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Review Article

Meniscal Tear and Repair, Past, Present, Future

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Abstract

The meniscus has an important biomechanical role in the normal function of the knee including load bearing, shock absorption joint stability and efficient synovial fluid dispersion. Tears of the meniscus are one of the common sport injuries. The outcome of meniscectomy causes early development of degenerative changes.The repair prevalence of meniscal tear, in order to preserve meniscal tissue and knee function, gradually increases. The type of tear, shape, location as well as general factors such as age and associated pathology have a critical effect on the ability to heal after suture of the tear.

INTRODUCTION

Knee Arthroscopy is the most common orthopedic surgery today, most of which are preformed due to meniscal tears. In the past these types of injuries have been treated with total meniscectomy.The degenerative changes that developed after total meniscectomy helped the orthopedic community understand the importance of maximal preservation of the meniscal tissue by partial meniscectomy or by suturing of the torn meniscus. We will review the anatomy and function of the meniscus and the current form of treatment for traumatic meniscal tears.

ANATOMY

The meniscus has a crescent shape; it has a triangular cross section, concave at the top part articulating with the femoral condyles and flat at the bottom were in articulates with the tibial plateau. The menisci cover half to two-thirds of the medial and lateral tibial plateau respectively. The meniscal lateral edge is attached via the coronary ligaments to the knee capsule and the tibial plateau while the inner portion of the meniscus is loose. The meniscus is composed of 70% water and the rest of organic matter, most of which (75%) is type I collagen. Most of the collagen fibers are arranged in a semi-circular formation similar to the shape of the meniscus and the remainders are arranged perpendicular to them in a radial fashion. Load transferred from the femur to the tibia produces pressure within the meniscus stressing it outward from between the articular surfaces. The collagen arrangement causes hoop tension within the meniscus and transfers the load to the tibia via attachment to the bone in the anterior and posterior portion. Understanding these biomechanics helps us comprehend how a meniscal radial tear affects the load transfer within the knee and why a radial tear that reaches the knee capsule is equivalent to complete meniscectomy [1].

A para-meniscal vascular plexus, which originates from the medial and lateral geniculate arteries, is located within the knee capsule and synovia. This plexus supplies the outer 10-30% and 10-25% of medial and lateral meniscus respectively. The meniscus is divided into 3 vascular zones. The red/red zone, upto 3mm from the joint capsule has a rich blood supply enabling regeneration of tormmeniscus. The red/white zone, located 3-5mm from the joint capsule is at the boarder of the vascular zone and therefor only some of the meniscal tears will heal. The white/white zone, in the inner third of the meniscus has sparse blood supply and therefore tears in this zone will not heal. Infact, the inner two-thirds of the meniscus are supplied via diffusion from the synovial fluid and affected from pressure alternation during knee motion and therefor tear location within the meniscus affects the healing potential [2].

FUNCTIONS OF THE MENISCUS

Bland-Sutton described in 1897 the meniscus as a remnant of a degenerated intraarticular muscle without any current function. Over 100 years of laboratory and clinical research helped us understand its importance to normal knee function. The menisci act as “space fillers” within the joint and by doing so prevent synovial and capsular impingement during knee motion. They also function as shock observers and have a cardinal function in distributing loads within the knee. The menisci help stabilize the knee in all planes of motion and especially in rotatory movement. Furthermore they aid joint lubrication and function as part of the proprioceptive system [3].

The menisci transfer about 50% of the load applied to the tibial plateau in knee extension and up-to 85% in flexion of 90 degrees. In fact they spare knee cartilage from compression forces [4]. The medial meniscus multiplies the joint contact area by 250%. Medial meniscectomy reduces 50-70% of the contact

area between the femur and tibia and by doing so doubles joint stress [4-5]. Lateral meniscectomy causes loss of 40-50% of the contact area but due to the convex shape of the lateral tibial plateau it raises joint stress by 200-300%. Studies have shown that even partial meniscectomy changes the mechanical function of knee joint and raises stress applied to the joint surface [6].

