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PCL INJURIES

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Epidemiology

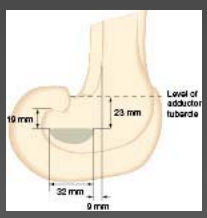
- PCL injuries- only 5 to 10% of all knee ligament injuries.
- PCL tear ~ 2% of HS knee injuries
- At NFL Rookie Combines- 2% isolated PCL laxity - players usually unaware

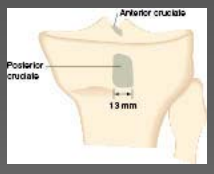
Epidemiology

- Isolated PCL's < 4 %
- Associated injuries: PCL & PLC, PCL & ACL, and PCL & MCL
- Causes of injury :
  - 50% vehicular trauma
  - 40% sports injury
  - 10% other

PCL Anatomy

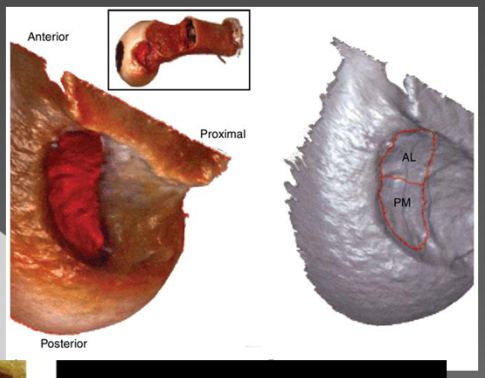
- Intra-articular / Extra-synovial
- 38 mm length / 13 mm width
- Fan-shaped structure
  narrowest-midportion
  widest at MFC origin
  (32mm in AP diameter)
- Compact insertion @ posterior tibial shelf- 1 cm distal to the tibial plateau

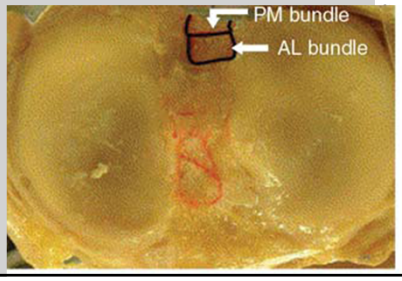


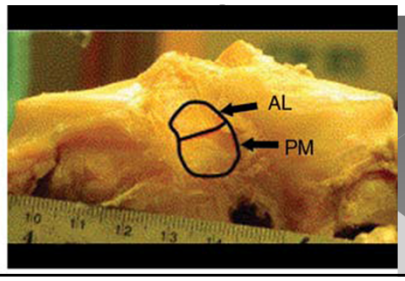


PCL Anatomy

- AL & PM Bundle Femoral & Tibial Insertions Sites
- Femoral site 1° influence on PCLR



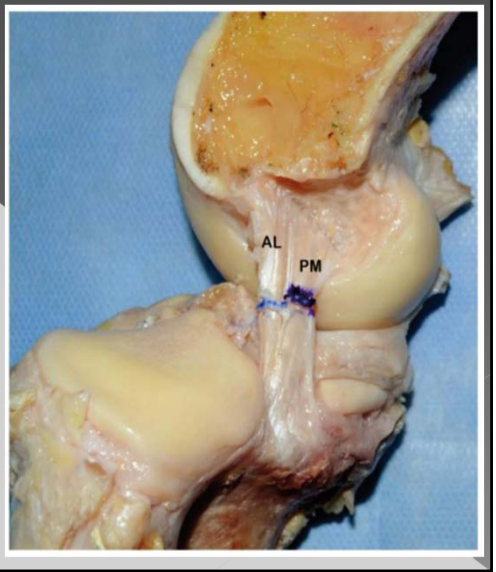




PCL Anatomy : Macroscopic

Two fiber bundles

- Anterolateral Band
  tightens in flexion
- 1° resists PD between 70-105°
- Posteromedial Band
  tightens in extension.
- 1° resists PD between 0-15°
- Role in controlling rotation at > 90° flexon
- Co-dominant relationship between bundles



Biomechanics : Normal PCL

- PCL - 1° restraint to PD
  - @ 90° flexion- 100% resisted by PCL
  - @ 30° flexion- 55% resisted by PCL
  - @ 0% flexion- 10% resisted by PCL
- PCL injury alters:
  - Knee biomechanics
  - Proprioception

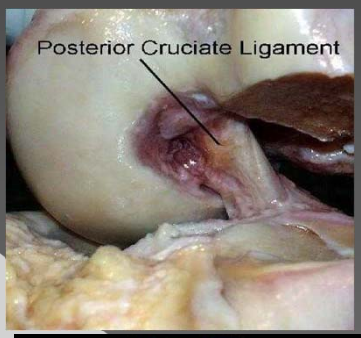
Biomechanics of PCL Injury

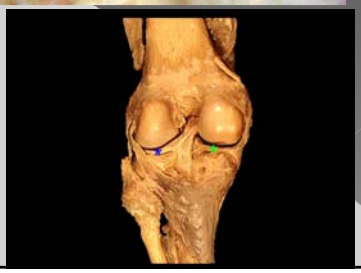
- Isolated PCLT- Minimal effect
  - Rotational
  - varus/valgus stability
- With PLC injury:
  - ↑ varus angulation
  - ↑ tibial external rotation.

