International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(2):2376-80. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.223

Original Research Article

EXPLORATION OF TIBIALIS ANTERIOR IN NORTH INDIAN CADAVERS IN RELATIONS TO FREQUENCY, MORPHOLOGY, MORPHOMETRY AND ITS CLINICAL IMPORTANCE

Poonam Verma

Associate Professor, Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, Punjab, India.

ABSTRACT

Introduction: The tibialis anterior is an important muscle because of its function and its use in tendon transfer as a treatment of recurrent congenital clubfoot and paralytic equinovarus foot deformities in cerebral palsy and arthroscopy. Morphology of the tibialis anterior muscle is important for its implications in minimally invasive plate osteosynthesis of tibial fractures. The insertion of the tendon of the tibialis anterior muscle may be related to pathologic changes of the foot and in particular, hallux valgus. Morphologic data should enable evaluation of such a relationship and perhaps offer a basis for improved therapy.

Aim: Our study is aimed to evaluate frequency, morphology, morphometry and use of Tibialis Anterior as tendon transfer in lower limb injuries.

Materials and Methods: Sixty lower limbs from formalin preserved cadavers (28 male and 2 female) were dissected and evaluated for the following parameters: origin of muscle, distal insertion, nerve supply, frequency, morphology, morphometry and any variation concerning this muscle.

Results: This muscle was detected in all the cases (60 limbs) with normal origin and insertion. Mean value of muscle belly length was 29 cm and width was 2.65 cm. The mean length of the distal tendon with no muscle fibers up to insertion was 12 cm, and the mean width was 1.1 cm.

Conclusions: Tibialis Anterior muscle is frequent and has a distinct morphology, making it a feasible option for use as a tendon graft. Knowledge of these variations may have useful clinical applications in cases of leg or foot trauma requiring tendoplasty or tendon transfer operations.

KEY WORDS: Myocutaneous Flaps, Intermuscular Septum, Tendoplasty.

Address for Correspondence: Dr Poonam Verma, Associate Professor, Department of Anatomy, Sri Guru Ram Das Institute of Medical Sciences and Research, Vallah, Amritsar, Punjab, India. Ph. No.: +918283816579 **E-Mail:** poonamabrol1@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.223

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 28 Apr 2016 Accepted: 16 May 2016
Peer Review: 29 Apr 2016 Published (O): 31 May 2016
Revised: None Published (P): 31 May 2016

INTRODUCTION

The human being is not unique in being bipedal because many lizards can run on their hind legs. Birds, kangaroos and some rodents run or hop bipedally. Human bipedalisim is exclusive in that we stand and walk with trunk erect and knees almost straight. Another rare feature is that we are plantigrade, setting down the whole length of the foot on ground. 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 [1]. Numerous muscles pass through

the ankle via tendons, the ones carrying the largest forces, one of them being the muscle tibialis anterior [2]. The tibialis anterior runs parallel to the tibia and is the chief muscle used for dorsiflexion of the foot. This dorsiflexion is key movement in the swing phase of the gait cycle, so that your foot remains off the ground [3]. Tibialis anterior has a quadrangular prismatic belly that arises from the lateral condyle of tibia, proximal ½ to 2/3 of lateral surface of tibial shaft, anterior surface of interosseous membrane, deep surface of fascia cruris and intermuscular septum [4]. Acting as an ankle dorsiflexor and invertor of the foot, it continues medially beneath the extensor retinacula of the ankle, to insert onto the medial cuneiform and the base of the first metatarsal bone [5]. Its fascial extensions forwards to the phalanges of the great toe and backward to navicular, talus and calcaneus may repeat phylogenetic history [6]. The tibialis anterior muscle has been used with great success as a donor for reconstruction of injuries, especially for the repair of skin loss of distal third of the leg [7]. This muscle is of interest to the foot surgeons because knowledge of the variations will help surgeons in performing anterior tibial tendon transposition for recurrent congenital club foot. Abnormality of tibialis anterior may be associated with flat foot or hallux valgus deformity [8]. This muscle is frequently affected in poliomyelitis than any other muscle of the body [9]. Tibialis anterior can be used as transplant in tibioperoneal tenoplasty for congenital club foot with peroneal insufficiency [10]. Herndon performed transposition of Tibialis Anterior in the treatment of Paralytic talipes calcaneus which is one of the most disabling deformities that may develop in paralytic foot [11]. The awareness of these variations will help the doctors to avoid postoperative complications and get better consequences in transposition and fasciotomies and creating fasciocutaneous flap operations.

