



MENISCUS AND CARTILAGE RESTORATION

– Written by Peter Verdonk, Belgium

Injuries to the articular cartilage may be caused by acute trauma, chronic micro-trauma, chronic instability, malalignment and meniscus deficiency. In recent years it has been established that only a minority of these articular cartilage lesions actually occur in isolation due to a traumatic event. The majority occur in conjunction with a deficiency of – or trauma to – another important tissue within the same knee joint, such as the meniscus or cruciate ligament, or in the presence of a significant malalignment of that joint, such as a varus or valgus alignment.

As techniques of cartilage repair have continued to develop and improve it has also become clear that the outcome of such advanced cartilage treatments are inferior if the concomitant meniscus defect, rupture of ACL or malalignment have not been

addressed. In the author's clinical experience, treating articular cartilage lesions needs an algorithmic approach, evaluating not only the size, location and age of the lesion itself, but also examining alignment, the status of the cruciate ligaments and the meniscus in order to obtain a successful outcome for that patient.

SOME IMPORTANT CONSIDERATIONS AND OBSERVATIONS

The incongruity between the rounded femoral condyles and the comparatively flat tibial plateau is accommodated by the meniscal surfaces. The menisci function to significantly increase the contact area in the femorotibial joint, thereby reducing the stresses on the articular cartilage. In a loaded in-vitro situation, 70% and 50% of the loads in the lateral and medial compartments

respectively, are transmitted through the corresponding menisci, reflecting their proportion of coverage of the respective compartment. After removal of the menisci, contact areas in the femorotibial joint are largely reduced and the peak stresses on tibial cartilage considerably increased. The load-distributing function of the menisci is made possible by their strong anterior and posterior entheses to the tibia, which prevent the menisci from extruding from the joint during axial loading. Joint loading will tension the insertional ligaments and also the circumferential fibres of the meniscus. Thus part of the axial load will be transformed into hoop stresses at the meniscal periphery.

The decrease in contact area, and subsequently the increase in peak stresses on the tibial plateau after meniscal



transection, are regarded as the main reason for the frequent bone and cartilage changes found after meniscectomy.

The important function the meniscus plays is reflected in several clinical scenarios. A root tear of the medial meniscus is often associated with a dramatic acute increase in stress on the articular cartilage and often results in a rapid onset of cartilage degeneration and subsequent osteoarthritis. Another scenario is lateral meniscectomy, followed by swelling and pain in the involved compartment, finally resulting in a large cartilage lesion on the lateral femoral condyle known as rapid chondrolysis. Although both acute scenarios are rare, they do clearly illustrate the importance of the meniscus for the health of the articular cartilage.

Most often, the orthopaedic surgeon will be confronted with a patient presenting a symptomatic cartilage defect who has previously had a meniscectomy or cruciate lesion (the chronic scenario). Chronic deficiency of the meniscus is frequently minimised in the analysis and treatment of the clinical problem, leading to the isolated treatment of the cartilage defect, thus neglecting the meniscus deficiency and resulting in an inferior clinical outcome.

In both of these scenarios – acute and chronic – the importance of the alignment cannot be underestimated. Cartilage and meniscus damage can be accelerated in the presence of a malalignment of the lower limb. The renewed interest in a corrective osteotomy is largely inspired by frustration at the inferior clinical outcome after isolated cartilage and meniscus repair operations. Indeed, over the past few years it has become clear that in the malaligned knee joint, there is no place for isolated cartilage or meniscus restoration unless the malalignment is also corrected by an osteotomy. This observation is of major importance to the athlete and more specifically, to soccer players who often present with a varus malalignment. Although cartilage repair can be successful in the varus knee, most clinical series show that this effect is only temporary – leading to a reduced sports career duration.

