CLINICAL PRACTICE GUIDELINES

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Knee Pain and Mobility Impairments: Knee Meniscal/Articular Cartilage Lesions Revision 2017

Clinical Practice Guidelines
Linked to the International Classification
of Functioning, Disability, and Health
from the Orthopaedic Section of the
American Physical Therapy Association

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KNEE PAIN AND MOBILITY IMPAIRMENTS-KNEE MENISCAL/ARTICULAR CARTILAGE LESIONS: CLINICAL PRACTICE GUIDELINES REVISION 2017

J Orthop Sports Phys Ther. 2017:47(_).A1-A_. doi:##.####/jospt.####.####

SUMMARY OF RECOMMENDATIONS*

WILL COMPLETE THIS SECTION AFTER ALL REVIEWS

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***These recommendations and clinical practice guidelines are based on the scientific literature published prior to December 2016.

LIST OF ACRONYMS

ACI: autologous chondrocyte implantation
ACL: anterior cruciate ligament
AE: athlete exposure
AGREE: Appraisal of Guidelines Research & Evaluation
AMIC: autologous matrix-induced chondrogenesis
APM: arthroscopic partial meniscectomy
APTA: American Physical Therapy Association
CI: confidence interval
CPG: clinical practice guideline
EQ-5: EuroQol-5
HCQ: Hughston clinic questionnaire
ICC: intraclass correlation coefficient
ICD: International Classification of Diseases
ICF: International Classification of Functioning, Disability and Health
ICRS: International Cartilage Repair Society
IKDC2000: International Knee Documentation Committee 2000 subjective knee form
JOSPT: Journal of Orthopaedic & Sports Physical Therapy
KOOS: Knee Injury and Osteoarthritis Outcome Score
KQoL-26: Knee Quality of Life 26-item questionnaire
MACI: matrix-supported autologous chondrocyte implantation
MCID: minimal clinically important difference
MRI: magnetic resonance imaging
OATS: osteochondral transplantation
OR: odds ratio
RCT: randomized controlled trial
SF-36: Medical Outcomes Study Short Form-36
SF-6D: Medical Outcomes Study Short Form-6 Dimensions
VAS: visual analogue scale
WOMAC: Western Ontario and McMaster Universities Arthritis Index
WOMET: Western Ontario Meniscal Evaluation Tool

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INTRODUCTION

AIM OF THE GUIDELINES

The Orthopaedic Section of the American Physical Therapy Association (APTA) has an ongoing effort to create evidence-based clinical practice guidelines (CPGs) for orthopaedic physical therapy management of patients with musculoskeletal impairments described in the World Health Organization's International Classification of Functioning, Disability, and Health (ICF).[93]

The purposes of these clinical guidelines are to:

- Describe evidence-based physical therapy practice including diagnosis, prognosis, intervention, and assessment of outcome for musculoskeletal disorders commonly managed by orthopaedic physical therapists
- Classify and define common musculoskeletal conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
- Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common musculoskeletal conditions
- Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure as well as in activity and participation of the individual
- Provide a description to policy makers, using internationally accepted terminology, of the practice of orthopaedic physical therapists
- Provide information for payers and claims reviewers regarding the practice of orthopaedic physical therapy for common musculoskeletal conditions
- Create a reference publication for orthopaedic physical therapy clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic physical therapy

STATEMENT OF INTENT

These guidelines are not intended to be construed or to serve as a standard of medical care. Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered guidelines only. Adherence to them will not ensure a successful outcome in every patient, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made based on clinician experience and expertise in light of the clinical presentation of the patient, the available evidence, available diagnostic and treatment options, and the patient's values, expectations, and preferences. However, we suggest that significant departures from accepted guidelines should be documented in the patient's medical records at the time the relevant clinical decision is made.

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Methods

Content experts were appointed by the Orthopaedic Section, APTA to conduct a review of the literature and to develop an updated Knee Pain and Mobility Impairments-Knee Meniscal/Articular Cartilage Lesions CPG as indicated by the current state of the evidence in the field. The aims of the revision were to provide a concise summary of the evidence since publication of the original guideline and to develop new recommendations or revise previously published recommendations to support evidence-based practice. Four authors of this guideline revision completed the Appraisal of Guidelines Research & Evaluation (AGREE) II tool to assess the quality and reporting of the current CPGs. The authors of this guideline revision worked with research librarians with expertise in systematic review to perform a systematic search for concepts associated with meniscus and articular cartilage injuries of the knee in articles published from 2008 related to classification, examination, and intervention strategies consistent with previous guideline development methods related to ICF classification.[79] Briefly, the following databases were searched from 2008 to Dec 31, 2016 MEDLINE (PubMed; 2008 to date); Scopus (Elsevier B.V; 2008 to date); CINAHL (EBSCO; 2008 to date); SportDiscus (EBSCO; 2008 to date); Cochrane Library (Wiley; 2008 to date); [See **APPENDIX A** for full search strategies and **APPENDIX B** for search dates and results, available at www.orthopt.org.]

The authors declared relationships and developed a conflict management plan which included submitting a Conflict of Interest form to the Orthopaedic Section, APTA, Inc. Articles that were authored by a reviewer were assigned to an alternate reviewer. Funding was provided to the CPG development team for travel and expenses for CPG development training. The CPG development team maintained editorial independence.

Articles contributing to recommendations were reviewed based on specified inclusion and exclusion criteria with the goal of identifying evidence relevant to physical therapist clinical decision-making for adult persons with knee pain and mobility impairments/knee meniscal/articular cartilage lesions. The title and abstract of each article were reviewed independently by 2 members of the CPG development team for inclusion. [See **APPENDIX C** for Inclusion and Exclusion criteria, available at www.orthopt.org]. Full text review was then similarly conducted to obtain the final set of articles for contribution to recommendations. The team leader (DSL) provided the final decision for discrepancies that were not resolved by the review team. [See **APPENDIX D** for flow chart of articles and **APPENDIX E** for articles included in recommendations by topic, available at www.orthopt.org]. For selected relevant topics that were not appropriate for the development of recommendations, such as incidence and imaging, articles were not subject to systematic review process and were not included in the flow chart. Evidence tables for this CPG are available on the Clinical Practice Guidelines page of the Orthopaedic Section of the APTA website: www.orthopt.org.

This guideline was issued in 2017 based on the published literature up to December 2016. This guideline will be considered for review in 2021, or sooner if new evidence becomes available that may change the recommendations. Any updates to the guideline in the interim period will be noted on the Orthopaedic Section of the APTA website: www.orthopt.org

LEVELS OF EVIDENCE

Individual clinical research articles were graded according to criteria adapted from the Centre for Evidence-Based Medicine, Oxford, United Kingdom for diagnostic, prospective, and therapeutic studies.[101] In 3 teams of 2, each reviewer independently assigned a level of evidence and evaluated the quality of each article using a critical appraisal tool. [See **APPENDIX F** and **G** for Levels of Evidence table and details on procedures used for assigning levels of evidence, available at www.orthopt.org]. The evidence update was organized from highest level of evidence to lowest level. An abbreviated version of the grading system is provided below.

I	Evidence obtained from high quality diagnostic studies, systematic reviews, prospective studies, or randomized controlled trials
II	Evidence obtained from lesser-quality diagnostic studies, systematic reviews, prospective studies, or, randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, less than 80% follow-up)
III	Case controlled studies or retrospective studies
IV	Case series
V	Expert opinion

GRADES OF EVIDENCE

The strength of the evidence supporting the recommendations was graded according to the previously established methods for the original guideline and those provided below. Each team developed recommendations based on the strength of evidence, including how directly the studies addressed the question on knee pain and mobility impairments/meniscus and articular cartilage lesion population. In developing their recommendations, the authors considered the strengths and limitations of the body of evidence and the health benefits, side effects, and risks of tests and interventions.

GRADES OF RECOMMENDATION		**STRENGTH OF EVIDENCE**
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation
C	Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies
E	Theoretical/ foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual

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		models/principles, or from basic sciences/bench research support this conclusion
F	Expert opinion	Best practice based on the clinical experience of the guidelines development team

DESCRIPTION OF GUIDELINE VALIDATION

Identified reviewers who are experts in knee meniscus and articular cartilage injury management and rehabilitation reviewed this CPG content and methods for integrity, accuracy, and that it fully represents the condition. Any comments, suggestions, or feedback from the expert reviewers was delivered to the author and editors to consider and make appropriate revisions. These guidelines were also posted for public comment and review on the orthopt.org web site and a notification of this posting was sent to the members of the Orthopaedic Section, APTA, Inc. Any comments, suggestions, and feedback gathered from public commentary was sent to the authors and editors to consider and make appropriate revisions in the guideline. In addition, a panel of consumer/patient representatives and external stakeholders, such as claims reviewers, medical coding experts, academic educators, clinical educators, physician specialists, and researchers also reviewed the guideline and provided feedback and recommendations that were given to the authors and editors for further consideration and revisions. Lastly, a panel of consumer/patient representatives and external stakeholders and a panel of experts in physical therapy practice guideline methodology annually review the Orthopaedic Section, APTA's ICF-based Clinical Practice Guideline Policies and provide feedback and comments to the Clinical Practice Guideline Coordinator and Editors to improve the Association's guideline development and implementation processes.

DISSEMINATION AND IMPLEMENTATION TOOLS

In addition to publishing these guidelines in the Journal of Orthopaedic & Sports Physical Therapy (JOSPT), these guidelines will be posted on CPG areas of both the JOSPT and the Orthopaedic Section, APTA websites, which are free access website areas, and submitted to be available free access on the Agency for Healthcare Quality and Research's website (www.guideline.gov). The implementation tools planned to be available for patients, clinicians, educators, payors, policy makers, and researchers, and the associated implementation strategies are:

Tool	Strategy
"Perspectives for Patients" and/or "Perspectives for Practice"	Patient-oriented guideline summary available on jospt.org and orthopt.org
Mobile app of guideline based exercises for patient/clients and healthcare practitioners	Marketing and distribution of app using www.orthopt.org
Clinician's Quick-Reference Guide	Summary or guideline recommendations available on www.orthopt.org
Read-for-credit continuing education units	Continuing Education Units available for physical therapists and athletic trainers

Webinars educational offering for healthcare practitioners	Guideline-based instruction available for practitioners on www.orthopt.org
Mobile and web-based app of guideline for training of healthcare practitioners	Marketing and distribution of app using www.orthopt.org
Physical Therapy National Outcomes Data Registry	Support the ongoing usage of data registry for common musculoskeletal conditions of the knee
Logical Observation Identifiers Names and Codes mapping	Publication of minimal data sets and their corresponding Logical Observation Identifiers Names and Codes for the knee region on www.orthopt.org
Non-English versions of the guidelines and guideline implementation tools	Development and distribution of translated guidelines and tools to JOSPT's international partners and global audience

CLASSIFICATION

The International Classification of Disease-10 (ICD-10) codes and conditions associated with knee pain and mobility disorders are S83.2 Tear of meniscus, current, M23.2 Derangement of meniscus due to old tear or injury, S83.3 Tear of articular cartilage of knee, current, and M93.2 Osteochondritis dissecans.

The corresponding ICD-9 Clinical Modification (CM) codes and conditions, which are used in the USA, associated with knee pain and mobility disorders are 836.0 Tear of medial cartilage or meniscus of knee, current, 836.1 Tear of lateral cartilage or meniscus of knee, current, 717.0 Old bucket handle tear of medial meniscus, 717.1 Derangement of anterior horn of medial meniscus, 717.2 Derangement of posterior horn of medial meniscus, 717.3 Other and unspecified derangement of medial meniscus, 717.40 Derangement of lateral meniscus unspecified, 717.41 Bucket handle tear of lateral meniscus, 717.42 Derangement of anterior horn of lateral meniscus, 717.43 Derangement of posterior horn of lateral meniscus, 717.49 Other derangement of lateral meniscus, 717.89 Other internal derangement of knee, and 732.7 Osteochondritis dissecans.

The primary ICF body functions codes associated with the above noted ICD-10 conditions are **b28016 Pain in joints, b7100 Mobility of a single joint,** and **b770 Gait pattern functions.**

The primary ICF body structures codes associated with knee pain and mobility disorders are **s75000 Bones of thigh, s75010 Bones of lower leg, s75011 Knee joint,** and **s75018 Structure of lower leg, specified as fibrocartilage or hyaline cartilage of the knee.**

The primary ICF activities and participation codes associated with knee pain and mobility disorders are **d2302 Completing the daily routine** and **d4558 Moving around, specified as quick direction changes while walking or running.**

A comprehensive list of codes was published in the previous guideline.[79]

ORGANIZATION OF THE GUIDELINE

For each topic, the summary recommendation and grade of evidence from the 2010 guideline are presented followed by a synthesis of the recent literature with the corresponding evidence levels. Each topic concludes with the 2017 summary recommendation and its updated grade of evidence.

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CLINICAL PRACTICE GUIDELINES
Impairment/Function-Based Diagnosis

INCIDENCE
2010 Summary

Meniscus. Injuries to the menisci are the second most common injury to the knee with a prevalence of 12 to 14% and an incidence of 61 cases per 100 000 persons.[84, 115] A high incidence of meniscal tears occurs with injury to the anterior cruciate ligament (ACL), ranging from 22% to 86%.[91] In the United States, 10% to 20% of all orthopaedic surgeries consist of surgery to the meniscus on an estimated 850 000 patients each year.[104]

Articular Cartilage. Based on studies of knee arthroscopies, the prevalence of articular cartilage pathologies is reported between 60% and 70%.[8, 58] The incidence of isolated articular cartilage lesions (30%) is lower than that of nonisolated cartilage lesions.[126] Thirty-two to 58% of all articular cartilage lesions are the result of a traumatic, non-contact mechanism of injury.[62, 126] Sixty-four percent of all chondral lesions were less than 1 square cm.[126] Thirty-three to sixty percent of articular cartilage lesions are greater than grade 3 lesions on the International Cartilage Repair Society (ICRS) grading system.[32, 118] The ICRS cartilage injury classification consists of 5 grading levels, from grade 0 (normal cartilage without notable defects) to grade 4 (severely abnormal, full-thickness osteochondral injury).[20] The most frequent localization of cartilage lesions were to the medial femoral condyle and the patella articular surface.[126] Medial meniscal tears (37%) and ACL ruptures (36%) were the most common injuries concomitant with articular cartilage injuries.

Evidence Update

Meniscus

II

In active-duty United States military service personnel, Jones et al[63] reported an unadjusted incidence rate of 8.27 per 1000 person-years (95% CI: 8.22, 8.32) for acute meniscal injury. For men, the adjusted rate per 1000 person-years was 7.08 and for women was 6.02. Oldest service personnel (older than 40 years of age) had more than 4 times (4.25) the adjusted rate of meniscus tears compared to youngest (less than 20 years of age) service personnel.

III

Yeh et al[132] identified 129 isolated meniscus tears over a 21-season span in 1797 professional basketball players. One-hundred eleven injuries (86.7%) were from a single incident. Lateral meniscus tears were involved in 59.2% and medial meniscus tears were involved in 40.8% of cases. Isolated tears accounted for 87.8% of cases, whereas 12.2% of cases were concomitant with a ligamentous injury. They reported an overall clinical incidence of 8.2 meniscus tears per 100 athletes. Lateral meniscus tears were more likely to occur in younger athletes (less than or equal to 30 years of age) whereas medial meniscus tears were more prevalent in older athletes (older than 30 years of age).

