

ANATOMICAL VARIATIONS OF PLANTARIS MUSCLE: A CADAVERIC STUDY

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ABSTRACT

Background: The Plantaris muscle is a small vestigial muscle having a small muscle belly and a long tendon, it is sandwiched between the Soleus and Gastrocnemius muscles present in the calf. Plantaris muscle is an important structure anatomically, surgically and radiologically. It is being used in various reconstructive surgeries as an autograft and in valvular heart repair, it has more advantages over the synthetic grafts. The aim of this study was to determine the percentage of agenesis and to know the variations pertaining to its origin and insertion.

Materials and Methods: The study was carried out in the Department of Anatomy, JSS Medical College, Mysore, Karnataka State, India. The Plantaris muscle was dissected in 30 adult embalmed cadavers (60 lower limbs), 10 females and 20 males, the average age of the cadavers was between 40-60 years. Variations pertaining to agenesis, aberrancy of its attachment in its origin and insertion, duplication and triplication, accessory slips were observed and noted.

Result: It was observed that in each specimen there were variations in the thickness and length of Plantaris muscle and tendon. Agenesis of Plantaris was observed bilaterally in a male cadaver, with the incidence of 3.33%.

Conclusion: The Plantaris muscle, which was once thought to be a vestigial and degenerating structure, can be of maximum use as a graft material in various plastic & reconstructive surgeries. After reviewing the literature it was noted that the Palmaris longus muscle has been well understood and discussed compared to the Plantaris muscle.

KEY WORDS: Agenesis, Autograft, Plantaris muscle.

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INTRODUCTION

The Plantaris muscle has a short muscle belly and a long slender tendon. It lies between the Soleus and Gastrocnemius. It takes its origin from the lower one-third of the lateral supracondylar line and the adjoining part of the oblique popliteal ligament. Its tendon blends with the medial margin of tendocalcaneus and inserted into the calcaneum medial to the attachment of

tendocalcaneus. It is supplied by the tibial nerve. Its action is weak plantar flexion of the ankle joint. It can be easily mistaken for a nerve by the medical students, hence, it is often termed as "freshman's nerve" [1].

In 1871, 1897 and in 1943 it was observed that the Plantaris muscle may originate from the following areas: (i) the lower part of linea aspera; (ii) the posterior ligament of the knee at the

intercondylar space; (iii) the fascial covering of the popliteus; (iv) the fibula, between the flexor hallucis longus and the peroneus longus; (v) the oblique line of the tibia, under cover of the soleus, or (vi) the lateral condyle of the femur above the origin of the lateral head of the gastrocnemius. The Plantaris insertion has been reported in following areas like: (i) the soft tissues between the muscle bellies of the gastrocnemius and the soleus; (ii) the inner border of the calcaneal tendon, (iii) the dorsomedial surface of the calcaneal tendon at the latter's insertion, (iv) the bursa between the calcaneal tendon and the calcaneum; (v) the fibrous and fatty tissues situated in front of the calcaneal tendon and (vi) the plantar aponeuroses [2-4].

In 2006, Rana KK reported the presence of double Plantaris. [5]

In 2010, it was observed that the Plantaris muscle was present in all the 20 adult male lower limbs. At the level of the muscle and tendon transition, it was observed that the tendon extended along the entire lower third of the belly of the muscle. The mean length of the Plantaris muscle from its origin to insertion was 43.25 cms. The mean length of the muscle belly and the tendon were 11.38 and 33.26 cms respectively. The muscle/tendon ratio was 1.3 cm, muscle/belly was 3.8 cms and muscle belly/tendon 0.3 cm [6].

In 2010, three types of origins and insertions were discovered in 52 lower limbs, the types of origin were: type I: Lateral supracondylar ridge, capsule of knee joint and lateral head of gastrocnemius in 73.07% cases; type II: Capsule of knee joint and the lateral head of gastrocnemius in 5.76% cases, type III: Lateral supracondylar ridge, capsule of knee joint, lateral head of gastrocnemius and fibular collateral ligament in 13.46% cases. The types of insertion were, type I: to the flexor retinaculum of the foot in 28% of cases; type II: independently to the calcaneum in 36.53% cases; type III: to the tendocalcaneus at various levels in 26.92% cases. In four limbs the Plantaris muscle was completely absent (7.69%) [7].

MATERIALS AND METHODS

The present study was carried out in the Department of Anatomy, JSS Medical College,

Mysore, Karnataka State, India. The Plantaris muscle was dissected in 30 adult embalmed cadavers (60 limbs), 10 females and 20 males, the average age of the cadavers was between 40-60 years. The duration of the study was one year. The materials used were as follows: Dissection instruments like Scalpel; Toothed forceps; Blunt forceps; Pointed forceps; Small pointed scissors; Large blunt Scissors; Divider and Scale; Vernier's Caliper; Measuring tape; Hand gloves and Cotton thread.

These embalmed cadavers were given for dissection to undergraduate medical students in the department of Anatomy, J.S.S. Medical College, Mysore, Karnataka state, India.

Each muscle was identified and meticulously traced taking care not to disturb its surrounding structures like blood vessels and nerves, first blunt dissection was done later followed by fine dissection. The origin, insertion and its nerve supply was noted and documented with utmost care. The length, breadth and the thickness of the muscle and tendon were measured using Vernier's caliper, Divider, Measuring scale and Cotton thread. Each muscle belly was measured from its point of origin to the myotendinous junction and for the tendon from the myotendinous junction to its point of insertion. The presence and absence of the Plantaris muscle was noted. The length, breadth and thickness of each muscle belly and tendon was carefully noted. The variations in the origin, insertion, duplication of the muscle was also noted and documented.

