Technical Note

The "Motionless Gastrocnemius": A Reliable Sign for Safe Graft Harvesting

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Abstract: Difficulties in graft harvesting of the hamstring have been the topic of many studies. These difficulties are related to the aponeurotic or fibrous attachments of the hamstrings with the medial head of the gastrocnemius muscle, soleus muscle, and leg fascia. Freeing the graft from these attachments is important because insufficient release prior to stripper insertion can lead to premature transection or amputation. We describe a reliable intraoperative physical examination sign to help understand the sufficient amount by which a tendon graft needs to be released prior to stripper insertion. The presence of the motionless gastrocnemius ("motionless gastroc") phenomenon is used in our clinic as a sign that the grafts have been sufficiently freed and that a tendon stripper can be used without fear of transection or graft amputation.

The pes anserinus is an anatomic structure situated on the anteromedial border of the tibia. It is essentially a conjoint tendon composed of 3 different muscle endings: sartorius tendon, gracilis tendon (GT), and semitendinosus tendon (STT). This anatomic landmark is of paramount importance in orthopaedic surgery because the tendons that attach here are harvested as grafts during ligamentous reconstruction surgery.[1] The anterior cruciate ligament (ACL) is the most commonly injured ligament in the knee.[2] Although different grafts have been applied over the years,[3] hamstring tendon grafts lead to significantly less anterior knee pain, have lower harvest-site morbidity, and help preserve the extensor mechanism of the knee.[1,4]

Difficulties in harvesting the hamstrings and associated complications have been the topic of many studies.[1,5] These harvesting complications mainly arise from the ligamentous attachments of the gastrocnemius muscle, the soleus muscle, and the leg fascia to the GT and STT.[5,6] Freeing the graft from these attachments is important because insufficient release prior to stripper insertion can lead to premature transection or amputation. Except for direct visualization and palpation through blunt finger dissection, no definitive physical examination sign exists to show whether a graft has been sufficiently released from the surrounding attachments.

The aim of this article is to describe a reliable intraoperative physical examination sign to help understand the sufficient amount by which a tendon graft needs to be released prior to stripper insertion: the motionless gastrocnemius ("motionless gastroc") sign. The presence of the motionless gastroc phenomenon is used in our clinic as a sign that the grafts have been sufficiently freed and that a tendon stripper can be used without fear of transection or graft amputation.

Surgical Technique

The patient is placed supine on a standard surgical table. After proper anesthesia is administered, a tourniquet is inflated on the designated lower extremity. The procedure begins with a clinical examination with the patient under anesthesia, followed by diagnostic arthroscopy. After visual confirmation of ACL rupture, we move on to graft harvesting. The hamstring tendons are palpated at their attachment site on the pes anserinus. The extremity is then placed in extension or in a figure-of-4 position.

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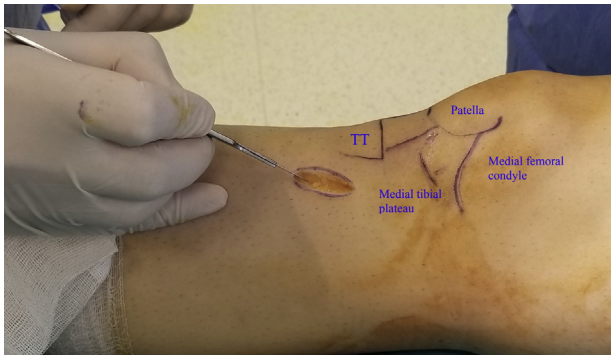

Fig 1. After arthroscopic confirmation of anterior cruciate ligament rupture, we perform graft harvesting. The patient is lying supine on the surgical table, and the extremity is placed in extension or in a figure-of-4 position. The hamstring tendons are palpated at their attachment site on the pes anserinus. A small oblique incision of approximately 4 cm is performed on the medial side of the tibial plateau, and the subcutaneous tissues are bluntly dissected. This is a right knee viewed medially while the patient is lying supine and the proximal part of the extremity is on the right side of the Figure. (TT, tibial tuberosity.)

