Evaluating ulnar tunnel morphology in response to wrist kinematics

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SUMMARY

This study evaluates the influence of wrist kinematics on the morphology and dimensions of the ulnar tunnel, a crucial area for ulnar nerve function. By analyzing 30 formalin-preserved cadaver hands, the study investigates the changes in the ulnar tunnel's compartments—proximal, middle, and distal—across various wrist positions, including flexion, extension, radial, and ulnar deviations. Results indicate significant alterations in the tunnel's dimensions, particularly during wrist flexion and ulnar deviation, where the tunnel length and width decrease, impacting the ulnar nerve and its surrounding structures.

The ulnar tunnel is a dynamic structure, with all compartments influenced by wrist motions. These findings highlight the importance of wrist positioning in diagnosing and treating conditions related to ulnar nerve compression and entrapment. Understanding these dynamic changes could guide surgeons in improving outcomes during ulnar tunnel surgeries and addressing nerve compression syndromes.

Key words: Pisohamate arcade – Pisohamte hiatus – Ulnar nerve – Ulnar tunnel – Wrist kinematics

INTRODUCTION

The Ulnar Tunnel was first described by anatomist and urologist Felix Guyon after his observation of cadaveric wrist dissection revealed small protruding fatty tissues at the distal forearm after he applied pressure to the hypothenar eminence. After further dissection, he discovered the space and described it as an "intra-aponeurotic space (Guyon, 1861). Within the tunnel lie the ulnar nerve, ulnar artery, and venae commitantes, embedded in connective fatty tissue. The ulnar nerve is slightly deeper and medial to the ulnar artery, and it divides inside the space into superficial and deep branches. Similarly, the ulnar artery divides into superficial and deep branches, forming the superficial palmar arch and the deep palmar arch of the hand, respectively (Denman, 1978; Depukat et al., 2014).

The tunnel is a composite space rather than a true canal, comprising several distinct anatomical compartments (Dupont et al.,1965; Gross and Gelberman, 1985). Despite its small size, the tunnel's dynamic morphology — affected by wrist motion as reported by Jackson Ombaba and his colleagues with three compartments that have variable morphologies, dimensions, and boundaries (Ombaba et al., 2010).

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While previous studies have described the tunnel's topographical relationships, few have explored how wrist kinematics influence its compartments and their relationship to ulnar nerve entrapment. This study aims to fill that gap by providing a detailed examination of the tunnel's anatomical structures and the effects of wrist positioning on its morphology.

MATERIALS AND METHODS

This descriptive cross-sectional study involved 30 formalin-preserved cadaver hands (22 male and 8 female), consisting of 15 right and 15 left hands, with ages estimated to range from 32 to 60 years and a mean age of 55.5 years. The cadavers used showed no apparent deformities, fractures, or pathologies. Cadavers that showed no range of movement were excluded from the study.

All the specimens were positioned supine, with the elbow and wrist extended. A transverse incision was made 10 cm proximal to the distal palmar crease, followed by a second transverse incision at the level of the webs of the fingers in the palmar aspect of the wrist. A longitudinal incision was then made across the palm, between these two transverse incisions on the anterior surface of the third digit. The skin, subcutaneous tissue, and palmar aponeurosis were cleaned and removed. The palmaris brevis muscle was detached and reflected medially. The palmar fascia covering the hypothenar muscles was cleaned.

The ulnar nerve and artery, as well as the origin of the hypothenar muscles, were exposed.