The menisci function as secondary stabilizers in the knee joint with intact cruciate and collateral ligaments. On the other hand, a total meniscectomy after an anterior cruciate ligament injury will raise anterior tibial translation in the anterior drawer test by 58% [7].

MENISCAL TEARS

The high incidence of meniscal injury is attributed to its location within the joint and the extreme forces appliedduring physical activity and contact sports. An acute or traumatic meniscal tear is found in the young and physically active patient. Degenerative tear occurs characteristically in the forth to sixth decade of life dueto structural changes within the meniscus, chronic knee joint instability and non-anatomic joint axis.

Different forces applied to the meniscus cause characteristic tears such as Horizontal cleavage tears, that related to continuous shear forces applied on the highly mobile lateral meniscus resulting in the chain of events wherein the torn elements of the meniscus create a “one way valve” mechanism resulting in typical para-meniscal cysts formation. Size of tear, its location and time of occurrenceare major prognostic factors in determining the healing potential following meniscal suture.

DIAGNOSIS

The diagnosis of meniscal tear is based on patient history and physical examination. Patientsmay describe a rotatory or hyperflexion injury to the knee prior to the appearance of symptoms. Injuries may be associated with popping sensation, audibleclicking or mechanical locking of knee joint.

Locking of the knee is a typical, but not pathognomonic, complaint of a displaced “bucket handle” tear. Other clinical features to support the diagnosis include joint effusion, para-meniscal cyst, quadriceps muscle atrophy and painful passive end extension/ flexion. Provocative tests include the Apply Grind Test and the McMurray test (Figure 1). It is important to examine joint stability to evaluate an additional ligamentous injury and specifically a cruciate ligament injury [8].

Plain X-Ray images have little value in acute meniscal tears but are important to rule out other pathologies which may cause similar clinical symptoms such as osteoarthritis, loose bodies within joint space or osteochondritis desiccants. Magnetic Resonance Imaging (MRI) is used to confirm the clinical diagnosis but its added value over the physical examination is questionable [9]. It should be emphasized that imaging studies, including MRI, cannot evaluate whether a meniscal tear can be repaired [10].

Knee arthroscopy is considered the gold standard for meniscal tear diagnosis, during the procedure one can probe the meniscus, evaluate the exact location, size and shape. Appropriate treatment plan is determined and finalised during Arthroscopic evaluation [11].

TREATMENT

Conservative treatment is acceptable for small (5-10mm) peripheral tears, stable tears, partial thickness tears (less than 50%) or short radial tears (up-to 3mm) in absence of associated articular pathology (e.g. cruciate ligament injury) [12-14]. Initial treatment includes rest, ice, temporary immobilization, partial weight bearing as tolerated followed by gradual return to activity with isometric exercise for muscle strengthening.

In presence of persistent mechanical derangement of the knee and lack of the possibility to repair the meniscus, partial or even subtotal meniscectomy is indicated with the inevitable degenerative changes resulting in the long run taken in consideration [15,16].

Surgical indications include persistent pain with low responsiveness to various conservative treatment modalities. Symptoms limiting normal daily activity, sports and occupation. In the event of anterior cruciateligament injury there is a clear indication for simultaneous surgical treatment attempt to preserve the meniscus. Locked knee due to meniscal tear is a surgical priority [11].

The most important factor affecting the healing capacity of repaired meniscal tissueis blood supply. A tear in the red/red zone has the highest potential for a meaningful recovery while a tear in the inner portion of the meniscus, the white/white zone, over 4 mm from the joint capsule, demonstrate a high failure rate [12,17]. Some studies have shown successful result of meniscal repair in the white/white zone in young patients (under 20 years) [13,18].

Figure 1 (1) Apley Grind Test – Patient in prone position, knee is flexed to 90o and an attempted to evoke pain is made by axial loading the Tibia while preforming internal / external rotation maneuvers. (2) McMurray Test is performed with the patient in supine position and the knee is flexed to 90o, as the knee is extended it is put under Valgus stress and the leg is internally rotated. (3) This maneuver is then repeated in varus stress and external rotation. The test is considered positive is a ‘Click’ is felt at the joint line.

