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Unilateral Accessory Plantaris Muscle: A Rare Anatomical Variation with Clinical Implications

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Unilateral Accessory Plantaris Muscle: A Rare Anatomical Variation with Clinical Implications

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Abstract- Plantaris, a small muscle with its long slender tendon, is of interest not only from anatomical but also from phylogenetic view point. It is regarded as vestigial in man, believing that, with assumption of an erect posture, the tendon lost its original insertion into plantar aponeurosis and gained a secondary calcaneal attachment. The muscle is known to exhibit variations but there are few reports on the existence of complete duplication of plantaris. During the routine dissection for the undergraduate medical students we encountered unilateral accessory plantaris muscle in the right lower limb of an adult male cadaver. Though often dismissed as a small vestigial muscle, an injury to this muscle should actually be included in the differential diagnosis of the painful calf. Also the knowledge of both normal and abnormal anatomy of the plantaris muscle is important for surgeons performing tendon transfer operations and clinicians diagnosing muscle tears.

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I. Introduction

The plantaris muscle consists of a small, thin muscle belly and a long thin tendon (approximately 2-4 inches long) that forms part of the posterosuperficial compartment of the calf.

The muscle originates from the lower part of the lateral supracondylar line of the femur just superomedial to the origin of the lateral head of the gastrocnemius muscle and from the oblique popliteal ligament of the knee joint. The muscle belly crosses the popliteal fossa inferomedially. In the proximal third of the leg, the muscle belly is situated between the popliteus muscle anteriorly and the lateral head of the gastrocnemius muscle posteriorly. The myotendinous junction occurs approximately at the level of the origin of the soleus muscle from tibia in the proximal part of the leg. Its long thin tendon then courses distally between the medial head of the gastrocnemius muscle and the soleus muscle in the middle third of the leg. Subsequently, it continues inferiorly along the medial aspect of the Achilles tendon up to its insertion on the calcaneum. Finally, it gets inserted either independently or in association with Achilles tendon on calcaneus[1].

The long, thin tendon of plantaris is humorously called the freshman's nerve, as it is often mistaken for a nerve by first-year medical students[2]. Neural innervation to this muscle is provided by the tibial nerve (S1, S2).

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II. Materials and Methods & Results

During the routine dissection of lower extremities for undergraduate medical students, we encountered an anomalous accessory plantaris muscle in the right lower limb of a male cadaver. The muscle was displayed by meticulous dissection. Morphometric measurements were taken and the specimen was photographed.

On the right side, the plantaris muscle showed complete duplication i.e. it had two separate bellies of origin (P1, P2) and two separate tendons of insertion (T1, T2). Out of the two bellies, P1 was thicker and much fleshy; measuring about 4 inches in length. It took origin from the lower part of the lateral supracondylar ridge of the femur just superomedial to the origin of the lateral head of gastrocnemius muscle. On the contrary, P2 was comparatively thinner; measuring about 2 inches in length. It took origin from the posterior surface of the lateral condyle of femur medial to the origin of the lateral head of gastrocnemius muscle.

Both the bellies terminated as separate tendons (T1 and T2) which travelled inferomedially between the gastrocnemius and the soleus and got inserted into the upper part of the posterior surface of calcaneum (T2 inserting relatively above T1) ; medial to the insertion of tendocalcaneus (Table/Fig 1). Dissection on the left side revealed no such variation regarding plantaris muscle.

III. Discussion

Plantaris muscle is known as vestigial muscle in human as its distal attachment has shifted secondarily well short of plantar aponeurosis to calcaneus due to process of evolution for erect posture and bipedal locomotion[3]. In some animals like the American bear, the plantaris muscle can be found to be attached to the plantar aponeurosis[4]. It is known to present several anatomical variations in terms of its occurrence, origin, course, relation with surrounding neurovascular structures and insertion.

Reports are available in the literature stating numerous anomalous sites of origin of this muscle which include: i) the lower part of the 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[4]. Similarly there are reports showing anomalous sites of insertion of plantaris which include: 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 immediately in front of the calcaneal tendon; and vi) the plantar aponeurosis[4] vii) Iliotibial tract or lateral patellar retinaculum[5] viii) As split attachments on posteromedial side of calcaneus[6]. The muscle is also reported to merge with the flexor retinaculum or with the superficial fascia of the leg[3].

