



“A study of Anatomical variability and histological structure of the ulnar nerve in the Guyon's canal”

Anatomy

Dr. Shruti Mamidwar

Associate Professor, Department of Anatomy, GMC, Chandrapur.

Dr. Abhilasha M

Vahane, Associate Professor, Department of Anatomy, GMC, Nagpur.

ABSTRACT

To analyze the prevalence of variations, branching patterns, and histology of the ulnar nerve (UN) in Guyon's canal to address its importance in hand surgery, particularly ulnar nerve decompression of the UN.

Materials and Methods:

50 fresh cadavers were dissected bilaterally, and the nerve in the area of Guyon's canal was visualized. Samples for histology were also taken and prepared. The collected data were then analyzed.

Results:

Morphometric measurements of the hands and histological studies were not found to have significant differences when compared by left or right side or by sex. Three major branching patterns were found, with division into deep and superficial UN being the most common (85%). Additional findings included a majority (70%) presenting with a cutaneous branch within the canal and/or with an anastomosis of its distant branches with those of the median nerve (57%).

KEYWORDS:

Guyon's canal, Ulnar canal.

Introduction:

The Guyon's Canal, also known as the ulnar canal, is a fibro-osseous tunnel located on the anteromedial side of the wrist, extending from the proximal end of the pisiform to the level of the hook of hamate [1]. This canal was first described in 1861 by Guyon [2] as an intra-aponeurotic compartment with its anterior wall being formed by a fibrous layer and its posterior wall being formed by the anterior carpal ligament.

Guyon described the canal as having a medial wall formed by the pisiform, coated with aponeurotic tissue proximally and fascia covering the hypothenar eminence distally [3]. Cobb et al. [4] described the lateral boundary of the Guyon's canal as extending to, but not attaching to the hook of hamate, thus allowing for the ulnar artery and sensory components of the ulnar nerve (UN) to take a radial course in relation to the hook of hamate.

Although the terminology “Guyon's canal” is widely accepted, there have been several proposals of alternate names of the canal in the literature. McFarlane et al. [5], who observed the palmaris brevis more distal but in the same position as Guyon, along with Enna et al. [6] suggested the term piso-hamate tunnel. Denman [7] noted that the ulnar carpal space passes beyond the level of the hook of hamate and that the palmaris brevis muscle forms the radial boundary of the space upon joining the flexor retinaculum. Furthermore, anatomical knowledge of the canal and the UN can be critical in surgical procedures of the hand [8–10]. Taking into account the clinical importance of UN compression in the Guyon's canal and the anatomical variability of the canal, this paper aimed to: (1) identify where the UN splits into its superficial and deep branches and the distance from the pisiform to its point of branching; (2) identify the distribution and variations in the branches of the UN; and (3) evaluate where the palmar cutaneous branch leaves the Guyon's canal; and (4) histologically evaluate cross sections of the UN.

Materials and methods:

Cadaveric dissection

A total of 50 fresh cadavers (43 male, 7 female) between the ages of 29 and 100 years were dissected bilaterally at the Department of Anatomy in a medical college in central India. No pathology or history of trauma was noted in the upper limbs of any of the cadavers. The area of the wrist was prepared and dissected to visualize the UN and the Guyon's canal. A lateral incision was made parallel to the flexor carpi ulnaris muscle, starting at a point 1/3 of the way from the distal end of the forearm. The incision was continued in the shape of a “Z” from the wrist furrows and extended along the axis of the fourth metacarpal.

Histology

The UN in the region of the wrist was removed and fixed using a 10%

solution of formaldehyde for 2–5 days. The sample was dehydrated in ascending concentrations of alcohol (50–96%), submerged and fixed in paraffin, sectioned (4 μm), stained with hematoxylin and eosin (H&E), and assessed.

Statistical analysis

Normally distributed data were analyzed using the student T test, while non-normally distributed data were analyzed using the Mann–Whitney U test. A p value of <0.05 was considered statistically significant.

Results:

Morphometrics of the hand

Gross morphometric measurements of the hand according to gender are presented in Table 1. Our analysis showed that male cadavers in general had wider wrists, longer and wider metacarpals, and longer Guyon's canal when compared to female cadavers. However, the distance from the branching point of the UN to the proximal end of the pisiform was longer in females, with a mean value of 2.6 ± 0.33 cm vs males (2.3 ± 0.80 cm, p-value 0.0861).

Morphometric measurements of the hand were also analyzed according to side and are presented in Tables 1 and 2. Our results showed that in general, all parameters measured were very similar on both sides with the p values of all measurements showing no statistically significant differences.

Histological structure of the ulnar nerve

Histological morphometric measurements according to gender and left and right hand are presented in Table 3. Similar to the gross morphometric measurements of the hand, our results did not reveal any statistically significant differences between the UN of male and female cadavers.

Discussion:

The UN passes through Guyon's canal as it makes its way from the forearm to the wrist, where it is prone to entrapment syndromes [11]. The goal of this study was to gather cadaveric data on the prevalence of variations of the UN and its branches within Guyon's canal, its histological presentation, and any correlations of the nerve and the canal with the gross morphometrics of the hand.

We found that males generally had longer canals; however, in women, the UN travelled further before branching. No significant differences were noticed when comparing right to left sides. Likewise, in the histological study, no significant differences were noticed. The surgical significance of the findings above means that risk of injury in the area is not increased on either side, since findings are symmetrical.