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III
In a case series of primary and subsequent revision ACL reconstruction, meniscus tear prevalence decreased from 54.8% at primary ACL reconstruction to 43.7% at revision ACL reconstruction, lateral meniscus tear prevalence decreased from 37.2% at primary ACL reconstruction to 18.4% at revision ACL reconstruction, and medial meniscus tear prevalence was unchanged (32.6% at primary ACL reconstruction to 32.6% at revision ACL reconstruction).[130]

IV
In a retrospective review, Ralles et al[102] reported a delay in ACL reconstruction (greater than 12 months from the index injury) was associated with increased incidence of medial meniscus lesions and cartilage lesions. Additionally, less active patients (based on Marx Activity Scale less than 7) were more likely to have cartilage lesions and medial meniscus tears compared to those who were more active.

IV
In an injury surveillance study of high school athletes, the meniscus was involved in 23.0% of all knee injuries in all reported sports, corresponding to 0.51 injuries per 10,000 athlete exposures (AEs).[117] In sex-comparable sports, boys had 0.22 injuries per 10 000 AEs and girls had 0.42 injuries per 10 000 AEs, resulting in girls having a higher rate of meniscus injuries compared to boys (rate ratio: 1.88 (95% confidence interval (CI): 1.48, 2.40).

IV
In a claims analysis study, Abrams et al[1] reported that from 2005 to 2011, 387 833 meniscectomies and 23 640 meniscus repairs were performed in the United States. They reported only a small increase in the number of yearly meniscectomies from 2005 to 2011 (4.7%) but there was a larger increase (11.4%) in the number of yearly meniscus repairs. The overall incidence of meniscectomies went from 0.21% per year to 0.24% per year whereas the incidence of meniscal repairs went from 0.01% per year to 0.02% per year.

IV
Similarly, in Denmark from 2000-2011, the number of yearly meniscus procedures doubled from 8750 to 17 368.[122] The largest increases in incidence rate in the same time period were seen in older patients (3-fold increase) and in middle-aged patients (2-fold increase).

Articular Cartilage

II
A systematic review of 11 studies (931 participants) of the prevalence of chondral lesions in athletes' knees identified by arthroscopy or magnetic resonance imaging (MRI) found the overall prevalence of full-thickness focal chondral lesions was 36% (range: 2.4% to 75%).[45] Thirty-five percent of lesions were located in the femoral condyles, 37% in the patella and trochlea, and 25% in the tibial plateaus. The prevalence of full-thickness focal chondral lesions in asymptomatic individuals was 14% but was substantially higher in basketball players and endurance runners (59% (range: 18% to 63%)).

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II
Brophy et al[21] examined 725 participants with revision ACL reconstructions to determine the presence of chondral lesions and their relationship with prior meniscus surgery. After adjusting for patient age, knees with prior partial meniscectomy were more likely to have cartilage deterioration -than knees with prior meniscus repair or no previous history of meniscus surgery.

IV
Nepple et al[90] identified 432 articular cartilage abnormalities in 704 knee MRI scans from 594 participants from the National Football League Scouting Combine. Full-thickness lesions were present in 17% of knees with the lateral compartment being the most common site. Previous surgery to the knee was significantly associated with full-thickness articular cartilage lesions.

Meniscus and Articular Cartilage

III
Wyatt et al[130] investigated the prevalence of meniscus and cartilage lesions in a sample of 261 patients who had primary and subsequent revision ACL reconstruction. The prevalence of cartilage injuries was twice more common among those undergoing revision ACL reconstruction (31.8%) compared to those undergoing primary ACL reconstruction (14.9%). There was a higher prevalence of meniscus tears at primary ACL reconstruction (54.8%) compared to revision ACL reconstruction (43.7%). There was a higher prevalence of lateral meniscus tears at primary ACL reconstruction (37.2%) compared to revision ACL reconstruction (18.4%) but no difference in prevalence of medial meniscus tears between primary (32.6%) and revision reconstruction (32.6%).

IV
Kuikka et al[74] reported on population-based incidence in young military men. They reported an incidence of 3.1 per 1000 person-years (95% CI: 2.7, 3.4) for old meniscus tears, 2.2 per 1000 person-years (95% CI: 1.9, 2.5) for new meniscus tears, and 0.2 per 1000 person-years (95% CI: 0.1, 0.3) for fresh chondral lesions. Twenty-seven percent of individuals were hospitalized for old meniscus tear, 19.9% for new meniscus tears, and 1.7% for chondral lesions. They reported that one-third of service class changes were the result of meniscal tears and new chondral lesions.

2017 Summary
Meniscus lesions account for almost one-quarter of all knee injuries. Women may have higher incidence of meniscus tears than men. Older individuals have a higher rate of meniscus tears compared to younger individuals. Lateral meniscus tears are more likely to occur in younger athletes and medial meniscus tears are more likely to occur in older participants. The incidence rate of meniscus procedures (partial meniscectomies and meniscus repairs) has substantially increased over the past decade.

The prevalence of articular cartilage lesions in athletes' knees ranges from 17% to 59%, some of those athletes being asymptomatic. The incidence rate of articular cartilage lesions is high after partial meniscectomy or second ACL injury.

PATHOANATOMICAL FEATURES
2010 Summary

Meniscus

The medial and lateral menisci cover the superior aspect of the tibia.[19] Each meniscus is comprised of fibrocartilage and is wedge-shaped. The lateral meniscus is more circular, whereas the medial meniscus is more crescent-shaped. The lateral meniscus is more mobile than the medial meniscus. The menisci function to distribute stress across the knee during weight bearing, provide shock absorption, serve as secondary joint stabilizers, provide articular cartilage nutrition and lubrication, facilitate joint gliding, prevent hyperextension, and protect the joint margins.[19] Individuals who sustain a meniscal tear report a similar history as an individual with an ACL tear, such as feeling a "pop" while suddenly changing direction with or without contact.[19] The rate of medial meniscal tears increases over time, whereas lateral meniscal tears do not.[64, 91, 118] Prolonged delays in ACL reconstruction is related to increased occurrence of meniscus injuries.[91]

Articular Cartilage

The articular cartilage that covers the gliding surfaces of the knee joint is hyaline in nature.[15, 75] Hyaline cartilage decreases the friction between gliding surfaces, withstands compression by acting as a shock absorber, and resists wear during normal situations.[15, 23] Injuries to the articular cartilage can be the result of acute trauma or repetitive minor trauma.[15, 62, 126] Some individuals who sustain articular surface injury do not seek treatment. Many lesions are nonprogressive and remain asymptomatic, while some experts believe that even small asymptomatic lesions may increase in size and eventually become painful if left untreated.[48] Four methods of operative care that are most widely used are arthroscopic lavage and debridement, microfracture, autologous chondrocyte implantation (ACI), and osteochondral transplantation (OATS).[75]

No evidence update

2017 Summary
Partial meniscectomies and meniscal repairs are the primary surgical procedures used to treat meniscus tears.. Microfracture procedures for articular cartilage lesions are largely used for young patients with good outcomes and has been combined with an extrinsic matrix known as autologous matrix-induced chrondrogenesis (AMIC). ACI procedures continue to progress with matrix-associated ACI and other cartilage engineering techniques.

CLINICAL COURSE
2010 Recommendation
C
Knee pain and mobility impairments associated with meniscal and articular cartilage tears can be the result of a contact or noncontact incident, which can result in damage to one or more

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structures. Clinicians should assess for impairments in range of motion, motor control, strength, and endurance of the limb associated with the identified meniscal or articular cartilage pathology or following meniscal or chondral surgery.

Evidence Update

Meniscus

I

Katz et al[66] randomized 351 patients with a meniscus tear and mild to moderate knee osteoarthritis into either arthroscopic partial meniscectomy (APM) and rehabilitation, or rehabilitation only. Patients were followed up at 6 and 12 months and results were similar for the 2 groups. In the intention-to-analysis (adjusted for study site), at 6 months, the mean Western Ontario and McMaster Universities Arthritis Index (WOMAC) physical function score improved by 20.9 points for the surgical group and 18.5 points for the rehabilitation group. At 12 months, the mean scores improved by 23.5 and 22.8 points for the surgical and rehabilitation groups respectively. Similar improvements in both groups were reported in Knee Injury and Osteoarthritis Outcome Score (KOOS) pain subscale scores at both time points. At 6 months, 30% of the patients assigned to the rehabilitation group crossed over to the surgery group whereas 5% assigned to the surgery group chose not to undergo surgery.

II

A systematic review of 4 studies (prospective and cross-sectional) assessing quadriceps strength after APM reported large quadriceps strength deficits less than 1 month after surgery (Cohen's d = -1.01 to -1.62), small to large deficits 1 to 3 months after surgery (d = -0.40 to -8.04), small to large deficits 3 to 6 months after surgery (d = -0.40 to -5.11), and small deficits (d = -0.30 to -0.37) greater than 6 months after surgery.[85]

II

A systematic review of 367 participants from 7 studies (included randomized control trials (RCT) and retrospective observational trials) evaluated outcomes comparing meniscal repair to meniscectomy.[131] Patients post meniscus repair reported similar long-term International Knee Documentation Committee 2000 knee examination form clinical scores, higher Lysholm scores (mean difference 5.24), and less change in Tegner scores (median difference -0.81) as compared to patients post meniscectomy. Patients post meniscus repair had better self-reported knee function and less activity loss compared to those post meniscectomy.

II

Al-Dadah et al[3] investigated proprioception and self-reported knee function pre-operatively (baseline) and 3 months later (follow-up) in patients undergoing knee arthroscopy. At baseline, the group scheduled for APM (n=50) had impaired proprioception compared to healthy controls and the contralateral uninjured knee. At follow-up, despite improvements in perceived knee function according to Lysholm, Cincinnati, and IKDC2000 scores compared to pre-operative scores, the APM leg continued to demonstrate impaired proprioception compared to their normal contralateral knee and to healthy controls.

II
Busija et al[24] assessed the change in Medical Outcomes Study Short Form-36 (SF-36) in patients undergoing 4 types of orthopedic surgeries. In 63 patients (85%) who underwent APM and completed 3-month follow-up assessment, a large effect size (1.0) was observed for improvement in body pain and a moderate effect size (0.70) for the Physical Component Summary of the SF-36.

II
Fabricant et al[42] studied factors related to patient recovery 12 months following APM. There was 141 patients included at baseline (tested 2-6 weeks prior to surgery) and 126 (89%) completed the study. Pain and knee function were rated by the surgeon. Variables assessed to predict recovery rate included: osteoarthritis severity (Modified Outerbridge Score), meniscal excision depth, involvement of both menisci, extent of tear, sex, age, body mass index, and time (preoperative, and 1, 3, 8, 16, 24, and 48 weeks post surgery). Of the variables assessed, female sex and greater osteoarthritis severity were associated with slower rate of short- to intermediate-term recovery.

II
In patients with degenerative meniscus lesions, Osteras and colleagues[95] randomized 17 patients to either specialized exercise therapy or APM. The exercise therapy group had similar to better adjusted differences in change from baseline to 3 months follow-up compared to the APM group for visual analog scale (VAS) pain scores (exercise therapy: -1.1; APM: -1.1), total KOOS scores (exercise therapy: -10.7; APM: -8.9), Hospital Anxiety and Depression Scale scores (exercise therapy: -1.7; APM: -0.7), and quadriceps muscle strength with maximal external load using 5 repetitions (exercise therapy: 10.5; APM: 4.1).

II
In this 10-year study, Zaffagnini and colleagues[133] compared clinical and structural outcomes in patients receiving a medial collagen meniscus implant (MCMI) compared to patients undergoing APM. Thirty-three of the 36 patients returned for re-assessment (92%) and results showed that on average patients receiving MCMI (n=17) compared to the APM group (n=16) had similar pain (VAS: 1.2 versus 1.8), higher physical activity levels (Tegner activity scale: 7.5 versus 5.0), and less joint space narrowing (radiographs: 0.48 mm versus 2.13 mm).

II
Kijowski et al[69] evaluated whether preoperative MRI features were associated with clinical outcomes 1 year later. In 100 patients undergoing APM, clinical outcomes were assessed using the IKDC2000 and structural integrity using the Boston Leads Osteoarthritis Knee scoring system. Poorer clinical outcome after surgery was associated with greater severity of cartilage loss and bone edema, specific to the compartment of the meniscal tear. Meniscal root tears were associated with an increased risk for limited improvement in middle-aged and older patients following APM.

II

Thorlund et al[120] assessed knee muscle strength included maximal isometric knee extension and flexion, one leg-hop for distance, and maximum number of one leg hops in 30 seconds and found no difference in change in knee muscle strength from 2 year post APM to 4 years post APM in patients who had undergone APM compared to healthy controls. KOOS-quality of life subscale was lower in patients 4 years after APM compared to healthy controls with no differences in the other 4 KOOS subscale scores between patients and controls.

II

A series of publications from a 2-year longitudinal cohort study assessed 82 patients 3 months post APM of the medial meniscus (baseline) with 66 (80%) who returned 2 years later for re-assessment (follow-up).[52, 54, 121] Thirty-eight healthy controls were assessed at baseline and 23 (61%) returned for re-assessment 2 years later. At baseline, the operated leg had a lower maximum loading rate during early stance phase of walking compared to healthy controls. The peak vertical force during stance increased (relative to baseline) in the operated leg compared to healthy controls over time.[53] Knee muscle weakness in the operated leg compared to controls that had been observed in patients 3 months following surgery had recovered 2 years later, such that no differences were observed at follow-up between groups.[54] Higher peak knee adduction moment and knee adduction moment impulse (indicators of knee joint loading) during walking were found in patients 3 months following surgery compared to healthy controls. Knee muscle weakness 3 months following APM was not associated with change in the knee adduction moment over the subsequent 2 years.[52] At baseline, in a sub-group of these patients (n=66), greater varus, valgus, and total knee joint angular laxity was found compared to healthy controls. No differences were observed in change in stiffness over the 2-year period between the operated legs and controls.[121]

III

Stein et al[113] investigated clinical and radiographic outcomes in patients with an isolated traumatic medial meniscal tear, who had undergone a meniscal repair (n=42) or partial meniscectomy (n=39). At long-term follow-up (5-8 years after surgery), 56% of the cohort (meniscal repair: 62%; partial meniscectomy: 51%) returned for follow-up and osteoarthritis progression was greater in the meniscectomy group (40%) compared to the meniscal repair group (20%). There was no difference between groups in knee function using the Lysholm score (meniscal repair: 91.5; partial meniscectomy: 88.4). Pre-injury activity levels according to the Tegner activity scale were reported in over 95% of the repair group compared to 50% of meniscectomy group.

III

Scanzello et al[109] investigated whether synovitis in patients undergoing APM (n=33) predicted post-operative symptoms. Synovitis and hyperplasia were assessed via surgical biopsies. In patients with inflammation, Lysholm scores and the physical component summary of the Medical Outcomes Study Short Form-12 were worse pre-operatively. However, there was no association between synovial inflammation and self-reported symptoms at 16 weeks, 1 year, and 2 year post-operatively.

III

Sung-Gon et al[116] evaluated return-to-sport after surgery in 56 athletes undergoing APM. Athletes younger than 30 years returned to sport on average 54 days following surgery while those older than 30 years returned to sports later, on average 89 days following surgery. Patients with medial meniscus tears had a longer return to sport time (79 days) than those with lateral meniscus tears (61 days). Elite and competitive athletes had shorter return to sport time (53-54 days), than recreational athletes (88 days). Therefore age, level of physical activity, and which meniscus is torn may influence time to return-to-sport.

Articular Cartilage

II
In a systematic review, Filardo et al[44] reported on failure rates after ACI surgeries (5-12 years post-surgery) in 193 patients. They reported that failure rates varied based on the definition criteria: (1) surgical: the percentage of patients needing revision surgery (10.4% failure rate), (2) clinical improvement based on minimally clinically important difference (MCID) on IKDC2000 (21.2% failure rate), (3) absolute IKDC2000 scores less than 60 (24.4% failure rate), or (4) IKDC clinical knee scores that were “severely abnormal” (3.6% failure rate). When all criteria were combined, the failure rate was 33.7% at a mean follow of 8.5 years.

