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Research article

Portal placement for endoscopic surgery in the deep gluteal area: a cadaveric study

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ABSTRACT

Partial or complete avulsion of the insertion of the proximal hamstrings at the level of the ischial tuberosity is most often treated by open exploration and reinsertion. However, endoscopic reinsertion could be considered to minimize the soft tissue damage. In this study, we aimed to determine the most optimal location of four endoscopic portals that allow for a safe exploration of the proximal hamstring insertion site. The reference points for the portals run vertically through the center of the sciatic tuberosity and through a horizontal line which lies on the inferior edge of the tuberosity. The distance and relationship between the sciatic, the inferior gluteal and posterior femoral cutaneous nerves and the four proposed endoscopic portals was documented. Our results showed that it was best to start with the inferior portal followed by the medial and lateral portal. The inferior portal allowed for a clear visualization of the sciatic nerve and was along with the medial portal at a distance of >5 cm from any of the surrounding nerves. Care must be taken with the lateral portal, as the distance to the surrounding nerves varied between specimens. A fourth portal could be used as a viewing portal when necessary. Our study showed that the sequence and position of the proposed endoscopic portals provide a safe approach to the proximal part of the hamstrings and the ischial tuberosity. These findings can be helpful for endoscopic procedures to the ischium and the sciatic nerve in the gluteal region.

INTRODUCTION

Proximal hamstring avulsions at the level of the insertion site on the ischium is a distinct type injury that can occur with extreme eccentric muscle contractions, forced hip hyperflexion, ipsilateral knee extension and fall accidents [1–4]. Patients often present with pain during walking and prolonged sitting and show tenderness to palpation in the ischial tuberosity [5, 6]. Although conservative treatments, such as shockwave therapy [7], eccentric exercises for the trunk and pelvis muscles [8], cortico-steroid [9] and platelet-rich plasma injections [10] can be effective, it has been shown that open surgical repair will often lead to an improved post-operative functionality [6, 11–13]. Although surgical repair procedures improve the prognosis of the patients [14], open surgery is considered challenging because of the close association of the hamstring muscles to the neuromuscular structures. The hamstring muscles consist of the biceps femoris, semitendinosus and semimembranosus muscles. The tibial branch of the sciatic nerve innervates the semitendinosus, semimembranosus and long head of the biceps femoris, whereas the short head of the biceps femoris is innervated by the peroneal branch of the sciatic nerve [6, 15]. Thus, open surgery for the repair of the proximal hamstring avulsions can cause neurologic damage to the sciatic nerve [6, 16]. In addition, the retraction of the gluteus maximus during open surgery could jeopardize the inferior gluteal nerve and the posterior femoral cutaneous nerve [1, 17, 18].

Because of the potential risks of open surgery and the advances in endoscopic procedures throughout the years, we believe that endoscopic exploration and suturing could have important advantages over open procedures. Endoscopic surgery minimizes disruption of the neuromuscular anatomy with a superior visualization and access to

