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THE KNEE
for Physiotherapists

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JAYPEE

Contents

Chapter 3

Soft Tissue Injuries

Knee joint pathologies are commonly of traumatic origin. Knee is freely movable in sagittal plane. Thus, forces acting to move the knee in frontal and transverse planes are largely attenuated as internal strain to soft tissues about the joint. Furthermore such force may act over the relatively long lever arms provided by femurs and tibia thereby increasing the potential loading of the structures. Therefore, soft tissue injuries about the knee joint are very common.

MEDIAL COLLATERAL LIGAMENT INJURY

Medial collateral ligament (MCL) is long and flat, attached to medial epicondyle to medial aspect of shaft of tibia about 4 cm below the joint line. It lies slightly anterior to the joint axis. It becomes taut in extension, abduction and external rotation of tibia and some of the anterior fibers become taut in flexion. It also prevents anterior displacement of tibia on femur. Its deep capsular fibers are attached to medial meniscus and compromises its mobility. Anteromedially medial patellar retinaculum and posteromedially pes anserinus tendons (Gracilis, semitendinosus, and sartorius) and semimembranosus prevent excessive abduction, external rotation and anterior displacement of tibia. They reinforce the medial collateral ligament.

Functional Anatomy

The MCL is the major stabilizing structure for the medial aspect of the knee joint protecting the knee from valgus (lateral to medial) forces. The MCL is divided into deep MCL (d-MCL), superficial MCL (s-MCL) and posterior oblique ligament, these are called static stabilizer of the medial knee. Dynamic stabilizer include musculotendinous unit of semimembranosus, quadriceps and pes anserinus. A bursae separates the superficial and deep MCL, which is a small jelly filled sac that reduces friction between the two segments, so it allows anteroposterior excursion of the s-MCL during flexion and extension. The superficial portion of the ligament is broad that arises proximally from the medial epicondyle on the femur and attaches 4–5 cm distal to the joint line on the medial surface of the tibia posterior to pes anserinus. Its anterior fibers become taut during flexion and lax during full extension. The deep portion lies just beneath the superficial portion and has a firm attachment to the medial meniscus and the fibrous capsule surrounding the knee joint (Moore, 1996). Posterior to the MCL is the posteromedial corner, made of the capsule called the posterior oblique ligament (POL). This complex is tight in extension and become confluent with the posterior joint capsule.[1-3] The MCL is primary restraint against valgus stress. At 25° of flexion, MCL provides 78% of the valgus-restraining force. In extension, the ACL, POL, medial meniscus, semimembranosus also contribute to valgus stress and MCL provides 57% of the restraining force against valgus stress. In general, an isolated MCL tear lead to valgus laxity in flexion, while additional injury to the secondary restraint (ACL) leads to increase laxity in extension.[1-3]

Gardiner et al. found that the amount of strain to valgus stress over different areas depends on flexion angle of knee.

1. In full knee extension, strain occurs over the posterior part of MCL.
2. Throughout different flexion angle—strain remains constant on anterior fibers.
3. Several radiographic studies confirm that posterofemoral attachment is common site of injury.

With valgus stress, there is tension over the medial aspect of the knee joint leading to stretching of MCL. A minor MCL sprain is a common lesion that usually occurs from an external rotation strain of tibia on the femur. Depending on the amount of force, there will be variable degrees of MCL sprain. One of the most common mechanisms occur when a football player is tackled from the side with the foot planted and the knee slightly flexed. The victim is usually struck while trying to turn or cut away. The forces on the knee include a valgus stress, external rotation of the tibia on the femur and usually an anterior movement of the tibia on the femur (Fig. 3.1).

