Frequency of third extensor compartment drill bit perforation in case of volar plating of radius fractures

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Objective of this study was to explore how frequently the third extensor compartment was penetrated by drilling distal screw holes when doing volar plating of distal radius fractures. Four different plates were tested on altogether one hundred and sixty cadaver forearms. All distal holes were drilled; the exit holes were analyzed on the dorsal radius cortex.

The overall penetration risk amounts to 43 percent. Differences could be observed: 3.5 LCP 4-hole locking T-plate: 20 percent, 3.5-LCP 3-hole locking plate: 42.5 percent, 2.4 volar LCP standard plate and the 2.4 volar LCP buttress plate: 55 percent. When doing volar plating of radius fractures, the surgeon should be aware of a considerable risk of penetrating the third extensor compartment. Extensor pollicis longus tendon may be harmed by drilling or by a prominent screw. Injuries to the extensor pollicis longus tendon may be avoided by not perforating the dorsal cortex, and downsizing the screws.

Research in the literature reveals miscellaneous causes of extensor pollicis longus tendon ruptures following distal radius fractures (Al-Rashid et al. 2006, Arora et al. 2007, Benson et al. 2006, Douhit 2005, Failla et al. 1993, Heidemann et al. 2002, Hela et al. 1982, Hove 1994, Jenkins and Mackie 1988, Payne et al. 2000, Stahl and Wolf 1988, Wong-Chung and Quinlan 1989). Since volar plate fixation of distal radial fractures has become increasingly popular, extensor pollicis longus tendon ruptures seem to increase, whereas no evidence exists for this observation (Benson et al. 2006, Failla et al. 1993, Wong-Chung and Quinlan 1989). Objectives of this study were as to follows: 1. to assess how frequently the third extensor compartment is perforated by drilling; 2. to determine the differences between diverse implants; 3. to discuss potential solutions to avoid this complication.

Materials & methods

One hundred and sixty forearms of eighty cadaveric specimens preserved according to Thiel's method were investigated with a mean age of 69.5 years (48-96 years; 43 female, 37 male) (Thiel 1992). No extremities demonstrated arthrosis, evidence of trauma, or other pathological changes. The plates used for this experimental study were: 3.5mm 4-hole locking compression T-plate (four distal holes in a row; Figure 1: plate number 1), 3.5mm 3-hole locking compression plate (three distal holes in a row; Figure 1: plate number 2), 2.4 volar locking compression buttress plate (five distal holes in a row; Figure 1: plate number 3), 2.4 volar locking compression standard plate (five distal holes in a row: Figure 1: plate number 4; all four Plates from Synthes GmbH, Switzerland). A total of 160 trials were performed. Each of the four plates was tested on forty forearms. After the soft tissue was completely stripped of the bone, the four different plates were applied on the volar side. The plates were applied

Figure 1: plates used for this study; plate number 1:3.5mm 4-hole locking compression T-plate; plate number 2:3.5mm 3-hole locking compression plate; plate number 3:2.4 volar locking compression buttress plate; plate number 4:2.4 volar locking compression standard plate

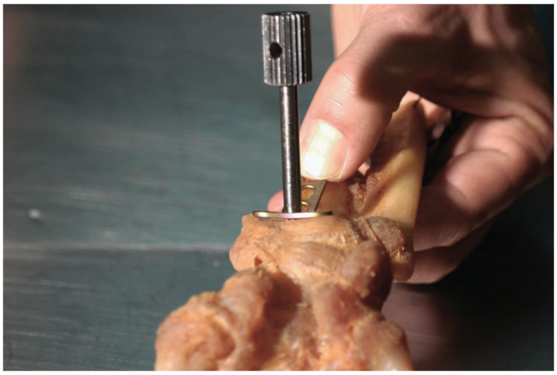

Figure 2: volar applied 3.5 LCP plate with mounted screw-in drill guide.

centred on the radius bone, according to the manuals of the manufacturer. Following correct application, the screw-in drill guide was mounted, and drilling was done by using the compulsory drill bit for each system (Figure 2). In each plate all distal holes were drilled bicortically. The procedures were done by two different surgeons; each did half of the trials. After the drilling, the exit holes were analyzed on the dorsal surface of the radius. Exit holes in the area of the third extensor compartment were recorded. Data was entered into a computerized database and analyzed subsequently.

