Lateral Retinacular Release of the Patella

and its relation with proximal and distal realignment procedures

Surgical Indications and Considerations

Anatomical Considerations: Two components of knee extensor mechanism primarily affect the limits of medial and lateral patellar displacement: bony constraints and ligamentous tethers. Fulkerson and Gossling described the lateral retinacular structures from superficial to deep as: the fibrous expansion of the vastus lateralis muscle, the superficial oblique retinaculum (iliotibial band to lateral border of the patella and patellar tendon), the deep transverse retinaculum (from iliotibial band to lateral patellar border) bordered superiorly by the epicondylopatellar ligament and inferiorly by the patellotibial ligament, and the capsulosynovial layer. Fascial interconnections between fibers of the iliotibial band, lateral hamstrings, lateral collateral ligament, and lateral quadriceps comprise the lateral retinaculum.
The medial retinacular structures from superficial to deep are the fascia over the sartorius muscle, the medial patellofemoral ligament (MPFL), the vastus medialis oblique muscle (VMO) and the retinaculum, and the medial collateral ligament and joint capsule. The primary restraint to lateral displacement is the medial patellofemoral ligament (MPFL). Slips of the vastus medialis oblique muscle insert into the MPFL. Contraction of the VMO tensions the MPFL – providing (approximately) a 60% contribution of this ligament force limiting lateral patellar dislocation.

Pathogenesis: The most common reasons for anterior knee pain are: overuse, patellofemoral malalignment, and trauma. Malalignment leads to instabilities (dislocations and subluxations), and overload of the retinaculum and subchondral bone. Patellar dislocations and subluxations can be categorized by chronicity (acute vs chronic), direction (medial vs lateral) and cause (traumatic vs non traumatic). Patellar instability can be predisposed by certain anatomic factors: patella alta, tightness of lateral structures, increased Q-angle (lateralization of the tibial tubercle), increased sulcus angle, excessive femoral anteversion, external tibial rotation, genu valgum, pes planus, hypoplastic lateral trochlear ridge, generalized laxity, weak or hypotrophic vastus medialis oblique, and hypertrophic vastus lateralis. Another factor is the altered motor control/strength of the hip abductors and external rotators during weight loading activities. Also, intra-articular effusion has been shown to lead to vastus medialis inhibition as well. With inhibition of this muscle, the oblique fibers of the vastus medialis are not effective in tracking the patella medially during extension predisposing the patient to experience patellofemoral pain.

Chain of events in lateral instability: Patellar tilt resulting from a tight lateral retinaculum can exert over time lateral retinacular strain and increased pressure on the lateral facet of the patella leading to lateral patellar compression syndrome or even excessive lateral pressure syndrome, heralded by arthrosis of the lateral patellofemoral joint. The syndrome is then primarily the result of chronic lateral tilt, with subsequent lateral retinacular shortening and tightening. This continues the lateral facet overload, and articular cartilage degeneration results in osteoarthritis (chronic imbalance of facet loads). In addition, studies have demonstrated MPFL tears at the adductor tubercle in patients with lateral patellar dislocation.

Epidemiology: Historically, it has been considered a primarily female disorder, however some studies clearly show a male preponderance. Based on the research done, it cannot be said what the relative risk of patellar dislocation is among males and females. Subluxation and dislocation occur most frequently laterally, though medial instability can occur as a result of trauma or overaggressive surgical treatment. There is a higher incidence of acute instability in young active patients between the ages of 13-20, with less incidence over age 30, reoccurrence is higher in patients who dislocate at younger than 15. A recurrent rate up to 44% in non-operatively managed patients has been reported. Fourteen to forty-nine (14%-49%) percent of patients who sustain a primary acute dislocation will experience recurrent dislocation. Acute dislocation is seen predominantly in football and basketball players.

