Rehabilitation of Knee Injuries

- Functional Anatomy and Biomechanics
- Medial Collateral Ligament
- Lateral Collateral Ligament
- Anterior Cruciate Ligament
- Posterior Cruciate Ligament
- Chapter 21

Functional Anatomy and Biomechanics

- Knee is part of the kinetic chain and is directly affected by actions occurring at the foot, ankle and lower leg
  1. Transmits forces to the hip, thigh, pelvis and spine
  2. Hinge joint with some degree of rotation and translation
  3. Support provided by ligamentous structures and muscles
- Joint designed primarily for providing stability during weight bearing and mobility during locomotion
  - Even with ligamentous support, joint unstable medially / laterally
- Motion
  - Flexion, extension, rotation, rolling and gliding
  - Screw home mechanism
- Locking of the knee

**Muscle Function**

**Knee Flexion**
- Bicep femoris, semimembranosus, semitendinosus, gracilis, sartorius, gastrocnemius, popliteus and plantaris

**Knee Extension**
- Rectus femoris, vastus lateralis, intermedius and medialis

**External Rotation**
- Biceps femoris

**Internal Rotation**
- Popliteus, semitendin / semimembranosus, sartorius, gracilis

**Dynamic Lateral Stability**
- Iliotibial band

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**Rehabilitation Techniques**

- **OKC**
  1. ex increases tibial translation, may be contraindicated
  2. OKC ex also increase rectus femoris activity
  3. Increased shear forces and patellofemoral compressive forces with OKC ex (at specific angles)

- **CKC**
  1. generate more vasti musculature strengthening and joint compressive forces than OKC ex
  2. best utilized during dynamic stability and functional mvt techniques
  3. Must be aware of potential joint stresses at varying degrees of motion during strengthening

- ROM lost due to injury, early mobilization - histological changes ligamentous tissue encounter - water content collagen cross linkage

- Re-establish accessory motions of tibiofemoral, tibiofibular and patellofemoral joints

- Principles of water (buoyancy, hydrostatic pressure and viscosity)
  - progress through the continuum of variable depths
  - Increasing water resistance

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**Medial Collateral Ligament Sprains**

**Pathomechanics**
- Injury occurs either proximally (minimal laxity) or nearer the insertion (less stiffness/more laxity)
  - May have associated damage to medial meniscus
- Graded injury

**Injury Mechanism**
- Result of laterally applied valgus force to knee, occasionally in concert with rotational forces
- Rarely a non-contact injury
Rehabilitation Concerns
- Immobilization generally effective (with intact ACL)
- For adequate healing
  • ligament fibers must remain in continuity
  • adequate stress to stimulate healing must be provided
  • protection from harmful stresses
- Possible residual laxity due to stretch of ligament
  • Minimal effect on knee function
- Symptomatic treatment with weight bearing ASAP

Rehabilitation Progression
- Initially RICE and modalities to treat pain and InF
- Crutch progression to full weight bearing as tolerated
  • Progress to no lag in extension and normal gait
  • Grade 2 - 1-2wks immobilization may be necessary
- Grade I - early ROM/quad str ex begin 1-2 days post-inj
  • Quad sets, STLR’s, knee slides, riding a stationary bike

- Grade II - may require 4-5 days for InF to subside
  • As pain continues to subside, ROM improves initiate OKC ex
  • CKC ex can also begin as tolerated
  • PNF, plyometric ex and functional activities should also be incorporated gradually to enhance dynamic stability
- Grade III - Bracing 2-3wks 0-45° → 2-3wks 0-90°
  • ISO quad sets and SLR str ex performed as tolerated
  • Non-weight bearing with crutches for 3wks
  • Strengthening program progress as with grade I and II
**Criteria for Return to Play**
1. Regained full ROM
2. Equal strength bilaterally
3. No tenderness
4. Successful completion of functional performance tests

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**Lateral Collateral Ligament Sprains**

Pathomechanics
- Isolated injuries are rare due to secondary stabilizers
- Often result of stress placed on lateral aspect of knee
- Majority of injuries occur at proximal and distal attachments
- May be associated with injuries to ACL, PCL, posterolateral joint capsule, and peroneal nerve
- Injuries graded based on physical examination

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**Injury Mechanism**
- Result of varus stress on knee

