A Custom-Designed Adjustable Surgical Guide Improves the Ease of K-Wire Placement in Transverse Middle Phalanx Fractures

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INTRODUCTION:

K-wire fixation of phalangeal fracture is a standard yet tricky procedure for both learners and those who may perform the procedure in low volumes. As such, in collaboration with attending hand surgeons, the senior author has designed a novel surgical guide to assist with the procedure. Using the novel Adjustable Surgical Guide (ASG) developed by the senior author will allow for placing the Kirschner wires (K-wires) in phalanx fractures with greater ease, fewer total attempts, and fewer total radiographs than the standard freehand technique. A pilot study was performed to test if, in fact, using the device could influence all the above categories.

METHODS:

Ten cadaveric hands were used. Transverse fractures of the middle phalanx in the long finger of each cadaveric hand were created using a sagittal saw from a dorsal approach. The soft tissue was subsequently closed to ensure the fracture could not be directly visualized. All hands were then pinned with 0.45-inch K-wires via a standard freehand technique and using the ASG. The ASG was custom designed, and 3D printed from radiolucent material to allow for use with fluoroscopy. Freehand technique and ASG use were alternated to ensure no bias favoring one approach over the other. Each trial was performed under fluoroscopic guidance by one fifth-year orthopaedic surgery resident. Excess attempts per pin (defined by attempts over the initial one), total time, number of radiographs, and resident-perceived difficulty were recorded by a second observer. Pins were placed retrograde in a crossed-pin configuration. Because all hands were pinned both freehand and with the ASG, repeated measure t-tests were used to analyze significant differences in outcome variables with a threshold of $p<0.05$.

RESULTS:

All outcome variables favored the use of the ASG over freehand technique. Excess attempts, on average, were 5.4 for freehand and 3.1 for ASG ($p=0.098$). The number of radiographs on average was 45 for freehand and 28.4 with the ASG ($p=0.008$). The average time to finish was 7.92 minutes for freehand and 7.14 minutes with the ASG ($p=0.356$). Resident-perceived difficulty on a scale from 1-10 (10 being most difficult) was 5.2 for freehand and 4.3 for ASG ($p=0.162$).

DISCUSSION AND CONCLUSION:

The use of the ASG improved the ease of phalanx pinning as well as reducing the total number of radiographs and excess attempts. While all results were not statistically significant, every category of outcomes favored the ASG over freehand. This device has the potential to provide a useful low-cost training and surgical tool for surgeons performing phalanx fractures. Future work will evaluate the effect of using the ASG on surgeons of varying experience levels to determine the benefit this device can provide to surgeons at all levels of their careers.

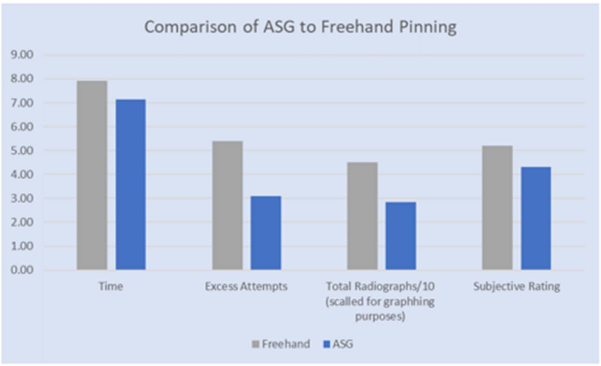

Figure 1: Outcomes measures for comparison of freehand transverse middle phalanx pinning, vs. use of ASG

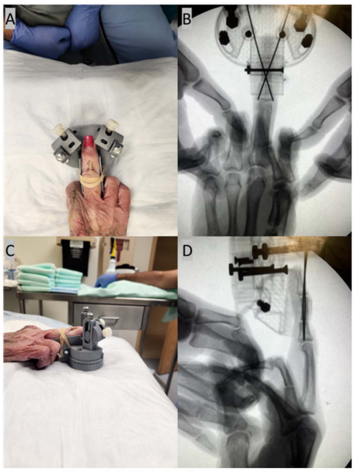

Figure 2 A) AP photo of hand in the ASG.
B) AP radiograph of a hand in the ASG with pins in place.
C) Lateral photo of a hand in the ASG.
D) Lateral radiograph of a hand in the ASG with pins in place.