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Review

Meniscal Tear Management Associated with ACL Reconstruction

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Abstract: Meniscal lesions often occur in association with anterior cruciate ligament (ACL) tears at the moment of the injury or, secondarily, as a consequence of knee instability. Both ACL and meniscus lesions are associated with a higher risk of osteoarthritis. Adequate treatment of these lesions reduces the rate of degenerative changes in the affected knee. Meniscal tears should be addressed concomitantly with ACL reconstruction and the treatment must be oriented towards preserving the meniscal tissue anytime this is possible. Several options for approaching a meniscus tear are available. The meniscal suture should always be considered, and, if possible, meniscectomy should be the last choice. "Masterly neglect" is a valuable option in selected cases.

Keywords: meniscus; ACL; meniscectomy; leave in situ; masterly neglect; meniscal suture; ramp lesion; meniscal root; ACL reconstruction

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1. Introduction

Meniscal injuries often occur in association with ACL injuries (incidence of 55–80%). The incidence of concomitant appearance of these lesions is higher in chronic instabilities than at the time of the initial trauma [1–5]. In association with an acute ACL lesion, their incidence varies (25–45% for the medial meniscus and 31–65% for the lateral meniscus) [6–8]. If left untreated, these tears increase in complexity and become less repairable over time, especially on the lateral side [7–10].

Patients with chronic ACL ruptures can develop consequent functional instability. If ACL reconstruction is not performed, secondary meniscal injuries may occur. Their incidence increases as the time pass from the initial trauma (about 40% after one year, over 60% after five years, and over 80% after ten years) [11,12]. Medial meniscus tears are more frequently associated with chronic ACL insufficiency [13,14].

Isolated ACL or isolated meniscus injuries are already associated with an increased risk of OA [15]. Concomitant meniscal and ACL tears are even stronger predictors for knee osteoarthritis (OA) that may be present in 60–90% of these patients after 10–15 years from the initial trauma [10,16,17].

Results after ACL reconstruction are worse in terms of patient satisfaction if a previous meniscectomy was performed or if a concomitant lateral meniscectomy (partial or total) is performed [18–21]. Initial meniscus damage increases the risk of OA by at least 3.54 times [15]. Delaying ACL reconstruction for more than six months increases the risk of secondary lesions or progression of initial lesions (meniscus/cartilage) [17,21–23].

To reduce the interval between the traumatic event and surgery, both a correct and early diagnosis and effective recovery after the initial trauma is important [5,17,21,24,25].

In combined ACL and meniscus lesions, the best option for both lesions, tailored to the needs of the patient, should be considered.

2. Therapeutical Options for Meniscal Lesions with Concomitant ACL Reconstruction

The treatment of meniscal tears has evolved in the last 30 years from open surgery to arthroscopy, from total to partial meniscectomy, and, in recent years, towards preserving meniscus techniques-leave in situ (masterly neglect) or meniscal repair (suture) [21].

2.1. Meniscectomy Associated with ACL Reconstruction

Meniscectomy (partial, total) was the preferred treatment for many years because of its benefits, namely the fact that a low rate of early complications and no short or medium-term re-arthroscopy is required (such as in failed sutured menisci lesions) [1,26,27]. After meniscectomy, patients generally require significant less time for recovery than after meniscus repair [28].

Unfortunately, meniscectomy is associated with disadvantages such as inferior results in terms of patient satisfaction with long-term pain, episodes of joint effusion, and a higher risk of OA [18,26,29]. Partial meniscectomy is better tolerated and has superior clinical results compared to total meniscectomy with a superior quality of life [18,30–34].

The meniscus has an important biomechanical role being the secondary stabilizer to the anterior translation and rotatory stability, after the ACL [35–39]. Therefore, in ACL deficient knees, meniscectomy can alter the loading patterns, increase the focal contact pressures, and accentuate the symptoms of instability [26,39].

Fortunately, in the treatment of meniscal lesions, partial meniscectomy decreased in frequency as our knowledge progressed and as the repair techniques improved. However, there is still room for improvement [40].

Partial meniscectomy in association with an ACL reconstruction can still be considered if other meniscal preservation techniques have a reduced chance of success [40,41]. Usually, meniscectomy is reserved for degenerative meniscal tears, ruptures in the white-white region of the meniscus, complex ruptures, and chronic displaced ruptures with plastic deformation [40].