Grood et al.

Biomechanics : Normal PCL

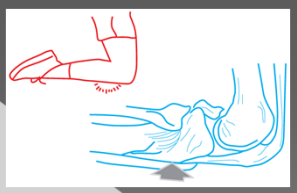
- Anterolateral Bundle- 1120-1620N
  - 1˚ restraint @ 90˚ flexion
- Posteromedial Bundle- 258-419N
- Meniscofemoral Ligaments- 300N each
  - Contributes 28% of restraint to PD





Mechanism of Injury- PCL

- Posteriorly directed trauma
  - dashboard injury
  - fall onto a flexed knee with the foot in plantar flexion.
- Hyper-flexion injury
- Forced hyperextension beyond 30 ˚ (ACL 1st)
- A rotational injury w/ varus or valgus stress can cause PCL injury w/ associated collateral ligament disruption.



History : Acute PCL Injury

- UNLIKE ACL-injured patients :
  - Deny hearing or feeling a pop at time of injury.
  - Report gradual, slow swelling over first few days.
  - Are usually able to bear weight on the injured leg.

History : Chronic PCL Injury

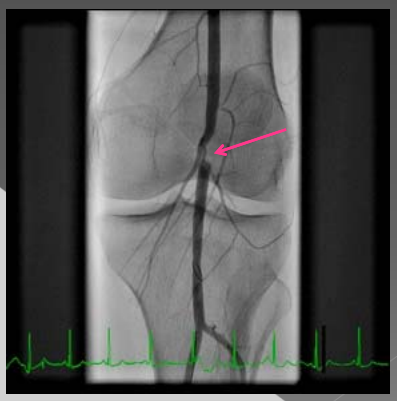
- Isolated PCL injury is more subtle, and can be missed for long periods.
- UNLIKE ACL-deficient patients:
  - PCL-deficient pts rarely complain of giving way or buckling.
  - 1˚ complain - pain & disability over time
  - Pain w/ long distance walking.
  - Anterior knee pain
  - Unsteadiness on descending stairs

Physical Exam : Acute

- Abrasions/ecchymosis @ tibial tubercle
  → suspect PCL injury
- Mild-Moderate swelling
- Posterior knee pain
- Typically lack 10-20˚ of Knee flexion

Physical Exam : Acute

- Careful NV exam
- Beware of subtle Multi-ligament Injuries
- Suspect vascular injury
  → angiogram.

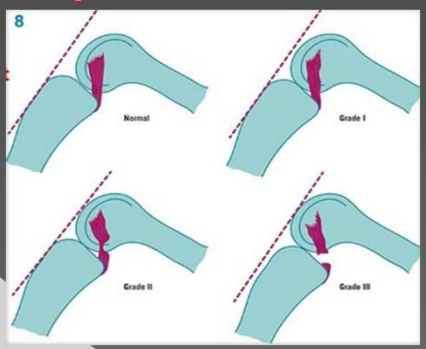


Tests for PCL Instability

- Posterior Drawer :
  - The most sensitive (90%) and specific (99%) test
  - Performed @ 90 ° knee flexion
  - Check MTP step-off
  - Beware (+) Pseudo-Lachman with ACLT

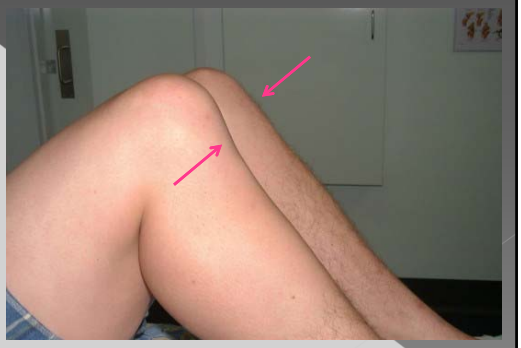
Tests for PCL Instability

- **POSTERIOR DRAWER**
  - **Grade I** : anterior tibial stepoff is only 5 mm
  - **Grade II** : there is no stepoff
  - **Grade III** : tibial crest lies posterior to the condyles
- **Grade III PD**
  - usually combined ligamentous injury
  - most often PCL & PLC



Tests for PCL Instability

- Posterior Sag Sign:
  - Supine -knee flexed 90 degrees, the tibia sags posterior subluxation
  - Acutely, can be limited by quads spasm, effusion and pretibial swelling.

