REVIEW ARTICLE

Knee Pain in Adults with an Osteopathic Component

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The incidence of knee pain is increasing due to the rising prevalence of obesity, sedentary lifestyles, and aging baby boomer population in the United States. Both acute and chronic knee conditions can result in the increased utilization of pain medications and a decreased quality of life. A multimodal approach to knee pain management can thus greatly benefit the patient population and decrease the burden of knee conditions on the healthcare system. This article presents the epidemiology, clinically relevant anatomy, physiology and major risk factors associated with common knee pain conditions. An overview of etiologies is presented in terms of major clinical presentation, diagnostic testing, and treatments. Practical guidelines for an osteopathic approach to the examination and diagnosis of knee pain are then discussed, with a focus on the osteopathic structural exam and the use of special tests to discern and localize soft tissue injury. A novel diagnostic algorithm summarizing a step-by-step approach to a patient with knee pain is also presented. This method integrates the physical exam, special tests, lab work, and imaging to formulate an evidence-based protocol for formulating a knee pain diagnosis. Finally, the article presents management strategies for common causes of knee pain including conservative, pharmacologic, manipulative, and alternative/complementary treatments. Evidence-based recommendations for manipulation efficacy are reviewed from meta-analysis data, randomized controlled trials, and a case report. The article also provides a description of commonly used manipulation techniques and their indications with respect to the anatomic location of knee pain and its underlying etiology.

INTRODUCTION & EPIDEMIOLOGY

Knee pain is among the most commonly cited reasons for outpatient doctor visits, accounting for over 1.9 million visits annually.[1] The aging population of the United States and the obesity epidemic have contributed to a nearly twofold increase in the incidence of symptomatic knee conditions over the past decade. Today, over one-half of adults in the U.S. can expect to experience clinically significant knee pain within their lifetime and over 25% are currently affected.[2,3] While age, overuse, and trauma are the most common etiologies, rheumatologic, infectious, vascular, and referred causes also contribute to the clinical picture.[1] Osteoarthritis of the knee results in more than $28 billion dollars in annual health care costs and is among the top 5 leading causes of disability in the United States.[4,5]

The individual and societal costs of knee pain, along with the debilitating long-term consequences, make diagnosis and effective management a top priority for a primary care physician. This paper presents an osteopathic approach to the diagnosis and treatment of knee pain in the primary care setting, with a focus on etiologies, clinical presentations, diagnostic strategies, and treatment. Major anatomical, biomechanical, and environmental considerations are also discussed. Finally, a summary of evidence-based studies investigating the effectiveness of Osteopathic Manipulative Treatment (OMT) and other non-pharmacologic treatments in the management of common knee conditions is presented.

BIOMECHANICS

In order to discern the etiology of knee pain and injury, it is important to understand the normal anatomy of the knee. The knee joint is a complicated articulation and the largest joint of the body with a normal range of motion (ROM) of 0 degrees extension, 140 degrees flexion, and 8 to 12 degrees rotation.[6,7] The knee joint is enclosed within a synovial capsule and functions as a complex hinge joint with three articulations: the medial and lateral femorotibial articulations, and the patellofemoral articulation.[6,8] The knee also has 6 degrees of motion which contribute to its instability and should be considered during evaluation: (1) flexion/extension, (2) internal/external rotation, (3) varus/valgus, (4) anterior/posterior translation, (5) medial/lateral translation, and (6) compression/distraction.[6,8] There are variants of these motions that can be considered normal or abnormal depending on the patient. Genu valgus for example is a posture where the feet are spread apart but the knees are close together. This is more commonly found as normal in women, but can be abnormal based on the joint pathology causing this. Genu varus is the opposite and is when the feet are close together but the knees are far apart. This is rarely normal and is

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sometimes correlated with rickets.[6] It is also important to understand that knee joint stability is reliant on foot biomechanics, which can absorb mechanical stress from ground contact and can impact postural alignment at the knee joint.[4] Therefore, patients with flat feet (pes planus) or who have a high arch (pes cavus), are more likely to get knee pain and medial tibiofemoral cartilage damage.[41] Knee joint stability is conferred mainly by the soft tissues of the capsule: ligaments, tendons, and menisci.[7,8] The ligaments confer static stability to the knee joint, while the muscles and tendons provide dynamic stability during motion.[8] Furthermore, the knee can be divided into four compartments: anterior, posterior, medial, and lateral. This classification has both anatomical and clinical implications.

