Optimal Screw Fixation in Treating Jones Fractures

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Introduction/Purpose: Jones fractures are among the most common fractures in the foot, mainly occurring in athletes. In order to facilitate return to sport and good functional outcomes, management with intramedullary screw fixation is often recommended [1-3]. While optimal screw dimension and location parameters have varied in the literature, it is clear that maximizing pull-out strength, providing adequate compression across the fracture, and minimizing irritation to surrounding soft tissue structures are of paramount importance. The aim of this study was to improve our guidelines regarding optimal insertion trajectory and screw parameters of Jones fractures by more accurately defining the bony and soft tissue anatomy of the fifth metatarsal bone and its intramedullary canal.

Methods: 21 fifth metatarsal bones were harvested from cadaveric feet. Three reference screws were placed on each bone for registration. 3D CT model of each bone with outer cortex, intramedullary canal and the articular cortex was created (Figure A). The insertions of the PB and PF and the reference screws of each bone were carefully digitized and mapped onto corresponding 3D model. The anatomic insertions and the surface areas were determined. Based on the length of the bone, the shape of the intramedullary canal, and the diameter of the canal at its narrowest point, the perceived ideal screw and placement was then modulated for each bone model. Also, the fracture zone where Jones fractures occur was determined (Figure B) based on Lawrence/Botte classification [1]. Screw and thread length were calculated in this position, and the impact of screw placement on the insertion sites of both the PB and PF were recorded.

Results: The mean length of the bones was 74.4±3.6mm, with the narrowest diameter of the intramedullary canal being 4.3±0.7 mm. Ideal screw position was identified as parallel to the cuboid and coaxial with the intramedullary cortex; this placement, however, was found to partially sacrifice the PB and PF insertions in 62% (13/21) and 33% (7/21) of cases, respectively; with an average of 1.6±0.8 mm of the PB and 1.3±0.8 mm of the PF insertion. The mean ideal screw length in this position was found to be 47.8±5.8 mm, with a minimal thread length of 28±6.8 mm and a minimal diameter of 4.5 mm (Figure B). The ratio of screw length to the total bone length was 0.64 (range 0.50-0.72).

Conclusion: In order to maximize compression and pull-out strength and minimize sacrifice of the adjacent soft tissue structures during screw placement, Jones fractures should be fixed with hardware parallel to the cuboid and collinear with the intramedullary cortex—which mitigates but does not avoid injury to the peroneal tendon and plantar fascia. Average optimal length of the screw should be 64% of the length of the bone, with a minimum 4.5 mm diameter and 50% thread length (relative to bone length). Given variability in metatarsal anatomy, screw choice should be tailored to the individual.
(a) The outer cortex (grey), intramedullary canal (red) and the articular surface (green) are identified within each bone model.
(b) A screw model is placed coaxial with the intramedullary cortex, to keep the articular cartilage intact while optimizing the length of the screw.