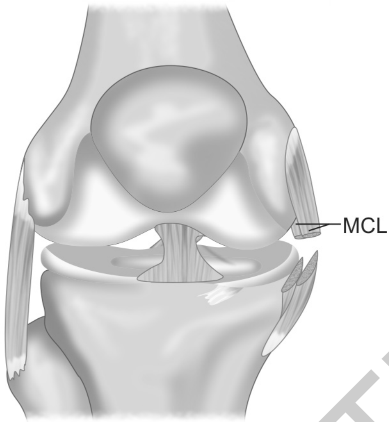

Fig. 3.1: Medial collateral ligament (MCL) injury.
(*Source:* Injuries to the medial collateral ligament of the knee. 2013.https://phoenixshoulderandknee.com/).

With severe sprain, there will be damage to medial joint capsule. If the force becomes more, there will be injury to medial meniscus to which the deep fibers of MCL gets attached. If the force further exceeds, there will be injury to anterior cruciate ligament (ACL). The conditions in which all these three ligaments are damaged are known as triad of O'Donoghue. Similar type of injury on the medial aspect of the knee joint is uncommon as both the medial sides are well protected.

Grade I (mild) sprain is essentially a stretch injury. Only a few fibers are disrupted. Valgus opening: 0–5 mm.[1] Anatomical and functional integrity of the structure are maintained. Anatomical integrity is checked by valgus stress test, which is characterized by pain but no increase in amplitude of abduction of tibia over femur. Functional integrity is determined by the level of activities and disability. Patient may complaint of pain during running and turning away from the affected side but no giving way. Localized tenderness present.

Grade II (Moderate) sprain is partial tear of the capsule-ligamentous structures. Damage of more fibers but some fibers are still intact. Valgus opening: 5-10 mm.[1] Generalized tenderness. There is loss of anatomical as well as functional integrity of the structure. Instability can be demonstrated by valgus stress test which shows hyperabduction of tibia over femur with pain. Functionally pain and

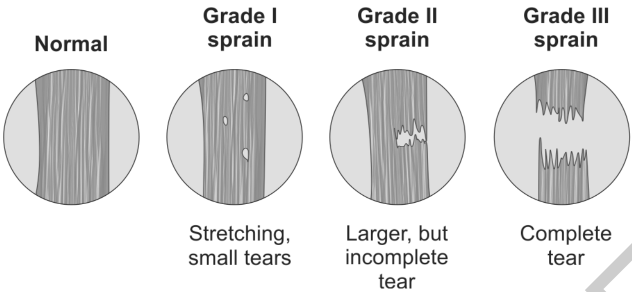

Fig. 3.2: Grades of ligament sprain.

(*Source:* Sprain or Strain – What is the Difference. Kintec. 2016. http://www.kintec.net).

giving way present during running and turning away from the affected side. Associated involvement of capsular ligament gives rise to joint effusion with limitation of range of motion in capsular pattern.

Grade-III (severe) sprain is complete rupture of the capsule-ligamentous structures. All ligamentous structures are damaged giving rise to complete loss of anatomical as well as functional integrity of the structure. Valgus opening : >10 mm.[1] Instability can be demonstrated by valgus stress test which shows hyperabduction of tibia over femur without pain. Functionally, there will be giving way during running and turning away from the affected side. No effusion or limitation movement present (Fig. 3.2).

Lateral collateral ligament is short and rounded, attached to the lateral epicondyle of femur to the head of fibula. It does not get attached to the lateral meniscus. Popliteus tendon runs underneath it, i.e. between lateral meniscus and LCL. It is covered by the biceps femoris tendon. It lies slightly posterior to the joint axis. It becomes taut in extension, adduction and external rotation of tibia.

Conservative Management

Medial collateral ligament sprain grade I is unimportant and persons with grade I sprain usually manage it by self-treatment. Measures to relief the pain only have to be taken.

Medial collateral ligament sprain sprain grade II is important for physiotherapy point of view. During the acute stage, the aim of physiotherapy is to prevent further damage, early resolution of the inflammation and pain relief. Keep the part in elevation with compressive bandage and apply ice 20 minutes 5 times per day for 48 hours to reduce swelling and resolve acute inflammation. High voltage pulsed galvanic stimulation or strong faradic stimulation or interferential therapy or transcutaneous electrical nerve stimulation (TENS) can be used for pain relief.

