

A Glipse of “Guyon's Canal” of the “Human Wrist”

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Abstract

“Guyon's Canal, also known as the common medial ulnar canal”. It is a fibro-osseous tube that extends from the distal end of the pisiform to the level of the hook of hamate on the anteromedial aspect of the wrist. From an anatomical perspective, it is intriguing as a peculiar feature. Comprehensive comprehension of the anatomical structure of the Guyon canal is imperative for the effective management of Ulnar tunnel syndrome, which is commonly known as Guyon's canal syndrome”. It is noteworthy that various symptoms are linked to ulnar nerve compression within the Guyon's canal. However, appropriate treatment and care can effectively mitigate these symptoms. The aforementioned variations have the potential to affect the categorization of Guyon's canal into three distinct zones, as well as the clinical symptoms that are linked to each zone. A comprehensive comprehension of probable variations could enhance the probability of suitable treatment of compression symptoms by surgeons.

Keywords: Guyon's Canal, Ulnar Canal, Three Distinct Zones, Treatment, Anatomical Feature.

INTRODUCTION

“The fibro-osseous tube referred to as Guyon's Canal, or the ulnar canal, is situated on the anteromedial aspect of the wrist, extending from the distal end of the pisiform to the level of the hook of Hamate”.¹ “The canal was defined by Guyon in 1861 as an “intra-aponeurotic compartment” having an anterior fibrous layer and a posterior carpal ligament wall”.² “According to Guyon, the canal has a clearly defined structure with a pisiform tissue-based medial wall, aponeurotic tissue covering the hypothenar eminence proximally, and fascia covering the canal's distal wall”.³ “Cobb et al.(1996) established that the ulnar artery and sensory components of the ulnar nerve (UN) can take a radial course in relation to the hook of hamate, thanks to the lateral boundary of the Guyon's canal extending to but not connecting to the hook of hamate”.⁴ The ceiling of Guyon's canal is made up of the strong antebrachial fascia, also known as the palmar carpal ligament, and cushioning adipose tissue. It's important to note that while the hamate hook may not act as a true lateral canal wall, there are still other factors that can contribute to successful treatment. It's great to know that the palmaris brevis muscle contributes to the formation of part of the canal's lateral border by inserting into the flexor retinaculum.⁵

Guyon canal anatomy is important to know to effectively treat the Ulnar tunnel syndrome (also known as Guyon's canal syndrome). It's important to note that there are identifiable symptoms associated with UN compression within the Guyon's canal, but with proper treatment and care, these symptoms can be managed effectively. It's great to know that only the majority of anatomical abnormalities in Guyon's canal are associated with auxiliary muscles, which means that there are cases where this is not a concern. Additionally, identifying this association can help in managing ulnar tunnel syndrome symptoms. It's possible that the symptoms are related to the piso-hamate gap, but with proper care and attention, it can be managed effectively. Moreover, having knowledge about the anatomy of the canal and the UN can prove to be crucial during hand procedures.⁵

ANATOMY

The Guyon canal is situated in the proximal hypothenar region on the volar aspect of the wrist, specifically in the ulnar (medial) space. The ulnar nerve is situated laterally to the deep ulnar artery within Guyon's canal.⁷ The anatomical structure in question is occasionally denoted as the canal or the ulnar tunnel. The aforementioned canal is an anatomical structure composed of bone and fibrous tissue that fulfills various functions. The canal

commences at the distal border of the pisiform bone and terminates at the hook of the hamate bone. The ulnar nerve and artery traverse through a specific anatomical compartment, extending from the distal forearm to the hand.⁶ The length of the canal measures between 40 and 45 mm, and it originates from the proximal boundary of the palmar carpal and terminates at the fibrous arch of the hypothenar

muscle.⁷ The ulnar nerve compression is frequently observed at the Guyon canal, which stands as the fourth most prevalent site after the cubital tunnel.

Additionally, a number of nearby anatomical structures define the Guyon Canal's boundaries, opening up an intriguing opportunity for additional research and understanding.⁶

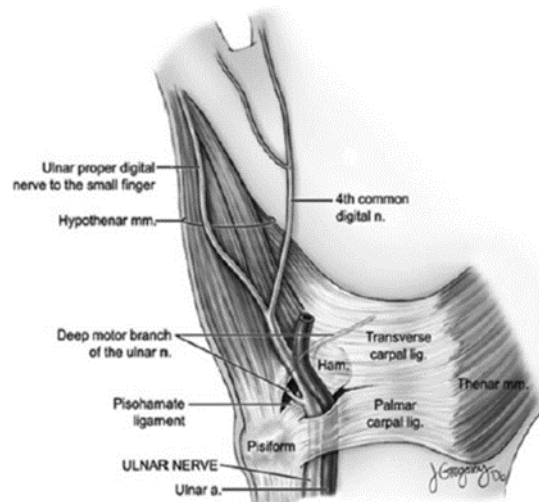


FIG 1: GUYON CANAL⁷

STRUCTURE

“The canal's superior and inferior boundaries are constituted by the palmar carpal ligament, palmaris brevis, and hypothenar connective tissue, respectively. The canal base comprises several crucial anatomical structures, such as the tendons of the flexor digitorum profundus and opponens digiti minimi, in addition to the transverse carpal ligament, the pisometacarpal ligament, and the opponens digiti minimi tendon. The

