Patellofemoral Instability Lab
Skills Centre for Health Science

Friday November 27, 2015
11 - 5 pm
Learning Objectives

At the completion of this session participants will be able to:

General:
1. Demonstrate a competent understanding of the anatomy and biomechanics of the patello-femoral joint.
2. Describe the patho-anatomy of patellofemoral joint instability.
3. List the pertinent steps of arthroscopic assessment of patellofemoral instability

Specific:
1. Review and apply patellofemoral surgical anatomy and biomechanics.
2. Differentiate patellofemoral treatments and comprehend logical approaches to treating patients with patellofemoral pain and instability.
3. Identify the newest concepts in patellofemoral joint preservation including how to optimize patellofemoral stability as well as patellofemoral articular loading & balance with the appropriate surgical technique(s)

Patellofemoral Instability Knee Lab Schedule

11 am       Lunch & Introduction
11:15-11:45  Anatomy and Pathophysiology of Patellar Instability - Dr. Nathan Urquhart
11:45-12:15  Acute and Chronic Patellar Instability - Dr. Catherine Coady
12:15 -12:45 Patellar Instability in the Paediatric Patient - Dr. Karl Logan
12:45-1:15   Diagnostic Imaging in Patellar Instability - Dr. Gord Boyd
1:15-1:45    Surgical Treatment of Recurrent Patellar Instability -Dr. Laurie Hiemstra
1:45-2:15    Surgical Demo - Dr. Laurie Hiemstra
2:15 - 5 pm  Hands On Cadaver Workshop
Arthroscopy - examination of the patellofemoral joint, arthroscopic/open medial imbrication, lateral release
MPFL Surgery - MPFL reconstruction, MQTFL reconstruction
Medial and Lateral Knee Dissection
Tibial Tubercle Transfers
Trocheoplasty Surgery

Faculty
Dr. Laurie Hiemstra
Banff Sports Med
Dr. Karl Logan
IWK Health Centre
Dr. Gord Boyd
QEII Health Sciences Centre
Dr. Nathan Urquhart
Dartmouth General Hospital
Dr. Catherine Coady
QEII Health Sciences Centre

Many thanks to ConMed Linvatec for sponsoring the hands-on skills lab and the Skills Centre for Health Sciences for hosting the session.
Patellofemoral Instability

Patellofemoral instability is a common disorder affecting the knee joint. Young athletes suffer patellar dislocations more commonly than any other age group. Patients most at risk for patellar instability are 12-20 years of age. Females are also at higher risk for patellar instability.

Traumatic dislocations may occur from both contact and noncontact injuries to the knee. An athlete can dislocate his/her patella when the foot is planted and a rapid change of direction or twisting occurs. This may happen in sports such as soccer, gymnastics or basketball. Direct blows to a knee can also cause dislocations. This type of injury may occur in sports such as hockey or football. The force of these types of injuries is typically much greater and usually causes more severe damage to the knee especially to the restraining ligaments. Patients with traumatic dislocations also have a higher incidence of associated fractures in the patellofemoral joint.

Some patients have “predisposing factors” which increase their chance of having patellar instability such as trochlear dysplasia, patella alta, lower extremity malalignment, quadriceps atrophy and an increased tibial tubercle offset. In these patients, the patella can sublux or dislocate with seemingly minor activities such as going up stairs or even kneeling.

**ANATOMY:**

Instability of the patellofemoral articulation can occur when the bony anatomy of the patella, and/or the femoral trochlea are abnormal. The patella is the largest sesamoid bone in the body. It has multifaceted articular surface with medial and lateral facets separated by a central ridge and a much smaller odd facet located far medially. The articular cartilage of the patella is the thickest in the body designed to withstand joint reactive forces up to 10 times body weight with daily activities and 20 times body weight with sporting activities. The patella is a fulcrum for the extensor mechanism. It increases the distance of the line of action of the extensor mechanism from the center of rotation of the knee -- increasing the force that can be generated by the contraction of the quadriceps. The medial and lateral facets of the patella articulate with the medial and lateral facets of the femoral trochlea.

The patellofemoral joint contains both static and dynamic constraints on its dislocation. The static constraints include the osseous anatomy of the patellofemoral joint (particularly its trochlear geometry), the medial patellar retinaculum, and the medial patellofemoral ligament (MPFL). The static constraints provide a constant checkrein to patellar dislocation, and when the trochlea can no longer provide stability, as it normally does in greater degrees of knee flexion, the soft-tissue restraints become the sole providers of patellar stability from 0° to 20° of flexion. The main dynamic restraint to patellar dislocation is the vastus medialis muscle, which neutralizes the lateralizing force of the vastus lateralis muscle during muscle contraction and activity. When there is disruption of any of these constraints either through direct trauma (eg, a tear in the MPFL) or indirectly through pathologic alignment or a fault in osseous anatomy (eg, an altered Q angle, external tibial torsion, femoral anteversion, foot pronation, genu valgum, patella alta, or trochlear dysplasia), subluxation or dislocation of the patella can occur.

Articulation between the inferior margin of the patella and the femur begins at approximately 10-20 degrees of knee flexion. The patella does not articulate with the trochlea near terminal knee extension. As the knee proceeds into greater degrees of knee flexion, the contact area of the patellofemoral joint moves proximally along the patella and posterior along the condyles.

Static stabilizers provide fixed inhibition to lateral translation of the patella. Absence has been demonstrated to cause up to 49% reduction in lateral stability at zero degrees of flexion. In addition, lying beneath are three ligaments; the patella-femoral (MPFL), patella-meniscal (MPML) and patella-tibial (MPTL). These are the primary ligamentous structures constraining lateral patellar motion, of which the MPFL is the most notable. The MPFL is a continuation of the deep retinacular surface of the vastus medialis obliquus (VMO). It runs transversely between the proximal half of the medial border of the patella to the femur between the medial epicondyle and the adductor tubercle, forming the second layer between the superficial medial retinaculum and the capsule. The anatomy of the lateral side is more complex. The superficial layer consists anteriorly of the fibrous expansion of the vastus lateralis and the superficial oblique retinaculum further posteriorly. The tightness of the ITB (dynamic stabilizer) will influence the lateral stability force inferred by the lateral retinacular structures.

