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Study of Extensor Hallucis Longus Muscle in Adult Human Cadavers of Punjab

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KEYWORDS Accessory. Dorsiflexion. Evolution. Hallux Varus. Tendinous Slips

ABSRACT The present paper is for the interest for the disciples of surgery, orthopedics and sports medicine. The aim is to study the variations in insertion of extensor hallucis longus muscle encountered during dissection, to analyze the anatomical basis of clinical or applied entities related to them and to correlate them with the available literature. This study was undertaken in 60 lower limbs in 30 adult cadavers in which extensor hallucis longus muscle was dissected in each limb. The variations encountered were recorded and analyzed. Three cases (6 limbs) had a variation of double tendons at its insertion site. Frequent variations seen in the musculature of the leg as regards their mode of origin and insertion indicate that they have not yet reached their final stage of evolution. Foot ankle surgeons thus should be aware of various extensor hallucis longus tendons and their potential use in problematic cases. The clinical significance of this variation is that the accessory tendons can be used in cases of tendon rupture, the repair of main tendon, to increase and sustain the power of dorsiflexion and in hallux varus deformity. Knowledge of these variations will help the surgeons to avoid post operative complications and get better results in transposition, neurotisations and fasciotomies and creating fasciocutaneous flap operations.

INTRODUCTION

Various muscles and ligaments of the lower limb are responsible for maintaining our erect posture and keeping the knees straight. The lower limb has got more stability at the cost of mobility as compared to upper limb (Borley et al. 2008). A few muscles, because of the process of evolution, get modified they are either degenerating like the Plantaris or are appearing like the Peroneus Tertius. Frequent variations seen in the mode of origin and insertion of the muscles indicate that they have not yet reached their final evolutionary stage. Bhargava et al. (1961). Keeping in view the frequency of variations in morphology and nerve supply of musculature of the lower limb, the present study has been taken up. Variations in the arrangement of muscles, as regards their mode of attachment and degree of subdivision are encountered frequently. The muscle may sometimes be united with extensor digitorum longus or it may send a slip to second toe (Borley et al. 2008). According to Kaneff (1982) these double tendons should be regarded as an adaptation rather than a variation. This penniform muscle of anterior compartment of leg can be used for hallux varus deformity and tendon transfer operations (Casal et al. 2010). According to some researchers, in addition to the utility of this variation in reconstructive surgery in the realms of orthopedics, it is also applied in plastic surgery, maxillofacial surgery, burn surgery, and even in heart surgery (Wehbe 1994; Schenk 2009; Terzis 2008). These tendon grafts can be used to reconstruct tendon or ligament defects, stabilize joints and maintain soft tissues in position (Breek et al. 1989). It is also used to increase the power of dorsiflexion or to sustain the dorsiflexion. Extensor hallucis longus is mostly supplied by one nerve that usually enters the muscle from the fibular side and has a close relation to the fibular periosteum. But nerve can enter through tibial side or there may be two innervating branches one from tibial side and other from fibular side (Elgafy et al. 2002).

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MATERIAL AND METHODS

The material for this study comprised of 60 lower limbs of 30 embalmed adult human cadavers obtained from the Department of Anatomy, Govt. Medical College, Amritsar. Muscles of anterior compartment of leg were dissected and the extensor hallucis longus was explored and studied. The origins of this muscle were cleaned from fibula and interosseous membrane. The tendon of this muscle was traced on the dor-

sal aspect of base of distal phalanx of hallux. The branch of deep peroneal nerve supplying it was secured. Length of the fleshy part of each muscle was measured as the distance from the origin of the most proximal muscle fibres to the insertion site of most distal muscle fibres. Unbraided silk thread was placed along the whole length of the fleshy part of the muscle. The most proximal and most distal points were marked with Indian ink. The length was calculated by keeping the marked unbraided silk thread on metal measuring ruler. Length of the tendons was also taken in a similar manner. Tendon slips were defined as tendinous divisions of common tendon. Individual length of each slip was taken from a point at which the common tendon starts dividing upto its attachment to the bone.

Any variation regarding the mode of origin, course, insertion and nerve supply of extensor hallucis longus was observed and was photographed.

RESULTS

In the present study, Out of 60 total limbs in the study, 56 (93.3%) belonged to male cadavers while 4 (6.7%) belonged to female cadavers. Variation was encountered in three male cadavers. In 4 female limbs, no variation was encountered. In the present study, in 6 (10%) limbs double tendons were present (Table 1). The muscle was observed to split into two tendons, lateral and medial at the level of ankle joint. The lateral tendon was inserted normally on the dorsum of base of distal phalanx of hallux but the medial tendon was variable in its insertion. In 2 (3.33%) limbs, the medial tendon was inserted on the dorsal aspect of head of 1st metatarsal however in 4 (6.66%) cases, the insertion of medial tendon was on the dorsal aspect of base of proximal phalanx of hallux (Fig. 1). All the cases of double tendons were bilateral (Table 4). Origin of extensor hallucis longus muscle was exactly in consonance with standard textbook pattern in all the 60 limbs. Table 2 summari-zes that in 4 (6.6 %) cases insertion was on dorsal aspect of base of proximal phalanx of hallux and in 2 (3.33 %) cases insertion was on dorsal aspect of head of first metatarsal (Fig. 2). The average length of this muscle was longer (28.5 cm) as compared to its tendinous part (13.5 cm). Deep peroneal nerve supplied this muscle in all the limbs of the present study.

