Case Report: Bilateral Communication between Superficial and Deep Group of Forearm Flexors

Arun Chaudhury[1], Anita Yadav, A. Shariff

Department of Anatomy, All India Institute of Medical Sciences (AIIMS), New Delhi 110029, India.

1, Present address: Monell Chemical Senses Center, 3500 Market Street, Philadelphia PA 19104 USA.

Total Numbers of figures and Tables: 1

Abbreviated Title: Connection of superficial and deep forearm flexors

Correspondence to:

Dr. Arun Chaudhury, Monell Chemical Senses Center, 3500 Market Street, Philadelphia PA 19104 USA. Call: (001)508-264-6503. achaudhury@monell.org

Summary

Presence of accessory muscles in both forearms was observed in a male cadaver during dissection. In both forearms, the muscle originated from the medial epicondyle of the humerus. Their tendons joined the tendons of flexor pollicis longus. On the left side the tendon of this muscle bifurcated almost in the middle of the forearm; one slip joining the flexor pollicis longus and the other joining the first tendon of the flexor digitorum profundus. These accessory muscles received their nerve supply from anterior interosseus nerves in both right and left forearms. Compression of the anterior interosseous nerve by this muscle is unlikely as the nerve is lateral and in a more posterior position. This supernumerary muscle belly can produce a distressing pain syndrome affecting the forearm and the wrist. It is pertinent to rule out this condition during evaluation for chronic painful states affecting the forearm. This accessory muscle belly hints at the persistence of a primitive trait and indicates a communication between the superficial and deep groups of flexors in the forearm.

Key words Gantzer's muscle; supernumerary muscle; muscle; hand; neuropathy; pain; nerve compression

Introduction

In 1813 Gantzer described two accessory muscles in the human forearm which bear his name (Gantzer C.F.L., De Musculorum Varietates. Thesis, Berlioni, I.F. Slarcku).[1,2,3,4] Here we report a unique pattern of bilateral communication between the superficial and deep groups of forearm flexors.

Materials and Methods

Twenty-four embalmed human subjects (male: female:: 7:1) were dissected over a period of three years by the 1st year undergraduate students of AIIMS, New Delhi. The upper extremities (48 arms with equal left/right distribution) were dissected as per instructions in the Cunningham's Manual of Practical Anatomy.[5] Any gross variations in the anatomy of the muscles of the forearm were noted. The numbers noted here, however, do not aim to hint at the statistical rates of occurrence of this condition.

Results

A supernumerary muscle was observed in flexor compartments of both forearms in one middle aged male cadaver. This muscle, on both the sides, was documented by photography and sketching. In the right forearm, the proximal attachment of the muscle was to the medial epicondyle of humerus, deep to the fibers of origin of flexor digitorum superficialis. The tendon of this fusiform muscle was attached distally to the junction of the middle and lower thirds of the tendon of flexor pollicis longus. The origin of the accessory muscle in the left forearm was same as that in the right forearm. However, the tendon of this supernumerary muscle divided into two slips in the middle of the left forearm; one attached to the tendon of flexor pollicis longus and the other, a more slender one, to the profundus tendon of index finger (figure 1).

A slender branch of anterior interosseus nerve supplied these accessory muscles in both the forearms (figure 1). They were supplied by several small twigs from anterior interosseus and ulnar arteries. Both the accessory muscles were lying anterior to the anterior interosseus nerves and the ulnar arteries, and posterior to the median nerves.

Discussion

Well-developed digital flexor muscles in modern human hand reflect an emphasis on strong flexion.[6] The unique features of human wrist relate primarily to requirements of manipulative movements of the thumb and index finger. The flexor pollicis longus muscle has provided the thumb with considerable degree of autonomy, which in turn has enabled the human hand into a versatile multifunctional tool.[7] It seems logical that this muscle is a relatively new acquisition in the evolutionary hierarchy of man. This muscle is absent in chimpanzees and gorillas.

The flexor pollicis longus muscle usually has an accessory muscle belly (Gantzer's muscle).[8] This muscle belly can be present unilaterally or bilaterally. It originates either from the medial epicondyle of humerus, under the cover of flexor digitorum superficialis, or coronoid process of ulna or both. It is usually attached to the ulnar part of flexor pollicis longus muscle and its tendon. Gantzer's muscle may be found in the proximal forearm of approximately 50% of dissected limbs. Kaplan and Spinner (1984) reviewed the history of Gantzer's muscle and found that the muscle was described by Albinus almost a century before Gantzer detailed its anatomy in 1813. Rarely, this accessory muscle may divide distally into more than one part, and the different slips insert into flexor pollicis longus (FPL), flexor digitorum profundus (FDP) and flexor digitorum superficialis (FDS).[9] It is essential to remember here that the flexor pollicis longus and the flexor digitorum profundus lie almost in the same plane separated by the anterior interosseus nerve and artery in the forearm.