RELEVANT ANATOMY

The medial aspect of the knee is the most commonly injured compartment in knee pain.[9] It contains the medial collateral ligament (MCL), which is the most commonly injured ligament in the knee, the medial meniscus, and the medial patellofemoral (MPFL) ligament.[10] The muscles of the compartment are the semimembranosus, sartorius, gracilis, and semitendinosus. The latter three form a conjoined insertion onto the anteromedial tibia, which is commonly implicated clinically in pes anserinus tendonitis and bursitis. The MCL is the primary resistor to valgus strain, and is commonly injured by lateral blows to the knee. The MPFL is the primary stabilizer of lateral patellar motion and is often involved in patellar dislocations, which are more common in females due to an increased Q-angle. The Q-angle is a measurement of the angle between the quadriceps muscle and the patella tendon. A high Q-angle on physical exam means that the patella has abnormal movement over the front of the knee joint, which overtime can lead trauma to the posterior cartilage of the patella. Finally, the medial compartment contains three bursae: the medial gastrocnemius bursa, the anserine bursa, and the semimembranosus bursa. If injured, the bursae can swell and produce localized tenderness on physical exam.

The anterior aspect of the knee is the second most common region involved in knee pain.[9] The anterior compartment contains the patellofemoral articulation, composed of the quadriceps tendon, the patella, the patellar tendon, and additional patella-stabilizing ligaments. These are individually involved in conditions like tendinitis, Osgood Schlatter, and Sinding-Larsen-Johansson syndrome. Tendinitis is the inflammation of a tendon and can be either patellar or quadriceps in this case. Osgood Schlatter and Sinding-Larsen-Johansson are both conditions that affect teens during growth, but involve inflammation of different attachments points of the patella tendon. All of these ligaments and tendons are collectively involved in patellofemoral syndrome. In addition, this compartment contains the anterior cruciate ligament (ACL), the intermeniscal ligament, and the bursae. The ACL is the main stabilizer to anterior translation of the tibia.. It's commonly associated with non-contact pivoting injuries.[10] This is often seen with athletes who compete in sports like soccer that involve sudden deceleration, landing and pivoting maneuvers. The anterior compartment also contains five bursae: pretibial, suprapatellar, subcutaneous, deep infrapatellar, and prepatellar. The prepatellar bursa is the most common bursa involved in injury of the knee.

The posterior compartment is comprised of the posterior cruciate ligament (PCL), meniscofemoral ligament, and the oblique popliteal ligament. In terms of muscles it is made up of the popliteus, gastrocnemius, and plantaris muscles. The PCL is the primary resistor to posterior translation of the tibia and is among the least injured ligaments of the knee.[10] Most posterior compartment pain is not associated with direct structural injuries, but with effusions present within the knee. An effusion in the back of the knee is often aggravated by flexion and can result in the posterior displacement of fluid and the formation of a baker's cyst. Posterior or popliteal pain can also result from extra articular causes such as deep vein thrombosis (DVT) and popliteal artery aneurysms.

The lateral compartment of the knee is less commonly implicated in knee pain[10] and contains the lateral collateral ligament (LCL), lateral meniscus, popliteofibular ligament (PFL), and arcuate ligament. The muscles of the lateral compartment include the iliotibial band (ITB) and biceps femoris. Pain along the lateral joint line is most often associated with lateral meniscal or LCL injuries, while pain localized over the lateral femoral condyle is characteristic of ITB syndrome. The lateral compartment also contains three bursae: the lateral gastrocnemius bursa, fibular bursa, and fibulopopliteal bursa.

RISK FACTORS

The risk factors for knee pain vary by etiology, but can generally be divided into modifiable and non-modifiable. Major modifiable risk factors are excess body mass, joint injury (trauma, sports, intense exercise), muscle weakness, structural malalignment, and occupation.[11-13] Non-modifiable risk factors include gender, age, race, and genetic predisposition.[12-15] Addressing modifiable risk factors via weight loss, bracing, strengthening exercises, and activity modification is often the initial treatment goal in non-traumatic knee pain presentations.

It is important to understand the most common presentations and etiologies of knee pain in the primary care setting in order to successfully arrive at a diagnosis using the minimum amount of resources. Table 1 *(page 29 and 31)*.[9,16-19] lists the clinical presentations and treatment strategies for the majority of knee pain etiologies encountered by the primary care practitioner.

