic healing. Studies on the reliability of mRUST in pediatric femoral shaft fractures is limited, and its correlation with validated patient-reported outcome tools, such as the Pediatric Quality of Life Inventory (PedsQL), has not been studied. In this study, we aim to assess the reliability of mRUST, as well as assessing its correlation with clinical and patient-reported outcomes (PROs).

## METHODS:

This is post-hoc analysis of a randomized control trial looking at outcomes for pediatric patients in Tanzania who were treated with either titanium elastic nails or Kirschner wires for femoral shaft fractures. Patients in this study were followed up at 6 weeks, 3 months, 6 months, and 1 year after their initial surgery. Radiographic findings were assessed by two North American Orthopaedic Surgeons and mRUST scores were generated based on their findings. Reliability was assessed with the use of Cohen's kappa and bland-altman plots, as appropriate. The average of the two mRUST scores was calculated and used to observe its association with clinical outcomes, including malunion, and squat depth. Malunions were defined using the Kasser and Beaty criteria. Descriptive statistics and ANOVA were used, as appropriate, to describe these relationships. Additionally, PROs were measured using PedsQL, a 23 domain survey assessing mental, emotional, and physical health of patients. Spearman correlations were used to assess how well mRUST correlates with both child and parent PedsQL scores.

## RESULTS:

A total of 52 patients were identified as having sufficient radiographic information to determine an mRUST score. Agreement of mRUST scores were excellent, with a mean difference of 0.05 (-0.10- 0.19), and a 95% limit of agreement ranging from -1.71- 1.62 (Figure 1). Average mRUST scores at 6 week, 3 month, 6 month, and 1 year follow up were 9.8 (SD 2.1), 13.1 (SD 1.6), 15.5 (SD 1.8), and 15.7 (SD 1.6), respectively ( $p < 0.01$ ). When assessing squat depth, the average mRUST score for patients who were able to place their hip above the level of their knee was 11.2 (SD 3.2), while those who were at the level of the knee or below had averages of 12.8 (SD 2.6) and 14.1 (SD 2.8), respectively ( $p < 0.01$ ). There were only 3 malunions, for which the mRUST scores were 6, 13, and 13.5 (AUROC 0.74,  $p = 0.15$ ). One patient had a nonunion. There was strong correlation between PedsQL child and parent scores ( $\rho = 0.94$ ,  $p < 0.01$ ). Similarly there was also a strong correlation between mRUST and PedsQL child and parent scores ( $\rho = 0.75$   $p < 0.01$ , and  $\rho = 0.76$   $p < 0.01$ , respectively) (Table 1).

**DISCUSSION AND CONCLUSION:** The mRUST scores increased significantly between each follow-up period, indicating a relationship between time and degree of bone healing. Additionally, mRUST scores predicted squat depth and malunion rates effectively. However, malunion rates were very low in this study, a larger scale study to assess the relationship between mRUST and malunions is merited. There was a strong correlation between mRUST and PedsQL, a validated PROs tool. The use of PROs has been increasingly used in clinical practice. As such, there is now a need for efficient and accurate tools that can relate clinical and radiographic findings to these metrics. This study demonstrates that mRUST can potentially act as this tool pending further, large-scale investigation.

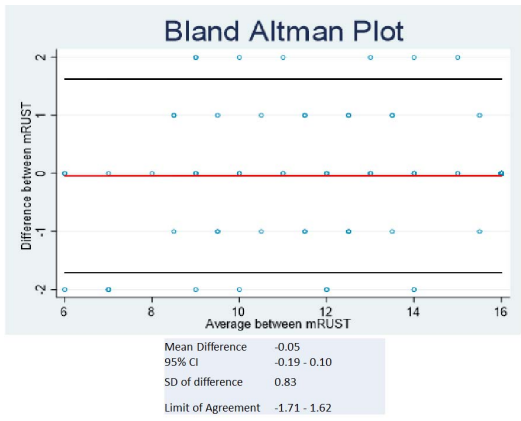


Figure 1. Bland Altman Plot of mRUST Scores

**Table 1. Spearman Correlations between mRUST and PROs tools**

	mRUST	PedsQL Child	PedsQL Parent
mRUST	-	0.75 (<0.01)	0.76 (<0.01)
PedsQL Child	0.74 (<0.01)	-	0.94 (<0.01)
PedsQL Parent	0.76 (<0.01)	0.94 (<0.01)	-