Table 1: Mode of insertion of extensor hallucis longus in the present study Total no of limbs- 60

S. No.	*Mode of insertion*	*No. of limbs*	*%age*
1	Normal mode of insertion	54	90%
2	Double tendons	06	10%

Table 2: Variations in insertion of double tendons of extensor hallucis longus in the present study

S. No.	*Lateral tendon*	*Medial tendon*	*%age*
1	Insertion on dorsal aspect of base of distal phalanx of hallux	Insertion on dorsal aspect of base of proximal phalanx of hallux	6.6%
2.	Insertion on dorsal aspect of base of distal phalanx of hallux	Insertion on dorsal aspect of head of 1st metatarsal	3.33%

Fig. 1. Double tendons of extensor hallucis longus. Medial tendon is inserting on dorsal aspect of base of proximal phalanx and lateral tendon inserting normally.

DISCUSSION

Supernumerary tendons in the hallucal extensor apparatus have been well documented for more than 125 years (Macalister 1875). Tate des-

Fig. 2. Double tendons of extensor hallucis longus. Medial tendon is inserting on dorsal aspect of head of 1st metatarsal and lateral tendon inserting normally.

cribed an accessory tendon of the extensor hallucis longus in the majority of individuals (Tate et al. 1976). Hallisy (1930) observed double tendons of extensor hallucis longus in 70 (24.13%) cases (Table 3). The secondary tendinous slip of the extensor hallucis longus may arise from the medial aspect of extensor hallucis longus tendon and insert into sling portion of the extensor apparatus (Lundeen et al. 1983). Without giving incidence, Anson (1966) also mentioned double tendons of extensor hallucis longus. More recently, these findings have been reproduced by several authors. The tendon of extensor hallucis longus may be double; the lateral tendon may be inserted to the middle of the dorsal aspect of the base of the distal phalanx of the hallux and medial tendon to the medial side of the insertion of the lateral tendon (Denk et al. 2002). Notwithstanding the reported high frequency of these accessory tendons, their clinical importance has been considered relatively minor, and their description is even omitted from many modern, comprehensive clinical anatomy textbooks (Moore et al. 2006). In the present study this muscle showed no variation in its mode of origin. The insertion was found normal on the dorsal aspect of base of distal phalanx of hallux in 54 (90%) limbs dissected in the present study. 6 (10%) limbs depicted variations in their mode of inser-

Table 3: Variations in insertion of Extensor Hallucis Longus (comparative study)

Year	*Author*	*Variations*
1930	Hallisy	i)Double tendons present in 24.1% of cases ii) Three tendons present iii) Slip to Extensor Digitorum Brevisi v) Double tendons present but inserted normally v) Insertion on dorsal part of 1st metatarsal vi) accessory insertion to proximal phalanx of great toe vii) Slip to Extensor Digitorum Longus viii) Communication with common extensor tendons of the toes
1966	Anson	i) Bellies of Extensor Hallucis Longus and Extensor Digitorum Longus may be fused ii) Tendinous slip from one muscle to other iii) Double tendons present iv) Tendon slips to metatarsal bones
2002	Denk et al	i) Double tendons present in 70% of cases ii) Slip to 2nd toe iii) Slip to proximal phalanx of hallux iv) Slip to metatarsal bone
2003	Al-Saggaf	Double tendons present in 92.3% of cases
2004	Bibbo	Double tendons present in more than 70- 87% of cases
2006	Boyd	Double tendons present in approximately in 93% of cases
2008	Hill	In 70-87% of cases Double tendons were present
2008	Aktekin	51% had accessory tendons
2008	Borley et al.	i) Muscle united to Extensor Digitorum Longus ii) Slip to 2nd toe
2010	Casal et al	Accessory tendons in 92.3% of cases
2011	Present study	Double tendons present in 10% of cases

Table 4: Distribution of bilaterally symmertrical variations in extensor hallucis longus

Name of muscle	*Variation encountered*	*No. of limbs [n(%age)]*	*Significance of variations*
Extensor hallucis longus	Double tendons present i) Lateral inserted normally ii) Medial on dorsal aspect of proximal phalanx of hallux Double tendons present i) Lateral inserted normally ii) Medial on dorsal aspect of head of 1st metatarsal	4 (13.32%) 2 (6.66%)	The clinical significance of these variations is that the accessory tendons can be used in cases of tendon rupture, the repair of main tendon, to increase and sustain the power of dorsiflexion and in hallux varus deformity.

tion (Table 1). In the present study the muscle was supplied by a branch of deep peroneal nerve in all the cases.

Al-saggaf (2003) found various pattern of insertions in extensor hallucis longus muscle. In some cases the muscle had a single tendon inserted on the dorsal aspect of the base of distal phalanx of the big toe, in other cases, the muscle terminated in two tendons while in few cases, the muscle terminated in three tendinous slips.