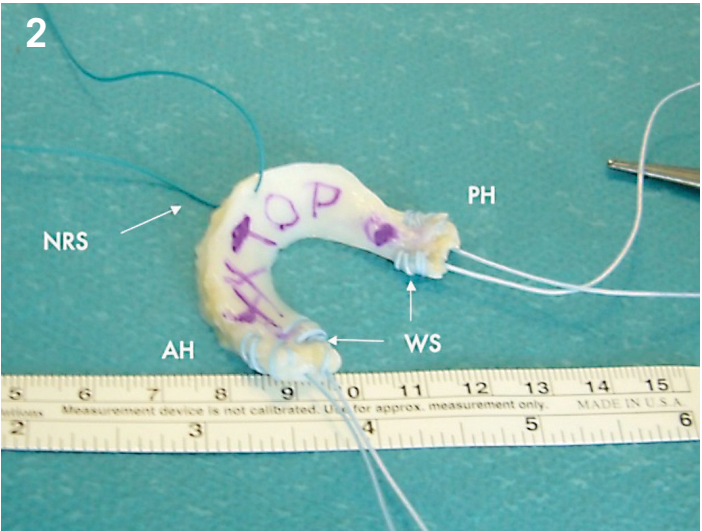
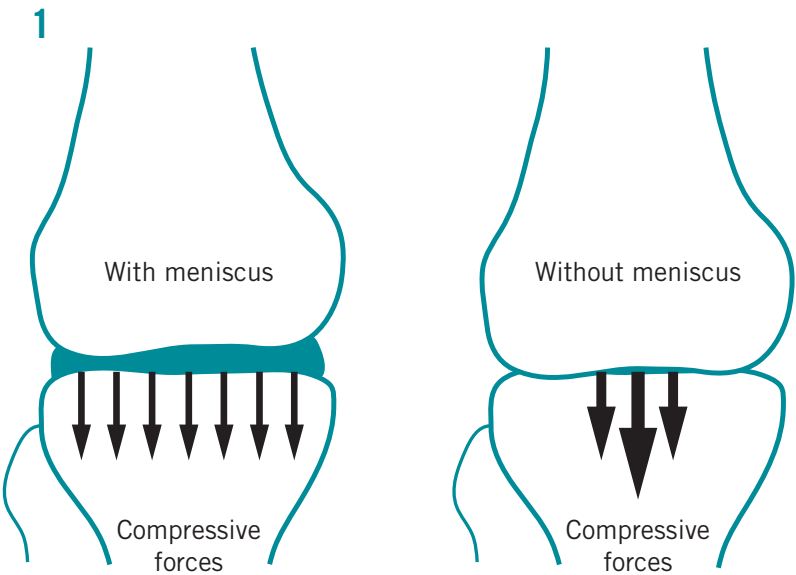


Figure 1: Compressive forces on the articular cartilage are significantly increased when the meniscus is absent. Introduction of a meniscus allograft or scaffold will improve the healing environment for the cartilage repair.

Figure 2: Meniscus allograft transplantation.

Overall, predictors of a successful surgical cartilage repair include alignment, cruciate ligament status and meniscus status. However, we should consider modifications of activity level and obesity as equally important in the successful treatment of cartilage defects.

THE SURGICAL ALGORITHMIC APPROACH

Based on clinical experience, the following algorithmic approach to the knee has been established with a symptomatic cartilage lesion:

1. Coronal alignment: coronal alignment should always be evaluated using a long leg standing X-ray. Normal

alignment is considered to be 178.4 degrees with a standard deviation of ± 2 degrees. This actually means that a knee is to be considered normal with an alignment ranging from 175 degrees up to 183 degrees. A middle-aged recreational athlete presenting with an isolated symptomatic medial femoral cartilage lesion of 2 cm² and a varus of 174 degrees should be informed that an isolated treatment of that cartilage lesion has a significant failure rate due to the excessive varus. In most of these patients, a corrective osteotomy should be recommended. Nevertheless, a corrective osteotomy will not be offered

to a professional soccer player with a similar lesion as an initial treatment, since the ability to play soccer is negatively influenced by the corrective osteotomy.

2. The status of the anterior cruciate ligament: a symptomatic unstable knee with an acute cartilage lesion and an acute ACL tear should be treated with an ACL reconstruction. The surgical treatment of the cartilage lesion in this scenario is still largely debated. Current data does not provide sufficient evidence that the acute surgical treatment of the cartilage lesion results in an improved short- or long-term outcome. However, untreated clinical instability of the knee joint may result in subsequent meniscus injuries, followed by degenerative cartilage lesions and osteoarthritis.
3. The state of the meniscus: although meniscectomy is considered a very successful surgery, a minority of patients will present secondary symptoms including cartilage defects. This is especially true in the lateral compartment and is explained by the specific biomechanical convexity of the femoral condyle and the tibial

plateau. Successful treatment of lateral cartilage defects can only be obtained in conjunction with meniscus restoration.

4. If all the previous conditions are met, cartilage repair can be successful in the long-term.

TREATMENT OPTIONS

Based on this algorithm, surgical treatments have evolved towards an 'à la carte' orthobiological approach. Corrective osteotomies have regained enormous interest and are often performed as an isolated procedure for the malaligned knee with a symptomatic cartilage defect in the recreational patient.

Clinical ligamentous instability should be treated surgically in the athlete and the recreational sportsperson as there is an increased risk of secondary meniscus and cartilage damage.

Frequently, however, the patient will present with a history of a reconstructed ACL and a partial meniscectomy which has allowed them to be asymptomatic for many years. That same patient may now present with additional progressive cartilage disease in the involved compartment, which is suggested to be the main cause

of the symptoms. A detailed analysis of the knee should allow the surgeon to evaluate treatment options. In the author's personal experience, isolated treatment of the cartilage defect in such scenarios is only successful in selected cases. A more comprehensive approach, including associated meniscus substitution and/or corrective osteotomy, is frequently needed. Similarly, isolated meniscus substitution such as meniscus allograft transplantation or scaffold implantation in the well-aligned knee joint with advanced cartilage defects has been associated with a higher failure rate. Associating cartilage restoration does improve the clinical outcome in complex cases.