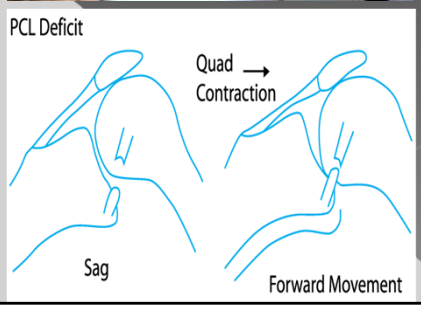


Tests for PCL Instability

- Godfrey test :
  - A modification of the posterior sag test
  - hip and knee both flexed to 90 °
  - Gravity accentuates the posterior subluxation.

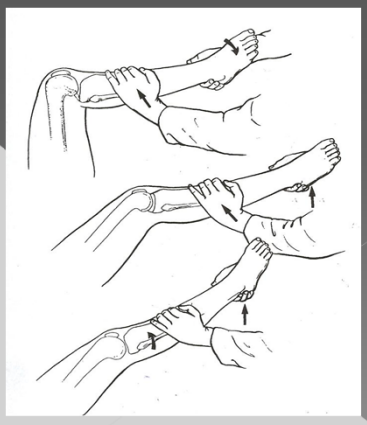
Tests for PCL Instability

- Quadriceps Active Test :
  - The quads contracted against resistance- knee flexed between 70 and 90 degrees.
  - With PCL tear-isometric quads contraction reduces the tibia.
  - This test is usually too painful to perform acutely, but is helpful with chronic cases.



Tests for PCL Instability

- Reverse pivot-shift test :
  - (+) if reduction sensation is appreciated as the flexed, ER knee is extended with a valgus stress.



Physical Exam : R/O Combined Instability

****Occurs in 50-90% of PCL injuries**

- Assessing the PL Corner :
  - Dial Testing
  - Hughston ER/recurvatum test
- Assessing the ACL :
  - Lachman, Anterior drawer, Pivot shift
- Assessing the collateral ligaments :
  - Varus/valgus stress testing at 30 and 0 degrees

Making the Diagnosis

- Because the symptoms of PCL injury are subtle, this diagnosis can initially be missed.
- Shelbourne, AJSM 1994 :
  - accuracy of the clinical exam
  - 96% Accuracy & 99% Specificity. But only 90% Sensitivity (70% Grade I, 97% Grades II & III).
  - Concluded that even in the best hands, the diagnosis is often not easy.

Radiographic Evaluation

- X-Rays :
  - R/O bony avulsions
  - Chronic- arthritic changes.

Radiographic Evaluation

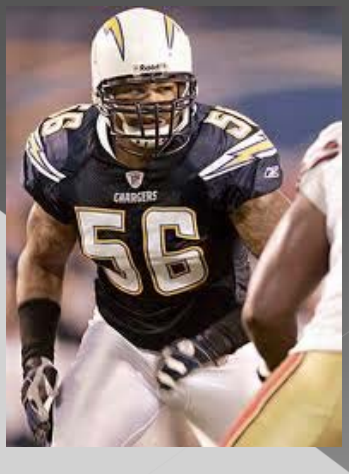
- MRI :
  - An important adjunct to diagnosing PCL injury
  - 99% accurate
  - evaluates menisci and other ligaments
  - PCL may appear "normal" in chronic grade I or II injuries

Natural History of PCL Deficient Knees

- Originally thought benign course with neglect
- Progressive disability and DJD
  - Medial & PF compartments
- Shelbourne et al, 1999:
  - 88% of patients > 4 year- x-ray evidence of DJD.
  - Return to Sport: 50% same level/ 33% lower level/ 17 % changed sports
  - No correlation between grade of laxity & DJD

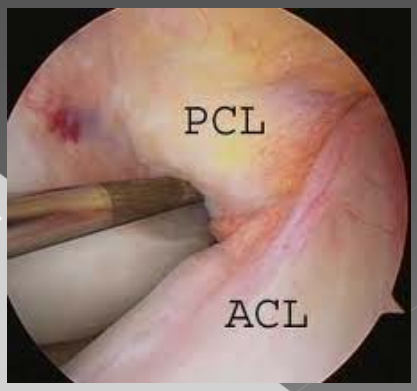
Natural History of PCL Deficient Knees

- Parolie & Bergfeld, 1986:
  - (+) correlation between improved scores & quad strength
  - No correlation between laxity & RTS
  - Return to Sport: av 6 wks post-injury
    - 68% same level
    - 16% lower level
    - 16 % no sports



Treatment Decisions : Op vs. Non-op

- FACTORS:
  - Acute vs. chronic.
  - Degree of laxity.
  - Associated injuries.
  - Symptoms and complaints.
  - Patient's activity level and demands.



