THE FORMAL EU-US MENISCUS REHABILITATION CONSENSUS: AN ESSKA-AOSSM-AASPT INITIATIVE

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A. SUMMARY

1. Introduction

Meniscectomy is one of the most frequent orthopaedic procedures in the world. The long-term results, even following arthroscopic “so-called partial” meniscectomy, are heterogenous. The concept of meniscal preservation has progressed over the years with more clear indications: non-operative management of some degenerative meniscus lesions, repair of many traumatic meniscus tears, and meniscus replacement if needed. Two ESSKA consensuses are already available.[1,2] However, the rehabilitation management of meniscus lesions or tears (operated or not) was not covered by these consensuses.

The aim of this consensus is to provide recommendations for the usage of rehabilitation (including physical therapy) of patients undergoing either conservative or surgical treatment for degenerative meniscus lesions or acute meniscus tears. Do concomitant pathologies have an impact on the management of degenerative meniscus lesions or acute meniscus tears? Prevention programs usefulness and return to sports modalities will also be discussed.

2. Definitions

Rehabilitation
The definition of rehabilitation according to the World Health organization (https://www.who.int/news-room/fact-sheets/detail/rehabilitation) is:

Rehabilitation is defined as “a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment”.
It does so by working with the person to address underlying health conditions and their symptoms, modifying their environment to better suit their needs, using assistive products, educating to strengthen self-management, and adapting tasks so that they can be performed more safely and independently.

The rehabilitation workforce is made up of different health workers, including but not limited to physiotherapists, occupational therapists, speech and language therapists and audiologists, orthotists and prosthetists, clinical psychologists, physical medicine and rehabilitation doctors, and rehabilitation nurses. Many other health workers, such as general practitioners, surgeons, and community health workers may also play an important role in a person’s rehabilitation.

This can include prevention, postoperative care, manual therapy, guided exercises, return to sports assessment, etc.

Physical therapy
According to World Physiotherapy (https://world.physio): Physical therapy is services provided by physical therapists to individuals and populations to develop, maintain and restore maximum movement and functional ability throughout the lifespan. The service is provided in circumstances where movement and function are threatened by ageing, injury, pain, diseases, disorders, conditions and/or environmental factors and with the understanding that functional movement is central to what it means to be healthy. Physical therapy involves the interaction between the physical therapist, patients/clients, other health professionals, families, care givers and communities in a process where movement potential is examined/assessed, and goals are agreed upon.

Physical therapists
A definition is needed because physical therapists are subject to very heterogeneous professional laws and job descriptions in the world:
Physical therapists are concerned with identifying and maximizing quality of life and movement potential within the spheres of promotion, prevention, treatment/intervention and rehabilitation. These spheres encompass physical, psychological, emotional, and social wellbeing.
Physical therapists are qualified and professionally required to:

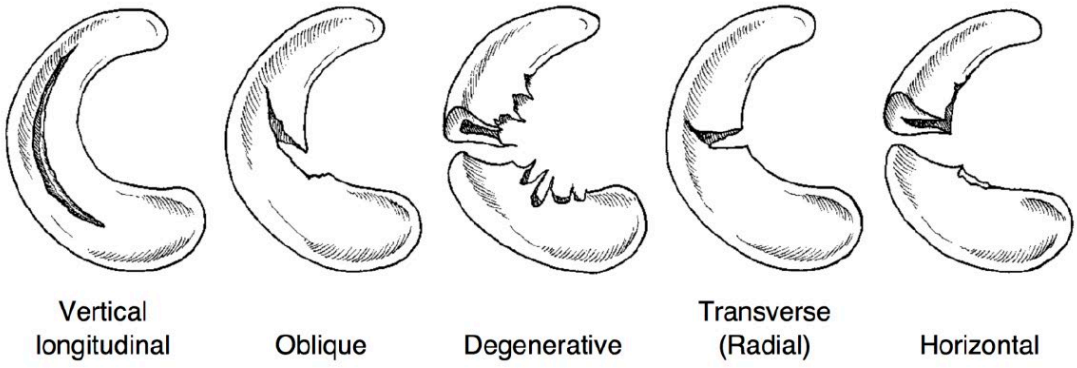
- Undertake a comprehensive examination/assessment of the patient/client or needs of a client group
- Evaluate the findings from the examination/assessment to make clinical judgments regarding patients/clients
- Formulate a diagnosis, prognosis and plan
- Provide consultation within their expertise and determine when patients/clients need to be referred to another healthcare professional.
- Implement a physical therapist intervention/treatment program.
- Determine the outcomes of any interventions/treatments.

- Make recommendations for self-management.

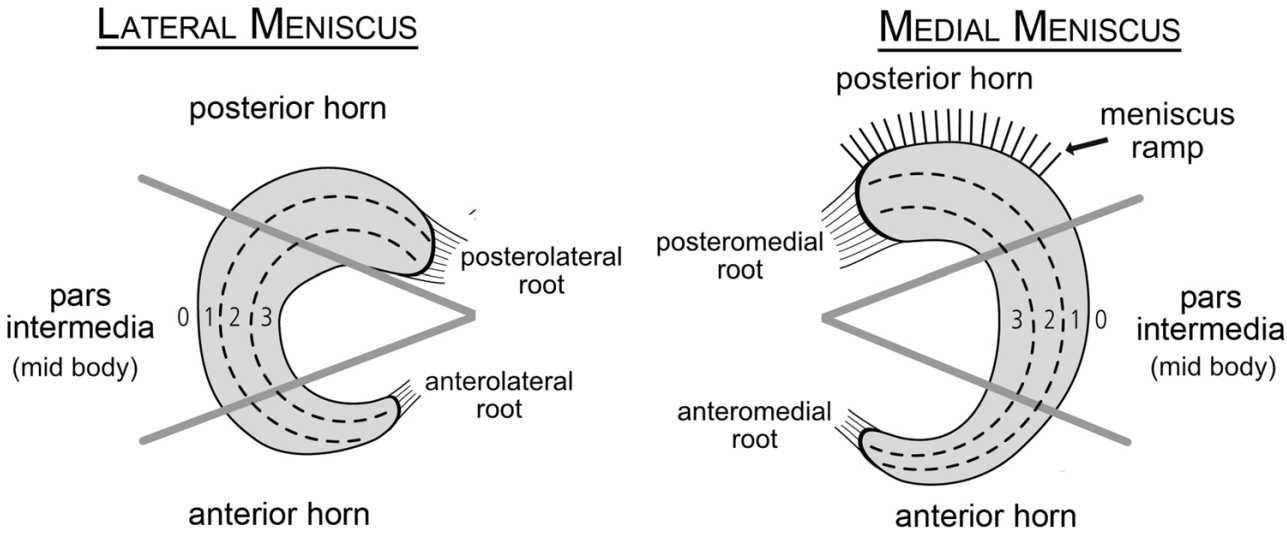
Classification of meniscus lesions

The classifications used for the previous ESSKA consensus about traumatic meniscus tears and degenerative meniscus lesions will be used in this consensus.[2]

Ramp lesions and root tears would also be discussed separately. The nomenclature of traumatic tears and degenerative chronic meniscus lesions should be distinguished based on their etiology. The ESSKA European meniscus consensus group defined traumatic meniscus injury as a 'meniscus tear', which is associated with a sufficient knee injury and a sudden onset of knee pain, whereas a 'degenerative meniscus lesion' is a meniscus lesion marked by a slow progression of tissue degeneration without a history of an acute trauma.



Classification of meniscus tears. [Fu FH, Harner CD, Vince KG. Knee surgery.1994] {Fu 1994}



3. Biology and biomechanics of meniscal healing

Basic science for connective tissue healing represents the key point for meniscal repair rationales and preservation techniques. The meniscus is an essential intra-articular fibrocartilaginous structure that provides load transmission, shock absorption, stability, and lubrication of the knee joint. Tears or lesions of the menisci sometimes require removal of the torn region. Partial removal of the menisci can lead to instability and induce degenerative joint changes. Thus, current clinical therapies seek to maximally preserve and restore meniscal structure and function after injury by repairing meniscal tears rather than removing meniscus tissue.

- **Meniscal healing for traumatic tears**

All connective tissues are able to produce a reparative response to an injury. This response follows the same steps whatever the tissue interested: exudation, organization, vascularization, cellular proliferation and finally tissue remodeling. The vascular response of the meniscus to a tear follows the same process. The torn meniscus tissue is able to heal but it takes time. Following an injury of the peripheral vascular rim of the meniscus a fibrin clot forms into and around the tear. Then a mitogenic and chemotactic stimuli via many growth factors to support the proliferative and synthetic response. A fibrovascular scar tissue is appearing after 10 weeks, and this tissue is not completely similar to native meniscus tissue. In this context, meniscal repairs are able to accomplish a sufficient tissue strength, so that an earlier rehabilitation can be considered. The protocols depend on the type of repaired lesions.

- **Degenerative menisci**

Degeneration of the meniscus is a slow process occurring during many years in the avascular zone. Fraying and splitting of menisci occur primarily in the inner surfaces. There is no significant increase of vascularity in response to chronic and degenerative meniscus tears explaining the poor ability of the degenerative meniscus tears to be successfully repaired. Some remodeling of the degenerative tissue is expected with time.

4. Biological and biomechanical impact of meniscectomy on cartilage and joint

It is well-established that joint contact mechanics are altered in the meniscal-deficient knee, resulting in a cascade of pathologic events that may cause progressive damage to the articular cartilage and joint degeneration. The risk for developing knee osteoarthritis (OA) after partial meniscectomy is variable. In 30–40% of patients, radiographic OA-like changes are present within 5 years of surgery and more than 50% of partial meniscectomy patients will develop OA within 10–20 years.[3]

5. Methodology of the consensus

The Meniscus consensus follows the ESSKA Meniscus consensus procedure. Chairs were nominated. A steering group was built up with experts in the field of meniscus and rehabilitation. The steering group was divided in two groups, one being mainly responsible for developing questions and statement drafts and the other one for screening the current literature and providing evidence to to support the development of statements. First, the question group developed relevant questions in the field. According to the questions literature was searched on summarized by the literature group. Therefore 395 relevant Systematic Reviews have been screened and where needed, supported by additional searches for additional available literature. In line with the available literature the question/statement group formulated statements to answer the questions and added grading according to the level of evidence supporting the statements. In the next step an independent rating group rates on the statements.

For more detailed description of the applied method the paper by Beaufils et al should be read.[4]

6. People involved in the consensus

For the first time, this consensus is the result of a combined work made by three scientific societies: ESSKA, AOSSM and AASPT.

Chairs
Robert Prill (ESSKA), Nicolas Pujol (ESSKA), Benjamin Ma (AOSSM), Airelle Giordano (AASPT)

Steering Group
Elanna Ahros (US), Roland Becker (EU), Francesco Della Villa (EU), Jonathan Goodloe (US), James Irrgang (US), Jitka Klugarová (EU), Emma Klostermann (US), Aleksandra Królikowska (EU), Aaron Krych (US), Rob Laprade (US), Rob Manske (US), Nicky van Melick (EU), Jill Monson (US), Marko Ostojic (EU), Mark Paterno (US) , Tomasz Piontek (EU), Simone Pirelli (EU), Alexandre Rambaud (EU), James Robinson (EU), Laura Schmitt (US), Eric Hamrin Senorski (EU), Thorkell Snaebjornsson (EU), Adam Tagliero (US), Stephanie Wong (US)

ESSKA Consensus Advisory Board
Philippe Beaufils, Juan Carlos Monllau Garcia

7. Abbreviations

- ACL : Anterior Cruciate Ligament
- ADL : Activities of Daily Living
- AOSSM : American Orthopaedic Society For Sports Medicine
- ESSKA : Eurpoean Society Of Sports Traumatology, Knee Surgery & Arthroscopy
- AASPT : American Association Of Sports PhysioTherapists
- NEMS : Neuromuscular Electrical Stimulation
- OKC : Open Kinetic Chain
- CKC : Closed Kinetic Chain
- ACLR : Anterior Crutiate Ligament Reconstruction
- ROM : Range Of Movement
- EMG : Electromyography
- TENS : Transcutaneous Electrical Nerve Stimulation
- PRO : Patient Reported Outcome
- PROM : Patient Reported Outcome Measurement
- RCT : Randomised Clinical Trial
- RTP : Return To Sports
- BFR : Blood Flow Restriction
- NWB : No Weight-Bearing
- WB : Weight-Bearing
- PWB : Partial Weight-Bearing
- FWB : Full Weight-Bearing
- MAT : Meniscal Allograft Transplantation
- LOE : Level of evidence
- HDD: Hand-Held Dynamometers

References:

1. Beaufils P, Becker R, Kopf S, et al. Surgical management of degenerative meniscus lesions: the 2016 ESSKA meniscus consensus. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(2):335-346. doi:10.1007/s00167-016-4407-4

2. Kopf S, Beaufils P, Hirschmann MT, et al. Management of traumatic meniscus tears: the 2019 ESSKA meniscus consensus. *Knee Surg Sports Traumatol Arthrosc*. 2020;28(4):1177-1194. doi:10.1007/s00167-020-05847-3

3. Souza RB, Wu SJ, Morse LJ, Subburaj K, Allen CR, Feeley BT. Cartilage MRI relaxation times after arthroscopic partial medial meniscectomy reveal localized degeneration. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(1):188-197. doi:10.1007/s00167-014-2997-2

4. Beaufils P, Dejour D, Filardo G, et al. ESSKA consensus initiative: why, when and how? *J Exp Orthop*. 2023;10(1):101. doi:10.1186/s40634-023-00664-2

B. QUESTIONS

1. Prevention of meniscus injuries

Q 1.1) Are any promising attempts to reduce TRAUMATIC meniscus tears currently available?

Statement:

Lower extremity injury risk reduction programs focusing on neuromuscular control exercises can be used to prevent overall lower extremity injury, however it is not specific to acute meniscal tears. Prevent Injury and Enhance (PEP), FIFA11+, and Knäkontroll are some examples of useful programs in lower extremity and ACL risk reduction.

Grade of recommendation: C

Rating:
Median: 8.5
Mean: 8.0

Literature Summary:
No studies were identified that specifically examined meniscus injury prevention or reduction in isolation. Meniscus injury is commonly included as one of several injury types monitored within research on exercise-based knee or knee ligament injury prevention programs within young athletic populations, which commonly focus on anterior cruciate ligament (ACL) injury. Such programs have demonstrated effectiveness in reducing overall injury lower extremity injury rates, but meniscus injuries are typically reported along with a variety of other diagnoses within the category of "knee injury" rather than as stand-alone injury type.[1]

The most famous since 2006, the FIFA 11+ Injury Prevention Program used to prevent knee joint injuries, especially the ACL, reduces the risk of injury by 77%.[2] Injury prevention programs are effective in reducing the incidence of general lower extremity injuries. Injury of any single joint of the lower extremity is complex. Increased risk of ACL injury can be attributed to biomechanical factors, deficits in neuromuscular control of the trunk, knee and hip, and anatomic factors at the hip and knee.[3] Prevention programs reduce the risk of knee joint injuries. They are generally designed to prevent common injuries and documented specifically in assessing the risk of anterior cruciate ligament injury.[4] Programs do currently not sufficiently directly address meniscus injuries, but knee injuries in general.[1,5]

References:

1. Donnell-Fink LA, Klara K, Collins JE, et al. Effectiveness of Knee Injury and Anterior Cruciate Ligament Tear Prevention Programs: A Meta-Analysis. *PLoS One*. 2015;10(12): e0144063. doi:10.1371/journal.pone.0144063

2. Silvers-Granelli HJ, Bizzini M, Arundale A, Mandelbaum BR, Snyder-Mackler L. Does the FIFA 11+ Injury Prevention Program Reduce the Incidence of ACL Injury in Male Soccer Players? *Clin Orthop Relat Res*. 2017;475(10):2447-2455. doi:10.1007/s11999-017-5342-5

3. Taylor JB, Ford KR, Nguyen AD, Terry LN, Hegedus EJ. Prevention of Lower Extremity Injuries in Basketball: A Systematic Review and Meta-Analysis. *Sports Health*. 2015;7(5):392-398. doi:10.1177/1941738115593441

4. Zarei M, Abbasi H, Namazi P, Asgari M, Rommers N, Rössler R. The 11+ Kids warm-up programme to prevent injuries in young Iranian male high-level football (soccer) players: A cluster-randomised controlled trial. *J Sci Med Sport*. 2020;23(5):469-474. doi:10.1016/j.jsams.2019.12.001

5. Arundale AJH, Bizzini M, Dix C, et al. Exercise-Based Knee and Anterior Cruciate Ligament Injury Prevention. *J Orthop Sports Phys Ther*. 2023;53(1):CPG1-CPG34. doi:10.2519/jospt.2023.0301

Q 1.2) What activities including ADL and sporting activities may increase the risk of meniscus tears or lesions?

Statement:
Participation in repetitive cutting, pivoting and landing activities increases risk of meniscal injury in athletes. Work related lifting and carrying (over 10 pounds/ 4.5 Kilograms), kneeling, deep squatting, and a high volume of climbing has increased risk of meniscus injury.

Grade of recommendation: A

Rating:
Median: 9
Mean: 8.5

Literature Summary:
Snoeker and colleagues investigated risk factors for meniscal tears with a systematic review and meta-analysis in 2013.[1] Their analysis found strong evidence of increased risk for acute meniscus tears among individuals participating in the sports of soccer and rugby. Acute meniscus tears are among the most common injuries in other sports, including professional level men's and women's basketball, where a meniscus injury rate of 2.3 to 3.3 per year has been reported.[2] Outside of high-impact sport, yoga has been investigated for injury risk. Yoga practitioners were reported to have a higher risk of meniscus injury (OR 1.72, 95% CI=1.23-2.41) compared to non-practitioners.[3] Snoeker et al. identified factors associated with a higher risk for degenerative meniscus tears included older age (>60 years), male gender, work-related kneeling and squatting, and a high volume of stair climbing (>30 flights).[1] Similar findings were reported by Bahns et al. in 2021 in a systematic review and meta-analysis of occupational risk factors for meniscal lesions.[4] In addition to the tasks of squatting, kneeling and stair-climbing reported by Snoeker et al., their study showed significant association with the occupational demands of lifting and carrying weights >10 pounds, work as a coal miner or floor layer and playing professional level football and meniscal injury.

