

Complications in medial meniscus suture: a cadaveric study

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Abstract The aim of this study was to examine the possibility of complications in medial meniscus repair using an inside-out suturing device. Anatomical cadaveric study. Six fresh frozen cadaveric lower limbs were used. The posterior horn of the medial meniscus was sutured using three vertical stitches. An anatomical dissection was subsequently performed to check for any possible effects upon the structures of the medial aspect of the knee. In addition, an incision was made in a safety zone in order to ascertain whether it was possible to carry out the suture without affecting the aforementioned structures. No vascular or nervous structures were pierced by the needle. On knotting, it was found that a number of different structures had become trapped: the sartorial tendon was affected in each of the specimens used. In four cases, the saphenous vein was trapped by some of the knots. The saphenous nerve was trapped in four instances. Once this had been established, a small accessory incision was made to provide access to a safety zone, where suture can be performed without affecting any neurovascular or tendinous structures. Inside-out suture of the posterior meniscal horn carries a high incidence of entrapment of the neurovascular structures of the medial aspect of the knee. The

sartorial tendon is constantly affected. Such complications can easily be avoided by entering the safety zone via a small auxiliary incision. This study provides evidence that complications affecting the peripheral structures of the medial aspect of the knee may arise during inside-out suture of the posterior horn of the medial meniscus and proposes a simple method of averting them.

Keywords Arthroscopy · Surgery · Meniscus · Knee · Suture

Introduction

Due to the frequency with which degenerative changes such as those described by Fairbank [12] occur in the articular space affected by meniscectomy, there is a growing tendency to attempt to preserve the meniscus, particularly in the cases where the tears affect the peripheral zone, where it enjoys better vascularization [2, 18].

Meniscal repair has been a well-known procedure for many years now, having first been described by Annandale in 1885. DeHaven [10] provided the first long-term results for the procedure, reporting a survival rate of 79% after 10.9 years.

In spite of the positive results obtained using meniscal repair, the process nevertheless involves an appreciable risk of complications, particularly of the neurovascular structures surrounding the joint. A multi-center study by Small [25] involving 375,060 arthroscopies revealed that, in general, 0.56% suffered complications, a figure which rose to 2.4% in cases of meniscal repair. Several years later, the same author

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published findings of saphenous nerve injuries in 1% of 3,034 meniscal repair carried out. Plasschaert et al. [22] detected six paresthesias of the saphenous nerve in 31 medial meniscus sutures (20%).

Injuries to the saphenous nerve or its branches have been reported as a complication of meniscal resection surgery [1] or anterior cruciate ligament reconstruction using semitendinosus and gracilis tendons [7].

Several studies have been carried out with the aim of locating the route of the saphenous nerve in order to avoid injury to it during surgery on the medial aspect of the knee, using either the medial epicondyle [3] or the saphenous vein, which can be located through transillumination [16], as a reference point.

In an attempt to reduce the likelihood of suture complications and improve technique, a variety of all-inside meniscal repair systems and devices have been employed in recent years, with positive results being reported using meniscal arrows [14, 21], meniscal staples [17], etc., in addition to all-inside meniscal suture systems, though these have not been entirely free of complications [5, 19].

However, most comparative studies suggest that meniscal suture using vertical stitches offers greater resistance [4, 6, 23, 13, 27].

An anatomical study carried out by Warren and Marshall [28] provided a clear description of the three layers of the medial collateral ligament, comprising a superficial layer consisting of the fascia cruris (layer I), an intermediate layer in the form of the medial ligament itself (layer II) and a deep layer in the joint capsule. Mochizuki et al. [20] later reported that the saphenous nerve and its branches descend across the superficial aspect of the aponeurosis of the gracilis (layer I of Warren and Marshall's medial ligament).

Bearing these anatomical considerations in mind, it can be deduced that no "injurable" structures exist between layers I and II described by Warren and Marshall, the space between them representing a safety zone as far as meniscal suture knotting is concerned.

The aim of this study is to evaluate the probability of injury to the neurovascular structures of the medial aspect of the knee when performing inside-out suture of the medial meniscus on a simulated tear in its posterior horn using a simple suture device which is introduced into the joint via the anteroexternal aspect of the knee; and to assess a simple method to prevent these injuries.

Methods

Using an arthroscopic technique, standard longitudinal tears of the posterior horn of the medial meniscus were

created in six cadaveric knees; the lesions later on were sutured. This zone has been shown to be most susceptible to neurovascular injury.

Three vertical stitches (central, medial and posterior portions) were inserted in each specimen via the inside-out technique using a device consisting of a needle with an eye at the point and 2/0 braided polyester thread [11].