Meniscectomy without ACL reconstruction should be performed only as an exception if all four of the following criteria are met: (1) symptomatic meniscal tear; (2) irreparable meniscal tear; (3) no significant knee laxity on clinical examination; and (4) elderly or inactive patient or refuses ACL reconstruction [40].

Lateral meniscus meniscectomy is associated with a higher risk of OA than medial meniscus meniscectomy, mainly due to the difference in the concavity of the two tibial plateaus [20,42,43]. Furthermore, the progression of OA depends on the amount of meniscal tissue that has been removed [44,45]. The Moon and Mars Groups studies showed that meniscectomy of more than 33% of the lateral meniscus at the time of ACL reconstruction determined a 17× increase in the damage progression of the lateral compartment articular cartilage [43]. This increased risk is significantly lower after a similar loss of the medial meniscus [21,42].

Worse results have been reported after lateral than after medial meniscectomy. [43]. This is due to anatomical and biomechanical reasons: the lateral meniscus carries more load in the lateral compartment than the medial meniscus does in the medial compartment (70% vs. 50%) and the lateral knee compartment is less congruent than the medial one [44].

In professional athletes who underwent partial lateral meniscectomy, a significantly delayed return to sports has been noted along with more adverse events such as persistent pain and joint effusion than those undergoing partial medial meniscectomy. This has led to a higher likelihood of further arthroscopic procedures and a higher rate in resuming sporting activity [45–47]. Radiographic deterioration and faster knee osteoarthritis progression were more frequent after lateral than medial meniscectomy [48–51].

Due to the high rate of OA progression after meniscectomy and ACL reconstruction, preserving the meniscus should be the first option when treating these knees and, if meniscectomy cannot be avoided, the minimal amount of meniscal tissue should be removed [52–55].

2.2. Masterly Neglect (Leaving In Situ) Associated with ACL Reconstruction

Healing of a meniscus lesion, without performing any type of procedure, is possible in certain conditions [56]. Lateral stable meniscal tears, left in situ (untreated), can heal in a high percentage of cases, avoiding the complications related to meniscectomy or suture but this happens only if the ACL is reconstructed [52]. If the ACL deficient knee is not stabilized, these stable meniscal tears will progress in size over time and become symptomatic [52].

There are strict indications for leaving the meniscus "in situ" or "masterly neglect": stable, complete longitudinal ruptures, less than 10 mm long [52]. This type of meniscal rupture, especially if associated with recent trauma, usually doesn't generate mechanical symptoms, and heals spontaneously in the vast majority of cases [1,52,57–60]. Lateral stable meniscus tears seem to heal better than medial tears if left in situ and therefore they are the best candidates for this type of approach [1,60–63]. Ramp lesions are a special category and will be treated separately.

2.3. Meniscal Repair Associated with ACL Reconstruction

When deciding what meniscal ruptures should be repaired, we must consider both rupture characteristics (size, appearance, acute vs. chronic, location) as well as general factors (age, activity level, knee stability, alignment) [1].

Although the repair rate is still low and there is a mismatch between the repairable meniscal tears (30%) and the number of performed repairs (4–10%), there is a visible trend toward surgical repair in the last 15–20 years [1,64–66].

The best indication for suturing is an unstable, vertical, longitudinal rupture located in the peripheral region (red-red zone) of the meniscus. Since the tissue is of good quality and well-vascularized, the healing rates are higher and the benefit the greatest [41,67]. The vertical longitudinal ruptures can be easily reduced and are ideal for the placement of vertical sutures [67].

Meniscal repair has significantly higher success rates in early stabilized knees if performed early after trauma (<12 weeks). A repaired meniscus also provides better outcomes in ACL reconstructed knees. When repair is required, surgery should be performed as soon as possible to maximize the suture success rate and reduce secondary damage [1,5,68–70].

Therefore, the general rule is to perform reconstruction of the ACL and the meniscal suture simultaneously. A possible exception/alternative could be a non-reducible bucket handle tear in an inflamed knee with a subacute ACL tear. A two-step approach may be the best option to reduce the risk of arthrofibrosis if one-stage surgery cannot be performed [1,71,72].