Immediately after the sprain the aim is to maintain mobility of the ligament while healing. Once the acute stage subsides the aim of physiotherapy is to accelerate more physiological healing. The means to achieve it is to apply optimal stress over the healing ligament.

Cyriax's deep transverse friction massage can be applied at the joint line, where it is attached to the medial meniscus, across the ligament in different positions of knee flexion-extension to prevent/breaks the adhesion of healing ligament and increases the extensibility, restore mobility and to realign the newly produced collagen perpendicular to the direction of stress. Care must be taken not to apply at the proximal attachment of MCL, which may give rise to periosteal disruption and heterotrophic bone formation. It also disperses inflammatory exudates relieving pain and preventing adhesion.

The patient lies on the couch and therapist's index finger reinforced by the middle finger lies over the affected part of the ligament and thumb on the outer side of the joint. By alternately flexing and extending the wrist, the fingers move to and fro over the ligament with adequate pressure and sweep, keeping the thumb still as the fulcrum fixed. Thus, the ligament moves over the underlying bone. As the initial pain and discomfort disappears gradually increase the pressure and again as the pain and discomfort disappears gradually increase the pressure further. The frequency of movement is 2/second. The treatment is applied for about 10 minutes followed by active movements and passive stretching.

Alternately optimal stress over the healing ligament can be applied by applying valgus stress in supine position with the knee in about 10° of flexion or external rotation of tibia in prone with the knee in 90° of flexion.

Mulligan's mobilization with movements: Patient in prone lying and therapist stands on the contralateral side. The belt is placed around the waist and patient's lower leg so that the proximal edge is at the tibial joint margin. The thigh is stabilized above the knee by one hand and the leg is supported by the other hand. Glide the tibia medially with the belt while the patient flexes and extends the knee painlessly.

Therapist in sitting position, patient stands in the front placing his foot of the affected side on the chair in-between therapist's knee. Therapist places his thumb reinforced by the other thumb over the joint line on the MCL. With the thumb pressure maintained, ask the subject to alternately flex and extend the knee.

Passive, active-assisted range of motion (ROM) exercise within pain free range are given after a few days. ROM exercise in cold whirl pool bath can be given immediately followed by warm whirl pool bath after a few days. Static quadriceps, straight leg raise (SLR) can be initiated from the next day and as the acuteness subsides active knee flexion, cycling, swimming, SLR in all directions except hip adduction, etc. can be added.

2nd week progressive resisted knee extension, multiangle quadriceps exercise, hamstrings curls, hip adduction, closed kinetic exercise and stretching of hamstrings, quadriceps, TA, iliotibial band (ITB) are given. Full weight-bearing is allowed once full range without any pain and swelling is achieved followed by balance training.

Grade III isolated MCL rupture can be managed non-surgically as MCL has an excellent secondary support system, weight-bearing force tends to compress the medial aspect aiding the stability. The injury can be protected adequately in hinged brace to avoid valgus stress, prevent atrophy. Nonweight-bearing exercises are performed for weeks and partial weight-bearing for 3 months with the functional knee brace. Progressive strengthening, endurance, stretching exercises are given. After 3 months balance exercises and gradual running can be added.

