Chapter

Anatomical Landmarks for Hamstring Tendon Harvesting in Anterior Cruciate Ligament Reconstruction

Radu Prejbeanu and Mihail-Lazar Mioc

Abstract

When performing an anterior cruciate ligament reconstruction (ACLR) with hamstrings autograft, one of the most delicate steps is graft harvesting. We will describe different anatomical landmarks that can be used in order to properly ensure that approach and tendon identification is facile. Knowing the anatomy of the 'pes anserinus' and different landmarks that can guide us towards harvesting is the goal of this chapter. Our descriptions will be based on existing literature and personal surgical experience. We shall also discuss different options described in the literature that have been used over the years. Knowing the correct anatomy as a surgeon helps improve our technique as such, we deal less local trauma and induce as little scar tissue as possible. Possible complications that can occur during the approach will be also discussed.

Keywords: hamstring tendons, pes anserinus, hamstring harvesting, ACL reconstruction

1. Introduction

Tendon harvesting represents an important step during ACLR procedures. It is a step that, if performed properly can ensure a smooth surgical intervention. On the other hand, it is a step that can lead to different types of complications that can increase patient morbidity. Having good anatomy notions, helps us surgeons understand the functionality of the structures we see, and allows us to perform our interventions safely. Hamstring grafting especially, requires us to have good knowledge regarding the anatomy of the 'pes anserinus' and the muscles that are attached to it. We must also be aware of potential neurovascular structures that could be encountered during the graft harvesting procedure, in order to preserve them accordingly. The goal of this chapter is to ensure proper approach and tendon identification at the level of the 'pes anserinus' through the aid of anatomical landmarks. Intraoperative complications such as tendon slippage and neuro-vascular lesions may occur, and it is important to avoid them as possible or have functional solutions in case they appear.

2. 'Pes anserinus' anatomy

The 'pes anserinus' is a tendinous structure located on the antero-medial face of the proximal tibia. The tendons that make up the structures belong to 3 thigh muscles – the sartorius, the gracilis and the semitendinosus. These muscles act as knee flexors partial adductors and tibial rotators, counteracting the valgus stress of the knee. The sartorius originates on the anterior superior iliac spine and crosses over the anterior part of the thigh, whereas the other 2 muscles originate at the level of the ischial tuberosity (semitendinosus) and the pubic symphysis (gracilis). These 2 muscles, also known as hamstring muscles end in a very long, fusiform tendinous insertion, making them extremely good candidates for acting as donor sites for the ACL autograft.

2.1 Tendon insertions

The anatomy of the pes anserinus and its variations have been described by multiple authors [1–4]. Thus, it is important that we differentiate between the sartorius' tendon and the hamstring tendons (HT), as the first muscle has a thin and flat tendon, resembling a fascia layer, unsuitable for grafting [1]. The sartorius tendon (ST), gracilis tendon (GT) and semitendinosus tendon (STT) are united in a structure described as the *anserinus plate*. According to McMinn's illustrations, the ST is usually the most superficial structure and the GT and STT are usually situated deep and distally [5]. **Figure 1** depicts the pes tendons placement together with the local bony landmarks.

In a study published in 2019, Olewnik et al. described multiple anatomical variations regarding the structure of the pes anserinus tendons [6]. Regardless of the identified variation type, the ST is always proximal and superficial, and the HT are always deep and distal, as seen in the following schematic (**Figure 2**).

Even though roughly half (52.9%) of the analyzed knees presented with monotendinous insertions for each muscle, the authors also emphasize that the gracilis and the semitendinosus can often have accessory bands. Insertion variations such as short,