**“The patella is the largest sesamoid bone in the human body.”**
Static Stabilizers

Trochlear geometry
The femoral trochlea anatomy typically closely matches the articular shape of the patella with a longer and higher lateral wall that serves as the most important bony restraint to lateral translation. Once the patella enters the confines of the trochlea, the bony anatomy allows for inherent stability of the PFJ. The normal shape of the trochlea is a concave trough, with a normal sulcus angle of 138 ± 6° (on Merchant view axial radiographs). The lateral femoral trochlea extends further anteriorly than the medial side, providing a buttress to lateral patellar subluxation thereby maintaining the patella’s centered position in the trochlea. The lateral extremity of the trochlea extends further proximally than it does on the medial side, providing a mechanism for engaging the patella in early knee flexion and deflecting it medially to the center. Trochlear dysplasia is an important risk factor for recurrent patellar dislocation (classification by Dejour et al.).

Patellar geometry
The patella has a convex articular surface and this congruity between the patella and the trochlea provides some constraint to the PFJ. When the knee begins to bend, the initial contact area is the distal and lateral patella facet. With further flexion the contact area on the patella articular surface moves more proximally until in deep flexion where the medial facet has then made contact. Patellar height also contributes to PFJ stability. Trochlear geometry is such that it encourages early engagement of the patella during the flexion arc. Engagement of the patella depends entirely on patella height. With patella alta, engagement into the trochlear does not occur in the early phase of knee flexion, thus potentiating instability and that of the patellar tendon into the trochlea. Dysplasia of the patellar facet significantly affects the patellofemoral articulation and may cause symptomatic abnormalities in patella tilt and tracking.

Soft-tissue structures
Important structure for PFJ stability include:
1. medial retinaculum
2. vastus medialis oblique muscle
3. medial patellofemoral ligament
4. lateral retinaculum
5. iliotibial band
6. vastus lateralis muscle

Normally, these all work in concert to provide proper stability and tracking of the patellofemoral articulation. When medial stabilizers are weakened or disrupted, the typical lateral instability may occur. Tightness or excessive force by the lateral stabilizers typically does not cause actual instability, as long as the medial structures are normal, but may cause symptomatic abnormalities in patella tilt and tracking.

Restraint to lateral subluxation in extension & early flexion:
MPFL: 60%
Lateral Retinaculum: 10%
Medial Patellomeniscal Ligament: 13%

SOF-TISSUE STRUCTURES
Importance of the patellar tendon is such that it encourages early engagement of the patella during the flexion arc. Engagement of the patella depends entirely on patella height. When the knee begins to bend, the initial contact area is the distal and lateral patella facet. With further flexion the contact area on the patella articular surface moves more proximally until in deep flexion where the medial facet has then made contact.

Limb alignment
Q angle is an angle formed by the line of pull of the quadriceps mechanism and that of the patellar tendon as they intersect at the center of the patella. Clinically, this angle is represented by the intersection of a line drawn from the anterior superior iliac spine to the center of the patella with a second line drawn from the center of the tibial tuberosity to the center of the patella. In males, the Q angle is 8-10° and in females it is 15±5°. An increase in the Q angle results in an increased valgus vector to the PFJ. Genu valgum, increased femoral anteversion, external tibial torsion and/or a lateralized tibial tuberosity can all ultimately affect patella tracking.

Soft-tissue restraints include the quadriceps and patellar tendons, the lateral retinaculum, the medial patellomeniscal ligament, and the medial patellofemoral ligament (MPFL). Warren and Marshall divided the soft tissue static restraints into 3 layers:
1. the superficial layer consists of the fasciae of the vastus medialis and sartorius
2. the second layer includes the MPFL and superficial medial collateral ligament (MCL)
3. the deepest layer consists of the joint capsule. Recent studies have documented the anatomy and function of the MPFL and identified it as the primary soft tissue restraint to lateral instability.

MPFL anatomy:
Length: 55 mm
Femoral origin width: 15 mm
Patella insertion width: 17 mm

Tissue Restraints
Medial soft tissue restraints include:
1. the superficial layer consists of the fasciae of the vastus medialis and sartorius
2. the second layer includes the MPFL and superficial medial collateral ligament (MCL)
3. the deepest layer consists of the joint capsule.

Recent studies have documented the anatomy and function of the MPFL and identified it as the primary soft tissue restraint to lateral instability.
Dynamic Stabilizers

The quadriceps muscles are the principal dynamic restraint. Of the 4 heads of the quadriceps, the vastus medialis obliquus (VMO) is best positioned to resist lateral subluxation, due to its approximately 60-degree angle of insertion on the patella. The function of the VMO as a restraint to subluxation is greatest in extension and early flexion because bony restraint at these positions is minimal. An underdeveloped VMO is a predisposing factor for recurrent instability and is a major focus of rehabilitative efforts during conservative management.

As well as influencing the patella in a lateral-medial direction, the vastii muscles also exert a posterior force vector. This force stabilizes the patella within the trochlear groove.

The VMO overlies and merges with the MPFL, acting together to provide both active and passive stabilization of the patella.

BIOMECHANICS

The patella can be thought of as a sliding tongue-in-groove joint that has soft-tissue restraints that guide motion within the groove. Variation in the depth of the trochlear groove, the size and sloped of the patellar facets as well as the length and integrity of the soft-tissue restraints play all play roles in establishing and maintaining patellar stability. The patellofemoral joint withstands the highest joint-reactive forces in the body. These forces are least when the knee is in extension and increase with flexion to approximately 7 to 8 times a person’s body weight at 130 degrees. PFJ stability is dependent on coordinated interaction between static, dynamic, and osseous structures to keep the patella centered within the trochlea during knee range of motion. During full extension, the patella is not engaged in the trochlear groove, and it is dependent on soft-tissue restraints for stability. The medial knee retinacular structures, including the VMO, MPFL and the medial patellofemoral ligament, provide static restraint to lateral patellar translation. Correct patellar centering within the groove during early knee flexion is essential to maintaining patella-femoral stability and is largely determined, again, by the dynamic and static soft-tissue structures. The MPFL is the primary soft tissue restraint to lateral translation of the patella during the initial 20 to 30 degrees of knee flexion. This ligament is most taut in full extension, with the quadriceps contracted, and assists in guiding the patella into the trochlea during the early stages of flexion. Once engaged in the trochlea, the patellofemoral joint compression provided by the increasing force vectors of the quadriceps and patellar tendons, combined with PFJ geometry, provides the major effect on stability as knee flexion progresses. At 30° of knee flexion, the patella should be centered in the trochlear groove, with <1 cm lateral translation. The depth and slope of the trochlea influence patellar stability as the knee continues to flex. The role of soft tissue constraints is minimized with flexion >30°, at which point the trochlea becomes the most important patellar stabilizer. The height and slope of the lateral trochlear facet provide the primary resistance to lateral patellar translation as knee flexion progresses. The lateral facet of the trochlear groove is most prominent proximally and decreases in height distally and posteriorly. Once flexion is initiated, the soft-tissue constraints of the quadriceps and patellar tendons place a posteriorly directed force on the patella and provide increased patellar stability. As the knee bends, the contact pressure across the chondral surface of the patella moves from the lateral facet to the medial facet and from distal to proximal along the chondral surface.
RISK FACTORS FOR PATELLAR INSTABILITY

