



IJCRR

Section: Healthcare

ISI Impact Factor
(2019-20): 1.628

IC Value (2019): 90.81

SJIF (2020) = 7.893



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Study of Structural Variation of Plantaris in Western Odisha Population

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ABSTRACT

Introduction: Plantaris muscle is a vestigial muscle in human beings. It may vary in its origin, course of its tendon, insertion and the number of bellies. It has a small, spindle-shaped muscle that originates from the lower end of the lateral supracondylar line and the oblique popliteal ligament above the origin of the lateral head of the gastrocnemius. It has a small fusiform belly, 7-10 cm in length, which joins with the medial head of the gastrocnemius muscle and finally inserts into the tendoachilis. Rarely, the plantaris muscle is absent, unilaterally or bilaterally. This vestigial muscle is used clinically in tendon grafting.

Aim: The aim of the present study is to study the structural variation of plantaris muscle and its clinical importance.

Materials and Methods: The present study was done in 60 lower limbs preserved in 10% of formalin obtained from the Department of Anatomy of a western Odisha medical college. The dissection of the popliteal fossa and the posterior compartment of the leg was done meticulously following Cunningham's manual of practical anatomy.

Results: In the present study, it was found that the plantaris muscle was present in 52 lower limbs (86.67%) and absent bilaterally in 4 limbs (6.67%) and absent unilaterally in 2 limbs (3.33%) and tendentious origin in 2 limbs (3.33%).

Conclusion: A brief data of anatomical variations of the plantaris muscle is very important for plastic surgeons operating tendon transfer operations, clinicians for identification of muscle tears and radiologists for decoding MRI scans physiotherapists for pain in the calf region.

Key Words: Plantaris, Vestigial, Tennis Leg, Plastic Surgeons, Tendon Transfer

INTRODUCTION

It is a long, slender, thin, muscle present in the superficial group of the posterior compartment of the leg. Plantaris, soleus and gastrocnemius are together known as the calf (sural region) muscle of the leg. It is a vestigial muscle in humans.¹ the muscle originates from the lower end of the lateral supracondylar line of the femur and the oblique popliteal ligament above the origin of the lateral head of the gastrocnemius.² The muscle belly is fusiform in shape present in the posterior part of the knee joint anteromedially and ends as a long slender tendon. The tendon crosses obliquely, in an inferomedial direction, between gastrocnemius and soleus and finally, it is inserted into the posterior surface of calcaneus just medial to the tendo-calcaneus tendon proper.³ It can be damaged in an Achilles tendon rupture but it's been a source of controversy in a few investigations⁴. It is innervated by the tibial nerve (S1, S2). The main action of plantaris is weak plantar

flexion of the foot and flexor of the knee joint. The muscle has several anatomical variations in its origin, insertion, course and relationship with the neurovascular bundle. The muscle belly may be absent, either unilaterally and bilaterally. In animals, it is inserted into the plantar aponeurosis. It becomes a vestigial muscle in human beings when the foot is evolved for walking and running.

Functionally it is of less importance as plantar flexor because it is considered a vestigial muscle. The anatomical knowledge of the variation of plantaris muscle is important for clinical diagnosis of the muscle rupture and to interpret the MRI scans. It is called the "freshman nerve" as it is often mistaken for a nerve by new medical students. The plantaris muscle is clinically important in the differential diagnosis of pain in the lower extremity as its rupture is indistinguishable from deep vein occlusion.⁵

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ISSN: 2231-2196 (Print)

ISSN: 0975-5241 (Online)

Received: 05.11.2020

Revised: 26.12.2020

Accepted: 06.03.2021

Published: 05.07.2021

Its long tendon can readily be harvested for reconstruction elsewhere with little functional deficit as its motor function is minimum. In the Tennis leg, there is an injury of the plantaris at the myotendinous junction with or without haematoma. It is seen in tennis players when there is a severe injury to the calf muscles.⁶

MATERIALS AND METHOD;

The present study was done in a medical college of western Odisha in four years. Total 60 lower limbs fixed in 10% formalin solution were obtained from adult cadavers. 30 limbs are on the right side and 30 on the left side. All the cadavers are aged between 40 to 60 years.

The ethical clearance for the study was taken from the Institutional Ethical Committee.

The dissection of the popliteal fossa and the posterior compartment of the leg was done meticulously following Cunningham's manual of practical anatomy. The plantaris muscle was traced from its origin to its insertion. While dissection out most care was taken not to damage the nearby structures. Digital photographs were taken. Morphometric measurements were taken with the help of measuring tape. The frequency of the occurrence of the plantaris muscle was noted.

