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Meniscus tears and repair: assessing failure rates of all-inside and outside-in methods

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ABSTRACT

Meniscal repair procedures are on the rise due to an enhanced understanding of the adverse long-term effects associated with the loss of meniscal tissue. Although meniscal repair has a higher reoperation rates compared to meniscectomy, recent systematic reviews indicate improved long-term outcomes with meniscal repair. Even though there are a lot of studies that compare the results of all-inside and inside-out techniques there are only few that evaluate all-inside and outside-in approaches. This study aims to review the relevant literature on the epidemiology, mechanism of injury, clinical presentation and imaging of meniscus and to compare the failure rates and time to failure of AI and OI meniscal repairs. PubMed and Scopus were searched for studies published between January 2014 and January 2024 reporting on meniscus repair outcomes using "outside-in" or "all-inside" techniques with a minimal duration of 6 months for follow-up. Failure was characterized as the recurrence of clinical symptoms or the need for a meniscal reintervention. Over 50 English-language articles were analyzed between 2000 and 2022. After conducting a review and data analysis, it is observed that the "all-inside" technique is more frequently chosen as a treatment method, possibly due to its simpler execution. Both total and percentage rates of failures are higher using this technique, amounting to 79 cases and reaching 16%, compared to "outside-in" approach, which is less commonly chosen, but has lower frequency of failures totaling 6 cases and 5%.

Keywords: Knee, Arthroscopy, Meniscus

INTRODUCTION

This paper discusses meniscal surgical treatment outcomes and failure rates after a minimal period of 9 months postoperatively and to overview the relevant literature on epidemiology, mechanism of injury, clinical presentation and imaging of meniscus. It is important to assess the success rate of meniscal repair as menisci used to be called functionless remains of muscles that stabilize the knee. Now there is a rise in recent decades of many investigations that describe menisci as irreplaceable anatomical structures of the knee.[2] Menisci are highly susceptible to sports injury and age or disease-related degenerative abnormalities as over a million patients undergo surgical suturing of the meniscus or meniscectomy annually in the U.S. alone.[3] Tears in the vascularized outer third part of the meniscus can be surgically repaired during arthroscopy, although tears in the inner avascular region are hardly repaired due to poor intrinsic healing capacity and frequently extend into the middle-third region followed by meniscus degenerative changes.[4] To relieve the symptoms caused by such irreparable meniscus injuries, partial or total meniscectomy is often performed. However, meniscectomy significantly increases the incidence of osteoarthritis.[5] Biomechanical studies revealed that the decrease in intra-articular contact area followed by a meniscectomy causes elevation in the peak contact

pressure and as a result the risk of osteoarthritis.[6,7] The main objective of meniscal repair is to rebuild anatomy as closely as feasible to natural physiology to restore normal biomechanics.[8] Despite the anatomy of collagen fibers, the best method for treating a meniscal injury depends on the kind of tear, where it is located, the meniscal vascularity and concomitant injuries. It has been reported that 10%-20% of meniscal tears and 30% of longitudinal tears are suitable for repair.[6]

It is thought that the optimal choice for meniscal healing is longitudinal vertical wounds in the periphery. Methods, such as "inside-out," "inside - in," and "all inside" are utilized for meniscal repairs.[9] Meniscal repair using "inside-out" sutures has been considered the best option in terms of successful meniscal healing. The method is more technically demanding, more time-consuming, and has been described as suboptimal for managing frequently encountered posterior horn tears. The "Inside-out" technique is associated with higher rates of injury to the saphenous nerve during medial meniscal repairs and the common peroneal nerve during lateral meniscal repairs. It demonstrated that the sutures tied on the posterior capsule were reported to lead to flexion contractures.[10]

Using "inside-out" meniscus repair techniques necessitates an extra surgical assistant to handle the passage and retrieval of the "inside-out" needle, along with making incisions for safeguarding the posterior knee structures and securing the sutures. In contrast, with "all-inside" meniscus repair, the risk of nerve entrapment during suturing, as seen in "inside-out" or "outside-in" meniscus repairs, is nearly eliminated. Furthermore, the additional incisions required for suture tying in "inside-out" and "outside-in" meniscus repairs heighten the risk of wound infection.[11]

As no consensus on the best approach to repairing meniscus tear has been made, researchers and practitioners are calling for the development of novel repair techniques and studies that compare the performance between different techniques so that evidence-based decisions on the optimal approach can be made.[9,12]

LITURATURE RESEARCH

PubMed and Scopus were searched for studies published between January 2014 and January 2024, reporting on meniscus repair outcomes using “outside-in” or “all-inside” techniques with a minimal follow-up duration of 6 months. The search terms used for this study were [meniscus OR meniscal] AND [repair] AND/OR [failure] AND [all-inside] OR [outside-in]. Published abstracts, narrative reviews, articles not written in English, commentaries, study protocols, and topics not focused on the meniscus were excluded. Four articles met the inclusion criteria and were identified.[13-15] To assess the success of the surgery, the number of unsuccessful operations was determined. Failure was characterized as the recurrence of clinical symptoms or the need for a meniscal reintervention, involving either repair or resection of the meniscus. Additionally, a literature review was conducted in the mentioned databases for articles published between 2000 and 2022. Articles were selected using the following keywords or a combination of keywords: [meniscus] AND/OR [meniscus diagnostics] AND [injury] OR [meniscus suturing]. Over 50 English-language articles were analyzed, and the most relevant and publishable scientific articles were chosen to illustrate the epidemiology, mechanism of injury, clinical presentation, diagnostics, images replicating meniscus tears, and suturing techniques for meniscus repair.

