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Flexor digiti minimi brevis – variations, development & its significance to ulnar neurovascular bundle

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Abstract:

Aim: Flexor digiti minimi brevis (FDMB) is one of the hypothenar muscles, which is subject to lot of variations. Its close relation to the ulnar neurovascular bundle makes it an important muscle. The developmental basis of FDMB, along with its clinical significance with respect to the ulnar nerve and artery were studied. **Materials & methods** - A total of hundred upper limbs (80 male & 20 female) were studied for the presence or absence of FDMB along with the presence of accessory slips in the hypothenar muscles and its relation to ulnar nerve and vessels in detail. **Results:** Of these hundred, five limbs showed absence of FDMB. Out of these five variant limbs, two had the presence of accessory abductor digiti minimi along with the absence of FDMB. **Conclusion:** FDMB is an important landmark within the Guyon's canal. Its absence or presence of accessory slips can result in hypothenar hammer syndrome of ulnar artery and/or in compression neuropathy of ulnar nerve, both of which are closely related to hook of hamate and FDMB. The reason behind such an absence or duplication is either non division or excess division of the ventral muscle mass respectively, which forms the hypothenar group of muscles.

Key words: Evolution; Flexor digiti minimi brevis; Guyon's canal; Ulnar artery; Ulnar nerve

Introduction

Flexor digiti minimi brevis (FDMB) is one of the hypothenar muscles which arises from the convex surface of the hook of the hamate and the palmar surface of the flexor retinaculum. It inserts into the ulnar side of the base of the proximal phalanx of the little finger along with abductor digiti minimi. Absence of FDMB or its fusion with abductor digiti minimi or presence of additional slips with varied origin and insertion were

reported in literature [1-3]. The presence of accessory slips or its absence may be attributed to the developmental anomalies which can result in either non division or excess division of the muscle mass contributing to its formation. FDMB lies lateral to the abductor, and its origin is separated from that of the abductor by the deep branches of the ulnar artery and nerve. FDMB is supplied by the deep palmar branch of the ulnar artery, branches from the ulnar end of the superficial palmar arch, and the palmar digital artery for the medial border of the little finger. FDMB is innervated by the deep branch of the ulnar nerve, C8 and T1 and produces flexion of the little finger at its metacarpophalangeal joint, together with some lateral rotation. The close relation of ulnar neurovascular bundle to FDMB has been the basis for this study, as either the presence or absence of it may lead to disturbances in the normal anatomy. The presence of an accessory slip may cause compression leading to ulnar nerve entrapment [4,5,6]. Its absence may lead to hypothenar hammer syndrome [7,8,9] due to direct compression of ulnar artery over the hook of hamate, during any injury.

Materials & Methods

A total of fifty cadavers, forty male & ten female were studied over a period of five years in the Department of Anatomy. A total of hundred upper limbs were taken for this particular study. An incision along the middle of the hand was made and the fold of skin was reflected along the webs of the fingers towards the medial side. Palmaris brevis was reflected, muscles of hypothenar eminence were exposed and abductor digiti minimi (ADM) and FDMB were looked for. ADM was separated from FDMB and deep branches of ulnar nerve and artery were identified. The attachments of these muscles were defined and ADM was either cut or reflected to visualize the opponens digiti minimi. The presence or absence of FDMB was confirmed. The presence of accessory slips in any of the hypothenar muscles was looked for along with its nerve supply and documented. The relation of such accessory slips to ulnar nerve and vessels were studied in detail.

Results

The total number of upper limbs studied were hundred. There were eighty male and twenty female upper limbs. The most commonest variation observed was the absence of FDMB. Of the hundred hands, five showed absence of FDMB. In these cases, the other hypothenar muscles, that is, abductor digiti minimi and opponens digiti minimi were looked for any associated anomalies. Out of these five variant limbs, two had the presence of accessory abductor digiti minimi along with the absence of FDMB. Case 1- absence of FDMB was seen on the right hand of a male cadaver. Case 2 **(Fig.1)** and 3 – absence of FDMB could be seen on the left hand of two male cadavers . Case 4 – FDMB was absent on the left hand of a male cadaver. But there was an additional slip passing to the abductor digiti minimi from the antebrachial fascia. This slip compressed the ulnar nerve and artery along its short course, which was only about 3 cms long. This additional slip received its nerve supply from the deep branch of ulnar nerve. **(Fig.2)**. Case 5 – on the left hand of a male cadaver FDMB was absent. There was also an accessory abductor digiti minimi (AADM) originating from the antebrachial fascia of the distal forearm and fusing with the normally present abductor digiti minimi, measuring 5.5 cms **(Fig.3)**. The deep branch of ulnar nerve supplied a twig to the AADM. This slip too was superficial to both ulnar nerve and artery.

