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Original Article

Anatomic considerations when performing the modified Henry approach for exposure of distal radius fractures

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ABSTRACT

Background: Identify the proximity of anatomic structures during the modified Henry approach (MHA).
Methods: Distances between median nerve (MN), palmar cutaneous branch (PCB), radial artery (RA) and the flexor carpi radialis (FCR) were measured at the wrist crease (WC), 5 and 10 cm proximal in 16 fresh frozen cadavers. The FPL origin and innervation was measured.
Results: Most at risk was the MN proximally and the PCB distally while the RA was safe. Innervation occurred at the proximal third of the FPL's origin along the ulnar aspect.
Conclusion: The MHA is safe when understanding the proximity of structures.

1. Introduction

Distal radius fractures are among the most common fractures seen in adults.[1,2] Operative treatment of distal radius fractures has increased dramatically over recent years secondary to the introduction of volar locking plates.[3] Koval et al. noted that operative treatment of distal radius fractures increased from 42 to 81% in 8 years.[4] The most common surgical approach for the application of volar plates is through the modified Henry approach. Complications from volar plating of distal radius fractures vary from 3 to 27% which includes neurovascular injury.[5–8] Accurate understanding of the neurovascular anatomy of the volar aspect of the distal radius is therefore fundamental in avoiding iatrogenic injury during the surgical approach.[9]

The two most common approaches to the distal radius are the classic Henry approach between the flexor carpi radialis (FCR) tendon and the radial artery, and the modified Henry approach through the sheath of the FCR tendon. Both approaches use an 8–10 cm skin incision directly over the FCR tendon differing only in the superficial interval utilized to expose the deep volar compartment.[10] The classic Henry approach requires identification and protection of the radial artery, while the FCR tendon sheath and the palmar cutaneous branch (PCB) of the median nerve are preserved. The modified Henry approach requires incision of the FCR tendon sheath to allow ulnarward retraction of the FCR tendon. Incising the floor of the FCR compartment allows access to the deep volar compartment. The advantage of this approach is avoiding dissection and potentially injury to the radial artery; however, the PCB of the median nerve does run within the sheath of the FCR tendon, thus subjecting it to potential injury during surgery.

Upon entering the deep compartment of the forearm, the modified Henry approach often requires elevation of the flexor pollicis longus (FPL) off the distal radius to improve visualization of the fracture. In the immediate postoperative period, FPL weakness has been reported.[11] It is unknown how much of the FPL origin can be elevated safely prior to weakening the muscle or possibly causing denervation of the FPL.

In addition to de-innervation of the FPL, other nerves are at risk of injury during the Henry approach. The median nerve and its PCB are located on the ulnar aspect of the FCR. Several studies have looked at the anatomic relationship of these structures at the level of the wrist, but the relationship of these structures are not static and have not been described through out the whole modified Henry incision.

The aim of this study was to examine the modified Henry approach to the distal radius for a distance of 10 cm from the volar wrist crease, documenting the proximity of key neurovascular structures including the median nerve, the PCB of the median nerve and the radial artery to the FCR tendon. We additionally were

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interested in the location, length and innervation pattern of the FPL muscle origin. We hypothesized that incision through the FCR tendon sheath would not place any of the vital neurovascular structures at direct risk of injury and distal elevation of the FPL origin may weaken but would not deinnervate the muscle; however a more detailed understanding of the regional anatomy may decrease neurovascular complications reported in the literature

2. Methods

Sixteen fresh frozen upper extremity cadavers were amputated above the elbow. All limbs were matched for size. No limbs had evidence of previous wrist or forearm surgery. Demographic data for the cadavers is not available in our programs cadaveric donor program.

Full thickness flaps were raised along the line defined by the course of the FCR tendon along the length of the forearm. Care was taken not to disturb the anatomic position of neurovascular structures. A standard ruler was used to make measurements. The width of the FCR tendon was measured at the level of the wrist crease in eight of the cadavers. All measurements were made with reference to the most distinctive wrist crease. The distance from the radial aspect of the FCR tendon to the ulnar edge of the radial artery was measured at the wrist crease and at 5 and 10 cm proximal to the wrist crease.

The distance between the radial edge of the median nerve and the ulnar border of the FCR tendon were measured at the same three reference points. After obtaining measurements for the radial artery and median nerve, the interval between the FCR and median nerve was dissected to identify the PCB of the median nerve. The distance between the origin of the PCB and wrist crease was measured. In eight of the cadavers, the sheath of the FCR tendon was then opened and the relationship between the PCB and the FCR tendon was examined at the level of the wrist crease.

