Anatomic Variation of the Hook of Hamate in Korea Carpal Tunnel Syndrome Patients

Joo-Yong Kim[1], Young-Keun Lee[2]*, Ki-Chan An[1], Yong-wook Kwon[1], Sang Hyun Woo[3] and Malrey Lee[4]*

[1]Department of Orthopedic Surgery, Pusan Paik Hospital, College of Medicine, Inje University, Busan, Korea
[2]Department of Orthopedic Surgery, Dason Orthopaedic Clinic, Jeonju, Korea,
[3]Department of Plastic Surgery, W Hospital, Daegu, Korea
[4]The Research Center of Industrial Tech., School of Electronics & Info. Eng., ChonBuk National University 664-14, 1Ga, DeokJin-Dong, Jeonju, Chon Buk, 561-756, South Korea
*[2]*trueyklee@naver.com(corresponding author),*
*[4]*mrlee@chonbuk.ac.kr(corresponding author)*

Abstract

Purpose: To determine the incidence of anatomic variations of the hook of hamate and to evaluate its association with the development of carpal tunnel syndrome (CTS) in Korean patients.

Materials and Methods: Carpal tunnel views of 916 hands (458 patients) that received out-patient treatment for tingling hands, from March 2008 to November 2009. The sex distribution was 69 men and 389 women and the average age was 52.7 years old. The frequency of appearance of variations of the hamate and the ratio of each variation were identified. In addition, patients with variant hooks of hamate with CTS were compared to patients with variant hooks of hamate who had no evidence of CTS. The counting variant age and the correlation of the variant of the hooks of hamate and the occurrence of CTS were analyzed.

Results: Variations of the hook of hamate were found in 48 of 916 hands. The ratio of width to height averaged 0.97 with a standard deviation of 0.32. Twenty-five right hands and twenty-three left hands were studied. Four men and forty four women were found with variations but there was no statistical significance to this finding. CTS was diagnosed in 42 of 48 patients. This group accounted for 6.1% of all patients diagnosed with CTS. Out of 42 patient cases 9 were bipartite hook cases, 27 were hypo plastic cases, and 6 were aplastic cases. Six cases, which made up 2.5% of the patients, were not diagnosed with CTS. These cases consisted of two bipartite cases, three hypo plastic cases, and one aplastic case. When the two groups were analyzed by Chi-square test & Fisher's exact test, there was a higher incidence of variation with the group that was diagnosed with CTS than with the others (P=0.0282).

Conclusion: The variations of the hook of hamate are found in 5.2% of the patients in this study. This variation appears to be one of the causal factors of CTS.

***Keywords**: Hook of hamate, variations, carpal tunnel syndrome*

1. Introduction

A trigonal prism-shaped carpal bone, the hamate has a hook stretching a long ways forward where nonarticular surface is set. The transverse carpal ligament or flexor retinaculum borders the end of the hook forming the carpal tunnel toward the radialis and ulnar nerve compression toward ulnar acting as a support keeping the surrounding neurovascular tissues in the right place1. The hook has two centers which remain ossicless if not agglutinated with each other. Hypoplasia and aplasia are considered congenital malformations developing on one or both sides.

The hook of hamate is a structure usually located in a fixed place and thus used for spot selection at the time of endoscopic carpal tunnel release and used as a boundary mark2, to avoid any neurovascular damage. It also is useful at the time of open carpal tunnel release in finding the right line to cut.