If the two-stage approach is chosen, the ACL reconstruction should be performed as soon as possible (weeks) after full ROM is obtained and the knee is no longer inflamed due to the increased risk of re-rupture of the repaired meniscus (1% for each month after the first surgery) [1,73].

Arthroscopic meniscus repairs have become part of the routine, open surgery being performed exceptionally for specific cases. Initially, the inside-out technique has been considered the gold standard for meniscal repair [74], till outside-in and all-inside techniques were developed. Currently, the newer generation meniscal repair devices exhibit biomechanical properties similar to inside-out sutures [74–76].

First-generation all-inside repair devices were rigid and had high failure rates and produced articular cartilage damage. Therefore, they became unsuitable for meniscal repair [74,77]. The presently preferred all-inside systems are the flexible suture- and anchor-based repair devices which are used for the management of tears located at the posterior horn and body of both menisci. They are built with dual anchors connected by a pre-tied, sliding, and self-locking knot, allowing for appropriate tensioning across the meniscal tear The anterior horn is better approached with an outside-in technique [78].

The ideal suture for meniscal repair should have a high load to failure to prevent detachment, high stiffness to prevent deformation, and low displacement to avoid suture elongation [79,80]. New biomaterials are better engineered to provide optimum strength and absorption profile [80].

Meniscal sutures have a higher load to failure and greater stiffness properties than meniscal repair devices [81]. With respect to the suture material, the top suture repairs were vertical sutures performed with PDS 0, Orthocord 00, Ethibond 0, FiberWire® and FiberTape®. FiberTape seems to be the strongest and stiffest material with the lowest elongation rate [79,82].

With regard to the devices, second-generation devices were significantly stronger and stiffer than first-generation devices (Meniscal Viper (Arthrex, Munich, Germany), MaxFire (Biomet, Warsaw, IN, USA), and FasT Fix (Smith&Nephew, London, UK)) [74,75].

Modern meniscal suture devices make repairs more feasible by increasing accuracy, speed and reproducibility. Newer devices with a backstop may be used in tears that are more peripheral [83]. Each particular technique and suturing device has its particular learning curve and potential pitfalls. The surgeon must maintain a flexible approach to meniscal repair to optimize results [81,83].

It seems that there is no difference between the use of absorbable sutures and the use of non-absorbable sutures, and the use of absorbable materials in all-inside meniscal repair devices should have no impact on clinical healing [84].

3. Management of Specific Types of Meniscal Lesions Associated with ACL Reconstruction

3.1. Ramp Lesions

Described in 1988 by Michael Strobel, the "ramp" lesions are a particular type of meniscal lesion involving the peripheral portion of the posterior horn of the medial meniscus [85].

This pathology is frequently associated with ACL ruptures (9–24%) and has been historically underestimated. Ramp lesions are often missed since they are usually located in a posteromedial "blind spot", visually accessible only through the trans-notch Gilchrist-visualization technical maneuver and due to the low sensitivity of preoperative MRI [86].

If a meniscal ramp lesion is suspected, an additional posteromedial portal should be created for better evaluation [87]. Soft tissue debridement could aid the identification of hidden lesions under an intact capsule [88]. Therefore, ramp lesions should always be verified through systematic exploration, and repair should be performed if necessary. Failure to recognize and repair a ramp lesion contributes to residual anteroposterior instability in the ACL–reconstructed knees and worse results [86,89–91].

Ramp lesion repair is correlated with significantly better biomechanical results and outcomes (reduce our percentage of secondary meniscectomy) [92,93], regardless of the technique [88–90]. Needling/trephination of a recent injury can be also a valuable option in short, stable lesions [94].

3.2. Meniscal Root Tears

Meniscal root tears are defined as bony or soft tissue attachment avulsion injuries or radial tears within 1 cm from the anterior or posterior tibial attachments of the menisci [95–97]. Meniscal root tears (10–21% of all meniscal ruptures) were historically frequently overlooked or treated with meniscectomy [95].

Due to the important role of the menisci as secondary stabilizers of the knee, the rupture of one of their attachments has a strong impact on their biomechanical role in the joint and, if left untreated, leads to the rapid development of knee OA [97]. Functionally, this type of meniscal rupture is equivalent to a total meniscectomy [97,98].