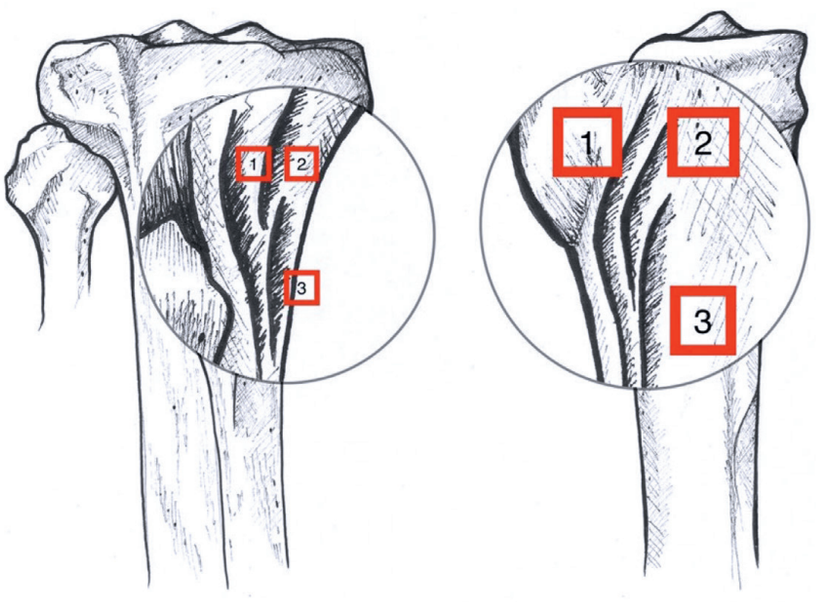

Figure 1.
Bony landmarks with ST (1) GT (2) and ST (3) insertions drawn out. Frontal view (left) and medial view (right).

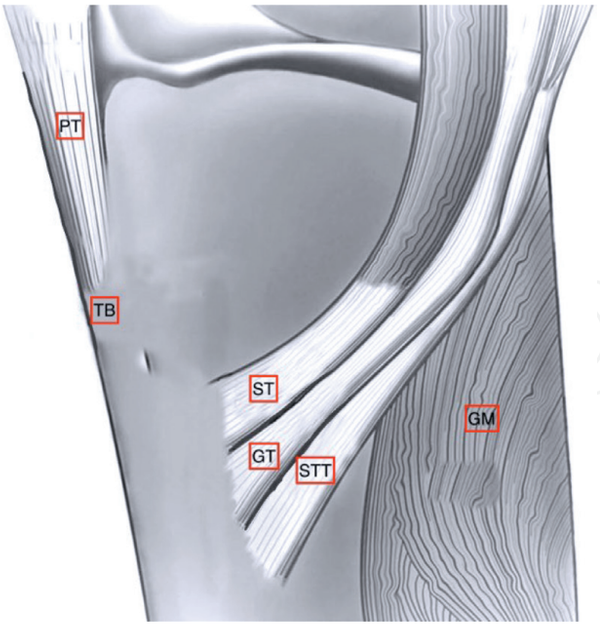

Figure 2.
Visual representation of the placement of tendon insertions on the pes anserinus (adapted from Olewnik et al.). (ST-sartorius tendon, GT-gracilis tendon, STT-semitendinosus tendon, PT-patellar tendon, TB-tibial tuberosity, GM-gastrocnemius muscle).

Figure 3.
Anatomical specimen depicting the 'pes anserinus. Poster-medial view of the knee. The surgical instrument is placed under the 3 tendons of the pes. From left to right we can observe the semitendinosus, gracilis and sartorius tendon.

band-shaped and fan-shaped can disorient the surgeon and lengthen the harvesting procedure [6].

2.2 Tendon placement

To further understand the local anatomy of the pes anserinus and the localization of the tendinous insertions, cadaveric studies [7] were carried out on fresh-frozen

knees. The tendons are usually attached to the tibia on its antero-medial surface, through a conjoined structure that has an average width of 20 m. Warren and Marshall described two layers of the pes anserinus from superficial to deep in an older anatomical study. In the first layer we can find the sartorius tendon. It is superficial to the HT at its insertion and proximal part. Distally, we find it fused to the HT and as we continue into the deeper layer, we can observe that proximally and posteromedially they become distinct tendons. This specific point where the tendons become individualized is located on average 18 mm proximal to the conjoined insertion. Moving deeper, we can encounter the medial collateral ligament, that is situated in layer II [8]. This anatomical description helps us understand the local situation better and facilitates the isolation procedure of the two HT tendons.

Anatomical specimen dissections can clearly depict the placement of the tendon insertions on the pes anserinus as shown in **Figure 3**. The most anterior tendon is the sartorius, which quickly transforms into a muscle structure and is directed anteriorly over the thigh and laterally, representing the longest muscle in the human body. The other two deeper tendons belong to the gracilis and semitendinosus, they have a longer tendinous structure and are best suitable for ACL grafting. These two tendons are directed towards the medial and posteromedial aspect of the thigh.

3. External landmarks, incision and approach

Visual external landmarks play a big role in identifying the pes anserinus and aid in the initiation of the graft harvesting. Multiple studies suggest that the incision spot should be medial and slightly distal to the tibial tubercule. The usual technique describes the incision spot to be located medial from the tibial tubercule and 4–6 cm distal to the medial plateau (medial joint line). Lun et al. identify the starting point located 2 finger breadths below the medial tibial plateau, at the level of the tibial tubercule, extending distally [9]. This is often our preferred technique (**Figure 4**), as we take into consideration the medial tibial plateau, but we also place our incision taking into consideration the tibial tubercule solely. If measurements are done correctly, the position of the approach will coincide, regardless of the landmarks that were used.