A small oblique incision of approximately 4 cm is performed (Fig 1), and the subcutaneous tissues are bluntly dissected. The pes anserinus is identified, and an upward reverse-L incision is performed on the sartorial fascia to reveal the underlying tendons (Fig 2). Care is taken not to disturb the medial collateral ligament lying just under the pes anserinus. After both GT and STT are detached from the sartorial fascia (Fig 3), they are gently pulled. Gentle traction of the tendon leads to a popping movement on the level of the medial head of the gastrocnemius (Fig 4). This is a sign that the tendinous attachments binding the GT and STT grafts to the fascia or the gastrocnemius itself have not been released (Fig 5). Blunt finger dissection is then used to further free the tendons from the surrounding soft tissues, and scissors are used to dissect fascial attachments (Fig 6). Gentle traction is applied after every dissection maneuver, and the site of the medial head of the gastrocnemius is evaluated for whether it is motionless (Fig 7). Care must be taken not to confound the movement of the hamstring muscles themselves with the gastrocnemius movement. The hamstring muscles are situated more proximally and posteriorly, and because it is virtually their tendon to which we apply traction, they move slightly during the pulling maneuver (Fig 8). The moment we observe the presence of the motionless gastroc sign, we cease dissection of soft tissue around the tendons, and a tendon stripper (Large Tendon Stripper; Smith & Nephew, Memphis, TN) is used to complete the harvesting procedure (Fig 9).

We have found the motionless gastroc sign to be reliable in identifying the amount of release the tendons require prior to being subjected to the tendon stripper. We always use the stripper in the presence of the motionless gastroc sign despite distal palpable additional attachments, which we have found are easily detachable with a stripper (Video 1). In our practice, no cases of tendon transection or premature amputation have occurred. The use of this technical tip has also decreased the time we spend harvesting the grafts.

After harvesting is completed, the grafts are peeled and prepared for the reconstruction procedure. A standard ACL reconstruction procedure then follows with a single-bundle ACL reconstruction technique.

Discussion

The ACL consists of dense connective tissue and is a key structure in the knee joint because it resists anterior tibial translation and rotational loads. Grafts were first introduced as a means of ACL reconstruction in 1917, with the use of the iliotibial band in the reconstructive treatment of an ACL rupture.[3] However, it was not until 1939 that the hamstring tendons were described as a viable graft source for the procedure. Since then, the technique has greatly improved, and standard tools now exist to ensure safe and easy graft harvesting.

Previous articles have described different ways of identifying the location of hamstring tendons through skin palpation and anatomic bony landmarks.[6-8] Once identified and exposed, harvesting of hamstring graft is sometimes made difficult by the numerous aponeurotic or tendinous attachments to the surrounding fascia, the medial head of the gastrocnemius, or the soleus muscle.[1,6] The nature, amount, strength, and length of

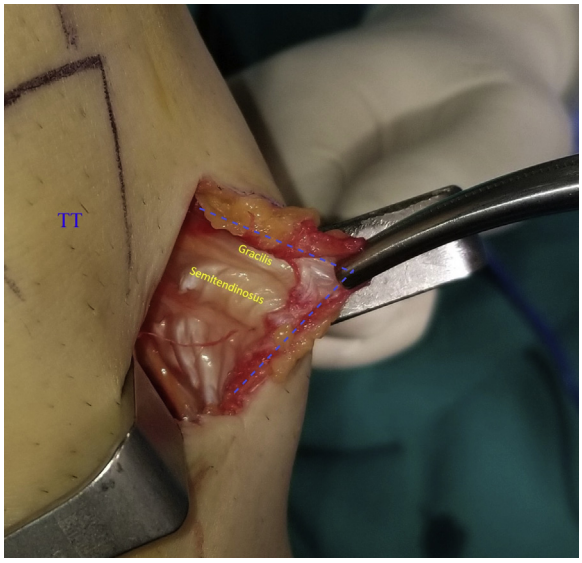

Fig 2. After the exposure of the pes anserinus with a reverse-L incision (blue dotted line), the gracilis and semitendinosus tendons can be identified. This is a frontal view of the right knee while the patient is lying supine. The proximal part of the extremity is on the upper part of the Figure. (TT, tibial tuberosity.)