MATERIALS AND METHODS

We received institutional approval from ethical committee for this research work performed at Government medical college, Amritsar. We dissected 60 lower limbs (30 left side and 30 right side) from male (28) and female (2) well embalmed adult cadavers. All cadavers were adults between the ages of 30 to 70 years. None of the cadavers had previous surgery or constant injuries. The absence of previous bone wounds was confirmed with naked eye examination. All the cadavers (30 cadavers means 60 limbs) were labeled from one to thirty with suffix R (right) or L (left) and M (male) or F (female). Dissection was done by giving incisions to expose the muscle and tendon on the leg, and dorsum of the foot after incising extensor retinacula (Fig.1). Tibialis Anterior muscle was identified in all the 60 dissected lower limbs and was analyzed for the following characteristics: proximal attachment (origin), distal insertion, morphology, morphometry and any variation regarding the muscle. The muscle belly was evaluated both for total length (from origin up to extent of muscle fibers) and width. Three parameters were evaluated during tendon analysis: extent of the tendon part without muscle fiber up to insertion and width of tendon and any variation at insertion site (Figure2 and 3). Length of the fleshy part of each muscle was measured as the distance from the origin of the most proximal muscle fibers to the insertion site of most distal muscle fibers. 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 ink. The length and width was calculated by keeping the marked silk thread on metal measuring ruler. Length and width of the tendons was also taken in a similar manner.

Fig. 1: Superior and inferior extensor retinacula.

Fig. 2: Insertion of Tibialis anterior by two slips.

Fig. 3: Insertion of Tibialis anterior muscle by one slip.

RESULTS

Frequency: Out of the 60 cadaveric dissected human lower limbs, tibialis anterior muscle was found in all the lower limbs (100%).

Morphology and morphometry: In all the 60 limbs the average length of fleshy belly found in present study was 29.0 cm whereas average length noted by Wickiewicz et al (1983) was 29.8cm [12]. So the length noted in present study was nearly equal to the length recorded by previous workers. Behncke (1998) in his study on human dorsal and flexor muscles suggested that increase in gross muscle length, muscle – tendon ratio in indicating a longer muscle length, is positively related to maximal isokinetic strength in lower limb [13]. As is evident from Table 1, Tibialis Anterior muscle has more muscle length (avg. 29 cm) compared to tendon length (avg. 12 cm), thus adding to isokinetic strength in the lower limb. Our study showed that length of fleshy part and tendon of Tibialis Anterior is independent of gender and side as is depicted from Table no. 1 and 2. However the no. of female limbs was too small to derive any conclusion. Length of fleshy belly of Tibialis Anterior in most of the cases was observed in the range of 23-27 cm whereas length of tendon observed was variable in the males and females. In male the length of tendon in maximum no. of cases were in the range of 9.1 – 13 cm. In female the range of length of tendon was also observed to be variable.

Table 1: Length of fleshy belly of Tibialis Anterior muscle (Sex wise distribution).

S. No.	Length of fleshy belly (cm)	No. of limbs in that range							
		Male				Female			
		Rt (n)	% age	Lt (n)	% age	Rt (n)	% age	Lt (n)	% age
1	23-25.0	5	20%	10	32.20%	2	66.66%	1	100%
2	25.1-27	9	36%	10	32.20%	1	33.34%	--	--
3	27.1-29	4	16%	4	12.90%	--	--	--	--
4	29.1-31	5	20%	2	6.45%	--	--	--	--
5	31.1-33	1	4%	4	12.90%	--	--	--	--
6	33.1-35	1	4%	1	3.20%	--	--	--	--
	Total	25	100%)	31	100%	3	100%	1	100%

Table 2: Length of tendon of Tibialis Anterior muscle (Sex wise distribution).