Figure 2 In 1948 Fairbank described radiographic features of degenerative changes post total meniscectomy. These include joint space narrowing, flattening of the femoral condyle and osteophyte formation.

Configuration of the tear is of considerable importance. Radial tears in the avascular (white/white) zone have low healing potential and therefore will be subject to partial meniscectomy. However, radial tear crossing the meniscus may be considered an indication for a meniscal repair. Horizontal tears usually represent degenerative tears and are technicality demanding and therefor usually are not considered for repair Vertical tears, usually caused by trauma and located in the vascular zone has the highest healing potential and should be considered for repair. Studies have shown that partial meniscectomy of a tear involving root of the medial meniscus are biomechanically equivalent to complete meniscectomy and therefor an attempt for surgical repair and meniscal preservation should be made in this type of tear [8].

Additional factors affecting healing potential and therefor important while considering surgical repair include: Tear size, 1-4 cm length, absence of degenerative changes or meniscal distortion, intact anterior cruciate ligament [8,11].

The effect of timing of the repair and patient age are controversial factors when considering meniscal repair. Some studies have shown that a repair performed within 6 weeks from injury has a higher success rate [19] while others have failed to show a statistically significant difference [12,13,17,20]. Young patients were reported to have a higher success rate [8]. However, early age in other studies did not show difference [12,18]. Until further studies are done one should prefer surgical repair in younger patients due to the risk of degenerative changes developing over the years after partial meniscectomy.

It cannot be over-emphasized that while torn fragments have to be completely removed, any effort should be made to preserve as intact meniscal tissue to minimize the bio-mechanical changes and knee function, in view of future degenerative changes. A reverse ratio has been found between post-surgical knee function and the percentage of meniscus tissue removed [21].

Abrams et al have evaluated the trends of treatment methods for meniscal tears in the years 2005-2011. While the number of surgical repairs has doubled only a small increase in the number of partial meniscectomy was reported. The number of meniscectomies preformed in the presence of anterior cruciate ligament injury has considerably decreased due to the additional loss of knee stability [22].

RESULTS

Higher grade of degenerative changes (Figure 2), were found after complete meniscectomy compared to partial meniscectomy [23,24]. Good to excellent subjective results were reported following partial meniscectomy, although imaging studies demonstrated more advanced degenerative changes in the operated knee compared to the contralateral knee [23,25,26]. While removal of more than 50% of the meniscus caused relatively rapid radiological degenerative changes, total meniscectomy brought the worst prognosis compared to the uninjured knee with-in the same time period [23]. An MRI study of asymptomatic subjects without osteoarthritis demonstrated meniscal tear in 54% of the patients that developed degenerative changes over a 30 month follow-up period, 18% of the patients that did not develop degenerative changes demonstrated similar findings [27].

Review of 13 studies with 566 patients that underwent meniscal suture, demonstrated good results in 75-80% of patients at 5 years follow-up. Failure was defined as need for re-operation. Of the reported failures 30% occurred two years after surgery, emphasizing the need for a long term follow-up after meniscal repair. No correlation was found with ACL deficient knees. These results contradict previous studies that determined that simultaneous ACL repair resulted in higher healing rates after meniscus repair [28].

Arthroscopic follow-up after 81 patients who underwent meniscal repair (N-42) or partial meniscectomy (N-39) found degenerative changes in 60% of patients who underwent partial meniscectomy compared to only 20% who underwent meniscal repair with more significant effect for meniscal repair in the younger patients.

96% of patients who underwent meniscal repair returned to their pre-injury level of activity compared to only 50% of patients who underwent meniscectomy [29].

Another review article found a higher reoperation rate after meniscal repair compared to partial meniscectomy (20% and 4% respectively). Meniscal preservation resulted in better clinical results and less degenerative changes in long term follow-up [22].

Studies of different repair techniques did not demonstrate any statistically meaningful results. The resultswere reflected in the tear characteristics and the presence of concurrent ACL injury [30].

There is no consensus regarding rehabilitation protocol after meniscal repair but in general there is a higher tendency towards earlier activation than in the past. For general rehabilitation protocol at our institute (Table 1).

