CLINICAL GUIDELINES

David S. Logerstedt, PT, MA • **Lynn Snyder-Mackler**, PT, ScD •
Richard C. Ritter, DPT • **Michael J. Axe**, MD

Knee Pain and Mobility Impairments / Meniscal and Articular Cartilage Lesions

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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REVIEWERS: Roy D. Altman, MD • Constance Chu MD • Anthony Delitto, PT, PhD • John Dewitt, DPT • Amanda Ferland, DPT • Helene Fearon, PT • G. Kelley Fitzgerald, PT, PhD • Joy MacDermid, PT, PhD • James W. Matheson, DPT • Philip McClure, PT, PhD • Paul Shekelle, MD, PhD • A. Russell Smith, Jr., PT, EdD • Leslie Torburn, DPT

For author, coordinator, and reviewer affiliations, see end of text. Address correspondence to: Joseph Godges, DPT, ICF Practice Guidelines Coordinator, Orthopaedic Section, APTA Inc., 2920 East Avenue South, Suite 200; La Crosse, WI 54601. Email: icf@orthopt.org

Recommendations*

Pathoanatomical Features and Clinical Course: 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 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. (Recommendation based on weak evidence.)

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

Clinicians should consider the patients' age and presence of a meniscal tear for the odds of having a chondral lesion. Patients' age and time from injury are predictive factors of the severity of chondral lesions and time from injury is significantly associated with the number of chondral lesions. (Recommendation based on weak evidence.)

Diagnosis/Classification: Knee pain, mobility impairments, and effusion are useful clinical 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 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). (Recommendation based on moderate evidence.)

Differential Diagnosis: 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 not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function. (Recommendation based on moderate evidence.)

Examination – Outcome Measures: Clinicians should use a validated patient-reported outcome measure with a general health questionnaire, along with a validated activity scale for patients with knee pain and mobility disorders. These tools are useful for identifying a patient's baseline status relative to pain, function, and disability and for monitoring a change in patient's status throughout the course of treatment. (Recommendation based on strong evidence.)

Examination – Activity Limitation Measures: Clinicians should utilize easily reproducible physical performance measures, such as single limb hop tests, to assess activity limitation and participation restrictions associated with their patient's knee pain or mobility impairments and to assess the changes in the patient's level of function over the episode of care. (Recommendation based on weak evidence.)

Interventions – Progressive Knee Motion: Clinicians may utilize early progressive knee motion following knee meniscectomy and meniscal repair surgery. (Recommendation based on weak evidence.)

Interventions – Progressive Weight Bearing: There are conflicting opinions regarding the best use of progressive weight bearing in patients with meniscal repairs or chondral lesions. (Recommendation based on conflicting evidence.)

Interventions – Progressive Return to Activity: Clinicians may utilize early progressive return to activity following knee meniscal repair surgery. (Recommendation based on weak evidence.)

Interventions – Supervised Rehabilitation: Clinicians should consider a clinic-based program in patients following arthroscopic meniscectomy to increase quadriceps strength and functional performance. (Recommendation based on moderate evidence.)

Interventions – Neuromuscular Reeducation: Clinicians can consider neuromuscular reeducation in patients following meniscectomy to increase quadriceps strength and functional performance (Recommendation based on weak evidence.)

*These recommendations and clinical practice guidelines are based on the scientific literature published prior to July 2009.

Introduction

AIM OF THE GUIDELINE

The Orthopaedic Section of the American Physical Therapy Association (APTA) has an ongoing effort to create evidence-based practice guidelines 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).[42]

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
- 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

This guideline is 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 in light of the clinical data presented by the patient, the diagnostic and treatment options available, and the patient's values, expectations, and preferences. However, we suggest that the rationale for significant departures from accepted guidelines be documented in the patient's medical records at the time the relevant clinical decision is made.

Methods

The Orthopaedic Section, APTA appointed content experts as developers and authors of clinical practice guidelines for musculoskeletal conditions of the knee which are commonly treated by physical therapists. These content experts were given the task to identify impairments of body function and structure, activity limitations, and participation restrictions, described using ICF terminology, that could 1) categorize patients into mutually exclusive impairment patterns upon which to base intervention strategies, and 2) serve as measures of changes in function over the course of an episode of care. The second task given to the content experts was to describe the supporting evidence for the identified impairment pattern classification as well as interventions for patients with activity limitations and impairments of body function and structure consistent with the identified impairment pattern classification. It was also acknowledged by the Orthopaedic Section, APTA that a systematic search and review solely of the evidence related to diagnostic categories based on International Statistical Classification of Diseases and Health Related Problems (ICD)[41] terminology would not be sufficient for these ICF-based clinical practice guidelines as most of the evidence associated with changes in levels of impairment or function in homogeneous populations is not readily searchable using the current terminology. For this reason, the content experts were directed to also search the scientific literature related to classification, outcome measures, and intervention strategies for musculoskeletal conditions commonly treated by physical therapists. Thus, the authors of this clinical practice guideline systematically searched MEDLINE, CINAHL, and the Cochrane Database of Systematic Reviews (1966 through July 2009) for any relevant articles related to classification, outcome measures, and intervention strategies for meniscal and chondral injuries of the knee. Additionally, when relevant articles were identified their reference lists were hand-searched in an attempt to identify other articles that might have contributed to the outcome of this clinical practice guideline. This guideline was issued in 2009 based upon publications in the scientific literature prior to July 2009. This guideline will be considered for review in 2014, or sooner if new evidence becomes available. 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 will be graded according to criteria described by the Center for Evidence-Based Medicine, Oxford, United Kingdom[83]. (Table 1)

I	Evidence obtained from high quality randomized controlled trials, prospective studies, or diagnostic studies
II	Evidence obtained from less equality randomized controlled trials, prospective studies or diagnostic studies (e.g., improper randomization, no blinding, < 80 % follow-up)
III	Case controlled studies or retrospective studies
IV	Case series
V	Expert opinion

Grades of Evidence

The overall strength of the evidence supporting recommendations made in this guideline will be graded according to guidelines described by Guyatt[32] as modified by MacDermid and adopted by the coordinator and reviewers of this project. In this modified system, the typical A, B, C and D grades of evidence have been modified to include the role of consensus expert opinion and basic science research to demonstrate biological or biomechanical plausibility. (Table 2)

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 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

Review Process

The Orthopaedic Section, APTA also selected consultants from the following areas to serve as reviewers of the early drafts of this clinical practice guideline:

- Claims review
- Coding
- Epidemiology
- Orthopaedic Section of the APTA, Inc
- Medical practice guidelines
- Orthopaedic physical therapy residency education
- Orthopaedic surgery
- Physical therapy academic education
- Sports physical therapy residency education

Comments from these reviewers were utilized by the authors to edit this clinical practice guideline prior to submitting it for publication to the *Journal of Orthopaedic & Sports Physical Therapy*.

Classification

The primary ICD-10 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, M93.2 Osteochondritis dessicans.

The corresponding ICD-9 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 of 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, 732.7 Osteochondritis dessicans, 733.92 Chondromalacia.

The primary ICF body functions codes associated with the above noted ICD-10 conditions are **b28016 Pain in joint, 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.**

The ICD-10 and primary and secondary ICF codes associated with knee pain and mobility disorders are provided in Table 3.

