Proximal attachments of Popliteus Muscle: A Morphological Study on 30 Adult Human Cadavers

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Abstract: *Popliteus is a flat muscle that forms floor of the popliteal fossa. It is attached to a depression at the anterior end of the groove on the lateral aspect of the lateral condyle of femur. Other proximal attachments are arcuate popliteal ligament, fibrous capsule adjacent to the lateral meniscus and outer margin of the lateral meniscus. In our study, proximal attachments of popliteus in inferior extremities of 30 adult human cadavers have been studied. Developmentally, Popliteus is a compound muscle and represents the pronator element of flexor pronator mass. The observations regarding proximal attachments of Popliteus show the accessory Popliteus attachment on fibula (90%), lateral meniscus (100%) and arcuate popliteal ligament (93.3%). These can be considered constant attachments. The knowledge of these attachment sites is important to the surgeons in reconstructive surgery of cruciate ligament. These observations supplement the role of Popliteus in the protection of knee meniscus and tibio-femoral cartilage. Variations and developmental descriptions are of particular value to comparative anatomists, anthropologists, kinesiologists and muscular physiologists.*

INTRODUCTION

Popliteus is a flat muscle that forms the floor of the lower part of the Popliteal fossa. It arises within the capsule of the knee joint by a strong tendon about 2.5cm long, which is attached to a depression at the anterior end of the groove on the lateral aspect of the lateral condyle of the femur. Medially, this tendon is joined by collagenous fibres from the arcuate popliteal ligament, from the fibrous capsule adjacent to the lateral meniscus and from the outer margin of the meniscus[1]. Popliteus plays a part in medially rotating the leg with the non weight bearing knee flexed, but its action cannot be isolated clinically. However, the main function is likely to be provision of the dynamic stability to the posterolateral part of the knee by preventing excessive external rotation of the tibia[1]. In the present study proximal attachments of popliteus were observed on 30 adult human cadavers.

MATERIAL AND METHODS

Inferior extremities of 30 embalmed adult human cadavers were obtained from the Department of Anatomy, Government Medical College, Amritsar. Out of these30 embalmed adult human cadavers, two were adult female human cadavers and rest were males. The cadavers were marked from 1 to 30. The limbs were marked R(Right) and L(Left). These were dissected as per the Cunningham's Manual of Practical Anatomy. All attachments were noted during dissection, the tendon of popliteus was reflected from its attachment at the depression on the lateral aspect of lateral femoral condyle and knee was flexed to see the attachment of popliteus on lateral meniscus.

RESULTS AND DISCUSSION

Developmental Aspects

Popliteus represents the pronator element of the flexor-pronator mass and corresponds to the upper part of the head of the pronator teres of the arm[2]. The popliteus is a compound muscle, being formed of a portion from the superficial layer, united with a portion of the fifth layer[3].

The development of knee joint proper and bending of the thigh to the leg at an angle of about 90 degree must have caused the long extensor muscles passing over the knee to develop a tendon, which again led to their partition. Due to bending of the knee, the whole dorsal muscular mass became at once subject to the mechanical influence of the modified direction of forces. It could no longer act on the leg either as an abductor or as an extensor, but became a flexor pure[3]. Popliteus is flexor of the knee joint; when a person is standing with the knee partly flexed, the Popliteus contracts to assist the posterior cruciate ligament in preventing anterior displacement of femur on tibia[4].

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Anatomical variations

All the variations observed were bilateral. 93% of limbs showed attachment to arcuate ligament. Oblique popliteal ligament and fibula were attached to popliteus in 40% and 90% of lower limbs. Lateral meniscus was attached to popliteus in 30 (100%) lower limbs (figure 1).

Figure 1: *Origin of popliteus muscle (PT) from the lateral meniscus of knee joint (LM). Tendon of popliteus muscle cut (from the popliteal groove) and reflected.*

Feipel et al conducted study on proximal attachment of popliteus muscle on 42 cadavers and described maximum number of variations. In the present study, fibular attachment was seen in 54(90%) lower limbs. They found fibular attachment of Popliteus in 98% of lower limbs[5]. This is in agreement with the previous studies. However a fibular attachment of popliteus is not mentioned in standard anatomy text books. Kim et al observed fibular attachments in only 37.55% lower limbs[6].