S. No.	Length of tendon (cm)	No. of limbs in that range							
		Male				Female			
		Rt (n)	% age	Lt (n)	% age	Rt (n)	% age	Lt (n)	% age
1	7.1-9	5	16.10%	2	8%	--		--	
2	9.1-11	9	29.00%	6	24%	--		--	
3	11.1-13	6	19.30%	8	32%	--		--	
4	13.1-15	7	22.50%	5	20%	1	50%	--	
5	15.1-17	4	12.90%	4	16%	1	50%	2	100%
	Total	31	100%)	25	100%	2	100%	2	100%

DISCUSSION

In anatomy, normality holds a range of morphologies and includes those which are most common and rest is called variations, which are less frequent but not considered abnormal. Variations ranging from subtle to significant affects every part of human body. They may have important impacts on predisposition to illness, symptomatology, clinical examination, investigation and patient management surgery. Clinician toclinicians to distinguish features

which merit further investigation or treatment from those that do not [14].

Variations in the arrangement of muscles, as regards their mode of attachment and degree of subdivision are met frequently. It had been proposed that the degree of subdivision depends on the action of some organizer and on this basis classifies anomalies. If the organiser starts working prematurely or prolongs its action, this results in abnormal splitting of the muscle mass, giving rise to supernumerary muscles. If the organiser starts functioning late or its action is too short, we have fusion of muscles belonging to the same or fundamentally different muscle mass. Tibialis anterior is the main dorsiflexor of the ankle and suitable knowledge of its normal anatomy and variations in attachments and course is vital for surgeons. Occasionally a muscle recorded as abnormal in man is present normally in some lower animals and at other times muscles that are supposed to be evolutionarily advanced are recorded in animals. Only some of these can be explained on the basis of comparative study. Function modifies the structure greatly and these changes are independent of the organizer theory [15]. Awareness of the anatomy and variations of the extensor tendons on the dorsum of foot is necessary when assessing traumatized or diseased foot and when considering tendon transfer operations [7]. In the present study higher up splitting of the tendon was found in one (1.66%) case, 2 slips thus formed were inserted normally on medial side of medial cuneiform and second slip on medial side of 1st metatarsal. This division was affecting only tendon of the muscle but was not extended higher up in the fleshy belly of the muscle. However in Apes, this division may affect fleshy belly too, as stated by Bardeen, who also described that the splitting of the tendon of Tibialis Anterior is not infrequent in man, but subdivision of fleshy belly is rare in man [16]. In all the 60 limbs the average length of fleshy belly found in present study was 29.0 cm whereas average length noted by Wickiewicz et al was 29.8cm [12]. So the length noted in present study was nearly equal to the length recorded by previous workers. Behncke in his study on human dorsal and flexor muscles suggested that surgery. Recognition of variations allows increase in gross muscle length, muscle tendon ratio in indicating a longer muscle length, is positively related to maximal isokinetic strength in lower limb [13]. In Table 3 comparison of derived results have been done with other observers. Although not much research has been done for morphometry of this muscle in literature, yet few authors has worked on muscle tendon length to look for strength of lower limb. Length of fleshy belly of Tibialis Anterior in most of the cases was observed in the range of 23-27 cm whereas length of tendon observed was variable in the males and females. In male the length of tendon in maximum no. of cases were in the range of 9.1 – 13 cm In female the range cannot be calculated properly because of less no.of cases available for comparison. The mean width of the muscle was 2.6 cm, and the mean width of tendon was 1.1 cm. Thompson et al., (2009) stated that recurrent dynamic and structural deformities following clubfoot surgery are commonly due to residual muscle imbalance from a strong tibialis anterior muscle and weak antagonists. They used the tibialis anterior tendon transfer to restore muscle balance in recurrent clubfoot [17].

Table 3: Variations in insertion of Tibialis Anterior (Comparative Study).

Year	Author	Mode of insertion
1930	Hallisy JE [6]	Tendon inserts on the shaft of 1st metatarsal just behind its head Tendon inserts on navicular, lst cuneiform and lst metatarsal.
1950	Herndon CH et al. [11]	Single insertion at the base of first metatarsal
1966	Anson [18]	Accessory slips to cuneiforms, metatarsals and phalanges.
1990	Arthornthurasook and Gaew [7]	Insertion by two slips on first cuneiform and base of first metatarsal or single insertion into first cuneiform only.
2002	Brenner [8]	Insertion on medial cuneiform only or on Ist metatarsal only
2013	Jain A et al. [19]	Inserted normally and also by a slip on deep fascia on extensor digitorum brevis
2016	Burlakoti A et al. [5]	Tendon passes superficial to extensor retinaculum
2016	Present study	Higher up splitting of the tendon in two slips. Normal insertion of tendon on medial cuneiform and first metatarsal

CONCLUSION

Tibialis Anterior muscle is frequent and has a distinct morphology, making it a feasible option for use as a tendon graft. Knowledge of these variations may have useful clinical applications in cases of leg or foot trauma requiring tendoplasty or tendon transfer operations. Thus variations are important for anatomists, plastic surgeons and orthopedic surgeons.