Meniscus allograft transplantation (MAT) and cartilage procedure

MAT has been shown to reduce the stress on the articular cartilage and thus improve the healing potential of the cartilage repair procedure, when used in combination. MAT is considered to be the surgery of choice when confronted with a symptomatic extensive meniscectomy in the medial or lateral compartment of a well-aligned knee joint. Ideally,



Figure 3: Meniscus scaffold implantation.



Figure 4: Typical patient presenting after lateral meniscectomy. He developed a large chondral lesion on the femoral condyle. Isolated treatment of that cartilage defect is bound to fail. Such a lesion necessitates meniscus allograft transplantation in combination with a cartilage procedure.



CONCLUSIONS

cartilage lesions should be limited to grade 3. Frequently however, young patients presenting with symptoms have associated extensive grade 4 lesions on the femoral condyle and/or the tibial plateau. If this lesion is shouldered by normal healthy cartilage, one might consider associating a cartilage repair procedure to the MAT. This is however a typical salvage procedure and should be communicated to the patient as such.

MAT surgery is performed arthroscopically using either bone-plug or a transosseus fixation of the allograft. The technique essentially involves dissecting the meniscus off the donor tibial plateau and preparing each end with non absorbable sutures, which are then fed through carefully placed bone tunnels, emerging in prepared insertion sites. The graft is passed into the knee through a slightly extended portal and fixed in place with a combination of all-inside devices and 'in-to-out' suture loops tied over the capsule. Anterior and posterior sutures are tied over a bone bridge on the proximal tibia.

Good outcomes of MAT with autologous chondrocyte transplantation, osteochondral grafting and microfracture have been reported. As modern MAT is performed arthroscopically, microfracture is commonly performed for smaller lesions on the femoral condyl and the tibial plateau. For larger lesions, autologous chondrocyte implantation (ACI) or osteochondral allografts might be considered. The timing and sequence of each procedure remains to be determined. The author prefers to perform the meniscus allograft transplantation first in order to create an optimal environment for the subsequent cartilage procedure. If autologous chondrocyte implantation or cartilage scaffolds are to be performed, this should be done 3 to 6 months after MAT, while microfracture or osteochondral grafting is generally performed as a combined procedure.

Meniscus scaffold and cartilage procedure

Meniscus scaffolds are primarily composed of natural collagen or synthetic poly-urethane. Both scaffolds enhance the intrinsic healing potential and allow meniscus tissue to regrow, thus improving the healing environment for associated

cartilage defects. Scaffolds are indicated in partial meniscus defects with a size ranging from 2 to 7 cm and an intact rim and horns. Ideally cartilage defects should be limited to grade 3.

However, in a number of patients, an associated grade 4 cartilage defect might be present. In such a scenario, one might consider performing an associated cartilage repair on the condition that the defect is shouldered with normal healthy cartilage. Microfracture, osteochondral grafting and autologous chondrocyte implantation have been successfully performed. Nevertheless, the success rate of combined procedures is considered lower.

Meniscus scaffold implantation is performed arthroscopically. The lesion is trimmed back to the 'red on red' area, ensuring an intact and continuous meniscus rim and horns. The meniscus defect is sized and the meniscus scaffold is trimmed to the defect. The meniscus scaffold is subsequently introduced and fixed using all-inside, outside-in or inside-out sutures. Next, the cartilage procedure can be performed as a combined procedure or in a second stage.

The combined occurrence of meniscus defects and cartilage defects is an unfortunate but frequent observation in both athletes and active individuals. This combined occurrence most often indicates a chronically injured knee joint and results in significant disability. The treatment of these complex injuries necessitates an algorithmic evaluation of the knee joint including the alignment, the status of the cruciate ligaments and the meniscus and the extent, age and location of the cartilage defect. It has become clear that an orthobiological restorative approach can be successful if all parameters are treated in an à la carte fashion. It has also become clear that isolated cartilage repair is bound to fail if the associated meniscus defect, ruptured cruciate ligament and/or malalignment are not addressed. For that purpose, meniscus allograft transplantation and meniscus scaffolds have been used in combination with cartilage repair procedures to enhance the healing potential of the knee joint by reducing the biomechanical stress on the cartilage repair area.

Further Reading

1. Bellemans J, Colyn W, Vandenuecker H, Victor J. The Chitranjan Ranawat award: is neutral mechanical alignment normal for all patients? The concept of constitutional varus. Clin Orthop Relat Res 2012; 470:45-53.
2. Verdonk P, Gersoff WK, Cole BJ, Spalding T, Getgood A. Meniscal allograft transplantation: a comprehensive review. Guildford, UK: DJO Publications 2015.

Peter Verdonk M.D., Ph.D.
Orthopaedic Surgeon, Knee Specialist
Knee Surgery & Sports Traumatology
Antwerp Orthopaedic Centre
Antwerp University Hospital
Belgium
Contact: Peter.Verdonk@aspetar.com