The leg is placed on an arthroscopic support and the arthroscope is introduced via the anteromedial portal. With the knee in 0–10° of flexion the needle is directed percutaneously tangential to the external aspect of the patellar tendon and into the medial compartment, however given the nature of the sutures system employed, this position can be varied and may not require the use of any arthroscopic portal (Fig. 1). After piercing the peripheral zone of the meniscus and the joint capsule, the needle exits the skin covering the posteromedial aspect of the knee (Fig. 2). During this step, one end of the thread is left outside the skin. The point of the needle is returned into the joint, and is redirected to pierce the meniscus (this time in the area closest to the free edge), the joint capsule and the skin, leaving the other end of the suture outside (Fig. 3), so that the tear is held reduced by the thread, which will later be knotted outside the joint.

Using the same technique, three meniscal stitches (medial, central and posterior) are inserted (Fig. 4). Once suture were passed a small incision was made on the exit zone and knotted in the subcutaneous layer, we dissected the exit zone of the suture layer by layer to check for any injured structures (Fig. 5).

An auxiliary incision was then made in the safety zone to ascertain if it was possible to perform suture

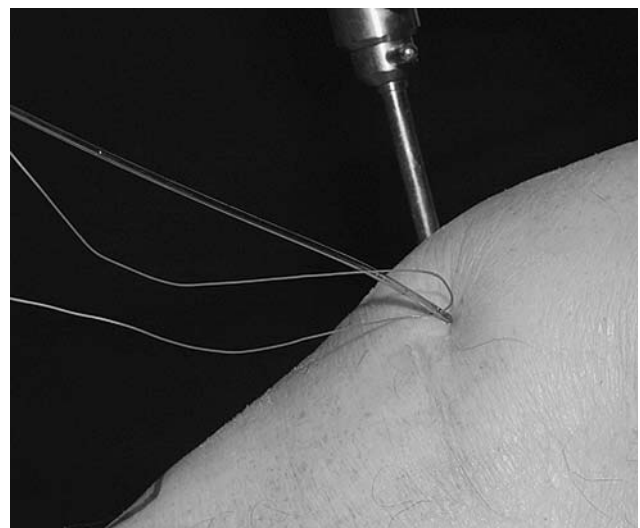


Fig. 1 Needle penetrating the skin tangential to the external aspect of the patellar tendon

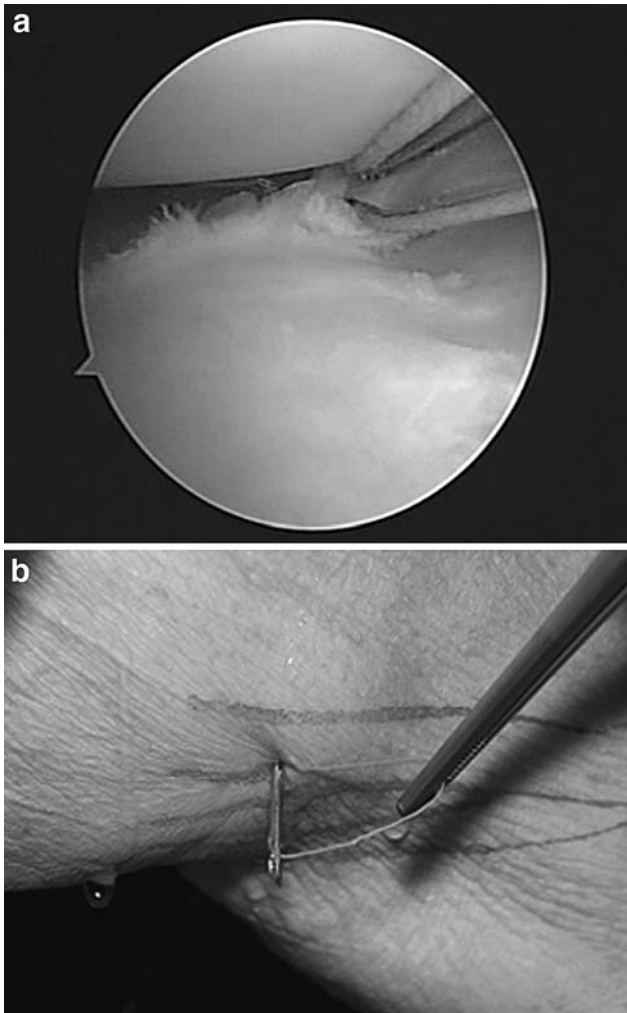


Fig. 2 **a** Needle piercing the peripheral zone of the meniscus and **b** exits the joint through the posteromedial aspect of the knee (anterior side on top of the picture, distal right)

without the stitches inserted “trapping” any neurovascular or tendinous structures.