OSTEOPATHIC STRUCTURAL EXAM/CLINICAL APPROACH

The osteopathic approach to treating a patient with knee pain incorporates osteopathic manipulative treatment (OMT) into a comprehensive treatment plan that may include medication, rehabilitative exercises, nutrition, surgical procedures, and lifestyle counseling. Through proper education on health promotion and disease prevention, osteopathic medicine emphasizes the overall wellness of its patients. The added benefit of hands on manipulation allows osteopathic physicians to address the shift in homeostasis that can occur in any pathology. This allows them to accelerate the healing process through natural means and develop a more therapeutic relationship with their patients.[20]

Knee pain is a common reason for both outpatient and emergency room visits depending on its severity. Since there is a wide differential for knee pain, osteopathic physicians use a combination of a detailed history and osteopathic structural exam to ascertain potential causes and treatments to alleviate pain. When taking a history of a patient with knee pain, it's important to focus on its origin, duration, and possible connection to trauma or other high-

risk activities. Traumatic injuries are most often elicited based on history and can be confirmed by physical exam findings. The need for radiographic studies to rule out a fracture may be determined by the Ottawa knee rules (see Management).[16] If a patient meets at least one criterion and is positive for a fracture on X-ray, they should be referred to an orthopedic or sports medicine specialist. However, if the x-ray is negative or a patient does not meet the criteria, special tests *(Table 2, page 32)*[6,44] should be performed to rule out ligamentous and meniscal injury. This is where a thorough physical exam is the most important, as it determines if a physician should refer their patient for an MRI or follow up with conservative treatment. The most common cause of acute knee pain, which should be considered if imaging and special tests are negative, is a sprain or strain.[16] For older patients with chronic knee pain, a physician should consider osteoarthritis high on the differential *(Table 1, Figure 1 - page 30)*.

Patients with knee pain can also present with a joint effusion for which they may need an arthrocentesis. Various etiologies such as soft tissue injuries, fracture, septic arthritis, infectious, autoimmune, crystalline deposits, and tumors can lead to this clinical presentation (Table 1). Evidence of inflammation in the synovial fluid can indicate a more serious cause, while the lack of inflammation can point to a strain or sprain.[16] If the patient's history is suspicious for autoimmune disease, serum markers should be obtained. If a physician is unable to diagnose the underlying cause of the patient's knee pain and conservative management is unsuccessful, they should consider referral to sports medicine, orthopedics or rheumatology based on the clinical history.

When evaluating a patient with knee pain, it is important for osteopathic physicians to perform a thorough osteopathic structural exam. This includes closely observing the patient's gait throughout the visit and noting any signs of discomfort. Patients with knee pain often present with a limp because they are unable to bear weight on one or both knees. Such a drastic change in gait may suggest an alteration in the patient's knee function due to the loss of muscular or ligamentous support.[6] Considering the interrelatedness between anatomical structures and function, landmarks as well as surrounding musculature and fascia should be palpated for any tissue texture changes.[6] Other potential causes should always be considered like leg length discrepancies, functional muscle imbalances and Q angle It is also important to diagnose somatic dysfunctions within the lower extremity and throughout the rest of the body. Somatic dysfunctions in proximal regions like the hip can often lead to the body compensating elsewhere in order to maintain normal gait and posture. This can lead to referred pain in areas like the lower back or the knee. Diagnosing and treating all somatic dysfunctions throughout the body is hence critical before a patient's knee pain can be directly attributed to the knee itself.

MANAGEMENT

Conservative management should be initiated in the majority of cases of knee pain presenting in the primary care setting. The level of clinical suspicion for a fracture can be assessed using the Ottawa Knee Rules and confirmed with plain film x-rays.[17,18] The Ottawa Knee rules are highly sensitive, evidence-based guidelines dictating that an x-ray is required in a patient with acute knee injury only if one or more of 5 criteria are met: Age 55 years or older; tenderness at head of fibula, isolated tenderness of the patella, inability to flex to 90 degrees, and inability to bear weight on the leg (take 4 steps) immediately following injury and in the emergency department. Patients who are older tend to have more fragile bones and are more likely to have fractures. The other criteria are based on common symptoms seen in acute knee fractures.[18] Surgical referral should be considered in the presence of specific types of ligamentous or meniscal injury, if the patient is young or an athlete, if meniscal injury results in locking of the knee due to a displaced fragment, or if a high degree of instability is present.[19] Immediate treatment of acute knee injury should begin with the application of "RICE"- rest, ice, compression, and elevation. Next, a combination of pharmacologic and non-pharmacologic treatments may be integrated to reduce inflammation and pain, strengthen the affected muscle groups, and correct somatic dysfunctions (see Treatments in Table 1).[21]