References:

1. Snoeker BAM, Bakker EWP, Kegel CAT, Lucas C. Risk factors for meniscal tears: a systematic review including meta-analysis. *J Orthop Sports Phys Ther*. 2013;43(6):352-367. doi:10.2519/jospt.2013.4295

2. Lian J, Sewani F, Dayan I, et al. Systematic Review of Injuries in the Men's and Women's National Basketball Association. *Am J Sports Med*. 2022;50(5):1416-1429. doi:10.1177/03635465211014506

3. Cramer H, Ostermann T, Dobos G. Injuries and other adverse events associated with yoga practice: A systematic review of epidemiological studies. *J Sci Med Sport*. 2018;21(2):147-154. doi:10.1016/j.jsams.2017.08.026

4. Bahns C, Bolm-Audorff U, Seidler A, Romero Starke K, Ochsmann E. Occupational risk factors for meniscal lesions: a systematic review and meta-analysis. *BMC Musculoskelet Disord*. 2021;22(1):1042. doi:10.1186/s12891-021-04900-7

2. Rehabilitation management of non-operated TRAUMATIC meniscus tears

The ESSKA consensus about traumatic tears of the meniscus[1] published in 2019 related to definitions, epidemiology, diagnostics, indications for optimal surgical treatment, factors affecting outcomes after meniscectomy or repair. There was no consensus about rehabilitation of such lesions (operated on or not).

References:

1. Kopf S, Beaufils P, Hirschmann MT, et al. Management of traumatic meniscus tears: the 2019 ESSKA meniscus consensus. *Knee Surg Sports Traumatol Arthrosc*. 2020;28(4):1177-1194. doi:10.1007/s00167-020-05847-3

Q 2.1) Does non-operative management benefit the treatment of TRAUMATIC meniscus tears?

Statement:

Research investigating non-operative interventions for **TRAUMATIC** meniscus tears is rare. While allocation to conservative treatment for acute meniscus tears might be an option, allocation criteria for conservative versus surgical interventions are not well established. Two studies, focusing on self-reported patient outcomes suggest that both surgery and exercise therapy are viable treatment options for **TRAUMATIC AND NON-TRAUMATIC** meniscus tears.

Research to improve the robustness of this literature is needed.

Grade of recommendation: B

Rating:
Median: 8
Mean: 7.9

More severe symptoms and larger tears may benefit from surgical intervention. Bucket handle and complete radial meniscus tears along with extended RAMP lesions and meniscal root tears in younger patients may require earlier surgical intervention to optimize outcomes.

Grace of recommendation: D

Comment: After finalizing this consensus, Evidence was was published supporting the idea of self healting potential and that a potential threshold for ramp lesion repair may be more than 3cm.

Siboni R, Pioger C, Jacquet C, Mouton C, Seil R. Ramp Lesions of the Medial Meniscus. Curr Rev Musculoskelet Med. 2023 May;16(5):173-181. doi: 10.1007/s12178-023-09834-2. Epub 2023

Deichsel A, Miets H, Peez C, et al. The Effect of Varying Sizes of Ramp Lesions in the ACL-Deficient and Reconstructed Knee: A Biomechanical Robotic Investigation. The American Journal of Sports Medicine. 2024;52(4):928-935

Literature summary:
No high-level studies exist only reporting on the management of isolated acute meniscal tears which are treated non-operatively. There are no studies which compare rehabilitation management to surgical management of matched patients and meniscal tear types. Based on the available low-level evidence and expert opinion, it seems obvious that certain acute meniscal tear types respond poorly to non-operative rehabilitation.[1–4]

Beaufils et al. in their open review article on meniscus tear and management state "In traumatic tears, the first-line choice is repair or non-removal…Success rate is high and cartilage preservation has been proven. Non-removal can be discussed for stable asymptomatic lateral meniscal tears in conjunction with anterior cruciate ligament (ACL) reconstruction."[5] The proposed benefit to avoid arthroscopic partial meniscectomy (APM) is based on data which supports progression to osteoarthritis (OA) at a faster rate following APM.[5–7] It remains unclear if non-operatively managed acute meniscal tears would follow this unfavorable trend toward OA.

Old data from 1985 in a lower impact peer reviewed journal supports the idea that in some cases manipulation alone might be a satisfying treatment option for acute knee locking, although this would generally not be considered the standard of care presently.[8]

Hou et al. published a protocol outlining a systematic review and network meta-analysis which was aimed at reporting on comparative clinical outcomes of different therapies for traumatic meniscal tears in adults in January of 2022.[9] The authors proposed a review of 10 databases, main outcomes were physical function and healing rate and they aimed to provide evidence-based findings for the clinical application of different therapies for traumatic meniscal tears in adults. This study would certainly inform the literature regarding this topic which appears too sparse and is generally of low quality. As of this writing the protocol is published, but as of yet their study is ongoing.

Damsted et al. published an RCT (the DREAM-trial) in 121 patients where they randomized into a group of surgery or 12-weeks supervised exercise and patient education. There was no difference in change in KOOS4 after 12 months between the two treatment groups or between those with traumatic versus non-traumatic tears. Early meniscus surgery regardless of the type of tear did not appear superior to one another. [10]

References:

1. Katz JN, Brophy RH, Chaisson CE. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *N Engl J Med*. Published online 2013.

2. Krych AJ, Reardon PJ, Johnson NR, et al. Non-operative management of medial meniscus posterior horn root tears is associated with worsening arthritis and poor clinical outcome at 5-year follow-up. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(2):383-389. doi:10.1007/s00167-016-4359-8

3. Krych AJ, Lamba A, Wang AS, et al. Nonoperative Management of Degenerative Medial Meniscus Posterior Root Tears: Poor Outcomes at a Minimum 10-Year Follow-up. *Am J Sports Med*. 2023;51(10):2603-2607. doi:10.1177/03635465231185132

4. LaPrade RF, Geeslin AG, Chahla J, et al. Posterior Lateral Meniscal Root and Oblique Radial Tears: The Biomechanical Evidence Supports Repair of These Tears, Although Long-Term Clinical Studies Are Necessary. *Arthroscopy*. 2022;38(12):3095-3101. doi:10.1016/j.arthro.2022.09.015

5. Beaufils P, Becker R, Kopf S, Matthieu O, Pujol N. The knee meniscus: management of traumatic tears and degenerative lesions. *EFORT Open Rev*. 2017;2(5):195-203. doi:10.1302/2058-5241.2.160056

6. Neyret P, Donell ST, Dejour H. Results of partial meniscectomy related to the state of the anterior cruciate ligament. Review at 20 to 35 years. *J Bone Joint Surg Br*. 1993;75(1):36-40. doi:10.1302/0301-620X.75B1.8421030

7. Aglietti P, Buzzi R, Bassi PB. Arthroscopic partial meniscectomy in the anterior cruciate deficient knee. *Am J Sports Med*. 1988;16(6):597-602. doi:10.1177/036354658801600608

8. Critchley IJ, Bracey DJ. The acutely locked knee--is a manipulation worth while? *Injury*. 1985;16(4):281-283. doi:10.1016/s0020-1383(85)80020-6

9. Hou JH, Gong YL, Ma P, et al. Comparative clinical outcomes of different therapies for traumatic meniscal tears in adults: A protocol for systematic review and network meta-analysis. *Medicine (Baltimore)*. 2022;101(2):e28557. doi:10.1097/MD.0000000000028557

10. Damsted CH; Skou ST; Hölmich P; Lind M; Varnum C; Jensen HP; Hansen MS; Thorlund JB. Early surgery versus exercise therapy and patient education for traumatic and non-traumatic 2 meniscal tears in young adults - an exploratory analysis from the DREAM-trial

Q 2.2) Which components and/or personal factors influence rehabilitation effectiveness in TRAUMATIC meniscus tears?

Statement:
Evidence is lacking in regard to which factors effect rehabilitation of traumatic meniscus tears. Effectiveness may be influenced by factors such as lower extremity alignment, body mass index, medical comorbidities, psychosocial and socioeconomic factors, use of tobacco products, age, occupation, compliance and level of activity. High grade OA, the type, location, and magnitude of the meniscus tear may also play a role in the effectiveness of rehabilitation.

Rating:
Median: 8
Mean: 8.0

Grade of recommendation: D

Literature Summary:
Indications for appropriate patient selection into non-operative rehabilitation management of acute or traumatic meniscus tear are not well established. Specific tear patterns are often unknown within studies investigating exercise-based rehabilitation as a first line treatment, because the diagnosis of meniscus tear is typically based on clinical exam and MR imaging without the benefit of arthroscopy to fully visualize the precise tear location and pattern. Obstructive or locking meniscal tears are typically excluded from exercise-based trials. Most studies compare exercise-based physical therapy to arthroscopic partial meniscectomy (APM) for patients with tears defined as degenerative. Tear categorization as traumatic or degenerative is often based on patient age, mechanism of injury, patient history, tear pattern or associated arthritic joint changes.[1] Swart et al. completed a systematic review and meta-analysis of 12 studies to observe the effect of exercise therapy for patients with meniscus tears.[2] Within the

included studies, only one study included “traumatic” tears; however, this study only looked at exercise as an intervention (compared to no exercise) after APM had been performed, rather than as a first line treatment.[3]

Prognostic indicators (patient characteristics, tear details, activity level, time from injury, etc.) of a favorable response to rehabilitation management for acute or traumatic meniscus tears are not defined in the existing literature. The limited evidence that does exist is specific to degenerative tears and these studies are generally underpowered and lacking in quality.[4]

References:

1. Thorlund JB, Juhl CB, Ingelsrud LH, Skou ST. Risk factors, diagnosis and non-surgical treatment for meniscal tears: evidence and recommendations: a statement paper commissioned by the Danish Society of Sports Physical Therapy (DSSF). *Br J Sports Med*. 2018;52(9):557-565. doi:10.1136/bjsports-2017-098429

2. Swart NM, van Oudenaarde K, Reijnierse M, et al. Effectiveness of exercise therapy for meniscal lesions in adults: A systematic review and meta-analysis. *J Sci Med Sport*. 2016;19(12):990-998. doi:10.1016/j.jsams.2016.04.003

3. Moffet H, Richards CL, Malouin F, Bravo G, Paradis G. Early and intensive physiotherapy accelerates recovery postarthroscopic meniscectomy: results of a randomized controlled study. *Arch Phys Med Rehabil*. 1994;75(4):415-426. doi:10.1016/0003-9993(94)90165-1

4. Kemp JL, Collins NJ, Roos EM, Crossley KM. Psychometric properties of patient-reported outcome measures for hip arthroscopic surgery. *Am J Sports Med*. 2013;41(9):2065-2073. doi:10.1177/0363546513494173

Q 2.3) What rehabilitation interventions are best indicated for management of non-operative TRAUMATIC meniscus tears?

Statement:

The efficacy of various interventions to treat impairments following knee ligament injury have been previously studied but are not specific to meniscus injury. Specific interventions implemented to resolve knee effusion, reduce pain, restore quadriceps strength, and regain joint-specific motor control may be advantageous in treating **TRAUMATIC** meniscus tears (i.e., cryotherapy, open and closed-kinetic-chain exercise, transcutaneous electrical nerve stimulation, neuromuscular electrical stimulation, exercise with blood flow restriction).

Grade of recommendation: D

There is no evidence comparing rehabilitation modalities. At 12 months follow up, a single 2024 study (the-DREAM trial) showed in **TRAUMATIC** meniscus tears (stable knees) that supervised neuromuscular and strength training along with patient education produced similar self-reported outcomes to surgery with the same rehabilitation program.

Comment from Consensus Group:
Research to improve the robustness of this literature is needed.

Grade of recommendation: B

Rating:
Median: 8
Mean: 7.1

Literature Summary:
Exercise is the most common physical therapy intervention investigated for non-operative management of meniscus tears. Most research on exercise-based management of meniscus tears is specific to degenerative tears and insufficient studies exist to conduct a systematic review and/or meta-analysis on the efficacy of exercise as an intervention for acute or traumatic tears. Skou et al.[1] published a prospective randomized controlled trial within a younger population (< 40 years old) with MRI-confirmed meniscus tears comparing exercise to surgical (APM or repair) for early management. They excluded displaced or locked buckle handle tears or patients with underlying ligamentous instability. The exact meniscus tear patterns included within the exercise intervention group were not known, because the diagnosis was based on MRI alone. Only patients randomized into the surgical group (APM or repair) had confirmation of precise tear patterns, as visualized intra-operatively. No significant differences were observed between groups when comparing baseline to 12-month outcomes (KOOS: pain, symptoms, function in sport and recreation, quality of life). There were no significant differences between groups for adverse events associated with the treatment approach. The authors concluded that for young, active patients, early surgery does not yield superior results compared to exercise and education and patients could elect to pursue surgery later if symptoms persist.

In the Randomized Controlled DREAM trial, 121 patients, again under 40 years, but with a wide range of time of symptoms have been included. In this trial the surgical group received APM or Meniscus repair and the conservative group 12 weeks of supervised group based neuromuscular and strengthening exercise therapy and two sessions of patient education. In this trial early surgery resulted in more effective relief of self-reported mechanical knee symptoms, but not in improving pain, function and quality of life.[2]

Despite the results of those studies, no prospective comparative studies are available to estimate the precise effect of one or the other treatment against each other.

Passive interventions are largely under-studied in the context of first-line treatment for acute meniscus tears, including interventions such as blood flow restriction therapy, dry needling, neuromuscular electrical stimulation or shockwave therapy. Such interventions are typically explored as adjunct treatments in a broader rehabilitation protocol. Manual therapy interventions were reported on by Reep et al. through a systematic review reporting on the efficacy of Mulligan Concept “Mobilization with Movement” (MWM) techniques to treat meniscal pathology. They included 6 studies and reported reduction of pain and improvement in function in the short term (1 to 21 weeks) with clinically diagnosed meniscal pathologies.[3] Unfortunately, patients were all included based only on physical examination alone and no MRI to confirm or detail the intra-articular knee pathology. This observation combined with low numbers of patients (72 in all 6 combined) and heterogeneous designs of the included studies all make these results difficult to meaningfully interpret.

Damsted et al. published an RCT (the DREAM-trial) in 121 patients where they randomized into a group of surgery or 12-weeks supervised exercise and patient education. There was no

difference in change in KOOS4 after 12 months between the two treatment groups or between those with traumatic versus non-traumatic tears. Early meniscus surgery regardless of the type of tear did not appear superior to one another. [10]

References:

1. Skou ST, Lind M, Hölmich P, et al. Study protocol for a randomised controlled trial of meniscal surgery compared with exercise and patient education for treatment of meniscal tears in young adults. *BMJ Open*. 2017;7(8):e017436. doi:10.1136/bmjopen-2017-017436

2. Damsted C, Thorlund JB, Hölmich P, et al. Effect of exercise therapy versus surgery on mechanical symptoms in young patients with a meniscal tear: a secondary analysis of the DREAM trial. *Br J Sports Med*. 2023;57(9):521-527. doi:10.1136/bjsports-2022-106207

3. Reep NC, Leverett SN, Heywood RM, Baker RT, Barnes DL, Cheatham SW. The Efficacy of the Mulligan Concept to Treat Meniscal Pathology: A Systematic Review. *Int J Sports Phys Ther*. 2022;17(7):1219-1235. doi:10.26603/001c.55540

4. Damsted CH; Skou ST; Hölmich P; Lind M; Varnum C; Jensen HP; Hansen MS; Thorlund JB. Early surgery versus exercise therapy and patient education for traumatic and non-traumatic 2 meniscal tears in young adults - an exploratory analysis from the DREAM-trial

Q 2.4) Is there an evidence-based non-operative treatment protocol for treating TRAUMATIC meniscus tears?

Statement:

A 12-week supervised neuromuscular exercise program that includes lower extremity strengthening, balance, hip and core strengthening along with patient education has been found to have similar outcomes to those that underwent surgery for **TRAUMATIC** meniscus tears with the same rehabilitation protocol.
However, there is no current evidence comparing evidence-based treatment protocols for treating acute meniscus tears non-operatively. When chosing non-operative treatment for acute meniscus tears management, one may follow criterion-based milestones similar to those followed for post-operative meniscal repairs.

Grade of recommendation: B

Rating:
Median: 8
Mean: 7.5

Literature summary:
The exercise treatment protocol applied by Skou et al.[1] in their study exploring exercise as an early intervention for meniscus tears in younger individuals is well defined and progressive in intensity and was assessed for feasibility in a preliminary study.[2] The Skou protocol is similar to other standardized protocols applied for patients with degenerative tears,[3] and such programs

typically include exercises to address range of motion (ROM), large muscle group strength at the thigh and hip, and neuromuscular or proprioceptive exercises including balance, stability and plyometric training activities.[2,3] More broadly in the literature, precise guidelines related to exercise type, intensity, frequency and overall duration required to achieve optimal outcomes are not precisely defined.[4] Beyond such examples of exercise-based interventions, other evidence-based treatment protocols have not been established.

References:

1. Skou Søren T., Hölmich Per, Lind Martin, et al. Early Surgery or Exercise and Education for Meniscal Tears in Young Adults. *NEJM Evidence*. 2022;1(2):EVIDoa2100038. doi:10.1056/EVIDoa2100038

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Q 2.5) Is outpatient rehabilitation superior to home exercise programs for non-operatively managed TRAUMATIC meniscal tears?