Surgical technique

Once the suture has been introduced, and before knotting the stitches the leg is flexed to 70–90°, and a 1–2 cm longitudinal incision is made in the medial (posterior angle of the medial border of the tibial plateau) zone of the knee, distal from the femorotibial joint interline and anterior to the exit of the sutures. This is incised longitudinally at the fascia cruris to enter the safety zone [8] (between the surface of the fascia cruris and the medial ligament). This area is bluntly dissected (Fig. 6) until the threads are reached. These are then retrieved using the probe itself and withdrawn via the incision (Fig. 7). Knotting can then be performed with complete safety, with the help of a

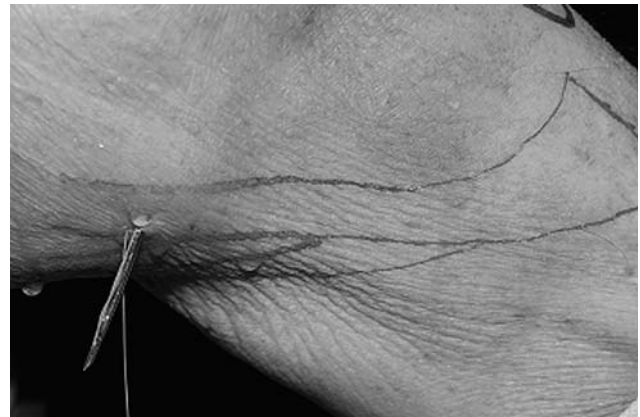


Fig. 3 Needle piercing for second time the skin, with one end of the thread previously left outside (anterior side on top of the picture)

knot pusher of the type used for suture in arthroscopic shoulder surgery (Fig. 8). When meniscal suture is carried out in conjunction with anterior cruciate ligament reconstruction using hamstring tendons, the incision made to extract the tendons can also be used to reach the safety zone and knot the suture (Fig. 9).

Results

Dissection revealed the following results (Table 1):

No vascular or nervous structures (saphenous vein/saphenous nerve or its branches) were pierced by the suturing needle. However, the sartorial muscle tendon was pierced in four of the cases examined, while in



Fig. 4 Three stitches holding reduced the internal meniscus



Fig. 5 Dissection of the exit zone showing entrapment of the saphenous vein and nerve (*anterior side on the right of the picture*)

another, the semimembranosus tendon of a specimen taken from an obese individual was similarly affected.

During knotting of the sutures, a number of neurovascular structures were trapped by the sutures (Fig. 5):

The medial stitch did not affect any neurovascular or tendinous structure.



Fig. 6 Small auxiliary incision to access the safety zone (*anterior side on the right of the picture*)

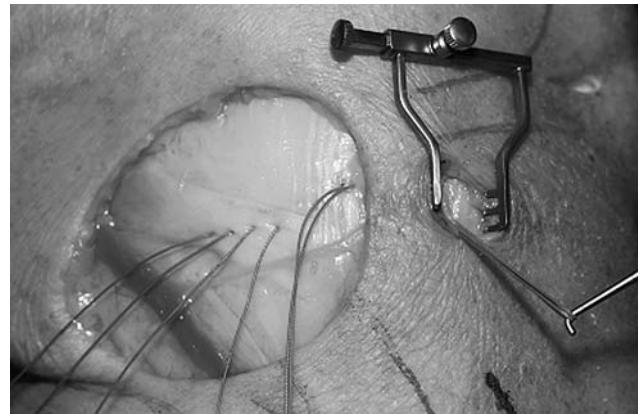


Fig. 7 Retrieval of the suture through the auxiliary incision (*anterior side on the right of the picture*)

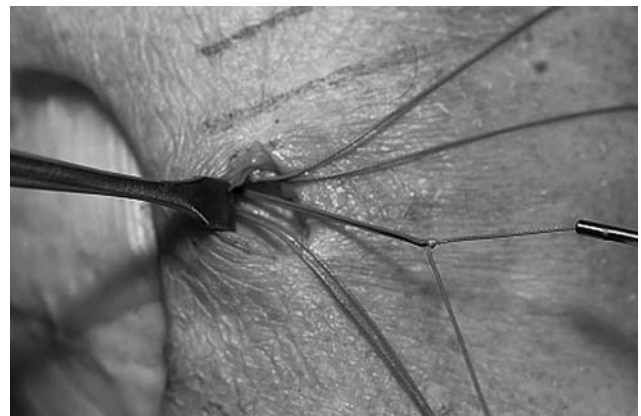


Fig. 8 Knotting the stitches through the auxiliary incision into the safety zone (*anterior side on the right of the picture*)

The central stitch did not affect any structures in one case. In the remaining five specimens, the sartorius tendon was trapped. In three specimens, the saphenous vein was trapped. The infrapatellar branch of the saphenous nerve was trapped in one instance.