Ulnar tunnel boundaries

After removing the anterior wall of the tunnel, all the boundaries were thoroughly dissected and delineated along its length, with emphasis on the distal part, including the pisohamate arcade and hiatus. The ulnar tunnel was divided into three compartments in relation to the pisiform bone, as we followed the same classification reported by Ombaba et al. (2010) in their study of the anatomy of the ulnar tunnel: a proximal compartment proximally to the pisiform bone, a middle at the level of the pisiform between the proximal and distal surfaces of the pisiform, and a distal compartment distally to the pisiform bone. The entire length of the tunnel was measured from the proximal compartment, proximal to the palmar carpal ligament, to the distal compartment, distally to the hook of the hamate. Digital calipers were used to measure tunnel dimensions in millimeters, (LCD Digital Electronic Vernier Caliper Gauge Micrometer, 150 mm, 6 inches). The length, width, and height of each compartment were measured as the length measured from the proximal to the distal surface, width from the ulnar to the radial surface, and height from the floor to the roof, and recorded in millimeters. The length of the pisohamate arcade was measured and recorded from its ulnar attachment on the pisiform bone to the radial attachment on the hook of the hamate. The thickness was measured from the midpoint of the arcade and recorded. The length, width, and height of the pisohamate hiatus were also measured and recorded. The length was measured from the ulnar to the radial direction; the width was measured from the distal pisiform (proximally) to the point in line with the center of the pisohamate arcade (distally); and the height was measured from the floor of the pisohamate hiatus to the point in line with the pisohamate arcade. All measurements were taken with the wrist in a neutral position. By using the goniometer, the neutral wrist position was defined as the position in which the angle between the third metacarpal bone and the radius and ulna was zero degrees.

Ulnar tunnel kinematics

Wrist kinematics were studied in two planes of motion: flexion/extension and radial/ulnar deviations. All wrist positions were performed passively by applying maximal force to the cadaver's hand and moving the wrist toward the targeted position. wrist motion was controlled using a goniometer (a 10.16- cm plastic 360-degree goniometer) to ensure accuracy in positioning and measured the maximum range of motion of each wrist position. The range of motion was measured three times, and the average of the readings was recorded.

We measured and recorded the ulnar tunnel length in all wrist positions, as well as the length, width, and height of the three compartments in each wrist positions. Next, we measured and recorded changes in the length of the pisohamate arcade fibers across all wrist positions. Additionally, the length, width, and height of the pisohamate hiatus were measured and recorded in each wrist positions.

Statistical analysis

Data were analyzed using the Wilcoxon signed-rank test to compare measurements across different wrist positions. Two tailed p value of < 0.05 is considered significant.

Ethical consideration

The study has been approved by Standing Committee for Scientific Research Ethics- Jazan University (SCSRE) (Ref.no. REC42/1/117).

RESULTS

The ulnar tunnel has three compartments in relation to the pisiform bone: proximal, middle, and distal. Each has special boundaries, relationships, and dimensions (Fig. 1). The ulnar tunnel's average length was 42 mm in the neutral position, with male specimens exhibiting significantly longer tunnels than female specimens (Table 1). The length, width, and height of the different compartments of the ulnar tunnel with the wrist in a neutral position are listed in Table 2.

Table 1. The length of the ulnar tunnel in neutral position in males and females' hands. Test for equality of means showed significant difference between males and females in the length of the ulnar tunnel.

Sex	Length (mm) M (SD)	T	Sig. (2-tailed)
Males	42.92 (1.8)	2.643	**.026**
Females	40.24 (2.7)		

The pisohamate arcade is a musculotendinous, curved, or C-shaped structure that was detected in 19 (63.3%) hands (Fig. 2). The arcade length and thickness were measured and listed in Table 3. It originates proximally as a ligament at the confluence of the flexor carpi ulnaris tendon and the anteromedial surface of the pisiform bone,