Statement:
There is no current evidence comparing outpatient rehabilitation programs to home exercise programs after **TRAUMATIC** meniscus tears. Supervised rehabilitation for range of motion, effusion management, lower extremity and quadriceps strength and function and neuromuscular control, in addition to a home exercise program may be recommended.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.3

Literature summary:
There are no studies directly comparing the efficacy of home exercise programs to supervised physical therapy for the treatment of acute meniscus tears.

3. Rehabilitation management of non-operated degenerative meniscal lesions

In 2016, the European Society of Sports Traumatology, Knee Surgery and Arthroscopy (ESSKA) published a consensus of the surgical management of degenerative meniscus lesions, which has been confirmed by several initiatives like Fidelity[1], Omex[2], and Escape[3], suggesting an initial non-operative treatment period of at least 3 months making the understanding of rehabilitation relevant for all degenerative meniscal lesions.[4] In 2020, a panel of 20 experts came together in a consensus statement regarding degenerative meniscus lesions. There was 100% expert agreement that meniscal lesions are a physiological part of aging. Not all of these degenerative meniscus lesions cause symptoms, but when they are symptomatic the initial treatment should be non-operative.[5]

References:

1. Sihvonen R, Paavola M, Malmivaara A. Finnish Degenerative Meniscal Lesion Study (FIDELITY) Group: Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *N Engl J Med*. Published online 2013.

2. Kise NJ, Roos EM, Stensrud S, Engebretsen L, Risberg MA. The 6-m timed hop test is a prognostic factor for outcomes in patients with meniscal tears treated with exercise therapy or arthroscopic partial meniscectomy: a secondary, exploratory analysis of the Odense-Oslo meniscectomy versus exercise (OMEX) trial. *Knee Surg Sports Traumatol Arthrosc*. 2019;27(8):2478-2487. doi:10.1007/s00167-018-5241-7

3. Noorduyn JCA, van de Graaf VA, Willigenburg NW, et al. Effect of Physical Therapy vs Arthroscopic Partial Meniscectomy in People With Degenerative Meniscal Tears: Five-Year Follow-up of the ESCAPE Randomized Clinical Trial. *JAMA Netw Open*. 2022;5(7):e2220394. doi:10.1001/jamanetworkopen.2022.20394

4. Beaufils P, Becker R, Kopf S, Matthieu O, Pujol N. The knee meniscus: management of traumatic tears and degenerative lesions. *EFORT Open Rev*. 2017;2(5):195-203. doi:10.1302/2058-5241.2.160056

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Q 3.1) Is non-operative management as beneficial as arthroscopic partial meniscectomy for treating symptomatic DEGENERATIVE meniscus lesions?

Degenerative meniscus lesions can be treated with comparable results with either non-operative (including physical therapy) or surgical approach. Therefore, non-operative treatment including physical therapy should be the first approach. In case of persistent symptoms despite non-operative treatment, arthroscopic partial meniscectomy might be considered.

Grade of recommendation: A

Previous surgical meniscus consensus recommends 3-6 months of non-operative treatment prior to surgical decision making.

Today, prognosis classifications assessing severity of degenerative meniscus lesions and severity of symptoms are missing and needed. This could help to determine the timing of surgery.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.9

Literature Summary:
Literature of high level of evidence is available on the topic.

A systematic review done by Zhang et al.[1] concluded that existing evidence is insufficient to determine whether exercise alone or the combination of surgery and exercise is the most effective for pain relief. Even though the presented result of ranking (SUCRA) values suggested that supervised exercise combined with surgery was the most effective treatment for reducing short-term and mid-term pain relief, the authors highlighted that this finding may be a result of statistical probability. The results of the meta-analysis showed no significant difference between different interventions. Wijn and colleagues did not find evidence to favor surgery or conservative treatment approach in their Systematic Review.[2]

Another systematic review done by Fernandez-Matias et al.[3] included six trials comparing arthroscopic partial meniscectomy with non-surgical treatment (exercise therapy) and found no differences in pain (at rest and during activity) between groups.

A seven-center randomized controlled trial was completed on 351 patients with a symptomatic meniscal tear and evidence of mild-to-moderate osteoarthritis on imaging assigned to receive standardized physical-therapy or surgery + standardized physical therapy.[4] Results showed no significant differences between the two groups in pain relief assessed by the pains score on the Knee Injury and Osteoarthritis Outcome Scale (KOOS) after 6 and 12 months.[4]

Thirty percent from the conservative group needed surgery at a later timepoint than inclusion. In a noninferiority trial testing arthroscopic partial meniscectomy (including degenerative and traumatic meniscus tears) compared to physical therapy, knee pain during weight-bearing measured on a visual analog scale (VAS; range, 0-100 with 0 as ‘no pain’ and 100 as ‘worst pain imaginable’) was not different between groups over a 24-month follow-up period.[5] In a comparative study of meniscectomy and nonoperative treatment for degenerative tears of the medial meniscus, pain relief as measured using a VAS was not different between arthroscopic

meniscectomy and nonoperative management with strengthening exercises after 2-years of follow-up.[6]

A pilot study comparing the effectiveness of conservative therapy involving medical exercise therapy versus arthroscopic surgery in patients with degenerative meniscus tears suggested that arthroscopy was not better than exercise therapy regarding knee pain as measured by a VAS.[7] A prospective randomized study comparing arthroscopic and conservative treatment using exercise alone for degenerative medial meniscal tears showed that pain, as measured by a VAS, KOOS pain scale, and Lysholm knee scoring scale was not different between groups after 8 weeks of physical rehabilitation. Of note, in this study patients who were randomized to the arthroscopic partial meniscectomy group also completed supervised exercise therapy for 8 weeks after their surgery.[8] Conflicting evidence, however, in a study on adults with meniscus tears comparing exercise therapy with a meniscectomy shows that the group undergoing surgery had significantly less pain at 3-months and 12-months than the non-surgery group as measured by the KOOS pain subscale.[9] Manual therapy seems to have a positive effect in the treatment of degenerative meniscus.[10]

References:

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2. Wijn SRW, Hannink G, Østerås H, et al. Arthroscopic partial meniscectomy vs non-surgical or sham treatment in patients with MRI-confirmed degenerative meniscus tears: a systematic review and meta-analysis with individual participant data from 605 randomised patients. *Osteoarthritis Cartilage*. 2023;31(5):557-566. doi:10.1016/j.joca.2023.01.002

3. Fernández-Matías R, García-Pérez F, Gavín-González C, Martínez-Martín J, Valencia-García H, Flórez-García MT. Effectiveness of exercise versus arthroscopic partial meniscectomy plus exercise in the management of degenerative meniscal tears at 5-year follow-up: a systematic review and meta-analysis. *Arch Orthop Trauma Surg*. 2023;143(5):2609-2620. doi:10.1007/s00402-022-04579-y

4. Katz JN, Brophy RH, Chaisson CE. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *N Engl J Med*. Published online 2013.

5. van de Graaf VA, Noorduyn JCA, Willigenburg NW, et al. Effect of Early Surgery vs Physical Therapy on Knee Function Among Patients With Nonobstructive Meniscal Tears: The ESCAPE Randomized Clinical Trial. *JAMA*. 2018;320(13):1328-1337. doi:10.1001/jama.2018.13308

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9. Gauffin H, Tagesson S, Meunier A, Magnusson H, Kvist J. Knee arthroscopic surgery is beneficial to middle-aged patients with meniscal symptoms: a prospective, randomised, single-blinded study. *Osteoarthritis Cartilage*. 2014;22(11):1808-1816. doi:10.1016/j.joca.2014.07.017

10, Hudson R, Richmond A, Sanchez B, Stevenson V, Baker RT, May J, Nasypany A, Reordan D. AN ALTERNATIVE APPROACH TO THE TREATMENT OF MENISCAL PATHOLOGIES: A CASE SERIES ANALYSIS OF THE MULLIGAN CONCEPT "SQUEEZE" TECHNIQUE. Int J Sports Phys Ther. 2016 Aug;11(4):564-74. PMID: 27525181; PMCID: PMC4970847.

Q 3.2) What components, and personal factors of a DEGENERATIVE meniscal lesion make rehabilitation most effective?

Statement:
There is no evidence to support or refute that knee specific factors or personal factors increase or decrease the likelihood of successful outcome with rehabilitation after degenerative meniscal lesion (including degenerative flap or unstable tears). However, high grade of OA, high BMI, and longer duration of symptoms may negatively influence the outcomes.

Grade of recommendation: D

Rating:
Median: 8
Mean: 8.3

Literature Summary:
There is one systematic review and meta-analysis from Wijn et al.[1], one systematic review from Eijgenraam[2] and one randomized controlled superiority trial by Kise et al[3] about this topic. The systematic review by Wijn et al.[1] is focused on identifying patients that benefit from APM versus physical therapy alone and is in large part influenced by the studies from Sihvonen et al.[4], Katz et al.[5], and van de Graaf et al.[6]

The conclusion of this review is that they were unable to identify any subgroup of patients that benefitted from APM compared to non-surgical or sham treatment.

The systematic review from Eijgenraam et al.[2] concludes that prognostic factors for worse clinical outcome after APM are: long duration of symptoms (over one year), radiological OA and resecting over 50% of meniscus. Kise et al.[3] compared exercise therapy alone versus APM alone and concluded that there is no clinically relevant difference (KOOS scale) two years after given treatment.

There are no studies specifically aimed at finding the relationship between certain types of degenerative meniscus injury and rehabilitation. The protocols in the abovementioned studies have been generalized with the same treatment given to patients undergoing APM, sham surgery or physical therapy alone.

References:

1. Wijn SRW, Hannink G, Østerås H, et al. Arthroscopic partial meniscectomy vs non-surgical or sham treatment in patients with MRI-confirmed degenerative meniscus tears: a systematic review and meta-analysis with individual participant data from 605 randomised patients. Osteoarthritis Cartilage. 2023;31(5):557-566. doi:10.1016/j.joca.2023.01.002

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6. van de Graaf VA, Noorduyn JCA, Willigenburg NW, et al. Effect of Early Surgery vs Physical Therapy on Knee Function Among Patients With Nonobstructive Meniscal Tears: The ESCAPE Randomized Clinical Trial. JAMA. 2018;320(13):1328-1337. doi:10.1001/jama.2018.13308

Q 3.3) What rehabilitation treatment is best indicated for the management of non-operated degenerative meniscus lesion?

Statements:
Manual therapy, joint mobilization techniques, range-of-motion exercises, progressive knee and hip musculature strength training, and neuromuscular training may be applied. Also, neuromuscular stimulation can be added. Homebased exercise programs should be added to supervised physical therapy.

Grade of recommendation: B

When not contraindicated, blood flow restriction training can be used to enhance strengthening efforts, maximize low intensity exercise or manage symptoms associated with exercise.
Knee bracing can be considered for symptom management and/or an improved perception of joint stability.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.7

Comment from the consensus group: Rehabilitation is not the only non-operative option. There are other possible treatments as rest, NSAID, intraarticular or perimeniscal injections. However, they are out the scope of this consensus and their usefulness (in conjunction or in place of rehabilitation) will not be discussed.

Literature Summary:
There is a paucity of literature to describe a specific rehabilitation protocol for treating non-operatively degenerative meniscus tears with outcomes-based evidence.

In 2018, Orthopaedic Section of the American Physical Therapy Association (APTA) published guidelines related to meniscus and articular cartilage lesions. While not all was applicable to degenerative meniscal tears, the recommendation of the interventions section was to include progressive range-of-motion exercises, progressive knee and hip musculature strength training, and neuromuscular training with neuromuscular stimulation.[1]

In 2019 a combined physician, physical therapists, and researchers at Harvard developed the TeMPO physical therapy interventions and home exercise program for the degenerative meniscus tear in the setting of concomitant osteoarthritis. This formulates a supervised and non-supervised rehabilitation program to include manual therapy, stretching, gluteus maximus, gluteus medius, quadriceps and hamstring strengthening as well as functional exercise in combination with a home-based program for the same muscles. Being a consensus-based recommendation only, this article lacks results on effectivity.[2]

Looking specifically at open kinetic chain versus closed kinetic chain exercises for degenerative meniscal tears, both exercises were associated with improved range of motion, pain, and functional performance.[3]

Blood flow restriction and bracing effects have not been specifically studied for degenerative meniscus tears.

A 20 patient case series was published that describes a 12-week program combining neuromuscular- and strength-training exercises for treatment of degenerative meniscus tears that led to improved patient reported outcomes with 17/20 maintaining that they felt “a lot better” at a year. For strength outcomes, 45% maintained peak knee flexion torque and 65% maintained peak knee extension torque at one year.[4]

References:

1. Logerstedt DS, Scalzitti DA, Bennell KL, et al. Knee Pain and Mobility Impairments: Meniscal and Articular Cartilage Lesions Revision 2018. *J Orthop Sports Phys Ther*. 2018;48(2):A1-A50. doi:10.2519/jospt.2018.0301

2. Safran-Norton CE, Sullivan JK, Irrgang JJ, et al. A consensus-based process identifying physical therapy and exercise treatments for patients with degenerative meniscal tears and knee OA: the TeMPO physical therapy interventions and home exercise program. *BMC Musculoskelet Disord*. 2019;20(1):514. doi:10.1186/s12891-019-2872-x

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Q 3.4) Is outpatient rehabilitation superior to home-based exercise programs for non-operatively managed DEGENERATIVE meniscal lesions?

Statement:

Supervised outpatient rehabilitation and home-based exercise have not been compared yet. Supervised rehabilitation for range of motion, effusion management, muscle strength, knee function and neuromuscular control, in addition to a home exercise program may be recommended.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.9

Literature Summary

In 2019 a combined physician, physical therapists, and researchers at Harvard developed the TeMPO physical therapy interventions and home exercise program for the degenerative meniscus tear in the setting of concomitant osteoarthritis. This formulates a supervised and non-supervised rehabilitation program to include manual therapy, stretching, gluteus maximus, gluteus medius, quadriceps and hamstring strengthening as well as functional exercise in combination with a home-based program for the same muscles. Being a consensus-based recommendation only, this article lacks results on effectivity. (1)

References:

1. Safran-Norton CE, Sullivan JK, Irrgang JJ, et al. A consensus-based process identifying physical therapy and exercise treatments for patients with degenerative meniscal tears and knee OA: the TeMPO physical therapy interventions and home exercise program. *BMC Musculoskelet Disord*. 2019;20(1):514. doi:10.1186/s12891-019-2872-x

4. Is pre-rehabilitation recommended prior to planned surgery of the meniscus?

Q 4.1) What clinical presentation or examination findings are indications or contraindications for pre-rehabilitation for surgical management of a meniscus injury?

Statement:
Pre-rehabilitation may be beneficial prior to meniscus surgery for those that have a joint effusion, limited range of motion, pain or quadriceps inhibition (i.e. poor quadriceps set and knee extensor lag during straight leg raise and/or altered gait).
The consensus group recommends immediate referral to a surgeon in the presence of a mechanically locked knee.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.7

Literature Summary

The question of whether mechanical locking presents a contraindication for conservative treatment continues to spark debate. Among patients experiencing "mechanical symptoms" such as the sensation of knee catching or locking, surgery is often advocated as the primary beneficial intervention.[1-5]

References

1. Sihvonen R, Englund M, Turkiewicz A, Järvinen TL; Finnish Degenerative Meniscal Lesion Study Group. Mechanical Symptoms and Arthroscopic Partial Meniscectomy in Patients With Degenerative Meniscus Tear: A Secondary Analysis of a Randomized Trial. Ann Intern Med. 2016 Apr 5;164(7):449-55. doi: 10.7326/M15-0899. Epub 2016 Feb 9. PMID: 26856620.
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Q 4.2) Is pre-rehabilitation recommended prior to surgery for isolated TRAUMATIC medial or lateral meniscus tears?

Statement:
There is no evidence related to the benefits or harms of pre-rehabilitation before surgical treatment of traumatic meniscus tears.

However, evidence in those undergoing ACL reconstruction (with and without meniscal pathology), pre-rehabilitation that focuses on reducing joint effusion, and exercises to improve range of motion and quadriceps and hamstring activation and strength may be considered prior to isolated or combined meniscus surgery and have an effect on better outcomes post-surgery.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.9

Q 4.3) Is pre-rehabilitation recommended prior to surgery for DEGENERATIVE meniscus lesions?

Statements:
Non-operative treatment including rehabilitation is the first line of treatment of degenerative meniscus lesions.

Grade of recommendation: A

In case of decision for surgery, pre-rehabilitation may be beneficial for those that have a joint effusion, limited range of motion, quadriceps inhibition (i.e. poor quadriceps set and knee extensor lag during straight leg raise and/or altered gait).

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.1

Q 4.4) What are the objective outcomes that need to be met at the end of pre-rehabilitation prior to planned meniscal surgery?

Statement:
Objective outcomes at the end of pre-rehabilitation prior to surgery for a traumatic meniscus tear or a degenerative meniscus lesion may include obtaining a quiet knee (no effusion or warmth), nearly full range of motion, a strong quadriceps contraction and ability to perform a straight leg raise without a knee extensor lag.

Grade of recommendation: D

Rating:
Median: 8
Mean: 8.3

Literature Summary

There was no literature available to speak to the use of pre-operative rehabilitation in the case of an isolated meniscus injury. Data exists to support the use of pre-operative rehabilitation with combined injuries (i.e., ACL reconstruction + meniscus involvement) in knee function and self-reported quality of life measured by KOOS and IKDC.[1-5] There is literature in individuals with degenerative meniscus tears that were randomized either to immediate arthroscopy or a 12 week rehabilitation program. These data suggest pre-operative muscle strength deficits of 20.7% ± 16.3% are prominent in patients with degenerative meniscus tears that improves after 12 weeks of progressive supervised exercise therapy to 13.3% ± 17.8%.[6] Similarly, better knee performance (i.e., 6-m timed hop test result) pre-operatively in middle-aged patients with degenerative meniscal tears treated with either exercise alone or arthroscopic partial meniscectomy was a significant prognostic factor for less knee pain and better knee function after 2 years. Across the whole cohort, a 1-s better 6-m timed hop test pre-operatively was associated with 3.1-7.1 points better (95% CIs 1.1-5.2 to 4.1-10.1 points) on all KOOS subscales after 2-years.[7]

References:

1. Failla MJ, Logerstedt DS, Grindem H, Axe MJ, Risberg MA, Engebretsen L, et al. Does Extended Preoperative Rehabilitation Influence Outcomes 2 Years after ACL Reconstruction? A Comparative Effectiveness Study between the MOON and Delaware-Oslo ACL Cohorts: Am J Sports Med. 2016;44(10):2608–14.

