

## Butterfly Fragments Heal Unpredictably in Otherwise Anatomically Nailed Diaphyseal Tibia Fractures

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**Purpose:** The natural history of diaphyseal tibial butterfly fragments is poorly documented. Numerous studies have analyzed risk factors for nonunions in the tibial shaft with known factors including Gustilo classification, American Society of Anesthesiologists (ASA) class, and cortical contact. However, the healing potential and ideal management of nonsegmental butterfly fragments in this setting remains unknown. The aim of this study was to determine the nonunion rate of diaphyseal tibial fractures with a butterfly fragment.

**Methods:** A retrospective chart review of patients at a single Level I tertiary referral center from 2000 to 2020 who underwent intramedullary nailing of tibial shaft fractures was performed. Those with nonsegmental butterfly fragments (OTA / AO: 42-B) and minimum 12-month follow-up were included. Morphologic measurements of butterfly fragments were performed to measure location, size, and displacement, and mRUST (Modified Radiographic Union Scale for Tibial Fractures) scores at final follow-up were calculated.

**Results:** A total of 99 patients were included with 21 patients requiring revision surgery to promote union. 36 patients had open fractures and 77% of patients were male with a mean age of 34 years (range, 12-80). The most common location of the butterfly fragment was the anterior cortex (42%), with a mean length of 7.8 cm (standard deviation [SD] 3.3) and width of 1.8 cm (SD 0.5cm). At final follow-up 37% of fractures had persistent lucency without callus at the site of the butterfly, while only 31% of fractures had remodeled cortex at final follow-up. Average time to complete healing was 13.3 months. Open fractures with butterfly fragments were more likely to go on to nonunion than closed (44% vs 9.2%,  $P < 0.001$ ). The length of the butterfly fragment was not different between the union and nonunion groups (7.7 vs 7.5,  $P = 0.42$ ). The postoperative combined displacement on AP/lateral radiographs of the butterfly was higher in the nonunion group (12.7 mm vs 7.9 mm,  $P < 0.001$ ).

**Conclusion:** In this series of tibial shaft fractures with butterfly fragments, there was a high nonunion rate in patients who sustained open and closed fractures. Open tibial shaft fractures with a butterfly fragment had a nonunion rate that approached nearly 50%. Perhaps adjunct treatment of butterfly fragments, such as lag screws around a nail at the time of the index surgery, despite being contrary to existing dogma, could improve healing rates. Given the nonunion rate of these fragments, such alternative treatment merits further study.