PHARMACOLOGIC MANAGEMENT

Appropriate pharmacologic management is critical for acute ligamentous injuries and chronic degenerative conditions such as osteoarthritis. For short-term pain relief in patients with acute knee injuries, non-selective, non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen or naproxen (first-line) and tramadol (second-line) may be used. Long-term pain management for osteoarthritis may begin with acetaminophen and progress to selective NSAIDs, such as celecoxib, as the disease advances. Topical NSAIDs are advantageous for chronic use due to higher selectivity and less GI side effects when compared to oral NSAID regimens. Topical Capsaicin, a naturally derived compound from chili peppers relieves pain by reduced sensitivity and analgesia. Other natural remedies that can be used for knee pain include turmeric, ginger tea, and epsom salt soak.[21] Corticosteroid injections provide effective temporary relief in moderate to severe degenerative disease and are most effective when local inflammation is present as indicated by erythema or synovial effusion.[22,23] Opiates may be used in chronic pain refractory to all other types of therapy. Narcotic medications should always be used at the minimum effective dose, in conjunction with acetaminophen or NSAIDs. Transdermal patches may be preferable for patients who take numerous medication or have esophageal irritation. It is important to be aware of the side effects and drug interactions of opioid medications. The most serious side effect is respiratory depression, especially pronounced if opioid use is concurrent with benzodiazepines or ethanol.[21]

NON-PHARMACOLOGIC MANAGEMENT

Combinations of manual therapy (OMT and PT) with supervised exercise have been shown to decrease pain and improve functioning in patients suffering from a variety of chronic knee pain conditions.[24,25,26,27] The most common conditions for which non-pharmacologic management is used are osteoarthritis (OA) and patellofemoral pain syndrome (PFPS). A study by Deyle[28] showed that a combination of manual therapy applied to the lumbar spine, ankle, and pelvis yielded a significant functional benefit in patients with OA of the knee as well as delayed the need for surgery.[29] The strengthening of the quadriceps muscle was shown to improve joint stability and significantly decrease pain.[28,29] Studies have also revealed that there is some gluteal muscle strength weakness in those with patellofemoral pain syndrome, and hence gluteal strengthening can be an effective treatment.[30,31] Pinto[32] found that exercise therapy and manual therapy were more cost effective when compared to pharmacological therapy for OA of the knee.

TABLE 1:

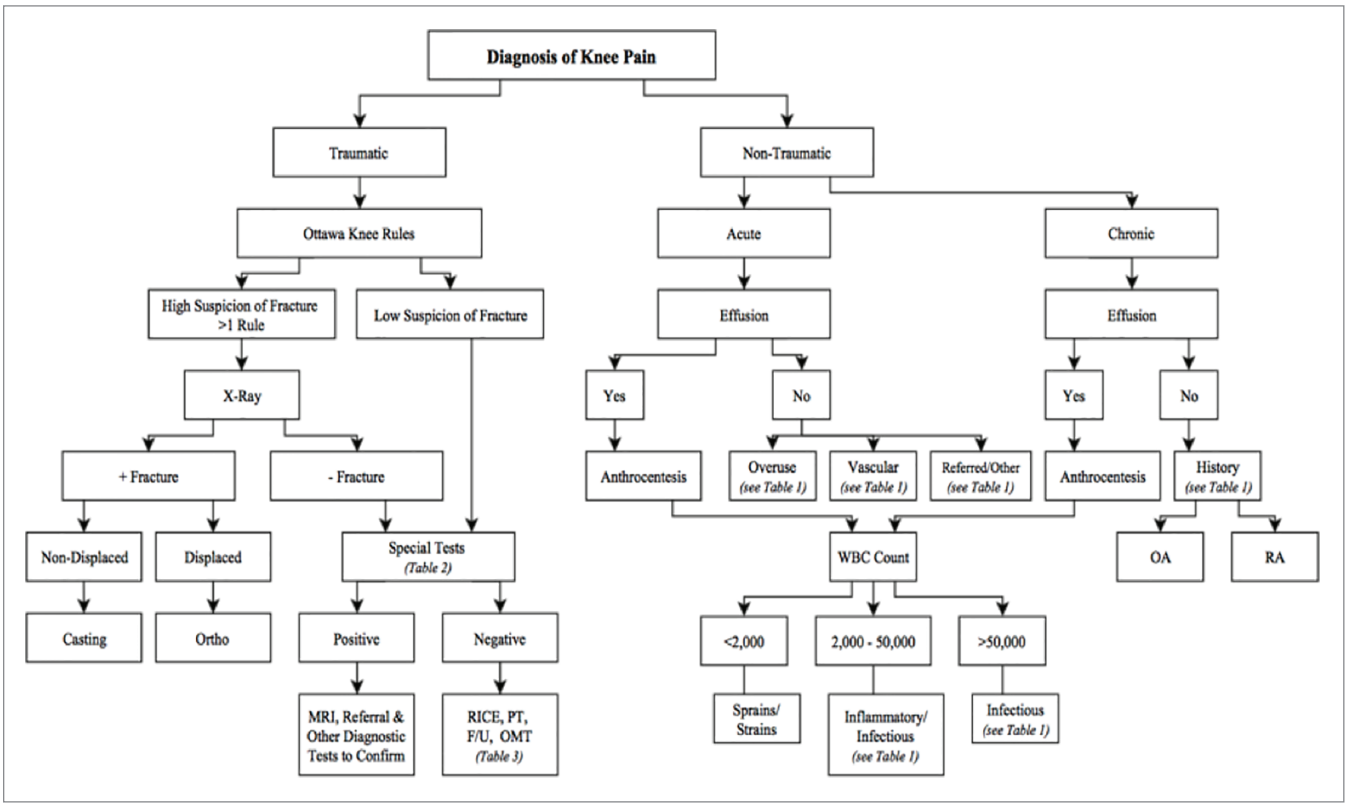
Etiologies, Diagnosis, and Treatment of Knee Pain