The flexor pollicis longus muscle is usually completely separate from the flexor digitorum profundus muscle in humans.[10] The presence of a communication between the superficial and deep groups of forearm flexors (as in the present case) can be explained on the basis of embryological development. All digital flexor tendons develop from an initial single staging area (premuscle mass).[11,12] Both the flexor pollicis longus and the flexor digitorum profundus have a common phylogenic derivation from the pronatoflexor group.[7] As a result, the communication between various flexors of forearm may result from persistence of the original junctions and lack of appropriate cleavage. Therefore, the presence of this accessory muscle belly is an expression of an atavistic trait.

The local factors operating during development may be different in each limb and this may explain the asymmetric pattern of attachment of these accessory muscles seen in the present case. Morphogenesis is a programmed process, which may be altered by release of messengers from cells that modify the program with successive iterations. The mechanisms of differentiation of the mesodermal cells into muscle, bone, and cartilage is not clear.[13] Myoblast differentiation requires activation and suppression of specific genes in a temporal and spatial sequence supervised by a complex array of regulatory transcription factors. These factors are basic helix-loop-helix (bHLH) proteins that are highly conserved throughout evolution. In later stages of muscle ontogenesis, the selective accumulation of MyoD1 and myogenin mRNA transcripts is not purely under genetic control but is modulated by the innervations of the muscle and hormonal influences.[14]

In sharks (*Scoliodon*), buds from the myotomes grow into the embryonic fins and these break down into mesenchyme and form the source for fin muscles. In birds and mammals, the direct myotomic origin of the muscles of the appendages is denied. The segmental nerve supply of the limb muscles of higher animals is merely suggestive, but not a proof, of myotomic origin.[15] The muscles of limbs in amphibians were presumably derived from the radial muscles that moved the fins of fishes.[16] These are formed from the myotomes and they are mainly arranged so as to raise and lower the fins. Presumably the original arrangement was such as to move the limbs in association with the waves of contraction passing down the body. In modern urodeles, the limb is brought forward and its joint flexed as the epaxial muscles at the level of its front end contract. The wave of contraction then passes back and extends the limb. This may have been the primitive movement, making the limb more useful as a lever during the early attempts to propel forward. Skeletal muscles have no requirement for contraction in early stages of development. In order to produce the massive but intricately coordinated movements of body parts that are required in postnatal life, skeletal muscle cells must form long muscle fibers which are highly oriented, and connected with a well-defined anatomical origin and insertion. Moreover, each muscle fiber must be precisely integrated into a functional neural circuit, as otherwise coordinated action of the muscle will be impossible. Innervations of muscle fibers are in full swing at 11 weeks of gestation. After the migration of the muscle cells in the peripheral staging area, there is splitting of the common muscle mass into the primordia of individual muscles. The basis for the splitting of the premuscle mass is unknown.[17] It is well established that the presence of nerve fibers is not required for splitting.[14] Cues from local connective tissue arising from the lateral plate also play a significant role in shaping the muscle. It is also well known that the extensors develop earlier than the flexors in the limbs.[15] Signals operating during terminal differentiation and pattern formation, and a plethora of other hitherto unknown factors, may be operant during ontogenesis of these accessory muscles. As Mangini (1960) had earlier pointed out, it is difficult to predict, why this accessory muscle belly is encountered only in human beings and is absent in nearly all other species.[7]

Apart from being an anatomical curiosity, the presence of this supernumerary muscle belly has a lot of clinical significance. Fracture dislocation of the elbow, especially of the medial side, can involve the fibers of origin of this accessory muscle and may result in unexplained flexion contracture deformity of thumb. The possibility of occurrence of this accessory muscle must be kept in mind during exploration of anterior region of the elbow to avoid injury to it, which may result in secondary contracture of the flexor pollicis longus. In the present case, the anterior interosseus nerve (AIN) supplied the accessory muscle bellies in both the forearms by slender branches arising from its posteromedial aspect. In most of its course, the anterior interosseus nerve was posterior to the accessory muscle belly. Though the chances of compression of the anterior interosseus nerve in such conditions are minimal, the hypertrophy of these accessory muscle bellies may readily compress it, resulting in anterior interosseus syndrome [18, 19] These patients may present with pain in volar wrist, weakness, difficulty in pinching or gradual deterioration of handwriting. Physical examination may not reveal complete paralysis of flexor pollicis longus and index finger profundus. Weakness and paresis of all fingers may be present as, sometimes, all the profundus tendons are innervated by anterior interosseus nerve. About half of the communications between median and ulnar nerves arise from the anterior interosseus nerve in the forearm. In such cases, compression of anterior interosseous nerve may also result in intrinsic muscle weakness of hand.[20] The relation of the Gantzer's muscle to the median nerve and the anterior interosseus nerve is of considerable interest. Mangini had mentioned that the Gantzer's muscle is sandwiched between median nerve anteriorly and AIN posteriorly. However, his opinion was opposed by Dellon and Mackinnon (1987) and Al-Qattan. (1996). [21, 9] According to them, the accessory muscle always lie posterior to both the median and anterior interosseus nerves. The accessory muscle belly can be closely related to the median nerve when the median nerve passes deep to the deep head of the pronator teres or the deep head of pronator teres is absent.[9] In such situations, the median nerve is vulnerable to compression by the Gantzer's muscle.