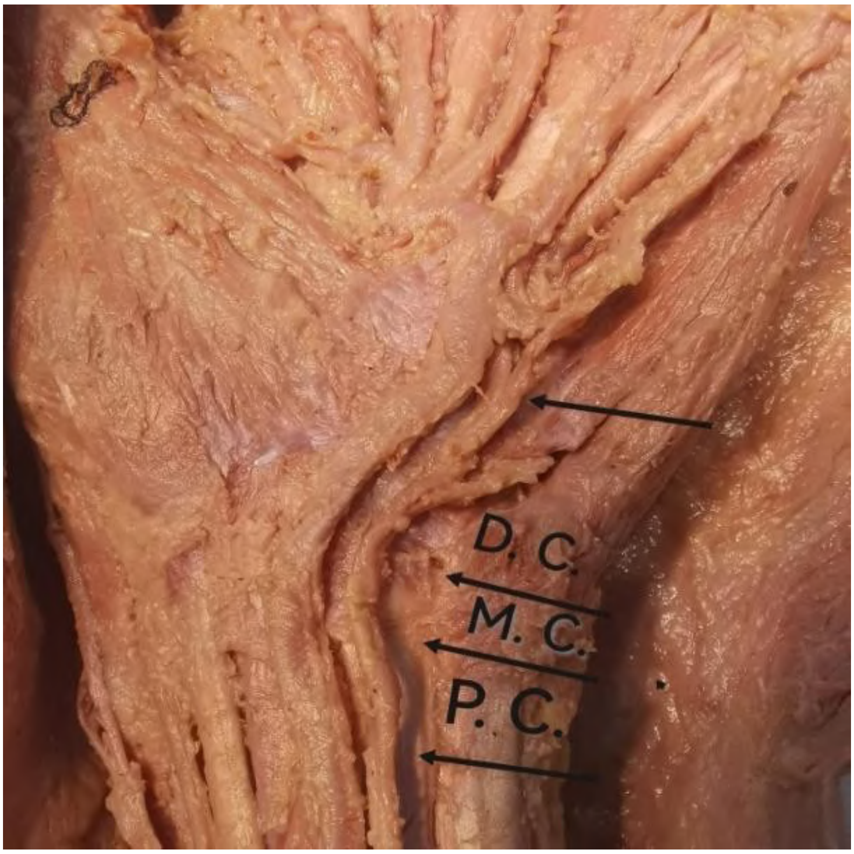

Fig. 1.- Ulnar tunnel compartments after dissecting the roof. Arrows show P.C.: proximal compartment, M.C.: middle compartment, D.C.: distal compartment.

then curved distally to blend with hypothenar muscles, the abductor digiti minimi and the flexor digiti minimi muscles to reach the hook of hamate radially. The arch span between the pisiform and the hook of the hamate to roof the opening that lodge the deep branch of the ulnar nerve. The fibers more developed proximally where they appear thicker than distally. The arcade was musculotendinous and well-developed in all specimens, except in eight of specimens, in which it was pure muscular; in five specimens, the muscular fibers of the arcade were found to give the flexor digiti minimi its origin between the pisiform and the hook of the hamate. In the remaining three specimens, there was an intermuscular space between the flexor digiti minimi and abductor digiti minimi.

The pisohamate hiatus is a rounded opening in 19 out of 27 (70.4%) and oval in 8 hands (29.6%). The pisohamate hiatus measurements in the neutral positions are listed in Table 3. It is located in the floor of the ulnar tunnel, bordered proximally by the pisiform bone and distally by the hook of the hamate bone, roofed by the pisohamate arcade

Table 2. The dimensions of the ulnar tunnel and its different compartments in the neutral position.

Dimensions						
	Length (mm)		Width (mm)		Height (mm)	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
Ulnar tunnel	42.23 (2.4)	36.1 - 46.7	-	-	-	-
Proximal compartment	10.91 (1.8)	5.0 - 14.5	5.0 (1.4)	3.4 - 9.7	6.3 (1.9)	4.0 - 9.8
Middle compartment	10.88 (1.2)	8.4 - 13.3	4.0 (0.8)	3.1 - 5.9	4.9 (1.6)	2.7 - 8.3
Distal compartment	20.44 (2.0)	17.2 - 27.0	5.5 (1.2)	4.0 - 8.5	3.8 (1.0)	2.0 - 6.2

