ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Multiple Tendons for Abductor Pollicis Longus in the First Dorsal Compartment and Variation in their Insertion Pattern: Anatomical and Clinical Relevance

Suhani S, Narga Nair, Naveen K and Mamatha H*

Department of Anatomy, Kasturba Medical College, Manipal University, Manipal-576104, India

ABSTRACT

Precession in the action of the thumb is an evolutionary modification for various skilled movements of the human hand. The fine and specialized movements of the thumb is depends on the co-ordination of the intrinsic and extrinsic muscles such as flexor, extensor, adductor and abductor group of muscles. Here in this study we made an attempt to evaluate the possible variations in the number of tendons of the abductor pollicis longus muscle that are passing through the first dorsal compartment and variability in their distal attachments. For this purpose we studied seventy three (32 males and 12 females) formalin fixed cadaveric upper limbs (35 right and 38 left) in the Department of Anatomy, Kasturba Medical College, Manipal. Our result show that, the presence of two tendons for APL was found in 47.95% and presence of five and 6 tendons were found in about 1.36% of the cases. In majority of the cases, the tendons were found to attach to the base of 1st metacarpal bone. In only one case, tendon was found to attached to the base of the proximal phalanx of the thumb via small extension. Knowledge of these multiple tendons and variation in their distal attachments of the APL are essential in the treatment of de Qurvain's stenosing tenosinovitis, in interposition arthroplasty, tendon transfer, tendon translocation and ligament reconstruction in arthrosis.

Key words: Abductor pollicis longus, First dorsal compartment, multiple tendons.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Thumb is an integral part of the functional hand without which most of the skilled actions of the hand are impossible. Human Thumb can perform flexion, extension, abduction, adduction, circumduction and opposition. Opposition and prehensile actions are the most evolved feature of the human thumb which is not seen in the lower primates. To perform these various actions precisely it requires great amount co-ordination between the intrinsic muscles such as flexor pollicis brevis, abductor pollicis brevis , opponens pollicis, adductor pollicis, interosseous muscles and extrinsic muscles such as extensor pollicis brevis.extensor pollicis longus, flexor pollicis longus,and abductor pollicis longus (APL) and adaptable stability in the joints of the thumb. APL is a fusiform muscle, powerful abductor of the thumb arises from the posterior surface of the shaft of the ulna, interosseous membrane and the radius. After its origin, the muscle belly spirals around the radial extensors of the wrist and ends as tendon which usually splits in to two slips: one to attach to the radial side of the base of 1st metacarpal bone and the other to the trapezium [1, 2]. It has been shown that, smaller tendeneous slips from the APL tendon may also continue with the fibers of abductor pollicis brevis (APB), opponens pollicis [1] scaphoid [3], base of the proximal phalanx of the thumb [4]. The distal attachment of the APL tendon is in close proximity to the carpometacarpal joint of the thumb, thus it helps in providing greater stability to the thumb [5, 6].

Though split insertions of APL in chimpanzees, gorillas and gibbons is normal phenomenon, persistence of such anomalies in humans is thought to be a result of an atavism. Precise knowledge of these anatomical variations is important for clinical diagnosis as well as for the surgical procedures like tendon transfer, tendon translocation, interposition arthroplasty, tendon reconstruction in arthrosis [7]. In the present study, we describe the variable number of APL tendons and also the different insertion pattern of these tendons.

MATERIALS AND METHODS

Seventy three (32 males and 12 females- 35 right and 38 left upper limbs) upper limbs of the adult south Indian formalin fixed cadavers were studied during routine MBBS dissection in Kastruba Medical College, Manipal, India between 2005 and 2009. The origin, course and insertion of the APL muscle was dissected and recorded. In each muscle, number of tendons, and their specific site of insertion were noted and photographed.