		Clinical Presentation	Diagnosis	Treatment
Trauma	Knee Fracture	Axial loading / falls onto flexed knee. Limited ambulation.	Radiographs. Assess neurovascular integrity	Non-displaced Fracture: Casting Displaced Fracture: Surgery
	Patellar Dislocation	Noticeable deformity, retinacular pain, inability to flex knee	Patella apprehension test. Radiographs	Patellar reduction with casting
	MCL / LCL	Medial or lateral pain and swelling with focal tenderness	Valgus / Varus stress tests, Radiograph / MRI	PRICE, NSAIDs, Brace, Surgical Correction
	ACL / PCL	"Pop" / Deep pain / Immediate swelling / Weakness / Instability	Lachman, Pivot shift, Anterior / Posterior drawer / MRI	PRICE, NSAIDs, Brace, Surgical Correction
	Meniscal Injuries	Medial / lateral pain / tenderness catching / locking / popping	Thessaly / McMurray / Apley tests / X-ray / MRI	PRICE, NSAIDs, PT, Activity Modification, Surgery
	Osteochondral Lesions / Osteochondritis Dessicans	Dull pain/ mild locking or clicking of the knee	X-ray/ MRI	PRICE, NSAIDS, PT, Brace, Surgical Correction
Overuse	Popliteus Tendinitis	Posterolateral knee pain, worse with downhill running	Webb test: painful internal rotation with 20-30 degrees of knee flexion	RICE, Quadriceps strengthening
	Patellar Tendinitis	Pain at inferior pole of the patella exacerbated by jumping	Focal patellar pain with activity	RICE, cryotherapy
	Iliotibial Band Syndrome	Lateral knee pain radiating towards hip; common in runners	Ober Test: abduct / adduct leg with hip hyperextended	RICE, iliotibial tract stretch; lateral wedge if heel is varus
	Patellofemoral Syndrome	Chronic, aching anterior bilateral pain with flexion; instability	Theatre sign; Pain with squatting and patellar compression	PRICE OMM, quadriceps & gluteus strengthening, tape, orthoses
	Bursitis (Pes anserinus pain syndrome (PAPS))	Medial knee pain along proximal tibia worse with ascending / descending stairs	Focal tenderness at bursa without swelling/induration	PRICE; hamstring and quad strengthening
	Bursitis (Pre-Patellar) Housemaid's Knee	Pain/swelling anterior to patella; History of direct pressure from repetitive kneeling	Fluctuant subcutaneous swelling anterior to lower patella;	PRICE
	Synovial Effusion	Tightness and extra-articular swelling anterior to patella	Arthrocentesis / Synovial fluid analysis	Fluid removal; treat underlying cause
Age / Rheumatic	Osteoarthritis	Insidious, bilateral swelling, pain with use, crepitus, and decrease ROM, stiffness	Weight bearing X-rays, joint narrowing, osteophyte, subchondral sclerosis	PRICE, NSAIDs, Weight loss, Lifestyle modifications, Total knee replacement if refractory
	Rheumatoid Arthritis	Morning stiffness > 1 hour, polyarticular swelling	Serum rheumatologic assays	Medications, PT, OT, Surgery if needed
	Gout	Swelling and tenderness often in big toe, onset of pain at night	Arthrocentesis (sodium urate crystals- treatment goal <6)	Medications (NSAIDS, Colchicine, steroids etc.)
	Pseudogout	Sudden joint pain and tenderness, often in the knee	Arthrocentesis (calcium pyrophosphate crystals)	Medications (NSAIDS, Colchicine, steroids etc.)