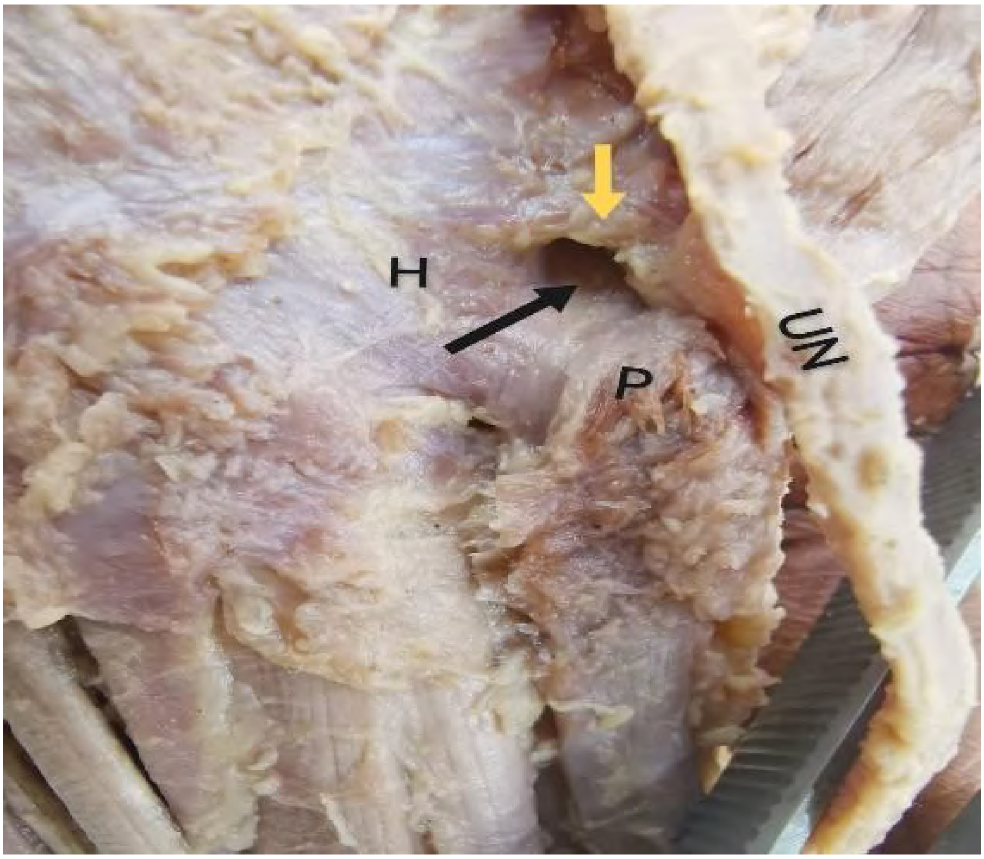

Fig. 2.- Distal compartment structures: Pisohamate arcade (yellow arrow), Pisohamate hiatus (black arrow), UN: ulnar nerve with its deep branch enters the hiatus, P: pisiform bone, H: hamate bone.

Table 3. The dimensions of the pisohamate hiatus and pisohamate arcade in the neutral position.

Dimensions						
	Length (mm)		Width (mm)		Height (mm)	
	M (SD)	Range	M (SD)	Range	M (SD)	Range
Pisohamate hiatus (OP)	6.04 (1.1)	4.2 - 9.1	5.8 (0.9)	4.4 - 7.6	4.6 (1.4)	2.1 - 7.1
Pisohamate arcade length (AR1)	9.01 (1.7)	5.8 - 12.4	-	-	-	-
Pisohamate arcade thickness (AR2)	1.44 (.35)	.9 - 2.7	-	-	-	-

and the proximal part of the palmaris brevis muscle. Distally, the flexor and abductor digiti minimi muscles constitute part of the roof. The floor is formed by the pisohamate ligament, pisometacarpal ligament, and opponens digiti minimi distally, where the hiatus narrows and declines. The pisohamate hiatus contains the deep branch of the ulnar nerve and the deep palmar branch of the ulnar artery, which run deep into the pisohamate arcade in four of the specimens, while in the 23 hands, the deep branch of the ulnar nerve is the only content of the pisohamate hiatus (Fig. 2).