RESULTS

Interestingly, we found variable number of tendons for abductor pollicis longus in the first dorsal/extensor compartment of the wrist. Abductor pollicis longus found to have one to 6 tendons in the first dorsal compartment (Figure 1-6). Among those, the presence of two tendons was found to be most common in both right (97.43%) and left (100%) limbs in 47.95% of the cases studied (Figure 2) (Table 1). Presence of five and six tendons was found only in 1.36% of the cases (Figures 5, 6). Interestingly we did not find any changes in the size of the space in the first dorsal compartment in relation to the number of tendons. As the number of

ISSN: 0975-8585

tendons increased, the size of the tendons was decreased to fit into the available space in the dorsal compartment. In majority of the cases (98.63%), irrespective of the number of tendons, most of the tendons were found to attach to the base of 1st metacarpal (Table 2). In case of two tendons, the most common site of tendon insertion was to the base of 1st metacarpal and to abductor pollicis bravis muscle (Figure 7), and most common site insertion was to the base of 1st metacarpal and trapezium in case of presence of three tendons (Figure 8) (Table 3). Only in one right upper limb, the accessory tendon was found to be attaching to the base of the proximal phalanx of the thumb via think tendeneous extension (Figure 9) (Table 2), which was quite rare and different from the available data.

Table 1- Frequency of number of tendons of abductor pollicis longus (n=73)

No. of Tendons	No. of Limbs		%
	Rt.	Lt.	
One	4	6	13.69%
Two	18	17	47.95%
Three	13	7	27.39%
Four	3	3	8.21%
Five	-	1	1.36%
Six	1	-	1.36%

Table 2- Site of distal attachments of abductor pollicis longus tendons (n=73).

Site of distal attachment	Rt. Limb (n=39)		Lt. Limb (n=34)		Total %
	No	%	No	%	
Base of the first metacarpal	38	97.43%	34	100.00%	8.63%
Trapezium	10	25.64%	14	41.17%	2.87%
Abductor pollicis brevis tendon	12	30.76%	11	32.35%	1.50%
Opponens pollicis tendon	1	2.56%	3	8.82%	5.47%
Base of Proximal phalanx of thumb	1	2.56%	-	-	1.36%

Table 3- Site of distal attachments of different types of APL Tendon.

No. of Tendons	Site of insertion (No. of tendons)	No of cases
I	Base of the 1st metacarpal	10
II		
a.	Base of the 1st metacarpal	13
b.	Base of the 1st metacarpal and Trapezium.	5
c.	Base of the 1st metacarpal and APB	14
d.	Base of the 1st metacarpal and OP	1
e.	Base of the 1st metacarpal and distal phalanx	1
f.	Trapezium and APB	1
III		
a	Base of the 1st metacarpal (3)	5
b.	Base of the 1st metacarpal (2)+Trapezium(1)	9
c.	Base of the 1st metacarpal (2)+ APB(1)	2
d.	Base of the 1st metacarpal (1)+Trapezium(2)	1

ISSN: 0975-8585

e.	Base of the 1st metacarpal (1)+Trapezium(1)+APB(1)	2
f.	Base of the 1st metacarpal (2)+OP(1)	1
IV		
a.	Base of the 1st metacarpal (3)+Trapezium(1)	2
b.	Base of the 1st metacarpal (3)+APB(1)	3
c.	Base of the 1st metacarpal (2)+Trapezium(1)+OP(1)	1
V	Base of the 1st metacarpal (3)+Trapezium(1)+APB(1)	1
VI	Base of the 1st metacarpal (5)+APB(1)	1