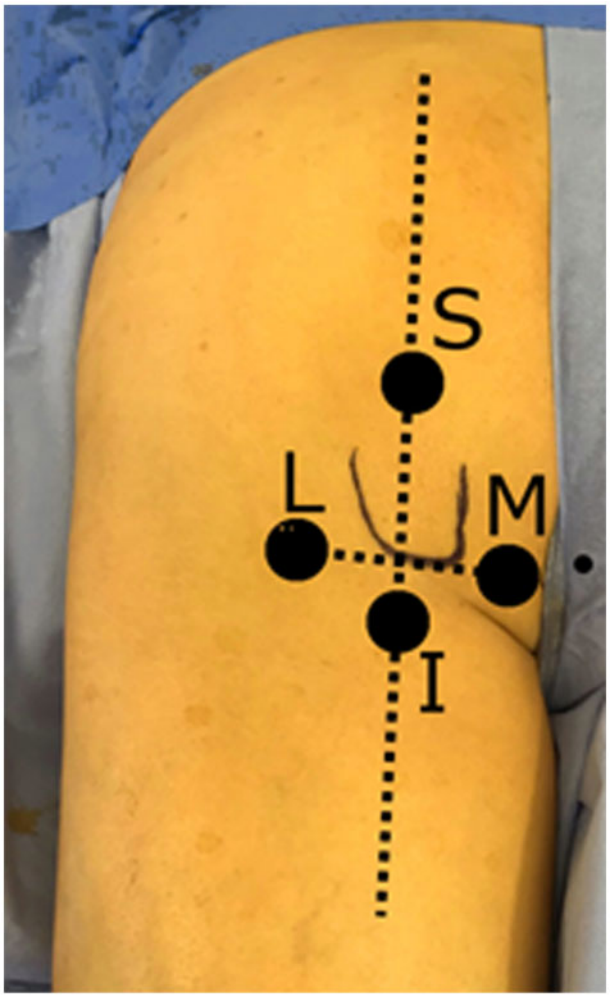

Fig. 1. Endoscopic portal location on cadaver specimen (right hip). A vertical and a horizontal line are drawn through the middle and the inferior edge of the ischial tuberosity in order to create the four reference points to place the endoscopic portals. I, inferior portal; L, lateral portal; M, medial portal; S, superior portal.

the sciatic nerve and proximal part of the hamstrings [19]. A study of Robertson *et al.* [20] showed all the possible endoscopic portals that could be used to perform hip arthroscopy both safely and accurately. One study has used two endoscopic portals to treat proximal hamstring avulsions located posterior and posterolateral in the gluteal fold [21], another study used two portals, created medial and lateral of the ischial tuberosity [22] and the most recent studies have used three portals (mid-central, medial and lateral portal) [23, 24]. To date, there is still some debate about which portals are best used to treat proximal hamstring avulsion endoscopically.

In this cadaver study, we investigated the most optimal and safe portal placements for the endoscopic exploration, release and suturing of the proximal hamstrings using four endoscopic portals. These portals were located inferior, medial, lateral and superior to the ischial tuberosity. The location of each portal with regards to the sciatic nerve, posterior femoral cutaneous nerve and inferior gluteal nerve was documented.

METHODS

Five fresh frozen cadaveric specimens of the right hip were used in this study. No pathologies or history of hip surgery were noted in any specimen. Specimens were placed in a prone position with the hip at 10° flexion. The surgeon was located at the contralateral side of the specimen. A radiofrequency (RF) probe with an endoscopic orientation of 70° was used. Four different endoscopic portals were made in each specimen (Fig. 1). The reference points for the portals run as a vertical line along the body axis, which is drawn through the center of the ischial tuberosity, and a horizontal

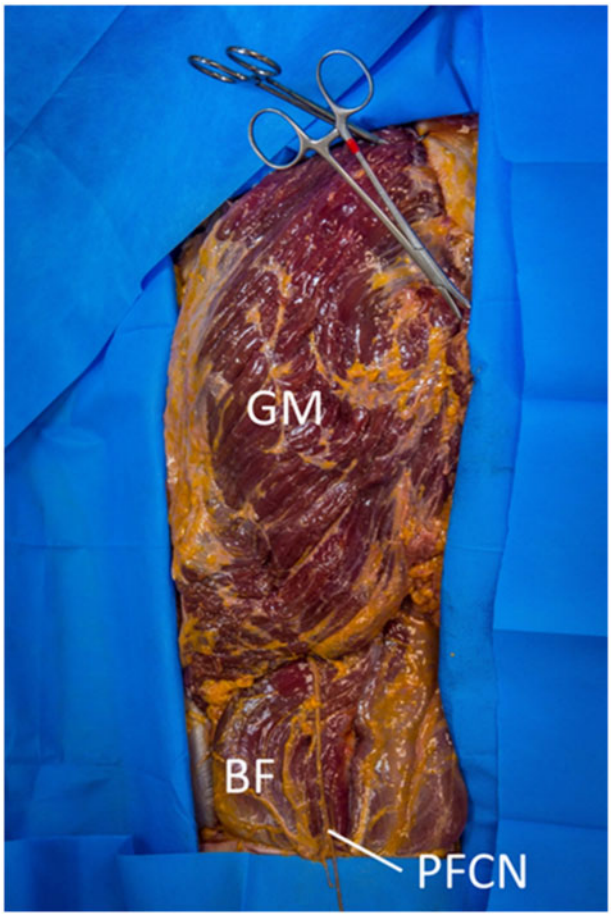

Fig. 2. Dissection of right hip with removal of the skin. Clear view on the gluteus maximus muscle (GM), biceps femoris (BF) and posterior femoral cutaneous nerve (PFCN).

