Technical Note

Meniscal Repair With Iliotibial Band Grafting and Collagen Membrane Wrapping Augmentation

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Abstract: This work contains a description of the modified Henning operation. This technique can be proven especially useful in difficult cases of damaged meniscus (complex injuries). It consists of three stages: stable suturing of the meniscus, placement of the graft from the iliotibial band on the meniscus, and covering the graft with a collagen membrane. Stitching the meniscus provides initial stabilization, the graft from the iliotibial band provides scaffolding for the reconstructed tissue, and the collagen membrane provides biological stimulation for healing.

The main function of the meniscus is absorption and transmission of axial forces exerted on the knee as well as alleviation of friction in the joint. Cutting out parts of the meniscus enhances the surface area for contact between bone and cartilage, resulting in greater exposure to chronic stress.[1,2] Its delayed-in-time result is a positive correlation between meniscectomy and development of early-onset degenerative osteoarthritis. In recent years, there has been an observed shift in treatment approach from meniscectomy toward techniques leading to maximizing preservation and regeneration of the structure.[3-5] The goal of this work is to present a modified wrapping technique for augmenting meniscal injuries with biomass loss and tissue degeneration. Based on the positive outcomes seen with collagen membrane wrapping and Henning's promising findings regarding fascia sheath utilization, this innovative approach involves integrating both of these layers along with bone marrow blood injection into the injured area. Such an approach is believed to provide sufficient structural support and enhance the healing potential of the underlying meniscal tissues encapsulated by double layer sheath.

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Surgical Technique

The technique is detailed in Video 1. The indications included: radial or longitudinal tears with tissue loss, horizontal damage resulting in the deformation of the upper and lower parts of the meniscus, and multifragmented injuries with extensive free edge involvement and tissue loss.

With the patient in the supine position and an Esmarch bandage secured around the operated limb, we perform standard anterior knee arthroscopy through two access points: anterolateral and anteromedial, subsequently widening them. After identifying the damage to the meniscus (Fig 1), we proceed to repair it. First, using a special tool (rasp), we scarify the meniscus at its pericapsular attachment to enhance healing. Next, we pre-stabilize the damaged meniscus by suturing. The choice of suturing method depends on the location of the meniscal tear. The authors prefer initial all-inside suturing only in the case of damage to the posterior horn of the meniscus. Injuries within the meniscal shaft are mostly treated by us using the inside-out method (Fig 2). The sutures are tied directly on the joint capsule via a small skin incision (Fig 3). We bend the needle holder to the desired angle with the guide needle inserted. Then, in arthroscopy, we sew the meniscus with horizontal inside-out sutures, tying the sutures on the capsule of the joint.

After initial stabilization of the meniscus, we move on to harvesting the graft. We make a skin incision measuring approximately 5 cm long on the lateral side of the knee joint from the lateral epicondyle of the femur vertically upward along the long axis of the limb (Fig 4). We prepare the soft tissues and reach the fascia. We make an incision in the fascia and use a blunt

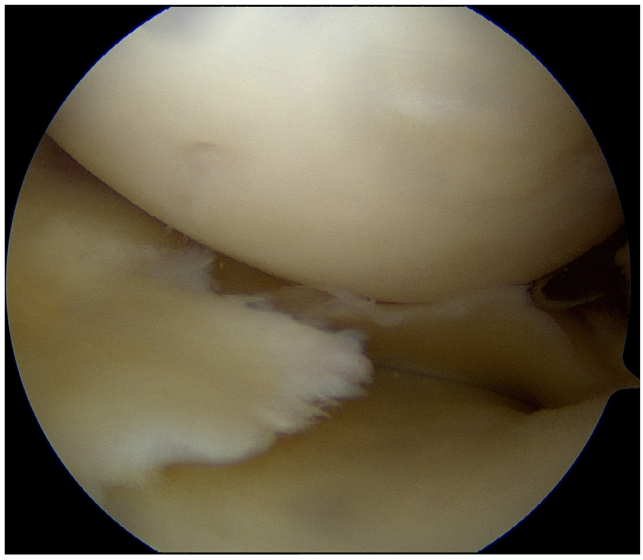

Fig 1. Complex tear of medial meniscus consisting of a radial and horizontal tear. Good indication for our technique. View from the anterolateral arthroscopy portal. Patient in supine position, left knee.