ICD-10 and ICF Codes Associated with Knee Pain and Mobility Disorders

INTERNATIONAL STATISTICAL CLASSIFICATION OF DISEASES AND RELATED HEALTH PROBLEMS		
Primary ICD-10	S83.2	Tear of meniscus, current
	S83.3	Tear of articular cartilage of knee, current
Secondary ICD-10	M23.2	Derangement of meniscus due to old tear or injury
	M93.2	Osteochondritis dessicans

INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY, AND HEALTH

PRIMARY ICF CODES		
Body function	b28016	Pain in joint
	b7100	Mobility of a single joint
	b7700	Gait pattern functions
Body structure	s75000	Bones of thigh
	s75010	Bones of lower leg
	s75011	Knee joint
	s75018	Structure of lower leg, other specified as fibrocartilage or hyaline cartilage of the knee
Activities and participation	d2302	Completing the daily routine
	d4558	Moving around, specified as quick direction changes while walking or running
SECONDARY ICF CODES		
Body function	b7150	Stability of a single joint
	b7303	Power of muscles in lower half of the body
	b7408	Muscle endurance functions, specified as endurance of muscles of one limb
	b7601	Control of complex voluntary movements
	b770	Gait pattern functions (absence of knee catching or locking with walking and running)
Body structure	s75002	Muscles of thigh
	s75012	Muscles of lower leg
Activities and participation	d4101	Squatting
	d4102	Kneeling
	d4551	Climbing
	d4552	Running
	d4553	Jumping
	d9201	Sports

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Impairment/Function-based Diagnosis

INCIDENCE

Meniscus. Injuries to the meniscii are the second most common injury to the knee with an incidence of 12-14%.[67, 98] A high incidence of meniscal tears occurs with an injury to the anterior cruciate ligament (ACL), ranging from 22% to 86%.[81] Ten percent to 20% of all orthopaedic surgeries consist of surgery to the meniscus.[87]

Articular Cartilage. The prevalence of articular cartilage pathologies is reported between 5 and 11%.[1, 39] The incidence of isolated articular cartilage lesions is more than one-third that of non-isolated cartilage lesions.[108] Thirty-two percent to 58% are the result of a traumatic, non-contact mechanism of injury.[47, 108] Sixty-four percent of the all chondral lesions were less than 1 cm^2 [108], whereas, 33-60% were greater than grade III lesions on the International Cartilage Repair Society grading system.[21, 100] The most frequent localization of cartilage lesions were to the medial femoral condyle and the patella articular surface.[108] Medial meniscus tears (37%) and ACL ruptures (36%) were the most common concomitant injuries.

PATHOANATOMICAL FEATURES AND CLINICAL COURSE

Meniscus

The medial and lateral menisci cover the superior aspect of the tibia.[12] They are comprised of fibrocartilage and are 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.[12] 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.[12] The rate of medial meniscal tears increases over time, whereas lateral meniscal tears do not.[49, 81, 100] Prolonged delays in ACL reconstruction is related to increased occurrence of meniscus injuries.[81]

III

A review of the literature by Meredith et al[74], which included studies published through June 2003 and abstracts presented at the American Academy of Orthopaedic Surgeons from 1990 to 2004, concluded that short-term outcomes in young patients with isolated meniscal tears was very good. Mean Lysholm scores ranged from 80/100 to 99/100 at a follow-up at 10 years post surgery. Tegner activity scores ranged from 5 to 7 preoperatively and at peak improvement, with a slight decrease at follow-up greater than 10 years.

III

Ericsson and colleagues[25] assessed isokinetic strength testing and functional performance testing, and administered the Knee Injury and Osteoarthritis Outcome Score (KOOS) at a mean follow-up of 4 years. They found lower knee extensor strength and diminished 1-leg rising capacity in the surgical limb. The mean scores for the different dimensions on the KOOS ranged from 63/100 to 89/100. Quadriceps weakness was related to all 5 subscales on the KOOS and 1-leg rising ratio.

II

Roos et al[91] conducted a prospective study to assess patient outcomes after meniscectomy. They found 40% of patients who were active in sports prior to injury had reduced their activity 3 months post-surgery. Patients did show improvement from pre-operatively to post surgery based on Lysholm scores (61/100 pre-operatively to 74/100 post operatively).

III

Matthews and St-Pierre[71] investigated isokinetic knee extension and flexion strength following arthroscopic meniscectomy. Following surgery, patients were given a home exercise program and reevaluated every 2 weeks from 2-12 weeks. They found strength was lower (15%) in the quadriceps of the involved knee prior to surgery. Quadriceps strength in the surgical knee improved to pre-surgical levels by 4 to 6 weeks but continued to remain lower (12-14%) than the uninvolved side. Hamstring strength in the involved side returned to normal levels within 2 weeks of surgery.

II

Morrissey and colleagues[78] studied the factors related to early recovery rate after partial knee meniscectomy. Eighty-three individuals were evaluated 4 days and 6 weeks following partial meniscectomy. Recovery rate was determined by the quotient of the change in the Hughston Clinic knee questionnaire during the time period by the baseline Hughston Clinic score and its relationship with demographic and knee impairment values. They found that gender, combination of gender and injured meniscus, and injury chronicity had a significant relationship with recovery rate.

IV

A recent study published by Logan and colleagues[61] investigated the long-term outcomes of meniscal repairs in elite athletes. Forty-two athletes underwent 45 meniscal repairs, including buckle-handle, radial, and complex meniscal tears. Thirty-three percent of the meniscal repairs were to the lateral meniscus and 67% to the medial meniscus. All subjects underwent the same surgical procedure and post-operative rehabilitation. The mean time from injury to surgery was 7 months (range, 0-45 months). The mean follow-up time was 8.5 years. The average Lysholm score was 87.4 (range, 37-100) and IKDC was 82.2 (range, 18-100). A vast majority of athletes returned to sports with a large number returning to the previous level of competition.

Articular Cartilage

The articular cartilage that covers the gliding surfaces of the knee joint is hyaline in nature.[8, 59] Hyaline cartilage decreases the friction between gliding surfaces, withstands compression by acting as a shock absorber, and resists wear during normal situations.[8, 15] Injuries to the articular cartilage can be the result of trauma or repetitive minor trauma.[8, 47, 108] Some individuals who sustain articular surface injury do not seek treatment. Many lesions are nonprogressive and remain asymptomatic, while others believe that even small asymptomatic lesions may increase in size and eventually become painful if left untreated.[29] In regards to operative care, four methods are most widely used: arthroscopic lavage and debridement, microfracture, autologous chondrocyte implantation (ACI), and osteochondral grafting.[59]

II

Jakobsen and colleagues[46] performed an analysis of the quality of cartilage repair studies. They found no significant difference among the outcomes between microfracture, osteochondral transplantation (OATS), autologous periosteal transplantation, or ACI. However, they also reported that the studies were generally of low quality, possibly due to the heterogeneity of the studies and the large diversity of outcome measurement scales used.

II

In a prospective follow-up study, Gobbi et al[29] investigated the outcome of microfracture technique in full thickness chondral knee lesions in athletes. Knee pain and swelling had improved in 70% of the patients. Single one-leg hop test for distance was normal in 70%, abnormal and severely abnormal in 30%. At 2 years follow-up, Tegner score was 6/10 and at final follow-up, it had decreased to 5/10. From pre-operative assessment to final follow-up, Lysholm scores improved by 53% and subjective improvement by 75%.

IV

Steadman et al[96] performed a case series with a long term follow-up of 11 years (range: 7-17 years) using microfracture. They reported significant improvements in Lysholm and Tegner scores and good to excellent results based on the modified SF-36 and Western Ontario and McMaster University Osteoarthritis Index (WOMAC).

IV

Hangody et al[36] reported on a large series dating back 14 years for the use of osteochondral grafting. The series of mosaicplasties consisted of 789 implantations on femoral condyles and 31 on the tibial condyles. Clinical scores showed good to excellent results in 92% of patients with femoral condylar mosaicplasties and 87% of tibial implantations.

III

Lahav and colleagues[57] evaluated the clinical outcomes in 15 of 21 patients over a 5-year period following osteochondral autologous transplantation. At final follow-up, KOOS pain scores was 81/100, symptoms 54/100, function of ADLs 93/100, function of sports and recreation 65/100, and quality of life 51/100. The mean IKDC score was 68/100.

I

The Cochrane Collaboration Review[107] on ACI for full thickness articular cartilage defects of the knee included 4 randomized controlled trials of 266 participants. They concluded that no significant differences in outcomes between ACI and other chondral lesion surgical interventions.

II

Loken and associates[62] evaluated the long-term effect of ACI to repair chondral lesions to the knee. They demonstrated that extension total work at 60 degrees/second improved from year 1 to year 2. During isokinetic quadriceps and hamstrings measurements at 60 and 240 degrees/sec, the surgically-treated strength measurements were significantly lower than the uninvolved knee at year 1, 2, and 7.