Proximal attachment of Popliteus muscle on the lateral meniscus is controversial. Some authors have not described such a relationship[7]. According to them, no clear meniscal attachment of the Popliteus was found in 82.5% of their 40 specimens. Last described meniscal termination of the popliteus as involving half of the popliteal belly fibers and reported the occasional presence of a lateral meniscal attachment, originating from the popliteal tendon[8]. Recent studies describe the meniscal attachments of the popliteus as constant[9,10], although the number of specimens studied was less than that of Tria et al[7]. Feipel et al found this attachment in 95% lower limbs. In the present study, this attachment was seen in 60(100%) of lower limbs[5].

The remaining attachment sites observed in the present study were arcuate ligament (93.3%) and oblique popliteal ligament (40%) which have been reported by some authors[9,11,12]. Fiepel et al described the incidence of attachment as 90% and 79% respectively[5].

Existence of Popliteus in other species

In the Gorilla and Gibbon, it arose by a single rounded tendon as in the case of man; in the Chimpanzee there were two origins, one rounded tendon as in man, other from the capsule of knee joint immediately behind the external condyle of the femur. In the Orang, there were also two origins for in addition to the usual rounded tendon, there was a second strong tendon which also arose within the capsule of the knee joint and was attached to the upper and outer part of the head of the fibula. The nerve of

supply in each case corresponded with that of man[13]. In Galago Senegalensis (lesser bush baby), the popliteus arises as a small tendon from the lateral condyle of the femur inferior to the lateral Gastrocnemius attachment. A sesamoid bone lying proximal and medial to head of fibula curves as an accessory attachment[13]. In our study, no proximal attachment to sesamoid bone in relation to head of fibula was found in any of the cadavers.

Clinical significance

Mayfield, Travell and Simons documented that popliteus muscle / tendon injuries occur most frequently with downhill running or walking[15,16]. Davis etal said this may be due to repetitive use of the popliteus musculotendinous unit in preventing anterior translation of the femur on the tibia as popliteus muscle activity is proportional to increased load on flexed knee[17]**.** David Bryde et al proposed strengthening of Popliteus muscle in preventing injuries to the athletes. Strengthening of Popliteus muscle could also be beneficial for people who have genu recurvatum. They proposed decreasing posterior translation forces of the tibia by increasing the strength and tone of this muscle to reduce pain levels[18].

Open exposure of the posterolateral corner of the knee is challenged by limitation of posterolateral ligamentous tissues and posterior neurovascular structures. The fascicles of popliteus to these proximal sites of attachment might be involved in the reinforcement of the postero-lateral knee joint capsule. The knowledge of discussed attachment sites is important to the surgeon in reconstructive cruciate ligament surgeries. Ruptures of lateral collateral ligaments can be easily recognised and an anatomic graft reconstruction is done to restore varus stability. However, additional injuries to the Popliteus tendon are often unappreciated. The Popliteus bypass reconstruction done typically uses a tendon graft (Achilles tendon allograft or semitendinosus allograft). These operations are normally performed to limit external tibial rotation. Reconstructions place the graft in an alignment favourable for restraining posterior tibial translation[19]. Feipel et al found that the popliteus has a role in the protection of knee menisci and tibiofemoral cartilage[5].

CONCLUSIONS

Popliteus is a compound muscle, developing partly from the superficial layer and partly uniting with the fifth layer. The present study suggests the accessory popliteus attachment on fibula (90%), lateral meniscus (100%) and arcuate popliteal ligament (93.3%) can be considered as constant characteristics. No reference could be found in relation to attachment of Popliteus to lateral meniscus in other species in the available literature. As suggested by other authors, a role of popliteus in the protection of knee meniscus and tibiofemoral cartilage is there. Popliteus muscle/tendon injuries occurring with downhill running or walking can be prevented by strengthening of popliteus muscle exercises. The knowledge of these attachment sites is important to the surgeons in reconstructive cruciate ligament surgeries. Popliteus muscle bypass reconstruction is done by using tendon grafts (Achilles tendon allografts or semitendinosus allografts). Discussed variations and developmental descriptions should be of particular value to comparative anatomists, anthropologists, kinesiologists and muscular physiologists. Further studies would be required to quantify the proposals presented in our study, as proposed by other authors thereby taking the muscle from its "forgotten" status to one that is recognised and clinically appreciated.

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