Therefore, repair of meniscal root tears should always be performed if possible, the gold standard being the trans-tibial pullout technique with anatomic reduction and fixation of the meniscus. A horizontal suture may be an option in some radial tears [99].

Meniscectomy in case of root tears is an option to consider only if the patient has diffuse Outerbridge grade 3 or 4 (a very rare condition in patients with ACL reconstruction), osteoarthritis of the ipsilateral compartment, non-symptomatic chronic meniscal root tears, and/or significant limb malalignment unless concurrently corrected [100,101].

The incidence of meniscal root tears at the time of ACL reconstruction is high −15.5–31% and even higher in revision cases, with four times more tears on the lateral than the medial side [101–103].

Postero-lateral meniscus root tears are frequently associated with ACL tears in a traumatic context and should be repaired concomitant with ACL reconstruction because it plays an important role in stabilizing the knee in both anterior tibial translation (ATT) and during pivoting activities [1,104–106]. However, root refixation has some limitations, such as a low cure rate evidenced by MRI, poor reduction of meniscal extrusion, and limited evidence of long-term efficacy to prevent osteoarthritis [106].

Medial meniscus root tears are usually degenerative, and their prevalence has been reported to be 9.1% [106–108]. Even so, they should also be repaired because of the better results and slower progression of OA compared to meniscectomy [1,108].

4. Biological Augmentation of Meniscus Healing

Augmenting the healing process after the meniscal suture has been of great interest in recent years, with a lot of research being carried out [1,109,110].

It has been shown that the meniscal repair concomitant with ACL reconstruction positively affects meniscus healing [1,28,111,112]. This may be explained by biological factors (platelet-derived growth factor, insulin-like growth factor and vascular endothelial growth factor) released while drilling the bone tunnels [62,113,114].

The use of platelet-rich plasma (PRP) [115,116], fibrin clots, marrow stimulation, and mesenchymal stem cells (MSC's) have shown preclinical success. However, the clinical efficacy and safety of biologic augmentation for arthroscopic meniscal repair, although promising, remain controversial [109,117,118].

The current level I evidence does not support PRP augmentation when performing arthroscopic meniscal repair [110,117,119]. Furthermore, it seems that PRP does not reduce the risk of meniscal repair failure in the setting of concomitant ACL reconstruction [120], suggesting that bleeding after bone tunnel drilling provides sufficient growth factors [121] and that additional administration of PRP is unnecessary [1].

Although several fibrin clot augmentation techniques were described in the last decade [122,123], they do not have sufficient high-quality evidence to support their routine use at this time [124,125] and therefore further confirmatory studies are needed to support this procedure.

Mesenchymal stem cells (MSCs) are used to enhance the ability of healing the meniscus [110] since they have a high proliferative [126] and chondrogenic potential [127]. Therefore, they are attractive for meniscal repair [128]. There is no evidence that they can form meniscal similar to primitive human meniscus in the human body [129]. Therefore, more in-depth research is needed.

There are no studies to back up the use of fibrin glue to enhance meniscus healing. Applying it locally may be considered but this is not currently recommended (especially if concomitant ACL reconstruction is performed) [1].

Although patient reports after repair with biological augmentation show some improvements in functional outcomes scores, the benefit over standard repair remains questionable [109].

5. Conclusions

The treatment of meniscal ruptures in the knees with an ACL rupture should be approached individually, according to the specific context for each rupture and each patient. The decision upon surgical or non-surgical treatment should be carefully made in the patient's best interest.

The main goal is to preserve the meniscus substance, maintain its functionality as much as possible, reduce the progression of osteoarthritis, and improve knee stability.

ACL reconstruction and meniscal surgery should be performed simultaneously. Separate interventions for these two lesions should be avoided.

Short and stable ruptures in the peripheral zone can be approached with a "masterly neglect" attitude, especially in acute settings but only in patients which are undergoing simultaneous ACL reconstruction.

Unstable vertical longitudinal peripheral ruptures without degenerative changes can usually be successfully sutured with current techniques that should be performed at the time of ACL reconstruction.

Unfortunately, many meniscal ruptures of the knees with concomitant ACL tears still require partial meniscectomy for various reasons.

As techniques improve and as we better comprehend the biological factors that increase meniscal healing, we hope to succeed in preserving more menisci in the future.

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