instrument to go under the fascia and detach the tissue, protecting the muscles. Using a knife, we take an oblong piece of fascia measuring approximately 2 cm wide and 3 cm long and place it in saline solution. We then suture the wound. We clean the subcutaneous tissue from the graft. Using a needle provider, we place sutures in the knee along the upper and lower edges of the meniscus in approximately the middle of the

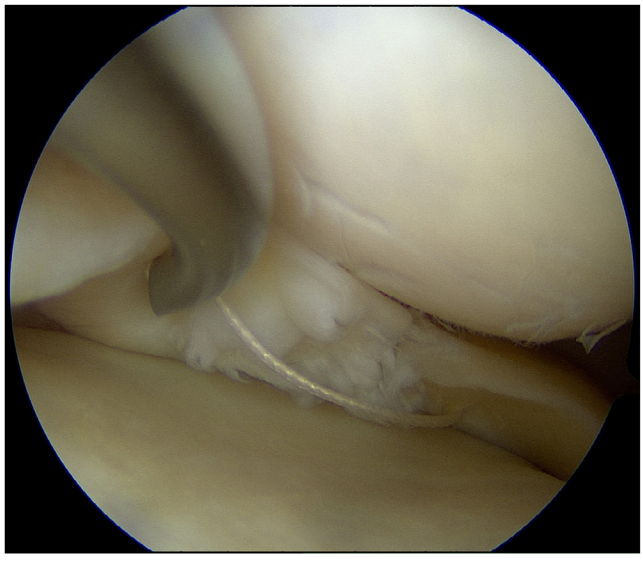

Fig 2. Horizontal sutures by inside-out technique to obtain early stabilization. We utilized a needle holder with a nitinol needle with a loop at the end to provide these sutures. Sutures are tightening on joint capsule and are made from nonabsorbable seams. View from the anterolateral arthroscopy portal. Patient in supine position, left knee.

Fig 3. Access for tightening inside-out sutures on the medial side of the knee. A skin incision of approximately 4 to 5 cm on the medial aspect of the joint capsule, followed by preparation of the subcutaneous tissue. Patient in supine position, left knee.

meniscal lesion. We then sew the other ends of these thread halfway along both long sides of the graft (Fig 5). Next, we insert the graft into the knee using these thread, pulling from the outside, and pull the graft onto the meniscus. Using the arthroscopic hook, we place the graft on the meniscus so that it covers the damage. We stabilize the graft with vertical inside-out sutures. We then place approximately 4 sutures, stabilizing the graft on the meniscus to ensure secure fixation (Fig 6).

We then proceed to cover the graft with the collagen membrane. Using a special arthroscopic device called a goat instrument, which is a tool designed by Aesculap Chifa especially for these types of operations (Fig 7), we insert the collagen membrane into the knee through one of the widened portals, open the goat instrument, and place the membrane on the graft from the fascia. The assistant holds the instrument with the membrane, and the operator then proceeds to apply the first staple.

We then place a vertical suture in the all-inside technique. We begin at the posterior section, piercing the needle through one-third of the membrane's length

Fig 4. Access for grafting of iliotibial band. Skin incision measuring approximately 5 cm long on the lateral side of the knee joint from the lateral epicondyle of the femur vertically upward along the long axis of the limb. We made an incision in the fascia and used a blunt instrument to go under the fascia and detach the tissue, protecting the muscles. Using a knife, we took an oblong piece of fascia measuring approximately 2 cm wide and 3 cm long and placed it in saline solution. Patient in supine position, left knee.