2017 Summary
The clinical course for most patients after meniscus injury managed with or without surgery is satisfactory. Patients who have non-operative management for meniscus repair have similar to better outcomes in terms of strength and perceived knee function in the short-term and intermediate term compared to those who had APM.

Impairments in proprioception and muscle strength, and poor patient-reported outcomes (PROs) are present early after meniscal injury and in the short-term time period (less than 6 months) after APM. Most of these impairments and PROs resolve within 2 years after APM, however, perceived quality of life is lower than healthy controls 4 years after APM. Demographics, meniscus tear location, physical impairments, and functional levels as determined by performance-based tests and PROs can influence return to sport rates after APM.

Patients who have meniscus repair have similar to better perceived knee function, less activity loss and higher rates of return to activity compared to those who have APM. Elite and competitive athletes or Athletes younger than 30 years or are likely to return to sport less than 2 months after APM and athletes older than 30 are likely to return by 3 months after APM.

Failure rates for ACI are higher with over 1/3 failing by 8.5 years after surgery.

RISK FACTORS

2010 Recommendation
C
Clinicians should consider age and greater time from injury as predisposing factors for having a meniscal injury. Patients who participated in high-level sports or had increased knee laxity after an ACL injury are more likely to have late meniscal surgery. (Recommendation based on weak evidence.)

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Clinicians should consider the patients' age and presence of a meniscal tear for the odds of having a chondral lesion subsequent to having an ACL injury. The greater a patient's age and longer time from initial ACL injury are predictive factors of the severity of chondral lesions, and time from initial ACL injury is significantly associated with the number of chondral lesions. (Recommendation based on weak evidence.)

Evidence Update

Meniscus

II
A systematic review of 11 studies of risk factors for meniscus tears found strong evidence that older age (greater than 60 years) (odds ratio (OR) = 2.32), male sex (OR = 2.98), work-related kneeling and squatting (OR = 2.69), and climbing more than 30 flights of stairs per day (OR = 2.28) were associated with the occurrence of degenerative meniscus tears.[112] Playing soccer (OR = 3.58) and rugby (OR = 2.84) were strong risk factors for acute meniscus tears. Additionally, delayed ACL reconstruction (OR = 3.50) was a strong risk factor for future medial meniscus tears.

II
Papalia et al[97] performed a systematic review of 32 studies to identify risk factors of knee osteoarthritis after meniscectomy. The overall mean prevalence of knee osteoarthritis was 53.5% (range: 16% to 92.9%). They found strong evidence that medial and lateral meniscectomy, and duration of pre-operative symptoms were associated with knee osteoarthritis. Consistent evidence was found that extent of meniscectomy was associated with knee osteoarthritis. Age at surgery, sex, duration of follow-up, cartilage status, body mass index, functional results, and objective symptoms were inconsistent in their association with knee osteoarthritis.

II
A systematic review of 5 studies on factors associated with knee osteoarthritis after partial meniscectomy found normal or nearly normal clinical results in 80% to 100% of patients.[100] Radiographic evidence of joint degeneration after partial meniscectomy was present in up to 60% of patients.

II
Rosenberger et al[105] found that women had poorer knee function on the Lysholm Scale than men until 48 weeks post-surgery. Among women, previous knee injury or impairment and lower preoperative fitness level were risk factors for slower postoperative recovery after partial meniscectomy.

II
In a study of all meniscal repairs and any concomitant procedures from a New York statewide database, risk factors for meniscectomy after meniscal repairs were identified.[82] Older age (hazard ratio = 0.53), lateral meniscus injury (hazard ratio = 0.71), and surgeon characteristics

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(high annual volume of meniscus repairs) (hazard ratio = 0.37) were associated with lower risk of subsequent meniscectomy after an initial isolated meniscus repair.

III
Brambilla et al[18] retrospectively examined the prevalence of associated meniscus and cartilage lesions in ACL reconstruction. They reported an increase of an average of 0.6% of associated lesion for each month of delay of ACL reconstruction. A delay in 12 months of ACL reconstruction increased the odds of developing a medial meniscus tear (OR, 1.81 (95% CI: 1.32, 2.48)) and developing a cartilage lesion on the medial femoral condyle (OR, 2.35 (95% CI: 1.50, 3.68)) and on the medial tibial plateau (OR, 5.57, (95% CI: 1.91, 16.26)). Male sex increased the odds for developing lateral meniscal tears (OR, 2.29, (95% CI: 1.60, 3.28)) and medial meniscal tears (OR, 1.75, (95% CI: 1.28, 2.40)).

III
In a retrospective analysis, Hwang et al[59] investigated the risk factors associated with medial meniscus posterior root tears. Patients with medial meniscus posterior root tears were older, more likely to be female, and had a higher body mass index (greater than 30 kg/m^2), greater varus mechanical axis angle, lower sports activity level, and higher Kellgren-Lawrence grade than patients with other types of meniscus tears.

III
In a case-control study, Englund et al[41] reported that a meniscus tear, independent of meniscectomy and adjusted for patient demographics, physical activity, and mechanical alignment, is highly predictive (OR = 5.7) of the development of radiographic tibiofemoral osteoarthritis.

III
In a retrospective analysis of 1252 patients on the Kaiser Permanente Anterior Cruciate Ligament Reconstruction Registry, time from injury to ACL reconstruction of greater than 12 months increased the risk of medial meniscus injury at the time of ACL reconstruction. At the time of ACL reconstruction, women had a lower risk of lateral meniscus injury as compared to men.[27] Increasing age and greater delay in time to ACL reconstruction increased the risk for cartilage injury at the time of ACL reconstruction. A decrease in the rate of medial meniscus repairs relative to medial meniscus injury were associated with delayed time to ACL reconstruction and increasing age.

III
In a cross-sectional analysis of 2131 knees from the MultiCenter Osteoarthritis Study,[31] meniscus tears in the medial and lateral compartments had OR of 6.3 in the medial compartment and OR of 10.3 in the lateral compartment for meniscus extrusion (meniscal margin extending beyond the tibial margin). Varus and valgus malalignment, and cartilage damage in the medial and lateral compartments, respectively were also associated with meniscus extrusion.

IV
In a retrospective analysis of 309 consecutive patients by Wu et al,[129] the prevalence of radial tears in the posterior horn of the medial meniscus was 25.3% and of horizontal tears in the

posterior horn was 26.3%. Higher static valgus angle of the knee (OR, 12.58 (95% CI: 2.83, 55.90)), older age (OR, 0.88, (95% CI: 0.78, 0.94)), and higher Outbridge grade were risk factors for radial tears in the posterior horn of the medial meniscus.

IV
In a retrospective analysis of 129 patients with ACL reconstruction, delay in ACL reconstruction of greater than 24 weeks was identified as a risk factor of medial, lateral, or both meniscus tears at time of surgery.[60]

Articular Cartilage

I
Pestka et al[99] evaluated clinical outcomes after matrix-supported autologous chondrocyte implantation (MACI) using IKDC2000 questionnaire. They reported that patients with good to excellent IKDC2000 scores 6 and 12 months after surgery were more likely to have good to excellent scores at 36 months, whereas patients with poor IKDC2000 scores 12 and 24 months after surgery were more likely to not show improvement by 36 months.

I
In a retrospective analysis of 454 patients, Salzmann and colleagues[108] found that absence of previous knee trauma, longer symptom duration, female sex, and previous surgery to the index knee predicted lower IKDC2000 scores in all patients undergoing microfracture surgery. In patients who failed microfracture surgery, absence of previous knee trauma, longer symptom duration, lower preoperative pain and function, smoking, and follow-up time were predictive of lower IKDC2000 scores. Lower preoperative pain and function, smoking, and patellofemoral lesions were related to higher probability of reoperation.

I
Jungmann[65] in a study of 88 patients reported that women (OR = 1.7) and having previous multiple knee surgeries (OR = 4.0), previous bone marrow stimulation procedures (OR = 1.9), and periosteum patch-covered ACI (OR = 2.0 to 2.4) were associated with significantly higher risk of surgical revision of the index knee.

II
Ebert et al[37] reported that higher pre-operative SF-36 mental and physical component summary scores, and shorter duration of symptoms were associated with higher KOOS Sports/Recreation scores 5 years after MACI. Younger age, higher SF-36 mental component scores, shorter duration of symptoms, fewer previous knee procedures, and smaller graft size predicted better 5-year MRI scores. Earlier return to full weight-bearing were associated with higher 5-year patient satisfaction scores.

Meniscus and Articular Cartilage

I

In a prospective, longitudinal observational study of 152 women older than 40 years of age, Crema et al[30] reported that cartilage loss in the medial tibia was associated with complex medial meniscus tears or medial meniscus maceration. However, cartilage loss in the medial femoral condyle was not associated with single medial meniscus tears.

III
Kluczynski et al,[71] in a prospective case-control study of 541 patients, reported that male sex was associated with overall lateral meniscus tears in patients undergoing ACL reconstruction, male sex and delayed surgery up to 6 weeks were associated with lateral meniscus tear surgical management. Male sex, obesity, sports injuries, and a greater number of instability episodes were identified as risk factors for medial meniscus tears in patients undergoing ACL reconstruction and medial meniscus tear surgical management. Older age, obesity, and delayed surgery up to 12 weeks were associated with chondral lesions in patients undergoing ACL reconstruction.

III
In a case-control study of 122 patients, people with a higher body mass index prior to ACI procedure were more likely to have poorer knee function as reported by the modified Cincinnati scores 24 months after surgery, independent of other demographic and lesion characteristics.[61]

IV
Among 103 patients (range: 14-85 years of age) prospectively followed, individuals with isolated root and radial/flap meniscus tears had greater articular cartilage degeneration on the medial femoral condyle.[57] Those with isolated root and complex meniscus tears had more articular cartilage degeneration on the medial tibial plateau, whereas those with isolated radial/flap meniscus tears had more articular cartilage degeneration on the lateral tibial plateau. An increase in age and body mass index decreased the Noyes lateral-compartment score, and an increase in age decreased the Noyes medial-compartment score.

IV
In a case series of 97 patients, symptoms lasting more than 6 months after initial injury and a wedge shaped (asymmetrical) discoid lateral meniscus was associated with an increased incidence of articular cartilage damage as observed on arthroscopy.[35]

2017 Summary
Cutting and pivoting sports are risk factors for acute meniscus tears. Increased age and delayed ACL reconstruction are risk factors for future meniscus tears. Female sex, older age, higher body mass index, lower physical activity, and delayed ACL reconstruction are risk factors for medial meniscus tears. Female sex, older age, higher body mass index, longer symptom duration, previous procedures and surgeries, and lower knee function are associated with higher failures with articular cartilage repair surgical procedures.

DIAGNOSIS/CLASSIFICATION

2010 Summary

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The ICD diagnosis of a meniscal tear and the associated ICF diagnosis of joint pain and mobility impairments are made with a fair level of certainty when the patient presents with the following clinical findings:[9, 13, 20, 56, 81, 86, 106]

- Twisting injury
- Tearing sensation at time of injury
- Delayed effusion (6-24 hours postinjury)
- History of "catching" or "locking"
- Pain with forced hyperextension
- Pain with maximum passive knee flexion
- Pain or audible click with McMurray's maneuver
  - Sensitivity: 55% (95% CI: 50%, 80%)
    - Medial meniscus: 50% (95% CI: 38%, 62%)
    - Lateral meniscus: 21% (95% CI: 9%, 43%)
  - Specificity: 77% (95% CI: 62%, 87%)
    - Medial meniscus: 77% (95% CI: 57%, 90%)
    - Lateral meniscus: 94% (95% CI: 85%, 98%)
- Joint line tenderness
  - Sensitivity: 76% (95% CI: 73%, 80%)
    - Medial meniscus: 83% (95% CI: 71%, 90%)
    - Lateral meniscus: 68% (95% CI: 46%, 85%)
  - Specificity: 77% (95% CI: 64%, 87%)
    - Medial meniscus: 76% (95% CI: 55%, 89%)
    - Lateral meniscus: 97% (95% CI: 89%, 99%)
- Discomfort or a sense of locking or catching in the knee over either the medial or lateral joint line during the Thessaly Test when performed at 20° of knee flexion
  - Sensitivity:
    - Medial meniscus: 59%-89%
    - Lateral meniscus: 67%-92%
  - Specificity:
    - Medial meniscus: 83-97%
    - Lateral meniscus: 95%-96%
- Meniscal Pathology Composite Score: The combination of history of "catching" or "locking", pain with forced hyperextension, pain with maximum passive knee flexion, and pain or audible click with McMurray's maneuver
  - Greater than 5 positive findings
    - Sensitivity: 11.2%
    - Specificity: 99.0%
  - Greater than 3 positive findings
    - Sensitivity: 30.8%
    - Specificity: 90.2%
  - Greater than 1 positive findings
    - Sensitivity: 76.6%
    - Specificity: 43.1%
  - Zero (0) positive findings
    - Sensitivity: 23.4%
    - Specificity: 56.9%

The ICD diagnosis of an articular cartilage defect and the associated ICF diagnosis of joint pain and mobility impairments is made with a low level of certainty when the patient presents with the following clinical findings:[22]

- Acute trauma with hemarthrosis (0-2 hours) (associated with osteochondral fracture)
- Insidious onset aggravated by repetitive impact
- Intermittent pain and swelling
- History of “catching” or “locking”
- Joint line tenderness

No Evidence Update

2017 Recommendation

C

Clinicians should use the clinical finding of knee pain, history of twisting knee mechanism injury, history of “catching” or “locking, effusion, and a composite score of Meniscal Pathology Composite Score greater than 3 positive findings for classifying a patient with knee pain and mobility disorders into the following International Statistical Classification of Diseases and Related Health Problems (ICD) categories: tear of the meniscus and the associated International Classification of Functioning, Disability, and Health (ICF) impairment-based category knee pain (b28016 Pain in joint) and mobility impairments (b7100 Mobility of a single joint).

D

Clinicians may use the clinical finding of intermittent knee pain, history of acute trauma to the knee, history of “catching” or “locking, effusion, and joint line tenderness for classifying a patient with knee pain and mobility disorders into the following International Statistical Classification of Diseases and Related Health Problems (ICD) categories: tear of the articular cartilage and the associated International Classification of Functioning, Disability, and Health (ICF) impairment-based category knee pain (b28016 Pain in joint) and mobility impairments (b7100 Mobility of a single joint).

A pathoanatomical/medical diagnosis of meniscus/articular cartilage lesions can provide valuable information in describing tissue pathology and may assist in preoperative planning and predicting prognosis. The proposed model for examination, diagnosis, and treatment planning for patients with Knee Pain and Mobility Impairments associated with knee meniscus/articular cartilage lesions uses the following components: (1) medical screening; (2) classify condition through evaluation of clinical findings suggestive of musculoskeletal impairments of body functioning (ICF) and associated tissue pathology/disease (ICD); (3) determination of irritability stage; (4) determination of evaluative outcome measure instruments; (5) intervention strategies for patients with meniscus/articular cartilage lesions. This model is depicted in the **FIGURE**.

