Proximal Phalanx Structural Integrity in Flexor to Extensor Tendon Transfer: A Biomechanical Study

Matthew S Ross, MD, Greg Gould, BS, Katie Flower, BS, Richard T Laughlin, MD

Wright State Orthopaedics
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Introduction

- The flexor to extensor transfer of the flexor digitorum longus (FDL) tendon
- Common operative procedure for the treatment of:
  - flexible hammer toe deformity
  - chronic metatarsophalangeal (MTP) dislocation
- A rare complication of the flexor to extensor transfer is iatrogenic fracture through the drill hole site

FDL tendon being passed through the drill hole in the proximal phalanx
Arthrex.com 2007
Purpose

• To understand the force necessary to create a fracture through the average drilled proximal phalanx

• Correlate that force to the amount of bone remaining after the drilling process.
Materials and Methods

- The 2nd, 3rd, and 4th toes of 14 fresh frozen cadavers were dissected and the proximal phalanx was removed.
- One half of the 2nd, 3rd, and 4th digit proximal phalanxes of fourteen cadaver feet were drilled with a 3.5mm drill bit as is often done in a tendon transfer procedure.
- The other matched non-drilled proximal phalanxes were used as matched controls for the drilled bones.
• Radiographs of the bones were taken
• The dimensions of the proximal phalanx were measured at the drill hole site or where the drill hole would be placed
• Measurements were made to calculate the area and volume of bone, volume of the drill hole, and the percentage of bone remaining with the drilled hole
• The bones (both drilled and undrilled) were tested for load to failure using a biomechanical testing apparatus (Enduratec SmartTest Pnuematic Machine)
Results

- The diameter of the bone averaged 8.1mm in the 2\textsuperscript{nd} toe, 7.2mm in the 3\textsuperscript{rd} toe, and 6.26mm in the 4\textsuperscript{th} toe.
- The drill hole resected approximately 20\% bone volume in the 2\textsuperscript{nd} toe, 25\% in the 3\textsuperscript{rd} toe, and 30\% in the 4\textsuperscript{th} toe of the bone drill hole area.
- 50\% of the bones fractured with forces between 100 and 200 N, 25\% with forces less than 100 N, and 25 \% with forces greater than 200 N.
- 83\% of the bones with diameters less than 6 mm fractured with less than 100 N of force.
- 86\% of the bones that were drilled fractured at the drill hole site, the remaining bones fractured at locations distal to the drill site.
• The average decrease in load to failure of the second toe after drilling was 89.8 percent of the non-drilled control
• The third toe was 75.8 percent vs. control
• The fourth toe was 63.3 percent vs. control.
Conclusions

• Bone diameter was the main determinant of the strength of the structure

• Iatrogenic fracture may occur in tendon transfer procedures with proximal phalanges with a diameter of less than 6 mm

• In pre-operative planning for a flexor tendon transfer a radiograph of the digit should allow the surgeon to analyze the dimensions of the digit and decide if the proximal phalanx is capable of withstanding a drill hole with sufficient size for the tendon to pass through.
References