Discussion

The peculiarity of the human hand is attributed to the movements of the thumb and the little finger. The thenar and hypothenar muscles are arranged in a mirror image pattern so as to complement each other in opposition movements. Of all hypothenar muscles, the variations of FDMB is very common. There may be absence, fusion with abductor digiti minimi or accessory slips may originate from FDMB or get inserted into FDMB. Whatever the variation, the close relation of the trunk and deep branches of ulnar nerve and ulnar artery makes these variations very important.

In the present study five hands had absence of FDMB in the hundred hands studied. Overall incidence of absence of FDMB in the present study is 5%. In males the incidence of absence is 6.25%, whereas in females it is nil (Table1). The associated presence of accessory abductor digiti minimi along with absence of FDMB is 2 out of 5 cases.

Table 1: Absence of FDMB and its incidence

Types	Total	Absence of FDMB	Incidence
Overall	100	5	5%
Males	80	5	6.25%
Females	20	NIL	NIL

The skeleton of the human hand has its evolutionary origin in the anterior fin of primitive fishes [10]. In many mammals including rats and primates FDMB is not present as a distinct muscle. Whereas in tree shrews it is seen as a distinct muscle [11]. The limbs in man develop from two basic sources – the ventro lateral edge of somites (forming muscles) and the somatopleuric mesenchyme (forming connective tissue). The muscle precursor cells from somatic origin migrate as cells during the fourth week, then as groups surrounded by extracellular fibrils, which determine the direction of filopodia of the migratory cells. Myogenic cells first form principal dorsal and ventral premuscular masses. Fusion of cells in the extracellular space of the myoblasts creates a gap and hence separates the dorsal and ventral masses into different groups, which later on differentiate into different muscles. As carriers of morphogenetic information, the fibroblasts play a very important role in the differentiation of individual muscles which are identifiable by seven weeks.

The more recent evolution of the hand can be understood as the expression of the development of the brain. Therefore, the hand is a direct tool of our consciousness. Evolutionary changes dictate the course of development of muscles from the muscle primordia. Hence, there are chances of persistence or even cessation of existence of certain muscles in the hand with time and evolution [12]. The basic thumb movement is the key factor in evolution of the hand and the movement of the little finger is of equal importance to complement the thumb in finer opposition. Hence depending on the usage and the evolution, with time muscles may either duplicate having accessory bellies or may be absent.

The commonest variation observed in FDMB is its absence. Absence of FDMB has been recorded as early as 1875 by Macalister [13]. Later cases of absence were reported in literature [14-16]. The absence of FDMB along with the presence of AADM is a unique finding not yet reported anywhere in literature. In this study we came across two such cases out of the five cases which had absence of FDMB. Carr et.al[17] is the only other author who has reported a case of absence of FDMB which was associated with a digastric flexor muscle extending from medial epicondyle to the proximal phalanx of fifth finger. Presence of AADM have been reported by several authors [18-21]. During development, if division of ventral muscle mass is hampered, the result is absence of a muscle from that particular primordium, as FDMB in this case. But at the same time there has been extra division of ventral muscle mass resulting in the AADM. So it is made clear that when certain regulating factors can hinder division, some factors can stimulate division in the same hand during development.

The absence of FDMB is of great significance because of its close relation to the ulnar neurovascular bundle. The ulnar artery along with ulnar nerve on its medial side enters the palm superficial to flexor retinaculum and on the radial side of pisiform bone. Beneath palmaris brevis the artery divides into superficial and deep branches, where the former is the direct continuation of ulnar artery and contributes mainly to superficial palmar arch. The deep branch of ulnar artery and nerve pass deeply between the abductor and flexor digiti minimi and then turn laterally below the hook of hamate to complete the deep palmar arch.