PB- Abductor Policis Brevis
OP- Opponens Pollicis

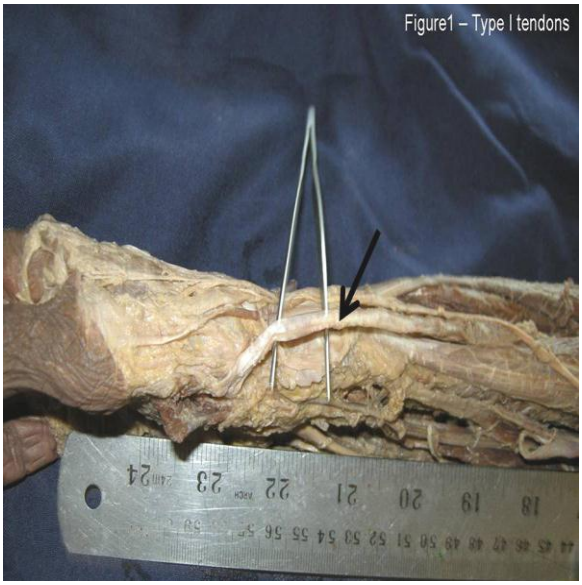

Figure1: Single tendon of the abductor pollicis longus muscle inserted to the base of the first metacarpal bone (arrow).

Figure 2: Double tendon of the abductor pollicis longus muscle inserted on to the base of the first metacarpal bone (arrow).

Figure 3: Three tendons of the abductor pollicis longus muscle inserted on to the base of the first metacarpal bone (arrow)

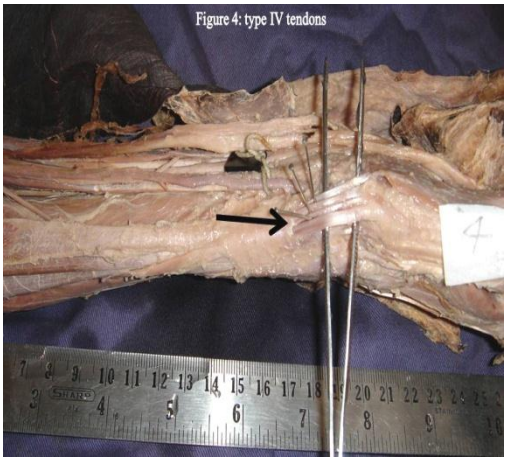

Figure 4: Four tendons of the abductor pollicis longus muscle. Three tendons were inserted to the base of the first metacarpal bone (arrow) and one tendon was inserted to the abductor pollicis bravis muscle (*)

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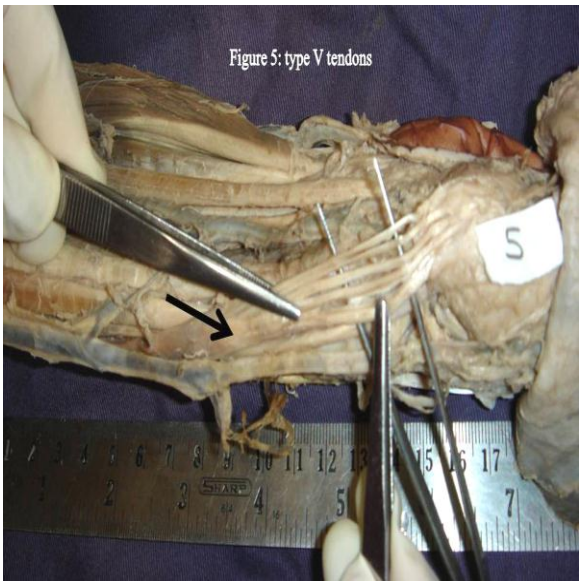

Figure 5: Five tendons of the abductor pollicis longus muscle inserted in to the base of the first metacarpal bone (arrow)

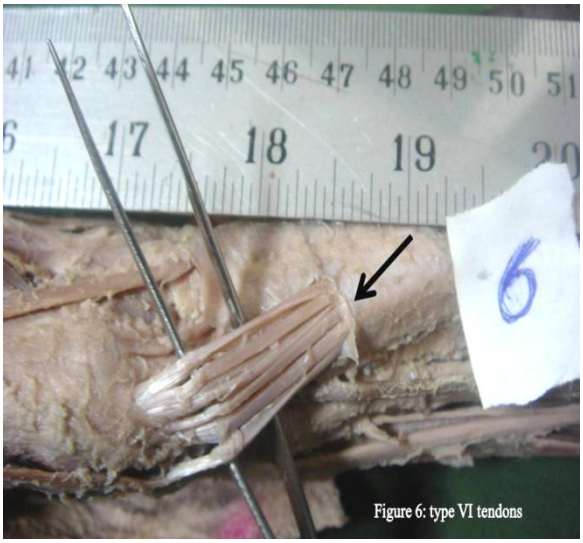

Figure 6: Six tendons of the abductor pollicis longus muscle. Five tendons were inserted to the base of the first metacarpal bone (arrow) and one tendon was inserted to the abductor pollicis bravis muscle