1. **Trochlear dysplasia**
2. **Patella alta**
3. **Increased (TT-TG)**
4. **Increased “Q” angle**
5. **Medial patellofemoral ligament injury / insufficiency**
6. **Quadriceps atrophy/dysplasia**
7. **Hypoplastic lateral femoral condyle**
8. **Patellar tilt**
9. **Miserable malalignment**
   - Femoral anteversion
   - External tibial torsion
   - Foot pronation
10. **Young age at time of dislocation**
11. **Family history**
12. **Female gender**
13. **Generalized ligamentous laxity**

The peak of instability occurs with the knee in extension and lesser degrees of flexion and is due in part to the fact that the tongue-in-groove relationship is not engaged until approximately 20 degrees of flexion. In associated conditions such as patella alta, the trochlea is not engaged by the patella until higher degrees of flexion and is thought to contribute to the patellar instability.

Normal patellofemoral function during strenuous physical activity requires a combination of stabilizing forces afforded by bony, dynamic, and static soft tissue restraints. The bony elements of the generally congruent PFJ contribute significantly to its stability. The patella is proximal to the femoral trochlea when the knee is in extension and does not enter the sulcus until about 20 to 30 degrees of knee flexion. The lateral trochlear ridge acts as a buttress to help resist lateral subluxation of the patella. If the lateral ridge is hypoplastic, the restraint to lateral subluxation is decreased.

The static constraints provide a constant check-rein to patellar dislocation, and when the trochlea can no longer provide stability, as it normally does in greater degrees of knee flexion, the soft-tissue restraints become the sole providers of patellar stability from 0° to 20° of flexion.

"When there is disruption of dynamic +/- static constraints either through direct trauma (eg, a tear in the MPFL) or indirectly through pathologic alignment or a fault in osseous anatomy (eg, an altered Q angle, external tibial torsion, femoral anteversion, foot pronation, genu valgum, patella alta, or trochlear dysplasia), dislocation can occur".
Risk Factors for Patellar Instability

The normal trochlea is concave. In the presence of dysplasia, the intercondylar groove may be flattened or convex. Trochlear dysplasia does not allow the patella to fit into the trochlea during range of motion. Trochlear dysplasia is one of the most important anatomical abnormalities in patellar instability. Trochlear dysplasia does not allow the patella to fit into the trochlea during range of motion. This is riskiest in the first degrees of flexion as the lateral structures can easily overtake the medial ones.

TT-TG distance is the distance measured on superimposed axial cuts on CT or MRI of the apex of the tibial tubercle (TT) and the deepest part of the trochlear groove (TG). A TT-TG distance of greater than 20 is pathologic.

The Q angle is the angle formed by the line of pull of the quadriceps and the patellar tendon as they intersect at the center of the patella. An increase in the Q angle results in an increased valgus vector to the PF joint.

The Q angle is largest in extension.
Males: Q angle: 8-10 degrees
Females: Q angle 15 +/- 5 degrees

Rotational and axial deformity of the entire leg can play a role in patellar instability. Increased femoral anteverision and/or increased tibial torsion are often associated with patellar instability.

The MPFL is a very important static stabilizer that helps prevent the patella from moving too far laterally out of the trochlear groove. The MPFL is almost always injured in traumatic patellar dislocations.

MPFL is the main static stabilizer and it provides 50-60% of the total restraining force against lateral patellar displacement.

MPFL: 55 mm in length

Patellar Insertion:
- Broad insertion on the patella
- 7.4 mm anterior to articular surface & 5.4 mm distal to the proximal edge of the articular surface.
- Insertion spans 20 mm
- Centered at the junction of the proximal 1/3 and distal 2/3 of the patella

Femoral Origin:
- 10.6 MM PROXIMAL & 8.8 MM POSTERIOR TO MEDIAL EPICONDYLE
- 1.9 mm anterior and 3.8 mm distal to adductor tubercle

Rotational and axial deformity of the entire leg can play a role in patellar instability. Increased femoral anteverision and/or increased tibial torsion are often associated with patellar instability.

The MPFL is a very important static stabilizer that helps prevent the patella from moving too far laterally out of the trochlear groove. The MPFL is almost always injured in traumatic patellar dislocations.
Clinical Findings

Physical examination of a patient with a patellar dislocation with vary depending on the timing of presentation. In the acute setting, a thorough neurovascular and ligamentous examination of the knee should be performed. Gross deformity should be noted. The entire knee region should be palpated. If the patella is still dislocated, reduction can be performed with gentle extension of the knee with a medially directed force on the patella. Sedation may be required. Many dislocated patellas do spontaneously reduce. Patients typically have tenderness over the medial structures where the medial retinaculum and MPFL are located. Traumatic first time dislocators often develop a large hemarthrosis. Patellar muscle atrophy may be noted early on due to the knee injury.

Patients with recurrent patellar instability should have a more thorough physical examination performed looking for identifying pre-existing risk factors for dislocation. These include generalized ligamentous laxity, pronation of the foot, genu valgum, femoral antversion, external tibial torsion, and a reflexive protective quadriceps contraction, observed clinically as a positive apprehension test. The moving patellar apprehension test, which has 100% sensitivity and 88% specificity, involves applying a laterally directed force on the patella to a knee that is being flexed concurrently by the examiner. The ligaments of the knee should be assessed especially the ACL as the mechanism of injury, history and clinical findings can be very similar.

Known predisposing factors for patellar instability (especially in patients with recurrent patellar instability) are often assessed such as generalized joint hypermobility, weakness in the muscles around the knee as well as the alignment of the lower extremity. Both varus and valgus stress examination of the knee also should be performed as there are fibers of the medial patellofemoral ligament that may be avulsed from the superficial medial attachment to the medial collateral ligament of the knee. An inspection of the patient’s stance and gait may reveal genu valgum, and additional measurement of the patient’s Q angle should be performed with special attention to the position of the patella as it approaches terminal extension. In patients with recurrent patellar instability, it may be observed that the patella moves from a central position within the trochlear groove to a more lateral terminal position as the knee transitions from flexion into extension. As the patella passes the lateral condylar ridge, this subluxation event might be recognized as the J sign. Additionally, when the patient’s knee is flexed to 20–30 degrees, a laterally directed force to the patella may induce displacement recorded in terms of number of quadrants of displacement produced, with two quadrants representing roughly half the width of the patella. Finally, it is important to examine the knee for crepitus throughout the arc of motion. Early crepitus may indicate an inferior pole of the patellar chondral defect, whereas later crepitus may indicate a proximal lesion.