Rehabilitation Concerns
- Determine extent of laxity
- Grade I or II injuries → degree of weight bearing
- Grade II will result in 4-6wks non-operative management
  - If rotational instability is associated with grade III injury surgical repair will be necessary
Rehabilitation Progression

- Follows the same course as MCL injuries
- Surgical intervention (bracing with partial weight bearing required for 4-6wks)
  - followed by a gradual progressive rehab program
- Return to activity = 6mths

Criteria for Return to Play

1. Regained full ROM
2. Equal strength bilaterally
3. No tenderness
4. Successful completion of functional performance tests

Anterior Cruciate Ligament Sprain

Pathomechanics

- Often occurs with cutting and jumping activities
- Injury generally involves a mid-substance tear
  - ACL deficient knee refers to grade III sprain
  - complete tear of ACL
- Generally accepted that torn ACL will not heal
- Exhibits rotational instability that may lead to functional disability
- Additionally, may experience tears in meniscus and degenerative joint changes due to instability

Injury Mechanism

- Non-contact injury twisting motion with foot planted and the athlete attempts to change direction
  - Results in deceleration, valgus stress and external rotation
  - Occasionally internal rotation is involved
- Knee hyperextension with internal rotation
Tears resulting from a valgus force disrupting MCL, ACL and medial meniscus termed unhappy triad.

Stop-jump landing phase of movement implicated in injury.

Risk Factors
- Shoe-surface interaction
- Femoral intercondylar notch, ACL size, lower extremity alignment
- Hormonal evidence
- Mechanics of the lower extremity and trunk

ACL Injury Prevention
- Multiple on-going studies
- Establishment of pre-habilitation programs
  - Proprioceptive balance training in conjunction with weight training and jump-landing strategies
  - Non-contact lower-extremity injury prevention plan (NC-LEIPP) program focuses primarily on group jump-landing strategies

Rehabilitation Concerns
- Conservative approach
  - Allow acute phase of injury to pass and follow up with aggressive rehabilitation
  - If required level of stability is not attained surgical intervention
  - Approach utilized with more sedentary individuals

- Surgical intervention
  - Largely dependent on patient selection
    - Highly athletic individual, unwilling to change lifestyle
    - Rotational instability and giving way with daily activity
    - Additional structures are also involved
    - Failure of rehabilitation following 6 month period
    - Surgery necessary to prevent early joint degenerative changes


**Rehabilitation Progression (Non-Operative)**

- Control pain/swelling, RICE, modalities and NSAID's
- Immobilization for protection and comfort
- Ambulation on crutches until extension is recovered (no extension lag in gait)
- Progress immediately to quad set, STLR's to regain motor control and prevent atrophy
- Early ROM work
  - heel/wall slides, stationary bike

- OKC ex
  - Flexion and extension ex - restrict motion to 0-45° first 8-12wks
  - Gastroc and hamstring strength critical

- CKC ex
  - Encourage co-contractions

- Utilization of PNF patterns that stress tibial rotation

- Functional knee brace utilization – controversial
  - Is it functional
  - Joint position sense feedback

- Patient instructions with regard to activity
  - Lifestyle changes may be necessary to prevent further injury and the need for surgery
Rehabilitation Progression (Surgical Intervention)

– Conservative vs. Accelerated

  • Slow progression emphasis
    – Slow progression to flexion and extension
    – Partial non-weight bearing post-operatively
    – CKC exercises at 3-4 wks
    – Return to activity 6-9 mths

  • Accelerated protocol
    – Immediate motion and weight bearing to tolerance
    – Early CKC for strength and neuromuscular control
    – Return to activity 2 mths and competition 4-5 mths

– Pre-operative period (2-3 wks)

  • Improve ROM, decrease pain and swelling
  • Re-establish quad control and normalize gait prior to surgery

– Post operative period

  • Changes in tensile strength
  • Early tensile strength levels are high = aggressive rehab
  • Graft necrosis (6 wks) revascularization (8-16 wks) and remodeling (16+ wks)

– Swelling Control

  • RICE (Cryocuff) and modalities
  • Significant swelling will limit quad firing

– Bracing

  • Locked in either full extension or 0-90° passive and 40-90° active ROM for first 2 wks
  • Brace will be used until flexion exceeds limits of brace

– Weight bearing (2-6 wks)