Since the success of nerve grafts greatly depends on the histological compatibility [12], our findings suggest that a nerve similar to the parameters described above can be used as a guide to picking a suitable graft. Women, however, would have a higher risk of a more complicated (sensory/motor) lesion if injury occurred, since there is a higher chance of encountering the combined, unbranched UN.

Branching patterns of the UN in this area commonly varied, with the most common bifurcation into superficial and deep branches constituting only 85% of the subjects. Trifurcation was the second most common with 13%. These branching patterns were found to be symmetrical in most cases (78%) suggesting that if surgery is needed on both hands in one patient, there is a strong chance that a similar pattern will be found. It was also noted that in 70% of specimens, the UN gave a cutaneous branch within Guyon's canal, providing another nervous structure to be aware of during surgery so as to avoid accidental transection. Other common variations included anastomoses between the ulnar and median nerves at the level of the digital nerves to fingers four and five, which was observed in 57% of specimens. These findings are similar to findings in the previous literature on an anastomosis in the same area named the Berretini anastomosis which has a prevalence of 60.9% [13]. We would like to acknowledge that other variations in the anatomy of the UN are possible; however, they were not seen in the samples studied.

The limitations encountered in this study were mostly the small number of specimens studied. Furthermore, dissection did not spare the ulnar artery. Thus, estimation of anatomical relationship between the ulnar artery and the UN is not possible. Studies done in the past on Guyon's canal have been performed using many different points of reference for measurement, making comparisons difficult. However, recent studies have shown similar findings in branching and anastomosing patterns. Murata et al. reported that in 86% of their samples, the UN bifurcated in Guyon's canal, with trifurcation making up the remaining 14% [14]. They also reported that in 8.6% of the specimens, there was an anastomosis between the UN's sensory branches to the fingers, compared to our 6% rate of occurrence [14].

Due to the variety of the UN within Guyon's canal, the zones described above may not encompass all patients presenting with symptoms of UN entrapment. Certain anastomoses like those with the median nerve that was found in our study could present with more extensive deficits than those described above. For example, sensory deficits are common in the area between the middle and ring fingers in traumatic lacerations of communicating branches between the median and UN communicating branches [13]. Current literature for exploration of Guyon's canal suggests exploring the canal from lateral to medial, or starting from zone 3 and proceeding up to zone 1 [1]. However, with such high prevalence of variation within the canal, we would like to stress that these suggestions should be followed to include all three zones, and not simply stop once the compression is thought to be found in a more distal zone. This way there can be little doubt as to whether the compression has been entirely eliminated.

Tables:

TABLE 1: Gross morphometrics of the hand (men vs women)

Measurement	Men				Women				p values
	N (number of hands)	Mean (cm)	Median (cm)	SD (cm)	N (number of hands)	Mean (cm)	Median (cm)	SD (cm)	
Width of wrist	43	11.50	11.60	0.89	7	9.60	9.00	0.92	<0.005
Width at metacarpals	43	16.20	16.20	0.93	7	13.60	13.60	0.79	<0.005
Length of metacarpal	43	16.30	16.20	1.33	7	15.20	15.40	0.63	0.053
Length of Guyon's canal	43	4.50	4.60	0.51	7	4.00	4.00	0.21	<0.005
Distance from the branching point of the ulnar nerve to the proximal end of the pisiform	43	2.30	2.30	0.80	7	2.60	2.70	0.33	0.086

Table 2: Gross morphometrics of the hand (left vs right)

Measurement	Left				Right				p values
	N (number of hands)	Mean (cm)	Median (cm)	SD (cm)	N (number of hands)	Mean (cm)	Median (cm)	SD (cm)	
Width of wrist	50	5.60	5.70	0.57	50	5.64	5.70	0.57	0.75
Width at metacarpals	50	7.86	7.95	0.66	50	7.98	8.10	0.66	0.37
Length of metacarpal	50	8.07	8.00	0.67	50	8.06	8.00	0.66	0.94
Length of Guyon's canal	50	2.23	2.30	0.26	50	2.23	2.20	0.26	0.95
Distance from the branching point of the ulnar nerve to the proximal end of the pisiform	50	1.19	1.30	0.50	50	1.03	1.15	0.50	0.05

Table 3: Histologic morphometrics (men vs women) and (left vs right)

Measurement	Men				Women				p values
	N (number of hands)	Mean	Median	SD	N (number of hands)	Mean	Median	SD	
Major axis (mm)	86	4.32	4.40	0.78	14	4.32	4.50	0.75	1.00
Minor axis (mm)	86	2.60	2.66	0.54	14	2.50	2.47	0.43	0.61
Cross-sectional area (mm ²)	86	8.43	7.91	2.97	14	7.77	7.29	2.88	0.45*
Number of bundles	86	17.03	17.00	4.37	14	17.8	18.00	2.55	0.57

Measurement	Left				Right				p values
	N (number of hands)	Mean	Median	SD	N (number of hands)	Mean	Median	SD	
Major axis (mm)	50	4.45	4.52	0.76	50	4.20	4.14	0.77	0.09*
Minor axis (mm)	50	2.60	2.65	0.45	50	2.57	2.57	0.60	0.79
Cross-sectional area (mm ²)	50	8.39	7.88	2.78	50	8.30	7.37	3.15	0.82*
Number of bundles	50	16.84	17.00	3.29	50	17.44	17.5	4.90	0.47

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