Evolutionary progression shows a tendency towards complete isolation of the common flexors of the hand. Whenever accessory muscle bellies connecting the forearm flexors are present, they lead to a multitude of functional disturbances. When an anomalous muscle or tendon tethers an adjacent muscle anywhere in the forearm, there is significant difference in excursion of the connected muscle bellies. An abnormal tendon or muscle, attached to another muscle or tendon, restricts the contraction of the later muscle-tendon unit in such a way that full proximal migration is hindered. This results in pain which is usually localized to the distal third of the forearm. Normal activity may be minimally impaired; however, after a certain stress level, it is impossible for the hand to function. In older patients, supernumerary muscle bellies may become symptomatic following unusual stress loading, for example, after an unaccustomed strenuous work. Once the symptoms set in, they tend to persist and are relieved only after surgical intervention. The pain results from a shear phenomenon between adjoining tendons.[22]

In the present case, in the left forearm, the tendon of the accessory muscle divided into two slips which were inserted into FPL and the first tendon of FDP. As a result, it would have been difficult to actively flex the interphalangeal joint of the thumb without simultaneously flexing the distal interphalangeal joint of the index finger. Any resistance to this movement causes pain in the palmar side of the wrist or in the distal part of the forearm. This condition, called the Linburg-Comstock syndrome results from muscle tendon shear phenomenon.[23]

Unfortunately, many cases of symptomatic supernumerary muscle belly syndrome have been misdiagnosed as dissociation disorder and referred for psychological consultations and evaluation [22, 24] Hence, it seems that unexplained, chronic forearm and wrist pain, warrants appropriate clinical examination and work-up to identify correctable causes. At the present, it is difficult to use the exisiting imaging techniques (MRI etc) to diagnose this condition with high precision, but its possibility should be bore in mind during surgical exploration for unexplained, chronic distress affecting the forearm and/or wrist.

References

1. Jones M, Abrahams PH, Sanudo JR, Campillo M. 1997. Incidence and morphology of accessory heads of flexor pollicis longus and flexor digitorum profundus (Gantzer's muscles). J Anat Oct; 191(Pt 3): 451-5.

2. Jones M, Abrahams PH, Sanudo JR. 1997. Case report: accessory head of the deep forearm flexors. J Anat Aug; 191(Pt 2): 313-4.

3. Tountas CP, Bergman RA. 1993. Anatomic variations of the Upper Extremity. Edinburgh: Churchill Livingstone, p 148.

4. Dykes J, Anson BJ. 1944. The accessory tendon of the flexor pollicis longus muscle. Anatomical Record; 90:83-89.

5. Romanes GJ. 1986. Cunningham's manual of Practical anatomy Vol.1, New York: Oxford University Press Inc.

6. Mary W Marzke, Ronald L. Linscheid. 1998. Anthropology and Comparative Anatomy. In: William P. Cooney, Ronald L. Linscheid James H. Dobyns, ed. The Wrist Diagnosis and Operative.Treatment. Vol One Mosby, p 14-29.

7. Mangini U. 1960. Flexor pollicis longus muscle its morphology and clinical significance. Journal of Bone and Joint Surgery; 42A: 467-470.

8. Romanes G.J. 1964. Cunningham's Textbook of Anatomy. 10th edn. Oxford University Press, p 316-345.

9. Al-Qattan MM 1996. Gantzer's Muscle An anatomical study of the accessory head of the flexor pollicis longus muscle Journal of Hand Surgery (British and European Volume) 21B :2: 269-270.

10.Murakami Y, Edashige K. 1980. Anomalous flexor pollicis longus muscle.

Hand. Feb; 12 (1): 82-4.

11.Chaplin DM, Greenlee TK Jr. 1975. The development of human digital tendons. J Anat. Nov; 120 (2): 253-74.