As many patients with patellar instability have underlying joint hypermobility, a Beighton score should be performed to document the extent of generalized ligamentous laxity.

KNEE EFFUSION
QUADRICEPS WASTING
APPREHENSION TEST
ASSESS ACL
J SIGN

Refers to lateral patellar deviation with terminal extension of the knee

PATELLAR TILT
PATELLAR GLIDE

The Beighton score

1. Can you put your hands flat on the floor with your knees straight? .......................... 1
2. Can you bend your elbow backwards? ......................................................... 1
3. Can you bend your knee backwards? ............................................................ 1
4. Can you bend your thumbs back on to the front of your hands? .................... 1
5. Can you bend your little finger up at 90° right angle to the back of your hand? .... 1

SCORE

Left
Right

_known predisposing fac-
tors for patellar instability (especially in patients with recurrent patellar instability) are often assessed such as generalized joint hypermobility, weakness in the muscles around the knee as well as the alignment of the lower extremity.

Both varus and valgus stress examination of the knee also should be performed as there are fibers of the medial patellofemoral ligament that may be avulsed from the superficial medial attachment to the medial collateral ligament of the knee.

An inspection of the patient’s stance and gait may reveal genu valgum, and additional measurement of the patient’s Q angle should be performed with special attention to the position of the patella as it approaches terminal extension. In patients with recurrent patellar instability, it may be observed that the patella moves from a central position within the trochlear groove to a more lateral terminal position as the knee transitions from flexion into extension. As the patella passes the lateral condylar ridge, this subluxation event might be recognized as the J sign. Additionally, when the patient’s knee is flexed to 20–30 degrees, a laterally directed force to the patella may induce displacement recorded in terms of number of quadrants of displacement produced, with two quadrants representing roughly half the width of the patella. Finally, it is important to examine the knee for crepitus throughout the arc of motion. Early crepitus may indicate an inferior pole of the patellar chondral defect, whereas later crepitus may indicate a proximal lesion.

As many patients with patellar instability have underlying joint hypermobility, a Beighton score should be performed to document the extent of generalized ligamentous laxity.
A standard series of radiographs of the knee should be obtained including:

**AP**

**Lateral**

**Merchant**

Initial assessment of these radiographs should include confirmation of a concentrically reduced patella as well as examination for the presence of fracture fragments. Lateral radiographs after an acute subluxation event often reveal an effusion. Evidence of a fluid/fluid level on lateral radiographs can serve as a clue that a lipohemarthrosis exists, which may indicate an associated osteochondral fracture.

Lateral radiographs with symmetric overlap of the medial and lateral posterior femoral condyles allow for assessment of patella alta.

There are several methods of measuring patella alta on the lateral radiograph including:

1. **Insall-Salvati Index**
2. **Modified Insall Salvati Index**
3. **Caton-Deschamps Index**
4. **Blackburne-Peel Index**

**Trochlear Dysplasia** can also be visualized on the lateral radiograph via the crossing sign, supratrochlear spur, or a double contour. In a normal trochlea, the trochlear groove is posterior to the femoral condyles. When the trochlea is flat, the trochlear groove is in the same plane as or anterior to the femoral condyles (the crossing sign). Alternatively, a prominent superolateral spur may develop (supratrochlear spur) to prevent lateral displacement of the patella. A double line at the anterior aspect of the femoral condyles (double contour) represents the subchondral bone of a hypoplastic medial condyle.

**Type A Dysplasia:** characterized by a crossing sign on the lateral view and a shallow trochlea on the axial view.

**Type B Dysplasia:** characterized by a crossing sign and supratrochlear spur on the lateral view and a flattened trochlea on the axial view.

**Type C Dysplasia:** characterized by the crossing sign with a double contour on the lateral view, and medial hypoplasia on the axial view.

**Type D Dysplasia:** characterized by the crossing sign, double contour, with supratrochlear spur on the lateral view, and asymmetry of the trochlear facets on the axial view.

---

**STANDARD RADIOGRAPHS**

**DIAGNOSTIC IMAGING**
Merchant view allows for assessment of:
1. Patellar tilt
2. Patellar subluxation
3. Trochlear dysplasia

Patellar subluxation can be measured using the congruence angle, which is an assessment of the angle formed by the patellar articular ridge and the intercondylar sulcus and averages 6 degrees ± 11 degrees in the medial direction.

Trochlear dysplasia can be measured via the sulcus angle which is formed by the highest points of the medial and lateral femoral condyles and the lowest point in the intercondylar sulcus and averages 138 degrees ± 6 degrees. Trochlear dysplasia is indicated with a sulcus angle greater than 145 degrees.

After plain radiographic examination, three-dimensional imaging has become increasingly used in the workup and treatment of patellar injuries because it can provide additional detail in delineating trauma and determining treatment. CT allows a three-dimensional assessment of bony pathology in the knee, including the study of loose bodies and trochlear dysplasia.

Computed tomography imaging, specifically, axial images with superimposed slices of the tibial tubercle with respect to the trochlear groove, allows for measurement of the tibial tubercle-trochlear groove (TT-TG) distance. Measurement of the TT-TG distance permits calculation of the lateral offset of the tibial tubercle. Ranges greater than 20mm indicate a lateralized tibial tuberosity, which likely contributes to patellar instability.

MRI has become an increasingly popular advanced imaging modality for patellar instability. Many patellar dislocation are associated with cartilaginous and soft tissue injury. MRI also reduces radiation exposure.

MRI permits visualization of:
1. The classic bone contusion pattern seen after injuries involving the anterolateral aspect of the lateral femoral condyle and the inferomedial patella
2. Loose bodies
3. Osteochondral fractures
4. MPFL injury
5. Knee extensor mechanism
6. Trochlear dysplasia with validated measurement of the TT-TG distance

Classic bone contusion pattern seen after injuries involving the anterolateral aspect of the lateral femoral condyle and the inferomedial patella
The treatment goals are to prevent further episodes of patellar instability, restore normal strength and function in the knee joint and to prevent further damage to the articular cartilage of the knee joint.