Diagnosis

- History of dislocation with giving way
- Anterior knee pain with prolonged knee flexion, ascending or descending stairs.
- Peripatellar retinaculum tenderness
- Effusion
- Crepitus
- Postitive apprehension test (Fairbank sign)
- Positive quadriceps pull test
- Other clinical findings may include:
    - Patella alta: most consistent physical examination feature associated with patellar instability
    - Patellar hypomobility (positive on glide if medial patellar excursion is less than ¼ of greatest patellar width, positive on tilt if decreased)
    - Increased Q angle (10° ± 5° for men and 15° ± 5° for women)
    - Increased Sulcus angle (normal = <150 degrees)

  Imaging studies that help confirm the diagnosis:
    - X-rays: Axial view (tilt, patellofemoral incongruence), lateral view (rotational malalignment, trochlear dysplasia)
    - CT: Patellar tilt angles are taken from three midpatellar transverse tomographic images at 15, 20, 40, and 60 degrees of flexion
    - MRI

  Arthroscopy also has a role in confirming the preoperative diagnosis of patellofemoral malalignment

The diagnosis is best made on the basis of the **history, physical examination and radiographic examination** (X-rays, CT scan).

Nonoperative Versus Operative Management: Consists of weight reduction, medial quadriceps and hip external rotator muscles strengthening, hamstrings and quadriceps stretching, mobilization of the tight lateral retinaculum, kinetic chain balancing, orthotic devices, correction of foot pronation, low impact loading exercises, taping and bracing and oral anti-inflammatory medication. It has been reported that 80% of symptomatic patellofemoral disorders respond to non-operative treatment.

Surgical Procedures:

Arthroscopic lateral release is primarily indicated for patients with persistent anterior knee pain despite of supervised physical therapy with a tight lateral retinaculum clinically and radiographically documented by lateral patellar tilt, a tender lateral retinaculum, a medial glide of two or less quadrants, a normal Q-angle, and minimal or nonexistent patellofemoral chondrosis. The superomedial portal is established 3-6 cm proximal to the superior pole of the patella in line with the medial edge. Excessive superior extension should be avoided so as not to damage the vastus lateralis muscle. The entire retinaculum is released, paralleling the lateral edge of the patella. At the superior aspect of the patella, the release should stay posterior. The patella should be able to tilt 70 to 90 degrees.

Goal: Allow the patella to seek a central position and prevent lateralization of the patella.

Complications: Hemarthrosis, infection, medial patellar subluxation if excessive lateral release. An isolated lateral release has poor prognosis in patients with patella alta, an abnormal q-angle or a hypoplastic trochlea.

Some studies reported better results when this release was combined with another procedure on the medial retinaculum. Many investigators suggest performing a lateral release if there is a residual patellar tilt after repair/reconstruction or reefing (tightening the medial structures) of the medial retinacular structures.

Other **proximal realignment** procedures include reefing (mentioned above, open or via arthroscopy) and the advancement of the vastus medialis oblique (VMO), which involves reattaching the VMO insertion more distally and laterally on the patella.

Goal: Restore patellofemoral alignment in recurrent subluxation or dislocation and to centralize the patella after a lateral retinacular release.

Complication: Reflex sympathetic dystrophy (possible entrapment of the saphenous nerve).

The lateral retinacular release and the other proximal realignment procedures do not address bone malalignment. Studies have reported a 86% return to previous level of activity within 3-4 months for individuals having a proximal realignment procedure.

Distal realignment consists of transferring the patellar tendon and tibial tubercle medially. Soft tissue distal realignment involves transferring the medial 1/3 of the patellar tendon to the tibial collateral ligament. Osteotomy involves reorienting the tibial tubercle medially or antero-medially to reduce the Q-angle.

Goal: correct patellar tracking on the skeletally mature patient with recurrent subluxation/dislocation, or an increased Q-angle, and unload damaged articular surfaces.

Indications for surgical procedures are: failure of nonoperative care, osteochondral injury, patella instability, disruption of MPFL-VMO, high level athletic demands and risk factors.

Surgical Outcomes: 79% obtain good to excellent functional outcome after lateral release with a combined VMO advancement and tibial tubercle transfer (Palmer 2004).