Giannotti et al.[4,5] published guidelines for a functional rehabilitation program after isolated grade 3 MCL injuries. They state that "good to excellent results can be expected with a return to full preinjury activity level being the norm." A simple hinged knee brace is used initially to protect the knee from valgus stress. Depending on the activity, bracing may be continued until the patient feels stable and safe playing without it. The protocol outlines four phases covering a time span of 10–12 weeks. During phase 1 (0–4 weeks), goals are to decrease swelling, restore knee range of motion from 0–100°, gain 4/5 quadriceps and hamstring strength, restore a normal gait pattern, and restore full-weight-bearing status. Treatment during phase 1 includes cryotherapy, electrical muscle stimulation, stretching, range of motion exercises, and quadriceps and hamstring strengthening. During phase 2 (4–6 weeks), goals are to continue to control swelling, restore full knee range of motion from 0–140°, and gain 5/5 quadriceps and hamstring strength. Treatment during phase 2 includes cryotherapy, closed chain exercises, and static proprioceptive exercises. During phase 3 (6–10 weeks) goals are to regain the ability to perform squats, return to light jogging and agility skills, and possibly progress to sport-specific skills and competition. Treatment during phase 3 includes treadmill jogging, dynamic proprioceptive exercises, slide board training and rebounder training. During phase 4 (8–12 weeks) goals are to attain 95% quadriceps index and 90% single leg hop index, return to full running and sport-specific drills, and resume competition. Treatment during phase 4 includes plyometric training, full agility and sport-specific drills, continued dynamic proprioceptive exercises and rebounder training, and road running. In general, return to competition is allowed after the following are achieved: there are no signs or symptoms of instability and there is a normal ligament exam; quadriceps strength is at least 90% when compared to the contralateral extremity; and sport-specific skills, agility testing, and athletic activities do not cause any pain.

Repair/Reconstruction

Immobilization in plaster cylinder or hinged cast brace is given for 3–6 weeks, during which static quadriceps, hamstrings exercises, SLR and ankle foot exercises should be done. Patellar mobilization, and electrical stimulation (ES) to quadriceps can be given.

After plaster removal, US followed by deep transverse friction massage (DTFM) are given over the ligament to improve its mobility. Then controlled mobilization technique followed by active movement is encouraged. Partial weight-bearing in hinged cast brace is allowed once about 10° knee extension is achieved.

After 6 weeks progressive strengthening, endurance, stretching and passive mobilization should be given.

Once full extension with adequate strength is achieved balance training is given, then patient returns back to activity.

Early Mobilization Protocol

2 weeks: Active ankle foot and toe movements, static quadriceps exercise, SLR, passive ROM exercise by lying in prone for knee extension, wall sliding once 80–90° range is achieved, patellar mobilization, ES are given.

Partial weight-bearing crutch walking with the brace locked in extension can be initiated once full knee extension is achieved.

2–4 weeks: 120° ROM should be regained by 4th week, active knee flexion followed by resisted, resisted SLR, cycling, closed kinetic chain (CKC) exercise, balance training, active knee extension 90–60°, Full weight-bearing can be allowed by 3–4 weeks.

4–6 week: Full joint range of motion (FJROM) should be regained by 6th week, 90–40° active knee extension.

8–10 week: Activity

12 weeks: FJROM, full knee extension and adequate strength

16–18 weeks: Jogging can be initiated once quadriceps become 65% of the sound side.

5–6 months: Return to sports once quadriceps become 80% of the sound side.

MENISCUS INJURY

Anatomy

Medial and lateral menisci are semicircular fibrocartilaginous structure that deepens the tibial articulating surfaces. Their anterior horns are attached in front of the intercondylar area of tibia and posterior horns behind it. Medial meniscus is semicircular in shape, forms part of a larger circle whereas lateral meniscus forms almost of a smaller circle as its both the horns are attached close to each other. Peripherally joint capsule is attached to the upper margin of the menisci and coronary ligament, which constitutes the inferior aspect of the joint capsule, is attached to the lower margin of the menisci. MCL is attached to the medial meniscus but LCL is not attached to the lateral meniscus. Therefore, lateral meniscus is more mobile, whereas medial meniscus is less mobile owing to its extensive peripheral attachment. Medial meniscus translates 2–5 mm whereas lateral meniscus translates 9–11 mm in the anteroposterior plane. That is the reason why medial meniscus is more prone to injury.

Peripheral one-third of menisci are vascular, supplied by branches from the superior, inferior and lateral geniculate arteries. The middle-third is not completely avascular as it receives some blood supply, whereas inner-third is avascular, is nourished by synovial fluid diffusion.