Figure. Model of Diagnosis, Examination, and Treatment

Component 1: medical screening

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Appropriate for physical therapy evaluation and intervention

versus

Appropriate for physical therapy evaluation and intervention along with consultation with another healthcare provider

versus

Not appropriate for physical therapy evaluation and intervention

Consultation with appropriate healthcare

Component 2: classify condition through differential evaluation of clinical findings suggestive of musculoskeletal impairments of body functioning (ICF) and the associated tissue pathology/disease (ICD)

Diagnostic Classification Criteria

Meniscus

Clinical Findings

- Twisting injury
- Tearing sensation at time of injury
- Delayed effusion (6-24 hours postinjury)
- History of "catching" or "locking"
- Pain with forced hyperextension
- Pain with maximum passive knee flexion
- Pain or audible click with McMurray's maneuver
- Joint line tenderness
- Discomfort or a sense of locking or catching in the knee over either the medial or lateral joint line during the Thessaly Test when performed at 20° of knee flexion
- Meniscal Pathology Composite Score: The combination of history of "catching" or "locking", pain with forced hyperextension, pain with maximum passive knee flexion, and pain or audible click with McMurray's maneuver

Articular Cartilage

Clinical Findings

- Acute trauma with hemarthrosis (0-2 hours) (associated with osteochondral fracture)
- Insidious onset aggravated by repetitive impact
- Intermittent pain and swelling
- History of "catching" or "locking"
- Joint line tenderness

Component 3: Determination of irritability stage

Diagnosis of tissue irritability is important for guiding the clinical decisions regarding treatment frequency, intensity, duration, and type, with the goal of matching the optimal dosage of treatment to the status of the tissue being treated. There are cases where the alignment of irritability and the duration of symptoms does not match, requiring clinicians to make judgments when applying time-based research results on a patient-by-patient basis.

Component 4: Select Measures

Meniscus

IMPAIRMENT MEASURES[B]

- Pain at Rest - Current Level of Pain
- Pain at Best - Lowest Level of Pain in recent 24 hours
- Pain at Worst - Highest Level of Pain in recent 24 hours
- Pain Frequency - Percent of Time in Pain in recent 24 Hours
- Level of Pain While Performing Most Aggravating Movement
- Modified stroke test for effusion assessment
- Assessment of knee active/passive range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Forced hyperextension
- Maximum passive knee flexion
- McMurray's maneuver
- Joint line tenderness

ACTIVITY LIMITATIONS – SELF REPORTED MEASURES

- IKDC and KOOS[B]
- Tegner or Marx Activity Scale[C]
- KQol-26[C]
- SF-36 or EQ-5D[C]

PHYSICAL PERFORMANCE MEASURES[c]

- Early rehabilitation time period
  - Stair Climb Test
  - Timed up and Go test (TUG)
  - 6 minute Walk Test
- Return to activity or sports
  - Single leg hop tests

Articular Cartilage

IMPAIRMENT MEASURES[D]

- Pain at Rest - Current Level of Pain
- Pain at Best - Lowest Level of Pain in recent 24 hours
- Pain at Worst - Highest Level of Pain in recent 24 hours
- Pain Frequency - Percent of Time in Pain in recent 24 Hours
- Level of Pain While Performing Most Aggravating Movement
- Modified stroke test for effusion assessment
- Assessment of knee active/passive range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Joint line tenderness

ACTIVITY LIMITATIONS – SELF REPORTED MEASURES

- IKDC and KOOS[B]
- Tegner or Marx Activity Scale[C]
- KQol-26[C]
- SF-36 or EQ-5D[C]

PHYSICAL PERFORMANCE MEASURES[C]

- Early rehabilitation time period
  - Stair Climb Test
  - Timed up and Go test (TUG)
  - 6 minute Walk Test
- Return to activity or sports
  - Single leg hop tests

Component 5: Select Intervention strategies

Meniscus

Early Rehabilitation Strategies

PROGRESSIVE MOTION

- progressive active and passive knee motion following knee meniscal surgery[C]

Early to Late Rehabilitation Strategies

PROGRESSIVE WEIGHT BEARING[D]

PROGRESSIVE RETURN TO ACTIVITY[C]

SUPERVISED REHABILITATION[B]

THERAPEUTIC EXERCISES[B]

- supervised, progressive range of motion exercises, progressive strength training of the knee and hip muscles, and neuromuscular training

NEUROMUSCULAR ELECTRICAL STIMULATION[C]

- provide neuromuscular stimulation/reeducation to increase quadriceps strength, functional performance, and knee function

Articular Cartilage

Early Rehabilitation Strategies

PROGRESSIVE MOTION

- progressive active and passive knee motion following knee meniscal and articular cartilage surgery[C]

Early to Late Rehabilitation Strategies

PROGRESSIVE WEIGHT BEARING[B]

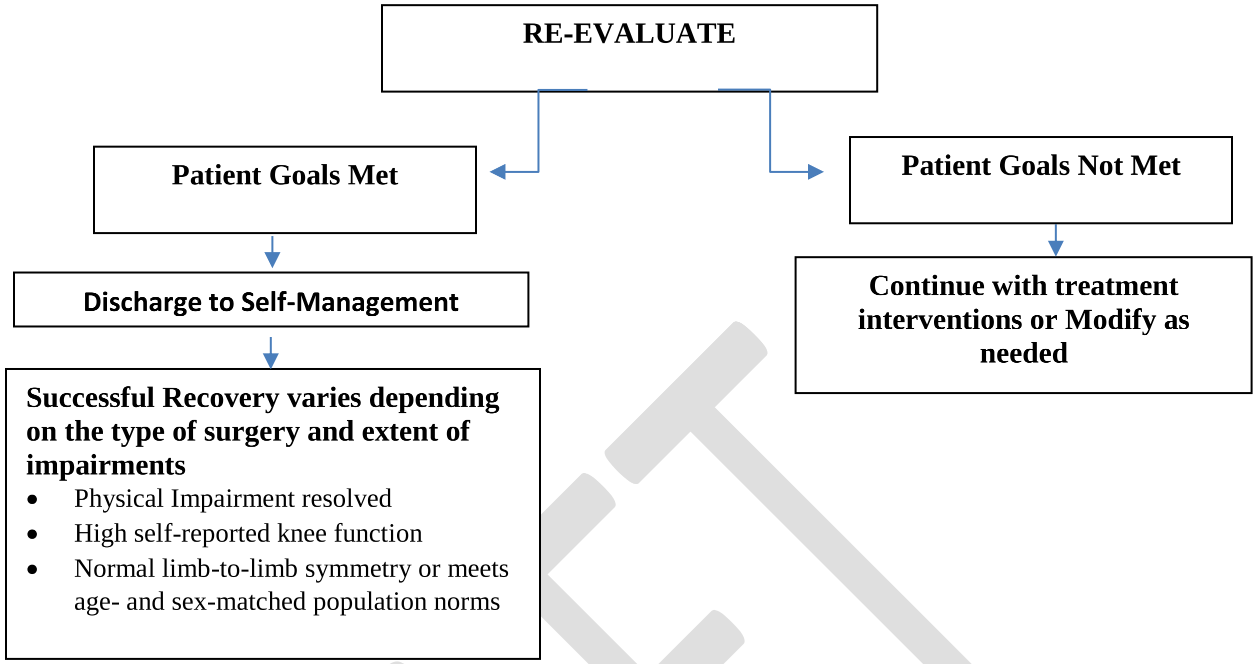
- reach full weight-bearing by 6-8 weeks after matrix-supported autologous chondrocyte implantation (MACI)

PROGRESSIVE RETURN TO ACTIVITY[E]

- Dependent upon type of surgery

THERAPEUTIC EXERCISES[B]

- supervised, progressive range of motion exercises, progressive strength training of the knee and hip muscles, and neuromuscular training



Guidelines based on strong evidence

A- Guidelines based on moderate evidence
B- Guidelines based on weak evidence
C- Conflicting evidence
D- Guidelines based upon theoretical/foundational evidence
E- Guidelines based on expert opinion

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Component 1

Medical screening incorporates the findings of the history and physical examination to determine whether the patient's symptoms originate from a condition that requires referral to another health care provider. The Ottawa Knee Rules, discussed later, is an example of tools that may be helpful in this decision-making process. In addition to these conditions, clinicians should screen for the presence of psychosocial issues that may affect prognostication and treatment decision making for rehabilitation. Psychological stress negatively influences recovery. Fear of reinjury is a frequently cited reason that athletes do not return to sport or reduce their level of physical activity.[5, 6] Low internal health locus of control (the belief in one's ability to control one's life), lower self-efficacy, and depressive symptoms prior to surgery results in worse outcomes after ACL reconstruction.[46, 119] Athletes who did not return to sport after ACL reconstruction had significantly lower preoperative motivation and more negative psychological response than those who did return.[7] Accordingly, identifying cognitive behavioral tendencies during the patient's evaluation can direct the therapist to employ specific patient education strategies to optimize patient outcomes to physical therapy interventions and potentially provide indications for referring the patient for consultation with another medical or mental health practitioner.[14]

Component 2

Differential evaluation of musculoskeletal clinical findings is used to determine the most relevant physical impairments associated with the patient's reported activity limitations and medical diagnosis.[67] Clusters of these clinical findings are described as impairment patterns in the physical therapy literature and are labeled according to the key impairment(s) of body function associated with that cluster. The ICD-10 and primary and secondary ICF codes associated with meniscus/articular cartilage lesions are provided in the 2010 ICF-based meniscus/articular cartilage lesions CPG.[78] These impairment patterns are useful in driving the interventions, which focus on normalizing the key impairments of body function, which in turn improves the movement and function of the patient and lessens or alleviates the activity limitations commonly reported by the patients who meet the diagnostic criteria of that specific pattern. Key clinical findings to rule in and rule out the common impairment patterns, and their associated medical conditions, are shown in the **FIGURE**. Impairment-based classification is critical for matching the intervention strategy that is most likely to provide the optimal outcome for a patient's clinical findings.[67] However, it is important for clinicians to understand that the impairment pattern and that the most relevant impairments of body function and the associated intervention strategies often change during the patient's episode of care. Thus, continual re-evaluation of the patient's response to treatment and the patient's emerging clinical findings is important for providing the optimal interventions throughout the patient's episode of care.[16]

Component 3

Irritability is a term used by rehabilitation practitioners to reflect the tissue's ability to handle physical stress,[88] and is presumably related to physical status and the extent of inflammatory activity that is present. There are cases where the alignment of irritability and the duration of symptoms does not match, requiring clinicians to make judgments when applying time-based research results on a patient-by-patient basis.[16] Diagnosis of tissue irritability is important for guiding the clinical decisions regarding treatment frequency, intensity, duration, and type, with the goal of matching the optimal dosage of treatment to the status of the tissue being treated.[16, 67] There are other biopsychosocial elements that may relate to staging of the condition, including,

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but not limited to, the level of disability reported by the patient and activity avoidance.[28]

Component 4
Outcome measure instrument are standardized instruments for measuring a specific end point, whether it is a body structure or function, activity limitation, or participation restriction. They are Important in direct management of individual patient care and for the opportunity they can collectively compare care and determine effectiveness through the repeated application of standardized measurement. Outcomes in clinical practice provide the mechanism by which the health care provider, the patient, the public, and the payer are able to assess the end results of care and its effect upon the health of the patient and society. Outcome measurement can identify baseline pain, function and disability, assess global knee function, determine readiness to return to activities, and monitor changes in status throughout treatment. Outcome measure instruments can be classified as patient-reported outcome measures (PROMs), physical performance measures, and physical impairment measures.

Component 5
Interventions are listed by phase of rehabilitation (early, early to late phase). Because irritability level often reflects the tissue's ability to accept physical stress, clinicians should match the most appropriate intervention strategies to the irritability level of the patient's condition.[16, 67] Additionally, clinicians should attend to influences from psychosocial factors[5-7] in patients with conditions in all stages of recovery.

DIFFERENTIAL DIAGNOSIS

2017 Summary (unchanged from 2010)
C
Clinicians should consider diagnostic classifications associated with serious pathological conditions or psychosocial factors when the patient's reported activity limitations or impairments of body function and structure are inconsistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with appropriate interventions.

IMAGING STUDIES

2017 Summary (unchanged from 2010)
When a patient reports a history of knee trauma, the therapist needs to be alert for the presence of knee fracture. The Ottawa Knee rule has been developed and validated to assist clinicians in determining when to order radiographs in individuals with acute knee injury.[11, 114] Clinical examination by well-trained clinicians appears to be as accurate as magnetic resonance imaging (MRI) in regards to the diagnosis of cruciate or meniscal lesions.[72, 83] A lower threshold of suspicion of a meniscal tear is warranted in middle aged and elderly patients.[50, 83] MRI may be reserved for more complicated or confusing cases.[72] MRI may assist an orthopaedic surgeon in pre-operative planning and prognosis.[72, 83]

CLINICAL GUIDELINES

Examination

OUTCOME MEASURES-
ACTIVITY LIMITATIONS-SELF-REPORTED MEASURES

2010 Recommendation
B
Clinicians should use a validated patient-reported outcome measure, a general health questionnaire, and a validated activity scale for patients with knee pain and mobility impairments. These tools are useful for identifying a patient's baseline status relative to pain, function, and disability and for monitoring changes in the patient's status throughout the course of treatment.

Evidence Update

II
The KOOS has been evaluated for its reliability and validity in people with articular cartilage lesions.[40] Using qualitative methodology, content validity of the KOOS was demonstrated in people who had undergone, or were candidates for, articular cartilage repair. In the quantitative analysis, KOOS subscales showed excellent test-retest reliability (all ICC>0.70) and construct validity was demonstrated against the SF-36, although correlation between the KOOS quality of life subscale and SF-36 General Health was non-significant. The KOOS showed excellent sensitivity to change from baseline to 12 months after baseline, with standardized response means from 0.8 to 1.2 and minimal detectable change estimates ranging between 7.4 and 12.1.

II
The psychometric properties (internal consistency, convergent validity, sensitivity to change and floor and ceiling effects) of the generic Euroqol-5 (EQ-5D) and Medical Outcomes Study Short Form-6 Dimensions (SF-6D) were compared using the knee-specific Hughston Clinic Questionnaire (HCQ) in 84 patients on average 5 days, 6 weeks, and 6 months following APM.[49] The results showed that the EQ-5D was more consistently responsive to change over time, was better at distinguishing differences between groups, and better reflected the results of the joint–specific HCQ than the SF-6D. Thus in this patient population, the EQ-5D is preferable to the SF-6D when used alongside a knee-specific instrument such as the HCQ.

II
This study reported the development and validation of the Knee Quality of Life 26-item questionnaire (KQoL-26) for patients with a suspected ligamentous or meniscal injury.[47] The questionnaire contains 26 items with 3 subscales of knee-related quality of life: physical functioning, activity limitations, and emotional functioning. The KQoL-26 was found to have good evidence for internal reliability (Cronbach's alpha 0.91-0.94), test re-test reliability (estimates of 0.80-0.93), construct validity (correlations with other knee scales including Lysholm Knee Scale, (r=0.58 to 0.76 with the 3 KQoL-26 subscales), EQ-5D questionnaire (r=0.21 to 0.54 with the 3 KQoL-26 subscales), SF-36 (r=0.39 to 0.64 with the 3 KQoL-26 subscales), and knee symptom questions), and responsiveness (higher effect sizes and responsiveness statistics than the EQ-5D and SF-36).

III
The KOOS has been cross-culturally adapted for use in both the Persian and Arabic languages. In Iranian patients with ACL, meniscus, and combined meniscus and ACL injuries, the Persian version showed acceptable test-retest reliability on all subscales (ICC>0.70) except the KOOS Sports/Recreation subscale (ICC=0.61), and adequate construct validity against the SF-36.[107] The Arabic version showed acceptable test-retest reliability (ICC>0.7) for all subscales, as well as good construct validity against subscales of the RAND-36 (Arabic version of SF-36) (r=0.61 to 0.78) scores of pain in Egyptian people with ACL, meniscus, and combined knee injuries.[4]

III
A study compared the measurement properties of the Dutch-language versions of the IKDC2000, Knee Form, KOOS, and WOMAC in patients with meniscal tears.[123] Findings showed good to excellent measurement properties for the IKDC2000. The KOOS and WOMAC dimensions performed suboptimally with respect to internal consistency, measurement error, ability to measure true change, and content validity.

III
In a study of 53 individuals obtained from a sports injury database and electronic medical records system, Balain et al[12] investigated responses to 4 self-report measures (patient satisfaction, Lysholm scale, VAS for worst pain, and the modified IKDC2000 scale). On all 4 measures, when asked to indicate their current status prior to microfracture surgery for cartilage defects, patients rated themselves better at least 6 months later than they did prior to surgery.