12. Benjamin A. Alman, Michael J. Goldberg 1998. Defective limb Embryology In: Fetal And Neonatal Physiology Richard A. Polin, William W. Fox W.B. Saunders Company, Vol. 2, 2363-2365.

13. Polin RA, Fox WW. 1998. Fetal and Neonatal Physiology. W.B.Saunders Company, 198:2226-2247.

14. Arey LB. 1963. Developmental Anatomy. 6th ed W.B.Saunders & Charles E. Tuttle Co., p 426-438.

15.Young JZ. 1994. The Life of Vertebrates. 3rd ed ELBS & Oxford University Press, p 225-266.

16. Carlson BM 1996. Patten's Foundation of Embryology. 6th ed, McGraw-Hill, p 311-354, p 393-426.

17. Spinner M. 1970. The anterior interosseus-nerve syndrome with special attention to its variations. Journal of Bone and Joint Surgery; 52A: 84-94.

18. Hill NA, Howard FM, Huffer BR 1985. The incomplete anterior interosseus nerve syndrome. The Journal of Hand Surgery, January; 10A:1: 4-16.

19. North ER, Kaul MP 1995. Compression Neuropathies: Median In: Peimer CA, ed. Surgery of the Hand and Upper Extremity. Vol. 1, McGraw-Hill, p 1307-1336.

20. Dellon AL, Mackinnon SE. 1987. Musculoaponeurotic variations along the course of the median nerve in the proximal forearm. Journal of Hand Surgery; 12B: 359-363.

21. Ryu J, Watson HK. 1987. SSMB syndrome. Symptomatic supernumerary muscle

belly syndrome. Clinical Orthopaedics and Related Research; 216: 195-202.

22. Hamitouche K, Roux JL, Baeten Y, Allieu Y. 2000. Linburg-Comstock syndrome. Epidemiologic and anatomic study, clinical applications. Chir Main May; 19(2): 109.

23. Honing ML, Kon M 1996. Dysfunctional Postures of the hand as part of a conversion reaction. Journal of Hand Surgery (British and European Volume) 21B:2: 271-275.

Footnotes

This project was completely supervised by Dr. A. Shariff, who also did the photography. This work was presented in part in the Annual Conference of Anatomical Society of India held at Gulbarga, India, December 2002. The authors thank the staff of the Gross Anatomy laboratory, especially Mr. Chandrika, for their support.

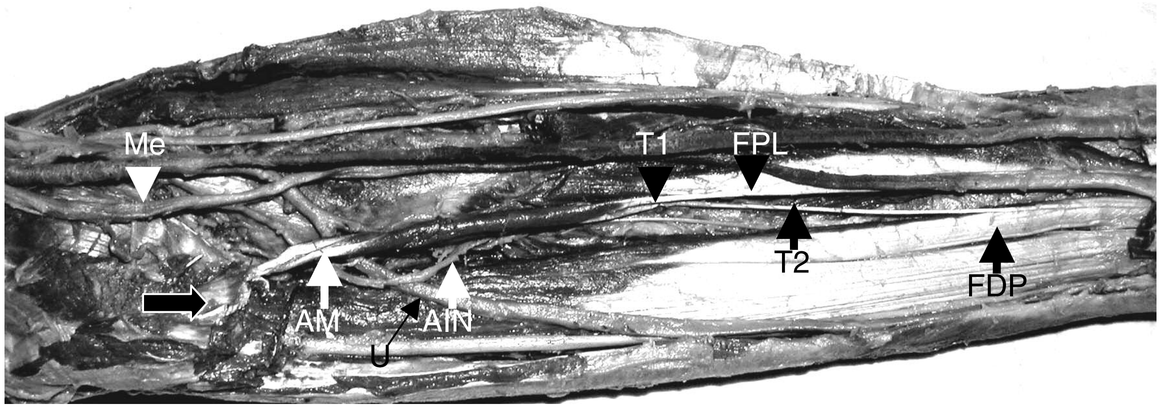

Figure 1. The accessory muscle belly (AM) arose from the common flexor origin in both forearms (block arrow pointing towards right, the region of medial epicondyle). Note the slender branch from the anterior interosseus nerve (AIN) supplying the muscle belly. In the right forearm, the tendon of this supernumerary muscle attached to the flexor pollicis longus. However, in the left forearm, as shown here, the tendons bifurcated and the two tendinous slips of the accessory muscle belly attached to the tendons of flexor pollicis longus (FPL) (T1) and flexor digitorum profundus (FDP) (T2). Also, note the anterior interosseus nerve running parallel to T2 in front of the interosseus membrane. The bifurcation in the tendon of a supernumerary muscle can produce chronic pain due to a muscle tendon shear phenomenon. U, ulnar artery, Me, median nerve