RICE: rest, ice, compression, and elevation; PRICE: physical therapy, rest, ice, compression, and elevation; PRICE OMM: PRICE with the additional application of OMM; PT: Physical Therapy; OT: Occupational Therapy.

FIGURE 1:

Diagnostic Algorithm for Knee Pain in the Primary Care Setting
This algorithm lists a step by step approach of how to diagnose and treat/refer a patient with knee pain as a primary care physician. While there are always rare etiologies, this covers the most common causes and how they can be ascertained based on the history.



Considering treatment options for chronic anterior knee pain (patellofemoral pain syndrome), Collins[31] presented a meta-analysis reviewing twenty-seven studies investigating the effects of multimodal physiotherapy, manual therapy, exercise, tape, foot orthoses, electrotherapy, and acupuncture. Evidence from the meta-analyses strongly supported the use of multimodal physiotherapy while evidence from individual studies such as Bratingham,[32] suggested only moderate clinical benefit of exercise, patella taping, foot orthoses, and acupuncture when compared to placebo.

Numerous studies have investigated OMT effectiveness in the treatment of knee pain over the last decade. Perlman[33] found statistically and clinically significant decreases in pain after application of soft tissue (myofascial) and high velocity, low amplitude (HVLA) techniques in patients with knee OA.[28] For patellofemoral pain syndrome, articulatory and myofascial techniques were found to significantly reduce pain, increase step test scores, and increase range of motion in a study by Van Den Dolder.[28,34] Suter[35] reports significant decreases in PFPS pain scores after treatment with HVLA combined with patellar mobilization, tape, exercise, and stretch.

OSTEOPATHIC APPROACH TO KNEE PAIN TREATMENT

In approaching the management of non-traumatic knee conditions, it is critical to conduct a careful exam of the knee, hip, foot and ankle joints and identify restrictions in ROM, tender points, and somatic dysfunctions (SD's). To evaluate and treat the osteopathic findings, the common principles of each technique should be applied to the area of dysfunction and treated according to the anatomic region of the knee in which the SD is found. Table 3 *(page 33 & 35)* lists the common treatments as they apply to the patient with knee pain based on their associated clinical findings and diagnoses.[6,34,38] The best studied conditions with proven OMT efficacy are osteoarthritis, patellofemoral pain syndrome and post-surgical care.[26,34]

KNEE CONDITIONS COMMONLY TREATED WITH OMT OSTEOARTHRITIS OF THE KNEE

The goals of non-pharmacologic treatment of knee OA are to control pain, improve function, and increase the patient's ability to complete activities of daily living. OMT for OA consists of HVLA, muscle energy, articulation, and myofascial release.[33,34] These techniques aim to improve arthritic pain, promote healing, and increase mobility. A study by Deyle[29] demonstrated that OMT combined with standard medical care is more effective for OA treatment than standard medical care alone. Furthermore, the authors found that the combination of manual physical therapy and supervised exercise yielded functional benefits for patients with OA in the knee and delayed the need for surgical interventions.

TABLE 1 (CONT.):

Etiologies, Diagnosis, and Treatment of Knee Pain

		Clinical Presentation	Diagnosis	Treatment
Infectious	Septic Arthritis	Febrile. One, painful, swollen joint with limited ROM	Radiographs. Assess neurovascular integrity	Non-displaced Fracture: Casting Displaced Fracture: Surgery
	Viral Arthritis	Acute onset, symmetric polyarticular joint involvement, short duration, rash	Patella apprehension test. Radiographs	Patellar reduction with casting
	Lyme Disease	Erythema migrans (early stage), nerve and cardiac symptoms (later stage), monoarthritis (late in disease)	Serological testing, Arthrocentesis if joint effusion	Antibiotics
Referred	Extrinsic Pain (myotomal, dermatomal, sclerotomal)	Non-localized knee pain with concurrent thigh / calf pain	Lumbar, sacroiliac, hip, knee and ankle exam	Address underlying case of pain
Vascular	Popliteal artery aneurysm	Claudication. Fullness or pain behind knee if large	Duplex Ultrasound	Symptomatic or > 2.0 cm- thrombolytic therapy, surgical repair
	Deep Vein Thrombosis (DVT)	Swelling, pain, erythema	Compression ultrasonography	Anticoagulant therapy, thrombolytics, IVC filter
	Hemarthrosis	Usually caused by trauma (ACL tear, fracture), immediate swelling within 2 to 4 hours	Joint aspiration if diagnosis unknown	RICE, analgesics, and arthrocentesis
Other	Tumor Osteochondroma	Painless bump near joints; pain with activity; numbness/tingling	Bony growth on X-ray; MRI/CT to confirm	Observation; Excision if symptomatic
	Popliteal (Baker's) Cyst	Fluid-filled mass within popliteal fossa	Medial popliteal mass prominent with full extension	Fluid drainage; PT; Medications: corticosteroids
	Plica	Anterior-medial knee pain; snapping with flexion/extension	Inelastic, band-like structure on palpation; redundant folds in CT on MRI	Stretching /strengthening; steroid injections; refractory: arthroscopic band resection