I

In a systemic review, Mithoefer et al[76] evaluated 28 studies involving 3122 patients who had undergone microfracture surgery for articular cartilage damage to the knee. They report that the average postoperative Lysholm score was 80.8/100 $\pm$ 6 and the average Tegner score was 4.8/10 $\pm$ 0.8 at the last follow-up. Good to excellent clinical improvement was seen in the first 2 years, and good clinical improvement after 2 years. Although, a moderate to high number of patients had a decrease in functional between 18 and 36 months, decreased functional scores were still greater than scores preoperatively.

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 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.

RISK FACTORS

III

Meniscus. In a multi-center study, Tandogan and associates investigated the relationship of age, time from, and level of sports with meniscal and chondral lesions concomitant with ACL tears.[100] At 2 to 5 years following the initial injury, the odds are 2.2 times higher of having a meniscal or articular cartilage tear associated with an ACL tear than in the first year. The odds increased to 5.9 times after 5 years. Time from injury and age were predictive of lateral meniscal tears, whereas, time from injury was only predictive of medial meniscal tears. Differences in mechanism of injury, lower extremity alignment, and timing of surgery may account for differences in the frequency of medial and lateral meniscal injuries.

III

Johnson and colleagues[48] reported that meniscal tears could be accurately diagnosed 76% of the time based on 30 predictors in the patient's medical history and 97% of the time based on 142 predicting questions. Pre-injury high-level sports participation and the greater the laxity after injury was predictive of those who undergo late meniscal or ligament surgery but the predictive value was too weak to be of clinical value.[22, 79]

II

In a cohort study based on the Norwegian National Knee Ligament registry, Granan et al[31] reported that the odds of meniscal tears increased for each month that elapsed from the injury date to surgery date. Previous surgery, age, and female gender decreased the odds for having meniscal injury in younger patients. In older patients, the presence of a cartilage lesion increased the odds of having a meniscal tear, whereas previous knee surgery and female gender decreased the odds.

C

Clinicians should consider time from injury and age as predisposing factors for having a meniscal injury. Patients who participated in high-level sports or had increased knee laxity after the injury are more likely to have late meniscal surgery.

III

Articular Cartilage. Tandogan et al[100] performed a retrospective multi-center study to document the location and type of meniscal and chondral lesions that accompany ACL tears. Cases of 764 patients were reviewed. Nineteen percent of the knees had one or more chondral lesions, with the majority located in the medial tibio-femoral compartment. High rates of chondral lesions are associated with meniscal tears in the same compartment. Patients' age greater than 30 and sustained an ACL injury greater than 5 years ago as predisposing factors for having an increased number of and more severe chondral lesions.

III

In a retrospective study, Eskelinen and colleagues[26] reviewed the records of 88 young male patients. A small percentage of chondral lesions were located on the medial femoral condyle. The majority of chondral lesions were of the superficial (grade I-II) type. The authors found that higher body mass index may predispose young male adults to more severe cartilage lesions.

III

Biswal and colleagues[9] retrospectively reviewed 43 patients who had repeat MRI of same knee on 2 different occasions, separated by at least one year. Fifty percent of the patients had sustained a sports-related injury and 23% had experienced an accidental fall. They noted that meniscal tears and ACL tears were associated with accelerated cartilage loss. Chondral lesions on the central aspect of the medial compartment had more rapid progressive loss than in other regions.

II

Granan et al[31] reported that the odds of cartilage lesions increased for each month that elapsed from the injury date to surgery date. Previous knee surgery and female gender decreased the odds for having chondral injury, whereas age increased the odds in younger patients. In older patients, the presence of a meniscal tear and previous knee surgery increased the odds of having a chondral lesion, whereas female gender reduced the odds.

C

Clinicians should consider the patients' age and presence of a meniscal tear for the odds of having a chondral lesion. Patients' age and time from injury are predictive factors of the severity of chondral lesions and time from injury is significantly associated with the number of chondral lesions.

DIAGNOSIS/CLASSIFICATION

I

Meniscus. The ICD diagnosis of a meniscal tear and the associated ICF diagnosis of joint pain and mobility impairments is made with a reasonable level of certainty when the patient presents with the following clinical findings:[2, 5, 38, 63, 75, 93]

- Twisting injury
- Tearing sensation at time of injury
- Delayed effusion (6-24 hours post injury)
- History of “catching” or “locking”
- Pain with forced hyperextension
- Pain with maximum flexion
- Pain or audible click with McMurray’s maneuver
- Joint line tenderness
- Thessaly’ Test at 5 and 20 degrees

III

Articular Cartilage. The ICD diagnosis of an articular cartilage tear and the associated ICF diagnosis of joint pain and mobility impairments is made with a fair level of certainty when the patient presents with the following clinical findings:[13]

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

B

Knee pain, mobility impairments, and effusion are useful clinical 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 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).

DIFFERENTIAL DIAGNOSIS

A primary goal of diagnosis is to match the patient's clinical presentation with the most efficacious treatment approach.[17] A component of diagnosis is to also determine whether physical therapy management is appropriate.[17] In a small percentage of patients, trauma to the thigh and knee may be something more serious than the commonly occurring contusions, muscle strains, cartilage tears or ligament disorders, such as fracture,[4] knee dislocation,[88] or neurovascular compromise.[88] In addition, following surgical intervention, serious conditions may develop, such as arthrofibrosis,[72, 73] postoperative infection and septic arthritis,[105] deep vein thrombosis,[85] anterior knee pain,[28, 40] and patella fractures.[102] Vigilance is warranted of the key signs and symptoms associated with serious pathological knee conditions, continually screen for the presence of these conditions, and initiate referral to the appropriate medical practitioner when a potentially serious medical condition is suspected.[17]

V

The following differential diagnosis have been suggested for knee pain based on anatomical site:[16]

- Anterior knee pain
  - Patellar subluxation or dislocation
  - Tibial apophysitis (Osgood-Schlatter's lesion)
  - Jumper's knee (patellar tendonitis)
  - Patellofemoral pain syndrome
- Medial knee pain
  - Medial collateral ligament sprain
  - Medial meniscal tear
  - Pes anserine bursitis
  - Medial plica syndrome
  - Medial articular cartilage lesion
- Lateral knee pain
  - Lateral collateral ligament sprain
  - Lateral meniscal tear
  - Iliotibial band tendonitis
  - Lateral articular cartilage lesion
- Posterior knee pain
  - Popliteal cyst (Baker's cyst)
  - Posterior cruciate ligament injury
- Non-specific knee and thigh/leg symptoms[4, 16, 72, 73, 85, 88, 105]
  - Arthrofibrosis
  - Deep vein thrombosis
  - Dislocation
  - Fracture
  - Neurovascular compromise
  - Osteoarthritis
  - Septic arthritis

III

Psychosocial factors may partially attribute to an inability to return to pre-injury activity levels. Fear of movement/re-injury decreases as a patient is farther removed from surgery and is inversely related to function as a function of time.[18] Patients that did not return to their pre-injury activity level had more fear of re-injury, which was correlated with low knee-related quality of life.[56] Elevated pain-related fear of movement/re-injury may place a patient at risk for chronic disability and reducing this fear can be accomplished through patient education and graded exercise prescription.[18, 58] Thomee et al[104] found that patients' perceived self-efficacy of knee function using the knee self-efficacy scale (K-SES) prior to ACL reconstruction is predictive of return to acceptable levels of physical activity, symptoms and muscle function 1 year following ACL reconstruction.

B

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 not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function.

