Low-Intensity Pulsed Ultrasound in Acute Tibial Shaft Fractures Treated with IM Nails: The Results of the TRUST Trial

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Background/Purpose: Tibial shaft fractures are one of the most common fractures treated by orthopaedic trauma surgeons and results of large trials have shown continued disability at 1 year. Additionally, functional outcome has been correlated with radiographic progression to union. The plateau period for functional outcome is between 6 months and 1 year for patients with fractures that heal without secondary intervention. Decreasing the time to union would likely hasten the recovery of patients. The use of low-intensity pulsed ultrasound (LIPUS) for acute tibial fractures has support in prior studies in animals and also in small series of tibial shaft fractures in adults. However, due to limitations of prior studies, the effect of LIPUS on promoting functional recovery for acute tibial fractures treated with IM (intramedullary) nailing remains uncertain. The purposes of this study were to evaluate the use of LIPUS on validated functional outcomes of patients with acute tibial fractures treated with IM nails and to evaluate healing using the RUST method (Radiographic Union Scale for Tibial fractures).

Methods: This trial was designed as a multicenter (43 centers) randomized, blinded, placebo/treatment controlled evaluation of the effects of LIPUS on validated functional outcomes (Short Form [SF]-36 PCS [Physical Component Summary] and HUI [Health Utilities Index]-III) and healing (RUST score). All patients over 18 years old with an acute closed or open fracture of the tibial diaphysis who were to be treated with intramedullary nailing were eligible. Fracture exclusion criteria included: soft-tissue damage precluding the use of the device, bilateral fractures, segmental fractures, and defects after open fracture of >75% of the circumference and longer than 1 cm. Patients were allocated to an active or sham LIPUS device through central randomization in a 1:1 ratio, stratified by fracture severity (ie, open vs closed). Patients used the device once daily after training. The device was set to an automated 20 minutes and recorded compliance. Outcomes were obtained at 6, 12, 18, 26, and 52 weeks. The study was powered for the minimum clinically significant difference in the SF-36 PCS using a repeated measures analysis at three levels (patient, center, and visit) at 500 patients assuming a 10% loss to follow-up. Time to adjudicated union was evaluated using a Cox proportional hazards regression model.

Results: 501 patients (156 F, 345 M, average age 38 years) with 114 open and 387 closed fractures were enrolled. The fracture patterns were: comminuted (132), transverse (114), spiral (177), and oblique (154). 125 were lost or withdrew consent, and 303 patients were followed for 1 year at which point the interim analysis met stopping rules and the study was concluded. The results are summarized in Table #1. There was no difference in time

to union, with the hazard ratio = 1.06 (95% confidence interval [CI]: 0.85, 1.33), P = 0.594. The Kaplan-Meier curves for percentage not united for both groups in days from surgery are seen in Figure #1.

Conclusion: LIPUS does not result in improved functional outcomes or time to union in patients with tibial diaphyseal fractures treated with IM nails. Only the presence of an open fracture had a negative influence on outcomes.

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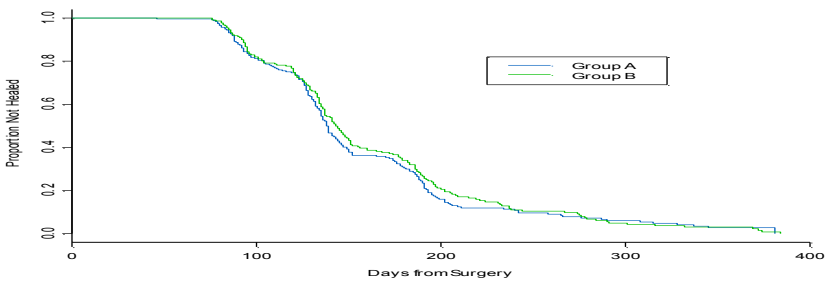
Table 1: 3-Level Repeated Measures Analysis. N=2294 observations from 477 patients (p values)

	SF-36 PCS	HUI-III
Randomized Treatment	0.346	0.345
Time from surgery	<0.001	<0.001
Open vs closed fracture	0.008	<0.001
Treatment by time interaction	0.230	0.904
Open/closed by time interaction	0.629	0.965
Pre-injury score	<0.001	<0.001

Figure #1



See pages 47 - 108 for financial disclosure information.