Preoperative Rehabilitation:

- Control pain and inflammation: **p**rotection, **r**est, **i**ce, **c**ompression, **e**levation (if acute)
- Maintain or improve strength and flexibility of the quadriceps and the hamstrings
- Improve general lower extremity alignment
- Patellar bracing and taping to prevent more damage

POSTOPERATIVE REHABILITATION
Lateral Retinacular Release

The following is a general guideline for the rehabilitation after lateral retinacular release. Advancement of the patient to the next phase should be considered on an individual basis taking also into consideration the surgeon's directives.
The overall goal of rehabilitation is to reestablish appropriate extensor mechanism function and reduce patellofemoral contact forces.

Phase I: *Immediate Postoperative* – Weeks 1-2

Goals: Control postoperative pain and swelling
Protect tissues in the process of healing limiting range of motion
Improve muscle function of the lower extremity, specially quadriceps and VMO
Improve range of motion: 0º- 115º knee flexion and full knee extension
Full weight bearing if extension ROM is controlled by muscle
Independent ambulation

Intervention:

- Pain, inflammation and hemarthrosis management: Cryotherapy, compression bandage, elevation and ankle pumps
- ROM: Early range of motion is needed to ensure that the lateral structures are maintained in an opened or released position.
  * Knee flexion: 0-1 week: 0º- 90º flexion, 75º by day 3, 110º-115º by week 2.
  * Knee extension: full.
- Brace: 0-2/4 wks – locked in full extension, removed for rehabilitation
  * Some do not recommend the use of immobilizers
- Weight bearing: immediate post-operative ambulation with crutches, weight bearing as tolerated (WBAT). Full by 2 weeks
- Therapeutic Exercise:
  Quadriceps sets at full extension progressing to multi angle isometrics
  Electrical stimulation for VMO
  Hip external rotators strengthening
  Heel slides and wall slides
  Non-weight bearing gastrocnemius/soleus, hamstring, ITB, hip flexors stretching
  4-way SLR with brace locked in full extension.
    * Begin abduction at approximately 3 weeks to minimize lateral pulling of this muscle group on the patella.
  Patellar mobilization (when tolerable)
  Aquatic therapy at 2 wks (when wound is healed) with emphasis on gait training
  Stationary bike for ROM when sufficient knee flexion is achieved

Phase II – Weeks 3-5

Criteria for progression: Well-controlled swelling and pain
Good quadriceps strength and control

ROM: 90º of active knee flexion and full active knee extension
Full weight bearing

Goals: Increase lower extremity strength and flexibility: 70% muscle reconditioning
Control of quadriceps and VMO for proper patellar tracking
Exercise swelling controlled
Improve gait pattern, balance and proprioception.
Establish home exercise program
Independent activities of daily living

Intervention:

- Brace: if brace is used, discontinue use for sleeping, brace at 0º-60º when ambulating
- Weight bearing: WBAT without crutches if:
  * Full active knee extension, active 90º- 100º knee flexion, non-antalgic gait pattern, and no extension lag with SLR.
  * Patient can progress from two to one crutches, and then ambulate without them.
- ROM: Knee flexion: Week 2: 100º-115º
  Week 3: 115-125º
  Knee extension: 60º-0º
- Therapeutic Exercise:
  45º flexion with heel slides
  Complete lower extremity flexibility: Quadriceps, ITB and hip flexors stretching and progress to weight-bearing gastrocnemius/soleus stretching
  Calf raises
  4 way hip exercises
  Wall slides progression (0-45º) to mini squats
  Closed chain kinetic terminal knee extension with resistive tubing or weight machine, and open chain reconditioning.
  Balance and proprioceptive activities
  Stationary bike
  Treadmill walking with emphasis on normalization of gait pattern
  Aquatic therapy
  Aerobic reconditioning

Phase III Week 6 weeks return to activity

Criteria for progression: Good to Normal quadriceps strength
Non-antalgic gait
No evidence of lateral patellar tracking or instability
Pain is controlled and associated with activity only
Clearance from physician to progress closed-chain exercises and resume full or partial activity
Necessary joint range of motion, muscle strength, and endurance to safely return to athletic participation
Knee extension: 70% of contralateral side.