RICE: rest, ice, compression, and elevation; PRICE: physical therapy, rest, ice, compression, and elevation; PRICE OMM: PRICE with the additional application of OMM; PT: Physical Therapy; OT: Occupational Therapy.

PATELLOFEMORAL PAIN SYNDROME

Patellofemoral pain syndrome is a common, chronic overuse condition presenting with anterior knee pain (Table 1). Nonsurgical modalities are the primary treatment method. Collins[33] conducted a systematic review and meta-analysis on the short- and long-term efficacy of non-surgical interventions for PFPS. Interventions studied were modal physiotherapy, manual therapy, exercise, tape, foot orthoses, electrotherapy, acupuncture, and pharmacotherapy. The results of the study showed favorable effects for multimodal physiotherapy compared to other nonsurgical interventions.

POST-SURGICAL CARE

To optimize a patient's return to normal function after surgery, OMT can address preoperative musculoskeletal findings as well as somatic dysfunctions that develop during rehabilitation.[37] Anterior cruciate ligament (ACL) tear is one of the most common and debilitating knee injuries. A JAOA Case report by Gugel[38] presents a 27-year-old patient who was actively treated with OMT after undergoing ACL reconstruction. OMT was used to address specific somatic dysfunctions in the patient's neck, thoracic, and lumbar/sacrum/pelvic areas. The patient was able to return to his athletic activities without restrictions 6 months following the reconstruction.

TABLE 2:

Special Tests for Diagnosis of Knee Pain

Test	Method or Appearance	Pictures	Significance
Varus-Valgus Stress Test	Abduction/adduction motion to the proximal tibia with knee extended and flexed	 	Laxity at 30 degrees = Injury to the MCL (valgus) or LCL (varus) Laxity at 0 degrees = Injury to the MCL/LCL and PCL
Lachman Test (most sensitive)	30 degrees of flexion, one hand on tibia and other on thigh, articulate tibia anteriorly		Positive test = anterior translation of the tibia on the femur = ACL injury
Pivot Shift Test	Knee in extension. Internally rotate tibia and place valgus stress on knee		
Anterior Drawer Test	90 degrees of flexion. Translate tibia anteriorly		
Posterior Drawer Test	90 degrees of flexion. Translate tibia posteriorly		Positive test = posterior translation of the tibia = PCL injury
McMurray's Test	Monitor joint line, flex knee, internally rotate tibia and apply a varus stress while extending the knee, or externally rotate tibia and apply a valgus stress while extending the knee		Palpable click or pop and pain = medial or lateral meniscal injury
Apley's Compression Test	90 degrees of flexion, press on heel down while internally/externally rotating foot		Joint pain = medial or lateral meniscal injury
External Rotation - Recurvatum Test	Lift patient's leg by great toe while stabilizing distal thigh, 10 degrees of flexion, release calf to allow full extension		Knee hyperextended and tibia externally rotated = injury to the posterolateral corner (PCL) - fibular collateral ligament, arcuate ligament and the popliteus
Knee Joint Effusion Test (Bounce Home Test)			Knee unable to fully extend = abnormal amount of joint fluid
Patellofemoral Grind Test	Knee extended, push patella inferiorly, tell patient to contract quadriceps muscles		Increased patellar motion, pain or crepitus = Deterioration of the cartilage under the patella (possibly) patellar chondromalacia)
Thessaly Test	Patient on one leg, holding onto examiners hands for balance, patient flexes knees to 20 degrees and rotates femur on tibia medially and laterally while maintaining flexion		Medial or lateral joint line discomfort, or a sense of locking or catching of the knee = meniscus tear

TABLE 3:

OMT Treatments of Knee Pain

Technique	Region of Treatment	Clinical Findings	Diagnosis
Muscle Energy: Place bone or joint into barrier and apply isometric resistance against patient's active contraction of muscle for 3-5 sec; Repeat 3-5 times	Posterior Fibular Head	Foot inversion, forefoot adduction, tibial rotation	Symptoms of compression of peroneal nerve
	Anterior Fibular Head	Foot eversion, forefoot abduction, tibial external rotation	Lateral Knee Pain
	Tibiofemoral joint: Knee Extension /Flexion, Internal / External Rotation Somatic Dysfunction	Internal rotation of femur, external rotation of tibia (due to relaxation of popliteus)	OA, RA, Baker's Cyst
		External rotation of femur, internal rotation of tibia (due to contraction of popliteus)	
	Hip: anterior / posterior rotation, superior / inferior shear, inflare / outflare somatic dysfunction	Flexion / Extension	Extrinsic causes / Referred Pain (see Figure 2)
		Abduction / Adduction	
		Internal / External Rotation	
	Lumbar Spine	Type I SD	Neutral Group Curve
		Type II SD	Non-neutral Group Curve
Counterstrain: Position joint to shorten muscle until pain is relieved / "mobile point" is reached. Hold positioning for 90 seconds to allow for reduction in proprioceptive firing. Return joint slowly to neutral to prevent re-initiation of inappropriate firing	Anterior Patella	T.P - Patellar tendon	Patellofemoral pain syndrome
	Medial/Lateral Patella	T.P - Medial or lateral patellar surface	
	Posterior Knee	T.P - Medial or Lateral ACL	ACL/PCL injury; Gastrocnemius sprain; Popliteal (Baker's cyst); DVT
		T.P - Center of Popliteal Fossa	
		T.P - Lower popliteal fossa	
	Medial Knee	T.P - Medial Joint Line	Medial Meniscus injury, OA, pes anserine bursitis, medial plica syndrome, medial collateral ligament sprain, medial meniscal tear
		T.P - Medial hamstring muscle, distal attachment	
	Lateral Knee	T.P - Lateral joint line	Lateral meniscus injury, lateral compartment OA, lateral collateral ligament sprain, lateral meniscal injury, iliotibial band tendonitis
		T.P - Lateral hamstring, distal attachment, near fibular head	
FPR: Articulation is placed into freedoms. Compression is applied to shorten involved muscle. Joint is moved in direction of muscle being treated and hold until release	Tibiofemoral joint	Point tenderness at and medial to midpoint of knee joint	OA, pes anserine bursitis medial plica syndrome, medial collateral ligament sprain, medial meniscal tear
HVLA: Restricted joint placed into restrictive barrier(s). A small to moderate amount of force is applied to the joint in a way that moves it through its barriers	Anterior / Posterior Fibular Head	Lateral Knee Pain; if Posterior Fibular Head symptoms of peroneal nerve compression	Lateral Compartment OA, lateral collateral ligament sprain, lateral meniscal tear, iliotibial band tendonitis

FPR: Fascilitated Positional Release; HVLA- High Velocity Low Amplitude, T.P.- Tender point

DISCUSSION/CONCLUSION

With knee pain accounting for almost a third of primary care visits,[41] osteopathic family physicians play an important role in improving their patient's overall quality of life. While the differential for patients presenting with knee pain is extensive, it is important for the family physician to combine their knowledge of knee anatomy, the common etiologies of knee pain, a detailed history, and a complete osteopathic structural exam to come up with an appropriate diagnosis and treatment plan. Osteopathic physicians hence provide a new approach to the management of these patients through incorporating osteopathic principles into their diagnosis and treatment. Manipulation has been shown to significantly reduce pain and improve functionality in patients with a wide range of knee pain etiologies. Future studies must be conducted to establish an OMT protocol that can be used and identify other etiologies of knee pain for which OMT is effective. However, the progress that has been made over the years is remarkable as it is and represents how OMT should be used as a standard of care for patients with knee pain.

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TABLE 3 (CONT):

OMT Treatments of Knee Pain

Technique	Region of Treatment	Clinical Findings	Diagnosis
Articulatory Technique: Joint is repeatedly taken through physiologic range of motion in all possible planes	Tibiofemoral joint	Decreased ROM in Flexion / Extension or Internal / External Rotation	OA
Myofascial/Soft Tissue (Popliteal Spread: Anterior and lateral force is applied to popliteal fossa to engage fascial barriers	Popliteal Fossa	Decreased lymphatic drainage proximal to tibiofemoral joint	Lymphedema (i.e- post-op); popliteal cyst; non-inflammatory effusion

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