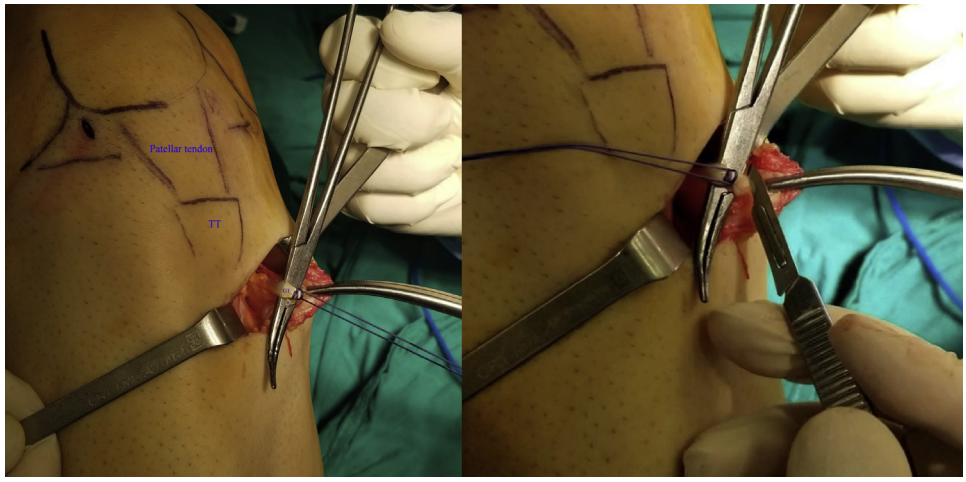

Fig 3. Both the gracilis and semitendinosus tendons are detached and released from the sartorial fascia. This is a frontal view of the right knee while the patient is lying supine. The proximal part of the extremity is on the upper part of the Figure. (TT, tibial tuberosity.)

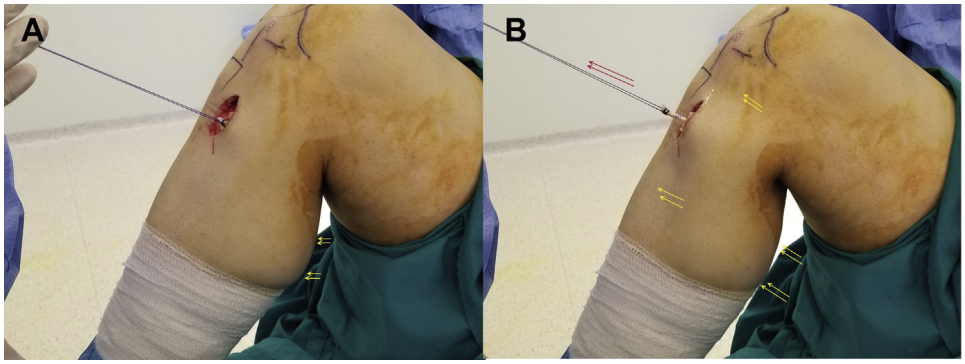

Fig 4. (A) Before any traction is applied on the newly released tendon, the gastrocnemius is visibly relaxed and loose (yellow arrows). (B) Once the tendon is gently pulled, a generalized movement can be observed on the whole gastrocnemius location (yellow arrows). The gastrocnemius clearly moves toward the pulling force (red arrows). This is a medial view of the right knee while the patient is lying supine. The proximal part of the extremity is on the right side of the Figure.