Kinematics of the ulnar tunnel (Table 4)

With wrist flexion, the average length of the ulnar tunnel significantly decreased, and all tunnel compartments significantly decreased in length. The width of the middle compartment decreased from an average of 4.02 mm to 3.6 mm, while there were no significant changes in the width of the proximal and distal compartments. There was no significant change in the height of the proximal, middle, or distal compartments.

With wrist extension, the length of the ulnar tunnel significantly increased. The proximal compartment showed a significant increase in length from an average of 10.91 mm to 11.04 mm, while there was no significant change in the length of the middle or distal compartment. The width of the proximal and middle compartments decreased from an average of 5.0 mm to 4.8 mm and from 4.02 mm to 3.92 mm, respectively. There was no significant change in the width of the distal compartment. The height of the middle compartment decreased from an average of 4.89 mm to 4.78 mm.

With wrist ulnar deviation, the length of the ulnar tunnel decreased from an average of 42.2 mm to 41.7 mm. The length of the middle compartment also decreased from an average of 10.9 mm to 10.4 mm. The width of the proximal and middle compartments decreased from an average of 5.0 mm to 4.8 mm and from 4.02 mm to 3.8 mm, respectively. There was no significant change in the height of the proximal, middle, or distal compartments.

With wrist radial deviation, there were no significant changes in the length, width, and height of any of the three compartments of the ulnar tunnel.

Pisohamate arcade

During wrist flexion, the length of the pisohamate arcade significantly increased from an average of 9.0 mm to 9.7 mm, converting from a C

Table 4. The length of the ulnar tunnel at different positions.

Position	N	Mean	Std. Dev.	Percentiles		
				25th	(Median)	75th
Neutral Position (M1L)	30	42.23	2.36	40.84	42.91	43.67
Flexion (M2L)	30	40.40	2.50	39.15	40.35	42.75
Extension (M3L)	30	42.42	2.41	41.45	42.91	44.35
Ulnar deviation (M4L)	27	41.70	2.40	39.56	42.63	43.60
Radial deviation (M5L)	29	42.10	2.31	40.78	42.80	43.60

shaped or curved to a little linear structure. There were no changes in measurements with the wrist in extension, ulnar, or radial deviations.

Pisohamate hiatus

During wrist flexion and ulnar deviation, there was a significant decrease in the length of the pisohamate hiatus, from an average of 6.0 mm to 5.4 mm and 5.98 mm, respectively. The width also decreased from an average of 5.8 mm to 4.99 mm and 5.7 mm, respectively. The height decreased during wrist flexion, from an average of 4.6 mm to 4.4 mm. There were no significant changes in length, width, or height in extension or radial deviation.

DISCUSSION

The ulnar tunnel is an area of interest due to its small size and the complicated relationships among its components. There is also increasing attention from hand surgeons toward the anatomy of the ulnar palmar region as a result of different pathologies that lead to compression of the ulnar nerve that passes through the tunnel. Although the topographic relationships of different parts of the ulnar tunnel have been described in previous studies (Zeiss et al.,1992; Cobb et al.,1996; Ombaba et al., 2010; Pierre et al., 2011), some anatomical structures remain to be established or agreed upon, such as the components of the anterior wall of the ulnar tunnel and the structures related to the distal part or that exit the tunnel, where variant nomenclatures have been used for the same structure by different authors, leading to misinterpretation and confusion.

The distal compartment of the ulnar tunnel is considered an area of ulnar nerve compression or entrapment. Bozkurt et al. (2005), reported that the distal part of the ulnar canal is the most common site for ulnar compression due to the different causes. Hayes et al. (1969) and Murata et al. (2004), believe that the cause of ulnar nerve entrapment is the presence of a fibrous arch over the deep ulnar nerve in the distal end of the Guyon's canal.