IMAGING STUDIES

I

Acute knee injury is one of most common orthopaedic conditions. When a patient reports a history of knee trauma, the therapist needs to be alert for the presence of knee fracture. Being able to properly identify a fracture at the knee can eliminate needless radiographs and be cost-effective.[4] The Ottawa Knee rule has been developed and validated to assist clinicians in determining when to order radiographs in individuals with acute knee injury.[4, 97] A knee radiograph series are required in patients with any of the following criteria:

- Age 55 or older
- Isolated tenderness of patella (no bone tenderness of knee other than patella)
- Tenderness of head of the fibula
- Inability to flex knee to 90 degrees
- Inability to bear weight both immediately and in the emergency department for 4 steps regardless of limping

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.[53, 65] A lower threshold of suspicion of a meniscal tear is warranted in middle aged and elderly patients.[35, 65] However, one recent study found an increased prevalence of meniscal damage with increasing age, although, the majority of tears were found in

asymptomatic patients.[23] MRI may be reserved for more complicated or confusing cases.[53] MRI may assist an orthopaedic surgeon in aiding in pre-operative planning and predicting the prognosis.[53, 65]

CLINICAL GUIDELINES

Examination

OUTCOME MEASURES

A vast number of knee injury outcomes scales have been developed and used over the years to evaluate a patient's disability. Recently, two reviews have been completed on knee outcome scales.[64, 109]

I

The Medical Outcomes Study 36-item Short Form (SF-36) is currently the most popular general health outcome measure.[109] The measure was designed to improve on the ability to measure general health outcomes without significantly lengthening the questionnaire and could be completed in less than 10 minutes. The SF-36 consists of 35 questions in eight subscale domains and one general overall health status question. Each subscale score is totaled, weighted, and transformed to fall between 0 (worst possible health, severe disability) and 100 (best possible health, no disability).[82] The SF-36 form has been validated for a variety of ages and languages.[109] It has demonstrated effectiveness in a vast number of conditions pertaining to orthopaedic and sports injuries.

I

The Knee Outcome Survey-Activities of Daily Living Scale (KOS-ADLs) is a patient-reported measure of functional limitations and impairments of the knee during activities of daily living.[45] The KOS-ADLs contains items, 7 related to symptoms, and 10 related to functional disability during ADLs. Each item is scored 0-5 and the total score is expressed as a percentage, with lower scores corresponding to greater disability. Irrgang et al[45] identified a higher internal consistency of the KOS-ADLs than that of the Lysholm Knee Scale. They also identified validity has demonstrated by moderately strong correlation with the Lysholm Knee Scale and global assessment of function. They found that the KOS-ADLs is responsive for the assessment of functional limitations of the knee.

I

The Knee Injury and Osteoarthritis Outcome Score (KOOS) is designed as a patient-reported assessment for evaluating sports injuries and outcomes in the young and middle-aged athlete.[90, 109] The KOOS consists of items in 5 domains, 9 items related to pain, 7 items related to symptoms, 17 items related to ADLs, 5 items related to sport and recreation function, and 4 items related to knee-related quality of life. Each item is graded from 0-4. Each subscale is summed and transformed to a score of 0 (worst) to 100 (best). Roos and colleagues[90, 109] identified a fair to modest relationship between the physical and mental health components of the SF-36. The pain, sport and recreation, and quality of life subdomains have been determined to be the most sensitive, with the largest effect size for active, young patients.[109] The KOOS has been

demonstrated to contain items regarding symptoms and disabilities important to patients with an ACL tear, isolated meniscal tears or knee osteoarthritis.[101]

I

The International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC) is a joint-specific outcome measure for assessing symptoms, function, and sports activity pertinent to a variety of knee conditions.[109] The form contains 18 questions, in which the total scores are expressed as a percentage. The IKDC has been demonstrated to contain items regarding symptoms and disabilities important to patients with an ACL tear, isolated meniscal tears or knee osteoarthritis.[101]

Irrgang et al[43] was able to demonstrate the responsiveness of the IKDC Subjective Knee Form. Two hundred and seven patients with a variety of knee patients who had scores at baseline and final follow-up participated in this study. They were able to identify a change score of 11.5 had a sensitivity of 0.82 and a specificity of 0.64, and a change score of 20.5 had a sensitivity of 0.64 and a specificity of 0.84 for detecting a patient who perceives improvement. The minimal detectable change (MDC) for the IKDC was a score of $\pm$ 12.8. Based on the close agreement of the cutoff score and MDC, a score of 11.5 is necessary to distinguish between those who have improved and those who have not improved.

II

The Lysholm Knee Scale was originally designed for follow-up evaluation of knee ligament surgery[109]. The scale contains 8 items of symptoms and function. It is scored from 0-100 points. Instability and pain are weighted the most heavily.[109] The Lysholm scale is arbitrarily graded with 95-100 as excellent, 84-94 as good, 65-83 as fair, and < 65 as poor. Research to date on validity, sensitivity, and reliability of the Lysholm scale is inconclusive.[109] The Lysholm scale may prove to be more meaningful when combined with an activity rating scale.[94] Two studies have examined the test re-test reliability of the Lysholm Knee Scale.[11, 54] These have demonstrated the overall ICC for test re-test reliability of >0.70 to 0.93.

II

The Cincinnati Knee Rating Scale is a clinician-based and patient-reported outcome measure. It was developed to assess subjective symptoms and functional activities.[109] It has been modified over the years. It has now designed as a 6 dimension scale based on a total of 100 points: symptoms (20 points), daily and sports activities (15 points), physical examination (25 points), knee stability testing (20 points), radiographic findings (10 points), and functional testing (10 points).[6] Portions of the rating scale have been validated.[109] The ICC value of test re-test reliability in patients with ACLR was greater than 0.75.[6]

V

The Tegner Activity Level Scale was developed as a score of activity level from 0 to 10 points. The scale grades a person's activity level where 0 is 'on sick leave/disability'

and 10 is ‘participation in competitive sports at the national elite level. It is commonly used in combination with the Lysholm score.[109]

II

The Marx Activity Level Scale is a patient-reported activity assessment. It contains 4 questions evaluating high-level functional activities. Each question is scored 0-4, based on the frequency per week performed at each item. It is designed to assess the patient’s highest peak activity over the past year.[109] The scale has been validated[70] but responsiveness has not been determined.[109]

A

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

ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION MEASURES

A variety of activity limitation and participation restriction measures have been described in the literature. The most common method to quantify lower extremity function is through functional performance tests. Hop testing has frequently been proposed as a practical, performance-based outcome measure that reflects the integrated effect of neuromuscular control, strength, and confidence in the limb.[86]

The single limb hop tests are the most common hop tests utilized to capture limb asymmetries in patients with lower extremity dysfunction. The following four hop tests are primarily used in patients with knee lesions: single hop for distance, triple crossover hop for distance, triple hop for distance, and 6-m timed hop. These hop tests have demonstrated high test re-test reliability in normal, young adults.[10, 92] For single hop for distance, ICC ranged from 0.92-0.96, the triple crossover hop for distance ranged from 0.93-0.96, triple hop for distance ranged from 0.95-0.97, and 6-m timed hop ranged from 0.66-0.92.

III

Noyes and colleagues[80] regard a limb symmetry index (LSI) of less than 85% as abnormal. Following ACL rupture, 50% of the patients exhibited abnormal LSI on a sole hop test. If the results of two tests were calculated, 62% of the patients were identified as having abnormal scores.

III

Following ACL reconstruction, patients performed hop tests at 16 weeks postoperatively (day 1), 16 weeks plus 24-48 hours (day 2 and 3) and 22 weeks postoperatively (day 4).[86] Hop test LSI test re-test reliability was assessed using values from day 2 and 3. ICC ranged from 0.82 to 0.88 with overall combination of hop tests was 0.93.

III

Low to moderate correlations were found between hop test performance and lower extremity muscular strength, as well as, between hop test performance and self-report outcome measures.[27]

Other activity limitation and participation restriction measures may be a part of the patient-reported outcome measure noted in this guideline's section on Outcome Measures.

C

Clinicians should utilize easily reproducible physical performance measures, such as single limb hop tests, to assess activity limitation and participation restrictions associated with their patient's knee pain or mobility impairments and to assess the changes in the patient's level of function over the episode of care.

ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION MEASURES

SINGLE LIMB SINGLE HOP TEST FOR DISTANCE	
ICF category	Measurement of activity limitation – jumping
Description	The amount of distance a patient performs a single hop on one limb.
Measurement method	The subject stands on the uninvolved leg, with his toe on the starting line. The subject hops as far as possible forward and lands on the same leg. The distance hopped is measured from the starting line to the point where the patient's heel landed. The patient is given 2 practice trials and 2 recorded trials. Testing is repeated on the involved limb while wearing a functional knee brace.
Nature of variable	Continuous
Units of measurement	Centimeters
Measurement properties	Test-retest reliability • Healthy individuals: ICC=0.92, SEM=4.61 cm[92] • Mean distance: 208.08-208.24 cm LSI reliability in patients with ACL reconstruction[86] • ICC=0.92 • Minimal Detectable Change = 8.09% • Mean LSI at 16 weeks post ACLR = 81.0-82.9% • Mean LSI at 22 weeks post ACLR = 88.2%

SINGLE LIMB TRIPLE HOP TEST FOR DISTANCE	
ICF category	Measurement of activity limitation – jumping
Description	The distance a patient performs three maximal forward hops as far as possible.
Measurement method	The subject stands on the uninvolved leg, with his toe on the starting line. The subject performs 3 consecutive maximal hops far as possible forward and lands on the same leg. The distance hopped is measured from the starting line to the point where the patient's heel landed. The patient is given two practice trials and two recorded trials. The test is repeated on the involved limb.
Nature of variable	Continuous
Units of measurement	Centimeters
Measurement properties	Test-retest reliability • Healthy individuals: ICC=0.97, SEM=11.17 cm[92] • Mean distance: 670.12-673.35 cm LSI reliability in patients with ACL reconstruction[86] • ICC=0.88 • Minimal Detectable Change = 10.02% • Mean LSI at 16 weeks post ACLR = 82.4-82.6% • Mean LSI at 22 weeks post ACLR = 87.7%

SINGLE LIMB CROSSOVER HOP TEST FOR DISTANCE	
ICF category	Measurement of activity limitation – jumping
Description	The distance a patient performs three maximal crossover forward hops as far as possible
Measurement method	The subject stands on the uninvolved leg, with his toe on the starting line. The subject performs 3 consecutive maximal hops far as possible forward and lands on the same leg while alternately crossing over a 15-cm strip on the floor. The distance hopped is measured from the starting line to the point where the patient's heel landed. The patient is given two practice trials and two recorded trials. The test is repeated on the involved limb.
Nature of variable	Continuous
Units of measurement	Centimeters
Measurement properties	Test-retest reliability • Healthy individuals: ICC=0.93, SEM=17.74 cm[92] • Mean distance: 637.40-649.19 cm LSI reliability in patients with ACL reconstruction[86] • ICC=0.84 • Minimal Detectable Change = 12.25% • Mean LSI at 16 weeks post ACLR = 82.2-83.1% • Mean LSI at 22 weeks post ACLR = 88.3%

SINGLE LIMB 6-M HOP TEST FOR TIME	
ICF category	Measurement of activity limitation – jumping
Description	The amount of time a subject hops on one leg a distance of 6-m as quickly as possible.
Measurement method	The subject stands on the uninvolved leg, with his toe on the starting line. After the examiner's command of "Ready, set, go", timing begins with a stopwatch accurate to 0.01 seconds. The subject hops the 6-m distance as quickly as possible with the test leg. The testing stops when the subject crosses the 6-m finish line. The subject performs two practice hops and performs 2 recordable hops. Testing is repeated on the involved limb while wearing a functional knee brace.
Nature of variable	Continuous
Units of measurement	Seconds
Measurement properties	Test-retest reliability • Healthy individuals: ICC=0.93, SEM=0.06 sec[92] • Mean time: 1.82-1.86 sec LSI reliability in patients with ACL reconstruction[86] • ICC=0.82 • Minimal Detectable Change = 12.96% • Mean LSI at 16 weeks post ACLR = 81.7-83.2% • Mean LSI at 22 weeks post ACLR = 89.6%

PHYSICAL IMPAIRMENT MEASURES

MODIFIED STROKE TEST	
ICF category	Measurement of impairment of body structure – Knee joint
Description	The amount of fluid in the knee joint measured by visual inspection by clinician
Measurement method	A stroke test is performed with the patient in supine and with the knee in full extension and relaxed. Starting at the medial joint line the examiner strokes upward two or three times toward the suprapatellar pouch in an attempt to move effusion from the knee. The examiner then strokes downward on the distal lateral thigh just superior to the suprapatellar pouch toward the lateral joint line. A wave of fluid may be observed within seconds on the medial side of the knee.[3, 66, 99]
Nature of variable	Ordinal
Units of measurement	Grading Zero = No wave produced with downward stroke Trace = Small wave of fluid on the medial side of the knee 1+ = Larger bulge of fluid on the medial side of the knee 2+ = Effusion completely fills the medial knee sulcus with downward stroke or returns to the medial side of the knee without downward stroke 3+ = Inability to move the effusion out of the medial aspect of the knee
Measurement properties	The modified stroke test has a Kappa value of 0.61.[99] 72% of testing pairs had perfect agreement. 8% had a disagreement of 2 grades.
Instrument variations	Minor effusion test can be used to assess knee effusion.[19, 51] In addition to visual inspection, knee effusion can be measured using a tape measure or Perometer (an optoelectric device designed to measure limb volume) for knee circumference.[68, 103]

BULGE SIGN	
ICF category	Measurement of impairment of body structure – Knee joint
Description	The amount of fluid in the knee joint measured by visual inspection by clinician
Measurement method	The examiner, with one hand superior to the patella, pushes the tissues (and possible fluid) inferiorly towards the patella. Keeping this hand in this position while holding pressure on these tissues, press the medial aspect of the knee just posterior to the patellar edge to force any fluid within the joint laterally. Now, as you watch this medial joint area, take your hand and press quickly along the lateral (i.e., opposite) aspect of the knee, looking for a fluid wave to present medially.
Nature of variable	Nominal
Units of measurement	• Absent • Present
Measurement properties	The bulge exhibited reliability coefficient of 0.97[19] in patients with knee osteoarthritis.
Instrument variations	Minor effusion test can be used to assess knee effusion.[51] In addition to visual inspection, knee effusion can be measured using a tape measure or Perometer for knee circumference.[68, 103]

KNEE PASSIVE RANGE OF MOTION	
ICF category	Measure of impairment of body function – mobility of a single joint
Description	The amount of passive knee extension and flexion measured using a goniometer
Measurement method	For measurement using the goniometer, 1 arm of the goniometer was placed parallel to the shaft of the femur lining up with the greater trochanter, and the other arm was placed parallel to the shaft of the lower leg lining up with the lateral malleolus of the fibula. The axis of the goniometer was placed over the lateral femoral epicondyle. Knee extension: The patient is supine. The heel of the limb of interest is propped on a bolster, assuring the back of the knee and calf are not touched the support surface. The amount of knee extension is recorded with the goniometer. Knee flexion: The patient is supine. The patient flexes the knee as far as possible. The amount of knee extension is recorded with the goniometer.
Nature of variable	Continuous
Units of measurement	Degrees
Measurement properties	Passive ROM measurements for flexion and extension[84] • Validity: ICC=0.98-0.99 • Intra-examiner reliability coefficients ranging from ICC=0.85-0.99. • Inter-examiner reliability coefficients ranging from ICC=0.62 to 0.99.