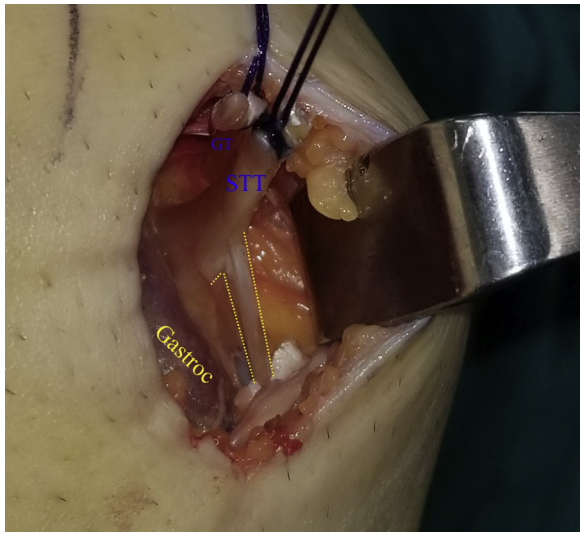

Fig 5. A closer look at the harvesting site clearly reveals the reason for the movement of the gastrocnemius. A relatively large fibrous band (dotted yellow lines) attached to the semitendinosus tendon (STT) can be seen. Although more frequently associated with the STT, these fibrous attachments can also be found on the gracilis tendon (GT). This band is distally attached to the gastrocnemius muscle (Gastroc), which can be partially seen in the bottom left region of the wound site. This is a frontal view of the right knee while the patient is lying supine. The proximal part of the extremity is on the upper part of the Figure.

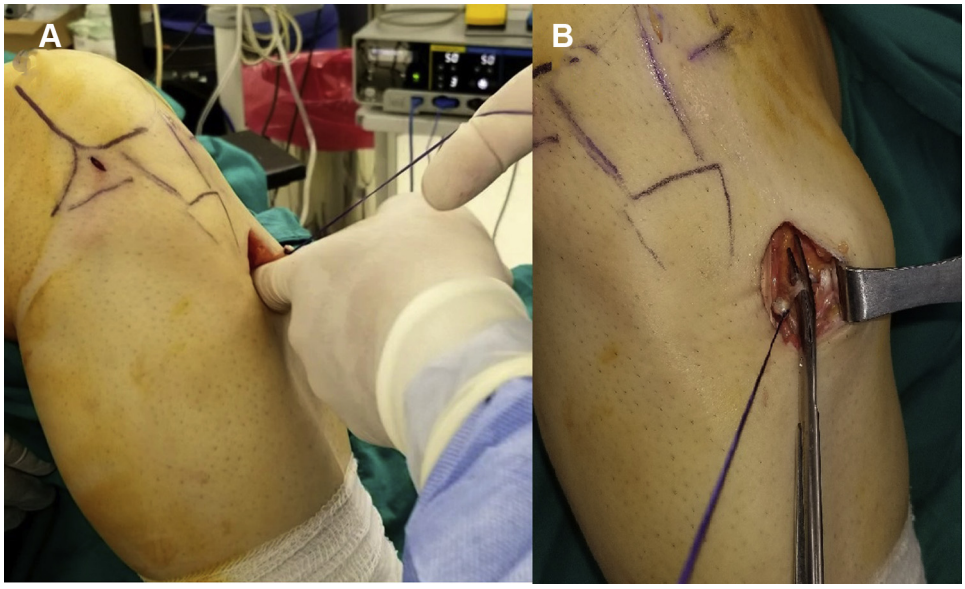

Fig 6. After identification of the fibrotic bands attached to the tendons, blunt finger dissection is used to further free them from the surrounding soft tissues (A), and scissors are used to dissect them (B). This is a lateral (A) and frontal (B) view of the right knee while the patient is lying supine. The proximal part of the extremity is on the upper part of the Figure.

these attachments have been studied before. Reina et al.,[8] in their study of 30 knees, stated that the GT had at least 1 band in 22 cases, with 2 bands found in 5 cases. The mean width of the first band was 10 mm. The bands mostly attached to the STT, and in 10 knees, the bands ran toward the fascia of the gastrocnemius medialis. The STT presented at least 1 band in all subjects, with 7 knees showing 2 bands. The mean width of the bands was 23 mm. These bands were more likely to run toward the fascia of the gastrocnemius medialis and usually met the tendon at an acute angle. They were almost exclusively tendinous and more resistant to traction and dissection and seemed to carry a greater risk of error during harvesting. The motionless gastroc sign described in our Technical Note points to a complete release of the bands and attachments of the medial head of the gastrocnemius to the pes anserinus. Because the main and most resistant bands attach there, their release opens the way for a quick harvest with a tendon stripper.