line which lies on the inferior palpable edge of the tuberosity. The first (inferior) portal was made 2 cm distal to the center of the inferior border of the tuberosity and under the distal fibers of the gluteus maximus muscle as this allows for more mobility in the subgluteal space. Through this portal the tuberosity could be felt. The second (medial) portal was made 2 cm medial to the inferomedial corner of the tuberosity and 1 cm under the inferior border of the ischial tuberosity. The third (lateral) portal was made 2 cm lateral to the inferomedial corner of the tuberosity and 1 cm under the inferior border of the ischial tuberosity. Care must be taken during the skin incision and the blunt dissection with the trocar in order not to damage the sciatic nerve or the posterior cutaneous nerves. The lateral portal is mainly used for exploring and palpating the muscle fibers and/or nerves. The fourth (superior) portal is positioned 3 cm cranial to the center of the inferior border of the tuberosity. This portal is often useful for hamstring suturing and to move the corresponding tendon more proximal when the muscle is torn. All portal incisions are made horizontal in the direction of the skin lines.

For the first portal, the blunt obturator was put against the ischium to release the connective fibers between the ischium and the skin. This step takes a significant amount of time as a lot of connective tissue can be found in this area. Once this step is completed, the medial portal is created and the RF probe is introduced in order to clear the connective tissue from the ischium. Through this portal an anchor can be inserted in the ischial tuberosity. Care must be taken not to injure the posterior femoral cutaneous nerve because of its proximity to the portals. It is important in this step to always have a view of the nerves that are positioned close to the lateral border of the ischium. After visualization of the posterior cutaneous nerve and the sciatic nerve, the lateral portal can be made.

A cannula was inserted through the lateral portal and the wire was pulled through. The tendon was then sutured from the cranial to the caudal direction through the cannula. From the lateral portal, the release of the posterior cutaneous nerve and the sciatic nerve was easier to perform. In two specimens, we were not able to have a

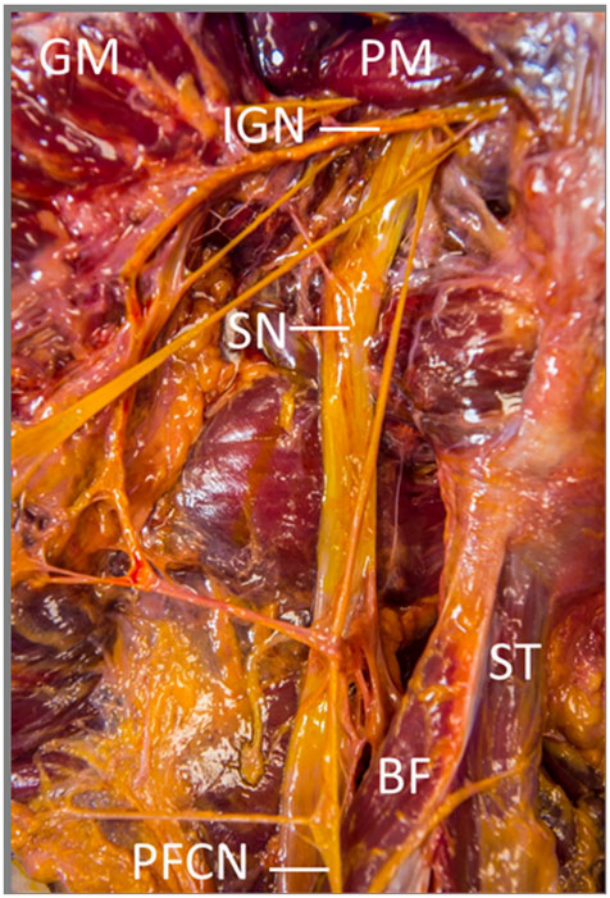

Fig. 3. Dissection of right hip. Clear view on the gluteus maximus muscle (GM), biceps femoris (BF), semitendinosus muscles (ST), piriformis muscle (PM), sciatic nerve (SN), posterior femoral cutaneous nerve (PFCN) and inferior gluteal nerve (IGN).