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5. Rehabilitation management after partial meniscectomy

Q 5.1) What rehabilitation treatment is best indicated for the management of patients after isolated partial meniscectomy? Is there an evidence-based treatment protocol?

Statement:
No evidence-based treatment protocol exists. A criterion-based rehabilitation protocol, based on milestones, is recommended. Following partial meniscectomy, immediate full weight-bearing and full range of motion are permitted as tolerated per symptoms.

Grade of recommendation: C

Although large effusions are uncommon after partial meniscectomy, they occasionally do occur and can lead to significant quadriceps inhibition that may require use of an assistive device, particularly in older people and those with high BMI or other comorbidities.

Grade of recommendation: D

To address quadriceps strength and neuromuscular control deficits, the use of NMES, OKC, and CKC strengthening is recommended as is seen in similar patient populations (i.e. after ACLR).

Grade of recommendation: C

Rating:
Median: 8
Mean: 8.4

Literature Summary

Systematic Reviews: A systematic review that included 18 RCTs out of which 6 were pooled in meta-analysis, was published in 2013.[1] When comparing outpatient physical therapy with home exercise to home exercise alone, significant improvement was found in favor of the outpatient physical therapy group for the outcome of patient-reported knee function on the Lysholm questionnaire, and for the knee flexion ROM. In other outcomes, outpatient physical therapy group did not show significant difference. Inpatient physical therapy proved superior to outpatient in knee effusion outcome. Evaluating modalities alone indicated that isokinetic training, EMG biofeedback, and electrical stimulation are effective for this condition, with EMG biofeedback with most promising results. The conclusion of this systematic review is that knee pain, lack of mobility, effusion, and thigh atrophy are the most common clinical findings after a partial arthroscopic meniscectomy procedure. At the end of the discussion they provide expert opinion that the treatment should include outpatient care and a home exercise program, and that it should be performed at least 3 times a week and start as soon as possible (preferably not more than 3 days). The following interventions are advised: early weight bearing, progressive knee mobilization exercises, quadriceps and hamstrings strengthening exercises (dynamic and isometric), sensory motor training, thermotherapy, and an early return to activities. It may use adjuvants such as neuromuscular electrical stimulation, EMG biofeedback, and isokinetics.[1]

A systematic review of older date (2001) concluded that home-based exercise program should be sufficient after partial meniscectomy.[2] Comparing home based and supervised rehabilitation, no difference was observed in terms of physical and functional outcomes, as well as work-related and patient-reported outcomes, both at short-term and midterm follow-up.[3]

Modalities: Concerning the Neuromuscular Electrical Stimulation (NMES), a systematic review concluded that regaining quadriceps strength is of high importance after knee surgery. This review included 8 RCTs which used NMES after different knee surgeries. Their conclusions have to be interpreted cautiously for partial meniscectomy patients because patients with other knee surgeries (eg. ACL reconstruction) have different ROM after surgery and different initial postsurgical tissue damage.[4] Only one RCT included in this systematic review was in patients in whom partial meniscectomy was performed.[5] It is an outdated study, which concluded that NMES and quadriceps strengthening exercise were not superior to the same exercise program alone except for quadriceps output at high speeds.[5] Another study had three groups and compared home exercise, electromyographic biofeedback training and electrical stimulation therapy to quadriceps muscle in patients after partial arthroscopic meniscectomy. Electromyographic biofeedback training showed superior results in lesser time of using walking aids, Lysholm score, and vastus medialis and lateralis muscle power compared to home exercise program, while electrical stimulation did statistically the same like home rehabilitation program.[6] In one RCT, in patients following partial meniscectomy, a functional exercise program comprised of postural stability training and functional strength, and endurance exercises for leg and trunk muscles yielded superior results in functional performance and thigh muscle strength compared to no intervention group.[7] In one study of older date, TENS was proven to have positive analgesic effects compared to the true placebo (non-working units) and the control (no units).[8] A recent meta-analysis showed that proprioceptive training is advised for patients after arthroscopic partial meniscectomy, with higher proprioception test, knee extensor muscle strength, knee flexor muscle strength and knee function scores (Lysholm and KOOS) compared with conventional training group.[9] Proprioceptive training included balance enhanced training, plyometric stretch-contraction cycles, knee dynamic stability, proprioception and agility exercises. A systematic review from 2023 including 9 RCTs concluded that strength-based rehabilitation (squats, lunges, knee extension, bicycle, etc.) showed no significant differences in quadriceps or hamstring strength measures between pre- and post-intervention for exercise and control groups. KOOS scores significantly increased from pre- to post-intervention in both control and exercise groups. VAS score was superior in exercise compared to control group.[10] One RCT included in this review found that the exercise group continued to have lower pain and better function 12 months after surgery, even though the program lasted only for 3 months, while the control group did not have such favorable results.[11] A study showed that early, protected active ROM exercise on a bicycle ergometer equipped with an adjustable pedal arm demonstrated improved gait performance in patients after partial meniscectomy.[12] One RCT showed that after partial meniscectomy, isokinetic eccentric training is more effective than conventional eccentric training to restore quadriceps muscle mass, strength, and functional capacity by Lysholm score.[13]

Protocols: A study was released that compared written protocols from 62 orthopedic institutions which offered 15 protocols related to partial meniscectomy. There is a consensus concerning full weight bearing and full ROM. Recommendation for full weight bearing start from the second postoperative week and full ROM is permitted immediately after surgery in all recommendations. The utilization of orthosis is not supported. Continuous active motion is recommended by the majority of the evaluated protocols for 4 postoperative weeks. Supporting rehabilitation training (e.g. cycling, strength training) was recommended to start after 3 weeks and specific training after 7 weeks.[14] An RCT investigated the effect of a 12-week exercise program that would cause medial

knee compartment unloading in patients after partial meniscectomy of medial meniscus. It showed no difference compared to the “no intervention group”.[15] A similar study in patients 3–12 months after partial meniscectomy of medial meniscus, showed a neuromuscular exercise program did not alter the peak knee adduction moment, a key predictor of osteoarthritis structural disease progression.[16]

Orthosis use: Concerning braces and insoles for compartment-unloading, it was concluded that 12 weeks with either a knee brace or wedge insoles was ineffective with regard to clinical outcome after partial meniscectomy. We have to note that 90% of the patients had a medial meniscus partial meniscectomy.[17]

Uninjured leg: A study was performed that advised the rehabilitation of the uninjured leg. There were no differences between the isokinetic, isotonic, and home exercise program group in isokinetic performance and functional performance with the single jump, triple jump and vertical jump.[18]

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Q 5.2) Is there a difference between rehabilitation proposed after medial or lateral partial meniscectomy)?

Statement:
There are no specific rehabilitation protocols after medial or lateral partial meniscectomy. More adverse events (Persisting swelling and pain, risk of early chondrolysis) may happen after lateral partial meniscectomy which may result in delayed return to higher impact activities and sports compared to medial partial meniscectomy.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.8

Literature Summary
For lateral meniscus tears, meniscectomy was associated with a high rate of revision surgery and risk of chondrolysis, whereas partial medial meniscectomy allowed for rapid return to play (RTP) but with the potential risk of developing knee osteoarthritis over the years.[1] A significant difference of RTP was noted between lateral and medial meniscus (49 days versus 35 days) in professional athletes. Lateral meniscectomy has a higher incidence of adverse events in the early recovery period, including pain/swelling and the need for further arthroscopy. It is also associated with a significantly lower rate of return to play.[2] Another study showed opposite results, with lateral meniscectomy patients returning to play faster (61 days compared to 79 days, respectively), but still, with higher percentage of adverse effects.[3] In cases where chondrolysis is suspected after partial meniscectomy of the lateral meniscus, immediate cessation of weight bearing and administration of intra-articular steroids is recommended.[4] In the same paper the authors' advise: "in those who require a significant meniscal resection of lateral meniscus it would be prudent to delay their return to sports with a slower, more graduated rehabilitation program. The lateral off-loading brace could be beneficial.". We have to stress that this is an expert opinion, not citing any reference to a study.[4]

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Q 5.3) Is there any difference between traumatic meniscus tears and degenerative meniscus lesions in terms of rehabilitation after partial meniscectomy?

Statement:
There is no comparative data to support any difference between rehabilitation protocols for partial meniscectomy for degenerative lesions and traumatic tears. Rehabilitation protocols can vary based on patient factors and the status of the knee post-operatively. Partial meniscectomy for degenerative lesions may require slower rehabilitation progression.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.8

Literature Summary

Reports from the early 1980s suggested poorer results in individuals with degenerative changes undergoing arthroscopic meniscectomy compared to acute tears. Studies of newer date report similar outcomes 1-2 years after surgery and slightly better after 4 years for acute tears. The most recent study reports better PROs after partial meniscectomy in degenerative meniscus tears, but still without clinically meaningful difference. There is data regarding PROs and degenerative changes following arthroscopic partial meniscectomy following acute and degenerative tears. However, no literature exists regarding rehabilitation measures following these procedures and therefore no recommendations can be made for this question.[1]

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Q 5.4) Should non-weight-bearing or partial weight-bearing be recommended after arthroscopic partial meniscectomy?

Statements:

After arthroscopic partial meniscectomy full weightbearing is allowed early after surgery.

Grade of recommendation: A

The usage of crutches may be recommended for mobility until gait is normalized.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.4

Literature Summary

A systematic review and meta-analysis concluded that early weightbearing should be encouraged.[1] Also, early weightbearing was part of early and intensive physiotherapy program that yielded positive results.[2] The study that examined 15 different institutions' protocols concluded that all protocols advised full weight-bearing second week after surgery.[3]

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Q 5.5) For how long is rehabilitation recommended after arthroscopic partial meniscectomy? What persisting signs and/or symptoms during rehabilitation require a referral to a surgeon (for example, includes time from injury or surgery, rom, pain, swelling, and activity limitations)?

Statement:
There are multiple rehabilitation guidelines for return to walking, work and sport with timeframes often ranging between 4 and 12 weeks. However, rehabilitation after arthroscopic partial meniscectomy should be criterion based and not time based. Return to these activities requires meeting progressive milestones throughout rehabilitation (e.g., effusion, range of motion, quadriceps strength, neuromuscular control) and not just meeting healing time frames.

Grade of recommendation: B

Patients should be referred to an orthopedic surgeon in cases of persistent pain, recurrence of stiffness and/or effusion, persistent functional instability, mechanical symptoms, any neurological symptoms, suspicion of infection or DVT.

Grade of recommendation: B

The inability to reach clinical milestones related to knee symptoms indicates a referral to the orthopedic surgeon.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.2

Literature Summary

Continuous active joint range of motion is recommended by the majority of the evaluated protocols for 4 postoperative weeks. Supporting rehabilitation training (e.g. cycling, strength training) was recommended to start after 3 weeks and specific sport training after 7 weeks.[1]

For athletes, a recent publication gave the protocol of their institution; post-meniscectomy protocols range from 8 to 12 weeks, and incorporate a variety of modalities including electrotherapy, cryotherapy, and progressive resistance exercises.[2] Also, other authors developed an 8-week rehabilitation program specifically tested on athletes between the ages of 18 and 35 that included hydrotherapy and massage therapy. The program led to better outcomes when compared to a conventional rehabilitation protocol.[3] It has to be stressed that these protocols are not always based on strong, evidence-based data.

A relatively outdated study from 1992, where the open meniscectomy was performed and the knee was in plaster until day 9 postoperatively, made a comparison between inpatient and outpatient physical therapy regimen. Both groups had similar times in days to return to work (55 days).[4] A more recent study showed more favorable outcomes for a supervised program compared to home program (18 days for return to work compared to 30 days, respectively).[5] Also, there was an older review article that gave much more optimistic prognosis, when arthroscopic surgery was in its beginnings: following arthroscopic meniscectomy, patients are routinely able to walk without support within 1 to 3 days, return to work after 1 to 2 weeks, resume athletic training by 2 to 4 weeks and return to competition in 3 to 4 weeks.[6] Also, an older study from the beginnings of arthroscopic surgery showed that patients after partial meniscectomies are ready to return to work after 3 weeks and to sport activities after 7 weeks.[7] Generally, after partial meniscectomy, athlete RTP is quicker than after meniscal repair (7-9 weeks compared to 5.6 months).[8] One study also concluded that 77% of patients returned to sport after meniscectomy at a mean of 2 months postoperatively and that higher preoperative scores on the KOOS-PS and KOOS-Pain were predictive of earlier RTP.[9]

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6. Rehabilitation management after meniscus repair

Basic science has demonstrated the crucial role of the menisci in the knee homeostasis a long time ago. It also demonstrated the repairability of the meniscus thanks to the peripheral vascularity which allows a healing process. This healing process may take up to 6 months, and it can interfere with the rehabilitation protocol. That's why the rehabilitation protocols after meniscus repair differ from the protocols after partial meniscectomies. Repaired meniscus lesions are mainly traumatic and we will use the same classification used for the traumatic meniscus consensus[1] Ramp lesions, complete radial tears and root lesions will also be separately discussed. The same main questions related to rehabilitation will be discussed independently for all repaired tears, such as limitation of range of motion, limitation of weight bearing, usefulness of bracing, self-rehabilitation or guided protocols.

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Q 6.1) What rehabilitation treatment is best indicated for the management of meniscal repair? Is there an evidence-based treatment protocol?

Statements:

Whilst no one evidence-based rehabilitation protocol has been shown to be superior to another, postoperative rehabilitation should consider the meniscal tear pattern and zone of injury, tissue quality and vascularity, surgical repair technique, repair stability and any patient specific characteristics known to influence the surgical prognosis.

Grade of recommendation: D

For isolated meniscal repair, no evidence exists for the use of specific rehabilitation protocol or adjuvant therapies. For knee surgeries where there is concomitant meniscal repair NMES, in the early post-operative phase, may help in recovery of quadriceps activation.

Grade of recommendation: D

Combined time and criterion-based protocols can be recommended. Management of effusion should be addressed in the protocol.

Grade of recommendation: D

Rehabilitation should be progressed according to both time and criterion-based milestones. A minimum of 4-months of rehabilitation may be recommended for repaired vertical tears of the meniscus, whereas complex, complete radial/root, and horizontal tears may require a longer duration of rehabilitation (i.e., 6 to 9 months).

Grade of recommendation: D

Rating:
Median: 8
Mean: 8.3

Literature summary

Rehabilitation protocols following meniscal repair vary widely and have been changing in the last 20 years according to the new suturing devices and techniques.

Early protocols were more conservative and recommended immobilization in full extension even for 6 weeks associated to no weight bearing (NWB) between 2 and 6 weeks.[1,2]

The more recently described protocols allow weight bearing as well as knee motion in the first weeks but with high variability of protocols between countries and centers.[3,4]

Carder (2021) compared publicly available rehabilitation protocols designated for meniscal repairs published online to determine variability in meniscus repair post operative protocols including different types of tears (radial vs non radial). Most of the protocols they found were outdated and incomplete. They recommended surgeons review existing protocols and update them.[5] Within the literature there is a huge variation in post operative weight bearing status, use of brace and rate of progression through rehabilitation.[6,7] Generally speaking we can divide the protocols in 3 categories: weight bearing restricted, double restricted (both weight bearing and ROM) or free protocols (weight bearing and ROM as tolerated).