Fig 5. Preparation of iliotibial graft. The sutures should be placed in the medial portion of both of the long segments of the fascia. We used nonabsorbable sutures. Patient in supine position, left knee.

from the staple towards the femoral surface of the meniscus at the upper edge. Once we break through all layers, we secure the first staple anchor. Next, we move to the tibial surface on the lower edge of the meniscus and apply the second staple anchor. We then tighten the knot with a knot pusher implant and cut the thread. Similarly, we place a second vertical suture in the anterior portion of the implant. We secure the inserted membrane onto the meniscus using vertical and horizontal sutures in the inside-out technique, adding the necessary number of sutures (approximately 4 more) to ensure sufficient stability (Fig 8). We avoid dragging the thread across the membrane when tying the sutures to avoid cutting it. Next, we perform several bends and extensions of the knee (range 0-90°) to check the stability of the structure.

After making sure that the graft is in the correct position, we insert a biopsy needle into the intercondylar notch and collect a few millimeters of bone marrow (Fig 9). After drying the inside of the knee with a suction device, we use a camera-assisted dry arthroscopy to inject the bone marrow into the area of meniscal damage. Next, we close the surgical incisions.

Discussion

The primary advantage of the surgical technique described is the preservation and retention of the meniscus. The meniscus is crucial for the stability of the knee and the cushioning of the articular cartilage, and its removal significantly accelerates the process of knee degeneration.[6] Unfortunately, traditional meniscectomy, which involves the removal of meniscal tissue, remains the most commonly performed procedure in cases of damaged meniscus..[7] We want to offer a

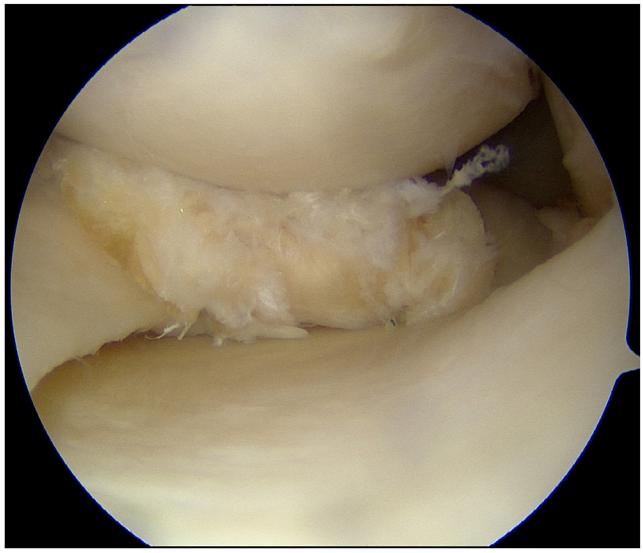

Fig 6. Fascia laid on meniscus. We inserted the graft into the knee using a thread, pulling from the outside, and pulled the graft onto the meniscus. Using the arthroscopic hook, we placed the graft on the meniscus so that it covered the damage. We stabilized the graft with vertical inside-out sutures. We then used approximately 4 sutures to stabilize the graft on the meniscus to ensure secure fixation. View from the anterolateral arthroscopy portal. Patient in supine position, left knee.