Olewnik et al.[6] classified these attachments and found that the first attachments started at approximately 3 cm below the muscle belly for the gracilis muscle and 9 cm for the semitendinosus muscle. Other studies suggested that the mean distance of the first attachments from the tibial tuberosity is 7.5 cm for the gracilis and 4.5 cm for the first band of the sartorius tendon and 7 cm for the second.[7,8] They also found the first band of the semitendinosus to be significantly wider than that of the

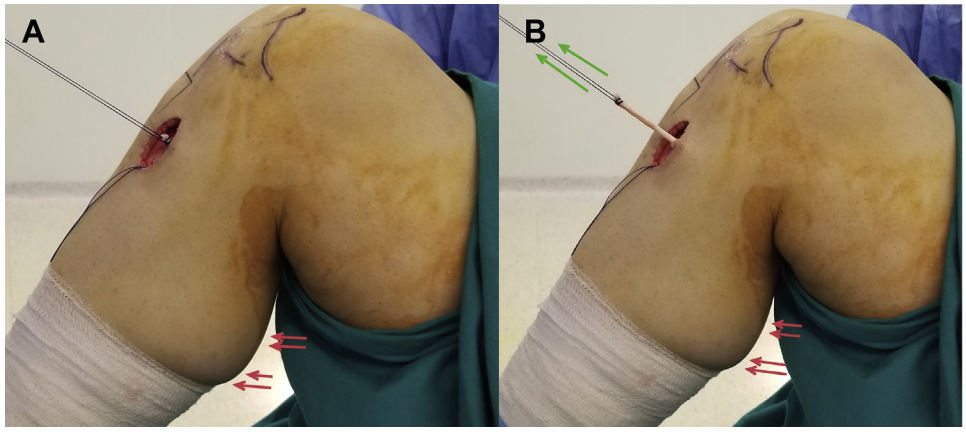

Fig 7. After all visible and palpable fibrous bands are released and cut, the pulling maneuver is repeated independently for each tendon. When all the attachments are released, the gastrocnemius will stay motionless independent of whether traction (green arrows) is being applied on the gracilis tendon or semitendinosus tendon (A) or not (B). The red arrows show the motionless gastrocnemius sign in the patient after all attachments were released. This is a medial view of the right knee while the patient is lying supine. The proximal part of the extremity is on the right side of the Figure.

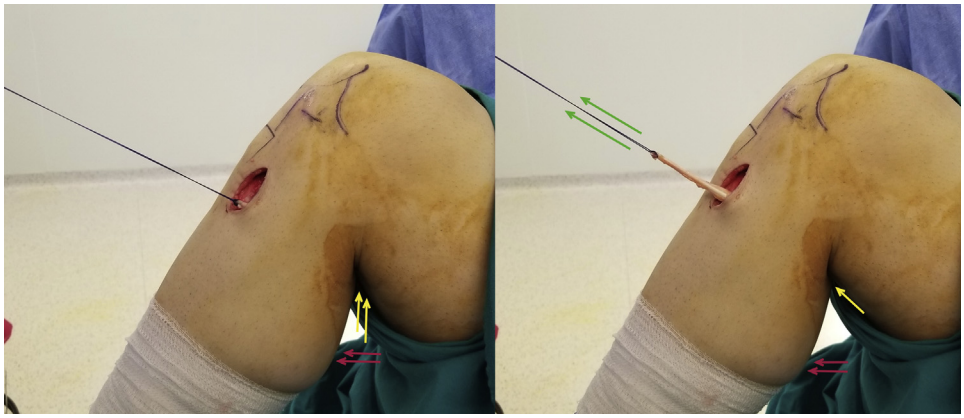

Fig 8. Care must be taken not to confound the movement of the hamstring muscles themselves with the gastrocnemius movement (red arrows). The hamstring muscles are situated more proximally and posteriorly, and because it is virtually their tendon to which we apply traction (green arrows), the subcutaneous tissue at this level slightly moves during the pulling maneuver (yellow arrows). This is a medial view of the right knee while the patient is lying supine. The proximal part of the extremity is on the right side of the Figure.