Some authors (expert opinion, level of evidence 5) tried to indicate an evidence-based protocol taking into account cadaveric and biomechanical studies: when the hoop tensile stress effect is preserved, an accelerated rehabilitation program may be suggested. Hence, partial weight bearing in association with range of motion (ROM) limited to 90° is allowed for the first four weeks, followed by weight bearing as tolerated, strengthening exercises with weights starts after three months. In contrast, when circumferential hoop fibers are disrupted (root or radial tears), a restricted rehabilitation protocol may be recommended. In this scenario no weight bearing is allowed for the first six weeks after the surgery and range of motion is limited to 90°, strengthening is delayed by one month.[8,9]

One RCT (level of evidence 1) study supports this recommendation in isolated vertical meniscal lesion. Two different rehabilitation protocols have been compared: in one group free rehabilitation was indicated, it consisted of 2 weeks of ROM 0-90º without brace and touch weightbearing, with unrestricted activity and free ROM allowed thereafter. In the second group a restricted rehabilitation protocol was adopted, it consisted of 6 weeks of hinged brace use with a gradual increase ROM to 90º and only touch weightbearing during the 6 weeks. The study concluded that a free rehabilitation protocol in this kind of meniscus repair is safe and does not entail increased failure rates. Furthermore, subjective and functional outcomes at 1- and 2-year follow-up were not affected by rehabilitation regimen.[10]

On the other hand, Dai W et al published a meta-analysis that partially contrast with these recommendations. They tried to identify the healing rates after arthroscopic repair of meniscal tears via second-look arthroscopic evaluation. 41 studies were included in the meta-analysis. There were 2 RCT and the remaining studies were observational studies. For the observational studies, 7 were judged to be at low risk of bias and 32 were judged to be at high risk of bias. They

observed that when the rehabilitation protocol was weight restricted, the complete healing rate was 92%, which was higher than that for the motion restricted (82%), dual restricted (70%), and accelerated (both motion and weight were not restricted) strategy groups (73%).[11]

A meta-analysis including 27 studies evaluated results of meniscal repair at follow up greater than 5 years (level of evidence IV). It analyzed 1630 meniscal repair with insufficient sub-analysis by tear type. Radial, root and horizontal cleavage were excluded. No differences in full weight bearing, partial weight bearing, or no weight bearing have been observed. Furthermore, no significative difference in failure among different method of immobilization (bracing, casting, splinting, no immobilization) have been presented.[12]

There was only one study evaluated in this meta-analysis that directly compared (in a retrospective manner) WB and NWB concluding that WB as tolerated after meniscal repair for isolated vertical tears does not result in a higher failure rate than traditional NWB over a five-year follow-up period.[13]

One meta-analysis was performed only including studies comparing the clinical outcomes between accelerated (immediate range of motion and weight-bearing) and restricted rehabilitation (immobilization and progressive weightbearing) for meniscus suture. Eleven studies with 612 patients were eligible for analysis. 4 were RCTs, 5 were retrospective studies, and 2 were prospective studies. Based on the Oxford Center for Evidence Based Medicine grading, 4 were in level 1, 2 were in level 2, and 5 were in level 3. For the patients after isolated meniscus suture, the accelerated group achieved higher Lysholm scores than the restricted group.[14]

One level I systematic review analyzed 8 RCT to evaluate the usefulness of NMES. It concluded that grade B evidence exists to support the use of NMES to aid in the recovery of quadriceps strength after knee surgery in general, but no RCT was specific about meniscal repair. One study was on meniscectomized knee, two after total knee prosthesis and the other 5 after ACL reconstruction. In the cohorts of patients that underwent ACL reconstruction some had also meniscal repair, but no subgroup analysis was done. Based on the parameters utilized by studies demonstrating optimal treatment effects, it is recommended to implement NMES treatment during the first 2 postoperative weeks at a frequency of ≥50 Hz, at maximum tolerable intensity, with a biphasic current, with large electrodes and a duty cycle ratio of 1:2 to 1:3 (2- to 3-second ramp).[15]

Looking to the return to sport (RTS) after a meniscal repair, Eberbach et al. analyzed 28 studies. Of the studies included, one was level I evidence, another was level II evidence, two were level III evidence, and 24 were level IV evidence. Regarding postoperative rehabilitation: partial weight bearing was allowed at an average of 1.1 weeks (range 0–4) and full weight bearing after 5.0 weeks postoperatively (range 3–10). Full flexion was allowed at a mean of 5.7 weeks (range 4–8) and return to normal activity including sports was allowed on average at 4.3 months postoperatively (range 1–6). 89% of all the patients were capable of RTS to their preinjury activity level, with a slight difference between mixed-level populations (90%) and professional athletes (86%).[16]

More recently Blanchard et al. published another systematic review, investigating RTS rate after meniscal repair. They evaluated 21 studies: 4 were prospective, 6 were retrospective, 4 were case reviews, and 7 were case studies (evidence level 4). 83.1% athletes were able to return to play with a mean return of 8.7 months (range, 3.4-30.0 months). The influence of the rehabilitation protocols has not been analyzed.[17]

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Q 6.2) How does location of meniscus tear/repair (i.e. stable, unstable, root tear, complex tear, white zone tear, etc.) influence the progression of rehabilitation after repair (ie. ROM, weightbearing, loading activities)?

Statements:
For vertical longitudinal tears full weight-bearing may be recommended, with a limitation of ROM for 6 weeks. For ramp lesions the rehabilitation protocol is driven by associated procedures (e.g., ACL reconstruction).

Grade of recommendation: C

Limitation of weight-bearing, and ROM for 4 to 6 weeks is recommended for complex, horizontal, radial, and root repairs.

Grade of recommendation: C

Following repair-specific early post-operative restrictions in ROM and weightbearing, rehabilitation after meniscus repair should follow criterion- and time-based components.
Return to activities requires meeting progressive milestones throughout rehabilitation (e.g., effusion, range of motion, quadriceps strength, neuromuscular control) and meeting healing time frames. This is different from arthroscopic partial meniscectomy, which is criteria based.

Grade of recommendation: D

Rating:
Median: 7.5
Mean: 7.2

Literature summary
Carder and colleagues report protocols vary widely for time to achieve full range of motion with either radial or non- radial tear repairs (Figure 1). Time in brace for non-radial tear repairs ranged anywhere from 3-10 weeks. When taken all protocols in total the average brace time would have been 5.7 weeks. For radial tears that timeline was slightly longer and ranged from 4-8 weeks, with an average of 6.7 weeks of bracing (Figure 2).[1]

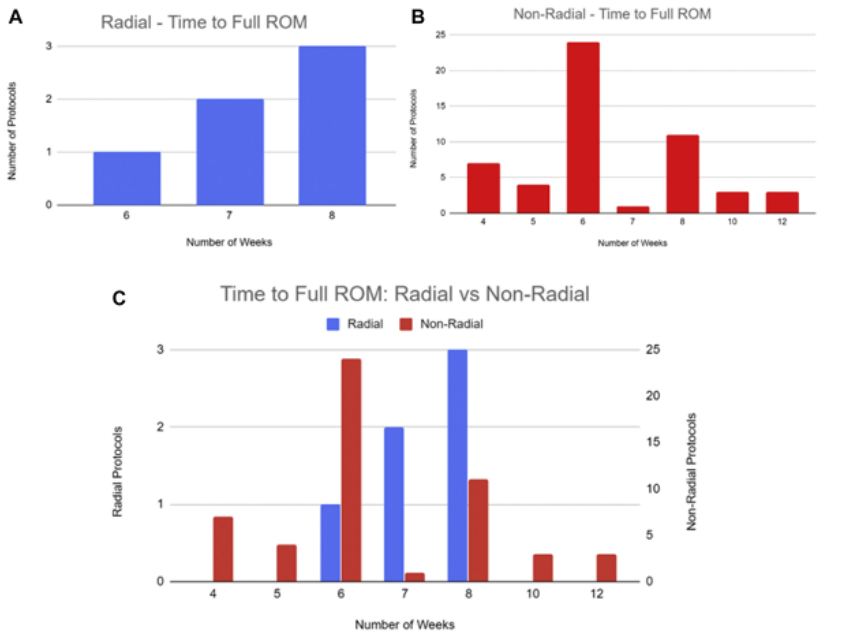

Fig 2. (A-C) Recommendations for return to full ROM following radial meniscus repair (A), nonradial meniscus repair (B), and the comparison between radial and nonradial return to full ROM (C). (ROM, range of motion.)

Figure 1. Time to full knee ROM. From Carder, 2021.[1]

A graph of different sizes and colors

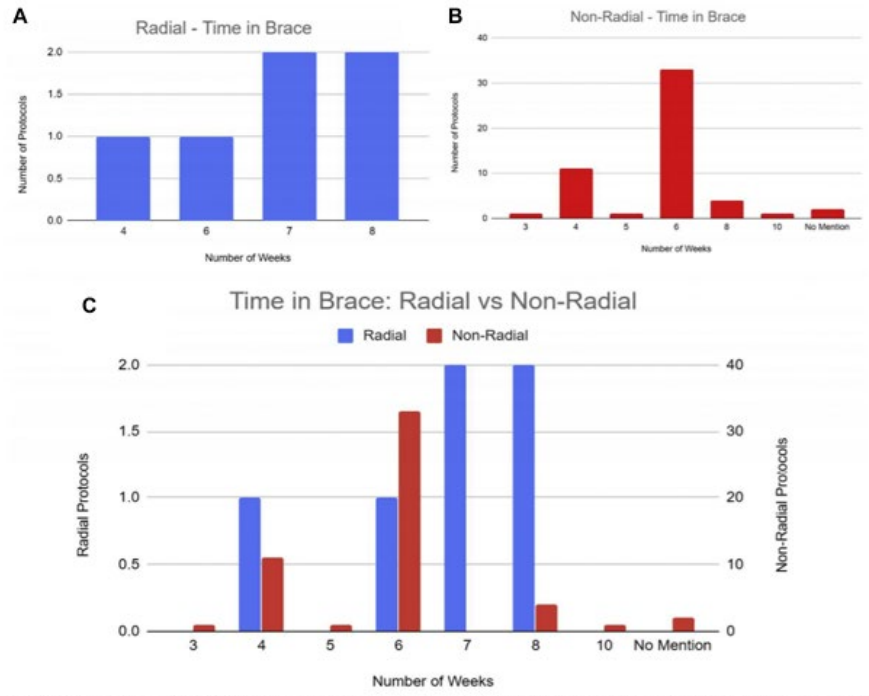

Fig 5. (A-C) Recommendations for time spent in a brace following radial meniscus repair (A), nonradial meniscus repair (B), and the comparison between radial and nonradial time in a brace (C).

Figure 2. Time in brace (From Carder, 2021).[1]

The data illustrated by Carder et al about publicly available rehabilitation protocols designated for meniscal repairs published online are somehow in contrast with current evidence and protocol suggested in published RCTs and case series.

As stated in the former question for vertical isolated meniscal tears no difference has been detected between a more conservative or free rehabilitation program (level 1 RCT[2] and level 4 systematic review[3]).

Regarding root tear repair there have been no long-term studies comparing the efficacy of varying rehabilitation protocols for patients recovering from meniscal root repairs, especially regarding the time course for introducing weight-bearing, increasing ROM and beginning strength training. Nonetheless, biomechanical models of cyclic loading have underscored the need for more gradual and cautious rehabilitation protocols compared with other types of meniscal lesions.[4,5]

It is therefore reported, that with radial/root repairs of meniscus a strict emphasis on non-weight bearing should be implemented for the first 6 weeks, during which time range of motion should also be limited to 90 degrees.[6]

Mueller et al. describes a five-phase rehabilitation protocol that adheres to a linear periodization approach, with the objective of progressively loading the repair over time (Level of Evidence 5, expert opinion).[7] In the first phase it suggests six weeks of NWB protection. Immediate passive range of motion is permitted but restricted to 0° to 90° for two weeks to protect the repair. Active range of motion is allowed at 6 weeks due to the involvement of the menisci in the anatomical insertion of the hamstrings and popliteus.

In the second phase at week seven, partial weight bearing (PWB) of about 25% WB begins. Transition from NWB to full weight bearing (FWB) is progressed as tolerated based on assessment of pain and joint effusion response. If either pain or swelling increases without dissipating within 24 hours, the degree of WB should be reduced. The third phase is focused on developing muscular endurance. Phase four start at week 16, and the focus of rehabilitation shifts to development of muscular strength, and exercise prescription is adjusted accordingly. With the development of a base in muscular strength, muscular power training (phase 5) begins at about 22 weeks. It suggested that the patients must avoid deep squatting or loaded knee flexion for the first 4 months, as these movements have been shown to subject the meniscal roots to increased biomechanical strain.

In a series of 14 patients underwent meniscal root repair, immediate PWB was allowed for the first six weeks, however, second look arthroscopy identified fixation strength to be loose in three knees and lost in two knees. Hoop tension was also assessed and determined to be loose in two knees and lost in two knees.[8] In contrast, Lee et al in another case series did not allow PWB until six weeks post-surgical repair. Of the 21 posterior medial meniscal root repairs, only one re-tear occurred.[9] Again, using the protocol outlined by Mueller et al. LaPrade et al. found a reinjury rate of only 6.7% in another prospective case series.[10]

One systematic review evaluated the management of ramp lesions. Seven studies have been analyzed, 2 RCT and 5 retrospective case series. At least 2 weeks of NWB were indicated in all the studies, full weight bearing (FWB) was permitted between 4 and 12 weeks. All authors allowed immediate postoperative passive joint movements from 0° to 90° to avoid stiffness. At 6 weeks from surgery, a full range of motion was permitted. The use of brace was prescribed in 181 (41%) of cases.[11]

One systematic review analyzed 12 studies about radial meniscus tear: 5 retrospective cohort studies, 1 case control study, and 6 case series. All the included studies restricted weight-bearing and range of motion to some degree postoperatively; however, no single postoperative restrictions predominated. In four studies 6 weeks of NWB protocol was used, in one study after 4 weeks of NWB a further period of 2 weeks of partial WB was suggested, in the remaining studies 4 weeks of NWB were indicated. In seven studies a period of 4 months before allowing return to sport was indicated, in 3 studies a 6-month period was suggested and in two studies the period before RTS was 9 months because ACL reconstruction was associated. Brace immobilization was suggested for 1 week in one study and for 3 weeks in another one study.[12]

Also, Kocabey et al suggested rehabilitation guidelines specific to the tear's characteristics based on a retrospective revision of their cases of meniscal repairs. For anterior-posterior longitudinal tears less than 3 cm, they promoted weight-bearing as tolerated without a brace. ROM progressed to 125° between 3 and 6 weeks. For tears greater than 3 cm, weight-bearing was allowed in a locked brace. ROM was limited to 0°–125° until 6 or 8 weeks. Return to sport was allowed after 3 months. For complex and radial tears, patients were required to wear a brace in which they were weight-bearing as tolerated ranging from 0° to 125° for 6 to 8 weeks. They returned to sport between 4 and 5 months.[13]

References:

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Q 6.3) Are there specific exercises that should be avoided following all meniscus repair (e.g. deep loaded flexion – e.g. deep squats)? If so, then for how long?

Statement: Deep squatting, jumping (deep loaded flexion) and rotational knee movements activities should be avoided for a minimum of 4 months.

For vertical longitudinal tears, mini squats up to 30° can be recommended from week 4-8, up to 45° from week 8-12 and up to 60-90° from week 13-16.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.6

Literature summaries:
Mueller et al. in their protocol after root tear repair suggested to avoid squat for a period of 4 months. Moreover, active range of motion is allowed only after 6 weeks due to the involvement of the menisci in the anatomical insertion of the hamstrings and popliteus (Level of Evidence 5, expert opinion).[1]

The same is reported in several case series about both medial and lateral root tear repair.[2–6] Despite that, no comparative studies evaluated the influence of squat movements in the first 4 months on the failure rate of root tear repair.

In papers included in a systematic review about outcomes of radial tear repair, several authors suggested to avoid squatting in the first 4 months after repair. Few specified to also avoid rapid twisting movements.[3] They were case series in all cases without comparative studies.

In papers included in a systematic review about outcomes of meniscal ramp repair, only one case series (out of seven works analyzed) suggested to avoid squatting and twisting activities for 4-6 months postoperatively.[5]

Spang et al in a systematic review analyzed the different rehabilitation protocols used after meniscal repair pooling 17 clinical studies with mixed level of evidence (two works level 1, 2 works level 3, one work level 5, 12 wors level 4). For longitudinal/vertical meniscal tears six authors specified in their rehabilitation protocol to avoid squatting or pivoting or both for a period between 4 and 6 months.[7] Again, we didn't find any comparative studies focused on whether these specific exercises can influence the failure rate.

References:

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Q 6.4) Does a medial and lateral repaired meniscus tear require different protocols?

Statement: Medial and Lateral meniscal repairs may be rehabilitated similarly, with the tear type (radial, root, vertical) influencing rehabilitation rather than laterality.

Grade of recommendation: C

Rating:
Median: 8
Mean: 7.9

Literature summary

A meta-analysis including 27 studies evaluated results of meniscal repair at follow up greater than 5 years (level of evidence IV). It analyzed 1630 meniscal repair with insufficient sub-analysis by tear type. Radial, root and horizontal cleavage were excluded. No difference in rehabilitation was reported between medial and lateral meniscus repair. The reported failure rate was higher when the medial side was involved.[1]

D'Ambrosi R et al. performed a systematic review with the intention to evaluate meniscal surgery in elite athletes. Eight studies were analyzed pointing out the higher rate of failure of medial meniscal repair, but the study could not state that a slower rehabilitation protocol would be able to reduce this rate of re-tear. In the same study is suggested to follow a slower rehabilitation protocol after lateral meniscectomy but not for meniscal repair. (29) Dai W et al published a meta-analysis tried to identify the healing rates after arthroscopic repair of meniscal tears via second-look arthroscopic evaluation. 41 studies were included in the meta-analysis. There were 2 RCT and the remaining studies were observational studies. For the observational studies, 7 were judged to be at low risk of bias and 32 were judged to be at high risk of bias. In their analysis they did not observe differences in medial or lateral meniscus healing rates despite a homogeneous distribution of postoperative rehabilitation protocols in the cohorts of patients. They observed that

when the rehabilitation protocol was weight restricted, the complete healing was higher than for other kind of rehabilitation protocols.[2]

One systematic review analyzed 12 studies about radial meniscus tear: 5 retrospective cohort studies, 1 case control study, and 6 case series. Lateral radial tears have been repaired in 56.7% of 243 operated knees, whereas 43.3% were medial radial tears. All the included studies restricted weight-bearing and range of motion to some degree postoperatively, however no single postoperative restrictions or RTP indications predominated depending on whether it involved a medial or lateral meniscus.[3]

One RCT investigated the use of two different rehabilitation protocols in isolated vertical meniscal tears. Medial and lateral meniscal tears were homogeneously distributed among the two groups. They tested several potential confounders for effect on healing rates concluding that repair of medial meniscus resulted in higher repair failure rate compared with lateral meniscus repair. Even so, the study concluded suggesting a free rehabilitation protocol in this kind of meniscus repair without any mention to differentiate postoperative protocols depending on whether it is involved a medial or lateral meniscus.[4]

Root tears were also analyzed in a couple of studies. There were no specific recommendation regarding the post operative protocol used depending on the medial or lateral root involved[5,6].

References:

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2. D'Ambrosi R, Meena A, Raj A, et al. In elite athletes with meniscal injuries, always repair the lateral, think about the medial! A systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2023;31(6):2500-2510. doi:10.1007/s00167-022-07208-8

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Q 6.5) For how long rehabilitation is recommended after meniscus repair?