Cobb et.al [22] has redefined the boundaries of Guyon's canal through which the neurovascular bundle of ulnar artery and ulnar nerve passes. Guyon's canal is conversion of the depression between pisiform and hook of hamate into a tunnel by pisohamate ligament. Hence the roof is formed by volar carpal ligament and pisohamate ligament. He has specified that the hypothenar muscles along with their fibres of origin and flexor retinaculum form the floor of the Guyon's canal. Ulnar artery is radial to the ulnar nerve. Hence any pathologies of ulnar artery or abnormalities of hypothenar muscles can result in ulnar nerve compression [23].

Pathology of ulnar artery that can compress ulnar nerve within the Guyon's canal is hypothenar hammer syndrome, which was first reported in 1934 by von Rosen [24]. The superficial palmar branch of the ulnar artery is traumatised when the hand is used in the manner of a hammer or is exposed to chronic repetitive blunt trauma [25]. The trauma is due to the presence of hook of hamate in close approximation to the ulnar artery in the Guyon's canal. The absence of FDMB can still enhance the injury due to lack of a softened floor as against the firm transverse carpal ligament. The presence of accessory FDMB can also enhance the injury due its own compressive effects on the ulnar artery in addition to the hook of hamate. This leads to luminal thrombosis, intimal thickening, hypertrophy and neovascularization of the ulnar artery. This is typically seen as corkscrew appearance in angiography [9]. Distal to the thrombosis, symptoms due to arterial occlusion such as pain, coldness, numbness, ulceration and gangrene can occur along with symptoms of ulnar nerve compression. Treatment is to excise the affected segment of ulnar artery and to do a venous graft.

Presence of accessory heads of origin of FDMB [26,27] and unusual origin of FDMB [28] has been reported in literature. In the present study too, presence of accessory abductor digiti minimi is seen in two cases with simultaneous absence of FDMB. This again can be attributed to mal division of muscle masses during the

embryonic period. Guyon's canal release is performed in cases of ulnar nerve or artery compression due to accessory slips, oedema of hypothenar muscles secondary to hypothenar hammer syndrome [29-33]. If the compressing factors are local within the canal, the release is done by dissecting Palmaris brevis, palmar aponeurosis and superficial volar carpal ligament in same plane with transverse carpal ligament. Then deep and dorsal to contents of Guyon's canal, the fibrous arcade origins of abductor digiti minimi and then flexor digiti minimi from piso-hamate ligament are dissected.

FDMB is one of hypothenar muscles which can be absent or duplicated. Though many authors have reported either absence or accessory FDMB as case reports (12 of them cited in reference) or have found variations of FDMB as part of study of muscles of hand (3 of them cited here) or have done a CT study on pathology of hypothenar muscles, a study on FDMB alone has not been attempted. Its importance to ulnar neurovascular bundle and hypothenar hammer syndrome has been the initiative to undertake this study on FDMB. The absence and duplication of ADM can coexist, leading to ulnar neurovascular bundle compression sydromes. The intricate relation within Guyon's canal is important to understand the etiological basis and as well as for any operative procedures within it.