**ACUTE DISLOCATIONS:**

Most first-time patellar dislocations are treated non-operatively unless there is evidence of an osteochondral fracture +/- significant MPFL injury. Patients are often immobilized for a short period of time after an acute dislocation. Rehabilitation in patellar dislocation should emphasize the recovery of full range of motion (ROM), strength, and proprioception. Gluteal muscle weakness should be addressed in addition to quadriceps function. Weight-bearing or closed-chain exercises have been shown to produce more rapid rehabilitative response than open-chain extension exercises have been produced to show a more rapid rehabilitative response when they have regained full range of motion, have no effusion in the knee joint and have 80% quadriceps strength. This typically takes at least 3 months.

**RECURRENT DISLOCATIONS:**

Operative intervention is appropriate for those recurrent patellar subluxations or dislocations, and in those where conservative treatment has failed. More than 100 different operations have been described for the treatment of patellar instability, and these procedures typically involve a combination of lateral release, medial imbrication, distal realignment, and anteromedialization of the tibial tubercle. Determining the appropriate intervention for recurrent patellar dislocation requires locating the causative pathology as:

1. Trochlear Dysplasia
2. Proximal Soft Tissue Compromise
3. Lateralized tibial Tubercle
4. Patella alta
5. Malalignment
6. Generalized Ligamentous Laxity

If multiple pathologies exist, the patient may require multiple procedures.

**LATERAL RELEASE**

Historically, a lateral retinacular release was a commonly performed procedure with the belief that a tight lateral retinaculum predisposed patients to lateral patellar subluxation and dislocation. Isolated lateral releases for patellar instability can be complicated by medial patellar instability if the release extends into, and detaches, the vastus lateralis obliquus. The lateral retinaculum contributes to 10% of medial stability. The addition of a lateral release to medial soft-tissue repairs has been shown to actually decrease the force required to dislocate the patella, compared to medial repair alone. At this time, lateral releases are recommended for treating patients with a stable patella and excessive lateral pressure associated with an increase in lateral patellar tilt. Furthermore, lateral release may be performed in combination with a medial-sided procedure such as a medial plication or a reconstruction of the medial patellofemoral ligament and/or if there is osseous malalignment. They are often required in congenital patellar dislocation surgery due to the extent of the pathology often present in these patients.

**MEDIAL REPAIR:**

There are a multitude of surgical options that have been described to stabilize the medial side of the knee including direct repair, imbrication or plication of the medial retinacular structures. These procedures can be performed as an open +/- arthroscopic technique.

**MPFL RECONSTRUCTION:**

Since the recognition of the importance of the MPFL, there has been increasing interest in treating this important medial patellar stabilizer. There are a number of surgical techniques described to reconstruct the MPFL as well as a number of graft options including autograft hamstrings, allograft tissue and synthetic grafts. The varying techniques all offer satisfactory results. The most important factor to ensure a good outcome includes anatomic reconstruction and ensuring that care is taken to tension the MPFL properly.

**TIBIAL TUBERCLE TRANSFER:**

There are several described techniques to realign the tibial tubercle including Elmslie Trillat, Fulkerson, and distalization. These procedures are geared toward correcting a large Q angle or an increased tibial-talar angle to trochlear groove (TT-TG) offset. The classic Elmslie Trillat procedure involves a lateral retinacular release, emdial capsule reefing and medial transposition of the anterior tibial tubercle hinged on a distal periosseous attachment. One potential complication of a classic Elmslie- Trillat procedure is overloading the medial patellar articular surface which may lead to patellofemoral arthritis.

Another popular tibial tubercle transfer is the Fulkerson procedure. This procedure involves medialization of the tibial tubercle to correct the Q angle and anteriorization of the tibercle which elevates the distal pole of the patella. By elevating the distal pole of the patella, there is a reduction in the contact on the distal patella during early knee flexion.

Finally, distalization of the tibial tubercle is performed in patients with patella alta and instability. Care must be taken not to overly medialisize the tibercle.

**TROCHLEOPLASTY:**

Trochleoplasty is a very technically challenging procedure with variable outcomes. This technique is indicated in severe dysplasia with a troclear bump of greater than 6 mm, trochlear dome, abnormal patellar tracking and/or failed previous surgery. Many methods of deepening the trochlea have been described including elevating the lateral facet and deepening the sulcus). Trochleoplasty has been shown to prevent recurrent instability but the risks include articular cartilage, trochlear necrosis, arthrofibrosis and patellar incongruence.

![Deepening Trochleoplasty](image)
Knee Preservation System™

Medial Patellofemoral Ligament Reconstruction

Medial Patellofemoral Ligament Reconstruction

The medial patellofemoral ligament (MPFL) functions by restraining lateral translation of the patella. MPFL reconstruction re-establishes this restraint, keeping the patella centered in the trochlear groove. Access to areas, such as anterior compartments of the knee, sparing over-tightening the graft and the need for handling of tissue, is the key to successful arthroscopy of the knee.

Prior to the MPFL reconstruction, the knee should undergo a careful examination and evaluation. Knee arthroscopy should be performed to assess the integrity of the cruciate ligaments, determine other pathology, debride and perform any necessary lateral release.

The following technique is described by Dr. L. Romeo Piazza, D.o., Italy, Canada

1 | Medial Patellofemoral Ligament Reconstruction
**BALLY PATTY PREPARATION**

A stainless-steel, grooved, serrated, or allis-gaff can be used. Cut the gaff to 23.4 mm and divide over to create an 1:1 arm ratio. Insertion uses the use of the pattern. Whip stitch approximately 5 cm of each end of the gaff with 63 mm, leaving equal ends of same cut ends.

Measure the diameter of the desired knot size, then knot the gaff with a good score.

**ARCHER PREPARATION**

Prepare two 3-Inch PegLock® arthrotomy anchors by pulling two inches of 5×5.5×6.5 cm through the suture, using the method described in instructions.

Leave a 3.5 cm distance to the dural tube of each PegLock® anchor.

**PATELLAR FIXATION**

Create a bone tunnel over the patellar tendon of the MPFL found at the suprapatellar pouch. The knee is extended 90°. Insert an 18-gauge needle into the tunnel and using a safety pin, take care to leave the needle in place at the site of the drill holes.

Dull two drill bits using the 3.5 mm PegLock® Drill Bit at the outer and inferior edge of the prepared tunnels with the drill bit. Advance the drill bit until the drill hole line is just below the subchondral bone.

Plate each 3-Inch PegLock® anchor and the plate holes at the same angle. The holes are adjusted. Grasp each anchor with a mallet until the horizontal lever is flush with the subchondral bone. Support the first anchor under the knee and using the second anchor, threaded using torsional force to insert the second anchor into the hole. This may prevent devascularization of the bone from the drill.

Confirm the free ends of the prepared gaff through the two loops of MPFL ensures equal ends of 3.5 mm PegLock® anchors.

