DOI: 10.5472/MMJ.2011.01860.1

Morphometry and Morphology of Hamate Hook and its Clinical Implications

Hamatum Kemikciğinin Hamulus'unun Morfometrik ve Morfolojik açıdan Değerlendirilmesi ve Klinik Önemi

Brijesh KUMAR[1], Bukkambudhi V. MURLIMANJU[2], Arvind K. PANDEY[1], Sushma R. KOTIAN[1]

[1] Manipal University, Kasturba Medical College, Department of Anatomy, Manipal, Karnataka, India

[2] Manipal University, Kasturba Medical College, Department of Anatomy, Mangalore, Karnataka, India

Abstract

Objective: The first objective of this study was to find out the weakest part of the hook of the hamate, the second objective was to find out the vascular pattern of the weakest part.

Materials and Methods: We used 55 dry bones from the Department of Anatomy, Manipal University. Bones were from adult cadavers of South Indian origin. Among 55 bones, 27 were from the right side and 28 from the left side. We measured morphometric parameters using a Metal Casing Electronic Digital Caliper, resolution 10µm. A magnifying lens (magnifying power 10x) was used to visualize the vascular foramina.

Results: The differences between the right and the left hamate hooks were not statistically significant for any of the variables. (P>0.05). All hamate hooks had vascular foramina at their bases. In 17 (30%) bones, no vascular foramina were seen at the tip of the bone. Only four hamate hooks had vascular foramina at the bend.

Conclusion: From the present study, we hypothesize that the bend of the hamate hook could be its weakest part, and since most of the hamate hooks lack vascular foramina at the bend, this site could be more prone to avascular necrosis. The study also aids to establish data on the hamate hook in a South Indian population. *(Marmara Medical Journal 2011;24:192-5)*

Key Words: Hamate hook, Vascular foramina, Excision

Özet

Amaç: Çalışmamızın esas amacı hamatum kemikciğinin hamulus'unun en zayıf kısmını tespit etmek ve bu zayıf bölgenin damarsal özelliğini belirtmektir.

Araçlar ve Yöntemler: Çalışmamızı Anatomi Bölümü, Manipal Üniversitesi'nden elde ettiğimiz 55 adet el kemiği üzerinde yaptık. Kemikler Güney Hindistan orijinli yetişkin kadavralara aitti. 55 kemiğin 27'si sağ, 28'i ise sol tarafa aitti. Ölçümlerimizde birim aralığı 10µm olan Elektronik Digital Kumpas kullandık. Vaskular foramen'leri görebilmek için x10 büyütmeli lens kullandık.

Bulgular: Ölçüm yaptığımız tüm parametrelerde sağ ve sol hamatum kemikciğinin hamulus'ları arasında istatistiksel olarak anlamlı bir fark bulmadık (P>0,05). Hamatum kemikciğinin hamulus'larının hepsinde vaskular foramen'ler hamulus'un tabanında yer almaktaydı. 17 vakada (%30) hamulus'un uç kısmında vaskular foramen'lere rastlanmadı. Sadece 4 hamatum kemikciğinin hamulus'unda vaskular foramen'ler hamulus'un kıvrımındaydı.

Sonuçlar: Hamatum kemikciğinin hamulus'larının çoğunda kıvrım yerlerinde vaskular foramen'lere rastlanmadığı için , bu bölge avaskuler nekrozlara daha yatkındır. Bu da bize hamatum kemikciği'nin en zayıf kısmının kıvrım yeri olduğunun hipotezini sunmaktadır. *(Marmara Üniversitesi Tıp Fakültesi Dergisi 2011;24:192-5)*

Anahtar Kelimeler: Hamatum kemikciğinin hamulus'u, Vaskuler foramen

Introduction

The hamate is a cuneiform bone with an unciform hamulus (hook) projecting from the distal part of its rough palmar surface. The hamulus is curved with a lateral concavity and its tip inclines laterally contributing to the medial wall of the carpal tunnel[1]. Fracture of the hamate hook is an uncommon injury. Despite the rarity of these fractures in the general population they are quite

Correspondence to/İletişim: Brijesh Kumar M.D., Manipal University, Kasturba Medical College, Department of Anatomy, Manipal, Karnataka, India
E-mail: drbrijesh@yahoo.com

Submitted/Başvuru Tarihi: 12.07.2011 **Accepted/Kabul Tarihi:** 07.09.2011

common in athletes, especially baseball players, golfers and tennis players[2]. Union often fails to occur and non-union causes pain, significant limitation of function and disability[3]. The standard treatment is surgical excision[3-6] and immobilization[7-9], bone grafting has also been reported[10]. The purpose of the present study was to establish data on morphometric parameters of the hamate hook and to find the part of the hamate hook which is more prone to avascular necrosis. The first objective of this study was to find out the weakest part of the hamate hook, which is more prone to fracture. Second objective was to find out the vascular pattern of the weakest part of the hamate hook.