Goals: Restore any residual loss of ROM
Improve functional strength and proprioception
Return to appropriate activity level
Maintenance program development

Intervention:

- Brace: for activity only
- Therapeutic Exercise:
  - Endurance – swimming, stairmaster
  - Complete lower extremity flexibility
  - Continue balance activities and gait training
  - Progression of closed-kinetic chain exercises and proprioception exercises
  - Step-ups - 2 inches progress to 8 inches: forward and lateral
  - Stationary bike – moderate resistance
  - Leg press 0-45 degrees of flexion
  - 0-70º wall squats
  - Knee extension 90-0º
  - Toe raises, hamstring curls
  - Jogging/running in pool with resistance
    - * Walk/jog progression, Jogging in pool with progression to land
    - * Forward and backward running, cutting, figure 8's
  - Slide Board
  - Plyometrics
  - Emphasis on sport/work -specific activity development

Return to sports when the knee is pain free, near full ROM has been obtained, and they have achieved at least 80% strength as compared with the opposite leg. Most patients are able to go back to sports by four to six months (Arendt, Fithian and Cohen 2002).

POSTOPERATIVE REHABILITATION
Proximal Realignment Procedures

After a combined proximal and distal realignment, the protocol for distal realignment is suggested.

Phase I: for *Immediate Postoperative* – Weeks 1-4

Goals: Control pain and inflammation
Activation of quadriceps and VMO
Full knee extension and reestablish 0º-110º knee flexion
75% weight bearing progression
Reestablish patellar normal glide
Note – with VMO advancement: Early flexion may stretch the advancement
Delay quad strengthening for tissue healing

Intervention:

- Pain and swelling management
- ROM: 0-1 wk: 0-30ºof flexion, 2 wks:0-60º, 3 wks: 0-90º, 4 wks:0-110º
  (others recommend no more than 90º for 4 weeks)
- Brace: 0-4 wks – locked in full extension and by 6 weeks unlocked for ambulation
  * Other studies: in full extension for 1 week then unlocked and by 3 weeks discontinued.
  * Some do not recommend brace locked, but brace as ROM limiting only
- Weight-bearing: with two crutches, from toe touch to 75% WB by end of phase
- Therapeutic Exercise:
  Muscle reeducation: initiate multi-angle exercises
  Heel slides 0-60º
  Non-weight bearing gastrocnemius/soleus, hamstring and ITB stretches
  4-way SLR with brace locked in full extension
  Patellar mobilization (when tolerable)
  Aquatic therapy at 3-4 wk – gait training

Phase II: – Weeks 4-10

Criteria for progression:
Minimal pain
No signs of active inflammation
0º- 110º of flexion
Muscle control of extension to 0º
75% weight bearing

Goals: Improve ROM and muscle strength (70% of contralateral side)
Avoid overstressing fixation
Exercise swelling controlled
Improve function to full activities of daily living

Intervention:

- Weight bearing: As tolerated with crutches
- Therapeutic Exercise:
  Complete lower extremity flexibility and progress to weight-bearing gastrocnemius/soleus stretching,
  Balance exercises and gait training
  Aquatic therapy
  Stationary bike – low-resistance, high seat
  Wall slides 0-45º of flexion progress to mini squats
  Late phase: close chain/open chain reconditioning
  Patella mobilization
  Aerobic reconditioning after 6 weeks

Phase III: Week 11 - 4 months

Criteria for progression: Full ROM achieved
70% of contralateral side
Pain is associated with activity only
Criteria for activity return must be met

Goals: Resume activity
Maintain program development

Intervention:

- Therapeutic Exercise:
  - Discontinue crutches when: no extensor lag with SLR, full knee extension, non-antalgic gait pattern
  - Step-ups - 2 inches progress to 8 inches
  - Stationary bike – moderate resistance
  - Endurance – swimming
  - Jogging/running in pool
  - Gait training
  - Progression of closed-kinetic chain exercises
  - Continue balance activities
  - Complete lower extremity flexibility: hamstrings, gastrocnemius/soleus, quadriceps and iliotibial band stretches
  - Emphasis on sport specific strength
  - Develop home exercise program

Some studies considered the phase between 4 and 6 months the returning to activity level phase

Phase IV: 4-6 months

Goals: Return to appropriate activity level
Improve functional strength and proprioception

Intervention:

- Progress close kinetic chain activities, jogging and running, sport specific activities.

POSTOPERATIVE REHABILITATION
Distal Realignment Procedures

Phase I: 1-2 weeks

Goals: Protect fixation
Control pain and inflammatory process, and minimize effects of immobilization
Re-gain quad and VMO control
ROM: 0º-90º/110º flexion and full knee extension
TTWB, two crutches (50% by end of phase)
Good skin integrity
Independent ambulation

Intervention:

- Pain, swelling and hemarthrosis management
- ROM: 0-90°/110º
- Brace: 0-30º 0-4/6 weeks; for ambulation only
  * Brace only days 1-4
- Weight Bearing: 0-4 weeks: crutches progressing to 50% weight bearing
- Therapeutic Exercise:
  Multi angle Quad sets with isometric adduction for VMO recruitment
  Full passive knee extension
  Passive and active-assisted ROM
  Calf, hamstring stretches (non-weight bearing)
  4 way SLR (locked brace if extensor lag)
  Patellar mobilization
  Muscle reeducation, use EMS
  Begin aquatic therapy with emphasis on gait at 3-4 weeks

Phase II: 3-4 wks

Criteria for progression:
70% of contralateral side
WB: 50% (X-ray verification of osteometry site healing)
Approximately 90° flexion ROM
No active inflammation
Pain controlled
Muscle control of extension

Goals: Increase flexion ROM: 0-110º
Avoid overstressing fixation
Muscle control of extension
Control inflammation and pain
Wound closure complete
Minimal gait deviation

Intervention:

- Pain and inflammation management
- Brace: for ambulation only Discontinue brace at 4 weeks
- ROM: 0-75º (3rd week), 90º/110º 4th week
  Passive and A/A ROM
  Discontinue CPM
  Mobilize patella
- Weight bearing: 4-6 weeks: wean from crutches
- Therapeutic Exercise:
  Emphasis on extension exercises
  Flexibility: hamstrings and gastrocnemius
  Muscle reeducation utilizing EMS

SLR and multi angle submaximal isometrics knee extension
Gait and balance training

Phase III: 4 weeks - 8 weeks

Criteria for progression: Approximately 110° flexion ROM
75% WB with 2-1 crutch
Pain control with WB and ROM
Independent in ADL's

Goals: Increase flexion ROM: 0-135º
Muscle control throughout ROM
Control pain and inflammation
One crutch to none (week 6)

Intervention:

- Continue modalities for pain and swelling
- Weight Bearing: 1 to no crutch, by 6 weeks full WB.
- Therapeutic Exercise:
  Continue Phase I exercise, progress to full flexion with heel slides
  Muscle reeducation using close chain program with 0-30º restriction
  Active extension with SLR
  Balance exercises and gait training
  Stationary bike - week 6 to 8
  Pool program

Phase IV: 9 weeks –

Criteria for progression: Swelling controlled
Full range of motion achieved
Normal gait pattern
Good dynamic patellar control with out evidence of lateral tracking or instability
Criteria for specific activity must be met

Goals: Resume activity
Maintain program development

Intervention:

- Pain is controlled and may be associated with activity only
- Brace: for activity
- Weight Bearing: full weight bearing
- Therapeutic Exercise:
  Step-ups, begin at 2 inches and progress to 8 inches
  Stationary bike with moderate resistance

Squats, leg press, forward and lateral lunges
Closed kinetic chain terminal knee extension with resistance
Toe raises
Hamstring curls
Sports specific activity development
Continue proprioceptive exercises
Develop and assess home exercise program

Some recommend a Phase V

Phase V: 4 months - 6 months

Goals: Continue improvements in quadriceps strength, improve functional strength and proprioception

Intervention:

- Progression of closed chain activities, Jogging in pool with progression to land, functional progression, sport/work specific training

Late Phase Exercises for Postoperative Patellofemoral Conditions

(Mangine et al proposed late phase exercises for postoperative patellofemoral conditions.)