clear view of these nerves before utilizing the lateral portal. In these cases, we made a gentle but blunt dissection from the lateral portal to the ischium under endoscopic view.

After the endoscopic procedure, an anatomic dissection was done to identify the posterior femoral cutaneous nerve, the sciatic nerve and the hamstrings attached to the ischium in each specimen (Fig. 2). A longitudinal incision was made on the posterior part of the gluteus maximus lateral to the ischium down to the posterior part of the upper leg to identify the semimembranosus muscle. The dissection was performed away from the lateral border of the semimembranosus and towards the sciatic nerve.

A second incision was made along the length of the sciatic nerve after which a precise dissection was performed. All the nerves were studied to detect any macroscopic damage to the nerves and the surrounding structures. We also dissected the proximal hamstrings, in order to assess the extent of the release of the semimembranosus muscle (Fig. 3).

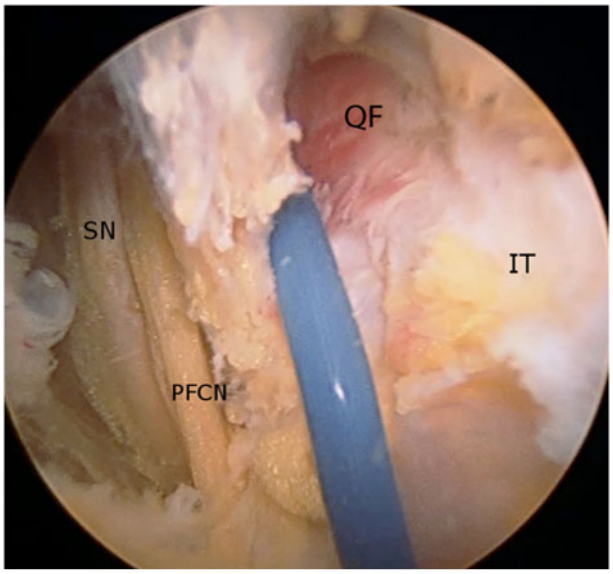

Fig. 4. Endoscopic location on cadaver specimen of the sciatic nerve (SN), the posterior femoral cutaneous nerve (PFCN), ischial tuberosity (IT) and quadratus femoris (QF).

RESULTS

Location of the nerves

The sciatic nerve could be clearly visualized 3 cm laterally and anteriorly of the ischial tuberosity and the semimembranosus. Dissection could be performed safely to a distance 6 cm distally to the inferior border of the ischial tuberosity (Fig. 4).

The posterior femoral cutaneous nerve was located 2 cm laterally to the ischial tuberosity, superficially to the sciatic nerve and close to the piriformis (Fig. 4). This nerve branched posteriorly of the ischial tuberosity which supports the necessity of clearing all the peritendinous fat and surrounding tissues thoroughly in order to visualize all the peri-muscular nerves.

The nerve branch of the semimembranosus was located 6 cm distally of the tuberosity. The distance of the lateral border of the proximal insertion of the semimembranosus to the sciatic nerve was between 1.5 and 3 cm.

Location and safety of the endoscopic portals

The inferior portal is created first to allow for a clear and direct field of vision that allows for a safe creation of the lateral portal after clearing the space by limited blunt dissection. The portal was located 2 cm below the sciatic tuberosity.