Materials and Methods

We used dry bones from the Department of Anatomy, Manipal University, India. Bones were from adult cadavers of South Indian origin. Damaged bones were excluded. The hamate bones which had straight hooks (no curve on the radial aspect and no bend on the ulnar aspect) were also excluded from the investigation. We observed 55 hamates. In 55 hamates, the hooks were curved laterally on the radial aspect, whereas on the ulnar aspect they had a bend (Figures. 1 and 2). Among 55 bones, 27 belonged to the right side and 28 belonged to the left side. We measured the width of the hamate hook in transverse (p-q) and antero-posterior (r-s) planes at three different levels (Figure 1), at the base (the point where the ulnar surface of the hook begins to project from the palmer surface of the hamate), at the bend and at three 3 mm proximal to the tip. We also measured its height from the base to the tip (H) and base to the bend (h) (Figure 1). We measured morphometric parameters using a Metal Casing Electronic Digital Caliper, resolution 10µm.

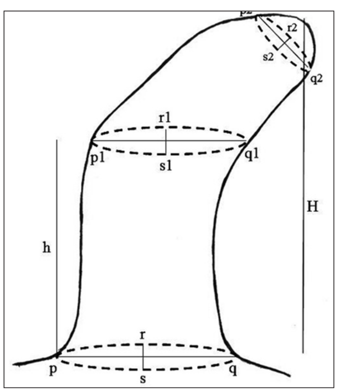

Figure 1. Diagram of right hamate hook. H is the height from the base to the tip, 'h' is the distance between the base and the bend. The width of the hamate hook in transverse plane, at the base = p-q, at the bend = p1-q1 and at 3mm proximal to the tip = p2-q2. At the the same points the width in antero-posterior plane = r-s, r1-s1 and r2-s2.

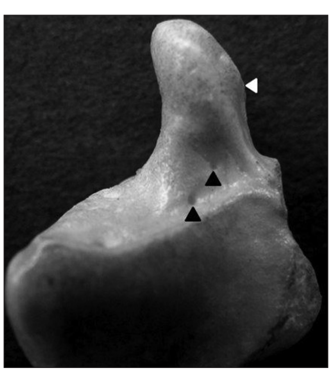

Figure 2. Photograph of left hamate hook. The white arrow head indicates the bend on the ulnar aspect of the hamate hook; the black arrow heads indicate vascular foramina at the radial base.

Externally, the hamate hook is seen to have a generally smooth surface of cortical bone. There are no bare areas of cancellous bone, and thus there are no intratrabecular spaces to be confused with vascular foramina. The foramina appear as distinct holes lined by the smooth cortical bone of the hamate exterior surface and are easily identified under loupe magnification[11]. We used a magnifying lens (magnifying power 10x) to visualize the vascular foramina.

All observations were made by three different observers at three different points of time.

A Student's t test was used for the statistical analysis for two independent samples.

Results

The average values of all the measurements are shown in Table I. All the measurements are in millimeters. Measurements in the transverse plane are: p-q at the base, p1-q1 at the bend and p2-q2 3mm proximal to the tip. At the similar points, measurements in the antero-posterior plane are r-s, r1-s1 and r2-s2. H is the distance between the base and the tip and h is the distance between the base and the bend. The difference between the right and left hamate hook for all the variables was not statistically significant ($P > 0.05$).

All hamate hooks had vascular foramina at their bases, these foramina are on the radial aspect (RB) or on the ulnar aspect (UB); few hamate hooks had vascular foramina on both aspects of the bases. Vascular foramina at the tip, are not present in all hamate hooks and when present, they are on either the radial (RT) or the ulnar aspect (UT). In 17 (30%) bones, no vascular foramina were seen at the tip. Only four hamate hooks had vascular foramina at the

Table I. Statistical analysis for measurements on the hook of the hamate. All the measurements are in millimeters.