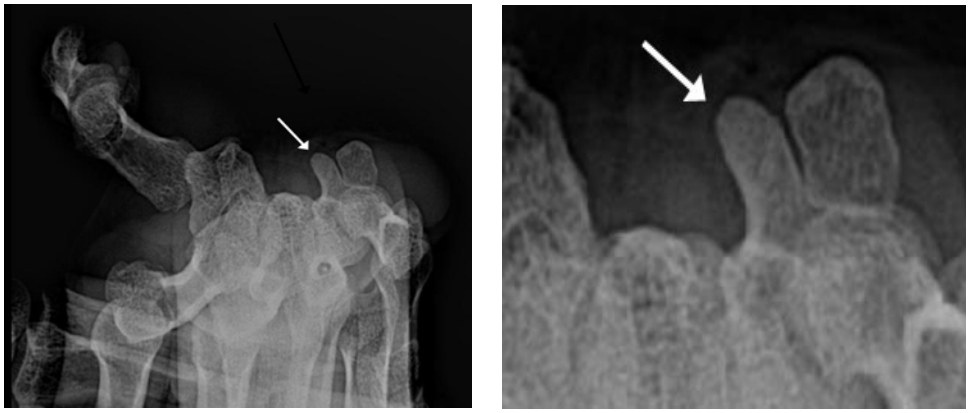

Figure 1. Normal Hook of Hamate

The average height of the hook is 9.8 mm, and the average width of the fundus is 7.5 mm with anatomical variations reported as very rare [7]. However, we have encountered such variations through radioactive examinations we did for patients with carpal tunnel syndrome. In addition, seeing that cases of deformations of the hook occur more often for patients with carpal tunnel syndrome, we wondered if such variations may influence the complications of carpal tunnel syndrome. Coming to realized that there have been no reports on the matter specific to Korea while there were reports by writers overseas [8 ,12], we decided to analyze possible connections between the frequency of anatomical variations in the hamate hook and the development of carpal tunnel syndrome in Koreans.

2. The Subjects and Methods of the Study

The subjects were chosen among 458 patients (69 males, 389 females) with an average age of 52.7 (20-87) who visited outpatient clinics from March 2008 to November 2009 complaining of numbness in their hands. We took radiographs on carpal tunnels on both hands of each subject.

We took the radiographs following the method of James *et al.*, [12] focusing on the fundus of the fourth metacarpal towards the palm with forearm in pronation and wrist

joint extended to at least a 70 degree angle with the other hand, and shot X-rays at 30-degree angles on the finger axis for every subject uniformly.

Carpal tunnel syndrome was diagnosed through physical exam including sensation, motor function, pain provocation tests (Tinel's sign, Phalen's test), and EMG, nerve conduction re-diagnosing to confirm when the results showed any abnormality in the thenar muscles through EMG and any delay in nerve conduction velocity. Ultrasonography was also conducted to verify the exercise condition of the flexor hallucis longus muscle in the carpal tunnel along with whether or not tumors existed. The autoradiograph was taken one more time to confirm if aplastic variations were shown considering in such cases that the autoradiograph taking angle and direction might not have accorded with classification standards.

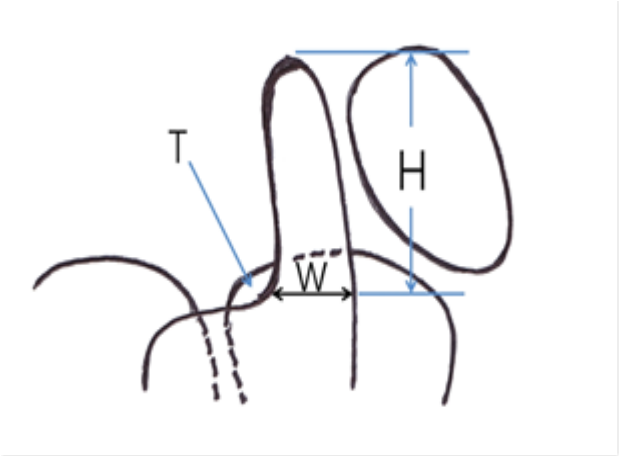

Figure 2. Hook Height Index. Turn Point(T), Width of Hook (W), Height of Hook (H)

Any subjects who ever had hand trauma, or tenderness in the hamate hook detected by physical exam, were excluded from the study together with those whose fundus or the full length of the hook were not shown in the autoradiograph of the carpal tunnel. Variations were classified into three types by measuring the ratio of the width of fundus and the height (height/fundus: the height-to-width ratio) according to the evaluation of James *et al.*, [12], such as hypoplastic hook if the ratio was less than 1.3, aplastic hook if less than 0.6, and as dichotomy hamate hook if the edge of the radiation images formed a compact bone shape and divided into two bones showing no involutional changes between the two bones.

We inquired into the frequency of occurrence of hamate variations and such variation ratio targeting the whole subjects. Patients who showed such variations were divided into two groups: those diagnosed with carpal tunnel syndrome and those not diagnosed to identify any connection with carpal tunnel syndromes, including age variables for the analysis on any correlation of age dependent hamate hook variations and carpal tunnel development with chi-square test & Fisher's exact test. The analysis showed $P < 0.05$ as statistical significance.