WHERE,

canal's lateral wall comprises robust anatomical structures, including the flexor tendons, transverse carpal ligament, and hamate hook. Conversely, the medial wall is composed of the pisiform, abductor digiti minimi, and flexor carpi ulnaris tendons. Moreover, the delimitations of the Guyon canal have been established by several adjacent anatomical structures, presenting an intriguing prospect for additional investigation and revelation”.

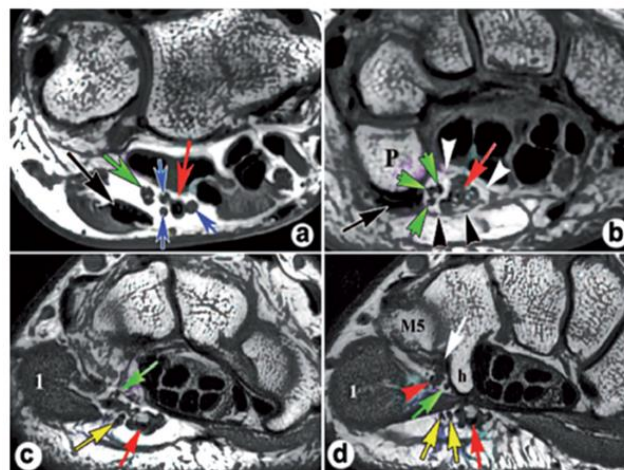


FIG 2 : SHAPE OF GUYON CANAL.⁸

a. **“Proximal to the canal.”**

Green Arrow shows = ulnar nerve. **Black Arrow** shows = tendon of flexor carpi ulnaris.

Blue Arrow shows = ulnar veins.

Red Arrow shows = ulnar artery”.

b. **“At the level of pisiform bone.”** **Green Arrow** shows = ulnar nerve. **White Arrowhead** shows = flexor retinaculum.

Black Arrowhead shows = palmar carpal ligament.

Red Arrow shows = ulnar artery and comitant veins.

P = pisiform bone”.

c). **“In the middle of the canal.”**

Green Arrow shows = deep branch of ulnar nerve.

Yellow Arrow shows = superficial branch of the ulnar nerve.

Red Arrow shows = ulnar artery”.

1 = abductor digiti minimi”.

d). **“On the level of the hook of hamate.”**

Green Arrow shows = deep branch of ulnar nerve.

Red arrowhead shows = deep branch of ulnar artery.

Yellow Arrow shows = proper palmar digital nerve of little finger, medial and palmar common digital nerve of anular and little fingers.

RED ARROW shows = ulnar artery”.

“H = hook of hamate bone”.

“M5 = fifth metacarpal bone”.

The roof of the canal has been removed and elevated on the ulnar side.⁶

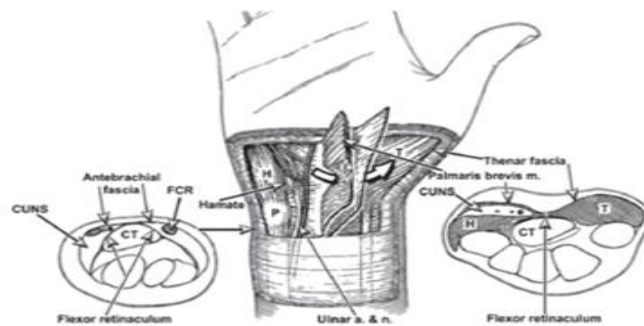


FIG 3: CANAL OF GUYON.⁸

WHERE,

“FCR — Flexor Carpi Radialis Tendon.”

“P — Pisiform Bone”

“T — Thenar Muscles”

“H — Hamate Bone”

“CUN — Carpal Ulnar Neurovascular Space.”

“CT — Carpal Tunnel.”