Plantaris muscle belly directly forming an aponeurosis without an intermediate tendon which merged with the soleus muscle close to its origin has also been reported[7].

The plantaris muscle may even be unilaterally or bilaterally absent[2,4,8,9]. Embryological development in man supports the idea advocated by McMurrich[10] that the plantaris is a derivative of the deeper portion of the lateral head of gastrocnemius muscle. When absent, it's likely that this separation has failed to take place during ontogeny. In many mammals, it is not differentiated (several edentates, carnivores etc.); in others especially in some rodents, it is highly developed.

An additional tendinous slip of origin from the fascia covering popliteus along with the entrapment of plantaris muscle belly between tibial nerve and its branch to soleus has also been reported separately by Das and Vasudeva[11] and Nayak et al[12].

Unilateral / bilateral bicipital origin of this muscle has also been reported in which the muscle took origin in the form of two separate bellies from two different sites but then joined to form a common tendon[13,14]. Similar unilateral bicipital origin was recorded by Sawant et al[15] with a difference that in their case both the bellies continued as separate tendons which then fused to form a common one which inserted on medial side of calcaneus. Similarly Kwinter et al[6] recorded a second plantaris muscle in the right leg of 47 year old female cadaver. The inner and outer bellies of the anomalous plantaris arose proximally from the medial condyle of the femur and formed a short tendon that fused distally with the tendon of the lateral plantaris muscle. The main tendon split forming three distinct attachments on the posteromedial aspect of the calcaneous anterior to the medial side of the calcaneal tendon.

Reports on complete duplication of plantaris as seen in our case are extremely rare. During the review of the relevant literature, we could find only one case report describing bilateral complete duplication of plantaris in a 45 year old male cadaver[16].

Surgical intervention without knowledge of bicipital origin of plantaris or its complete duplication may lead to inadvertent damage to surrounding structures. The additional plantaris muscle as in our case may also confuse clinicians when diagnosing a posterior knee injury and / or tennis leg and create hindrances in surgical procedures involving the popliteal fossa. Hence, prior knowledge of such variations may be helpful during surgical operations involving the popliteal fossa and the posterior compartment of leg[11,14].

IV. Clinical Significance

In terms of function, the plantaris muscle acts with the gastrocnemius but is insignificant as either a flexor of the knee, or a plantar flexor of the ankle. It has been considered to be an organ of proprioceptive function for the larger, more powerful plantar flexors, as it contains a high density of muscle spindles[17]. The plantaris tendon has elicited further interest because of its potential use as a graft[8]. Removal of the plantaris muscle does not typically hinder the patient's lower extremity function in the presence of a normal soleus and gastrocnemius. Surgeons have recognized the noticeable tensile strength of the tendon. They have used the structure successfully in flexor tendon replacement in the hand and have suggested its use in atrioventricular valve repair[18]. Also it has been established through MRI, sonography and surgical exploration that injuries to this muscle may in fact occur in isolation as well as in association with tears of gastrocnemius, soleus and anterior cruciate ligament. Hence, the observation made in our case report will supplement our knowledge of variations in the posterior aspect of the knee joint, which may be useful for surgeons and orthopedicians performing tendon transfer operations, clinicians and physiotherapists diagnosing muscle tears, and radiologists interpreting MRI scans.

V. Conclusions

Considering the above facts, the existence and significance of the variations of plantaris muscle cannot be undermined. The presence of complete duplication of plantaris, as seen in the present case may be of academic interest too, as the standard textbooks of anatomy mention little about this fact. Also the advancements in anatomical understanding of the structures that may influence a joint may subsequently lead to improved surgical interventions and rehabilitative procedures.

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Legends of Table/Fig 1 : Posterior view of the right lower limb of the cadaver showing complete duplication of Plantaris muscle. (P1 & P2 – Its two bellies of origin, T1 & T2 – Its two tendons of insertion, LHG – Lateral head of Gastrocnemius muscle, AT – Achilles tendon)