References

1. GeorgiP . Georgiev,M D,LazarJelev, MD, PhD An Aberrant Flexor Digiti Minimi brevis Manus Muscle, J Hand Surg Am 2011, Vol 36A; 1965-1967.
2. G.P. Georgiev L, Jelev L. Surchev, Undescribed variant muscle -"Deep abductor'flexor" of the little finger, in relation to ulnar nerye compression at the wrist Ann Anat 189 2007, 276-282.
3. M.L. Hill, M.M. Shoja, E.G. Salter, R.S. Tubbs An unusual muscle of the wrist with potential compression of the ulnar nerve Folia Morphol.Vol. 65, No. 2, pp. 178–180
4. Lebreton E. Hypothenar eminence, Chir Main. 2010 Sep;29(4):213-23. doi: 10.1016/j.main.2010.04.003. Epub 2010 May 20.
5. Harris Gellman and Patrick Owens , Decompression of the Ulnar Nerve at Guyon's Canal In: Sam W. Wiesel, Editor, Operative Techniques in Orthopaedic Surgery, Volume III 1st edition, Lippincott Williams & Wilkins Available at https://www.inkling.com/read/operative-techniques-orthopaedic-surgery-vol-3-1st/chapter-hwf-69/decompression-of-the-ulnar
6. Gusmão, L. C. B.; Feijó, M. J. F. & Sousa-Rodrigues, C. F. S. Morphologic aspects of Abductor digiti minimi muscle in the hand. Int. J. Morphol., 23(4):373-6, 2005.
7. C. Timothy Ablett, Laurel A. Hackett, Hypothenar Hammer Syndrome: Case Reports and Brief Review Clin Med Res. 2008 May; 6(1): 3–8. doi: 10.3121/cmr.2008.775
8. Alain G. Blum, Jean-Philippe Zabel, Romain Kohlmann, Toufik Batch, Karine Barbara, Xavier Zhu,et.al., Pathologic Conditionsof the Hypothenar Eminence: Evaluation with Multidetector CT and MR Imaging RadioGraphics 2006; 26:1021–1044
9. Larsen BT, Edwards WD, Jensen MH, Johnson CH, McBane RD, Harmsen W S et.al.,Surgical Pathology of Hypothenar Hammer Syndrome With New Pathogenetic Insights: A 25-Year Institutional Experience With Clinical and Pathologic Review of 67 Cases. Am J Surg Pathol. 2013 Jul 24. [Epub ahead of print]
10. Putz RV, Tuppek A. Evolution of the hand Handchir Mikrochir Plast Chir. 1999 Nov;31(6):357-61.
11. Rui Diogo, Bernard Wood, Comparative anatomy and phylogeny of primate muscles and human evolution, NewHampshire, USA, Science Publishers, 2012.
12. Diogo R, Richmond BG, Wood B. Evolution and homologies of primate and modern human hand and forearm muscles, with notes on thumb movements and tool use. J Hum Evol. 2012 Jul;63(1):64-78. doi: 10.1016/j.jhevol.2012.04.001. Epub 2012 May 27.
13. Macalister A. Additional observations on muscular anomalies in human anatomy (third series), with a catalogue of the principal muscular variations hitlrerto published. Trans Roy kish Acad 1875;25:I-130
14. Le Double A. Muscles de la main. In: Trait6 des variations du systdme musculaire de l'homme. Tome IL Paris: Schleicher Frbres, 1897:170-17Carr ND, O'Callaghan JD, Vaughan R An unusual flexor of the fifth finger Acta Anat (Basel). 1977;98(4):376-9.
15. Von Lanz T, Wachsmuth W. Arm. In: Praktische anatomie. 1. Bd. 3.Teil. Berlin: Verlag von Julius Springer, 1935:193
16. Susan Standring, Gray's Anatomy 39th ed. UK, Elsevier Churchill Livingstone, Pg.919.
17. Carr ND, O'Callaghan JD, Vaughan R An unusual flexor of the fifth finger Acta Anat (Basel). 1977;98(4):376-9.
18.Svetoslav.A.Slavchev, Georgi.P.Georgeiv, Aberrant Digiti minimi Muscle found during open surgical decompression of of the carpal tunnel : A case report, Rev Arg de Anat Clin; 2013, 5(2): 88-91
19.Luis Ernesto Ballesteros, Luis Miguel Ramirez Possible implications of an accessory abductor digiti minimi muscle: a case report DOI: 10.1186/1749-7221-2-22
20.Sheppard JE, Prebble TB, Rahn K. Ulnar neuropathy caused by an accessory abductor digiti minimi muscle.

Wis Med J. 1991 Nov;90(11):628-31.

21.Soldado-Carrera F, Vilar-Coromina N, Rodríguez-Baeza A. An accessory belly of the abductor digiti minimi muscle: a case report and embryologic aspects Surg Radiol Anat. 2000;22(1):51-4.

22.Cobb TK, Carmichael SW, Cooney WP. Guyon's canal revisited: an anatomic study of the carpal ulnar neurovascular space. J Hand Surg Am. 1996 Sep;21(5):861-9.