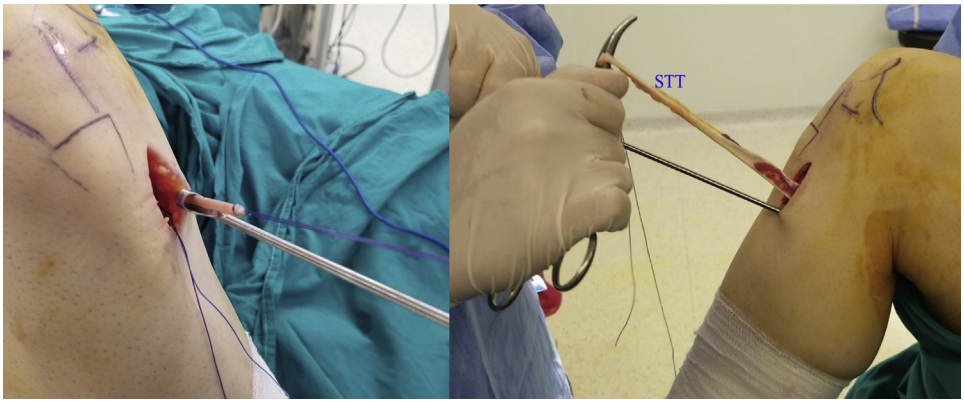

Fig 9. The moment we observe the presence of the motionless gastrocnemius sign, we cease dissection of soft tissue around the tendons, and a tendon stripper (Large Tendon Stripper) is used to complete the harvesting procedure. This is a frontal (left) and medial (right) view of the right knee while the patient is lying supine. The proximal part of the extremity is on the upper (left) and right (right) part of the Figure. (STT, semitendinosus tendon.)

Table 1. Pearls and Pitfalls

Pearls
The surgeon should start by gently pulling the tendons as soon as he or she exposes them. This way, the surgeon will have a good understanding of what a motile versus motionless gastrocnemius looks like for every single patient.
The hamstring muscles themselves, situated more proximally and posteriorly, will remain mobile during the whole pulling procedure. It is only the gastrocnemius site that should be observed during surgery.
Pitfalls
Very rarely, distal fibrotic bands not causing motion on the gastrocnemius may still be attached to the graft tendons. Premature stripper insertion may lead to graft amputation. The surgeon should always double-check with blunt dissection.

Table 2. Advantages and Disadvantages

Advantages
The technique gives a speedy and sound understanding of the amount of release needed before stripper insertion.
Disadvantages
The technique is experience bound. Less experienced surgeons might confound the movement of the hamstring muscles themselves—situated more proximally and mobile during the whole procedure—with that of the gastrocnemius, leading to a prolonged and excessive "release" and potential damage to the posteromedial structures.

gracilis. Our experience has shown that it is the release in approximately these distances that makes the motionless gastroc sign appear.

Mouarbes et al.[1] suggested that all attachments, independent of their nature and size, be identified by direct observation or finger palpation and then released prior to stripper insertion. We suggest that in addition to those signs, the motionless gastroc sign should be performed to mark a definitive and complete release.

Despite our experience, the described technique has its own risks and limitations (Tables 1 and 2). We advise all surgeons to make sure the potential grafts are properly released and motile before stripper insertion. Rare cases of distal accessory bands not causing movement of the gastrocnemius can be misleading and may result in graft amputation. A safe but slower procedure is always preferred over a quicker but less safe procedure. The technique can also be misleading when

used by less experienced surgeons, who might confound the movement of the hamstring muscles themselves—situated more proximally and motile during the whole procedure—with that of the gastrocnemius, leading to a prolonged and excessive "release" and potential damage to the posteromedial structures. Surely, our study is prone to bias because our surgical team has a mean length of experience in ACL reconstruction of 20 years. On the other hand, we have found the motionless gastroc sign to be reliable and safe for adequate graft harvesting.

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