KNEE ACTIVE RANGE OF MOTION	
ICF category	Measure of impairment of body function – mobility of a single joint
Description	The amount of active knee extension and flexion measured using a goniometer
Measurement method	For measurement using the goniometer, 1 arm of the goniometer was placed parallel to the shaft of the femur lining up with the greater trochanter, and the other arm was placed parallel to the shaft of the lower leg lining up with the lateral malleolus of the fibula. The axis of the goniometer was placed over the lateral femoral epicondyle. Knee extension: The patient is supine. The heel of the limb of interest is propped on a bolster, assuring the back of the knee and calf are not touched the support surface. The patient is asked to actively contract the quadriceps. The amount of knee extension is recorded with the goniometer. Knee flexion: The patient is supine. The patient flexes the knee as far as possible. The amount of knee extension is recorded with the goniometer.
Nature of variable	Continuous
Units of measurement	Degrees
Measurement properties	Intra-examiner ICC for active extension and flexion was 0.85 and 0.95, respectively.[20]

KNEE JOINT LINE TENDERNESS			
ICF category	Measure of impairment of body function – pain in joint		
Description	The amount of tenderness present in the medial and lateral joint lines of the knee joint		
Measurement method	The examiner palpates the medial and lateral joint lines of the knee joint. The presence of tenderness is recorded.		
Nature of variable	Nominal		
Units of measurement	• Absent • Present		
Measurement properties	Diagnostic Accuracy[55, 75]		
			95% CI*
	Sensitivity[75]	76%	73-80%
	Medial Meniscus[55]	83%	71-90%
	Lateral Meniscus[55]	68%	46-85%
	Specificity[75]	77%	64-87%
	Medial Meniscus[55]	76%	55-89%
	Lateral Meniscus[55]	97%	89-99%
	Positive Predictive value[55]		
	Medial Meniscus	91%	81-96%
	Lateral Meniscus	87%	62-96%
	Negative Predictive value[55]		
	Medial Meniscus	59%	41-75%
	Lateral Meniscus	91%	82-96%
	Diagnostic accuracy[55]		
	Medial Meniscus	81%	71-88%
	Lateral Meniscus	90%	82-95%
	Negative Likelihood ratio[55]		
	Medial Meniscus	0.2	0.2-0.3
	Lateral Meniscus	0.3	0.2-0.4
	Positive Likelihood ratio[55]		
	Medial Meniscus	3	2-5
	Lateral Meniscus	22	8-64
	Diagnostic Odds ratio[75]	10.98	3.02-39.95
	Medial Meniscus[55]	15	5-50
	Lateral Meniscus[55]	68	12-376

*CI – Confidence Interval

McMURRAY'S TEST			
ICF category	Measure of impairment of body function –mobility in a joint		
Description	A palpable or audible thud or click during McMurray's test		
Measurement method[93]	The patient is supine. The examiner grasps the ankle of the index limb with one hand. The opposite hand is placed on the index knee with the thumb in the lateral joint line and the middle finger in the medial joint line. The knee is maximally flexed, externally rotated and then slowly extended to assess the medial meniscus; internal rotation to evaluate the lateral meniscus.		
Nature of variable	Nominal		
Units of measurement	• Absent • Present		
Measurement properties	Diagnostic Accuracy[55, 75]		
			95% CI
	Sensitivity[75]	55%	50-60%
	Medial Meniscus[55]	50%	38-62%
	Lateral Meniscus[55]	21%	9-43%
	Specificity[75]	77%	62-87%
	Medial Meniscus[55]	77%	57-90%
	Lateral Meniscus[55]	94%	85-98%
	Positive Predictive value[55]		
	Medial Meniscus	86%	71-94%
	Lateral Meniscus	50%	22-78%
	Negative Predictive value[55]		
	Medial Meniscus	35%	23-50%
	Lateral Meniscus	80%	70-88%
	Diagnostic accuracy[55]		
	Medial Meniscus	57%	46-67%
	Lateral Meniscus	77%	67-85%
	Negative Likelihood ratio[55]		
	Medial Meniscus	0.6	0.6-0.7
	Lateral Meniscus	0.8	0.8-1.0
	Positive Likelihood ratio[55]		
	Medial Meniscus	2	1-3
	Lateral Meniscus	3	0.3-35
	Diagnostic Odds ratio[75]	3.99	1.04-15.31
	Medial Meniscus[55]	3	1-10
	Lateral Meniscus[55]	4	0.9-18
Testing variation	A varus or valgus stress during the McMurray's test to reproduce thud or click. Isolated re-creation of pain constitutes a positive test.		

THESSALY'S TEST			
ICF category	Measure of impairment of body function – pain in joint and mobility of a joint		
Description	Discomfort or a sense of locking or catching in the knee in either the medial or lateral joint line		
Measurement method[93]	The patient is standing. The patient is instructed to stand on the index limb. The patient can be supported by holding his outstretched hands during the test. The patient rotates his knee and body internally and externally three times with the knee in variable degrees of flexion.		
Nature of variable	Nominal		
Units of measurement	• Absent • Present		
Measurement properties	Diagnostic Accuracy[55, 93]		
	<u>5° knee flexion</u>		<u>95% CI</u>
	Sensitivity		
	Medial Meniscus	41-66%	
	Lateral Meniscus	16-81%	
	Specificity		
	Medial Meniscus	68-86%	
	Lateral Meniscus	89-91%	
	Positive Predictive value		
	Medial Meniscus	77%	60-89%
	Lateral Meniscus	30%	11-60%
	Negative Predictive value		
	Medial Meniscus	31%	20-45%
	Lateral Meniscus	77%	66-85%
	Diagnostic accuracy		
	Medial Meniscus	49-86%	
	Lateral Meniscus	71-90%	
	Negative Likelihood ratio		
	Medial Meniscus	0.9	0.8-1.0
	Lateral Meniscus	1.0	0.8-1.0
	Positive Likelihood ratio		
	Medial Meniscus	1.0	1-2
	Lateral Meniscus	1.0	0-59
	Diagnostic Odds ratio		
	Medial Meniscus	2	1-4
	Lateral Meniscus	1	0.3-6
	<u>20° knee flexion</u>		<u>95% CI</u>
	Sensitivity		
	Medial Meniscus	59-89%	
	Lateral Meniscus	67-92%	
	Specificity		
	Medial Meniscus	83-97%	

	Lateral Meniscus	95-96%	
	Positive Predictive value		
	Medial Meniscus	83%	69-92%
	Lateral Meniscus	66%	35-88%
	Negative Predictive value		
	Medial Meniscus	37%	23-53%
	Lateral Meniscus	81%	71-89%
	Diagnostic accuracy		
	Medial Meniscus	61-94%	
	Lateral Meniscus	80-96%	
	Negative Likelihood ratio		
	Medial Meniscus	0.6	0.5-1.0
	Lateral Meniscus	0.7	0.6-1.0
	Positive Likelihood ratio		
	Medial Meniscus	2	1-2
	Lateral Meniscus	6	2-25
	Diagnostic Odds ratio		
	Medial Meniscus	3	1-8
	Lateral Meniscus	9	2-40

CLINICAL GUIDELINES

Interventions

A variety of interventions have been described for the treatment of knee pain and mobility impairments associated with meniscal or cartilage tears. A limited amount of evidence for high-quality randomized, controlled trials and systematic reviews exists to support the benefits of physical therapy interventions in these patients.

PROGRESSIVE KNEE MOTION

IV

Haapala et al[33] and Haapala et al[34] studied the effects of immobilization and subsequent remobilization on dogs. The right hind limbs were immobilized for 11 weeks and subsequently remobilized for 50 weeks. After immobilization the mean thickness of the medial femur was 19-20% but no changes on the lateral femur or medial tibia. Proteoglycans content was decreased by 29-44% in the medial compartment with no changes in the lateral compartment. Equilibrium shear modulus (ESM) was decreased on the summit of the lateral femur and tibia after 11 weeks of immobilization. After remobilization, ESM returned to control levels in the tibia but was still only 85% of control levels in the femur.

IV

Jurvelin and colleagues[50] studied the biomechanical properties of articular cartilage after 11 weeks of immobilization and 15 weeks of remobilization in dogs. After immobilization, cartilage thickness was reduced by 13% in the femur, 6% in the medial tibia, and 4% in the lateral tibia. Elastic modulus was decreased by 17-25%. However, equilibrium shear modulus (ESM) was still reduced as compared to controls after remobilization.