FUNCTION

“The Guyon canal functions as a safeguarding mechanism for the ulnar nerve and artery during their passage from the wrist towards the hand's distal region.⁶

BLOOD VESSEL

“Upon traversing the antecubital fossa, the brachial artery bifurcates into two distinct branches, namely

the radial artery and the ulnar artery. A pair of arteries supply the upper arm with blood. Subsequently, it proceeds in a lateral direction toward the palm, specifically towards the central region of the hand. The distal region of the forearm is situated in proximity to the ulnar nerve on its lateral aspect. The carpal bone receives blood and nutrients from the ulnar artery. In proximity to the Guyon canal, a division occurs wherein the dorsal and volar carpal branches emerge. Upon traversing the Guyon canal, the aforementioned structure establishes a connection with the superficial and deep palmar arterial canals. The radial artery located in the hand bifurcates into two distinct branches that supply blood to the superficial and deep palmar arches. It is imperative to exercise caution during hand procedures owing to the anatomical variances between the superficial and deep palmar arches and their corresponding branches.⁶

The proximity of vein and lymphatic vessels to arterial vessels is a common occurrence.⁶

NERVE

“The Guyon canal serves as a pathway for the ulnar nerve. Upon traversing the canal, the ulnar superficial nerve commonly bifurcates into two distinct branches, namely the superficial branch and the deep branch. The hypothenar region receives sensory innervation from the superficial branch of nerves, which also supplies the fifth digit in its entirety and half of the fourth digit. The ulnar nerve's common distal web and the ulnar digital nerve of the little finger diverge from

the nerve as it progresses distally. The motor branch is considered to be the deepest among the branches”.⁶

MUSCLE

Upon traversing the Guyon canal, the deep ulnar branch of the nerve undergoes a transition to a motor-only function. The nerve supply to the medial lumbricals, interossei, adductor pollicis, flexor pollicis brevis, opponens, and flexor digiti minimi muscles is provided. Under exceptional conditions, it is possible for the hypothenar muscles to receive innervation via the superficial branch.⁶

HISTOLOGICAL MEASUREMENTS

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

* Was evaluated with the Mann-Whitney test and is based on the median

TABLE 1: HISTOLOGICAL COMPARABLE MEASUREMENTS MEN & WOMEN IN CM.⁹

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

* Was evaluated with the Mann-Whitney test and is based on the median

TABLE 2: HISTOLOGICAL COMPARABLE MEASUREMENTS LEFT & RIGHT IN CM.⁹

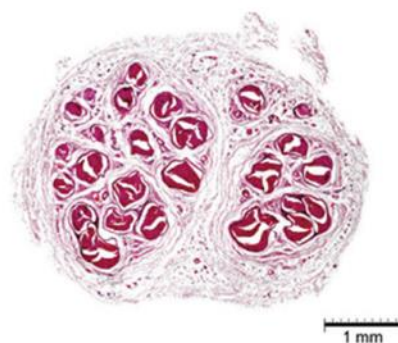


FIG 4: HISTOLOGICAL APPEARANCE OF ULNAR NERVE (H & E STAINING).⁹

PHYSICAL DIFFERENCE

The phenotypic expression of patients with “ulnar nerve compression in the Guyon canal” is heterogeneous. Anatomical variations play a contributing role in the passage of the ulnar nerve through the tunnel.¹⁰ The Guyon canal serves as the point of origin for both the superficial and deep branches of the ulnar nerve. In the majority of instances, this assertion holds true with an 80% rate of accuracy. In approximately 10% of instances, the nerve undergoes division within the Guyon canal. The trifurcation process gives rise to a pair of sensory nerves, namely the common digital web of the fourth web and the ulnar digital web of the little finger, and a single motor nerve, the deep branch. The remaining 10% of cases are attributed to atypical branching patterns, which are observed only in exceedingly rare anatomical variants.¹¹

OTHER ABNORMALITIES⁷

LISTED BELOW ARE SOME OF THE EXAMPLES OF RARE VARIATIONS⁶:-

1. "Aberrant branching occurs in ulnar nerve of the distal forearm".
2. "Low trifurcation at proximal level to Guyon canal happens with total of 3 branches to pass through the Guyon canal".
3. "High trifurcation at proximal level to Guyon canal happen with total of 3 branches to pass through Guyon's canal, or the volar sensory branch".
4. "Accessory type of branch arising from the dorsal sensory branch of the ulnar nerve".
5. "Branch of the median nerve and the ulnar nerve that communicates in the forearm area sometimes".

Ulnar Nerve Anomalies

Branching pattern

- Bifurcation of the ulnar nerve proximal to the canal
- Trifurcation of the ulnar nerve proximal and within the canal
- Bifurcation of the ulnar nerve that encircles the pisiform
- Aberrant branches arising from the ulnar nerve proximal to the canal

Deep motor branch

- Aberrant origin of motor branch of the ulnar nerve
- Nerves to hypothenar muscles ranges from 1 to 4 branches
- Bifid deep motor branch of the ulnar nerve with or without neural loop

Superficial sensory branch

- Aberrant origin of superficial branch of the ulnar nerve
- Single, bifurcated, or trifurcated sensory branch(es)