Aktekin (2008) studied the incidence of accessory tendons of extensor hallucis longus muscle. In 23 (51%) out of 45 fetuses, there were accessory tendons. In all cases, the accessory tendons were always diverging to the medial side of the main EHL tendons and attached to the metatarsophalangeal joint capsule distal to the joint space (Table 3).

However, our value is not significantly higher than that described recently by other authors, who described accessory tendons of EHL in 70-87% of cases (Bibbo et al. 2004; Hill et al. 2008; Al-Saggaf 2003; Boyd et al. 2006; Aktekin et al. 2008) (Table 3).

CONCLUSION

The evidence of supernumerary tendons in the extensor hallucis longus have been well documented many years ago. However, our value is not significantly higher than that described recently by other authors. As a conclusion, anatomical characteristics of EHL so found and mentioned in this study may be used as an additional source for tendon grafting procedures. These can be used in tendon ruptures, repair of main tendon, in tendon transfer operations in e.g. in Hallux varus deformity, ligament defects, to stabilize joints and maintain soft tissues in position. These double tendons may be regarded as an adaptation rather than a variation. These accessory tendons can also be used to increase and sustain the power of dorsiflexion.

REFERENCES

Aktekin M, Uzmansel D, Kurtoglu Z, Sanli EC, Kara AB 2008. Examination of the accessory tendons of extensor hallucis longus muscle in fetuses. *Clinical Anatomy,* 21: 713–717.

Al-Saggaf S 2003. Variations in the insertion of the extensor hallucis longus muscle. *Folia Morphol,* 62(2): 147-155.

Anson BJ 1966. The musculature. In: H Morris (Ed): *Morris Human Anatomy,* 12th Edition. New York: McGraw Hill Book Company, pp. 585-591.

Bhargava KN, Sanyal KP, Bhargava SN 1961. Lateral musculature of the leg as seen in hundred Indian Cadavers. *Ind J Med Sci,* 15(3): 181-185.

Bibbo C, Arangio G, Patel DV 2004. The accessory extensor tendon of the first metatarsophalangeal joint. *Foot Ankle Int,* 25: 387-390.

Borley NR, Healy JC, Collins P, Johnson D, Crossman AR, Mahadevan V et al. 2008. Leg. In: S Standring (Ed.): *Gray's Anatomy.* 40th Edition. New York: Churchill Livingstone Elsevier, P. 1418.

Boyd N, Brock H, Meier A, Miller R, Mlady G, Firoozbakhsh K 2006. Extensor hallucis capsularis: frequency and identification on MRI. *Foot Ankle Int,* 27: 181- 184.

Breek JC, Tan AM, Thiel TP, Daantje CR 1989. Free tendon grafting to repair the metacarpophalangeal joint of the thumb. Surgical techniques and a review of 70 patients. *J Bone Joint Surg Br,* 71: 383-387.

Casal D Pais D, Almeida M, Bilhim T, Santos A, Neil G 2010. Morphometric analysis of the extensor tendons of the hallux and potential implications for tendon grafting. *Eur J Anat,* 14 (1): 11-18.

Denk CC, Oznur A, Surucu HS 2002. Double tendons at the distal attachment of the extensor hallucis longus muscle. *Surg Radiol Anat,* 24: 50-52.

Elgafy H, Ebraheim NA, Shaheen PE, Yeasting RA 2002. Extensor hallucis longus innervation. *Clin Orthop and Related Research,* 398: 245-251.

Hallisy JE 1930. The muscular variations in the human foot: A quantitative Study. *Am J Anat,* 45(3): 411-442.

Hill RV, Gerges L 2008. Unusual accessory tendon connecting the hallucal extensors. *Anat Sci Int,* 83: 298-300.

Kaneff A, Stephanoff A 1982. Comparative anatomical investigation of the M. extensor hallucis longus in man . *Gegenbaurs Morphol Jahrb*, 128(5): 690-701

Lundeen RO. Latva D, Yant J 1983. The secondary tendinous slip of the extensor hallucis longus (extensor ossis metatarsi hallucis) *J. Foot Surg*, 22(2): 142-144.

Macalister A 1875. Additional observations on muscular anomalies in human anatomy. *Trans R Ir Acad Sci*, 25: 1-130.

Moore KL, Dalley AF 2006. *Lower Limb. Clinically Oriented Anatomy.* 5th Edition. Philadelphia: Lippincott Williams and Wilkins.

Schenk S, Meizer R, Kramer R, Aigner N, Landsiedl F, Steinboeck G (2009). Resection arthroplasty with and without capsular interposition for treatment of severe hallux rigidus. *Int Orthop*, 33: 145-150.

Tate R, Pachnik RL 1976. The accessory tendon of extensor hallucis longus: its occurrence and function. *J Am Podiatry Assoc*, 66: 899-907.

Terzis JK, Kyere SA 2008. Minitendon graft transfer for suspension of the paralyzed lower eyelid: our experience. *Plast Reconstr Surg*, 121: 1206-1216.

Wehbe MA 1994. Tendon graft anatomy and harvesting. *Orthop Rev*, 23: 253-256.