Statement: Rehabilitation after meniscus repair should be both criterion and time based according to the healing process. A minimum of 4 months of rehabilitation may be advised for repaired vertical meniscus tears. Complex, radial, root, horizontal tears may require a longer rehabilitation, up to 6 to 9 months.

Grade of recommendation: D

Rating:
Median: 8.5
Mean: 8.0

Literature summary

No clear recommendations about precise period of rehabilitation to reduce failure rate or to increase clinical outcomes after meniscal repair have been found in the literature. If we consider the RTS as the end of the rehabilitation protocol, one systematic review by Eberbach et al. found that the mean RTS after meniscal repair was 4.3 months postoperatively and in another systematic review Blanchard et al. described a mean return to play at 8.7 months. No analyses of different subtype of lesions have been done.[1,2]

References:

1. Eberbach H, Zwingmann J, Hohloch L, et al. Sport-specific outcomes after isolated meniscal repair: a systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2018;26(3):762-771. doi:10.1007/s00167-017-4463-4

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Q 6.6) What are the criteria-based recommendations after meniscus repair?

Statements: Rehabilitation following meniscal repair should be divided into protective, restorative, and preparation to return to activity and sports phases, with additional criterion-based goals recommended. Criteria for progression to the restorative phase of rehabilitation include full or nearly full passive ROM, no effusion, and neuromuscular control of the quadriceps. Initiation to return activity phase of rehabilitation begins once the patient demonstrates full active ROM, strength (larger or equal to 80% of contralateral leg would be ideal), and adequate single leg dynamic knee control.
Progression of quadriceps strength is recommended to be tested at each phase of rehabilitation via the use of isokinetics or appropriately stabilized handheld dynamometry.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.9

Literature summary

Many Expert Opinions (Level of evidence 5) suggest that the phases of physical therapy following meniscal repair should generally be divided into protective, restorative, and return to activity/sports preparation phases.[1,2]

Time-based progression has been suggested following the indications of biomechanical cadaveric studies[3,4]: when the hoop tensile stress effect is preserved, an accelerated rehabilitation program may be suggested. Hence, partial weight bearing in association with range of motion (ROM) limited to 90° is allowed for the first four weeks, followed by weight bearing as tolerated, strengthening exercises with weights starts after three months. In contrast, when circumferential hoop fibers are disrupted (root or radial tears), a restricted rehabilitation protocol may be recommended. In this scenario no weight bearing is allowed for the first six weeks after the surgery and range of motion is limited to 90°, strengthening is delayed by one month.[5,6]

Kocabey et al suggested some rehabilitation guidelines specific to the tear's characteristics based on a retrospective revision of their cases of meniscal repairs. They are time-based recommendations. For anterior-posterior longitudinal tears less than 3 cm, they promoted weight-bearing as tolerated without a brace. ROM progressed to 125° between 3 and 6 weeks. For tears greater than 3 cm, weight-bearing was allowed in a locked brace. ROM was limited to 0°–125° until 6 or 8 weeks. Return to sport was allowed after 3 months. For complex and radial tears, patients were required to wear a brace in which they were weight-bearing as tolerated ranging from 0° to 125° for 6 to 8 weeks. They returned to sport between 4 and 5 months.[7]

Criteria-based progression has been suggested in expert opinion publications (Level of evidence 5): criteria for progression to the restorative phase of rehabilitation include full passive ROM, no effusion, and neuromuscular control of the quadriceps. A return to activity phase of rehabilitation begins once the patient demonstrates full active ROM and adequate single leg dynamic knee control.[2,8]

Barber FA et al. published a prospective case series of different types of meniscal lesions associated with ACL reconstruction in 63 patients using a criteria-based rehabilitation program. WB as tolerated and unrestricted ROM without bracing were permitted from the immediate postoperative period. Patients had permission to return to all activities including pivoting sports when 0 to 120º of ROM, good strength and no effusion were achieved. The progression of the strengthening phase was not detailed. They reported an 11% of failure at 38 months postoperatively.[8]

Recent consensus statements on ACL injury (with or without meniscal injury) also highlight that continued injury prevention serves as a fourth phase [9,10].

References:

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3. LaPrade RF, LaPrade CM, Ellman MB, Turnbull TL, Cerminara AJ, Wijdicks CA. Cyclic displacement after meniscal root repair fixation: a human biomechanical evaluation. *Am J Sports Med*. 2015;43(4):892-898. doi:10.1177/0363546514562554

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Q 6.7) Does concomitant ACL reconstruction have an impact on rehabilitation after medial or lateral meniscus repair when compared to meniscus repair on a stable knee?

Statement: Rehabilitation protocols for repaired menisci with concomitant ACL reconstruction are similar to protocols for isolated meniscal repairs; however, return to sport may be delayed on account of the ACL reconstruction. Meniscus repairs requiring limitation of weight-bearing and/or ROM would affect ACL rehabilitation protocols. Most stable vertical meniscal tear repairs do not affect ACL rehabilitation protocols.

Grade of recommendation: C

Rating:
Median: 9
Mean: 8.1

Literature summary

One systematic review analyzed 12 studies about radial meniscus tear: 5 retrospective cohort studies, 1 case control study, and 6 case series. Eight of the 12 studies reported concomitant anterior cruciate ligament (ACL) reconstruction, with 64% of all the cases having concomitant ACL injury. All the included studies restricted weight-bearing and range of motion to some degree postoperatively, however no single postoperative restrictions predominated depending on whether the ACL was reconstructed or not. The only difference in rehabilitation protocol between isolated meniscal lesions and associated to ACL reconstruction was the RTS phase. When RTS was described (7 out of 12 studies) it was between 4 and 6 months in case of isolated meniscal lesions and 9 months when an ACL reconstruction was associated.[1] Dai W et al published a meta-analysis of studies that tried to identify healing rates after arthroscopic repair of meniscal tears via second-look arthroscopic evaluation. 41 studies were included in the meta-analysis. There were 2 RCT and the remaining studies were observational studies. For the observational studies, 7 were judged to be at low risk of bias and 32 were judged to be at high risk of bias. Subgroup analysis found higher meniscal healing rates in patients with repair concomitant with anterior cruciate ligament reconstruction and patients that followed a weight-restricted rehabilitation protocol. Nonetheless no analysis has been done of the different rehabilitation protocols used in patients with concomitant ACL reconstruction in comparison to patients with an isolated meniscal tear.[2]

A 2007 Cochrane review pooled 5 randomized analyzed trials testing exercise programs designed to treat adults with ACL injuries in combination with collateral ligament and meniscal damage. They conclude that pooling of data was rarely possible due to the wide variety of comparisons, outcome measures and time points reported, and lack of appropriate data. The review demonstrated an absence of evidence to support one form of exercise intervention over another.[3]

A meta-analysis including 27 studies evaluated results of meniscal repair at follow up greater than 5 years (level of evidence IV). It analyzed 1630 meniscal repairs; radial, root and horizontal cleavage were excluded. In 55% the meniscal repair was associated with ACL reconstruction, 45% were isolated meniscal repairs. The study could not detect any difference in failure of meniscal repairs in these two groups. Furthermore, it concluded that there were no differences in terms of failure when a full weight bearing, partial weight bearing, or non weight bearing protocol was applied postoperatively. Nonetheless, a specific subgroup analysis of rehabilitation protocols used for isolated meniscal tears or repairs with associated ACL reconstruction has not been performed.[4]

There was only one study evaluated in this meta-analysis that directly compared (in a retrospective manner) WB and NWB after meniscal repair. It evaluated 157 meniscal repairs with or without concomitant ACL reconstruction. Concomitant ACL reconstruction was performed in 54% of cases in the NWB group and 62% of cases in the WB group. Even in case of concomitant ACL reconstruction the postoperative protocol did not change. The study concluded that WB as tolerated after meniscal repair for isolated vertical tears does not result in a higher failure rate than traditional NWB over a five-year follow-up period. RTS was not reported.[5]

You et al performed a systematic review with meta-analysis only including studies comparing the clinical outcomes between accelerated (immediate range of motion and weight-bearing) and restricted rehabilitation (immobilization and progressive weightbearing) for meniscus suture. All selected studies were divided into 2 subgroups: isolated meniscus suture or combined with ACL reconstruction. Eleven studies with 612 patients were eligible for analysis. 4 were RCTs, 5 were retrospective studies, and 2 were prospective studies. Based on the Oxford Center for Evidence Based Medicine grading, 4 were in level 1, 2 were in level 2, and 5 were in level 3. For the patients

after isolated meniscus suture, the accelerated group achieved higher Lysholm scores than the restricted group. For the patients after meniscus suture with ACLR, patients undergoing accelerated rehabilitation were associated with a significantly larger tibial tunnel enlargement in the postoperative X-Ray but no difference in meniscal re-tear rate.[6]

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Q 6.8) Questions for all repaired lesions:

- Should non-weight-bearing or partial weight-bearing be recommended after meniscus repair (for lateral or medial meniscus)? If yes, for how long?
- If full weight bearing is allowed, is the usage of crutches recommended after meniscus repair? If so, for how long crutches should be used?
- Is there any restriction in terms of range of motion in the post-operative period?
- Is there any indication for a knee brace after meniscus repair in the post-operative period (locked brace or soft brace)?

Statement:

There are different categories of repaired traumatic meniscus tears, and a specific rehabilitation protocol should be considered for each of them. A summary table is provided below.

Grade of recommendation: C

Rating:
Median: 8
Mean: 7.4

Summary table:

	Weight bearing (WB)	Crutches	Range of motion restriction	Knee brace
Stable vertical meniscal tear	Full WB	No	No	No recommendation
Complex vertical meniscal tear repairs	Full WB	Yes	Yes	No recommendation
Complete oblique and radial tears	No WB for 4 to 6 weeks	Depending on WB	0-90° for 4 to 6 weeks	No recommendation
Horizontal lesions in the young athlete	Partial or no WB for 4 weeks	Depending on WB	0-90° for 4 weeks	No recommendation
Ramp lesions	No recommendation	No recommendation	No recommendation	No recommendation
Root tears	No WB for 6 weeks	Depending on WB	0-90° for 4 weeks	No recommendation

Literature summary

Vertical/longitudinal tear

The literature with higher level of evidence seem to support WB as tolerated[1–3] with no specific indications about crutch weaning. Even analyzing individually all the papers of a systematic review about comparison of accelerated and conservative rehabilitation protocol we cannot draw conclusions: some authors do not specify about crutch use and when it is specified there are no clear indications about the duration of use.[3]

The literature with higher level of evidence seem to support free motion as tolerated from the beginning.[1–3]

No standardized indications exist in literature about the use of a knee brace. In the protocols in which ROM and weight bearing are restricted the brace is indicated for a 3-6 weeks postoperative period. In more accelerated protocols, the use of the brace is not routinely mentioned. The authors that mention it describe its use for the first postoperative days in some cases or for the first weeks only to protect the knee during the WB.[1–3]

Complete oblique/radial tear

Systematic review analyzed 12 studies: all the studies suggested at least 4 weeks of restricted weight bearing.[4]

No specific indications were defined for crutch use. Even analyzing individually all the papers of the systematic review[4] we cannot draw conclusions: the vast majority of the authors don't specify about crutches, when is specified there are no clear indication about how many time. Crutches are associated with the limitation of weight bearing.

Analysis of the systematic review[4]: different guidelines exist regarding ROM, ranging from passive motion starting the first postoperative day to immobilization for 8 weeks. In 7 out of 12 studies it was suggested not to exceed 90º of flexion in the first 4 weeks postoperatively. Three out of 12 studies analyzed in the systematic review (26) suggest the use of a knee brace for the first postoperative period. The immobilization period with brace was 1 week, 3 weeks, and 6-8 weeks. No indications were found about brace use during subsequent phases of rehabilitation.

Horizontal tear in the young athlete

Analysis of one systematic review analyzed 19 studies (one Level 1, two Level 2, three Level 3, and the remainder Level 4). 6 studies suggested NWB for 4 weeks, 2 studies suggested NWB for 2 weeks, 2 studies suggested WB as tolerated, 9 studies suggested partial weight bearing (the percentage was not specified).[5]

Analysis of the systematic review[5]: no specific indications about crutches. Five studies explain that the use of crutches was recommended for the first 6 weeks without specifying the modalities for crutches use.

Analysis of the systematic review[5]: 2 studies suggested full extension for 2 weeks, 13 studies suggested to restrict ROM < 90º in the first 4 weeks, 4 studies suggested ROM as tolerated from the beginning.

Analysis of the systematic review[5]: in the 2 studies in which full extension is recommended postoperatively the use of a rigid brace is suggested. In four studies in which a restricted ROM < 90º is indicated, it is specified to use a knee brace in the first postoperative weeks.

Ramp lesion

One systematic review analyzed 7 articles, in which all meniscus ramp lesion repairs were associated with concomitant ACL reconstruction.[6] All the studies analyzed presented different recommendations that are the following:

- No WB 4 weeks
- No WB 8 weeks
- No WB 2 weeks, partial WB 2 weeks
- No WB 6 weeks
- No WB 4 weeks
- Partial WB 4 weeks
- No WB 3 weeks

No specific indications were detailed about crutches in the analysis of the systematic review[6]: most of the studies did not explicitly explain details about the use of crutches. 3 studies suggested the use of crutches for the first 4 to 6 weeks but without explanation concerning the modalities of use.

Analysis of the systematic review[6]: all the studies presented different recommendations that are the following:

- brace with passive ROM 0-90 for 4 weeks
- Not reported
- brace locked in extension for 4 weeks allowing passive motion 0-90º
- 0-45º for the first 2 weeks, afterward 0-90º from 2 to 4 weeks
- 2 weeks full extension than 0-90º 2 weeks more, full ROM within 6 weeks, brace 4 weeks
- brace with 0-90º ROM for 4 weeks
- 0-90º ROM at 3 weeks

Analysis of the systematic review[6]: in four studies out of seven the use of knee bracing was described. See question number 3 in the table for details in its use.

Root tears

Two systematic reviews were analyzed: one pooled 13 studies comparing medial meniscal root tear treated by meniscectomy or meniscal repair.[7]

Eight studies described results of meniscal repair, 7 of those reported postoperative protocol:

- NWB for 6 weeks was indicated in 6 studies
- Partial WB was suggested from the beginning of postoperative protocol in 2 studies (the percentage was not specified).

The second systematic review pooled 19 studies to describe the outcomes of medial and lateral meniscal root repair.[7] Data about postoperative rehabilitation protocols are not reported.

In 15 studies outcomes were described for meniscal root repair, of those only 4 presented data about lateral meniscal roots that we analyzed:

- only one study presented results of mixed medial and lateral root repair suggesting the same postoperative protocol[8]: no WB during the first 6 weeks then progressive WB as tolerated
- partial WB during 6 weeks[9]
- partial WB during 2 weeks[10]
- 3 months partial WB (they indicated 50%) for the first 3 months[11]

In 5 studies of the first systematic review[5], it is specified that the use of crutches is recommended for the first 6 weeks. For the studies of the second systematic review[7], the use of crutches is always indicated in the first postoperative period. In one it is specified that crutch use was encouraged for at least 6 weeks postoperatively and in another study the crutches are indicated for 3 months.

Two systematic reviews were analyzed: one pooled 13 studies comparing medial meniscal root tear treated by meniscectomy or meniscal repair.[5]
8 studies described results of meniscal repair, 7 of those reported postoperative protocol:
- 3 weeks full extension with brace then free ROM
- 2 weeks full extension in a cast, 2 weeks 0-30º with a brace, then increased flexion to 90º up to 6 weeks
- Passive ROM 0-90º in the first 2 weeks protected with brace. Active ROM after 4-6 weeks
- Free passive ROM as tolerated from the first postoperative day
- Full extension with cast for 2 weeks, free passive ROM afterward, active motion up to 90 after first 4 weeks, increased flexion by 10 degrees per week up to 130 degrees until 8 weeks
- Full extension with cast for 2 weeks, then free ROM as tolerated
- Full extension with brace for 2 weeks, ROM exercises gradually to 90º from 2-6 weeks

The second systematic review pooled 19 studies to describe the outcomes of medial and lateral meniscal root repair.[7] Data about postoperative rehabilitation protocols are not reported.
In 15 studies outcomes were described for meniscal root repair, of those only 4 presented data about lateral meniscal roots that we analyzed:
- only one study presented results of mixed medial and lateral root repair suggesting the same postoperative protocol[8]:
- passive ROM as tolerated from the first postoperative day limited to 90º protected by brace up to 6 weeks then passive and active ROM as tolerated[9]
- full extension with brace 2 weeks then progressive ROM to achieve 90º at 6 weeks[10]
- in 2 studies a gradual increase of ROM (protected in a limited-motion brace) up to 90º was suggested for the first 6 weeks[11]

Two systematic reviews were analyzed: one pooled 13 studies comparing medial meniscal root tear treated by meniscectomy or meniscal repair.[5] Eight studies described results of meniscal repair, 7 of those reported postoperative protocol: in four studies out of seven the use of brace was described. See question number 3 in the table for details in its use.

The second systematic review pooled 19 studies to describe the outcomes of medial and lateral meniscal root repair.[9] Data about postoperative rehabilitation protocols are not reported.
In 15 studies outcomes for medial meniscus root repair were described, of those only 4 presented data about lateral meniscal roots that we analyzed. In all 4 studies the brace was indicated.[8–11]
See question number 3 in the table for details in its use.

References:

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7. Return to sports after meniscus injury and surgery

Q 7.1) What are the criteria and the time for return to sports after management of meniscus tears or lesions?

Statement:
Return to sports management after meniscus tears or lesions should be criterion based and time based. Healing time frames should also be considered.

A criterion-based return to sport progression is recommended for patients after conservative or surgical treatment of meniscus tears or lesions.

The main criteria to consider are subjective and objective knee function, physical and psychological factors. Knee function includes ROM, joint effusion, quadriceps and hamstring muscle strength and activation. Performance based parameters are coordination and stabilization-based tasks. Patient's motivation and readiness to return to sports needs to be evaluated. However, these criteria are not specific for traumatic meniscus tears.