Variables	Right side	Left side
p-q	7.94 ± 0.79	8.32 ± 0.88
p1-q1	4.75 ± 0.65	4.62 ± 0.50
p2-q2	3.89 ± 0.55	3.80 ± 0.37
r-s	8.45 ± 0.74	8.57 ± 0.76
r1-s1	9.46 ± 1.52	9.16 ± 1.13
r2-s2	8.57 ± 1.86	8.65 ± 1.26
H	9.50 ± 1.35	10.14 ± 1.03
h	5.51 ± 0.66	5.82 ± 0.89

Table II. Distribution of vascular foramina. Radial base (RB), ulnar base (UB), radial tip (RT), ulnar tip (UT).

Location of foramina	Number of bones	Number of bones with one foramen	Number of bones with 2 foramina	Number of bones with≥3 foramina
RB	49 (89%)	9	9	31
UB	8 (15%)	2	2	4
RT	6 (11%)	3	1	2
UT	34 (62%)	8	3	23

bend, out of the four, three had multiple and one had two foramina. The distribution of the vascular foramina is summarized in table II.

Discussion

Chow et al.[12] reported three variants of the hamate hook (bipartite, hypoplastic and aplastic) by measuring the height of the hamate hook and the width at the base of the hook, all the measurements were made on radiographs[12]. Stark et al.[13] mentioned the average dimensions of hook of the hamate as 1.3 by 1.0 by 0.5 centimeters, making the measurements on computed tomography scans[13]. In the available literature, we could not find any study based on the measurements on the bone. Our observation on the bone showed that the width of the hamate hook in the transverse plane decreases from the base to the tip, in the antero-posterior plane, there is a slight increase in the widthfrom the base to the bend and a decrease from the bend to the tip. As most of the hamate hooks have a bend (5.51±0.66 millimeter above the base on the right side and 5.82±0.89 millimeter on the left side) on the ulnar aspect (Figure 2) and since the width of the hamate hook in both antero-posterior and transverse planes decreases from the bend to the tip, both these factors could make the bend of the hamate hook the weakest point. When a racket, club, or bat is grasped, the end of the handle is located over the distal and ulnar surface of the hook. Fracture of the hamate hook occurs when the grip is relaxed, or when the centrifugal force of the swinging bat or

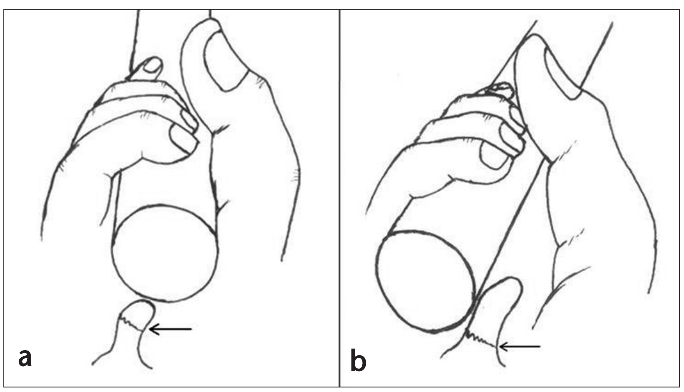

Figure 3. Diagram 3a showing the grasped object striking the tip of the hamate hook, the arrow indicates the fracture at the bend. Diagram 3b showing the grasped object striking the hamate hook proximal to the bend, the arrow indicates the fracture at the base.

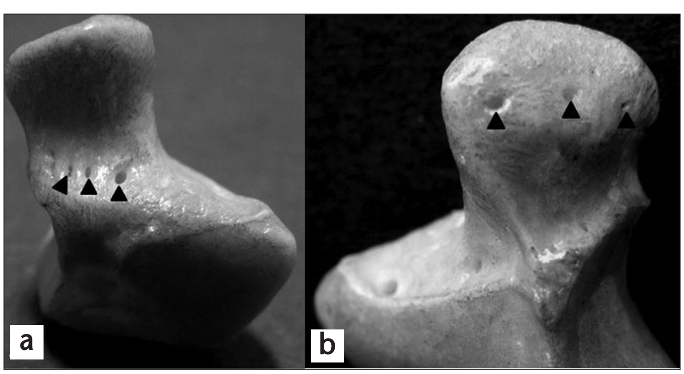

Figure 4. Photograph of the left hamate hook, black arrow heads indicate the vascular foramina. In Figure 4a vascular foramina are at the radial base. In figure 4b vascular foramina are at the ulnar tip. No vascular foramen is present at the bend.

club overcomes the grasping powers[4]. Any object striking the hamate hook distal to the bend may cause the fracture at the bend (Figure 3a), if the object strikes the hamate hook proximal to the bend, it may result in fracture of the hamate hook at the base or between the base and the bend (Figure 3b), if the striking force is, it may cause a crush injury, irrespective of the point of impact on the hamate hook. Hamate fractures represent approximately 2-4% of all fractures of carpal bones[14]. Xiong et al. classified hamate hook fractures on the basis of the fracture sites into 3 types: Type I referred to an avulsion fracture at the tip of hamate hook, type II was a fracture in the middle part of the hamate hook, and type III represented a fracture at the base of the hamate hook. In their study type II was the commonest fracture[15]. The weakest part of the hamate hook defined in the present study also lies in the middle part of the hamate hook.