Results

The survey shows considerable differences between the four different plates used. The overall risk of penetrating the third extensor compartment regarding all four plates is 43 percent (69/160). The 3.5 LCP 4-hole locking T-plate had the lowest perforation rate amounting to 20 percent (8/40 cases). Five times (63 percent) perforation was observed when drilling hole three (counting the holes from radial to ulnar) and three times (37 percent) when drilling hole number two. The 3.5-LCP 3-hole locking plate was second: 42.5 percent of the drill bits penetrated the third extensor compartement (17/40 cases). In all cases perforation was seen when drilling the middle hole. The 2.4 volar LCP standard plate and the 2.4 volar LCP buttress plate had equal results with a total perforation rate of 55 percent (22/40). The 2.4 volar LCP standard plate had the highest perforation rate in the central hole (13 cases, 60 percent), four perforations (18 percent) were seen when drilling the hole radial to the middle hole and five perforations (22 percent) were observed when drilling the hole ulnar to the middle hole. The 2.4 volar LCP buttress plate showed likewise the highest perforation rate in the middle hole (14 cases, 64 percent), each four perforations (18 percent) were seen when drilling the hole radial and ulnar to the middle hole. Statistic analysis was done using Microsoft Excel ® software (Redmond, Washington, United States). Pearson coefficient of correlation was used to find statistic correlations between gender (p-value>0.05) or side (p-value>0.05) and our results. P-values below 0.05 were seen as statistically significant. No statistical correlation between gender or side and these results could be found.

Discussion

Research in literature reveals an incidence of extensor pollicis longus ruptures following distal radius fractures between 0.07% and 8.6%. In the majority of cases ruptures have occurred between one to three months after the injuries (Al Rashid et al. 2006, Heidemann et al. 2002, Jenkins and Mackie 1988). Incidence of extensor pollicis longus ruptures seem to increase since volar plate fixation has become a standard procedure for the treatment of distal radial fractures, whereas this observation requires additional clarification and analysis (Benson et al. 2006). The objective of this study is to explore how frequently the third extensor compartment is perforated by drilling the distal holes.

The results show an overall rate of third extensor compartment perforation of 43 percent. However, a distinct difference of perforation risks can be observed among the four plates. Plates providing more distal holes (2.4 volar LCP standard plate and the 2.4 volar LCP buttress plate: both 5 distal holes in a row) with less distance in between show an increased risk of third extensor compartment perforation.

When doing volar plating of radius fractures the surgeon should be aware that already penetrating the third extensor compartment by drilling may harm the extensor pollicis longus tendon: Al-Rashid et al. present a patient suffering from extensor pollicis longus tendon rupture following volar plate osteosynthesis. The exploration of the extensor compartment has shown no evidence of screw protrusion, but an empty drill hole at the base of the third dorsal compartment (Al-Rashid et al. 2006). This complication may be prevented by not perforating the dorsal cortex when drilling the middle distal screw holes.

Confirming the correct screw length displays difficulty in some cases and may be affected by the Lister tubercle for example. Imprecise measurements lead to an incorrect screw length. Dorsally prominent screw tips may harm the tendons of the third extensor compartment promoting an extensor pollicis longus tendon rupture. Al-Rashid et al. (2006) present three different cases with ruptures of an extensor tendon, two of them caused by attrition on a screw perforating the third compartment. Rozental and Blazar (2006) report one patient presented with dorsal swelling and irritation caused by a prominent screw making hardware removal necessary. Nevertheless, not only sharp screw tips irritate the extensor pollicis longus tendon: Orbay and Fernandez (2002) report one case of dorsal tendon irritation from an excessively long peg which was treated with hardware removal. To avoid tendon attrition on prominent screws, shorter lengths for screws used in the middle plate holes are therefore to recommended (Arora et al. 2007, Benson et al. 2006). Some authors advice to downsize the screw length routinely by 2 millimetres (Arora et al. 2007, Musgrave and Idler 2005). Recent literature has demonstrated that the distal screws of a fixed-angle plate system should act as a rake maintaining reduction when placed close to the subchondral zone. Stability is optimized by placing the distal screws as close as possible to the subchondral zone (Drobetz et al. 2006). Perforating the dorsal cortex may not increase rigidity.

It is our hypothesis that by not perforating the dorsal cortex and selecting shorter screws, injuries to the extensor pollicis longus tendon may be avoided.

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