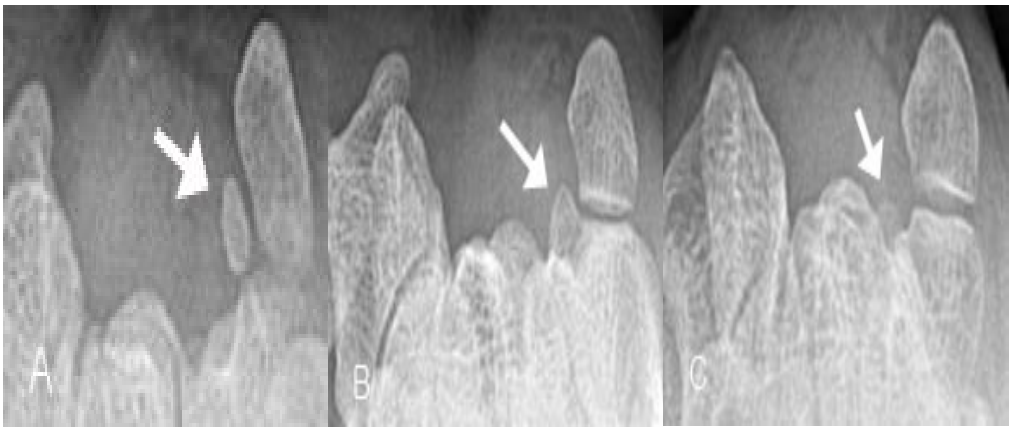

Figure 3. Variation of Hook of Hamate (A)Bipartite, (B)Hypoplastic, (C)Aplastic

3. Results

Six hundred eighty of nine hundred sixteen hands were diagnosed with carpal tunnel syndrome. Forty-eight hands showed hamate hook abnormalities (5.2%), and the length ratio of height and fundus appeared as an average of 0.97 with a standard deviation of 0.32. The distribution of right and left hands was 25 right and 23 left showing no significant difference (P=0.8823). Gender-dependent variations also revealed no statistical differences, for the ratio was 4 females and 44 males among a total of 458 subjects (P=0.805). Forty-two cases were diagnosed with carpal tunnel symptoms among forty-eight cases with hamate hook variations making up 6.1% of the total six hundred eighty cases diagnosed with carpal tunnel syndrome. Nine cases were diagnosed with hamate hook variations, twenty-seven cases with hypoplasia variations and six cases with aplasia. Six cases with variations of the horn of hamate were not diagnosed with carpal tunnel syndrome making up 2.5 % of the two hundred thirty-six cases without CTS. Two of these cases were dichotomy hamate hook variations, three cases with hypoplasia and one case with aplasia (Table 1). The occurrence frequency was significantly higher in the group diagnosed with carpal tunnel symptoms as the result of the two groups being analyzed with Chi-square test and Fisher's exact test .(P=0.0282)

Table 1. Summary of Cases

	CTS (680 hands)	No CTS (236 hands)	Total Variant
Bipartite	9	2	11 (1.2%)
Hypoplastic	27	3	30 (3.3%)
Aplastic	6	1	7 (0.8%)
Total	42 (6.1%)	6 (2.5%)	48 (5.3%)

4. Consideration

Having two ossification centers, unlike other carpal tunnel bones, the hamate may show dichotomy variations in the process of the two bones adhering together although hamate hook variations are very rarely reported [4]. Anatomical variations in the carpal tunnel are seen in many studies along with hamate hook variations [3-6].

Bianchi et al were the first writers reporting cases of hamate hook variations adding that such conditions easily are misdiagnosed as fractures and so require great attention6. Bogart *et al.*, reported the frequency of variations as 0.06% through an analysis done of 1452 ordinary people [7], Pierre-Jerome *et al.*, also reported cases of congenital dichotomy hamate hook variations developed on both hands which were detected by MRI3, and Seeger *et al.*, also reported cases of congenital hamate hook variations on both hands [5].

Richards *et al.*, reported that they found variations in 6 of 131 one cases (4.6%) by analyzing the autoradiograph of patients with carpal tunnel syndrome8, but this might better be considered as 4 cases (3.1%) of actual congenital variations due to 2 included cases of non-union of hook fractures. When compared to a frequency of variations of 0.06 % released in 1932 found by Bogart for ordinary people [7] it would appear that the frequency of variations is much higher in patients with carpal tunnel syndrome than for the general public. However, the causes for the increase in the frequency of variations might also be ascribed to the development of diagnosis technology and methods rather than any actual increase in number. Abbitt *et al.*, stress the usefulness of autoradiographs of the carpal tunnel mentioning four cases of carpal tunnel fractures detected by autoradiograph of carpal tunnel which were not disclosed by the simple autoradiograph of the front, rear and sides [9]. On the other hand, Andresen et al reported the accuracy of the autoradiograph as 80% as a result of the studies on 18 corpses, with the explanation that the hook of hamate and body fracture were not clearly detected only by simple radiograph [10]. Accordingly, it seems to be a little too much to conclude the connection with carpal tunnel syndrome comparing with previous values.