Besides the criterion-based frame the recommended time to return to sport after meniscus surgery varies depending on the surgical procedure, concomitant injuries and the type of sports. Return to sport is recommended 4 to 12 weeks for partial meniscectomies, and 6 to 9 months for meniscal repair.

Grade of recommendation: C

Rating:
Median: 8
Mean: 7.7

Literature summary
Lee et al. (2019) carried out a systematic review to determine the time to and rate of the RTS after meniscal surgery as an isolated or combined procedure and to compare these values among the different types of meniscal surgeries, such as meniscectomy, meniscal repair, and meniscus allograft transplantation (MAT).[1] In the final analysis, 11 studies were included.[2–12]

Fried et al.[13] performed a systematic review to assess the reported rehabilitation protocols, return-to-play guidelines, and reported rates of return-to-play after meniscal repair. The final analysis included 88 studies consisting of patients undergoing meniscal repair and reporting a rehabilitation protocol and/or return-to-play data. (LOE I: 4, LOE II: 17, LOE III: 33, LOE IV: 34). The rate of return-to-play ranged between 71.2% and 100% in 13 studies, including 507 patients. The rate of return-to-play at the same/greater level was reported to range between 53.9% and 92.6% in 3 studies with 214 patients. The mean reported time of return-to-play ranged between 3.3 and 10 months in 11 studies with 409 patients (range 3.3-10).[13]

The surgeon guidelines for return-to-play were reported in 64 studies. The most commonly reported time surgeons allowed return to full activity was 6 months postoperatively (46.9%), but one-half of the included studies allowed return before this time. The mean quality of return-to-play criteria score was 1.3 ± 0.8. However, the conditional criteria and measurement for conditional

criteria were under-reported in most studies, 9.1% and 6.8%, respectively. The most commonly reported conditional criteria was the return of full ROM.

The most significant finding from this systematic review by Fried et al.[13] was a high rate of return to sport following meniscal repair, with a large percentage of patients returning to the same level of play. However, the authors indicated significant heterogeneity in reported rehabilitation protocols and insufficient reporting in return-to-play criteria in the current literature. Furthermore, it remains vague in the literature when it is safe to return to play, with considerable variations with respect to when athletes could return. The major limitation of the analysis is the lack of information about the type and size of meniscus tear and the repair.

Koch et al.[6] presented time-frames for return to sports based on an analysis of written protocols for early rehabilitation after meniscus therapy used in German, Austrian, and Swiss orthopedic institutions, representing standard recommendations by orthopedic surgeons to their patients as well as physiotherapists and include rehabilitation algorithms for the early postoperative period. The authors defined rehabilitation training as basic sports activities, such as ergometer, cycling, aqua jogging, general strength training, or crawling. The so-called specific training included roadwork, coordination, and proprioception training, as well as sport-specific training. According to Koch et al.,[6] rehabilitation training is recommended to start an average of 3.2 weeks (SD: 1.0 weeks) after a partial meniscectomy, an average of 5.6 weeks (SD: 1.5 weeks) after meniscus repair, and an average of 6.3 weeks (SD: 2.1 weeks) after meniscus replacement [11]. Specific training is allowed after a mean period of 7.3 weeks (SD 2.6 weeks), 14.6 weeks (SD: 5.4) weeks, and 6.3 months (SD: 2.1 months) after consecutively partial meniscectomy, meniscus repair, and meniscus replacement.

D'Ambrosi et al.[5], in a recent systematic review that included eight articles and 421 athletes, reported an increased time for return to sport after meniscal repair with an increased rate of revision surgery and a reduced rate of return to sport after subsequent surgery. The time to return to sport after meniscal repair in their review ranged from 129 to 209 days (mean time of 6.05 months).

Lee et al.[1], in another systematic review of 11 articles, including 514 cases, evaluated the return to sport after meniscal surgery (meniscectomy, meniscal repair, and meniscal allograft transplantation (MAT) of the athlete.

After partial meniscectomy, the return to sport at the pre-injury level was reported at 7 to 9 weeks. Time to return to sports after partial lateral meniscectomy [7 (5-18) weeks] was significantly longer than time after partial medial meniscectomy [5 (3-6) weeks; $p<0.01$] per Nawabi et al.[8]. Though Kim et al. found the opposite with time to return to sports after a partial medial meniscectomy [79 (63-95) days] was significantly longer than time after a partial lateral meniscectomy [61 (50-73) days; $P <0.017$].[14] The tear pattern in relation to return to sports was studied by Osti et al., who reported a return to sports time for lateral meniscus with isolated longitudinal, radial, horizontal, and complex type tears was 38, 42, 55, and 49 days, respectively.[9] Kim described the return to sports differing according to the amount of resection [small: 79 (65-93) days; large: 54 (39-69) days, $P <0.0155$].[14] Time to RTS sport also was dependent on athletes with elite and competitive athletes returning faster than recreational athletes [elite: 54 (37-70) days; competitive level: 53 (43-60) days; recreational: 88 (69-107) days; $P <0.0001$].

After meniscal repair, the average time to return to sports was 5.6 months in the two studies that reported on this. A concomitant ACL-R lengthened the time to return to sport to 8.23 to 11.8 months.[12]

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Q 7.2) Is on-field rehabilitation suggested for athletes willing to return to sports after management of meniscus tears or lesions?

Statement:
Sport specific rehabilitation on the field is recommended to complete the on-field rehabilitation phase. The specific requirements of the sport do matter when making progressive return to sport rehabilitation decisions.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.1

Q 7.3) What patient-related (age, type of sport, profession, psychological factors) and knee-related (type of tear, concomitant injuries, type of meniscal surgery, etc.) factors influence return to sports after meniscus treatment?

Statement:
Patient-related and knee-related factors have an impact on return to sport.
Type, location, size of the tear or lesion, type of surgery, concomitant injuries and muscle function might be more important factors determining the time to return to sport.

Grade of recommendation: D

Rating:
Median: 9
Mean: 8.1

Literature summary
Totlis et al.[1] performed a systematic review of 19 studies comprising 872 patients following all-inside meniscus repair and determined whether a concomitant ACLR influenced outcomes. Three studies reported a return to sports rate ranging from 89.6% to 90% at follow-up. Four studies examined the effect of ACLR on outcomes. Two studies reported no difference; one favored the isolated meniscus surgery, and one favored the combined cohort. Conclusions stated that concurrent ACLR did not significantly affect outcomes.

In a systematic review, Eberbach et al.[2] identified sport-specific outcomes after isolated meniscus repair. They examined 28 studies with a total of 664 patients who met inclusion criteria. The mean

patient age was 26+/- 7.2 years, and 71% of patients were male. Mean Tegner scores increased from 3.5 to 6.2 postoperatively. Return to sports on the preinjury level was achieved in 89%. Mixed-level populations returned to their preinjury activity level in 90% and professional athletes in 86%. The mean delay of return to sports varied between 4.3 and 6.5 months. The pooled failure rate was 21%.

References:

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Q 7.4) Are activity outcomes dependent on the type of tear (e.g. complex, medial, lateral, repaired, resected, etc.?) When is the return to sports not recommended after a meniscus injury or surgery?

Statement:

Activity outcomes can be dependent on the type of tear or lesion, treatment and whether the patient desires to return to sports.

If knee function cannot be restored and clinical milestone cannot be met, return to sports is not recommended after a meniscus injury or surgery.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.9

Literature summary

Calanna and colleagues[1] report that factors such as tear type, medial vs. lateral meniscus tear, and presence of concomitant injuries all influence healing and time to return to sports.

Carder et al.[2] report a huge variability in rehabilitation protocols designated for meniscal repairs published online. These protocols include variability in progression, when to allow return to sport and methods to examine for return to sports.

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8. Meniscus reconstruction (transplantation or scaffold)

In young adults who have pain due to post-meniscectomy syndrome, meniscus reconstruction (i.e meniscus allograft transplantation (MAT) or meniscus scaffold) can be considered as a salvage procedure. The ideal candidate for meniscus reconstruction is a young patient with unicompartmental tibiofemoral pain, a history of meniscectomy in this compartment, a stable or stabilised knee with a favourable alignment and as less chondral damage as possible.

So, associated procedures are often needed (cartilage reconstruction, ACL reconstruction, high tibial osteotomy etc).

Although rarely performed, meniscus reconstruction is considered as the most complex meniscus repair needing a longer healing process. During surgery, the aims are to position the meniscal roots anatomically and achieve solid capsule fixation with a correctly sized graft. During rehabilitation, there is a risk of failure and early extrusion of the graft while healing and maturation processes.

The history of research on the use of meniscus grafts dates back over 30 years. Allograft transplantation has been introduced as a treatment method for massive meniscus loss.[1] The main disadvantages of allograft transplantation are the limited availability of musculoskeletal tissue banks and strict regulations on using allogenous tissues in some countries.[2] Moreover, meniscus transplantation is indicated in treating total or subtotal meniscus loss, while in a great majority of patients, partial meniscus injury is observed.

Therefore, the idea of using scaffolds was a response to the limitations of allograft transplantation. Precisely, the scaffolds were developed to treat partial meniscal injuries, and they aim to restore the native biomechanics of the knee and provide a substratum for meniscal regeneration. The scaffolds might be defined as biomimetic materials able to stimulate tissue repair and regeneration by recruiting autologous stromal cells that can populate the 3-dimensional architecture of the scaffold and restore the meniscal fibrocartilage.[3]

The developed scaffolds are divided into natural, synthetic, and hybrid scaffolds. Each type of scaffold can be implemented with cells or without cells. So far, most literature concerning meniscal scaffolds remains *in vivo* studies. Regarding clinical studies, two types of acellular scaffolds have been investigated: CMI and Actifit®. Even though the results are promising, the quality of the evidence remains modest; therefore, there is a strong need for future research.[2]

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Q 8.1) Is there any difference between different types of meniscus reconstruction (transplantation or scaffold) in terms of rehabilitation management?

Statement:
Scaffolds and Allografts rehabilitation protocols follow the same rules and restrictions.

Grade of Recommendation: D

Rating:
Median: 8
Mean: 7.63

Literature summary
MAT and meniscal scaffold procedures remain rare and underreported entities in the literature. There are no high-level studies to guide the direction of rehabilitation in this setting available. The available literature focuses on indications, technique, outcomes, complications and return to sport with little reported on the effect of rehabilitation management or differing strategies. Rodkey et al. reported in a prospective RCT comparison of the collagen meniscus implant with partial meniscectomy that patients were non weight bearing for 2 weeks followed by partial weight bearing to week 6 and full weight bearing there after without a gait aid once able to ambulate without a limp. ROM was restricted 0-60 degrees for weeks 0-4, 0-90 degrees for weeks 5-6 and unrestricted thereafter. There was no comparison arm with differing rehabilitation and the CMI patients were compared to partial meniscectomy patients.[1] Similarly, Zaffagnini et al. report on prospective long-term outcomes of the medial CMI versus partial medial meniscectomy, and reports a similar post-operative protocol involving CPM 0-60 degrees for weeks 0-2, 0-90 degrees weeks 2-4, then complete passive ROM and 2 weeks of non-weight bearing followed by a progressive weight bearing protocol from week 3 forward.[2] Both studies cite evidence derived from basic science or preclinical studies for the rationale behind the treatment protocols.[1,2] Whereas Bulgheroni et al. reports follow up of CMI at 5 years and utilized a protocol of 6 weeks of non-weight bearing, and ROM restricted 0-60 for weeks 0-4 and 0-90 for weeks 5-6 before unrestricted ROM.[3] All of the aforementioned studies allowed unrestricted activity or return to sport at 6 months post operatively. A systematic review by Warth et al. amalgamated the available information regarding published rehabilitation protocols in the setting of collagen scaffolds for the treatment of meniscal defects demonstrating significant variability in the protocols with respect to time to full weight bearing and progression of ROM as well as the utilization timing of post-operative bracing.[4] As compared to the best available literature reporting on rehabilitation after MAT, as noted in question 3 of this section, there appears to be a generally accepted faster timeline to weight bearing and ROM with collagen scaffold procedures amongst authors. There remains little to no evidence comparing the effectiveness of varying rehabilitation protocols amongst these groups due in large part to the heterogeneous patient population, wide variety of concomitant surgical procedures undertaken and a lack of standardized rehabilitation approach.

References:

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Q 8.2) What rehabilitation protocol is best indicated for the management of meniscus reconstruction (transplantation or scaffold)?

Statement:
Rehabilitation after meniscus reconstruction should be criterion and time based.
Different stages of rehabilitation are an early protective phase, followed by an intermediate restorative phase, and finally a return to activity phase. Progression through phases will vary significantly for each patient based on associated procedures, level of activity, and individual rates of recovery. Rehabilitation protocols could follow those of meniscus root repair (two roots are repaired after MAT), which require up to 9 months (or more) of rehabilitation. The consensus group suggests return to sports at 12 months or more.

Grade of Recommendation: D

Rating:
Median: 9
Mean: 8.4

Literature summary:
Hence, patients who undergo meniscal allograft transplantation are recommended to follow a dual restriction protocol. Rehabilitation is based on active and passive exercises depending on the time after surgery and the goals achieved earlier. In the first 8 weeks the goals are: manage pain and effusion, full passive extension, improve quadriceps activation, flexion up to 120 degrees between 8-12 weeks. Treatment based on ankle pumps, patellar mobilizations, straight leg raise, hip adduction and abduction, heel slides, knee extension and flexion against resistance (90–20 degrees), ¼ squats, then 0-120, gastrocnemius and soleus stretching, hamstring and IT band stretching. Exercises can be increased after discontinuation of bracing at 8 weeks. 75% of athletes could return to sport after meniscal allograft at an average of 12 months postoperatively, with the highest rates of return noted in lower impact sports such as yoga, swimming, cycling, and weightlifting. Only 49% of patients returned to their prior level of sporting activities.

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Q 8.3) Is there a difference between rehabilitation proposed after medial or lateral meniscus reconstruction (transplantation or scaffold)?

Statement:

Similar rehabilitation protocols can be used for medial or lateral meniscus reconstruction.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.89

Literature summary

No high-level studies exist aimed at elucidating the differences in management of rehabilitation in between medial and lateral meniscal allograft transplantation (MAT). Based on the available low-level evidence and expert opinion, all the aspects which contribute – together with patient's desired activity – to the establishment of an adequate rehabilitation goal should be assessed.

Lee et al. demonstrated that medial meniscal allograft transplantation led to improved contact mechanics and force however, this remained statistically significantly different from the intact or even root repair state.[1] After medial meniscectomy, contact stresses increase 100%, whereas after a lateral meniscectomy, contact stresses increase 200% to 350%.[2]

Fixation techniques for MAT differ among surgeons, Abat et al[3] evaluated 88 MAT procedures that obtained fixation with either suture-only technique (n = 33) versus bone plugs (n = 55). At 40-

month follow-up, MRI evaluation showed a greater percentage of extruded meniscal body with suture fixation, with no difference in functional outcome. Evidence supports biomechanical differences in contact area and loading between medial and lateral MAT that suggest differing rehabilitation protocols could be tailored to each. Best available evidence remains unclear on how protocols should be adjusted, if at all, based on laterality, or fixation type.

Brophy et al[4] reported that "patellar mobilization, therapeutic modalities, and quadriceps/hamstring strengthening are initiated immediately postoperatively. Bracing is often recommended for the first 6 weeks to allow protected range of motion (except deep flexion) so as to enhance the biologic milieu of the healing transplant. Despite a lack of supportive data, limited weight bearing has been recommended while the transplanted meniscus heals to the periphery. Most patients are able to bear full weight on the involved limb by 8 weeks. Jogging is allowed at 3 to 4 months, with progression to running, cutting, and sports-specific activities at 4 to 6 months, as tolerated." Whereas a systematic review by Rosso et al.[5] examined 55 papers and reported no agreement on rehabilitation protocol after MAT, noting significant variability based on concomitant procedures. Weighted average time to full weight bearing of 6.2 ± 1.9 weeks and full ROM at 6.3 ± 2.9 weeks after surgery. Twenty four of the 55 studies utilized a brace postoperatively and nine utilized CPM. Lee et al. reported that delayed rehabilitation after lateral MAT can reduce graft extrusion, and joint space narrowing on weight bearing compared with standard rehabilitation without differences in clinical outcomes at approximately 25 month follow up. Their rehabilitation protocols are summarized in the table below.[1] Others have reported that meniscal extrusion does not progress after lateral MAT at mid and long term follow up, suggesting avoidance of early extrusion may endure.[6,7]

TABLE 1
Rehabilitation Protocols After Lateral Meniscal Allograft Transplantation

Rehabilitation Type	Immobilization	Brace	Weightbearing	Isokinetic Muscle Exercise	Light Running	Return to Sports
Standard	For 7 d with long leg splint	Hinged brace for 7 wk after splint off	Partial weightbearing for 6 wk	At 8 wk after surgery	At 12 wk after surgery	At 6 mo after surgery
Delayed	For 3 wk with long leg cast	Lateral unloading brace for 9 wk after cast-off	Partial weightbearing for 6 wk	At 10 to 12 wk after surgery	At 4 to 5 mo after surgery	At 7 to 9 mo after surgery

No similar studies for medial MAT were identified, however Lee et al.[8] report that graft extrusion in both the coronal and sagittal planes is greater after medial MAT as compare with lateral MAT with no difference in clinical outcomes at mean 25 month follow up, suggesting a need for further evaluation of delayed versus early rehabilitation protocols for a medial MAT. Given the lack of high level data to guide management in this area the International Meniscus Reconstruction Experts Forum (IMREF) 2015 consensus statement on rehabilitation after MAT made no distinction on medial versus lateral MAT and provided only general guidelines for 4 stages of rehabilitation while acknowledging there will be significant variability for each patient based on concomitant procedures, desired level of activity, and individual rates of recovery.[9]

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Q 8.4) What are the weightbearing precautions recommended after meniscus reconstruction (transplantation or scaffold)?