RESULTS

The muscle was present in 52 lower limbs (86.67%) and absent bilaterally in 4 limbs (6.67%) and absent unilaterally in 2 limbs (3.33%) (**Figure 3**) and tendinous origin in 2 limbs (3.33%) (**Figure 1**). Such a complete tendinous origin of plantaris are a very uncommon observation. It was thought that the absence of plantaris muscle indicates that the muscle has become fused with the gastrocnemius or soleus muscle, but no such condition was observed in the present study. The length of muscle belly in those 52 cadavers varied from 5.5cms – 8.5cms.

The Plantaris Muscle was present in 32 (61.53%) right and 20 (38.47%) left limbs (**Figure 2**). Differences in occurrence between body sides were not statistically significant ($p=0.67$).

DISCUSSION

In the present study, the plantaris was absent in 11% of specimens which is near to the study done by Savita k et al. in which the plantaris muscle was absent in 12.5%.⁷ Olewnik A et al also found that PM was found to be absent in 10.8% which is similar to our study.⁸

Harvey et al.⁹ observed the absence of the PM in 19% of cases which is higher than our study and Nayak et al.¹⁰ in 7.69% which is less than our study. The entire limbs were carefully examined to confirm if the PM had fused with the surrounding muscles.

Van Sterkenburg et al.¹¹ and Arag˜ao et al.¹² reported no cases of absence of plantaris muscle in their study. The plantaris muscle is known to have a lot of variations. Some books of anatomy have reported that the muscle may be sometimes totally absent or it may be double.¹ The plantaris muscle was attached to the plantar aponeurosis of the foot in quadrupeds but in humans due to its erect posture, it got shifted to a higher position as a normal evolutionary process.¹³ In many mammals, it inserts directly or indirectly into the plantar aponeurosis.

In American bear, the plantaris muscle attached to the plantar aponeurosis.¹⁴ Dual origin was noted in 6 specimens and in one specimen it was the double head.¹⁵

According to Moore and Dalley, the PM is often found to be absent.³ Daseler and Anson found that the muscle was absent in 6.67% of 750 lower extremities that they examined.¹³

Variation in terms of its interdigitation with the lateral head of gastrocnemius or having a thick fibrous extension to the patella can cause patellofemoral pain syndrome.¹⁶ The presence of a double Plantaris muscle has conjointly been noted within the medical literature.¹⁷ Plantaris has the lowest motor performance and its long tendon can readily be harvested for reconstruction elsewhere within the human body.¹⁸ Due to excellent tensile strength, the tendon of plantaris can be used as a graft for reconstruction of the flexor tendon in the hand and anterior talofibular and calcaneofibular ligament of the ankle and a substitute for the fascia lata in hernial repair.^{19,20}

The topographic anatomy of plantaris assumes importance for orthopaedic surgery intervention.²¹ A rare variation seen in plantaris is two separate heads of origin of plantaris which was found by Sawant et al. on the left lower limbs of a male cadaver.²² The plantaris muscle maybe double or absent.²³ The plantaris tendon may also pass between the tibial nerve and nerve to the soleus, thereby causing entrapment of the tendon.²⁴⁻²⁷

Das et al. reported a case in which the plantaris tendon took origin from the lateral supracondylar line and the oblique popliteal ligament, and its tendon passed between the tibial nerve and the nerve to the soleus.²⁴ Nayak et al. reported a case in which they found an extra tendon of the plantaris muscle arising from the fascia covering the popliteus, which joined the original tendon of the plantaris to form one tendon and inserted into the calcaneal tendon.²⁵ Saha et al. reported a case, in which they found a plantaris muscle with double bellies and both the bellies then fused to form a common tendon and inserted into the calcaneal tendon.²⁶ Biswas et al.

the plantaris tendon passed between the tibial nerve and the nerve to the soleus, thereby causing its entrapment.²⁷ During their passage, the muscle bellies were entrapped between the tibial nerve and the nerve to the soleus

The muscle may be absent in 10 % of cases.¹ The tendinous origin of plantaris, found in the present study, might confuse surgeons and make hindrances in surgical procedures involving the popliteal fossa

An ultrasonographic investigation by Delgado et al. showed that the tennis leg occurred due to the rupture of the plantaris tendon at the middle of the leg in only 1.4% of cases. They found that 66.7% of cases of tennis leg occurred because of the rupture of the medial head of the gastrocnemius muscle, without damaging the PM.²⁸