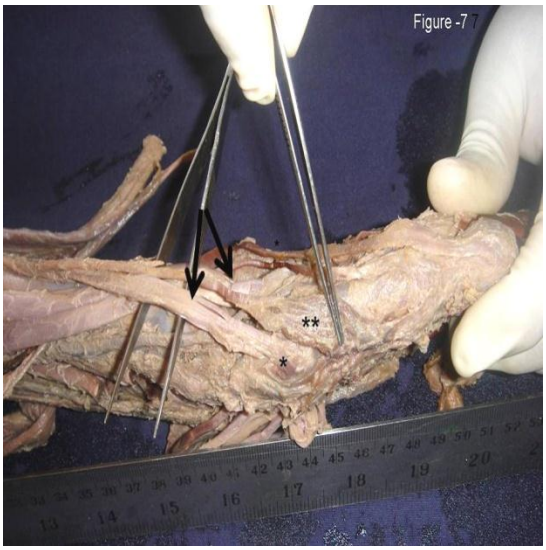

Figure 7: Two tendons of the abductor pollicis longus muscle. One tendon was inserted to the abductor pollicis bravis (**) and the other tendon is to the base of the first metacarpal bone (*)

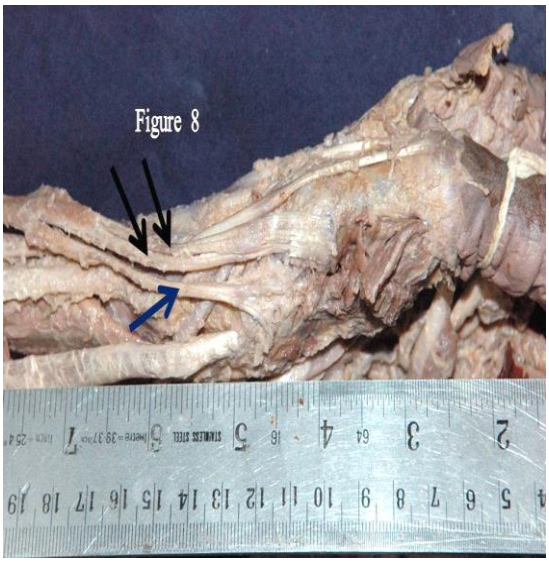

Figure 8: Three tendon of the abductor pollicis longus muscle. Two of them were attached to the base of the 1st metatcarpal bone (arrow) and one to the Trapezium (*)

ISSN: 0975-8585

Figure 9: Two tendons of the abductor pollicis longus muscle, One large tendon was attached to the base of the first metacarpal bone (arrow) and one slender tendon was attached to the of proximal phalanx (*).

DISCUSSION

Precision and power grips and pushing movements are the most important functions of thumb, and these functions are successfully achieved by two important factors, stability and mobility. Shape of the joint surface and arrangement of the ligaments and tendons around the first carpometacarpal joint are the key factors for the mobility and stability. As ligaments alone fail to serve the purpose of stability, it is proposed that the additional stability is achieved by the one or more tendons of APL which is inserted in and around this joint [8, 9]. Anomalous insertion of the APL may alter the function and power grip, because thumb forms one half of the functional unit while holding or gripping object. It has been documented that, the extension of the muscle belly of APL in to the first dorsal compartment results in wrist and thumb pain during even in the normal range of movements [10].

Martinez and Omar describes a case where APL tendon had four slips, which is inserted in to fascia of abductor pollicis brevis resulting in laxcity and repeated subluxation of trapezometacarpal joint bilaterally [11].