III
A Rasch model was used to assess the internal construct validity of the Lysholm knee scale in 157 patients with chondral pathology.[110] Fit to the Rasch model with 7 remaining items was achieved after removal of the swelling item. There was a high degree of agreement between the patient and health professional scoring (ICC 0.90). By removing the swelling item and using unweighted scores, a modified version of the Lysholm knee scale can be used as an outcome measure for knee chondral damage.

III
A study translated and culturally adapted the Western Ontario Meniscal Evaluation Tool (WOMET) into Turkish and evaluated the reliability and validity of the translated tool in 96 patients with meniscal pathology.[26] Validity of the tool was compared against the Lysholm knee scale and the SF-36. Test-retest reliability of the Turkish-version of the WOMET was good to excellent, and it demonstrated good correlation with the Lysholm knee scale. Weaker correlations were observed with several SF-36 domains, predominantly mental component and emotional role scores.

III
After cross-cultural adaptation of the KOOS into Spanish, the Spanish version was evaluated in 20 patients who underwent arthroscopic surgery for knee cartilage defects with a microfracture technique.[124] Validity was assessed against the SF-36. The Spanish KOOS demonstrated adequate test-retest reliability with ICCs exceeding 0.8 for all domains. Significant agreement

between the Spanish-version KOOS and the SF-36 domains of physical function and pain was observed.

2017 Recommendation

B

For knee-specific outcomes, clinicians should use the IKDC2000 or KOOS (or a culturally-appropriate version for patients whose primary language is not English) and may use the Lysholm scale (with removal of swelling item and using unweighted scores).

C

Clinicians may use the Tegner Scale or Marx Activity Level Scale to assess activity level, before and after interventions intended to alleviate the physical impairments, activity limitations, and participation restrictions associated with meniscus or articular cartilage lesions, however, these have less robust evidence about measurement properties. The SF-36 or the EQ-5D are appropriate general health measures in this population. The KQol-26 may be used to assess knee-related quality of life.

PHYSICAL PERFORMANCE MEASURES

Refer to the 2010 Knee Pain and Mobility Impairment CPG for a list of activity limitation measures and their measurement properties.[79]

2010 Recommendation

C

Clinicians should utilize easily reproducible physical performance measures, such as single limb hop tests, 6-minute walk test, or timed up-and-go test to assess activity limitations and participation restrictions associated with their patient's knee pain or mobility impairment and to assess the changes in the patient's level of function over the episode of care.

No Evidence Update

2017 Recommendation

C

Clinicians may administer appropriate clinical or field tests, such as single-legged hop tests, (eg, single hop for distance, cross-over hop for distance, triple hop for distance, and 6-meter timed hop), that can identify a patient's baseline status relative to pain, function, and disability; detect side-to-side asymmetries; assess global knee function; determine a patient's readiness to return to activities; and monitor changes in the patient's status throughout the course of treatment.

PHYSICAL IMPAIRMENT MEASURES

Refer to the 2010 Knee Pain and Mobility Impairment CPG for a list of physical impairment measures and their measurement properties.[80]

Evidence Update

II
A systematic review of 4 articles examined the validity and reliability of tests to assess meniscus tears.[33] They reported that the Thessaly test had fair reliability (kappa=0.54) based on 1 study of moderate quality. The McMurray and joint line tenderness tests had poor reliability (kappa $\leq$ 0.38) based on 3 studies of low to moderate quality.

II
In a large diagnostic study of 292 patients with knee pathology and 75 healthy controls, Blyth et al[17] examined the diagnostic accuracy of several meniscal tear clinical tests compared to MRI in primary care clinicians. McMurray's test had fair diagnostic accuracy, while all other tests had poor diagnostic accuracy. The McMurray's test had sensitivity: 0.58 (95% CI: 0.49, 0.67); specificity: 0.56 (95% CI: 0.45, 0.66); OR: 1.79 (95% CI: 1.04, 3.09) compared to MRI. The Thessaly test had sensitivity: 0.66 (95% CI: 0.57, 0.74); specificity: 0.39 (95% CI: 0.29, 0.50); OR: 1.24 (95% CI: 0.71, 2.18) compared to MRI. The Apley's test had sensitivity: 0.53 (95% CI: 0.44, 0.62); specificity: 0.53 (95% CI: 0.42, 0.63); OR: 1.24 (95% CI: 0.73, 2.12) compared to MRI. The joint line tenderness test had sensitivity: 0.77 (95% CI: 0.68, 0.84); specificity: 0.26 (95% CI: 0.18, 0.36); OR: 1.16 (95% CI: 0.63, 2.13) compared to MRI.

III
Haviv et al[55] investigated the accuracy of joint line tenderness of meniscus tears in 134 men and 61 women. Medial and lateral meniscus tears in men had sensitivity of 0.50-0.58, specificity of 0.74-1.00, and diagnostic accuracy of 0.63-0.86. Medial and lateral meniscus tears in women had sensitivity of 0.40-0.49, specificity of 0.71-0.98, and diagnostic accuracy of 0.57-0.93.

III
Snoeker et al[111] investigated the reliability and diagnostic accuracy of deep squat, Thessaly test, and the joint line tenderness test. The Thessaly test had a kappa of 0.54, sensitivity of 0.52-0.67, specificity of 0.38-0.44, positive likelihood ratio of 0.91-1.07, and negative likelihood ratio of 0.88-1.12. The deep squat test had a kappa of 0.46, sensitivity of 0.75-0.77, specificity of 0.36-0.42, positive likelihood ratio of 1.20-1.29, and negative likelihood ratio of 0.60-0.64. The joint line tenderness test had a kappa of 0.17.

IV
Campbell and colleagues[25] examined the association between patients' pain symptom location with arthroscopy findings in patients with meniscus tear. They reported that pain symptom location was not correlated with the location of the meniscus tear (P=.98).

2017 Recommendation
B
Clinicians should administer appropriate physical impairment assessments of body structure and function, at least at baseline and at 1 follow-up point, for all patients with meniscus tears to support standardization for quality improvement in clinical care and research, including:

- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing

DRAFT

- Forced hyperextension
- Maximum passive knee flexion
- McMurray's maneuver
- Joint line tenderness

D
Clinicians may administer the appropriate physical impairment assessments of body structure and function, at least at baseline and at 1 follow-up point, for all patients with articular cartilage lesions to support standardization for quality improvement in clinical care and research, including:

- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Joint line tenderness

BEST-PRACTICE POINT
Essential Data Elements
Clinicians should use the following measures, at least at baseline and at 1 follow-up point, for all patients with meniscus tears to support standardization for quality improvement in clinical care and research:

Activity Limitation – Self Report Measures
- IKDC and KOOS

Activity Limitation – Physical Performance measures
- Early rehabilitation time period
  - 30 second Chair Stand Test
  - Stair Climb Test
  - Timed up and Go test (TUG)
  - 6 minute Walk Test
- Return to activity or sports
  - Single leg hop tests

Physical Impairment Measures
- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Forced hyperextension
- Maximum passive knee flexion
- McMurray's maneuver
- Joint line tenderness

DRAFT

Clinicians should use the following measures, at least at baseline and at 1 follow-up point, for all patients with articular cartilage lesions to support standardization for quality improvement in clinical care and research:

Activity Limitation – Self Report Measures

- IKDC and KOOS

Activity Limitation – Physical Performance measures

- Early rehabilitation time period
  - 30 second Chair Stand Test
  - Stair Climb Test
  - Timed up and Go test (TUG)
  - 6 minute Walk Test
- Return to activity or sports
  - Single leg hop tests

Physical Impairment Measures

- Modified stroke test for effusion assessment
- Assessment of knee active range of motion
- Maximum voluntary isometric or isokinetic quadriceps strength testing
- Joint line tenderness

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CLINICAL GUIDELINES
Interventions

PROGRESSIVE KNEE MOTION

2010 Recommendation
C
Clinicians may utilize early progressive knee motion following knee meniscal and articular cartilage surgery.

Evidence update

II
A systematic review of 4 Level III studies on clinical effectiveness of continuous passive motion after articular lesion surgery did not find improved histological outcomes on second-look arthroscopic biopsies or improved radiographic findings greater than 1 year after surgery.[43] Mixed results in clinical outcomes were reported between the continuous passive motion groups and the active range of motion groups, although, the study results were heterogeneous.

II
In a randomized controlled trial, patients randomized to the supervised active range of motion group (n=14) using an adjustable pedal arm stationary cycle ergometer had significantly better gait measures (presence or absence of antalgic gait and limp during gait) early after partial meniscectomy compared to the control group (n=14) who did not have supervised therapy.[68] No differences were reported between the groups over time in range of motion, effusion, or IKDC2000 scores.

2017 Recommendation
C
Clinicians may use early progressive active and passive knee motion following knee meniscal and articular cartilage surgery.

PROGRESSIVE WEIGHT BEARING

2010 Recommendation
D
There are conflicting opinions regarding the best use of progressive weight bearing in patients with meniscal repairs or chondral lesions.

Evidence update

I
Ebert and colleagues[36] randomized 62 patients after MACI to an accelerated weight-bearing group (stepwise progression in weight-bearing with full weight-bearing by 8 weeks) or to a standard of care weight-bearing group (5 weeks of 20% partial weight-bearing followed by stepwise progression in weight-bearing with full weight-bearing by week 11). Three months after

MACI, patients in the accelerated group had better KOOS scores compared to those in the standard of care group (range KOOS subscales: 11.84 to 83.32 versus 6.82 to 78.55). Both groups demonstrated progressive graft tissue healing over time with no difference between groups at any time period (no complete graft de-lamination).

I
Twenty-eight consecutive patients after MACI were randomized to an accelerated weight-bearing group (stepwise progression in weight-bearing with full weight-bearing by 6 weeks) (n=14) or to a standard of care weight-bearing group (stepwise progression in weight-bearing with full weight-bearing by 8 weeks) (n=14).[38] Six and 12 months after MACI, patients in the accelerated group had better KOOS quality of life scores compared to those in the standard of care group (6 months: 62 versus 50; 12 months: 77 versus 58). Both groups demonstrated progressive graft tissue healing over time with no difference between groups at any time period.

I
Thirty-one patients after ACI were randomized to an accelerated weight-bearing group (stepwise progression in weight-bearing with full weight-bearing after 6 weeks) or to a standard of care weight-bearing group (stepwise progression in weight-bearing with full weight-bearing after 8 weeks).[128] Both groups showed improvement in clinical scores (IKDC2000 and Tegner scale) and MRI scores over 2 years but no significant difference between groups were noted at 1 year and 2 years after ACI.

IV
A retrospective analysis of 34 patients with degenerative medial meniscus tear and knee osteoarthritis using a foot-worn biomechanical device during activities of daily living were assessed before and 3 months and 12 months of wearing the device.[39] Using a gait mat, patients had significant improvement in gait velocity, step length, and single-limb support of the involved knee and improved limb symmetry 3 months after device use. These results were maintained 12 months after device use.

2017 Recommendation
B
Clinicians should use a stepwise progression of weight bearing to reach full bearing by 6-8 weeks after matrix-supported autologous chondrocyte implantation (MACI) for articular cartilage lesions.

2017 Recommendation (unchanged from 2010)
D
Conflicting evidence exists for the best use of progressive weight bearing in patients with meniscal repairs.

PROGRESSIVE RETURN TO ACTIVITY

2017 Recommendation (unchanged from 2010)

C

Clinicians may utilize early progressive return to activity following knee meniscal repair surgery.

E (unchanged from 2010)
Clinicians may need to delay return to activity depending on the type of articular cartilage surgery.

SUPERVISED REHABILITATION

2010 Recommendation
D
There are conflicting opinions regarding the best use of clinic-based programs for patients following meniscectomy to increase quadriceps strength and functional performance.

Evidence update

II
A systematic review of 18 randomized controlled trials (RCTs) and meta-analysis of 6 RCTs conducted by Dias et al[34] supports the utilization of outpatient physical therapy with a home exercise program compared to a home exercise program alone to improve knee range of motion and self-reported knee function, and reduce knee joint effusion in patients after PAM. However, the studies were of moderate to high risk of bias.

II
In a systematic review of 12 articles conducted by Reid and colleagues,[103] supervised clinic-based rehabilitation or well-structured home exercise program demonstrated improvements in knee muscle performance and knee function early after partial meniscectomy. However, the evidence is limited on the use of exercise to prevent the development of osteoarthritis or total knee joint arthroplasty.

II
In a systematic review by Coppola et al,[29] 5 RCTs were identified comparing outcomes of home-based versus supervised outpatient rehabilitation after meniscectomy. In early and intermediate follow-ups, there was no difference between groups in patient-reported outcomes at 3 weeks and 1 year after meniscectomy. However, the mean scores for these groups were lower than population norm, which may suggest that patients in both groups were not fully rehabilitated. Two studies[87, 125] reported on higher vertical jump height and single hop distances in the supervised rehabilitation group (vertical jump: 22.5 cm; single hop: 113.8 cm) compared to the home-based group (vertical jump: 20.1 cm; single hop distance: 94.7 cm), though, both studies had short follow-ups (less than 4 weeks).

II
Papalia and colleagues,[98] in a systematic review, evaluated the same 5 RCTs as Coppola et al[29] comparing outcomes between home-based versus supervised outpatient rehabilitation after meniscectomy. They reached similar conclusions that differences were demonstrated in performance-based outcomes (vertical jump height, single hop distance, and knee extensor strength) but not in patient-reported outcomes (Lysholm, Tegner, Hughston questionnaire).

2017 Recommendation
B
Clinicians should use exercises as part of the in-clinic supervised rehabilitation program after arthroscopic meniscectomy and should provide and supervise the progression of a home-based exercise program, providing education to ensure independent performance.

THERAPEUTIC EXERCISES

2010 Recommendation
B
Clinicians should consider strength training and functional exercise to increase quadriceps and hamstrings strength, quadriceps endurance, and functional performance following meniscectomy

Evidence update

I
Osteras et al[94] randomized 42 participants after degenerative meniscectomy to receive either 12 weeks of specialized exercise therapy (n=22) or no exercise therapy (n=20). Four participants (2 in each group) were lost to follow-up. Improvements in pain (VAS: 1.9), muscle strength (quadriceps peak torque: 38.1 Nm), and KOOS scores (18.0 points) were significantly higher in the specialized exercise therapy group compared to the no exercise therapy group (VAS: 0.6; quadriceps peak torque: 10.4 Nm; KOOS: 6.5) after the intervention period and 12 months later.

I
In a similar study, Osteras et al[96] randomized 75 participants with degenerative meniscus tear to receive either 12 weeks of specialized exercise therapy (n=38) or no physical therapy (n=37). Eleven participants (5 in the exercise group, 6 in the no-therapy group) were lost to follow-up. Improvements in pain, muscle strength, and patient-reported measures were significantly higher in the exercise therapy group compared to the no therapy group after the intervention period and 12 months later.

I
Assche and colleagues[10] implemented the same standardized rehabilitation protocol to patients who were initially randomized into an ACI surgery group (n=57) or a microfracture surgery group (n=61). Both groups received the same rehabilitation program consisting of progressive, stepwise weight bearing, joint mobilization exercises, progressive strength training to the knee muscles, neuromuscular training, and return to sports integration. The authors reported no differences in recovery between the 2 groups at 2-year follow-up. When assessing patient recovery, activities that were repetitive movements of active modalities in low-load conditions (range of motion, non-weight bearing strengthening exercises, proprioceptive exercises) were considered low-load modalities. Patients that had low levels of activity (<12 minutes per day of activity) in these low-load modalities had poorer outcomes in quadriceps strength and single-legged hop performance than patients that had high levels of activity (>12 minutes per day of activity) in low-load modalities.