The tendinous injury of the plantaris muscle is significant since it is related to oedema and haemorrhage. The burst of the ligament of the plantaris muscle is regularly hard to analyze and a significant finding is the presence of a strained mass between the gastrocnemius and the soleus muscle. The plantaris muscle has been utilized as an amazing graft. Studies have delineated anatomical procedure of employing a free plantaris tendon graft for reconstruction of the anterior talofibular and calcaneofibular ligaments.²⁹ within the presence of alternative flexors like skeletal muscle and soleus muscle muscles, the removal of plantaris muscle might not have an impact on the conventional limb function. The ligament of the plantaris muscle is considered as an amazingly pliable structure and has been utilized effectively for flexor ligament substitution in hand and atrioventricular valve fix. magnetic resonance imaging and sonography are used as the essential imaging methods for the assessment of patients with the clinical diagnosis of nonspecific posterior lower leg pain. pain in the lower extremity due to rupture of plantaris is indistinguishable from deep vein occlusion,²⁰ ultrasound with a colour Doppler are the first-line choice in diagnosing ruptures and deep vein thrombosis.

CONCLUSION

The presence of tendinous origin of plantaris muscle as seen in the present case may be of academic interest as very few text book of anatomy mentions less about this fact. It is of great interest to surgeons and clinicians for diagnosing muscle tears in the leg. The compression of the nerve to soleus by the tendon of the plantaris causes compression neuropathy.

It may complicate the surgical exploration of the structures of the posterior compartment of the leg in the repair of the muscle tear by the surgeons.

This tendon is often used by surgeons as a tendon graft. Its high tensile strength and no functional deficit after removal, help the surgeons for its use in tendon grafting

This variation of plantaris muscle is an interesting finding, which could be important for anatomists, radiologists, anthropologists, physiotherapists, surgeons and orthopaedic surgeons

ACKNOWLEDGMENT

The authors acknowledge the immense help received from the scholars whose articles are cited and included in references to this manuscript. The authors are also grateful to authors/editors/publishers of all those articles, journals, and books from which the literature for this article has been reviewed and discussed.

Conflict of Interest: Nil

Source of Funding: Nil

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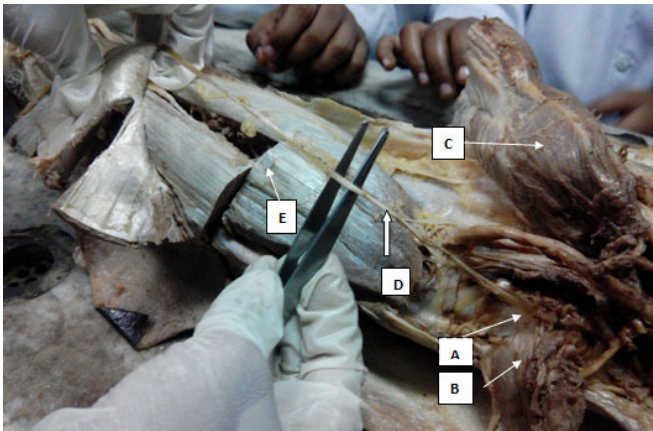


Figure 1: Showing the tendinous origin of plantaris muscle from the lower end of lateral supracondylar ridge. A) Tendinous origin of plantaris muscle, B) Lateral head of Gastrocnemius, C) Medial head of Gastrocnemius, D) Tendon of plantaris, E) Soleus.

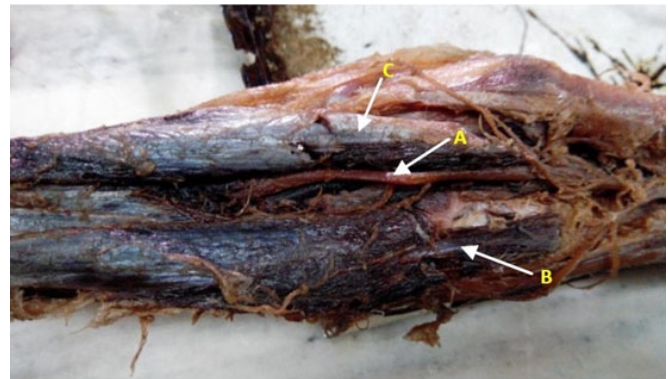


Figure 3: Showing absence of plantaris muscle. A) Tibial Nerve, B) Lateral head of Gastrocnemius, C) Medial head of Gastrocnemius.



Figure 2: Showing normal muscle belly of Plantaris. A) Muscle belly of Plantaris, B) Lateral head of Gastrocnemius, C) Medial head of Gastrocnemius, D) Tendon of plantaris.