Bearing momental pressure is maintained on the PegLock® anchors. When tightening the gaff, ensure that the loops are snug and the gaff is not too hefty for the tunnels.

When tightening the aneurysm loops, adjust the gaff to ensure that the two ends are compressed by each aneurysm loop. Repeat the same steps with the second PegLock® arthrotomy anchor.
**FEMORAL PREPARATION**

Create a 3 cm incision over the femoral orientation of the MCL. Place a 7.7 mm Golf Passing Guide 11 mm into the femoral attachment site of the MCL on the femur. Pass the femoral tunnel made to the anterior insertion site of the MCL on the femur. If necessary, make the femoral tunnel made to the anterior insertion site of the MCL on the femur. If necessary, make the femoral tunnel made to the anterior insertion site of the MCL on the femur.

Screw the pin into the femoral tunnel made to the anterior insertion site of the MCL on the femur. If necessary, make the femoral tunnel made to the anterior insertion site of the MCL on the femur. If necessary, make the femoral tunnel made to the anterior insertion site of the MCL on the femur.

**BREAST PASSAGE**

Once the 7.2 x 38 mm passing wire through the distal end of the femoral tunnel made to the anterior insertion site of the MCL on the femur, place a Kelly clamp inside the femoral tunnel made to the anterior insertion site of the MCL on the femur, deep to the epicondylar flare superficial to the capsule of the lateral femoral condyle. Glue the wire to the femoral tunnel made to the anterior insertion site of the MCL on the femur. Glue the wire to the femoral tunnel made to the anterior insertion site of the MCL on the femur.

Lead the passing wire through the epicondylar flare superficial to the capsule of the lateral femoral condyle. Place a clip, advance the pin through the femoral tunnel made to the anterior insertion site of the MCL on the femur. Glue the pin to the posterior femoral condyle. Glue the pin to the posterior femoral condyle.

**FEMORAL FIXATION**

Center the patella in the tunnel by bending the knee to 30 degrees. Position the patella by applying with gentle pressure on the patella using the lateral femoral condyle to make it rest while allowing adequate mobility of the patella.

Once satisfied with the tension on the golf pass a BioTape®® Figure 9®® BioTape® into the femoral tunnel. Insert a CRANE®® 8mm arthroscopic suture to the femoral tunnel over the BioTape®® BioTape® into the femoral tunnel. Insert the craniotubular ligament reconstruction. Suture the craniotubular ligament reconstruction. Suture the craniotubular ligament reconstruction.
Tibial Tubercle Osteotomy

Jack Pank, M.D.
Clinical Associate Professor of Orthopaedic Surgery, Indiana University School of Medicine, Indianapolis, Indiana, U.S.A.

Abstract

The patellar tendon junction presents a complex challenge to the surgeon. There are many surgical options that have been described, but none is universally successful in all cases. Tibial tubercle osteotomy has a long history in the surgical approach to treating patellar problems. The current approach to the patellar tendon is to stabilize it. Prevention of femoral and tibial patellar tracking and tension are the primary goals of the osteotomy. The ultimate goal is to improve patellar tracking and prevent osteoarthritis.

Key words: arthroscopy, arthritis, patellar tracking, patellar instability, patellar osteotomy

Historical Perspective

Tibial tubercle osteotomy represents one technique for treating patellar problems with patellofemoral pain and dysfunctions. The undisputed element of the patellar tendon profusion in the instability, as well as the instability of the patellar tendon, may cause osteoarthritis. The osteotomy is a surgical procedure to treat the patellofemoral joint, which focuses on the bony anatomy.

The patellar tendon is a strong, fibrous cord that attaches the quadriceps muscle to the tibia. The tendon is involved in the function of the knee joint, particularly during activities that require a high degree of knee flexion and extension, such as running, jumping, and climbing. The patellar tendon helps to transfer the force generated by the quadriceps muscle to the tibia, allowing for the extension of the knee joint.

However, when the patellar tendon is injured or diseased, it can cause pain and affect the function of the knee joint. Patellar tendonitis, a common condition, is characterized by pain and swelling over the patellar tendon. Patellar tendinopathy, a more severe form of the condition, can cause a chronic pain and discomfort that may affect the patient's daily activities.

For these reasons, it is essential to understand the surgical options available to treat patellar problems. Tibial tubercle osteotomy may be an effective treatment option for patients with patellar tendinopathy and patellar instability. However, as with any surgical procedure, there are potential risks and complications associated with this approach. It is crucial to carefully consider the individual patient's condition and the potential benefits and drawbacks of the procedure before making a decision.

The patellar tendon is a critical component of the knee joint, and its function is essential for proper knee alignment and joint stability. When the patellar tendon is affected, it can lead to pain, limited range of motion, and decreased function. Tibial tubercle osteotomy is a surgical technique that may be used to address patellar tendon problems. The procedure involves the realignment of the patellar tendon by cutting and shifting the patellar bone. This can help to relieve pain, improve joint function, and prevent further degeneration of the patellar tendon.

The outcomes of tibial tubercle osteotomy depend on various factors, including the patient's age, the severity of the condition, and the surgical technique used. In general, the procedure appears to be effective in managing patellar tendon problems, with improved pain relief and function for many patients. However, it is important to note that results may vary, and some patients may require additional treatments or follow-up care.

Overall, tibial tubercle osteotomy can be a useful option for managing patellar tendon problems. It is essential to carefully consider the patient's condition, the potential benefits and risks of the procedure, and the availability of other treatment options before making a decision. In conclusion, tibial tubercle osteotomy may be a viable option for some patients with patellar tendon problems. However, it is crucial to weigh the potential benefits and drawbacks of the procedure and consider alternative treatment options before proceeding with surgery.
Tibial Tubercle Osteotomy

TABLE 1. Tibial tubercle surgery for specific patellofemoral problems tending to occur with various patellar problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Procedure</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patellar tendinitis</td>
<td>Patellar tendon release</td>
<td>Arthroscopic release, arthroscopy, patellar tendon lengthening</td>
</tr>
<tr>
<td>Patellar fracture</td>
<td>Patellar tendon repair</td>
<td>Internal fixation, arthroscopic debridement</td>
</tr>
<tr>
<td>Patellar instability</td>
<td>Patellar realignment</td>
<td>Soft tissue reconstruction, bone block realignment</td>
</tr>
<tr>
<td>Patellar tendinopathy</td>
<td>Patellar tendon ablation</td>
<td>Arthroscopic debridement, arthroscopic patellar tendon release</td>
</tr>
</tbody>
</table>

TABLE 2. Tibial tubercle surgery for use in conjunction with cartilage restoration

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartilage restoration</td>
<td>Autologous chondrocyte transplantation, osteochondral allograft transplantation</td>
</tr>
<tr>
<td>Cartilage repair</td>
<td>Microporous tantalum, microfracture</td>
</tr>
<tr>
<td>Cartilage resurfacing</td>
<td>Autologous osteoarticular transplantation, osteochondral allograft transplantation</td>
</tr>
</tbody>
</table>

The most common complications in pain or disability that does not have a negative influence on the patient. All other complications must be addressed as well as other factors that may contribute to pain or disability. This includes the use of tibial tubercle osteotomy, patellar resurfacing, and the use of cartilage restoration techniques.