In the current study, we explored the anatomy of the ulnar tunnel with a focus on the distal compartment and examined whether there is a significant effect of wrist kinematics on the tunnel morphology and different structures of the tunnel.

The figures reported for the length of the ulnar tunnel in previous studies varied from 27 to 45 mm (Gross and Gelberman, 1985; Cobb et al., 1996; Bozkurt et al., 2005; Ombaba et al., 2010; Pierre et al., 2011). Our finding concurs with these measurements, as we found the average length of the ulnar tunnel to be 42.2 mm in neutral position (range, 36 to 46.7).

According to our measurements, the length of the ulnar tunnel extends from the proximal border of the palmar carpal ligament to the hook of the hamate 12 mm distally. This finding aligns with Ombaba et al. (2010) result, which indicate that the ulnar tunnel extends from 2.5 mm proximal to the pisiform to 12.8 mm distal to the hook of the hamate.

We found that the male cadavers have a significantly longer ulnar tunnel than female cadavers, with a mean length of 42.9 mm compared to 40.2 for the female ones (p- value.004). This difference may be due to the morphological variations between the two genders, as noted by Depukat et al. (2017), who stated that male cadavers generally have wider wrists and longer and wider metacarpals compared to female cadavers. They reported a difference of 4.50 to 4.00 cm in the dimensions of the ulnar tunnel length between males and females. Additionally, an anthropometric hand study found significant difference between male and female volunteers in measurements of wrist width, depth, circumference, palm length, and hand width, with male volunteers showing greater measurements in all categories (Reckelhoff et al., 2015).

Ombaba et al. (2010) in their study of the anatomy of the ulnar tunnel, divided the tunnel into three anatomical compartments according to the bony landmarks. In our study, we followed the same division, considering the ulnar tunnel to have three compartments in relation to the pisiform bone: the proximal, middle, and distal compartments. Each compartment has its own dimensions, boundaries, and relationships.

We found that the anterior wall of the proximal compartment is formed by the palmar (volar) carpal ligament, which is a continuation of the antebrachial fascia. In the middle compartment, the anterior wall consists of the hypothenar fascia, which covers the pisiform and proximal parts of the palmaris brevis muscle. In two out of the thirty hands we dissected, the palmaris brevis muscle was absent and replaced by the hypothenar fascia.

The anterior wall of the distal compartment is formed by the palmaris brevis muscle and the hypothenar fascia. These findings align with those reported by Gil et al. (2015), who reported that the anterior wall of the ulnar tunnel is formed mainly by the hypothenar fascia and the palmaris brevis muscle. In contrast to what Cobb et al. (1996) mentioned in an anatomic study of the carpal-ulnar neurovascular space, the central part of the anterior wall was open and contained only adipose tissue.

At the wrist in neutral position, the middle compartment was the narrowest, while the distal was the widest and longest compartment, with its measurements are approximately equal to the lengths of the proximal and middle compartments collectively. This finding contradicts what Ombaba et al. (2010) reported, stating that the proximal compartment was the widest, measuring 5.0 mm. A magnetic resonance imaging (MRI) study of the ulnar tunnel anatomy indicated that the tunnel measurements increase distally, with the distal cross-section appearing larger than the proximal and mid-tunnel measurements (Zeiss et al.,1992). These findings are further supported by Pierre et al. (2011) who in their 3-T MRI assessment of the normal anatomy, noted that the cross section gradually widens from the proximal border of the pisiform bone distally to the hook of the hamate, reporting a cross-sectional area of 33 ± 11 mm^2 proximally, versus 45 ± 19 mm^2 distally.

In our study, we found that the ulnar tunnel length decreased with wrist flexion and ulnar deviation, while it increased during extension. This was attributed to the vertical displacements of the pisiform bone relative to the triquetrum, which moved proximally during flexion and distally during extension. In their study on pisiform kinematics, Moojen et al. (2001) reported that the pisiform bone shifted proximally away from the triquetrum during wrist flexion, while it pressed against the triquetrum during wrist extension as the pisiform displaced distally. Similarly, Jameson et al. (2002) reported found in their radiographic analysis of the pisotriquetral joint that the space between the pisiform bone and the triquetrum increases during wrist flexion, whereas during wrist extension, the two bones are pressed together and the space decreases due to the movement of the pisiform bone.