III

In a retrospective study, Rodrigo et al[89] investigated the use of continuous passive motion (CPM) in patients following debridement with microfracture. Patients (n=295) were assigned to 2 groups: CPM use or non-CPM use. Patients were not randomized into groups, but usually placed into groups based on insurance coverage for the use of CPM. Patients in the CPM use groups utilized a CPM machine 6 to 8 hours per day for 8 weeks. Patients in the non-CPM use were advised to perform intermittent active extension and flexion of the operated knee several hundred repetitions 3 times per day. Seventy-seven patients underwent second-look arthroscopy. A satisfactory outcome of 85% was noted in patients who used a CPM with a 55% satisfactory outcome of 55% in those patients who did not use a CPM upon second-look arthroscopy.

II

In a randomized controlled clinical trial, Kelln and associates[52] investigated the use of cycle ergometer to determine if early, active ROM was beneficial to patients after partial

knee meniscectomy. Thirty-one subjects (11 males, 20 females) were divided into a control and interventional group (using cycle ergometer). They evaluated 3 different knee girth circumferences, knee ROM, gait evaluation, quality of quadriceps contraction, and 3 IKDC questionnaires pre-operatively, and day 1, weeks 1 and 2, and months 1 and 3 post-operatively. For knee girth measurements, pre-operative values were less than post-operative values. Pre-operative knee flexion values were significantly less most post-operative values, whereas pre-operative knee extension was only significantly less than post-operative day 1. The intervention group exhibited better gait patterns than the control group. For IKDC scores, pre-operative values were significantly less for all but one post-operative measures. Randomization was not clearly described.

V

Heckmann and colleagues[37] recommend the use of a hinged, long-leg brace for the first 6 weeks to be used by patients following complex meniscal repairs and transplants. These authors recommend that the brace to be opened from 0 to 90 degrees immediately after surgery but locked at 0 degrees extension at night for the first 2 weeks. This is used to prevent ROM limitations after complex meniscal repairs and transplants.

III

In a study assessing the effect of accelerated rehabilitation including no bracing in individuals following meniscus repair, Barber[7] found no significant differences between the healing rates of meniscal repairs in the standard and accelerated rehabilitation groups.

IV

Shelbourne and associates[95] reported on clinical results of accelerated rehabilitation including no bracing after isolated meniscal repair. Meniscal repair was successful in managing symptoms in 88% in the standard group and 90% in the accelerated group. The accelerated group showed a shorter time period to full ROM, higher quadriceps index at 2 months, and a more rapid return to full activity.

C

Clinicians may utilize early progressive knee motion following knee meniscectomy and meniscal repair surgery.

PROGRESSIVE WEIGHT BEARING

III

Barber[7] investigated the effects of accelerated rehabilitation in individuals who underwent meniscus repair using a minimum of a12-month follow-up. A total of 95 patients were included in the study. The standard rehabilitation group (n=58 meniscal

repairs) consisted of immobilization with a brace in a flexed position for 6 weeks, and non-weight bearing up to 12 weeks. When the brace use was terminated, an exercise program was initiated and pivoting sports were restricted for 6 months post-surgery. The accelerated rehabilitation group (n=40 meniscal repairs) consisted of no bracing, no limits in range of motion, and full weight bearing as tolerated. Return to all activities including pivoting sports was permitted as soon as desired. Failure of a meniscal repair was defined as incomplete healing noted at second-look arthroscopy or objective signs of meniscal tear. In the standard group, an 84% success rate was noted in acute tears that were repaired (n=43), 73% in chronic tears that were repaired (n=15), 67% success rate in meniscal repairs in unstable knees (n=15), 77% in knees with intact ACLs (n=13), and 90% success rate in knees that were stabilized after ACL reconstruction (n=30). In the accelerated group, an 83% success rate in acute tears that were repaired (n=23), 100% in chronic tears (n=16), 50% success in unstable knees (n=2), 75% with intact ACLs (n=4), and 94% success rate in knees that were stabilized after ACL reconstruction (n=34). No significant differences were seen between the healing rates of meniscal repairs in the standard and accelerated rehabilitation groups.

IV

Shelbourne et al[95] reported on clinical results of accelerated rehabilitation after isolated meniscal repair. Sixty-nine patients with isolated meniscal repairs were included in this study. Rehabilitation in the standard group consisted of limited ROM and weight bearing until 6 weeks after repair and patients and were restricted from returning to sporting activity until after 4 months. The accelerated rehabilitation group consisted of immediate weight bearing as tolerated, early mobilization with emphasis on prevention of knee effusion and patients could return to sports when full ROM was achieved, 75% strength index, and completion of functional running program. Meniscal repair was successful in managing symptoms in 88% in the standard group and 90% in the accelerated group. The accelerated group showed a more rapid return in full ROM (6 weeks in the accelerated group vs. 10 weeks in the standard group), a higher quadriceps index at 2 months (82% in the accelerated group vs. 71% in the standard group), and an accelerated return to full activity (10 weeks in the accelerated group vs. 20 weeks in the standard group). However, randomization and statistical analysis was not reported in the clinical results.

V

In a clinical commentary, Heckmann et al[37] recommends that patients who undergo peripheral meniscal repairs to be partial weight bearing for the first 2 weeks and progress to full weight bearing at 3-4 weeks post surgery. They recommend that patients who undergo complex meniscal repairs or transplantations restrict their weight bearing for the first 6-8 weeks. This limitation is designed to control high compressive and shear forces that could disrupt the healing meniscus repair or transplant.[37]

V

In a clinical commentary by Irrgang and Pezzullo[44] and Buckwalter[14], articular cartilage healing may benefit from compression of the articular cartilage lesions without

concomitant shear stress, whereas premature, or excessive loading, especially with shear forces during compression, may impede or inhibit healing.

D

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

PROGRESSIVE RETURN TO ACTIVITY

III

Barber[7] studied the effects of accelerated rehabilitation in individuals who undergo meniscus repair at a minimum of 12-month follow-up. Fifty-six patients were placed in the standard rehabilitation group consisted of immobilization with a brace in a flexed position for 6 weeks. When the brace use was terminated, an exercise program was initiated and pivoting sports were restricted for 6 months post-surgery. Thirty-nine patients were placed in the accelerated rehabilitation group consisted of no bracing, no limits in range of motion, and full weight bearing as tolerated. Return to all activities including pivoting sports was permitted as soon as desired. Failure of a meniscal repair was defined as incomplete healing noted at second-look arthroscopy or objective signs of meniscal tear. In the standard group, 7 of 43 failed in acute tears that were repaired, 4 of 15 chronic tears that were repaired failed, 5 of 15 repairs in unstable knees failed, 3 of 13 failed in knees with intact ACLs, and 27 of 30 repairs in knees that were stabilized after ACL reconstruction were considered successful. In the accelerated group, 4 of 23 were failures in acute tears that were repaired, 0 of 16 were failures in chronic tears, 1 of 2 were failures in unstable knees, 1 of 4 were failures with intact ACLs, and 2 of 34 were failures in knees that were stabilized after ACL reconstruction. No significant differences were seen between the healing rates of meniscal repairs in the standard and accelerated rehabilitation groups.

IV

Shelbourne et al[95] described the results of clinical outcomes of accelerated rehabilitation after isolated meniscal repair. Sixty-nine patients with isolated meniscal repairs were included in this study. Rehabilitation in the standard group consisted of limited ROM and full weight bearing until 6 weeks after repair and patients were allowed to return to sporting activity after 4 to 6 months. The accelerated rehabilitation group consisted of immediate weight bearing as tolerated, early mobilization with emphasis on prevention of knee effusion and patients could return to sports when full ROM was achieved, 75% strength index, and completion of functional running program. Meniscal repair was unsuccessful in managing symptoms in 12% in the standard group and 10% in the accelerated group. The standard group showed a protracted return in full ROM, a lower quadriceps index at 2 months, and a slower return to full activity.

IV

Mariani et al[69] investigated the use of accelerated rehabilitation, which included early mobilization and weight-bearing, in 22 patients with BPTB autograft ACL reconstruction and concomitant outside-in meniscal repair. Patients were reviewed by clinical assessment and MRI a mean follow-up of 28 months. 77.3% of patients reported good results. 88.9% exhibited normal knee extension. 13.6% of patients demonstrated clinical signs of meniscal retear. Based on these results, the authors concluded that accelerated rehabilitation in these patients had no deleterious effects.