Variation in the number of APL tendon and its insertion has been reported earlier. Insertion in to the thenar muscles and first metacarpal bone, is considered as normal insertion site for abductor pollicis longus [12]. Earlier it has been shown that in case of single tendon, it was inserted on to basse of the first metacarpal bone, in case of two tendons, the additional tendon was inserted on to abductor pollicis bravis muscle or to the [13] which is similar to present study.

In another study, the all the additional tendons were shown to attached solely to the trapezium or abductor pollicis brevis or opponens pollicis or to the thenar fascia [14, 15].

However, our studies show that in case of multiple tendons, the tendons were having insertion to different boney or facial components. In addition, we also found a rare insertion of the APL tendon to the proximal phalanges of the thumb.

The mechanical conflict between tendons and the osteo-fibrous tunnel due to repetitive moventes generates a tenosynovitis of the extensor pollicis brevis and the abductor pollicis longus tendons in first dorsal extensor compartment of the wrist is called de Quervain tenosynovitis. The stenosing tenosynovitis of the first dorsal extensor compartment of the wrist is a relatively frequent pathology in the young woman [18]. The number, thickness and length of accessory tendons have a functional significance in the development of de Querivains stenosing tendovaginitis [16]. It has been suggested that variation in number of APL tendons and corresponding osseo-fibrous canals are involved in etiology and subsequent surgical decompression of de Quervains syndrome [17]. De Querin syndrore incidence rate may increase in the patients with lymphedema (Lin et al 2003), more so in case of multiple tendons in the first compartment. The gliding resistance of the tendons of the first dorsal compartment increases by the presence of the septum in this compartment [29]. Thus, presence of additional/accessory tendons in this compartment may increases the risk of microdamage to the tendons in this compartment.

Earlier, it has been proposed that the anatomic variation of the trapeziometacarpal joint stabilizing structures is one causes for the pathogenesis of trapeziometacarpal arthritis. However, recently, the role of variation in the number of tedons in the first dorsal compartment and variations in the insertion of these tendosn found to be insignificant in etiology of the trapeziometaracpal arthritis [19].

Further, the knowledge of multiple tendons of APL is useful while treatment of the thumb carpometacarpal osteoarthritis by abductor pollicis longus suspension arthroplasty, which is found to be a faster and technically easier technique that avoids any additional deficit by using an accessory tendon [23], while assessing the de Quverian syndrome using scintigraphic appearance [27] and while percutaneous pinning of the distal radial fractures using K-wires as these multiple tendonsy may interfere in this process and may cause damage to these tendons [21]. Distal radial malunion alters the mechanical advantage of the muscles in the first dorsal extensor compartment. Therefore, functions of the abductor pollicis longus and extensor pollicis brevis are significantly affected by the most common deformities accompanying distal radial malunion such as, the dorsal angulation, radial inclination, and radial shortening [22]. Thus, presence of multiple tendons may version the complications.

Recently a new occupational disorder of the thumb has been reported. The intersection syndrome, described since the 19th century, is an uncommon disorder associated with the abductor pollicis longus and extensor pollicis brevis bellies (first dorsal compartment) rubbing against the extensor carpi radialis longus and brevis tendons (second dorsal compartment) (Descatha et al 2008). Presence of multiple tendons may aggravate this syndrome.

The multiple tendons of the APL can be successfully used to reconstruct the chronic extensor pollicis longus tendons [25], to restore the index abduction in sever cases of carpal tunnel syndrome [26] and to restore the abduction of the thumb during posterior interosseous nerve paralysis by a tenodesis of the abductor pollicis longus to the brachioradialis [28]. Interposition grafting material is used frequently to treat osteoarthritis of the base of the thumb or tendinous and ligamentous injuries of the hand. Recently, it has been shown that the thickness the all the additional/duplicate tendons of the abductor pollicis longus were same and suggested as a suitable grafting material [20].

Knowledge of the presence of the multiple tendons of abductor pollicis longus and variations in their distal attachment is important for various treatment stratergies of the thumb deformities and diseases, in reconstructuive surgeries and while diagnosis using radiological image systems.

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