The lateral portal was located directly posterior of the sciatic nerve and the posterior femoral cutaneal nerve within an average distance of 5 cm. However, the distance of

the lateral portal to the nerves was highly dependent on the operative maneuvers performed and differed between specimens. Thus, this portal should always be made under complete endoscopic control from the inferior portal and directed towards the ischial tuberosity.

The medial portal was within a safe distance of more than 5 cm to the sciatic nerve and the posterior femoral cutaneal nerve.

The superior portal was located 5 cm above the ischial tuberosity and can be used as a viewing portal or as an additional portal for instrumentation.

DISCUSSION

In this study, we describe the locations and safety of four portals useful for the endoscopic exploration and re-suturing of proximal hamstring avulsion. Our results showed that these portals cause minimal disruption to the surrounding anatomy and give a good visualization of the surrounding nerves and muscles, though the vasculature of the subgluteal area was not studied.

This is in contrast to the open surgical repair of proximal hamstring avulsion which has inherent risks as described above. Open surgery can cause both superficial and deep wound infections because of the location of the incision to the perineal region. There is also a potential risk of neurovascular complications in open surgery because of the close relationship of the inferior gluteal, the posterior femoral cutaneous and the sciatic nerve to the surrounding tissues [6, 16].

In contrast to other studies which use only two endoscopic portals and make the lateral portal first [21, 25], our results suggest that it is best to start with the inferior portal (scope portal) and use three endoscopic portals in total. A fourth (superior) portal can be used when necessary but is often not obligatory. The inferior portal allows the surgeon to get a clear visualization of the sciatic nerve and the posterior femoral cutaneal nerve and allows the possibility of releasing the semimembranosus more laterally. This portal also allows for a clear creation of the lateral portal, which often lies close to the sciatic and posterior cutaneal nerves. The medial portal should be made secondly. After some blunt dissection to clear the surrounding tissues, the RF probe can be introduced to locate the sciatic and the posterior femoral cutaneous nerves. Because of the close relationship to the sciatic nerve and the posterior femoral cutaneal nerve to the lateral portal, the authors advise, in contrast to previous studies [21, 25], to make the lateral portal last, after creating enough space around the ischium or when you a clear visualization of both nerves has been obtained. An abduction of the leg would also draw the sciatic nerve in a safer position as it would move more lateral to the ischium [26, 27].

Another possible portal sequence consists of starting with the medial portal first. Although the medial portal is a good portal for exploring the medial tuberosity, it does have the risk of not clearing enough surrounding tissues laterally. In addition, it is required to look around the tuberosity without being able to look straight at the nerves. For these reasons, the inferior portal sequence is preferred by the authors.

When we compare the three portals with respect to safety, the medial, superior and inferior portals can be considered very safe if the correct landmarks are being used. It is necessary to take into consideration that for obese patients the location of the landmarks can be challenging as it can be difficult to palpate the tuberosity and to identify the center of the inferior border of the tuberosity. For patients with extreme obesity fluoroscopy can be useful to correctly identify the necessary landmarks. However, this aspect was not further studied in our cadaver experiment. Another aspect to take into consideration is the close proximity of the nerves during lateral stitching. Re-inserting the semimembranosus on the lateral side, brings the nerves much closer together and places them at risk. Therefore, the authors recommend to perform lateral stitching, the re-insertion of the hamstrings to the lateral side of the tuberosity, only when good visualization is possible. Iatrogenic injury to the pudendal nerve with placement of retractors superior and medial to the ischium is possible, as it lies 2–3 cm superior and medial to the hamstring origin [28].

CONCLUSIONS

This is the first study which describes the location and safety of four endoscopic portals that can be used for proximal hamstring avulsion in the ischial area. The proposed endoscopic portal sequence, namely first the inferior portal, then medial portal and lastly the lateral portal, is shown to be the safest option for the surrounding nerves and vessels. Using this technique, the neurolysis of the sciatic nerve and surgery to the proximal hamstrings can be performed safely. The authors are convinced that endoscopic surgery is a safer option than open surgery, gives a better view of the ischial area and drastically decreases the danger for the sciatic, the inferior gluteal and the branches of the posterior cutaneous nerves.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest or financial ties to disclose.

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