Are 3.5mm Plates and Screws Ideal Forearm Fixation? Biomechanical Analysis of Diaphyseal Forearm Refracture

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Introduction: Diaphyseal forearm fractures including those of the radius, ulna, and both bones are common injuries that can result from a wide variety of mechanisms. Early literature reported the results of reconstruction with 4.5 mm and 3.5 mm, large and small fragment, plate and screw constructs. Both of these provided adequate strength of fixation in order to facilitate fracture union, but the incidence of periprosthetic fracture and refracture with the use of 4.5 mm plates and screws was much higher. As a result of this data, 3.5 mm small fragment fixation has been the standard of care. Reported plate removal rates are high and the need for removal is sometimes unavoidable. At the time of these publications, smaller screws were not generally available for clinical use, but today we have many more fixation options available. Despite this, there are no studies in the literature examining the use of screws smaller than 3.5 mm, such as 2.7 mm screws, for fixation of diaphyseal forearm fractures. The purpose of this study is to examine the effect of screw hole size and the risk of re-fracture. We believe that the use of 2.7 mm screws will significantly decrease the risks of refracture, just as was observed in the comparison of 4.5 and 3.5 mm plates.

Methods: Two screw hole models were created to compare 2.7 mm threaded holes and 3.5 mm threaded holes. The first involved standard four-point bend test of acrylic tubing with one screw hole of either size to measure peak force required for fracture. The second model consisted of lengths of tube with two holes, one of each size, in each length. Ten samples were divided into two groups; one four-point bend group and one torsion group.

Results: In the single hole portion of the experiment all samples fractured through the screw hole. The 2.7mm screw hole group had a significantly higher peak fracture force as compared with the 3.5mm group (225.5 vs 166.7, p<.05). The second portion of the experiment with two screw holes in each length of tube fractured at the 3.5mm screw hole in all ten samples in both bending (5 samples, p=.0015) and torsion (5 samples, p=.0015). All bending samples showed a transverse or slightly oblique fracture pattern and the torsion produced all spiral fractures.

Discussion: Despite the high union rates achieved with the use of 3.5 mm plates and screws in the treatment of diaphyseal forearm fractures, refracture and peri-implant fracture remain significant concerns. Refracture after removal of hardware from diaphyseal forearm fractures can be a major complication and proposed methods to decrease this risk have had some success, but remain very problematic. In our study, we have provided strong evidence, in a biomechanical model, that fracture risk in the diaphyseal forearm is strongly correlated to screw hole diameter. This supports the hypothesis that the currently widely accepted use of 3.5 mm screws likely poses a greater risk of refracture than would the use of constructs with 2.7 mm screws. However, the effect on fracture healing
rates with the use of smaller diameter screws is not known. Therefore, this study provides a strong rationale for further investigation of the use of 2.7 mm screws in order to determine if a new standard of preferred fixation for diaphyseal forearm fractures should be established. **Significance:** This study demonstrates that the use of 2.7 mm screws for plating of forearm fractures has the potential to greatly decrease re-fracture risk.

![Incidence of Failure 2.7mm vs 3.5mm](image1)

**Figure 1.** Incidence of failure for two-hole test in bending and torsion. Five samples were used in each test.

![Torsion sample](image2)

**Figure 2.** Torsion sample depicted with bone cement on either side showing spiral fracture initiating through the 3.5mm screw hole.

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