The principles of knee pain and disability that does not have a negative influence on the patient. All other complications must be addressed as well as other factors that may contribute to pain or disability. This includes the use of tibial tubercle osteotomy, patellar resurfacing, and the use of cartilage restoration techniques.
3332

I. Fact

Proper operative approach and joint space narrowing. (b) After complete joint disarticulation and allo- gen transplant procedures and AICP.

FIG. 3. (a) Proximal metaphyseal and joint space narrowing. (b) After complete joint disarticulation and allo- gen transplant procedures and AICP.

FIG. 4. Merchant radiograph.

3. PLANNING

As is evident from the indications of surgery, the first phase of preoperative planning is to plan an accurate and precise operative approach. Operationally, we have observed a more functional approach to surgical technique selection. As with any surgery, the logical and physical body of the patient is involved in the planning. This is often seen in the patient's anatomy, with an extensive internal position of the joint or a region of extensive internal joint space narrowing. These physiological changes will allow increased interpretation of additional studies. While the literature contains many references to different techniques such as CT, dynamic MRI, and fluoroscopes, the large emphasis on abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection. It is important to evaluate the usefulness of the abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection.

MILD MODERATION

As is evident from the indications of surgery, the first phase of preoperative planning is to plan an accurate and precise operative approach. Operationally, we have observed a more functional approach to surgical technique selection. As with any surgery, the logical and physical body of the patient is involved in the planning. This is often seen in the patient's anatomy, with an extensive internal position of the joint or a region of extensive internal joint space narrowing. These physiological changes will allow increased interpretation of additional studies. While the literature contains many references to different techniques such as CT, dynamic MRI, and fluoroscopes, the large emphasis on abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection. It is important to evaluate the usefulness of the abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection.

TYPICAL TECHNIQUES

As is evident from the indications of surgery, the first phase of preoperative planning is to plan an accurate and precise operative approach. Operationally, we have observed a more functional approach to surgical technique selection. As with any surgery, the logical and physical body of the patient is involved in the planning. This is often seen in the patient's anatomy, with an extensive internal position of the joint or a region of extensive internal joint space narrowing. These physiological changes will allow increased interpretation of additional studies. While the literature contains many references to different techniques such as CT, dynamic MRI, and fluoroscopes, the large emphasis on abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection. It is important to evaluate the usefulness of the abnormality MRI, joint distraction, and the use of special imaging systems to create various locations such as the Merchant view (Fig. 4) with weight-bearing AP and lateral views (Fig. 5A, B) supplemented with direct arthroscopic visualization of the joint and the operative procedure (a key point in this discussion). The information is also immediate and allows for a more functional approach to surgical technique selection.
through holes in the cutting block that will hold in the tibia. An\nincising saw (irrigated) makes the cut, fully\nsevering posterior meniscus and extended \nexcavation (Fig. 9). The sciatic nerve is identified during \nthe anterior approach of the patellar\ntrucks to the tibia. The tibia is fully released after \na slightly oblique transverse cut is made from the lateral \naspect of the patellar truck to the proximal attachment to the\nmedial side. The truckers is then tied (Fig. 10). In open\nsurgery, isometric anastomosis is achieved, the patellar and\npatellar may be reflected superiority, fully exposing the\ntrucks and patellar surface. After the desired truckers position is\nachieved, it is fixed with the referenced techniques.\nIf the elevated, medial trucker of the truckers is sharp and\nimpregnating as well, it is trimmed with a reamer (Fig. 11). Figures 12\ndemonstrate intramedullary elevation measured.\n
Anastomosis\nThe elbow anastomosis is the most critical aspect of the\nprocedure. The elbow is in a neutral position, which\nrequires the elbow to be brought posterior. Multiple\nvariations are available for revision to the literature. Today, with\ndemonstration of a lower complication rate using the Fulkerson\nAMZ, the AMZ technique may be modified to other\nanastomosis without modification. The technique\nbegins like a standard AMZ, except the elbow is in a\nneutral position. To avoid cutting through the posterior\nmedial collateral ligament, an additional (non-essential)\npatellar cut is made just anterior to the posterior aspect of the\nmediolateral. As a result, the tibia contacts the \nankle joint, rather than penetrate the posterior cortex.\nAlternatively, first a standard \nAMZ cut is made, but it is an extremely deep slice. This\nis followed by inserting a local anesthesia block. This \nblock is the thickness of the measured\nelevation, which is most critical. Once the procedure results in \nelevation measured (Figs. 9, 10).\n
Anastomosis\nThe elbow anastomosis is the most critical aspect of the\nprocedure. The elbow is in a neutral position, which\nrequires the elbow to be brought posterior. Multiple\nvariations are available for revision to the literature. Today, with\ndemonstration of a lower complication rate using the Fulkerson\nAMZ, the AMZ technique may be modified to other\nanastomosis without modification. The technique\nbegins like a standard AMZ, except the elbow is in a\nneutral position. To avoid cutting through the posterior\nmedial collateral ligament, an additional (non-essential)\npatellar cut is made just anterior to the posterior aspect of the\nmediolateral. As a result, the tibia contacts the \nankle joint, rather than penetrate the posterior cortex.\nAlternatively, first a standard \nAMZ cut is made, but it is an extremely deep slice. This\nis followed by inserting a local anesthesia block. This \nblock is the thickness of the measured\nelevation, which is most critical. Once the procedure results in \nelevation measured (Figs. 9, 10).\n
Anastomosis\nThe elbow anastomosis is the most critical aspect of the\nprocedure. The elbow is in a neutral position, which\nrequires the elbow to be brought posterior. Multiple\nvariations are available for revision to the literature. Today, with\ndemonstration of a lower complication rate using the Fulkerson\nAMZ, the AMZ technique may be modified to other\nanastomosis without modification. The technique\nbegins like a standard AMZ, except the elbow is in a\nneutral position. To avoid cutting through the posterior\nmedial collateral ligament, an additional (non-essential)\npatellar cut is made just anterior to the posterior aspect of the\nmediolateral. As a result, the tibia contacts the \nankle joint, rather than penetrate the posterior cortex.\nAlternatively, first a standard \nAMZ cut is made, but it is an extremely deep slice. This\nis followed by inserting a local anesthesia block. This \nblock is the thickness of the measured\nelevation, which is most critical. Once the procedure results in \nelevation measured (Figs. 9, 10).
FIG. 7. Tibial tubercle medilization.