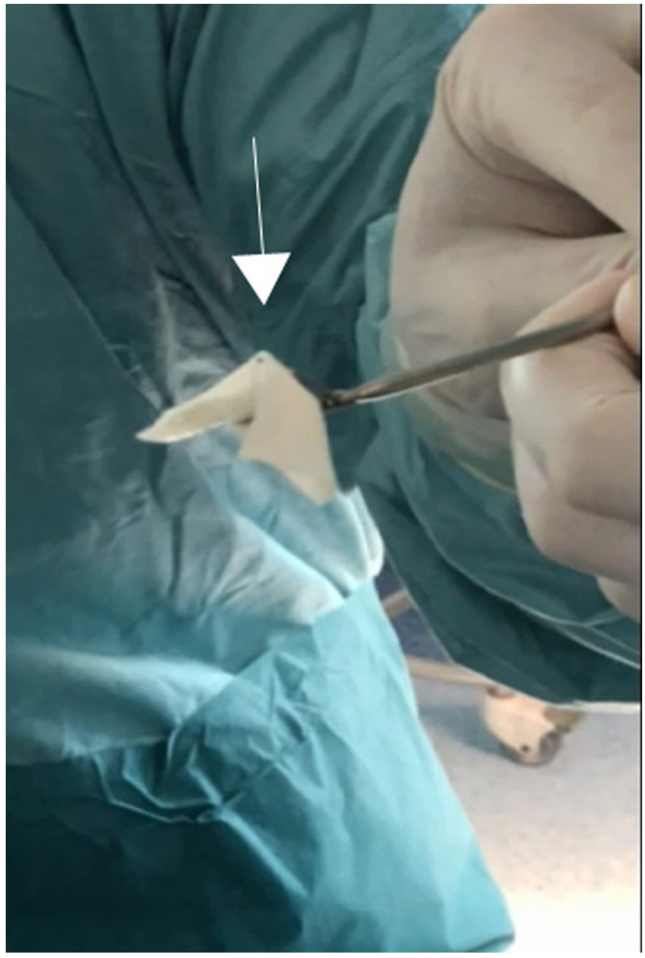

Fig 7. Goat instrument with collagen membrane ready for insertion into the knee. The membrane was impaled on the device. We inserted the collagen membrane through one of the widened portals, opened the goat instrument, and placed the membrane on the graft from the fascia. The assistant held the instrument with the membrane and the operator then proceeded to apply the first staple. Patient in supine position, left knee.

solution in difficult cases, in which most surgeons would decide to remove the meniscus.

Complex meniscal injuries are characterized by a loss of meniscal mass, which is associated with poor suturing results. The method used in these cases is removal of the meniscus followed by implantation of a meniscal substitute or allograft. This approach yields poor long-term outcomes, resulting in inadequate cartilage protection and the onset of degenerative changes.[8]

Our technique is based on three pillars: preliminary suturing of the meniscus, application of a fascia graft (scaffolding), and coating with a collagen membrane (biological reconstruction). Stable suturing of the meniscus is crucial for the proposed method. Only a stably stitched meniscus can regenerate and act as a shock absorber for the cartilage.

There are 2 main advantages of the proposed method. The first is the fascia graft, which creates a scaffold for the reconstructed meniscus. Complex meniscal injuries often involve loss of mass, and suturing alone does not provide adequate support for the knee because of the lack of a meniscal body. We use the iliopsoas fascia to rebuild the height and shape of the damaged tissue. This is taken from the patient, so we are using antigenically compatible material instead of allogeneic or artificial materials. From a surgical standpoint, iliopsoas fascia offers the advantage of easy and swift collection within the arthroscopic operating field, eliminating the need for expanding the surgical site. There is no risk of damaging important nervous or vascular structures. The graft is solid and quick to prepare. This material is successfully used in knee and shoulder surgery and has been shown to remodel into fibrocartilage.[9,10] Excision of part of the iliac fascia does not seem to cause much mechanical harm to the patient. Its role is to provide mechanical protection, thereby aiding in biological reconstruction.

The second advantage is the biological stimulation of healing of the meniscus by covering it with a collagen membrane. This membrane has 2 layers. The porous part is strongly adhesive, thanks to which it adheres well to the damage, and is also a scaffold for progenitor cells. The smooth layer is impermeable to these cells to prevent them from escaping into the joint cavity and also provides a lubricated surface for the cartilage. Collagen fibers create