Conflicts of Interests: None

REFERENCES

[1]. Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE et al. Embryology and Development; Musculoskeletal System and Muscle, Collins P, Soames RW and Salmons S Edrs). In: Gray's Anatomy, 38th Edn; Churchill Livingstone, New York 1995; 264-93 and 881- 884.

[2]. KendalFp:Muscles:TestingandFunction.On:http://www.case.edu/artsci/sportsmed/ankle%20notes.htm. Williams & Wilkins Company, 1993.

[3]. Donatelli R. Normal Mechanics of the Foot and Ankle and Abnormal Mechanics of the Foot and Ankle, in Donatelli, R., (eds) The Biomechanics of the Foot and Ankle, F.A. Davis, Philadelphia, 1990.

[4]. Borley NR, Healy JC, Collins P, Johnson D, Crossman AR, Mahadevan V et al. Leg. In, Standring S. Gray's Anatomy, 40th edition. New York, Churchill Livingstone Elsevier. 2008; 1417.

[5]. Burlakoti A, Lee J, Westropp NM. An unusual presentation of tibialis anterior. International Journal of Anatomical Variations 2016;9:1–2.

[6]. Hallisy JE. The muscular variations in the human foot: A quantitative Study. Am J Anat 1930; 45:411-42.

[7]. Arthornthurasook, Gaew. Anterior tibial tendon insertion: An Anatomical study. J Med Assoc Thai 1990;73:693-96.

[8]. Brenner E. Insertion of the tendon of the tibialis anterior muscle in feet with and without hallux valgus. Clin Anat 2002;15:217-23.

[9]. Romanes GJ. Muscles of leg and foot. In, Romanes GJ (ed). Cunningham's Text Book of Anatomy, 10th edition. New York, Oxford university press, 1964:360.

[10]. Farill J. Tibioperonealtenoplasty for congenital club-foot with peroneal insufficiency. The American Orthopaedic association. J Bone Joint Surg Am. 1956;38A(2):329-336.

[11]. Herndon CH, Strong JM, Heyman CH. Transposition of the Tibialis Anterior in the treatment of Paralytic Talipes Calcaneus. J Bone and Joint Surg 1956;38A(4):751-760.

[12]. Wickiewicz TL, Roy RR, Powell PL, Edgerton VR. Muscle architecture of the human lower limb. Clin Orthop and Related Research 1983;179:275-283.[13]. Wickiewicz TL, Roy RR, Powell PL, Edgerton VR. Muscle architecture of the human lower limb. Clin Orthop and Related Research 1983;179:275-283.

[13]. Behnceke. Relationships between muscle-tendon ratios, muscle morphology, isokinetic strength and reactive strength characteristic in human dorsi and plantar flexor muscles. Faccioni Publications, Australia 1998.

[14]. Willan PLT and Humpherson JR. Concepts of variation and normality: In Morphology: Important issues at risk of neglect in modern undergraduate Medical courses. Clin Anat 1999;12:186-190.

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

[16]. Bardeen CR. Development and variation of the nerves and the musculature of the inferior extremity and of the neighboring regions of the trunk in man. Am J Anat 1907;6:259-351.

[17]. Thompson GH, Hoyen HA and Barthel T (2009). Tibialis anterior tendon transfer after clubfoot surgery. Clinical Orthopaedics and Related Research 2009;467(5):1306-1313.

[18]. Anson BJ. The musculature. In : Morris Human Anatomy, 12th Edn., McGraw Hill Book Company, New York, 1966;585-591.

[19]. Jain A, Sikka A, Goyal N.Tibiofascialis Anticus: A rare variation. Indian J of med case report 2013;2(2):8-10.

How to cite this article:

Poonam Verma EXPLORATION OF TIBIALIS ANTERIOR IN NORTH INDIAN CADAVERS IN RELATIONS TO FREQUENCY, MORPHOLOGY, MORPHOMETRY AND ITS CLINICAL IMPORTANCE. Int J Anat Res 2016;4(2):2376-2380. **DOI:** 10.16965/ijar.2016.233