The length and orientation of the skin incision do not matter too much as they play almost no role in influencing the identification of the tendon insertions. What it can influence though is the rate and severity of donor site morbidity and complications, that will be discussed later. Several authors describe different variants such as vertical and oblique incisions, ranging from 1.5 cm to 5.2 cm in length [10–17].

Performing the proper incision for HT harvesting may lower the risk of complications such as the iatrogenic saphenous nerve injury. This injury can cause symptoms such as hypoesthesia, anterior knee pain and reflex sympathetic dystrophy. The sartorial terminal branch and the infrapatellar branch are at risk when performing HT harvesting. The first could be damaged by the stripper, due to its proximity with the gracilis tendon, while the second may be damaged when performing vertical incisions in the approach of the pes anserinus. A systematic review performed in 2016 studied the complication rates of different types of incisions performed for HT harvesting [18]. It concluded that performing an oblique incision lowers the rate of saphenous nerve damage, when compared to either horizontal or vertical ones.

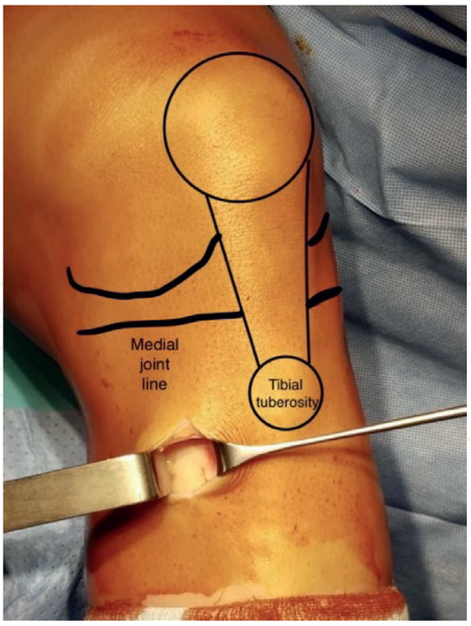

Figure 4.
Intraoperative photo of a left knee in a flexed position, depicting the approach we suggest for pes anserinus identification. Some key landmarks were drawn over.

4. Internal landmarks

As described previously, after the identification of the pes anserinus location, and performing the incision, we dissect the soft subcutaneous tissues to visualize the conjoined tendon of the pes anserinus. The current literature does not describe many subcutaneous landmarks that could help the surgeon.

There have been discussions regarding a vascular structure that can be encountered and could be used as an internal landmark. This vessel is a branch of the inferior medial geniculate artery (bIMGA) and is a part of the knee's superficial arterial grid. Some authors have depicted this vascular structure as a good indicator for pinpointing the insertion of the HT on cadaveric studies [9, 19, 20]. Babu et al. performed a prospective study on a lot of 100 patients, with a 98% rate of encountering the bIMGA during the approach. De Lima Lopes et al. performed ACL reconstructions on 30 patients and all of them presented a vascular ach at the level of the pes anserinus with "a greater or smaller diameter". Taking into consideration what these 2 manuscripts describe, allows us to believe that the bIMGA could serve as a proper landmark for the identification of HT insertion. The clinical relevance of it though, remains uncertain, as the amount of data is still small regarding this topic. There is also much to be discussed regarding anatomical variability and the ability of the surgeon to identify a small vascular structure through a small surgical approach. The reproducibility of the technique remains to be seen, as personal experience shows that there is a decently high variability, when it comes to encountering this vessel when performing the approach.

Proceeding through the skin and the subcutaneous tissue, we should be able to encounter the conjoined tendon of the sartorius, gracilis and semitendinosus. The two HTs are depicted in a surgical setting in **Figure 5**. Usually, the insertion of the gracilis muscle is proximal (superior) to the semitendinosus. Careful dissection of the conjoined insertion will lead to the identification of the two tendons which can then be separated, ligated and prepared for harvesting with either a closed or opened

Figure 5.
Intraoperative photo of a dissected pes anserinus of the left knee. The two hamstring tendons can be observed – Gracilis tendon (left side) and hamstrings tendon (right side).

stripper. Special attention must be kept as to not mistake the sartorius insertion with the HT that usually lie distal and posterior.

5. Conclusions

Developing good knowledge regarding the anatomy of the pes anserinus helps the surgeon in the process of ACL graft harvesting. Young and unexperienced surgeons must take great caution in identifying the proper tendons and making sure that the harvesting process is done with as less trauma as possible. Even if complications may arise it is very important to identify them and address them properly.

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