EPIDEMIOLOGY

The frequency of meniscal injuries is rising as participation in sports is increasing as well. Technological advances and availability of imaging technology such as MRI increase the accuracy of diagnostics. Professional occupations that require frequent squatting/kneeling, and sports such as soccer, rugby, football, basketball, baseball, skiing, and wrestling all increase the risk of meniscal tears. It is also known that male gender and age over 40 y/o are also associated with an increased risk of meniscal tears.[17]

Medial meniscal tears are more frequently injured in comparison than lateral meniscal tears. The reason behind this may be the relatively decreased mobility of the medial meniscus secondary to its connection to the medial collateral ligament.[17,18] Medial meniscal tears are more common than lateral meniscal tears, possibly due to the relatively decreased mobility of medial meniscus secondary to its connection to the medial collateral ligament.[19]

MECHANISM OF INJURY

Meniscal injuries often cause pain in the knee area and limit the range of motion, impeding normal daily or sports activities.[20] The menisci are usually injured by a noncontact mechanism caused by sudden deceleration or acceleration combined with the patient changing direction-these are called 'cutting manoeuvres.' Cutting maneuvers are described as a sudden change of direction. A meniscal tear can be caused during activities and sports that include jumping and induce angular momentum together with femoral tibial rotation. Any radical rotation of the tibia together with varus, or hyperextension pressure to the knee can cause the injury of menisci. One of the most often leading events to meniscal injury is an anterior cruciate ligament (ACL) tear or a buckling of the knee. Other causes of meniscal injury may also occur either as a result of contact stress or, for the older population, from degenerative changes with little to no traumatic events.[21]

CLINICAL PRESENTATION

Patients with meniscal injuries often present with a history of knee injury involving sudden twist, change in direction, jumping, pivoting or deep knee flexion that are often

encountered in knees with ACL rupture. During examination there are abnormal findings consisting of tibiofemoral joint line pain on palpation, pain during full flexion and full extension. Positive McMurray test can reveal crepitus, clicking and pain.[18] Pain typically manifests immediately after the injury event and is concentrated on either the medial or lateral side of the knee. It may extend to adjacent areas along joint line due to associated collateral ligament sprains. In case of degenerative tears, onset of pain and swelling can be gradual rather than acute, and there might be a delay of up to a day.[19]

DIAGNOSTICS

There are many clinical tests for diagnostics of meniscal injuriers. One of them is McMurray's test, during which the joint is moved passively from flexion to extension while internally and externally rotating. Test is interpreted as positive when a noticeable click occurs on the joint line.[22,23]

Another test used for diagnostics of this pathology is Apley's grind test that is conducted with the patient lying prone and the knee flexed to 90 degrees, with compression of the tibiofemoral joint causing pain and joint distraction resulting in reduced pain.[24] True locking of the knee may occur in the case of a displaced bucket handle tear, causing the inability of the patient to extend their knee fully due to a mechanical obstruction.[3]

The diagnosis has to be made by combining clinical information and radiological images. The treatment plan must be personalized as the severity of symptoms often does not directly correlate with the type and location of the tear. Though a detailed history and clinical examination may not always lead to a definitive diagnosis, radiographic and arthroscopic evaluations are necessary for confirmation. While traditional clinical tests like McMurray's, Apley's, and Thessaly's have been recommended for diagnosis, their accuracy and reliability remain poor. Plain radiographs are not suitable for routine evaluation of meniscus tears and should only be used in specific conditions, such as chondrocalcinosis.[25]

MRI remains the preferred imaging method, with high sensitivity (93%) and specificity (88%) for diagnosing meniscus tears. On an MRI, meniscal tears typically appear as a linear signal extending from the meniscal substance to a free edge. Diagnostic arthroscopy without therapeutic intervention is not advised.[3]

IMAGES REPLICATING MENISCUS TEARS

Recognizing potential misinterpretations is crucial as normal knee structures can mimic meniscal tears. For instance, the anterior horn of the lateral meniscus may have a normal striated appearance near its anterior root attachment and it must not be mistaken for a tear as the higher intensity signal may replicate the look of the tear.[27]

The anterior transverse ligament connecting the anterior horns of the lateral meniscus and medial meniscus may exhibit high signal intensity, creating a tear-like appearance between the ligament and the lateral meniscus anterior horn. Moreover the popliteal hiatus with a regular capsular opening through which the popliteus tendon enters the knee joint lies superficially to the posterior horn of the lateral meniscus. The main anchoring fascicle of the lateral meniscus becomes visible along the hiatus's medial margin in the sagittal plane, further simulating a tear of the posterior horn.[27]