C

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

SUPERVISED REHABILITATION

II

Moffet et al[77] conducted a randomized controlled trial on the efficacy of an early, intensive, supervised rehabilitation program on knee strength recovery in the first 3 weeks post-meniscectomy. Strength measurements were performed pre-operatively and 3 weeks post surgery. They demonstrated that patients that received 9 supervised physical therapy visits had better knee extensor strength recovery than patients that only received a home-based program ($p < 0.001$). In a subgroup analysis matched based on pre-operative deficits, the home-based group deficits were as large as 26% of the supervised group at 3 weeks post meniscectomy.

II

Vervest et al[106] randomized 20 patients into two groups: home-based group and supervised exercise group. Distance and height of single limb hops, pain, Tegner and Lysholm scores, and sports and occupational rating scales were measured at 7, 14, 21, and 28 days post meniscectomy. At 28 days post surgery, the supervised exercise group was significantly better than the home-based group regarding Sports Activity Rating scale and hop tests. However, no differences were noted in functional outcomes, pain, or patient satisfaction.

II

In a randomized controlled trial, Goodwin et al[30] randomly assigned 84 patients to either a supervised program with a home program or a home program alone. Blinded sessions were conducted at 5 and 50 days post surgery. The examined patients' self-reported outcomes with the Hughston Clinic, Medical Outcomes Study SF-36, the EuroQol EQ-5D questionnaires, and the number of days to return to work after surgery divided by the Factor Occupational Rating System score. Functional performance was measured with vertical and horizontal hope. The authors demonstrated no differences in outcome measures or return to work between patients who received a home-based program and patients who received supervised physical therapy along with a home program. This study only consisted of immediate follow-up.

B

Clinicians should consider a clinic-based program in patients following meniscectomy to increase quadriceps strength and functional performance.

NEUROMUSCULAR REEDUCATION

II

Ericsson et al[24] studied the effects of multimodal functional exercise program on performance and muscle strength in patients who had undergone meniscectomy between 1 and 6 years previously. Forty-five subjects (22 in exercise group, 23 in control group) were initially evaluated. The exercise group greater improvement in single limb single hop test, hamstrings strength at 60 degrees/second, and quadriceps endurance at 180 degrees/second. All functional tests, hamstring strength and quadriceps endurance improved from baseline to follow-up in the exercise group, with no changes noted in the control group. Moderate correlations were seen between the number of supervised sessions and with single limb single hop test, and quadriceps and hamstring endurance.

C

Recommendation: Clinicians can consider neuromuscular reeducation in patients following meniscectomy to increase quadriceps strength and functional performance.

SUMMARY OF RECOMMENDATIONS

C

PATHOANATOMICAL FEATURES AND CLINICAL COURSE

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 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..

C

RISK FACTORS

Clinicians should consider time from injury and age as predisposing factors for having a meniscal injury. Patients who participated in high-level sports or had increased knee laxity after the injury are more likely to have late meniscal surgery.

C

Clinicians should consider the patients' age and presence of a meniscal tear for the odds of having a chondral lesion. Patients' age and time from injury are predictive factors of the severity of chondral lesions and time from injury is significantly associated with the number of chondral lesions.

A

DIAGNOSIS/CLASSIFICATION

Joint pain and knee effusion are useful clinical 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 tear of the articular cartilage; and the associated International Classification of Functioning, Disability, and Health (ICF) impairment-based category joint pain (b28016 Pain in joint).

B

DIFFERENTIAL DIAGNOSIS

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 not consistent with those presented in the diagnosis/classification section of this guideline, or, when the patient's

symptoms are not resolving with interventions aimed at normalization of the patient's impairments of body function.

A

EXAMINATION – OUTCOME MEASURES

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

C

EXAMINATION – ACTIVITY LIMITATION MEASURES

Clinicians should utilize easily reproducible physical performance measures, such as single limb hop tests, to assess activity limitation and participation restrictions associated with their patient's knee pain or mobility impairments and to assess the changes in the patient's level of function over the episode of care.

C

INTERVENTIONS – PROGRESSIVE KNEE MOTION

Clinicians may utilize early progressive knee motion following knee meniscectomy and meniscal repair surgery.

D

INTERVENTIONS – PROGRESSIVE WEIGHT BEARING

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

C

INTERVENTIONS – PROGRESSIVE RETURN TO ACTIVITY

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

B

INTERVENTIONS – SUPERVISED REHABILITATION

Clinicians should consider a clinic-based program in patients following arthroscopic meniscectomy to increase quadriceps strength and functional performance.

C

INTERVENTIONS – NEUROMUSCULAR REEDUCATION

Recommendation: Clinicians can consider neuromuscular reeducation in patients following meniscectomy to increase quadriceps strength and functional performance.

AFFILIATIONS & CONTACTS

AUTHORS

David S. Logerstedt, PT, MA
PhD Student
Biomechanics and Movement Sciences
University of Delaware
Newark, DE 19716
davlog@udel.edu

Lynn Snyder-Mackler, PT, ScD
Alumni Distinguished Professor
Department of Physical Therapy
University of Delaware
Newark, DE 19716
smack@udel.edu

Richard C. Ritter, PT, DPT, OCS
Asst. Clinical Professor
UCSF/SFSU Graduate Program in Physical Therapy
San Francisco, CA 94143
rcritter@comcast.net

Michael J. Axe, MD
First State Orthopaedics
4745 Ogletown-Stanton Road,
Suite 225
Newark, DE 19713
mjaxe@udel.edu

ICF Practice Guidelines Coordinator
Joseph J. Godges, DPT
ICF Practice Guidelines Coordinator
Orthopaedic Section, APTA Inc.
2920 East Avenue South, Suite 200
La Crosse, WI 54601
icf@orthopt.org

REVIEWERS

Roy D. Altman, MD
Professor of Medicine
Division of Rheumatology and Immunology
David Geffen School of Medicine at UCLA

Los Angeles, California
journals@royaltman.com

Constance R. Chu, MD
Albert B. Ferguson, Jr. MD Endowed Chair Associate Professor
Director of the Cartilage Restoration Program
Department of Orthopaedics
University of Pittsburgh
Pittsburgh, Pennsylvania
chucr@upmc.edu

Anthony Delitto, PT, PhD
Professor and Chair
School of Health & Rehabilitation Sciences
University of Pittsburgh
Pittsburgh, Pennsylvania
delittoa@upmc.edu

John Dewitt, DPT
Director of Physical Therapy Sports Medicine Residency
The Ohio State University
Columbus, Ohio
john.dewitt@osumc.edu

Amanda Ferland, PT
Clinic Director
MVP Physical Therapy
Federal Way, Washington
aferland@mvppt.com

Helene Fearon, PT
Principal and Consultant
Fearon & Levine
Phoenix, Arizona
helenefearon@fearonlevine.com

G. Kelley Fitzgerald, PT, PhD
Associate Professor
School of Health & Rehabilitation Sciences
University of Pittsburgh
Pittsburgh, Pennsylvania
kfitzger@pitt.edu

Joy MacDermid, PT, PhD
Associate Professor
School of Rehabilitation Science
McMaster University
Hamilton, Ontario, Canada
macderj@mcmaster.ca

James W. Matheson, DPT
Minnesota Sport and Spine Rehabilitation
Burnsville, Minnesota
jw@eipconsulting.com

Philip McClure, PT, PhD
Professor
Department of Physical Therapy
Arcadia University
Glenside, Pennsylvania
mcclure@arcadia.edu

Paul Shekelle, MD, PhD
Director
Southern California Evidenced-Based Practice Center
Rand Corporation
Santa Monica, California
shekelle@rand.org

A. Russell Smith, Jr., PT, EdD
Chair
Athletic Training & Physical Therapy
University of North Florida
Jacksonville, Florida
arsmith@unf.edu

Leslie Torburn, DPT
Principal and Consultant
Silhouette Consulting, Inc.
Redwood City, California
torburn@yahoo.com

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