  • Begin at 50% and work to full
  • Crutches removed swelling is minimal, no extension lag and good quad strength with relatively normal gait

– Range of motion

  • Begin immediately
  • Continuous passive motion units
  • Must regain knee extension
  • Active knee extension should be limited (60-90°)
  • Active knee flexion achieved (90°) by end of second week, full flexion at weeks 5 or 6
  • At 100-110°, cycling can begin to help regain ROM
– Early patellar mobilization to enhance return of ROM
– Strengthening
  • Avoid high level stress on graft early on
  • Controlled strengthening of all muscles with emphasis on hamstrings
  • CKC ex can begin when 90° of flexion is achieved (1-2 wks)
  • Minimize OKC ex to reduce stress/shear forces

– Isokinetic testing
  • Timing relative to rehabilitation program
– PNF strengthening – rotational component is critical
  • Initiate progressive resistance at 5 mths (OKC ex)
– Neuromuscular control
  • In addition to CKC ex BAPS board (seated) should also be integrated
  • Balance training (BAPS board, Filter)

– Cardiorespiratory endurance
  • Cycling, UBE
  • Walking on treadmill can begin at 3 wks
  • Swimming at 4-5 wks, X-country skiing 6-7 wks
  • Jogging and running 4-6 mths depending on program
– Functional training
  • Gradually incorporate running, jumping and pivoting activities in controlled environment
  • Single, double leg hop, carioca, shuttle runs, vertical jump
  • 5-6wks for accelerated program and 4 mths for traditional training
– Movement Technique Assessment
  • Determine deficits and incorporate into training progression
  • Assess technique and muscle activity
  • Eliminate areas of predisposition for future injury
Criteria for Return to Play
1. Physicians will vary depending on surgical techniques and rehabilitation progressions
   • Vary anywhere from 4-12 mths
2. No joint effusion
3. Full ROM
4. Isokinetic testing indicates quad/hamstring strength within 85-100% of uninvolved side
5. Satisfactory ligament stability (KT 1000)
6. Successful progression walking → running
7. Successful performance during functional testing

Posterior Cruciate Ligament Sprains
Pathomechanics
- Not commonly injured in athletics
- Often concurrently injured ACL, MCL, LCL or menisci
- Controls rolling and gliding of tibia with ACL
- Prevents posterior translation of the tibia on the femur
- Meniscal lesions and chondral defects likely with PCL deficient knees
- 70% of tears occur at the tibia
  • remaining 30% are split at the femur and mid-substance

Injury Mechanism
- Knee is forced into hyperflexion with foot plantar flexed
- Posteriorly driven tibia on fixed femur
- Anteriorly forced femur on tibia
- Knee hyperflexion with downward force on thigh
- Hyperextension may result in combined PCL/ACL injury

Rehabilitation Concerns
- Altered arthrokinematics
- Surgical vs. non-operative
Rehabilitation Progression (Non-operative)

- Swelling and pain control initially
- Immobilization for comfort and protection initially
- Early ROM and strengthening should be initiated
  - General strengthening
  - Focus on quadriceps
    - Work initially in the 20-45° range
    - Avoid OKC hamstring work due to posterior tibial translation
  - Incorporate CKC ex to emphasize co-contractions
  - Functional knee braces are often not recommended
    - Possible proprioceptive/joint position sense benefits
  - Avoid repetitive stressful activities due to the incidents of progressive degenerative changes

Rehabilitation Progression (Surgical Intervention)

- Maturation and healing process not well documented
- Limit pain and swelling with RICE and NSAID’s
- Immobilization in full extension for first week
- During second week the brace should be unlocked for ambulation and PROM exercises
- The brace should be worn for 4-6 wks until flexion 90-100°
- Crutch use should occur for 4-6 wks until full weight bearing and can achieve full extension

- Quad ex and general hip musculature strengthening should begin at wks 2-4
  - Again, avoid knee flexion
- At 4-6 weeks CKC ex should begin
  - Utilize terminal knee extension
- Incorporate NM control activities
- Cycling can begin at 6 wks (100-110°)
- Progress to jogging at 9 mths
- Incorporate functional training
Criteria for Return to Play

1. No joint effusion
2. Full ROM
3. Isokinetic testing indicates quad and hamstring strength within 85-100% of uninvolved side
4. Successful progression walking → running
5. Successful performance during functional testing