SUMMARY

Complete meniscectomy results in early and significant degenerative changes in the knee joint. Partial meniscectomy while trying to preserve as much tissue as possible has shown

Table 1: General rehabilitation protocol at institute.

	Partial Meniscectomy	Suture of Vertical Tear	Suture of Radial Tear
Range of Motion	Immediately post operation – according to pain tolerace	0-90° up-to 4 weeks	0-90° up-to 4 weeks
Weight Bearing	Immediately post operation – according to pain tolerace	Non weight bearing / Partial weight bearing(according to tear size) for 4-6 weeks	Non weight bearing for 4-6 weeks
Return to Sports	Immediately post operation – according to pain tolerace	4-6 month post operation	6 month post operation

good clinical results but degenerative changes still appear earlier than in the uninjured knee. The current trend favors meniscal repair especially in young physically active patients with traumatic meniscal tear.

Meniscal repair has shown promising clinical and radiographic results and reduced the risk of degenerative changes in the operated knee.

Several factors influence the healing potential after meniscal repair. An acute/traumatic longitudinal tear in the peripheral third of the meniscus, in the red/red zone with good blood supply is more likely to heal. Due to the long and demanding rehabilitation period after meniscal repair, proper patient selection, education and expectation management are essential prior to surgery.

REFERENCES

1. Athanasiou, Kyriacos A, Johannah Sanchez-Adams. Engineering the Knee Meniscus. Synthesis Lectures on Tissue Engineering. 2009; 1: 1-97.
2. Arnoczky SP, Warren RF. Microvasculature of the Human Meniscus. Am J Sport Med. 1982; 10: 90-95.
3. Bland-Sutton J. Ligaments: Their Nature and Morphology, Ed 2. JK Lewis, 1897.
4. McDevitt CA, Webber RJ. The Ultrastructure and Biochemistry of Meniscal Cartilage. Clin Orthop Relat Res. 1990; 252: 8-18.
5. Fukubayashi T, Kurosawa H. The Contact Area and Pressure Distribution Pattern of the Knee. A Study of Normal and Osteoarthrotic Knee Joints. Acta Orthopaedica Scandinavica.1980; 51: 871-879.
6. Makris EA, Hadidi P, Athanasiou KA. The Knee Meniscus: Structure-Function, Pathophysiology, Current Repair Techniques, and Prospects for Regeneration. Biomaterials. 2011; 32: 7411-7431.
7. Shoemaker SC, Markolf KL. The Role of the Meniscus in the Anterior-Posterior Stability of the Loaded Anterior Cruciate-Deficient Knee. Effects of Partial versus Total Excision. J Bone Joint Surg Am. 1986; 68: 71-79.
8. Laible, Catherine, Drew AS, Kiridly. Meniscal Repair. J Am Acad Orthop Surg. 2013; 21: 204-213.
9. Miller GK. A Prospective Study Comparing the Accuracy of the Clinical Diagnosis of Meniscus Tear with Magnetic Resonance Imaging and Its Effect on Clinical Outcome. Arthroscopy: J Arthro Rel Surg. 1996; 12: 406-413.
10. Bernthal Nicholas M, Leanne L, Seeger. Can the Reparability of Meniscal Tears Be Predicted with Magnetic Resonance Imaging? Am J Sports Med. 2011; 39: 506-510.
11. Greis, Patrick E, Davide DB, Michael CH, Robert T. Meniscal Injury: I. Basic Science and Evaluation. J Am Acad Orthop Surg. 2002; 10: 168-176.
12. Scott GA, Jolly LB, Henning CE. Combined Posterior Incision and Arthroscopic Intra-Articular Repair of the Meniscus. An Examination of Factors Affecting Healing. J Bone Joint Surg Am. 1986; 68: 847-861.