Menisci are one of the protectors of knee. It provides congruity to the articulating surfaces; absorb shock and reduces the stress. Forces across the knee joint may be as high as 2–4 times body weight during walking and up to 6–8 times body weight during running. Menisci transmit approximately 50% of the load and about 90% of load at 90° of knee flexion. The lateral meniscus transmits greater percentage of load in the lateral compartment (approximately 70%) where as medial meniscus transmits approximately 50% of load in the medial compartment. Surgical excision of meniscus can result in alteration in knee joint function, degeneration of articular cartilage, reduction in joint space, osteophyte formation, alteration in shape of femoral condyle, etc. It also helps in lubrication and nutrition to the joint. During loading of the knee, when the meniscus is compressed, synovial fluid is driven into the articular cartilage.

Menisci move with the tibia in flexion-extension and with femur in rotation. Normally, external rotation of tibia in nonweight-bearing or internal rotation of femur in weight-bearing occurs during terminal knee extension and internal rotation of tibia in nonweight-bearing or external rotation of femur in weight-bearing occurs during initial flexion. Full extension is possible in the absence of normal rotation, but at the expense of deformation of articular tissues, i.e. sprain meniscus. Flexion-extension without rotation or with abnormal rotation put stress over the meniscus giving rise to injury. Rotation at complete extension is not possible, but forced rotation put stress over the meniscus. In extension, the menisci are at their extreme forward position, with rotation either of the menisci tends to move forward and the other tends to move back. There will be excessive stress over the former leading to injury. Similarly in hyperflexed knee, i.e. in squatting, where the menisci are at their extreme posterior position, rotation in either direction will tend to move one of the menisci backward and the other forward. The one which tends to move back will have excessive stress; it cannot move further backward and gets injured.

Epidemiology

The mean annual incidence of meniscal lesions has been reported to be 66 per 100,000 inhabitants, 61 of which result in meniscectomy (Makris et al. 2011). A meniscus tear (Fig. 3.3) can be located in any location, and in any conceivable pattern. Anterior horn tears are unusual. Tears typically begin in the posterior horn and progress anteriorly. Patients with sports injuries are usually in mid-thirty years, and account for approximately 33% of cases. Patients with non-sporting injuries are in fourth decade of life, and account for approximately 39% of cases. Patients with an indefinable injury have a mean age of 43 years, and account for about 29% of cases. There is a 4:1 male to female ratio in these tears, and approximately 2/3 of all cases occur in the medial meniscus. It should also be noted that associated ACL tears were found in 47% of the patients in sports injuries and in 13% of the non-sporting injuries. In the no-injury group, there were no ACL tears. In chronic ACL injuries medial meniscus tear occurrence is 36%, lateral meniscus tear occurrence is 22% and both menisci tear occurrence is 16%.[6-9]

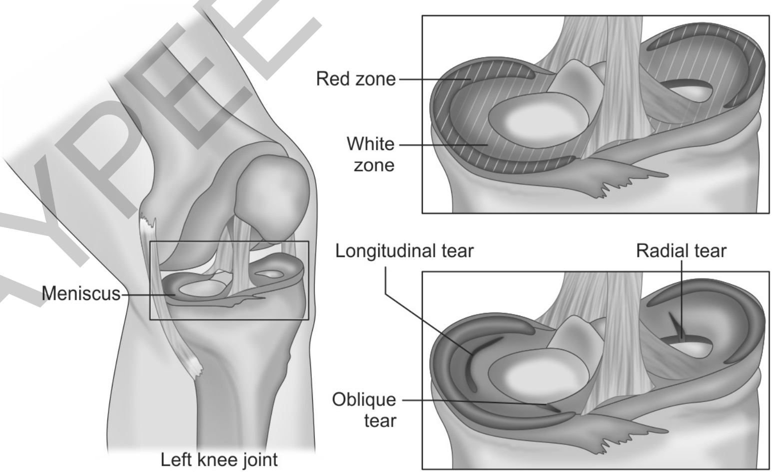

Fig. 3.3: Meniscus tear.
(*Source:* Miller J. Meniscus tear. http://physioworks.com.au/).