Statement:
Early weight-bearing has been shown to increase the risk of meniscus extrusion after meniscus reconstruction. Therefore, non-weight-bearing is recommended for 6 weeks, progressing to full weight-bearing gait after 8 weeks. Weight bearing status may also be affected by other concomitant procedures such as osteotomy, cartilage, or ligament surgeries.

Weight bearing through a flexed knee (example: stairs, squatting, lunging) should be delayed. Initial weight bearing should occur in relative knee extension, such as with gait and standing.

Grade of Recommendation: C

Rating:
Median: 9
Mean: 8.5

Q 8.5) Should the range of motion be restricted in the postoperative period after meniscus reconstruction (transplantation or scaffold)? If yes, for how long?

Statement:

90 degrees of non-weightbearing flexion should not be exceeded until 6 weeks postoperatively. Associated surgical procedures may alter further ROM restrictions.

Grade of Recommendation: D

Rating:
Median: 9
Mean: 8.2

Focus on meniscal scaffolds:
According to a systematic review from Filardo et al.[1] on meniscal scaffolds, the post-operative protocol is heterogenous with ROM limited to 0-90 degrees for 3-6 weeks, before full range of motion was allowed and achieved in 6-12 weeks. A knee brace was used for 4-9 weeks, while partial weight bearing was allowed 2-8 weeks after operation. Full weight bearing allowed 6-10 weeks after implementation. Return to all activities without restrictions after 6-12 months. There is even another systematic review from Gomoll et al.[2] describing rehabilitation and brace usage after either meniscal regeneration or transplantation.

When comparing partial meniscal resection to medial collagen meniscal implant treatment (MCMI), Zaffagnini et al.[3] treated patients with Menaflex protocol. A knee brace was worn for 6 weeks after operation, locked in full extension although it was removed 4 time per day for continuous passive motion (complete passive motion achieved first after at least 4 weeks). Weight bearing was not allowed the first two weeks, but progressive weightbearing after that. Elastic resistance and isotonic strengthening from week 4. Strict rehab protocol for at least 6 months after operation. The same protocol was used when treating lateral collagen meniscal implant treatment.[4]

Similar rehabilitation protocol was found from Rodkey et al.[5] using Actifit meniscal scaffolds
Rehabilitation after meniscal allograft transplantation is described by Verdonk et al.[6] The protocol is to avoid weight bearing for three weeks after operation, followed by 3 weeks of partial weight bearing. Knee brace is not necessary and depends on the morphology and the patient. ROM is limited to 0-30 the first two weeks, followed by 30 degrees increase of ROM every other week.

References:

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Q 8.6) Is a brace useful after meniscus reconstruction (transplantation or scaffold) in the post-operative period (postop/unloading or functional for return to activity)?

Statement:

There is a lack of evidence for bracing after meniscus reconstruction. The consensus group has no recommendation on the use of a knee brace. The use of a knee brace after meniscus reconstruction surgery is dependent on surgeon preference and concomitant procedures.

Grade of Recommendation: D

Rating:
Median: 9
Mean: 8.3

9. Patient-Rated Outcome Measures (PROMs)

Q 9.1) What patient-reported outcomes should be used to evaluate treatment for meniscal tear or lesion and/or meniscal surgery?

Statement:
Rehabilitation after meniscal tear or lesion and/or meniscal surgery should be evaluated using patient-reported outcomes that cover disease specific questionnaires (recommended: the WOMET), knee-related questionnaires (recommended: subjective IKDC or KOOS forms), activity-related questionnaires (recommended: Tegner or Marx activity scale), and pain scales (recommended: VAS).

Grade of recommendation: B

Rating:
Median: 9
Mean: 8.39

Literature summary
According to the systematic review by Abram et al. (2017), the evidence regarding the validity of the patient-reported outcome measures (PROMs) used to assess patients with meniscal injuries is poor quality and incomplete. The authors concluded that many PROMs have been used in clinical studies of patients with meniscal tears. Still, the overall quality of evidence supporting the validity of these PROMs is poor. Abram et al. (2017) distinguished ten different PROMs used in studies concerning this group of patients.[1] Five intend to assess symptoms and functional status, four health-related quality of life, and one activity level. Among the highlighted PROMs there were mentioned following tools measuring symptoms and functional status: Hughson Clinic Questionnaire[2], International Knee Documentation Committee (IKDC) Subjective Knee Form[3], Knee Injury and Outcome Osteoarthritis Score (KOOS)[4], Lysholm Knee Scoring Scale[5,6] and Western Ontario McMaster Osteoarthritis Index (WOMAC).[7] Health-related quality of life so far has been assessed using the EuroQol-5 dimension (EQ-5D)[8], 26-item Knee Quality of Life (KQoL-26)[8], Short-Form-6 dimensions (SF-6D)[9], and Western Ontario Meniscal Evaluation Tool (WOMET).[10] The activity level is determined using the Tegner Activity Level Scale (TAS).[6]

Wang et al. (2010) conducted a systematic review examining psychometric evidence of PROMs for specific knee conditions.[11] The authors identified 24 unique instruments, with most having satisfactory internal and test re-test reliability. Based on psychometric data, the Western Ontario Meniscal Evaluation Tool (WOMET) was best for meniscal injuries. The IKDC Subjective Knee Form can be used as a general knee measure, but no instrument is widely applicable across all patient groups and knee disorders.[11]

Berg et al. (2022) performed a systematic review of what tests should be used to assess functional performance in youth and young adults following anterior cruciate ligament (ACL) or meniscal injury.[12] The systematic review summarized functional performance test measurement properties in patients with ACL injuries, ACL injuries with concomitant meniscus tears, or patients with meniscus tears with a mean age of equal or more than 30 years. However, in the final analysis, no meniscal injury-alone papers were included. Thirty studies on 26 different functional performance tests following ACL injury were included. Measurement error, reliability, structural validity, construct validity, and responsiveness were examined. Frequently used functional

performance measures need more evidence to support their use. The single-leg and crossover hop measures were the only functional measures to show sufficient construct validity, responsiveness, and intrarater reliability.[12]

For pain assessment purposes, the Visual Analogue Scale is most frequently used. In studies on patients with meniscus injuries, most commonly assessed pain intensity during rest[13–17]; however, there are studies evaluating pain after exercises.[18] Also, the numeric rating scale (NRS) is used.[19]

Agarwalla et al. (2019) used IKDC and KOOS to predict RTS. A high preoperative score on the KOOS is linked with a reasonable likelihood of returning to sport after meniscectomy.[20]

An example of the most commonly used outcome measures constitutes a meta-analysis performed by van de Graaf et al.[19] (2016) on arthroscopic partial meniscectomy or conservative treatment for nonobstructive meniscal tears (Level I, systematic review and meta-analysis of Level I studies). The meta-analysis involved only RCTs in which at least one group of adults with a meniscal injury received conservative treatment of any kind or arthroscopic partial meniscectomy. Primary outcomes were physical function on PROMs. Secondary outcomes included change in activity level, knee pain, complications, return to work, quality of life, and general health. Used PROMs included Lysholm Knee Scoring Scale, Knee Injury and Outcome Osteoarthritis Score (KOOS), Western Ontario Meniscal Evaluation Tool (WOMET), and Western Ontario McMaster Osteoarthritis Index (WOMAC), Visual Analog Scale and numeric rating scale were used in these studies to quantify function and pain. No studies found significant differences in the outcomes between the groups. More minor favorable results were found in the APM group up to 6 months for physical function and pain, but no differences were found at longer-term follow-up.[19]

A systematic review on scaffolds for partial meniscal replacement performed by Papalia et al. (2013) indicated that the clinical outcomes in the analyzed studies were rated most commonly with the Lysholm score and Tegner index. Fifteen studies were included, all prospective studies, but only two were randomized controlled trials.[21]

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Q 9.2) Which clinical exams or functional performance-based measures (PBMS) are to objectify the rehabilitation process?

Statement:
Rehabilitation after meniscal tear or lesion and/or surgery may be evaluated in a criterion-based approach (initial-intermediate-activity-return to sport) and include assessments of range of motion, knee-joint effusion, objective strength test (isokinetic or HDD), and hop tests to objectify the rehabilitation process.

It could functionally be evaluated with strength tests (recommended: quadriceps/knee extension and hamstrings/knee flexion strength) and activity-related testing (recommended: hop for distance) and interpreted with the limb symmetry index.

Grade of recommendation: D

Rating:
Median: 8
Mean: 7.8

Literature summary
One of the examples showing different measures used to objectify the rehabilitation process may be a narrative review authored by Sherman et al.[1] (2020). The authors proposed a 4-phase meniscal repair rehabilitation, with criteria for progressing from one phase to the following.[1]
Here are the requirements from the narrative review:
Phase I: Immediate Postoperative/Postinjury Phase (Protected Motion)

1) Requirements for Progression to Phase II: Intermediate Phase (Low Impact)
   - Full active knee extension (equal to contralateral side)
   - Normal gait without compensation (hip hiking, adequate extension during midstance)
   - No active effusion (negative or trace Brush test)
   - Normal patellar mobility (superior, inferior, medial)
   - Ability to complete 20 straight leg raises without extensor lag
   - Physician clearance to WBAT, brace, and crutches
2) Requirements for Progression to Phase III: Minimal Protection Phase (Linear)
   - Ability to reciprocally ascend/descend 1 flight of stairs without compensation
   - Soreness lasting no longer than 24 h after activity
   - Performs squat to 75 without pain and symmetric weight bearing
   - Good understanding and self-correction of exercise techniques
   - Single-leg stance for 30 s without loss of balance
   - Return-to-work functional testing (per the discretion of the physician)
   - Return to linear running testing (per the discretion of the physician)
     - Modified return-to-sport testing at three months - Isokinetic testing ≥70% quadriceps/quadriceps strength, ≥70% hamstring/hamstring strength
   - Lateral step-down: no more than mild dynamic valgus

3) Requirements for Progression to Phase IV: Return to Activity Phase (High Impact)
    - <2 out of 10 pain with weight-bearing exercise
    - Cleared to hop/run/jog per physician discretion (not before three months for reconstruction/repair, or six weeks for arthroscopy or nonoperative knee injury)
    - Good single-leg balance without dynamic valgus
    - Normal jogging gait pattern
    - Modified return-to-sport testing
        - Isokinetic testing - ≥75% quadriceps/quadriceps strength - ≥75% hamstring/hamstring strength
    - Lateral step-down: no more than trace dynamic valgus
4) Requirements for Return to Sport
    - 0 out of 10 pain with all activity
    - ACL-RSI Questionnaire ≥65%
    - No active effusion (negative brush test)
    - Quadriceps girth within 1.5 cm bilaterally
    - Return-to-sport testing
        - ROM equal or within 2 of the contralateral limb
        - Isokinetic testing : ≥90% quadriceps/quadriceps ratio, ≥90% hamstring/hamstring ratio, and ≥66% hamstring/quadriceps ratio
        - Y balance testing: Anterior reach within 4 cm bilaterally and Composite score ≥90% bilaterally
        - Lateral step-down (no dynamic valgus)
        - Hop testing (≥ 90% contralateral limb)
            - 5-0-5 test
            - Single hop
            - Triple hop
            - Triple crossover hop
            - 6 m hop

The needed outcome measures can also be identified on the criteria established for return to sport decision-making purposes indicated by Fried et al.[2] (2021). The authors performed a systematic review to assess the reported rehabilitation protocols, return-to-play guidelines and reported return-to-play rates after meniscal repair. The final analysis included 88 studies consisting of patients undergoing meniscal repair and reporting a rehabilitation protocol and/or return-to-play data. (LOE I: 4, LOE II: 17, LOE III: 33, LOE IV: 34). The surgeon guidelines for return-to-play were reported in 64 studies. The most commonly reported time surgeons allowed return to full activity was six months postoperatively (46.9%), but one-half of the included studies allowed return before this time. The mean quality of return-to-play criteria score was 1.3 ± 0.8. However, the conditional criteria and measurement for conditional criteria were under-reported in most studies, 9.1% and 6.8%, respectively. The most commonly reported conditional criteria was the return of full ROM.[2]

Among the criteria that can be measured to objectify the rehabilitation process, Wiley et al. (2020) proposed for the early phase after meniscal repair full passive ROM, no effusion (Stroke Tests), and neuromuscular control of the quadriceps. Then, for the return to activity phase of rehabilitation, full active ROM and adequate single-leg dynamic knee control are proposed as criteria.[3]

Bremander et al. (2007) evaluated several functional tests in patients who had undergone surgery and had completed rehabilitation to determine which tests were the most reproducible and

associated with an OA risk.[4] At the end of rehabilitation, in middle-aged patients who have undergone meniscectomy, two tests could be carried out to identify patients at high risk of osteoarthritis: the "maximum number of knee flexions/30s" and the one-legged jump over a certain distance. Poor results in these two functional performance tests could predict the development of osteoarthritis. These two tests have good validity and repeatability.[4]

Ganderup et al. (2017) investigated a deficiency in muscle strength and lower extremity functional performance in the affected leg compared to the contralateral leg before meniscectomy and at different time points postoperatively.[5] The maximal muscle strength during an isometric maximal voluntary contraction of the knee extensors (seated), knee flexors (seated), and hip abductors (standing) in the listed order was measured unilaterally in both the affected leg and the contralateral leg. The specific method used for the assessment of muscle strength has previously been reported and shown reliable in patients with hip OA (ICC > 0.8).[6] Also, the rate of force development (RFD200) was derived from the Δforce/Δtime relationship for the knee extensor, knee flexor, and hip abductor muscles. What's more, data from two lower extremity functional performance tests described earlier by Bremander et al. (2007) were collected; namely, the maximum number of single-leg knee bends in 30 seconds, the single-leg hop for distance test.[4] Both functional performance tests are valid and reliable in meniscectomized patients with ICC = 0.92 and ICC = 0.93, respectively.[4] The maximum number of knee bends in 30 s tests the patient's ability to perform fast changes between concentric and eccentric contraction over the knee joint, previously shown to be affected in meniscectomized patients[7] and essential skills in activities of daily living.[8] Furthermore, this test assesses endurance in the hip and knee extensors and neuromuscular control.[7] The single leg hop for distance test assesses the patient's lower extremity muscle strength and ability to perform tasks that challenge knee stability and has been suggested to provide an overall view of the dynamic knee function.[9,10]

In a narrative review, Feeley and Lau (2018) pointed out that knee extensor muscle strength has been suggested as an essential marker of recovery after arthroscopic partial meniscectomies.[11] Studies suggest an association between knee extensor weakness and arthroscopic partial meniscectomies that may lead to structural changes in the tibiofemoral compartment. Following this type of surgery, there appears to be a decrease in extensor muscle strength, proprioception, knee function, and knee adduction moment compared with the contralateral leg at three months postoperative, and maybe for even longer[11]. To prevent OA, the functions mentioned above must be assessed and be a priority objective during rehabilitation.

- For the knee extensor muscle strength, muscle strength must be assessed objectively, precisely under isokinetic conditions with the use of isokinetic dynamometers or under static conditions using, for example, hand-held dynamometers (HHD).
- For the proprioception assessment, the Star Excursion Balance Test (SEBT) seems to be valid and well-described.
- For the knee adduction moment, hip abductor muscle strength must be assessed objectively (with an HHD, for example), and a qualitative assessment of dynamic valgus, using an error scoring system scale.

Even if the healthy limb has a decrease in its overall performance, it will seem that an LSI score greater than 90% is generally proposed.[11]

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Q 9.3) What persisting signs and/or symptoms during rehabilitation require a referral to a surgeon?

Statement:
Patients should be referred to an orthopedic surgeon in cases of persistent pain, recurrence of stiffness and/or effusion, persistent functional instability, mechanical symptoms, or unexpected neurological symptoms.

Grade of recommendation: C

Rating:
Median: 9
Mean: 8.2

The inability to reach clinical milestones related to knee symptoms indicates a referral to the orthopedic surgeon.

Grade of recommendation: D

Literature summary

The postoperative protocol should protect the repair to allow healing while at the same time promoting motion to prevent potential arthrofibrosis.[1]

In general, the complications in meniscal-repaired patients can be divided into:

- complications related to errors in diagnosis/indications
- complications related to technical errors
- neurovascular complications
- postoperative complications[1]

Gwathmey et al. (2012) reviewed the complications of meniscal repair associated with preoperative, intraoperative, and postoperative errors.[1] Based on the information presented by the authors, we have chosen signs and/or symptoms observed during rehabilitation that require a referral to a surgeon because of the possibility of postoperative complication occurrence as follows:

- persistent postoperative pain, effusion, and mechanical symptoms (device fracture/migration);
- pain and local swelling after meniscal repair by the formation of synovial fluid cyst adjacent tear (peri meniscal cyst formation);
- pain with decreased range of motion after repair (arthrofibrosis, stiffness);
- continued pain, swelling, and loss of range of motion (hemarthrosis or effusion)
- a brief period of improvement followed by a recurrence of symptoms (recurrent tear of the meniscus)

Based on Gwathmey et al. (2012),[1] we can assume that the physiotherapist's attention should always be drawn to persistent pain, recurrence of symptoms after surgery, stiffness, or persistent instability, as they may be signs of complications related to errors in diagnosis/indications. No change in the quality of pain after surgery may also be one of the complications related to errors in diagnosis/indications suggesting incorrect or incomplete diagnosis. Persistent neuropathic pain after surgery, sensation deficits on the medial leg/foot, and/or painful neuroma may indicate saphenous nerve and vein injury that belongs to neurovascular complications Other neurovascular complications that might be observed during rehabilitation are deficits in ankle/toe dorsiflexion and lateral leg/dorsal foot sensation, suggesting peroneal nerve injury.

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