Allen et al.[16] mentioned that fracture of the hamate hook occurs by direct trauma or as the result of an indirect blow. A direct blow occurs most commonly in sports and indirect injury results from falls on an outstretched hand, with the force transmitted to the hook via its muscular or ligamentous attachments. Allen et al.[16] conducted their study on twenty one patients: twelve patients had a direct injury during sports activity (golf 33.3%, baseball 9.5%, tennis 4.8%, weightlifting 4.8%, diving 4.8%) and nine patients had an indirect injury (fall 14.3%, motor vehicle accident 9.5%, miscellaneous 14.3%, unknown 4.8%) (16).

Stark et al[13] observed from their sixty two patients thatfifteen fractures were at the base, thirty two at the lower 1/3rd, eight at the middle 1/3rd and seven at the upper 1/3rd 13. Their study reported that the fractures are more common in the lower half of the hamate hook, We believe that this could be due to the impact from the striking object proximal to the bend.

Failla et al.[11] reported that the hamate hook has a dual blood supply. Foramina for vessels are present at the hook base and tip, both radially and ulnarly but primarily at the radial base and ulnar tip. Since one of the two blood supplies, namely that at the hook tip, may not be present in all cases, there is a potential for developing compromised blood supply to the hamate hook after fracture. Failla et al. conducted a study of 52 hamates and reported that the base supply was always present and the tip supply was absent in 15 specimens. The base supply is predominantly radial and is occasionally present from the ulnar side of the base; the tip supply is predominantly ulnar and occasionally present on the radial side of the tip of the hook. 14 of the 52 specimens lacked a foramen at the tip and also at the ulnar base, suggesting that the blood supply to the hook in these specimens presumably entered via the only foramina present at the radial base[11]. The authors did not mention any vascular foramina in the region of the bend. In the present study, we also found that base supply was always present (figures. 2 and 4a), RB supply was present in 89% and UB was in 15% of hamate hooks, whereas Failla et al reported the presence of an RB supply in 100% and a UB supply in 23% of the bones. In the present study the tip supply was absent in 30% of the bones. Only four bones showed vascular foramina at the bend, out of these four bones, three had multiple and one bone had two foramina. Since most of the hamate hook does not have vascular foramina at the bend (Figure 4b), this part could be more prone to nonunion and avascular necrosis, than any other part of hamate hook.

Fractures of hamate hook often fail to unite[17], non-union causes pain and significant limitation of function and disability, especially in sports that require a strong grip, such as baseball, squash, tennis, and golf[3]. Though surgery is the preferred modality, occasionally conservative care can result in the fracture healing[18]. Carter et al, Stark et al, Gupta et al and Kang et al reported good results after excision of the hamate hook[3-6]. Whalen et al. and Walsh et al. reported that the acute cases (within seven days of injury) heal with immobilization and suggested that surgery should be reserved for displaced fractures and nonunions[8,9]. According to Stark et al. all hamate hook fractures (both acute and chronic) should be excised[13]. Plancher et al.[19] reported that fragment excision yields the best results . Scheufler et al. from their study on fractured hook of hamate, recommended surgical treatment since they observed that the clinical outcome of patients, which were treated conservatively by lower arm splinting, was disappointing. They reported the surgical intervention by either screw fixation or excision, led to elimination of symptoms[20] and in an experimental study performed on cadaveric hands, it was suggested that minimal invasive repair of isolated hamate hook fractures is feasible[21]. Watson et al. reported that there was loss of the power grip in ulnar deviation secondary to the loss of pulley effect of the hook on flexor tendons after excision of the hamate hook, and to restore the pulley effect of the hook, they recommended bone grafting for hamate hook nonunion[10]. Demirkan et al. conducted an experimental study and showed thatafter hamate hook excision there was a reduction of flexor tendon force owing to the loss of the normal hamate pulley[2].

From the present study, we hypothesize that the bend of the hamate hook could be its weakest part, and since most of the hamate hooks lack vascular foramina at the bend, this site could be more prone to avascular necrosis. However, further clinical and biomechanical studies could be done to test this hypothesis. We believe that findings of the present study will help towards a better understanding of hamate hook fractures, which may assist the orthopedic surgeons. The study also aids to establish the data on hamate hook in a South Indian population.