Clinical Features

The onset is usually sudden with an immediate deep pain associated with giving way of the joint. If hemarthrosis occurs, there will be severe diffuse pain and tense swelling arising within minutes of injury. In the absence of severe effusion pain is localized at the site of injury on the joint line. Longitudinal tear of medial meniscus extending anteriorly often gets displaced interfering with the normal joint mechanics resulting in locking of the joint so that terminal 20–30 of extension will be lost. Locking is usually preceded by previous minor incidences of giving way followed by effusion.

The severity of symptoms can vary for different types of meniscal tears. The most common meniscal tear pattern is a single longitudinal tear, which is traumatic in origin. A long central fragment attached at each to the meniscal horns progressed over time to become bucket handle tear. When the unstable bucket handle fragment displaces into the intercondylar notch, it blocks full extension of knee and quite painful. Horizontal/transverse tears often results of chronic degenerative changes and usually occurs in elderly. It may progress to become flap tear. Radial tears occur in the central aspect of the meniscus, which progress peripherally to become parrot beak tear. Transverse or radial tear move in and out of the joint without locking the joint, but may cause occasional symptoms of giving way, mild pain and effusion.

Patient with locked knee or effusion is hesitant to bear weight. As the effusion subsides and movement is restored patient can resume activities with little or no pain. Complaint of intermittent buckling or locking followed by effusion. Altered joint mechanics gives rise to persistent clicks and there develops quadriceps wasting.

Vascularity of menisci decrease from periphery to central. Injury to peripheral margin of meniscus has favorable prognosis for healing whereas injury to central portion of meniscus has poor prognosis for healing.

Physical Examination

Acute Stage

Observation

The patient reports either by hopping or carried by the care-givers or by a pair of crutches with the knee semiflexed and toe touch position.

Finds difficulty to remove the shoe, sock, trouser as the knee can be flexed.

Inspection

Knee assumes semiflexed position to accommodate the effusion. Suprapatellar girth measurement is increased. Overlying skin becomes red, shiny and glossy.

Movements

1. Active weight-bearing movement is not possible.
2. Active nonweight-bearing knee flexion-extension is restricted in capsular pattern. Considerable loss of extension is present if the knee is locked.
3. Passive movements are restricted in capsular pattern with muscle spasm end-feel and springy rebound end feel in case of locked knee.
4. Joint play cannot be assessed properly due to spasm. External rotation of tibia is painful in case of medial meniscus injury.
5. Resisted isometric contraction should be strong and painless.

Palpation

1. Localized tenderness present at the site of injury over the medial joint line, overlying skin becomes warm and moist.
2. Fluctuation test and patellar tap test are positive. Hemarthrosis may accompany cruciate tear, meniscus tear, intra-articular fracture.

Special Tests

Special tests may not be possible in the presence of effusion.

Chronic Stage

Chronic Lesion without Effusion

1. Patient with chronic meniscus injury complains of intermittent giving way or locking of the knee followed by effusion. Patient learns to reduce and unlock the joint following which pain gets relieved and movement gets restored. Quadriceps atrophy, more of vastus medialis, is one of the significant findings and weakness is also present.

THE KNEE
for Physiotherapists

Salient Features

- Includes a broad variety of common knee lesions affecting the knee joints, traumatic injuries may be experienced by the sports persons as well as more sedentary persons, degenerative joint diseases involving the knee, common in middle-aged and older individuals
- Covers almost all the common conditions in the physiotherapy of knee
- Contains basic anatomy and the biomechanics of the knee which is essential to diagnose and treat mechanical problems
- Presents comprehensive planning of the physiotherapy, management, evaluation and assessment scheme for common knee disorders
- Emphasizes manual therapy approaches to deal with various knee problems
- Describes the do's and don'ts with home exercise programs.

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