DRAFT

I
Hall et al[51] performed a RCT to investigate the effects of a neuromuscular training program on knee kinetics, cartilage quality, and physical function during walking and single-legged sit to stand after APM. Groups were randomly assigned to the neuromuscular training group or a control group. The authors reported no differences in peak knee adduction moment, cartilage quality, and physical function. The neuromuscular group was more likely to demonstrate improvements in physical function and overall improvement compared to the control group.

I
Kise and colleagues[70] randomized 140 participants into 2 treatment groups: exercise therapy (n=70) or APM. Thirteen (19%) of 70 participants crossed over to the APM group and were analyzed in the as treated group. The authors reported no clinically relevant differences in KOOS change scores from baseline to 2-year follow-up between groups (0.9 points, 95% CI: -4.3, 6.1). Both groups demonstrated similar improvements from baseline to 2-year follow-up (exercise group: 25.3 points (95% CI: 21.6, 29.0): APM group: 24.4 point (95% CI: 20.7, 28.0). The exercise group had greater improvement in muscle strength at 3 and 12 months (P<.03)

II
Koutras and colleagues[73] randomized 20 male patients after APM to either receive standard rehabilitation augmented with progressive isokinetic muscle strength training or progressive isotonic muscle strength training. Both groups demonstrated a significant improvement in knee extensor and flexor isokinetic strength and single-legged hop limb-to-limb symmetry (knee extensor at 60°/sec: 17% improvement; knee flexor at 60°/sec: 12% improvement; single hop: 14% improvement; triple hop: 17% improvement; vertical hop: 18% improvement) and in Lysholm scores (17% improvement) over time but no significant differences were noted between groups.

II
Lind et al[77] randomized 60 patients after isolated meniscal repair to receive either free rehabilitation (restricted range of motion and toe-touch weight-bearing and no brace for 2 weeks with unrestricted activity and free range of motion afterwards) or restricted rehabilitation (braced toe-touch weight bearing and progressive restricted range of motion for 6 weeks). Patients were followed at 3 months, and 1 and 2 years on KOOS and Tegner measures. Patients who underwent repeat arthroscopy demonstrated little to partial healing in approximately one-third of patients in each group (n=19). KOOS and Tegner scores was similar in both groups at 1 and 2 years.

IV
In a retrospective study, 30 patients with non-traumatic posterior root tear of the medial meniscus had supervised physical therapy, focusing on knee range of motion and knee muscle strength for at least 8 weeks and were prescribed non-steroidal anti-inflammatory drugs for 8 to 12 weeks.[76] Patients demonstrated significant and clinically meaningful improvements in pain levels (4 point improvement on VAS) and self-reported knee function (13 points improvement in Lysholm scores).

IV

DRAFT

Neogi et al[89] reported benefit in symptoms and function with 12-week rehabilitation and analgesics (up to 6 weeks) in 37 patients with degenerative meniscus. Patients demonstrated improvements in Lysholm scores from pre-treatment to final follow-up (56 to 79), Tegner scores (2 to 4), VAS of pain at rest (2- to 0). Despite the improvement, the number of participants with radiographic osteoarthritis had increased by the final follow-up from 24 knees with Kellgren Lawrence classifications at grades 0 and 1 and 9 at stage 2 or greater at pre-treatment to 12 knees with grade 0 and 1 and 21 at stage 2 or greater at final follow-up.

IV
Forty-eight patients with full-thickness articular cartilage lesions with poor knee function participated in a 3-month rehabilitation program consisting of cardiovascular training, progressive strength training of the knee and hip muscles, and neuromuscular training.[127] Primary outcome measures were KOOS and IKDC2000 scores, and isokinetic muscle strength and hop test scores. The authors reported an 83% adherence rate to the rehabilitation program and 4 patients showed increases in pain and effusion. They reported clinically significant increases in KOOS-sports/recreation and KOOS-quality of life subscales. Patients also had large effects in standardized response means for muscle strength (0.99 to 1.22) and hop performance (0.53 to 0.75).

2017 Recommendation
B
Clinicians should provide supervised, progressive range of motion exercises, progressive strength training of the knee and hip muscles, and neuromuscular training in patients with knee meniscus tears and articular cartilage lesions and after meniscus or articular cartilage surgery.

NEUROMUSCULAR ELECTRICAL STIMULATION

2010 Recommendation
B
Neuromuscular electrical stimulation can be used with patients following meniscal or chondral injuries to increase quadriceps muscle strength.

Evidence update

II
Akkaya et al[2] conducted a 3-arm RCT in 45 patients comparing a home exercise program (without any biofeedback or electrical stimulation) to electromyographic biofeedback to the quadriceps in addition to home exercise program and to electrical stimulation to the quadriceps in addition to home exercise program after partial meniscectomy. All 3 groups similar gait measures muscle performance values 2 and 6 weeks after surgery. All groups had significant improvement in pain during walking and Lysholm scores early after partial meniscectomy.

II
In a RCT, 64 participants were randomized to receive either electromyographic biofeedback (n=33) or usual care (n=31) early after meniscal repair.[92] Electromyographic values and KOOS Sports/Recreation scores were significantly better in the biofeedback group (Electromyographic:

16 to 25% higher; KOOS Sports/Recreation: 6% higher) compared to the usual care group 8 weeks after meniscal repair. However, these differences may not be clinically meaningful.

2017 Recommendation

C

Clinicians may provide neuromuscular stimulation/reeducation in patients following meniscus procedures to increase quadriceps strength, functional performance, and knee function.

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APPENDIX A: SEARCH STRATEGIES FOR ALL DATABASES SEARCHED

MEDLINE

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (classif* [TW])

(("Menisci, Tibial"[MH]) OR (knee joint[MH] AND (menisc*[TW] OR "articular cartilage"[TW] OR chondral[TW]))) AND (sensitiv*[Title/Abstract] OR sensitivity and specificity[MeSH Terms] OR diagnos*[Title/Abstract] OR diagnosis[MeSH:noexp] OR diagnostic[MeSH:noexp] OR diagnosis, differential[MeSH:noexp] OR diagnosis[Subheading:noexp] OR questionnaires[Mesh] OR "disability evaluation"[mesh:noexp] OR questionnaire[tiab] OR questionnaires[tiab] OR instrument[tiab] OR instruments[tiab] OR scale[tiab] OR scales[tiab] OR measurement[tiab] OR measurements[tiab] OR index[tiab] OR indices[tiab] OR score[tiab] OR scores[tiab])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (physical therapy modalities [MH] OR recovery of function [MH] OR rehabilitation [MH] OR therapeutics [MH] OR “physical therapy” [TW] OR physiother* [TW] OR recovery [TW] OR restoration [TW] OR re-education [TW] OR early ambulation [MH] OR strengthening [TW] OR resistance training [MH] OR “resistance methods” [TW] OR exercise therapy [MH] OR biofeedback, psychology [MH] OR “neuromuscular electrical stimulation” [TW] OR pain management [MH] OR pain measurement [MH] OR mobilization* [TW] OR “continuous passive motion” [TW] OR manipulation, spinal [MH] OR ultrasonography [TW] OR ultrasound [TW] OR acupuncture [TW] OR laser* [TW] OR patient education as topic [MH] OR electrical stimulation [MH] OR electrical stimulation therapy [MH] OR Transcutaneous electric nerve stimulation [MH] OR taping [TW] OR bracing [TW] OR orthotic* [TW] OR weight-bearing [MH] OR Range of motion [MH] OR Treatment Outcome [MH] OR Exercise [MH] OR “physical therapy treatments” [TW] OR “training program” [TW])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (prognos* [tw] OR return to work [tw] OR return to work [MH] OR return to sport [tw])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (preval* [tw] OR incidenc* [tw] OR epidem* [tw])

((“Menisci, Tibial” [MH]) OR (knee joint [MH] AND (menisc* [TW] OR “articular cartilage” [TW] OR chondral [TW]))) AND (associat* [tw] OR risk* [tw] OR probabil* [tw] OR odds* [tw] OR relat* [tw] OR prevalen* [tw] OR predict* [tw] OR caus* [tw] OR etiol* [tw] OR interact* [tw])

SCOPUS

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (classif*))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (sensitiv*) OR TITLE-ABS-KEY (sensitivity and specificity) OR TITLE-ABS-KEY (diagnos*) OR TITLE-ABS-KEY (questionnaires) OR TITLE-ABS-KEY ("disability evaluation") OR TITLE-ABS-KEY (questionnaire) OR TITLE-ABS-KEY (questionnaires) OR TITLE-ABS-KEY (instrument) OR TITLE-ABS-KEY (instruments) OR TITLE-ABS-KEY (scale) OR TITLE-ABS-KEY (scales) OR TITLE-ABS-KEY (measurement) OR TITLE-ABS-KEY (measurements) OR TITLE-ABS-KEY (index) OR TITLE-ABS-KEY (indices) OR TITLE-ABS-KEY (score) OR TITLE-ABS-KEY (scores))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (“physical therapy modalities”) OR TITLE-ABS-KEY (“recovery of function”) OR TITLE-ABS-KEY (rehabilitation) OR TITLE-ABS-KEY (therapeutics) OR TITLE-ABS-KEY (“physical therapy”) OR TITLE-ABS-KEY (physiother*) OR TITLE-ABS-KEY (recovery) OR TITLE-ABS-KEY (restoration) OR TITLE-ABS-KEY (re-education) OR TITLE-ABS-KEY (“early ambulation”) OR TITLE-ABS-KEY (strengthening) OR TITLE-ABS-KEY (“resistance training”) OR TITLE-ABS-KEY (“resistance methods”) OR TITLE-ABS-KEY (“exercise therapy”) OR TITLE-ABS-KEY (biofeedback) OR TITLE-ABS-KEY (“neuromuscular electrical stimulation”) OR TITLE-ABS-KEY (“pain management”) OR TITLE-ABS-KEY (“pain measurement”) OR TITLE-ABS-KEY (mobilization*) OR TITLE-ABS-KEY (“continuous passive motion”) OR TITLE-ABS-KEY (“spinal manipulation”) OR TITLE-ABS-KEY (ultrasonography) OR TITLE-ABS-KEY (ultrasound) OR TITLE-ABS-KEY (acupuncture) OR TITLE-ABS-KEY (laser*) OR TITLE-ABS-KEY (“patient education”) OR TITLE-ABS-KEY (“electrical stimulation”) OR TITLE-ABS-KEY (“electrical stimulation therapy”) OR TITLE-ABS-KEY (“Transcutaneous electric nerve stimulation”) OR TITLE-ABS-KEY (taping) OR TITLE-ABS-KEY (bracing) OR TITLE-ABS-KEY (orthotic*) OR TITLE-ABS-KEY (weight-bearing) OR TITLE-ABS-KEY (“Range of motion”) OR TITLE-ABS-KEY (“Treatment Outcome”) OR TITLE-ABS-KEY (Exercise) OR TITLE-ABS-KEY (“physical therapy treatments”) OR TITLE-ABS-KEY (“training program”))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (prognos*) OR TITLE-ABS-KEY (return to work) OR TITLE-ABS-KEY (return to sport))

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((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND ((TITLE (prevalence) OR KEY (prevalence)) OR (TITLE (incidence) OR KEY (incidence)) OR (TITLE (epidemiology) OR KEY (epidemiology)))

((TITLE-ABS-KEY (“menisc*”) AND (TITLE-ABS-KEY (tibial) OR TITLE-ABS-KEY (medial) OR TITLE-ABS-KEY (lateral))) OR (TITLE-ABS-KEY (semilunar) AND TITLE-ABS-KEY (cartilage*)) OR (TITLE-ABS-KEY (“knee joint”) AND (TITLE-ABS-KEY (menisc*) OR TITLE-ABS-KEY (“articular cartilage”) OR TITLE-ABS-KEY (chondral)))) AND (TITLE-ABS-KEY (associat*) OR TITLE-ABS-KEY (risk*) OR TITLE-ABS-KEY (probabil*) OR TITLE-ABS-KEY (odds*) OR TITLE-ABS-KEY (relat*) OR TITLE-ABS-KEY (prevalen*) OR TITLE-ABS-KEY (predict*) OR TITLE-ABS-KEY (caus*) OR TITLE-ABS-KEY (etiol*) OR TITLE-ABS-KEY (interact*))

CINAHL

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (classif*))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (sensitiv*) OR TX (sensitivity and specificity) OR TX (diagnos*) OR TX (questionnaires) OR TX ("disability evaluation") OR TX (questionnaire) OR TX (questionnaires) OR TX (instrument) OR TX (instruments) OR TX (scale) OR TX (scales) OR TX (measurement) OR TX (measurements) OR TX (index) OR TX (indices) OR TX (score) OR TX (scores))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (“physical therapy modalities”) OR TX (“recovery of function”) OR TX (rehabilitation) OR TX (therapeutics) OR TX (“physical therapy”) OR TX (physiother*) OR TX (recovery) OR TX (restoration) OR TX (re-education) OR TX (“early ambulation”) OR TX (strengthening) OR TX (“resistance training”) OR TX (“resistance methods”) OR TX (“exercise therapy”) OR TX (biofeedback) OR TX (“neuromuscular electrical stimulation”) OR TX (“pain management”) OR TX (“pain measurement”) OR TX (mobilization*) OR TX (“continuous passive motion”) OR TX (“spinal manipulation”) OR TX (ultrasonography) OR TX (ultrasound) OR TX (acupuncture) OR TX (laser*) OR TX (“patient education”) OR TX (“electrical stimulation”) OR TX (“electrical stimulation therapy”) OR TX (“Transcutaneous electric nerve stimulation”) OR TX (taping) OR TX (bracing) OR TX (orthotic*) OR TX (weight-bearing) OR TX (“Range of motion”) OR TX (“Treatment Outcome”) OR TX (Exercise) OR TX (“physical therapy treatments”) OR TX (“training program”))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (prognos*) OR TX (return to work) OR TX (return to sport))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND ((TI (prevalence) OR SU (prevalence)) OR (TI (incidence) OR SU (incidence)) OR (TI (epidemiology) OR SU (epidemiology)))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (associat*) OR TX (risk*) OR TX (probabil*) OR TX (odds*) OR TX (relat*) OR TX (prevalen*) OR TX (predict*) OR TX (caus*) OR TX (etiol*) OR TX (interact*))

SportDiscus

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (classif*))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (sensitiv*) OR TX (sensitivity and specificity) OR TX (diagnos*) OR TX (questionnaires) OR TX ("disability evaluation") OR TX (questionnaire) OR TX (questionnaires) OR TX (instrument) OR TX (instruments) OR TX (scale) OR TX (scales) OR TX (measurement) OR TX (measurements) OR TX (index) OR TX (indices) OR TX (score) OR TX (scores))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (“physical therapy modalities”) OR TX (“recovery of function”) OR TX (rehabilitation) OR TX (therapeutics) OR TX (“physical therapy”) OR TX (physiother*) OR TX (recovery) OR TX (restoration) OR TX (re-education) OR TX (“early ambulation”) OR TX (strengthening) OR TX (“resistance training”) OR TX (“resistance methods”) OR TX (“exercise therapy”) OR TX (biofeedback) OR TX (“neuromuscular electrical stimulation”) OR TX (“pain management”) OR TX (“pain measurement”) OR TX (mobilization*) OR TX (“continuous passive motion”) OR TX (“spinal manipulation”) OR TX (ultrasonography) OR TX (ultrasound) OR TX (acupuncture) OR TX (laser*) OR TX (“patient education”) OR TX (“electrical stimulation”) OR TX (“electrical stimulation therapy”) OR TX (“Transcutaneous electric nerve stimulation”) OR TX (taping) OR TX (bracing) OR TX (orthotic*) OR TX (weight-bearing) OR TX (“Range of motion”) OR TX (“Treatment Outcome”) OR TX (Exercise) OR TX (“physical therapy treatments”) OR TX (“training program”))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (prognos*) OR TX (return to work) OR TX (return to sport))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND ((TI (prevalence) OR SU (prevalence)) OR (TI (incidence) OR SU (incidence)) OR (TI (epidemiology) OR SU (epidemiology)))