FIG. 8. AMF saw cut.

Distalization
As noted previously, distalization is most commonly used in conjunction with other pelvic tibial procedures that are addressing segmental pelvic instability in which there is a component of patellar tilt. The tibia is approached as per the medilization technique above, but before the knee cap is retracted, a saw is used to make two vertical cuts. The distal cut is made when a line across the tubercle will be translated with distalization. A vertical cut is made in this cut, a resected cap is made. The distance between the cuts

FIG. 9. Measuring tibial alignment.

FIG. 10. Tibial tubercle osteotomy.

FIG. 11. Final AMF, surgeon trimming tubercle.

Determines the amount of distalization that will occur (Fig. 13). The goal is to maximize the patellar height, not in regard to the tibia. If distalization is also desired, the more proximal cut is made slightly obliquely such that when reduction occurs, the tibia can outsize the blades with the tibia cut (the obliquely hinged axes account the rotation of the tibia and may be malaligned, as the amount of rotation is anatomically imperative). During evaluation of the final position, a tibial cortex hole is made, through which a K-wire is inserted. This can allow rotation of the tubercle as it is aligned by the blade with distalization. Final fixation is performed with two screw-fragment screws. Figures 10, 11, 12, and 13 show preoperative and postoperative radiographs in which minor distalization was used in conjunction with medilization of the tibia performed to medilization the
Distalization

![Image of distalization procedure]

Distalization is only one part of a more extensive surgery to address the pathology before other treatments. The precise nature of the surgery will depend on the patient's condition and the specific pathology involved.

**REFERENCE**

Fig. 14: (A) Preoperative ALZ (ante-humerus medullary P. anterograde lymphogranular injection); (B) Nine years postoperative ALZ (ante-humerus medullary P. anterograde lymphogranular injection).

**RESULTS**

As shown, the lymphatic system is only one part of a comprehensive approach to the patient's condition. Further treatments may be required for optimal recovery.

**COMPLICATIONS**

Each of the procedures comes with unique complications. In general, with any medullary procedures, a common complication is that of a technically successful procedure, but with an unhappy pa-
The concurrence of techniques that they are based on clinical observation and the theory of alignment. Some practitioners arrange their operations in such a way as to be not only more efficient but also to suit the needs of the particular question at hand. The more extensive a surgical procedure is, the more time it will take to accomplish it.

**Postoperative Management**

Many of these techniques may be performed on an outpatient basis, but in the case of more extensive or concurrent surgeries, hospital admission for postoperative observation is indicated. If there is a concern for a standard inpatient regimen, early postoperative recovery is essential. To facilitate early mobility and rehabilitation, early ambulation can be encouraged by prolonged weight-bearing, which is combined with 2 to 3 days per week of study where the patient is gradually returned to usual activities. Weight-bearing is initiated with respect to the extent of the surgery, and all weight-bearing may be done with a normal gait. Free movement is begun immediately. If quadriiceps strength occurs, rapid quadriceps re-education is initiated with isometric and functional electrical stimulation. In light of the complex nature of the postoperative patient, early use of a physical therapist can be timely. In the postoperative period, the patient is usually ambulated in the office every 3 to 4 weeks for the first 3 months, and free walking and agility in the initial radiographic with 6 to 8 weeks. If knee is uneventful, pain is controlled, and strength is normal, ambulate patients may be released to remote follow-up (6-12 weeks) (Fig. 10).

![Figure 10: Prophylactic cancerous plus repletion ( Immediate radiographic)](https://www.zoo.com)

FIG. 10. Prophylactic cancerous plus repletion (Immediate radiographic).

Proximalization

**Step 1**

For marked paresis of the flexor muscles, assessment of the fascia of the flexor tendo in the region of the flexor carpi radialis (FCR) and flexor carpi ulnaris (FCU).

**Step 2**

After a few more degrees of flexion, the fascia cutaneous muscle is released from the flexor tendo in the region of the flexor carpi radialis (FCR) and flexor carpi ulnaris (FCU).

![Figure 20: Prophylactic of flexor tendo in the region of the flexor carpi radialis (FCR) and flexor carpi ulnaris (FCU).](https://www.zoo.com)

FIG. 20: Prophylactic of flexor tendo in the region of the flexor carpi radialis (FCR) and flexor carpi ulnaris (FCU).

![Figure 31: Prophylactic plus repletion (Immediate radiographic).](https://www.zoo.com)

FIG. 31: Prophylactic plus repletion (Immediate radiographic).

![Figure 41: Prophylactic plus repletion (Immediate radiographic).](https://www.zoo.com)

FIG. 41: Prophylactic plus repletion (Immediate radiographic).

![Figure 51: Prophylactic plus repletion (Immediate radiographic).](https://www.zoo.com)

FIG. 51: Prophylactic plus repletion (Immediate radiographic).

![Figure 61: Prophylactic plus repletion (Immediate radiographic).](https://www.zoo.com)

FIG. 61: Prophylactic plus repletion (Immediate radiographic).

**Postoperative Management**

Many of the techniques may be performed on an outpatient basis, but in the case of more extensive or concurrent surgeries, hospital admission for postoperative observation is indicated. If there is a concern for a standard inpatient regimen, early postoperative recovery is essential. To facilitate early mobility and rehabilitation, early ambulation can be encouraged by prolonged weight-bearing, which is combined with 2 to 3 days per week of study where the patient is gradually returned to usual activities. Weight-bearing is initiated with respect to the extent of the surgery, and all weight-bearing may be done with a normal gait. Free movement is begun immediately. If quadriiceps strength occurs, rapid quadriceps re-education is initiated with isometric and functional electrical stimulation. In light of the complex nature of the postoperative patient, early use of a physical therapist can be timely. In the postoperative period, the patient is usually ambulated in the office every 3 to 4 weeks for the first 3 months, and free walking and agility in the initial radiographic with 6 to 8 weeks. If knee is uneventful, pain is controlled, and strength is normal, ambulate patients may be released to remote follow-up (6-12 weeks).
REFERENCES


Techniques in Knee Surgery