References

1. Soames RW. Skeletal system. In: Gray's Anatomy. London: Churchill Livingstone, 1995: 649.
2. Demirkan F, Calandruccio JH, DiAngelo D. Biomechanical evaluation of flexor tendon function after hamate hook excision. J Hand Surg 2003; 28:138-43. doi:10.1053/jhsu.2003.50005.
3. Carter PR, Eaton RG, Littler JW. Ununited fractures of the hook of the hamate. J Bone Joint Surg 1977; 59:583-8.
4. Stark HH, Jobe FW, Boyes JH, Ashworth CR. Fracture of the hook of hamate in athletes. J Bone Joint Surg 1977; 59:575-82.
5. Gupta A, Risitano G, Crawford R, Burke F. Fracture of the hook of the hamate. Injury 1989; 20:284-6. doi:10.1016/0020-1383(89)90169-1.
6. Kang H, Jung S, Jung J, Park K, Hahn S. Fragment excision for the treatment of hamate hook nonunion. J Korean Orthop Assoc 2008; 43:458-64. doi.org/10.4055/jkoa.2008.43.4.458.
7. Milch H. Fracture of the hamate bone. J Bone and Joint Surg 1934; 16:459-62.
8. Whalen JL, Bishop AT, Lindscheid RL. Nonoperative treatment of acute hamate hook fractures. J Hand Surg 1992; 17:507-11. doi:10.1016/0363-5023(92)90363-T.
9. Walsh JJ 4th, Bishop AT. Diagnosis and management of hamate hook fractures. Hand Clin 2000; 16:397-403.
10. Watson HK, Rogers WD. Nonunion of the hood of the hamate: An argument for bone grafting the nonunion. J Hand Surg 1989; 14:486-90. doi:10.1016/S0363-5023(89)80008-5.
11. Failla JM. Hook of hamate vascularity: Vulnerability to osteonecrosis and nonunion. J Hand Surg 1993; 16:1075-9. doi:10.1016/0363-5023(93)90405-R.
12. Chow CYJ, Weiss MA, Gu Y, Vernon M. Anatomic variations of the hook of hamate and the relationship to carpal tunnel syndrome. J Hand Surg 2005; 30:1242-47. doi:10.1016/j.jhsa.2005.05.018.
13. Stark HH, Chao EK, Zemel NP, Rickard TA, Ashoworth CR. Fracture of the hook of the hamate. J Bone and Joint Surg 1989; 71:1202-7.
14. Resnick D, (editor). Diagnosis of bone and joint disorders. Philadelphia: WB Saunders, 2002:2847-8.
15. Xiong G, Dai L, Zheng W, Sun Y, Tian G. Clinical classification and treatment strategy of hamate hook fracture. J Huazhong Univ Sci Technolog Med Sci 2010; 30: 762-6.doi:10.1007/s11596-010-0654-7
16. Allen T, Bishop MD, Robert D. Fracture of the hamate hook. J Hand Surg 1988; 13:135-9. doi:10.1016/0363-5023(88)90217-1.
17. Smith P 3rd, Wright TW, Wallace PF, Dell PC. Excision of the hook of the hamate: A retrospective survey and review of the literature. J Hand Surg 1988; 13: 612-5. doi:10.1016/S0363-5023(88)80107-2
18. Fujioka H, Tsunoda M, Noda M, Matsui N, Mizuno K. Treatment of ununited fracture of the hook of the hamate by low-intensity pulsed ultrasound: a case report. J Hand Surg Am 2000; 25:77-9. doi:10.1053/jhsu.2000.jhsu025a0077
19. Plancher KD, Piza PA, Bravo CJ. Treatment of hook of hamate fractures in golfers. Atlas of Hand Clinics 2006; 11: 67-78.
20. Scheufler O, Andresen R, Radmer S, Erdmann D, Exner K, Germann G.. Hook of hamate fractures: critical evaluation of different therapeutic procedures. Plast Reconstr Surg 2005; 115:488-97. doi:10.1097/01.PRS.0000149480.25248.20
21. Scheufler O, Radmer S, Bogusch G, Andresen R. Minimal invasive fixation of hamate hook fractures through a dorsal percutaneous approach using a mini compression screw: an experimental feasibility study. Eur J Trauma Emerg Surg 2009; 35:397-402. doi: 10.1007/s00068-008-8112-y