((TX (“menisc*”) AND (TX (tibial) OR TX (medial) OR TX (lateral))) OR (TX (semilunar) AND TX (cartilage*)) OR (TX (“knee joint”) AND (TX (menisc*) OR TX (“articular cartilage”) OR TX (chondral)))) AND (TX (associat*) OR TX (risk*) OR TX (probabil*) OR TX (odds*) OR TX (relat*) OR TX (prevalen*) OR TX (predict*) OR TX (caus*) OR TX (etiol*) OR TX (interact*))

Cochrane Library

(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AND (classif*)

(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AND ((sensitiv*) OR (sensitivity and specificity) OR (diagnos*) OR (questionnaires) OR ("disability evaluation") OR (questionnaire) OR (questionnaires) OR (instrument) OR (instruments) OR (scale) OR (scales) OR (measurement) OR (measurements) OR (index) OR (indices) OR (score) OR (scores))

(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AND ((“physical therapy modalities”) OR (“recovery of function”) OR (rehabilitation) OR (therapeutics) OR (“physical therapy”) OR (physiother*) OR (recovery) OR (restoration) OR (re-education) OR (“early ambulation”) OR (strengthening) OR (“resistance training”) OR (“resistance methods”) OR (“exercise therapy”) OR (biofeedback) OR (“neuromuscular electrical stimulation”) OR (“pain management”) OR (“pain measurement”) OR (mobilization*) OR (“continuous passive motion”) OR (“spinal manipulation”) OR (ultrasonography) OR (ultrasound) OR (acupuncture) OR (laser*) OR (“patient education”) OR (“electrical stimulation”) OR (“electrical stimulation therapy”) OR (“Transcutaneous electric nerve stimulation”) OR (taping) OR (bracing) OR (orthotic*) OR (weight-bearing) OR (“Range of motion”) OR (“Treatment Outcome”) OR (Exercise) OR (“physical therapy treatments”) OR (“training program”))

(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AAND ((prognos*) OR (return to work) OR (return to sport))

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(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AND ((prevalence) OR (incidence) OR (epidemiology))

(((“menisc*”) AND ((tibial) OR (medial) OR (lateral))) OR ((semilunar) AND (cartilage*)) OR ((“knee joint”) AND ((menisc*) OR (“articular cartilage”) OR (chondral)))) AND ((associat*) OR (risk*) OR (probabil*) OR (odds*) OR (relat*) OR (prevalen*) OR (predict*) OR (caus*) OR (etiol*) OR (interact*))

SEARCH RESULTS

Database	**Date Conducted**	**Results, n**	**Date Conducted**	**Results, n**	**Total**
MEDLINE	November 2014	3773	December 2016	1900	5673
SCOPUS	November 2014	6692	December 2016	3879	10571
CINAHL	November 2014	2207	December 2016	672	2879
SportDiscus	November 2014	5573	December 2016	3044	8617
Cochrane Library	November 2014	244		218	462
Cochrane reviews		6		3	9
Other reviews		15		3	18
Trials		221		204	425
Technology assessments		1		7	8
Economic evaluations		1		1	2
Total		18489		9713	28202
Total with duplicates removed		4990		2690	7680

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APPENDIX C. CRITERIA FOR INCLUSION AND EXCLUSION OF STUDIES FOR REVIEW

Articles published in peer-reviewed journals that include studies of the following types: systematic reviews, meta-analyses, experimental and quasi-experimental, cohort, case series, and cross-sectional studies will be included.

Exclusions: meeting abstracts, press releases, theses, non-systematic review articles, case reports, and articles that cannot be retrieved in English

Inclusion criteria
We will include articles reporting on isolated and combined injuries for meniscus and articular cartilage injuries:

- the functional anatomy of the menisci and articular cartilage of the tibiofemoral joint

OR

- tests and measures for diagnosis and/or differential diagnosis of meniscal and chondral lesions within the scope of physical therapist practice, including but not limited to "specific tests and measures".

OR

- measurement properties of instruments and tests specific to measuring meniscal and chondral lesions-related outcomes (including but not limited to symptoms, functions, activity and participation)

OR

- measurement properties of instruments that are not specific to meniscal and chondral lesions BUT are specific to lower extremity outcomes.

OR

- measurement properties of instruments using data from a sample of patients with meniscal and chondral lesions

OR

- primarily adolescents and adults (>=12 years old)
    - studies reporting on persons <12 years old IF the proportion in the sample is small (<5%) OR that separate data are available for adults

AND

meniscal and chondral lesions, including the following topics:

- risk of meniscal and chondral lesions, including but not limited to.
- diagnostic characteristics of meniscal and chondral lesions, including but not limited to location, duration, and quality, and related impairments and functional limitations
- interventions within the scope of practice of physical therapists for meniscal and chondral lesions, to include:

We will include all outcomes.

Exclusion criteria

We will exclude articles reporting on:

- degenerative/OCD lesions
- primarily infants and children (<12 years old)
- ligament-related injuries of the tibiofemoral joint
- patellofemoral pain, patellar tendinopathy/tendon pain, or iliotibial band
- Non-musculoskeletal tibiofemoral pain:
    - diabetes
    - ulcers
    - primary peripheral nerve entrapment
- topics outside the scope of physical therapist practice
    - decisions to order radiologic tests (MRIs etc.)
    - pharmacological interventions

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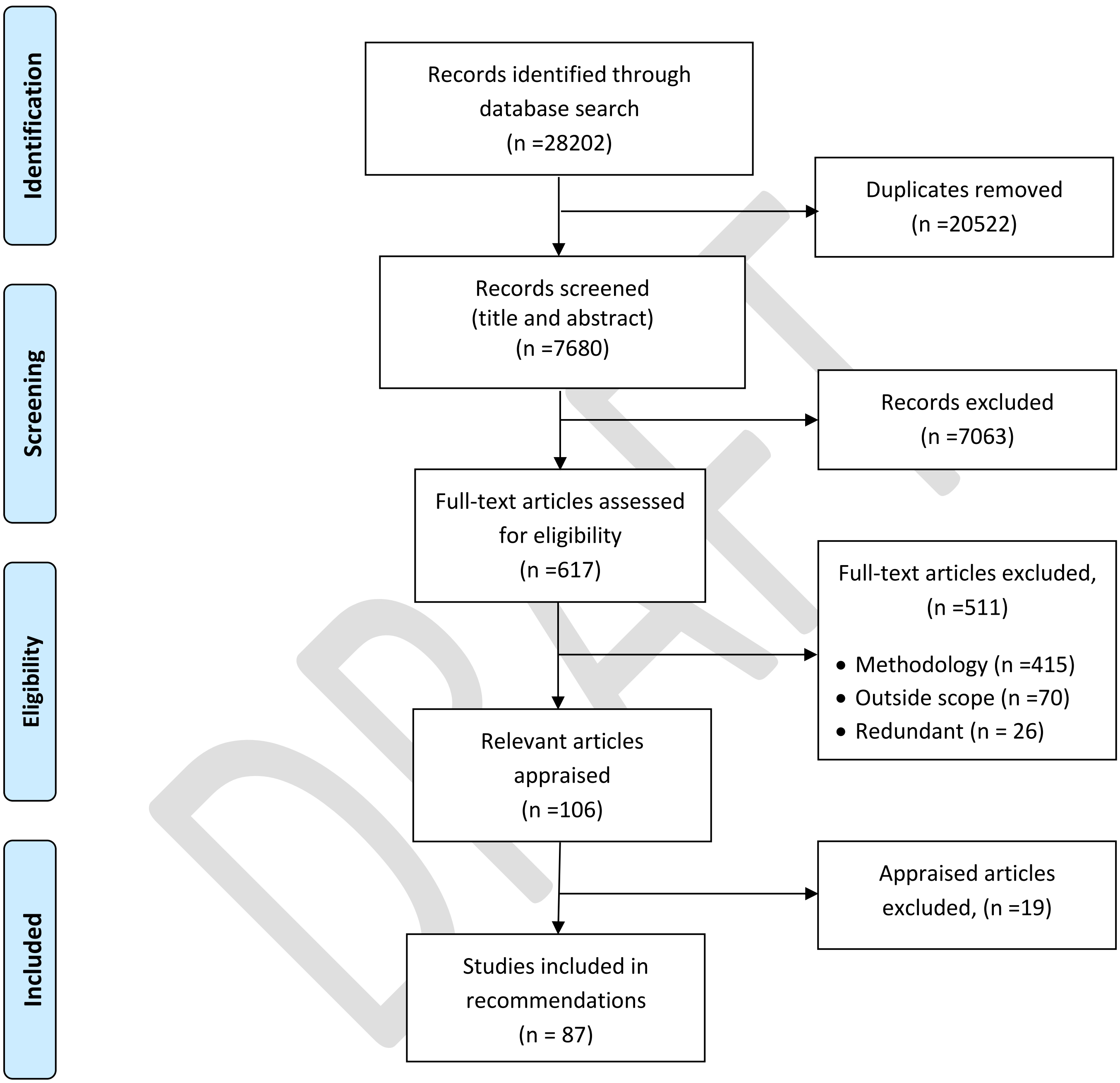
APPENDIX D: Flow Chart of Articles



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APPENDIX E. ARTICLES INCLUDED IN RECOMMENDATIONS BY TOPIC

Impairment/Function-Based Diagnosis

Incidence

Jones JC, Burks R, Owens BD, Sturdivant RX, Svoboda SJ, Cameron KL. Incidence and risk factors associated with meniscal injuries among active-duty US military service members. *Journal of athletic training*. 2012;47:67-73.

Yeh PC, Starkey C, Lombardo S, Vitti G, Kharrazi FD. Epidemiology of isolated meniscal injury and its effect on performance in athletes from the National Basketball Association. *American Journal of Sports Medicine*. 2012;40:589-594.

Ralles, S., J. Agel, M. Obermeier and M. Tompkins (2015). "Incidence of Secondary Intra-articular Injuries With Time to Anterior Cruciate Ligament Reconstruction." The American Journal of Sports Medicine **43**(6): 1373-1379.

Swenson DM, Collins CL, Best TM, Flanigan DC, Fields SK, Comstock RD. Epidemiology of knee injuries among U.S. high school athletes, 2005/2006-2010/2011. *Medicine and Science in Sports and Exercise*. 2013;45:462-469.

Abrams GD, Frank RM, Gupta AK, Harris JD, McCormick FM, Cole BJ. Trends in meniscus repair and meniscectomy in the United States, 2005-2011. *The American Journal of Sports Medicine*. 2013;41:2333-2339.

Thorlund JB, Hare KB, Lohmander LS. Large increase in arthroscopic meniscus surgery in the middle-aged and older population in Denmark from 2000 to 2011. *Acta Orthopaedica*. 2014;85:287-292.

Flanigan DC, Harris JD, Trinh TQ, Siston RA, Brophy RH. Prevalence of chondral defects in Athletes' Knees: A systematic review. *Medicine and Science in Sports and Exercise*. 2010;42:1795-1801.

Brophy RH, Wright RW, David TS, et al. Association between previous meniscal surgery and the incidence of chondral lesions at revision anterior cruciate ligament reconstruction. *The American Journal of Sports Medicine*. 2012;40:808-814.

Nepple JJ, Wright RW, Matava MJ, Brophy RH. Full-thickness knee articular cartilage defects in national football league combine athletes undergoing magnetic resonance imaging: prevalence, location, and association with previous surgery. *Arthroscopy: The Journal of Arthroscopy & Related Surgery*. 2012;28:798-806.

Wyatt RWB, Inacio MCS, Liddle KD, Maletis GB. Prevalence and incidence of cartilage injuries and meniscus tears in patients who underwent both primary and revision anterior cruciate ligament reconstructions. *American Journal of Sports Medicine*. 2014;42:1841-1846.

Kuikka PI, Pihlajamaki HK, Mattila VM. Knee injuries related to sports in young adult males during military service - incidence and risk factors. *Scandinavian Journal of Medicine & Science in Sports*. 2013;23:281-287.

Clinical Course

Katz JN, Brophy RH, Chaisson CE, et al. Surgery versus physical therapy for a meniscal tear and osteoarthritis. *The New England journal of medicine*. 2013;368:1675-1684.

McLeod MM, Gribble P, Pfile KR, Pietrosimone BG. Effects of Arthroscopic Partial Meniscectomy on Quadriceps Strength: A Systematic Review. *Journal of Sport Rehabilitation*. 2012;21:285-295.

Osteras H, Osteras B, Torstensen TA. Medical exercise therapy, and not arthroscopic surgery, resulted in decreased depression and anxiety in patients with degenerative meniscus injury. *Journal of Bodywork and Movement Therapies*. 2012;16:456-463.

Al-Dadah O, Shepstone L, Donell ST. Proprioception following partial meniscectomy in stable knees. *Knee Surgery, Sports Traumatology, Arthroscopy*. 2011;19:207-213.

Busija L, Osborne RH, Nilsdotter A, Buchbinder R, Roos EM. Magnitude and meaningfulness of change in SF-36 scores in four types of orthopedic surgery. *Health & Quality of Life Outcomes*. 2008;6:55-55.

Fabricant PD, Rosenberger PH, Jokl P, Ickovics JR. Predictors of short-term recovery differ from those of long-term outcome after arthroscopic partial meniscectomy. *Arthroscopy: The Journal of Arthroscopy & Related Surgery*. 2008;24:769-778.

Zaffagnini S, Marcheggiani Muccioli GM, Lopomo N, et al. Prospective long-term outcomes of the medial collagen meniscus implant versus partial medial meniscectomy: a minimum 10-year follow-up study. *American journal of sports medicine*. 2011;39:977-985.

Kijowski R, Woods MA, McGuine TA, Wilson JJ, Graf BK, De Smet AA. Arthroscopic partial meniscectomy: MR imaging for prediction of outcome in middle-aged and elderly patients. *Radiology*. 2011;259:203-212.

Hall, M., T. V. Wrigley, B. R. Metcalf, R. S. Hinman, A. R. Dempsey, P. M. Mills, F. M. Cicuttini, D. G. Lloyd and K. L. Bennell (2014). "Knee muscle strength after recent partial meniscectomy does not relate to 2-year change in knee adduction moment." Clinical orthopaedics and related research 472(10): 3114-3120.

Hall, M., T. V. Wrigley, B. R. Metcalf, R. S. Hinman, A. R. Dempsey, P. M. Mills, F. M. Cicuttini, D. G. Lloyd and K. L. Bennell (2014). "A longitudinal study of impact and early stance loads during gait following arthroscopic partial meniscectomy." Journal of Biomechanics 47(12): 2852-2857.

Hall M, Wrigley TV, Metcalf BR, et al. A Longitudinal Study of Strength and Gait after Arthroscopic Partial Meniscectomy. *Medicine & Science in Sports & Exercise*. 2013;45:2036-2043.

Thorlund JB, Creaby MW, Wrigley TV, Metcalf BR, Bennell KL. Knee joint laxity and passive stiffness in meniscectomized patients compared with healthy controls. *Knee*. 2014;21:886-890.

Thorlund JB, Aagaard P, Roos EM. Muscle strength and functional performance in patients at high risk of knee osteoarthritis: a follow-up study. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2012;20:1110-1117.

Stein T, Mehling AP, Welsch F, von Eisenhart-Rothe R, Jäger A. Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. *American Journal of Sports Medicine*. 2010;38:1542-1548.

Scanzello CR, Albert AS, DiCarlo E, et al. The influence of synovial inflammation and hyperplasia on symptomatic outcomes up to 2 years post-operatively in patients undergoing partial meniscectomy. *Osteoarthritis and Cartilage*. 2013;21:1392-1399.