Taleisnik (1988) mentioned that with the wrist in ulnar deviation, the triquetrum transfers distally on the hamate and dorsiflexes together, which forces the hamate into a palmar position, thus shortening the space between the hamate-styloid process. This is consistent with our results, which show that the length of the ulnar tunnel decreases with ulnar deviation.

In our findings, there were no noticeable changes in the radial deviation across all compartments of the tunnel. A study by Petric et al. (2020) investigated the Piso-triquetral kinematics and reported that during maximal radial deviation of the wrist, the flexor carpi ulnaris does not contract. Consequently, the pisiform bone is not influenced by the flexion of the flexor carpi ulnaris tendon, resulting in a fixed distance between the piso-triquetral articular surfaces.

The width of the proximal compartment did not show any appreciable change with the wrist in flexion, while it decreased with the wrist in extension and ulnar deviation. This finding contrasts with Ombaba et al. (2010), who reported an increase in the width of the proximal compartment during flexion, justifying it to the pulling of the flexor carpi ulnaris tendon as the pisiform bone moves proximally. We speculate that the width does not change, because the movement of the pisiform and the flexor carpi ulnaris tendon occurs along the vertical axis, which does not affect the width. Alternatively, as suggested in another study, there may be other factors affecting the movement of the pisiform. Beckers et al. (1998) measured the resulting pressure forces of the pisiform bone during palmar flexion and stated that the pisiform is not pulled proximally along the line of the applied force by the flexor carpi ulnaris tendon; in lieu, it is influenced by the action of the abductor digiti minimi, which drags the pisiform distally and laterally.

In our study, we found that the dimensions of the middle compartment changed in all wrist positions, except during radial deviation. With the wrist in extension, both the width and height of the middle compartment decreased, which led to keeping the ulnar nerve under tension.

The pisohamate arcade was identified in 19 (63.3%) of the hands in our study, with measurements and thickness consistent with those reported by Konig et al. (1994) and Bozkurt et al. (2005) who found the fibrous arcade in 14 of 23 (60.9%) and 21 of 37 (56.7%) cases, respectively. In our specimens the arcade was musculotendinous and well developed in 11 cases, while in the other eight, it was purely muscular. In five of eight specimens, the muscular fibers were found to give the origin of flexor digiti minimi muscle. In the remaining three specimens, there was an intermuscular space between the flexor digiti minimi and abductor digiti minimi. In these cases, the fascial continuity between the muscles forms a muscular arch that overlies the hiatus, under which the deep branch of ulnar nerve runs. Zeiss et al. (1992) in their study of 36 wrists, reported that 50% of the specimens had a fibrous arch, while the other 50% had a muscular arch as observed in magnetic resonance imaging sections.

Lotem et al. (1973), in their cadaveric study of the structures around the deep branch of the ulnar nerve, mentioned that the fibrous arch, which was present in all dissected hands, was not tight enough to compress the deep nerve unless additional factors interfered (i.e., trauma, swelling). Our results support these findings, and we propose another factor that may tighten the arch: during wrist flexion, the length of the pisohamate arcade increases, causing it to become linear. This could lead to compression of the deep branch of the ulnar nerve against the floor of the pisohamate hiatus, although our study agreed that the presence of the pisohamate arcade was not constant or the texture differed. With a knowledge of such changes, surgeons could elucidate the diagnosis and the location of nerve compression. Further investigation is needed to explore other factors that may tighten the arch.