Criteria for progression: No effusion, painless ROM, joint stability,
Patient performs ADL's and can complete previous protocol
ROM: minimum of 0-135º, minimal bilateral difference in muscle tone

Goals: Increase function to full activity level
Return to previous activity level
Establish maintenance program

Intervention:

- Warm up: jump rope, stretch, push-ups, sit ups.
- Lifting: leg curls, squats, lunges, toe rises, triceps, bench press
- Agility: plyoball sit-ups, dots, chest bands.

Selected References

Ahmad CS, Lee FY. An all-arthroscopic soft-tissue balancing technique for lateral patellar instability. *Arthroscopy*. 2001;17:555-557.

Ahmad CS, Stein BE, Matuz D, Henry JH. Immediate surgical repair of the medial patellar stabilizers for acute patellar dislocation. A review of eight cases. *Am J Sports Med*. 2000;28:804-10**.**

Arendt EA, Fithian DC, Cohen E. Current concepts of patella dislocation. *Clin Sports Med.* 2002;499-519.

Brotzman SB , Wilk KE. *Clinical Orthopaedic Rehabilitation.* 2nd Ed. Philadelphia, Mosby, Inc.; 2003.

Fithian DC, Meier SW. The case for advancement and repair of the medial patello femoral ligament in patients with recurrent patellar instability. *JOTSM.* 1999;7:81-89.

Fithian DC, Paxton EW, Stone ML, Silva P, Davis D, Elias D, White LM. Epidemiology and natural history of acute patellar dislocation. *Am J Sports Med.* 2004;32:1114-1121.

Fu FH, Maday MG. Atthorscopic lateral release and the lateral patellar compression syndrome. *Orthop Clin North Am.* 1992;24:601-612.

Fulkerson JP, Gossling HR: Anatomy of the knee joint lateral retinaculum. *Clin Orthop.* 1980;153:183-188.

Fulkerson JP. Diagnosis and treatment of patients with patellofemoral pain. *Am J Sports Med.* 2002;30:447-456.

Halbrecht JL. Arthroscopic patella realignment: an all-inside technique. *Arthroscopy*. 2001;17:940-945.

Hinton RY, Sharma KM. Acute and recurrent patellar instability in the young athlete. *Orthop Clin North Am.* 2003;34:385-96.

Irwin LR, Bagga TK. Quadriceps pull test: an outcome predictor for lateral retinacular release in recurrent patellar dislocation. *J R Coll Surg Edinb*. 1998;43:40-42.

Mangine RE, Eifert-Mangine M, Burch D, Becker BL, Farag L. Postoperative management of the patellofemoral patient. *J Orthop Sports Phys Ther*. 1998;28:323-335.

Marumoto Jm, Jordan C, Akins R. A biomechanical comparison of lateral retinacular releases. *Am J of Sports Med*. 1995;23:151-155.

Myers P, Williams A, Dodds R, Bulow J. The three-in-one proximal and distal soft tissue patellar realignment procedure. *Am J Sports Med.* 1999;27:575-579.

Nam EK, Karzel RP. Mini open medial reefing and arthroscopic lateral release for the treatment of recurrent patellar dislocation. a medium-term follow-up. *Am J Sports Med* [on line publication].December 2004; volume 32.

Palmer SH, Servant CT, Maguire J, Machan S, Parish EN, Cross MJ. Surgical reconstruction of severe patellofemoral maltracking. *Clin Orthop.* 2004;419:144-148.