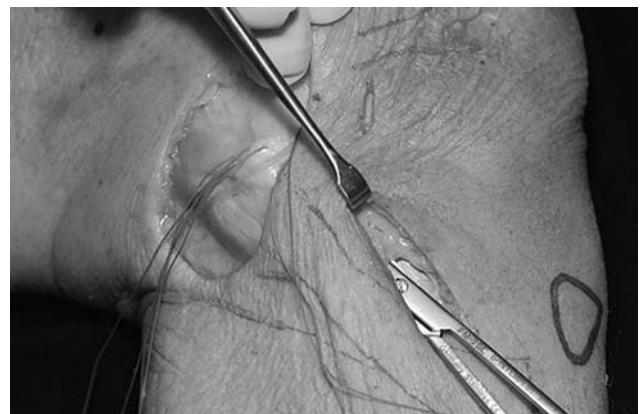


Fig. 9 Access to the suture via the hamstring approach

Table 1 Results of structures entrapment

Specimen	Medial stitch	Central stitch	Posterior stitch
1	–	Sartorius tendon	Saphena vein Saphenous nerve
2	–	Sartorius tendon Saphena vein Saphenous nerve	
3	–	Sartorius tendon Saphena vein	Saphena vein Saphenous nerve
4	–	Sartorius tendon Saphena vein	Sartorius tendon Saphenous nerve Semimembranosus tendon
5	–	–	Sartorius tendon
6	–	Sartorius tendon	Sartorius tendon

The posterior stitch did not trap any structures at all in one specimen. The sartorius tendon was trapped in three cases, as was the oblique popliteal branch of the semimembranosus tendon in one case. The saphenous nerve was affected in three specimens. The saphenous vein was trapped twice.

When knotting was performed through the safety incision, no neurovascular structures or tendons were trapped.

Discussion

Recent years have seen intense efforts on the part of industry and researchers alike to produce an all-inside meniscal repair device that could both minimize the risk of complications and make the technique easier to perform. As a result, a variety of such devices have appeared in the shape of darts, meniscal arrows, staples etc., and even a number of all-inside suturing methods. However, these have not been without complication [5, 9, 24, 26] and, furthermore, have proved to offer less resistance than meniscal suture [4, 14].

Meniscal repair by “inside-out” techniques [22, 25] may also result in neurovascular complications, though it seem like the possibility of these complications is less than with “inside-out techniques”, the probability of these has not yet been established.

In this study, we simulated a medial meniscus tear in the area where repair is most frequently performed. Meniscal repair was performed using a novel device that allows percutaneous access to the medial meniscus utilizing a trajectory that is likely to avoid the risk of injury to the popliteal neurovascular structures. The percutaneous technique allows the placement of the sutures without the need for an accessory portal. This

study showed that in a significant number of cases, particularly in the posterior zone, entrapment of the saphenous vein and nerve can occur, when this percutaneous inside-out technique is employed without the use of a safety incision, particularly when suture repair is performed in the most posterior zone. More unlikely is the piercing of this neurovascular structures, probably due to the fact that, though one of these may have been touched by the point of the needle, the needle then would have slipped off without piercing it.

Although incarceration of the Sartorius tendon is unlikely to result in a functional complication, contraction of this tendon during knee motion may result in failure of the repair.

The findings of this study indicate that inside-out technique of suture of the posterior aspect of the medial meniscus that enters the joint from the anterolateral aspect of the knee can lead to a significant number of complications in terms of incarceration of the saphenous vein and nerve. The sartorius tendon is frequently affected, incarceration of this could potentially result in failure of the meniscus repair, and can be avoided by knotting the suture in safety zone between layers I and II of the medial collateral ligament.

To ensure knotting is made safely in order to prevent complications, as well as to confirm the knots will lay over the collateral medial ligament, several authors propose to execute an auxiliary incision in the posteromedial aspect of the knee, distal from the femorotibial joint interline. The length of this incision varies from 3 to 4 cm for Rosemberg [8] to 6 cm for Henning [15]. With this study we suggest that a 1.5–2 cm incision it's enough to reach the safety zone between Warren and Marshall's layers I and II of the collateral medial ligament; and using an arthroscopic probe to retrieve the suture, knotting can be performed with total guarantee.

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