However, this writer team is convinced from such reports that taking of accurate autoradiographs is very important. Consequently, we made a great effort to take autoradiographs of hands in a uniform way including excluding any patients where stiffness in the wrist joint or similar problem disabled the taking of autoradiographs, while repeating the autoradiograph for confirmation if any aplasia variations were detected. Our analysis found the incidence of hook of hamate variations to be 5.2%, a little higher figure than previously reported, though, we are not sure such frequent detection of the variations is limited to Korean patients or is a result of a more accurate way of taking autoradiographs.

Manske *et al.*, in their report on cases of the patients with carpal tunnel syndrome after hamate hook fractures, emphasized that physicians should carefully check for hamate hook fractures through autoradiograph when any median nerve compression is detected after trauma [11]. Such evidence leads us to accept to some extent that the deformation of the hamate hook could be connected with the occurrence of carpal tunnel syndrome, although not knowing actually how large initial trauma in the soft

tissue and flexor areas was beside the nerve itself or the hamate hook. Our analysis also found a statistically significant association between variations in the hook of hamate and carpal tunnel syndrome.

James *et al.*, examined 3218 hands and detected hook variations on 96 (2.9%) which consisted of 42 cases of Dichotomy Variations, 50 cases of hypoplasia variations and 4 cases of aplasia variations, and reported that 93 cases of hook variations were detected on patients diagnosed with carpal tunnel syndrome while only 3 cases were detected from those diagnosed without, showing strong correlation between hook variations and carpal tunnel syndrome. They also found such variations were not related to EMG abnormalities and whether or not the patient had had surgery [12].

Jebson *et al.*, reported two cases of hamate hook variations emphasizing that endoscopic surgery for that cases should be avoided due to the possibility that the ulnar neurovascular bundle might have transferred to the radial side [13], and thus patients who are thinking of having endoscopic surgery for carpal tunnel release should consider any possible existence of variations and confirm absence by x-ray before undergoing such surgery. James *et al.*, added one more criteria that such confirmation is also necessary for open carpal tunnel release [12]. However, any particular difficulties or complications by anatomical variations hadn't arisen during the surgeries by those writers.

Many studies inquiring into the causes of primary carpal tunnel syndrome have been released. Ikeda reports that the sectional area of the carpal tunnel is narrowed by synovial increase in hyperplasia of the flexor tendon in the flexor area suppressing nerves caused by increasing pressure [13]. Based on such hypothesis, Greene *et al.*, reported cubital tunnel syndrome caused by dichotomy variations in the hamate hook. [14] James *et al.*, set forth a mechanism explaining the high frequency of hamate hook variations for people diagnosed with carpal tunnel syndrome as that the transverse carpal ligament is located a little backward in cases of hypoplasia / aplasia variations, resulting in decreasing the size of the carpal tunnel, and in the case of dichotomy variations unstable fibro-osseous lesions push the transverse carpal ligament backward causing carpal tunnel syndrome [12].

There appeared no gender-dependent differences in occurrence of variations in hamate tunnel hook. However, in actuality, the occurrence frequency of carpal tunnel syndrome is reported higher in females than males. Thus, while any variations in the hamate hook seem to correlate with the outbreak of carpal tunnel syndrome, we haven't yet solved the question about biomechanical causes of the outbreak of carpal tunnel syndrome.

5. Conclusion

A 5.2% incidence of variations of the hamate hook has been detected in this study, a higher ratio than generally reported. In addition, those patients diagnosed with carpal tunnel syndrome showed a higher ratio in variations of the hamate hook, but there seems to be no connection with age and gender. Accordingly, any variations of the hamate hook could be considered as one of causes of the outbreak of carpal tunnel

syndrome rather than being a direct cause, and patients who are thinking of having endoscopic or open carpal tunnel release should be checked for such variations to reduce complications before undergoing such surgery.

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Authors

Young-Keun Lee received a Ph.D, in Orthopaedic from University of Chonbuk National University. He used to work at Eulji University as a professor. Now He is working at Dason Orthopaedic clinic center as a doctor, He has over forty publications in various areas of Orthopaedic.

Malrey Lee received a Ph.D. in Computer Science from the University of Chung-Ang. She has been a Professor at the ChonBuk National University in Korea. She has over seventy publications in various areas of Computer Science, concentrating on Artificial Intelligence, Robotics, Medical Healthcare and Software Engineering.