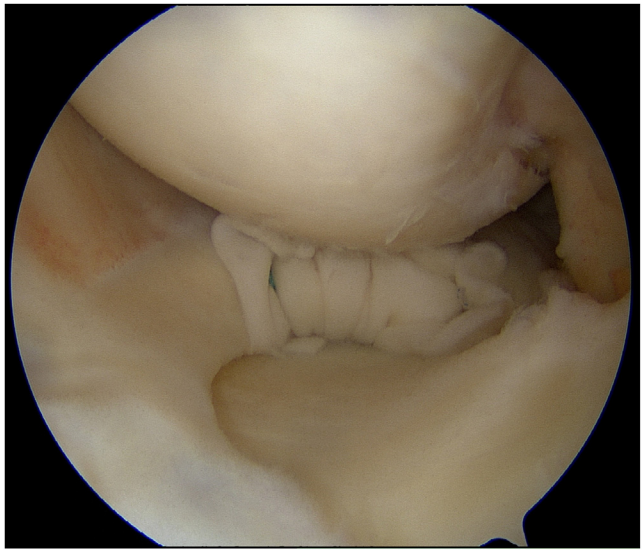

Fig 8. Collagen membrane laid on meniscus and fascia implant. We stabilized the introduced membrane on the meniscus with vertical and horizontal sutures in the all-inside and inside-out technique using the number of sutures necessary to ensure adequate stability. We avoided dragging the thread across the membrane when tying the sutures to avoid cutting it. View from the anterolateral arthroscopy portal. Patient in supine position, left knee.

a friendly space for cells from the synovial fluid to migrate and proliferate in the damaged zone. These cells are attracted to the matrix, which creates an ideal environment for them to settle in the nonvascular zone. This membrane has already been used successfully to treat the meniscus in the past[11,12] and has shown very good results.[13] The wrapping technique with graft and collagen membrane is already in use in some proven techniques.[3-5]

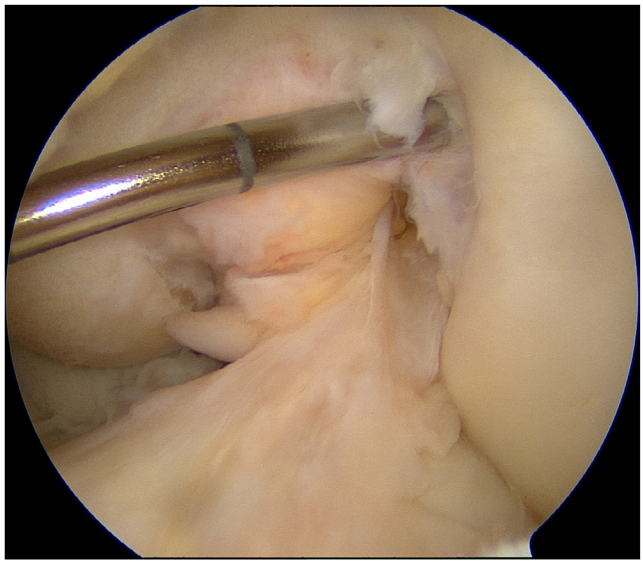

Fig 9. Bone marrow collection site. We inserted a biopsy needle into the intercondylar notch and collected a few millimeters of bone marrow. After drying the inside of the knee with a suction device, we used a camera-controlled dry arthroscopy to inject the bone marrow into the area of meniscal damage. We used a longer anesthetic needle for paravertebral anesthesia. View from the anterolateral arthroscopy portal. Patient in supine position, left knee.

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
1. Scaffold for meniscus (body mass from fascia graft) 2. Biological stimulation of healing via collagen membrane	1. Additional incision for graft harvesting 2. Cost of collagen membrane

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
1. Autologous transplant: A. Easy to take B. Without cost 2. Goat instrument to facilitate placement of the membrane in the knee 3. Three pillars of repair: suturing, scaffolding, and biological stimulation	Difficulties with sewing the fascia graft and membrane into the meniscus

The disadvantage of this operation may be technical difficulties, especially when introducing the fascia and collagen membrane into the knee. However, thanks to the proposed technique, and with qualified operational assistance, the risk of failure decreases. We think this method is simplified primarily by the use of the goat instrument, which makes the introduction of both the graft and the membrane much easier. Despite this, we think this is the most difficult part of the procedure. The clamp facilitates the implantation of these structures by ensuring the stable positioning of the membrane until the initial suture is placed. It also prevents the rotation of the membrane inside the knee, which would result in changing sides, and enables the entire procedure to be performed in classic wet arthroscopy.

We believe this technique will be the next step in improving meniscal rescue, joint preservation, and long-term cartilage protection. We have listed all the pros and cons of the proposed method in Tables 1 and 2.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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