13. Noyes, Frank R, Barber-Westin SD. Arthroscopic Repair of Meniscal Tears Extending into the Avascular Zone in Patients Younger than Twenty Years of Age. Am J Sports Med. 2002; 30: 589-600.
14. Muellner T, Egkher A, Nikolic A, Funovics M, Metz V. Open Meniscal Repair: Clinical and Magnetic Resonance Imaging Findings after Twelve Years. Am J Sports Med. 1999; 27: 16-20.
15. McGinity JB, Geuss LF, Marvin RA. Partial or Total Meniscectomy: A Comparative Analysis. J Bone Joint Surg. 1977; 59: 763-766.
16. Jørgensen US, Sonne HF, Lauridsen, Rosenklint A. Long-Term Follow-up of Meniscectomy in Athletes. A Prospective Longitudinal Study. J Bone Joint Surg Br. 1987; 69: 80-83.
17. Cannon WD, Vittori JM. The Incidence of Healing in Arthroscopic Meniscal Repairs in Anterior Cruciate Ligament-Reconstructed Knees versus Stable Knees. Am J Sports Med. 1992; 20: 176-181.
18. Rubman MH, Noyes FR, Barber Westin SD. Arthroscopic Repair of Meniscal Tears That Extend into the Avascular Zone. A Review of 198 Single and Complex Tears. Am J Sports Med. 1998; 26: 87-95.
19. Tengrootenhuysen, Mike, Geert Meermans, Kathleen Pittoors, Roger van Riet, Jan Victor. Long-Term Outcome after Meniscal Repair. Knee Surgery, Sports Traumatology, Arthroscopy: J ESSKA. 2011; 19: 236-241.
20. Noyes FR, Barber Westin SD. Arthroscopic Repair of Meniscus Tears Extending into the Avascular Zone with or without Anterior Cruciate Ligament Reconstruction in Patients 40 Years of Age and Older. Arthroscopy. 2000; 16: 822-829.
21. Paxton ES, Michael VS, Robert HB. Meniscal Repair versus Partial Meniscectomy: A Systematic Review Comparing Reoperation Rates and Clinical Outcomes. Arthroscopy. 2011; 27: 1275-1288.
22. Abrams, Geoffrey D, Rachel MF, Anil KG. Trends in Meniscus Repair and Meniscectomy in the United States, 2005-2011. Am J Sports Med. 2013; 41: 2333-2339.
23. Andersson Molina H, Karlsson H, Rockborn P. Arthroscopic Partial and Total Meniscectomy: A Long-Term Follow-up Study with Matched Controls. Arthroscopy. 2002; 18: 183-189.
24. Hede AE, Larsen, Sandberg H. Partial versus Total Meniscectomy. A Prospective, Randomised Study with Long-Term Follow-Up. J Bone Joint Surg. 1992; 74: 118-121.
25. Petty, Catherine A, James HL. Does Arthroscopic Partial Meniscectomy Result in Knee Osteoarthritis? A Systematic Review with a Minimum of 8 Years' Follow-Up. Arthroscopy. 2011; 27: 419-424.
26. Hulet CH, Locker BG, Schiltz D, Texier A, Tallier E, Vielpeau CH. Arthroscopic Medial Meniscectomy on Stable Knees. J Bone Joint Surg Br. 2001; 83: 29-32.
27. Englund, Martin, Ali Guermazi, Frank W. Roemer. Meniscal Tear in Knees without Surgery and the Development of Radiographic Osteoarthritis among Middle-Aged and Elderly Persons: The Multicenter Osteoarthritis Study. Arthritis and Rheum. 2009; 60: 831-839.

28. Nepple, Jeffrey J, Warren RD, Rick WW. Meniscal Repair Outcomes at Greater than Five Years: A Systematic Literature Review and Meta-Analysis. J Bone Joint Surg Am. 2012; 94: 2222-2227.

29. Stein, Thomas, Andreas Peter Mehling, Frederic Welsch. Long-Term Outcome after Arthroscopic Meniscal Repair versus Arthroscopic Partial Meniscectomy for Traumatic Meniscal Tears. Am J Sports Med. 2010; 38: 1542-1548.

30. Grant, John A, Jeff Wilde, Bruce SM, Asheesh Bedi. Comparison of inside-out and All-inside Techniques for the Repair of Isolated Meniscal Tears: A Systematic Review. Am J Sports Med. 2012; 40: 459-468.

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