Finally the FPL was then dissected; the distal end of the bony muscular origin was identified and measured from the wrist crease. The beginning of the bony muscular origin was identified and measured from the wrist crease. Lastly, the anterior interosseous nerve (AIN) nerve was then identified proximally, followed distally until all branches of AIN that were identified and measured. The muscle was divided into thirds in which third of the muscle the branches innervated the muscle.

3. Results:

The FCR tendon was an average of 5.6 mm (std dev: 0.99) wide at the level of the wrist crease (Table 1). The distance between the radial aspect of the FCR tendon and the ulnar aspect of the radial artery was wider proximally than distally. At 10 cm proximal to the wrist crease, the average distance was 4.2 mm (std dev: 1.8), 4.4 mm (std dev: 1.5) at 5 cm and 5.3 mm (std dev: 2.7) at the level of the wrist crease.

While the median nerve lies separate from the FCR tendon at the wrist, the two structures were closely related proximally in the forearm. The radial aspect of the median nerve was 0.1 mm (std dev: .3) away from the ulnar aspect of the FCR at 10 cm proximal to the wrist crease and continued to diverge going distally. At 5 cm proximal to the wrist crease, the two anatomic structures are 2.2 mm apart (std dev: 1.3) and by the wrist crease the two structures were 4.5 mm (std dev: 2.2) apart.

The PCB of the median nerve branched off from the radial aspect of the median nerve at an average of 48.6 mm (std dev. 18) proximal to the wrist crease and tracked radially toward the FCR (Fig. 1). The palmar cutaneous branch of the median nerve ran within the ulnar edge of the sheath of the FCR tendon but never crossed the tendon. A schematic of the distances are summarized in Fig. 2.

The FPL muscular origin terminated on average 81.5 mm (std dev: 13.5) and started 199 mm (std dev 23) from the wrist crease The FPL footprint on average was 117.5 mm in length (std dev: 11). Branches from the AIN innervated the FPL along the ulnar aspect of the muscle belly along the proximal third of the muscle (Fig. 3).

4. Discussion

This study demonstrates that there is a changing relationship between the radial artery, FCR tendon and median nerve over the distal 10 m of the volar forearm. Secondarily, the flexor pollicis has a 117.5 mm bony origin with ulnar sided innervation within the proximal third of the muscle. Previous studies have looked at individual anatomic positions of specific key neurovascular structures but not in the context of the whole length of the modified Henry approach. MR scanning has been utilized to identify a 7 mm safe zone on either side of the center of the FCR tendon to avoid damage to the median nerve and radial artery at the level of the watershed line of the distal radius.[12] An anatomic study has reported the distance from PCB to FCR was 3.4 mm, median nerve to FCR was 8.9 mm and radial artery to FCR was 7.8 mm at the level of the watershed line of the radius.[9] However, the authors of this anatomic study obtained measurements from the center of the FCR tendon, which does not take into account variability in diameter of the tendon itself and makes surgical interpretation difficult.[9] We chose to perform measurements from the edges of the FCR sheath to eliminate variability in the tendon

Table 1
Averages and standard deviation of measurements in centimeters of all 16 cadavers.

Anatomic landmarks measured	Average distance (mm)	Standard deviation
Distance between radial aspect of FCR and ulnar aspect of radial artery at wrist crease (mm)	5.3	2.7
Distance between radial aspect of FCR and ulnar aspect of radial artery 5 cm proximal to wrist crease (mm)	4.4	1.5
Distance between radial aspect of FCR and ulnar aspect of radial artery 10 cm proximal to wrist crease (mm)	4.2	1.8
Distance between ulnar aspect of FCR and radial aspect of median nerve at wrist crease (mm)	4.5	2.2
Distance between ulnar aspect of FCR and radial aspect of median nerve 5 cm proximal to wrist crease (mm)	2.2	1.3
Distance between ulnar aspect of FCR and radial aspect of median nerve 10 cm proximal to wrist crease (mm)	0.1	0.3
Distance between ulnar aspect of FCR and radial aspect of PCB at wrist crease (mm)	0	0
Bifurcation of PCB from median nerve distance from wrist crease	48.6	18
PCB ever cross FCR?	No	
Width of FCR tendon at wrist crease (mm)	5.625	0.99
Proximal aspect of FPL origin to WC	199	23
Distal aspect of FPL origin to WC	81.5	13.5
Length of origin footprint of FPL	117.5	11.2
Innervation of FPL by AIN	Proximal 1/3	
Innervation of FPL by AIN	Ulnar aspect	

FCR, flexor carpi radialis; PCB, palmar cutaneous branch; FPL, flexor pollicis longus; WC, wrist crease; AIN, anterior interosseous nerve.