Anomalous course

- The ulnar nerve inside the carpal tunnel

Communication with median nerve

- Martin-Gruber anastomosis
- Marinacci communications
- Riche-Cannieu anastomosis
- Berrettini anastomosis and ramus communicans

Dorsal cutaneous branch

- Kaplan accessory branch

TABLE 3: ANOMALIES OF THE ULNAR NERVE WITHIN AND AROUND THE GUYON CANAL.⁷

“Upon examination of cadaveric specimens, it was discovered that the Guyon canal exhibited multiple anomalous muscular structures that traversed its pathway. The preponderance of the identified digiti muscles were muscles of the abductor digiti minimi variety”.¹²

Further studies have described the space known as Guyon’s canal divided into three zones. “Francisco and Agarwell describe the three zones” and their deficits as follows¹³:



FIG 5: 3 ZONES OF GUYON'S CANAL.¹³

“Zone 1 = The space past, the bifurcation of the UN into deep and superficial branches, presents with sensory, motor, or both types of deficits”.

“Zone 2 = The space surrounding the deep motor branch of the UN can present with paralysis of the intrinsic muscles and/or the hypothenar muscles”.

“Zone 3 = The space surrounding the superficial branch of the UN presents with only sensory deficits”.

MANAGEMENT

1. NON- SURGICAL MANAGEMENT

“The initial approach for managing ulnar nerve compression in the wrist involves conservative treatment. Viable non-surgical treatments for the condition include rest, anti-inflammatory drugs, avoidance of canal pressure, and splinting. In cases where conservative treatment fails to alleviate symptoms, surgical intervention is advised. Surgical intervention may be advised in cases where there is a discernible indication of significant pathological conditions. “Ganglion cysts, tumors, auxiliary hypothenar muscles, fractures in the distal ulna or carpal bones, and ulnar muscle atrophy or compression resulting in denervation are just a few causes of extrinsic paralysis.”¹⁰

2. SURGICAL MANAGEMENT

“Surgical intervention is utilized to alleviate the compressing component in instances where there is evidence of ulnar nerve compression at the Guyon canal. Ulnar artery compression is frequently linked to the ulnar tunnel and can be caused by various factors, such as the palmar carpal ligament, the brevis muscle,

and auxiliary fibers originating from the ulnar tunnel. In cases where a specific source of pathology, such as a fracture or mass, has been identified, surgical intervention should prioritize the reduction, fixation, and/or excision of the identified mass. The incision made during a surgical intervention is the primary step in the treatment of carpal tunnel syndrome. Both the second and third methods deviate from the conventional path towards the ulnar hypothenar. Two discrete methodologies that can be utilized are the Brunner methodology and the longitudinal approach. Both of the aforementioned methods have the potential to be modified or extended”.¹⁴

CLINICAL IMPORTANCE

“A variety of disorders and diseases have the potential to elicit neuropathic and/or vascular symptoms in the upper extremities. There are several potential factors that may be implicated in the aforementioned condition. These include pathologies of the central nervous system, neuromuscular diseases, thoracic outlet syndrome, infectious neuropathies, cervical radiculopathy, brachial plexus injuries, cubital tunnel syndrome, thoracic canal syndrome, ulnar canal syndrome, tumors, and acute or chronic carpal tunnel syndrome.”¹⁰ “It is believed that Guyon syndrome cases are attributed to ganglion cysts in approximately 30 percent to 45 percent of instances”.¹⁵ “The comprehensive evaluation of a patient's medical history and physical condition is crucial in aiding healthcare professionals in establishing accurate diagnoses. The conflation of ulnar nerve compression within the Guyon canal and cubital tunnel compression is a frequently observed phenomenon.

The dorsal ulnar sensation that the hand experiences can help you distinguish between the two compression zones. The dorsal ulnar cutaneous nerve is responsible for providing sensory input to the affected region.¹⁰ In cases of nerve compression within the aforementioned canal, it has been observed that the branch of the ulnar nerve does not pass through the Guyon canal. Ulnar nerve compression in the Guyon canal as a result of an ulnar artery thrombosis or aneurysm may cause the occurrence of hypothenar hand syndrome (HHS). Individuals who have undergone recurring trauma to their hands and palms are at a higher risk of developing the aforementioned ailment.^{15,16}

CONCLUSION

There is notable inter-species variation in the anatomy of the ulnar nerve (UN) as it traverses Guyon's canal. Several prior research works have indicated the possibility of a UN bifurcation within Guyon's canal, particularly the dominant type. During UN decompression surgery, surgeons must exercise great care due to compression variations, such as the trifurcation of the UN and the presence of unusually small sensory and motor branches. The aforementioned variations may potentially influence the division of Guyon's canal into three discrete canals, along with the corresponding clinical manifestations linked to each zone. The likelihood of successful surgical treatment of compression symptoms increases when surgeons possess a comprehensive comprehension of potential variations.

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