OBSERVATIONS AND RESULTS

The Plantaris muscle was dissected in 30 adult embalmed cadavers (60 limbs), 10 females and 20 males, the average age of the cadavers was between 40-60 years.

The observation made in the length of the tendon & muscles are as follows:

- (a) Mean length of the tendon = 32.32 cms;
- (b) Mean length of the muscle belly = 7.65 cms
- (c) Mean girth of muscle belly = 0.40 cms

Depending on the classification made in 2013 by Nazeer et al, the origin pattern was identified: type I: supracondylar ridge and oblique

popliteal ligament; type II: supracondylar ridge, lateral condyle and capsule of the knee joint, type III: supracondylar ridge and lateral condyle of femur, type IV: supracondylar ridge, lateral condyle, capsule of knee joint and lateral patellar ligament, type V: lateral condyle of femur only, type VI: supracondylar ridge and interdigitations with lateral head of gastrocnemius. The insertion pattern type I: to calcaneum medial to Achillis tendon, type II: Fan shaped expansion superficial to the Achillis tendon, type III: Fan shaped expansion deep to Achillis tendon, type IV: Fan shaped expansion deep to Achillis tendon and flexor retinaculum, type V: with Achillis tendon to the calcaneum [8].

In our present study all the muscles dissected showed normal origin and insertion, no accessory muscle or slips or duplication were noted. All were supplied by the tibial nerve. Only one case of bilateral agenesis was noted in the same male cadaver. (See Table 1,2,3).

Fig. 1: The red needle pointer is the belly of Plantaris muscle (specimen no: 07, male cadaver).



Fig. 2: Picture showing the entire length of Plantaris muscle (specimen n0:7, male cadaver).



Table 1: Frequency of agenesis of Plantaris muscle in the present study:

Right side				Left side			
Methods	Agenesis	Presence	%	Methods	Agenesis	Presence	%
Dissection (60 limbs)	UL=00 BL=01 (male)	58	3.33	Dissection (60 limbs)	UL=00 BL=01 (male)	58	3.33

(Unilateral – UL, Bilateral (BL))

Table 2: Frequency and percentage of origins (total 58 limbs).

TYPES OF ORIGIN	FREQUENCY	PERCENTAGE
Type 1	10	20.68%
Type 2	14	24.13%
Type 3	26	44.82%
Type 4	5	8.62%
Type 5	3	5.17%
Type 6	0	0.00%
TOTAL	58	100%

Table 3: Frequency and percentage of insertions (total 58 limbs).

TYPES OF ORIGIN	FREQUENCY	PERCENTAGE
Type 1	38	65.51%
Type 2	7	12.06%
Type 3	2	3.44%
Type 4	4	6.89%
Type 5	7	12.06%
TOTAL	58	100%

DISCUSSION

In, 1932 Glissan was the first person to utilize the plantaris tendon as a living suture for the repair of gaps in the flexor tendons of the palm, in tendon transplants above the ankle, in repair of a ruptured coracoclavicular ligament, and in repair of a slipping patella by Gallie's technique. The author explained that the plantaris can be used for hernia repair due to its property of lateral stretching [9].

In 2003, it was put forth that Plantaris can be used as an autogenous donor graft for heart valve repair. Most clinical studies recommend valve repair as an alternative to replacement. The use of Plantaris as an autograft would increase the supply of autogenous donor tissue for valve repair, thereby enhancing the surgeon's armamentarium [10].

Therefore, it becomes very important for the surgeons, clinicians and anatomists to have a

firm knowledge about the variations of the plantaris muscle.

In 2005, it was observed that the Plantaris muscle is sometimes double and is absent in 10% of cases [11].

In 2009, during routine dissection of the right lower limb of a 51 year old male cadaver, it was observed that there was an additional tendon (length 10.2 cm; width 0.4 cm) of the Plantaris muscle arising from the fascia covering the popliteus muscle and joining the tendon of the Plantaris muscle. Both the tendons then merged to form a single tendon that was attached to the tendocalcaneus. The Plantaris originated from the capsule of the knee joint and the lateral head of the gastrocnemius. In the same limb, the Plantaris was entrapped between the tibial nerve and its branch to the soleus muscle. The origin of an additional tendon of the Plantaris muscle from the fascia covering popliteus, as found in this case was a rare occurrence. Therefore, knowledge of such variations is important for the surgeons performing tendon transfer operations and clinicians diagnosing muscle tears [12].

In 2011, retrospective review of 1,000 consecutive MRI examination of knee performed on patients presenting with acute or chronic knee symptoms revealed an accessory plantaris muscle in 63 out of 1000 patients (6.3%) 38 males and 25 females (5.1%). Origin of 62 of 63 of the accessory plantaris muscles merged with the origin of the normal plantaris muscle, and one of 63 merged with the origin of the lateral head of the gastrocnemius muscle. These accessory plantaris muscles inserted into the iliotibial tract, lateral patellar retinaculum or the iliotibial band [13].

CONCLUSION

The plantaris tendon can be used as an autograft by the surgeons in various reconstructive surgeries due to its highly tensile, stretchable property, without leaving any residual deformity in the donor. Therefore, it becomes very important for the surgeons, clinicians, radiologists and anatomists to update their knowledge about the variation of the plantaris muscle.

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Conflicts of Interests: None

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