23.Hans Martin Scmidt, Ulrich Lanz, Surgical anatomy of the hand, [Gerhard Kohnle, trans] 2nd Edition, Germany, Thieme Verlag, 2003

24.Von Rosen S. Ein Fall von Thrombose in der Arteria ulnaris nach Einwirkung von stumpfer Gewalt. *Acta Chir Scand* 1934; 73: 500–506**.**

25.Emanuele Cigna, Anna Maria Spagnoli, Mauro Tarallo, Liliana De Santo, Giampaolo Monacelli, and Nicolò Scuderi, Therapeutic Management of Hypothenar Hammer Syndrome Causing Ulnar Nerve Entrapment, Plastic Surgery International, Volume 2010 (2010),ArticleID 343820,5pages http://dx.doi.org/10.1155/2010/343820**.**

26.Georgi Georgiev, L Jelev Variant triple origin of the flexor digiti minimi brevis (manus) muscle in relation to ulnar nerve and artery compression at the wrist, Clinical Anatomy 12/2007; 20(8):976-7. DOI:10.1002/ca.20529**.**

27.Saadeh FA, Bergman RA. An unusual accessory flexor (opponens) digiti minimi muscle. Anat Anz 1988;165:32'1-329.

28.Wingerter S, Gupta S, Le S, Shamasunder S, Bernstein R, Rabitaille W, et.al. Unusual origin of the flexor digiti minimi brevis muscle. Clin Anat. 2003 Nov;16(6):531-3.

29.Spinner RI, Lins RE, Spinner M. Compression of the medial half of the deep branch of the ulnar nerve by an anomalous origin of the flexor digiti minimi. A case report. J Bone Joint Surg 1996;784: 427-430.

30.Shea JD, McClain EJ. Ulnar-nerve compression syndromes at and below the wrist. J Bone Joint Surg 1969;51A:1095-1103

31.Jeffery A.K., Compression of the deep palmar branch of the ulnar nerve by an anomalous muscle. case report and review. J. Bone Joint surg.1971 538, 718 723

32.Carneirio, R.5., Mann, R.J., 1979. Occlusion of the ulnar artery associated with an anomalous rnuscte: a case report. J. Hand Surg. 4A, 412 414.

33.Winterer JT, Ghanem N, Roth M, Schaefer O, Lehnhardt S, Thurl.C, et al. Diagnosis of the hypothenar hammer syndrome by highresolution contrast-enhanced MR angiography. Eur Radiol 2002;12:2457–2462

Figure 1: Case 2- Absence of FDMB

ODM – Opponens digiti minimi

ADM – Abductor digiti minim

UN – Ulnar nerve

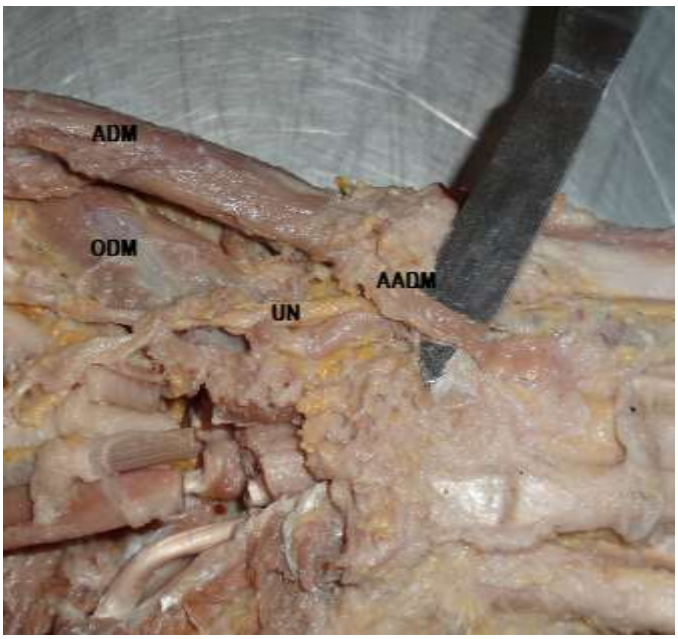

Figure 2: Case 4 – Absence of FDMB with AADM

ODM – Opponens digiti minimi

ADM – Abductor digiti minim

UN – Ulnar nerve

AADM – Accessory Abductor digiti minimi

Figure 3: Case 5- Absence of FDMB with AADM

UA – Ulnar artery

ADM – Abductor digiti minim

UN – Ulnar nerve

AADM – Accessory Abductor digiti minimi