"OUTSIDE – IN" TECHNIQUE

Initially, a diagnostic arthroscopy is conducted using standard anterolateral and anteromedial portals to confirm and assess the meniscal pathology along with any concurrent issues. Once the anterior horn tear is verified, the arthroscope is then directed through the portal on the opposite side of the compartment containing the affected meniscus to observe the tear's extent and characteristics. A small vertical incision is made aligned with the portal on the same side as the anterior meniscal tear. To begin the outside-in repair, a spinal needle is introduced by piercing the overlying capsule, advancing it under the anterior edge of the injured meniscus and through the body of the anterior horn, thus traversing the area of the tear. After that, the inner cannula of the needle is removed, and a suture is placed through the needle and into the joint. Likewise, a second needle is threaded through the capsule beneath the front edge of the meniscus, traversing the body of the anterior horn. Once more, the inner cannula is taken out, and a looped suture retriever is guided through the second needle into the joint. Using a grasper, the free end of the previously inserted PDS suture is drawn through the looped retriever, and the suture is then pulled back out of the knee.This process creates a mattress suture construct, effectively securing the anterior horn. Multiple sutures can be added to strengthen the construct, depending on the injury. Both horizontal or vertical mattress sutures can be used.[28]

"ALL-INSIDE" TECHNIQUE

The "all-inside" technique is usually used for more posterior tears, while the "outside-in" approach is used for more anterior tears. The "all-inside" approach is superior to "outside-in" for posterior tears as it poses less risk for injury to popliteal structures and does not require an assistant and an additional incision. Various "all-inside" devices have been used, with early generations consisting of a rigid device and newer devices being suture-based.[29]

After preparation of the surgical repair site, the surgical probe is introduced through the accessory portal and remains there for the duration of fixation. The repair device of choice is introduced through the anterior portal and is directed to the site of fixation. The surgical probe acts as a guide, with the elbow of the probe providing a cradle to direct the instrument to the correct position at the

repair site. Once in position, the probe can be used to manipulate the meniscal tissue and allow entry of the large-bore repair device.

Once the meniscus is penetrated, the probe acts to reduce the meniscus to its origin. After deployment of the first anchor, the probe again guides the tip of the device around the condyle to a vertical position to allow for either a superior-surface or under-surface vertical mattress suture. Next, the second anchor is deployed, and the suture is tightened. The next step can be critical in the setting of questionable or thin meniscal tissue. The probe is used inside the adjustable loop of the vertical mattress suture to protect the suture from cutting through the meniscal tissue during tightening. Finally, fixation is secured, and the suture is cut. The meniscus is sutured posteriorly to anteriorly with sequential superior and undersurface mattress sutures to recreate the normal position of the meniscus and reestablish the meniscal flounce sign.[30]

RESULTS

After reviewing four articles published since 2014, a total of 702 cases were identified.[13-16] The average follow-up period from surgery to postoperative evaluation was four years. Among the identified patients, 122 lateral and 571 medial meniscus surgeries were performed. The "all-inside" technique for meniscus surgery was performed 487 times, while the "outside-in" technique was performed 126 times. Both the total and percentage rates of failures using "all-inside" accounted to 79 cases and reached 16%, compared to "outside-in" approach totaling 6 cases and 5%.

DISCUSSION

Fixing a torn meniscus is now commonly done through meniscus repair, a preferred treatment over removal. This change is due to a better understanding of the meniscus's role in how our knees work. Various techniques exist for treating meniscal tears, such as the "outside-in", "inside-out", and "all-inside" methods. The "outside-in" technique, developed in 1985, is a widely used procedure for treating tears. It involves small incisions, carries a low risk of complications, and has a high success rate, especially for tears in the front two-thirds of the meniscus.[30] However, a downside to the outside-in method is the need for an extra 1-2 cm skin incision and tying knots under the skin over the capsule.[31] The "all-inside" technique is another option with good results, but it's not as commonly used because it can be expensive and sometimes lead to nerve or blood vessel issues. There are only a few reports of its use, even for tears in the back part of the meniscus, because it requires larger cuts around the knee and more complex needle and instrument maneuvers.[32] It is evident that factors such as various factors such as location of the injury, duration of operation, repair type, medial or lateral location, and ACL status have impact on the failure rate as indicated by the currently available literature.[33]

CONCLUSION

After conducting literature overview, such conclusions can be made: the prevalence of meniscal repair procedures is increasing, driven by a deeper understanding of the detrimental long-term consequences linked to the loss of meniscal tissue. An elevated risk of meniscal tears is evident in males and individuals aged over 40, particularly in specific professions requiring kneeling and certain sports involving cutting maneuvers. While patients commonly report joint line pain, the onset of painful sensations can be delayed. It is crucial to emphasize that the diagnosis should integrate both clinical presentation and radiological findings. Although the "outside-in" technique is selected less frequently, its failure rate is significantly lower, totaling six cases and constituting only 5% while the "all-inside" approach demonstrates a 16% failure rate on average.

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