The pisohamate hiatus was described by Uriburu et al. (1976) as a narrow oblique opening between the fibrous arch and the pisohamate ligament, allowing entrance to the deep ulnar nerve and artery into the deep palmar space. However, they did not provide details about the morphology or dimensions of the hiatus. In our study, we found the pisohamate hiatus to be a narrow opening at the beginning of the distal compartment. It was round in 19 hands and oval in 8 hands. Its length, width, and height have significantly decreased with wrist flexion, and its length and width also decreased significantly during ulnar deviation. In the study of the anatomy and radiography of the pisotriquetral joint by Rayan et al. (2005), it was reported that the length of the pisohamate ligament averaged 5.9 mm in the neutral position compared to 5.2 mm in passive flexion. Radiographically, in the anteroposterior (AP) view, the pisohamate ligament distance averaged 13.5 mm in the neutral position and 11.5 mm during flexion. In the oblique view, the distance was 7.0 mm in the neutral wrist position versus 1.0 mm in full flexion. In the same study, when they radiographically assessed the pisiform kinematics during ulnar/radial deviation, they noted that the pisohamate distance in the AP view was 13.5 mm in the neutral position and 11.6 mm during ulnar deviation.

Contrary to the finding of McFarlane et al. (1976), who suggested that the deep branch of the ulnar nerve is fixed in position by the fibrous arch of the hypothenar muscles and the pisohamate ligament, our study is in accordance with Ombaba et al. (2010), who reported that the deep branch of the ulnar nerve is mobile and relaxes within the pisohamate hiatus. We found that the deep branch was mobile in all dissected hands and not fixed under the pisohamate arch. With wrist flexion, the roof of the hiatus became linear and lost its concavity, bringing it closer to the nerve, and the length, width, and height of the hiatus decreased in dimensions. Additionally, during wrist ulnar deviation, the hiatus's length and width also decreased, which contrast with Ombaba et al. (2010) who mentioned that ulnar deviation did not affect the dimensions of the pisohamate hiatus.

However, we did not observe any noticeable changes in wrist extension or radial deviation.

Flexion and ulnar deviation were the positions that most significantly affected the pisohamate hiatus, and could lead to compression of the deep branch of the ulnar nerve. Consequently, the deep branch of the ulnar nerve may be at greater risk in these two positions. Thus, a detailed understanding of the distal compartment kinematics is essential for accurately diagnosing ulnar nerve problems and ulnar tunnel syndrome, especially for those who are susceptible to acute or repetitive trauma.

The limitations encountered in this study were that the embalmed cadaver specimens might be different from the living tissue due to the potential alterations of tissue properties, the decrease in actual muscular force, the nature of the nerve and artery, and the size of the tunnel. Simulated active movement was not applied due to the same cadaveric difficulties that would make the simulated movement for the tendons difficult to control and not smooth. Also, we did not compare the dimensions of the ulnar tunnel between the right and left hands because some of the samples included in the study were separated limbs, and we could not figure out if they were from the same body or not.

CONCLUSION

Our findings support the observations of Ombaba et al. (2010) that the ulnar tunnel is a dynamic anatomical structure whose morphology is significantly influenced by wrist positioning. Flexion and ulnar deviation have the most profound impact on the tunnel's dimensions, particularly in the middle and distal compartments. Consequently, the ulnar nerve may become particularly vulnerable to compression in these wrist positions at different times. In these wrist positions, the risk of compression of the deep branch of the ulnar nerve increases, first, when the middle compartment length and width decreased, second, the pisohamate hiatus narrows; and third, the pisohamate arcade compresses the nerve during flexion.

The radial deviation is the only wrist position that does not change the tunnel dimension or morphology of its structures.

Recommendations

Demographic factors influence tunnel size, as males tend to have longer ulnar tunnel dimension. However, the influence of age or race on tunnel morphology may require further investigation.

Surgeons should be familiar with the nature of the pisohamate arcade during ulnar tunnel surgeries. This arcade may give the origin of the flexor digit minimi in some patients, so these surgeries must be performed with caution to avoid impairment of flexion of the little finger if they decide to release it.

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