Sung-Gon K, Nagao M, Kamata K, Maeda K, Nozawa M. Return to sport after arthroscopic meniscectomy on stable knees. *BMC Sports Science, Medicine & Rehabilitation*. 2013;5:1-8.

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Filardo, G., L. Andriolo, F. Balboni, M. Marcacci and E. Kon (2015). "Cartilage failures. Systematic literature review, critical survey analysis, and definition." Knee Surgery, Sports Traumatology, Arthroscopy **23**(12): 3660-3669.

Xu, C. and J. Zhao (2015). "A meta-analysis comparing meniscal repair with meniscectomy in the treatment of meniscal tears: the more meniscus, the better outcome?" Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA **23**(1): 164-170.

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APPENDIX F. LEVELS OF EVIDENCE TABLE*

Level	Intervention/ Prevention	Pathoanatomic/Risk/ Clinical Course/Prognosis/ Differential Diagnosis	Diagnosis/Diagnostic Accuracy	Prevalence of Condition/Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT†	Systematic review of prospective cohort studies High-quality prospective cohort study‡	Systematic review of high-quality diagnostic studies High-quality diagnostic study§ with validation	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study‖	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study‡ Outcomes study or ecological study Lower-quality RCT¶	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Systematic review of exploratory diagnostic studies or consecutive cohort studies High-quality exploratory diagnostic studies Consecutive retrospective cohort	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Lower-quality exploratory diagnostic studies Nonconsecutive retrospective cohort	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case-control study		Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.

Adapted from Phillips et al*62 *(http://www.cebm.net/index.aspx?o=1025). See also* **APPENDIX G.

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†*High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.*
‡*High-quality cohort study includes greater than 80% follow-up.*
§*High-quality diagnostic study includes consistently applied reference standard and blinding.*
║*High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses.*
¶*Weaker diagnostic criteria and reference standards, improper randomization, no blinding, and less than 80% follow-up may add bias and threats to validity.*

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APPENDIX G. PROCEDURES FOR ASSIGNING LEVELS OF EVIDENCE

- Level of evidence is assigned based on the study design using the Levels of Evidence table (**APPENDIX F**), assuming high quality (eg, for intervention, randomized clinical trial starts at level I)
- Study quality is assessed using the critical appraisal tool, and the study is assigned 1 of 4 overall quality ratings based on the critical appraisal results
- Level of evidence assignment is adjusted based on the overall quality rating:
  - High quality (high confidence in the estimate/results): study remains at assigned level of evidence (eg, if the randomized clinical trial is rated high quality, its final assignment is level I). High quality should include:
    - Randomized clinical trial with greater than 80% follow-up, blinding, and appropriate randomization procedures
    - Cohort study includes greater than 80% follow-up
    - Diagnostic study includes consistently applied reference standard and blinding
    - Prevalence study is a cross-sectional study that uses a local and current random sample or censuses
  - Acceptable quality (the study does not meet requirements for high quality and weaknesses limit the confidence in the accuracy of the estimate): downgrade 1 level
    - Based on critical appraisal results
  - Low quality: the study has significant limitations that substantially limit confidence in the estimate: downgrade 2 levels
    - Based on critical appraisal results
  - Unacceptable quality: serious limitations - exclude from consideration in the guideline
    - Based on critical appraisal results

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APPENDIX H. Ligament sprain CPG revision – Critical Appraisal Scores

Clinical Course-Levels of Evidence adapted from Phillips

	Systematic review of prospective cohort studies High-quality prospective cohort study	Systematic review of retrospective cohort studies Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Lower quality retrospective cohort study High-quality cross-sectional study Case-control study	Case series	Expert opinion
Katz 2013	X				
McLeod 2012		X			
Osteras 2012		X			
Al-Dadah 2011		X			
Busija 2008		X			
Fabricant 2008		X			
Zaffagnini 2011		X			
Kijowski 2011		X			
Hall 2014		X			
Hall M 2014		X			
Hall 2013		X			
Thorlund 2014			X		
Thorlund 2012			X		
Stein 2010			X		
Scanzello 2013			X		
Sung-Gon 2013			X		
Filardo 2015			X		
Xu 2015			X		

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Risk factors – AMSTAR systematic reviews

	Was an 'a priori' design provided?	Was there duplicate study selection and data extraction?	Was a comprehensive literature search performed?	Was the status of publication (i.e. grey literature) used as an inclusion criterion?	Was a list of studies (included and excluded) provided?	Were the characteristics of the included studies provided?	Was the scientific quality of the included studies assessed and documented?	Was the scientific quality of the included studies used appropriately in formulating conclusions?	Were the methods used to combine the findings of studies appropriate?	Was the likelihood of publication bias assessed?	Was the conflict of interest included?	What is your overall assessment of the methodological quality of this review? (High, Acceptable, Low, Unacceptable)
Snoeker 2013	Y	Y	Y	N	Y	Y	Y	CA	Y	CA	Y	HQ
Papalia 2011	Y	Y	Y	N	N	N	Y	Y	Y	CA	N	AQ
Petty 2011	Y	N	N	Y	N	N	N	N	Y	N	N	LQ

Risk factors – SIGN Cross-sectional

	The study addresses an appropriate and clearly focused question	The two groups being studied are selected from source populations that are comparable in all respects other than the factor	The study indicates how many of the people asked to take part did so, in each of the groups being studied	The likelihood that some eligible subjects might have the outcome at the time of enrolment is assessed and taken into	What percentage of individuals or clusters recruited into each arm of the study dropped out before the study was completed	Comparison is made between full participants and those lost to follow up, by exposure status	The outcomes are clearly defined	The assessment of outcome is made blind to exposure status. If the study is retrospective this may not be applicable	Where blinding was not possible, there is some recognition that knowledge of exposure status could have influenced the assessme	The method of assessment of exposure is reliable	Evidence from other sources is used to demonstrate that the method of outcome assessment is valid and reliable	Exposure level or prognostic factor is assessed more than once	The main potential confounders are identified and taken into account in the design and analysis	Have confidence intervals been provided?	How well was the study done to minimise the risk of bias or confounding? (High, Acceptable, Low, Unacceptable)

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		under investiga tion		account in the analysis					nt of outcome						
Chhadia 2011	Y	Y	DNA	DNA		DNA	Y	CS	CS	Y	CS	DNA	Y	Y	AQ

Risk factors – SIGN Cohort

	The study addresses an appropria te and clearly focused question	The two groups being studied are selected from source populatio ns that are compara ble in all respects other than the factor under investiga tion	The study indicates how many of the people asked to take part did so, in each of the groups being studied	The likelihoo d that some eligible subjects might have the outcome at the time of enrolmen t is assessed and taken into account in the analysis	What percenta ge of individua ls or clusters recruited into each arm of the study dropped out before the study was complete d	Compari son is made between full participa nts and those lost to follow up, by exposure status	The outcomes are clearly defined	The assessme nt of outcome is made blind to exposure status. If the study is retrospec tive this may not be applicabl e	Where blinding was not possible, there is some recogniti on that knowled ge of exposure status could have influence d the assessme nt of outcome	The method of assessme nt of exposure is reliable	Evidence from other sources is used to demonstr ate that the method of outcome assessme nt is valid and reliable	Exposure level or prognosti c factor is assessed more than once	The main potential confound ers are identified and taken into account in the design and analysis	Have confiden ce intervals been provided ?	How well was the study done to minimise the risk of bias or confound ing? (High, Acceptab le, Low, Unaccept able)
Pestka 2014	Y	Y	N	N		N	Y	N	Y	Y	Y	Y	N	N	AQ
Salzman n 2013	Y	Y	Y	N		N	Y	DNA	N	Y	Y	N	N	N	AQ
Ebert 2013	Y	Y	N	Y		N	N	DNA	CS	Y	Y	N	N	Y	AQ
Jungman n 2012	Y	Y	N	N		N	Y	Y	Y	Y	Y	N	N	N	AQ

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Hwang 2012	Y	Y	DNA	DNA		N	Y	DNA	CS	Y	Y	N	N	Y	AQ
Lyman 2013	Y	Y	N	DNA		DNA	Y	DNA	N	Y	Y	N	Y	Y	AQ
Jaiswal 2012	Y	Y	N	DNA		N	Y	N	N	Y	Y	Y	N	Y	AQ
Rosenberger 2010	Y	Y	N	N		N	Y	Y	Y	Y	Y	Y	N	Y	AQ
Wu 2016	Y	CS	Y	Y		CS	Y	NA	N	Y	Y	N	N	N	AQ

Risk factors – SIGN Case Control

	The study addresses an appropriate and clearly focused question	The cases and controls are taken from comparable populations	The same exclusion criteria are used for both cases and controls	What percentage of each group (cases and controls) participated in the study?	Comparison is made between participants and non-participants to establish their similarities or differences	Cases are clearly defined and differentiated from controls	It is clearly established that controls are non-cases	Measures will have been taken to prevent knowledge of primary exposure influencing case ascertainment	Exposure status is measured in a standard, valid and reliable way	The main potential confounders are identified and taken into account in the design and analysis	Confidence intervals are provided	How well was the study done to minimise the risk of bias or confounding?
Englund 2009	Y	Y	Y		Y	Y	Y	Y	Y	Y	N	HQ
Kluczynski 2013	Y	Y	Y		N	Y	Y	CS	Y	N	Y	AQ

Risk factors – Modified Case Series

	Did the study address a clearly focused question / issue?	*Is the research method (study design) appropriate for answering the research question?*	*Are both the setting and the subjects representative with regard to the population to which the findings will be referred?*	*Is the researcher's perspective clearly described and taken into account?*	*Are the methods for collecting data clearly described?*	*Are the methods for analyzing the data likely to be valid and reliable? Are quality control measures used?*	*Was the analysis repeated by more than one researcher to ensure reliability?*	*Are the results credible, and if so, are they relevant for practice?*	*Are the conclusions drawn justified by the results?*	*Are the findings of the study transferable to other settings?*	How well was the study done to minimise the risk of bias or confounding?

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Henry 2012	Y	Y	Y	CS	Y	Y	CS	Y	Y	Y	HQ
Crema 2012	Y	Y	Y	CS	Y	Y	Y	Y	Y	Y	HQ
Crema 2010	Y	Y	Y	CS	Y	Y	CS	Y	Y	Y	HQ
Ding 2009	N	Y	Y	CS	N	Y	CS	Y	Y	Y	AQ
Guenther 2014	Y	Y	Y	CS	Y	Y	CS	Y	Y	Y	HQ
Jacob 2012	N	Y	Y	CS	N	Y	CS	Y	Y	CS	AQ

Examination – Outcome measures- Levels of Evidence adapted from Phillips

	Systematic review of prospective cohort studies High-quality prospective cohort study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study	High-quality cross-sectional study	Lower-quality cross-sectional study	Expert opinion	**What is your overall assessment of the methodological quality of this review? (High, Acceptable, Low, Unacceptable)**
Engelhart 2012		X				AQ
Goodwin 2011		X				AQ
Garratt 2008		X				AQ
Salavati 2008			X			AQ
Van de Graaf 2014			X			AQ
Almangoush 2013			X			AQ
Balain 2009			X			AQ
Smith 2009			X			AQ
Celik 2015			X			AQ
Vaquero 2014			X			AQ

Examination – Physical Impairment Measures- Levels of Evidence adapted from Phillips

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	Systematic review of prospective cohort studies High-quality prospective cohort study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study	High-quality cross-sectional study	Lower-quality cross-sectional study	Expert opinion	**What is your overall assessment of the methodological quality of this review? (High, Acceptable, Low, Unacceptable)**
Décary 2016		X				AQ
Blyth 2015		X				AQ
Haviv 2015			X			AQ
Snoeker 2015			X			AQ
Campbell 2014				X		LQ

Interventions- AMSTAR systematic review

	The study addresses a clearly defined research question	At least two people should select studies and extract data	A comprehensive literature search is carried out	The authors clearly state if or how they limited their review by publication type	The included and excluded studies are listed	The characteristics of the included studies are provided	The scientific quality of the included studies is assessed and documented	The scientific quality of the included studies was assessed appropriate-ly	Appropriate methods are used to combine the individual study findings	The likelihood of publication bias is assessed	Conflicts of interest are declared	**What is your overall assessment of the methodological quality of this review? (High Quality ≥ 8;Acceptable ≥5; Low ≤4**
Fazalare 2010	CA	N	Y	N	N	Y	Y	Y	Y	N	N	AQ
Wasielewski 2011	CA	Y	Y	N	N	Y	Y	Y	Y	N	N	AQ
Imoto 2011	CA	Y	Y	Y	Y	Y	Y	N	Y	N	N	AQ
Papalia 2013	CA	Y	Y	N	N	Y	Y	Y	CA	N	N	AQ
Dias 2013	CA	Y	Y	N	Y	Y	Y	Y	Y	N	N	AQ
Harston 2012	CA	CA	Y	N	N	Y	Y	Y	NA	N	N	LQ
Coppola 2009	CA	Y	Y	N	N	Y	Y	Y	CA	N	N	AQ
McLeod 2012	CA	CA	Y	N	N	Y	Y	Y	Y	Y	N	AQ
Reid 2012	CA	Y	Y	N	N	Y	Y	Y	Y	N	N	AQ

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Interventions- PEDro

	The study addresses a clearly defined research question	At least two people should select studies and extract data	A comprehensive literature search is carried out	The authors clearly state if or how they limited their review by publication type	The included and excluded studies are listed	The characteristics of the included studies are provided	The scientific quality of the included studies is assessed and documented	The scientific quality of the included studies was assessed appropriate-ly	Appropriate methods are used to combine the individual study findings	The likelihood of publication bias is assessed	Conflicts of interest are declared	**What is your overall assessment of the methodological quality of this review? (High Quality ≥ 8;Acceptable ≥5; Low ≤4**
Kelln 2009	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	AQ
Edwards 2013	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	HQ
Wondrasch 2009 AJSM	Y	Y	Y	CA	N	N	Y	Y	Y	Y	Y	HQ
Akkaya 2012	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y	HQ
Lind 2013	Y	Y	Y	CA	N	N	N	N	N	Y	Y	AQ
Katz 2013	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	AQ
Osteras Bodywork 2014	Y	Y	Y	CA	N	Y	N	Y	Y	Y	Y	HQ
Østerås KSSTA 2014	Y	Y	N	CA	N	N	N	Y	N	Y	Y	AQ
Østerås Bodywork 2012	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	HQ
Ebert 2008	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	HQ
Oravitan 2013	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	AQ
Koutras 2012	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	HQ
Kise 2016	Y	Y	Y	CA	N	N	Y	Y	Y	Y	Y	HQ
Hall 2015	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	HQ

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Interventions- Modified Case Series

	Did the study address a clearly focused question / issue?	*Is the research method (study design) appropriate for answering the research question?*	*Are both the setting and the subjects representative with regard to the population to which the findings will be referred?*	*Is the researcher's perspective clearly described and taken into account?*	*Are the methods for collecting data clearly described?*	*Are the methods for analyzing the data likely to be valid and reliable? Are quality control measures used?*	*Was the analysis repeated by more than one researcher to ensure reliability?*	*Are the results credible, and if so, are they relevant for practice?*	*Are the conclusions drawn justified by the results?*	*Are the findings of the study transferable to other settings?*	How well was the study done to minimise the risk of bias or confounding?
Wondrasch 2013	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	HQ
Assche 2011	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	HQ
Neogi 2013	Y	Y	Y	CA	Y	Y	CA	Y	Y	Y	HQ
Lim 2010	Y	Y	CA	CA	N	CA	CA	Y	Y	Y	AQ
Elbaz 2013	N	Y	Y	Y	Y	CA	CA	Y	Y	Y	AQ

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