

Time to Union in Ballistic Trauma Lower Extremity Diaphyseal Fractures Treated with Intramedullary Nailing

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Purpose: Civilian firearm injury is an accelerating public health crisis and ballistic long bone injury has become more common as a result. The time to union in these injuries is variable. This study compares the time to union in tibial and femoral shaft fractures treated with an intramedullary nail secondary to ballistic trauma (BT) to open and closed fractures secondary to blunt trauma.

Methods: Diaphyseal femoral and tibial shaft fractures from a single Level I trauma center between 2015 and 2020 were identified. Six distinct groups were formed: (1) BT tibial shaft fracture (N = 20), (2) OPEN tibia shaft fracture (N = 20), (3) CLOSED tibial shaft fracture (N = 20), (4) BT femur shaft fracture (N = 20), (5) OPEN femur shaft fracture (N = 14), and (6) CLOSED femur shaft fracture (N = 20).

Radiographic union scale (RUS) fracture scoring system was performed by 2 separate individuals. A 2-way analysis of variance was performed to compare RUS in BT, OPEN, and CLOSED groups up to 1 year postoperatively, using $P = 0.05$ for significance. A nonlinear sigmoidal model was performed to predict fracture healing.

Results: CLOSED tibia RUS was significantly higher than both BT and OPEN ($P < 0.038$ and $P < 0.0003$) at 4-6 months. At 7-9 months, CLOSED RUS was significantly higher than OPEN RUS ($P < 0.01$); however, BT was not significantly different from CLOSED or OPEN. At greater than 1 year postoperatively, OPEN RUS was delayed compared to CLOSED and BT injuries (Fig. 1A).

Femoral OPEN fractures at 4-6 months postoperatively showed significantly lower RUS than CLOSED and BT injuries ($P < 0.027$ and $P < 0.031$). At later time points, all 3 groups achieved union with mean RUS > 10 (Fig. 1C).

The sigmoidal best-fit model predicts time to fracture healing when RUS > 10 and can be seen in Fig. 1B and 1D.

Conclusion: This study demonstrates that tibial shaft fractures from a ballistic mechanism heal at a rate that is not significantly different from closed fractures using the RUS after 6 months postoperatively. Additionally, femoral shaft fractures from a ballistic mechanism healed similarly to closed and open fractures from a blunt mechanism.