Indications for Non-op Treatment

- All isolated acute Grade I-II PCL injuries.
- Shelbourne et al.
  - acute isolated PCL injury
  - can heal w/ a firm endpoint & minor residual laxity
- Clancy et al.
  - If synovial sheath intact the healing PCL contracts
  - laxity can improve one grade

Non-Surgical Rehab: PCL Injury

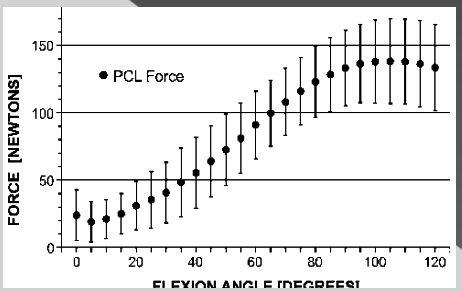
- Knee brace in full extension 2-4 wks
  - Prevent posterior tibial sag
- Protected WB
- ROM
- Quad strengthening/ SLR/ mini-flexion squats
- Avoid HS resistive exercises
- Return to sports – 6 + wks (I/II PCL)
  - ≥ 3 mos (III PCL)
- Functional/Dynamic Brace
  - Rebound PCL brace
  - Jack PCL brace

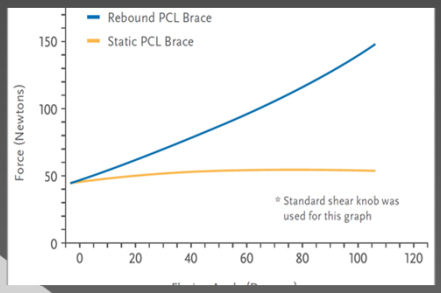
Dynamic Bracing

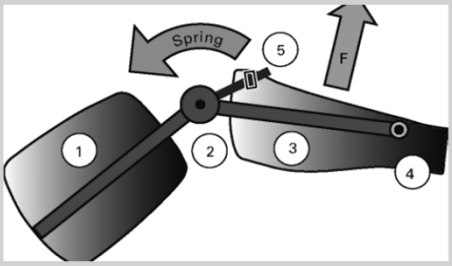
- Rebound PCL brace

- Jack PCL brace

DYNAMIC PCL BRACE







JACOBI ET AL (JBJS-B 2010)

-Posterior sag reduced from 7.1 mm to 2.3 mm at 12 mo fu

-Tegner 7.5 preinjury/ 7.2 at 24 mo

Literature: Non-Operative Treatment

Favorable Results

- Fowler & Messier, 1987
- Parolie & Bergfels, 1986
- Torg et al, 1989
- Shino et al, 1995
- Boynton & Tietjiens, 1996
- Shelbourne et al, 1998

Poor Results

- Dandy & Dussey, 1983
- Clancy et al, 1983
- Keller et al, 1993
- DeJour et al, 1987
- Noyes, 1994

Minimum 10-Year Follow-up of Patients After an Acute, Isolated Posterior Cruciate Ligament Injury Treated Nonoperatively

K. Donald Shelbourne,*y MD, Melanie Clark,y BS, and Tinker Gray,y MA
Investigation performed at Shelbourne Knee Center, Indianapolis, Indiana

AJSM, 2013

- All 68 pts had subjective f/u @ mean 17.6 yrs;
  - 44 pts had both objective & subjective assessments @ mean 14.3 yrs
- PCL laxity gr 1-41%; gr 1.5-14%; gr 2-45%
  - At f/u 9% increased laxity; 16 % decreased
- X-rays- 89% N/NN; no difference based on PCL laxity grade
  - Only 11.4% showed > 2 mm medial joint space narrowing
- No subjective score differences between PCL grades

Indications for Operative Tx

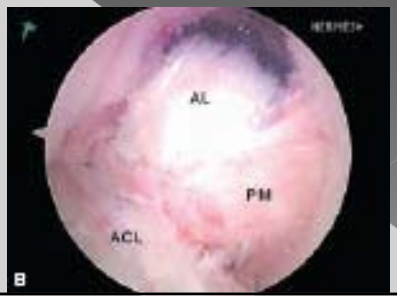
- Isolated grade III PCL injuries
- Grade III PCL with combined instability patterns.
- Displaced bony avulsion → ORIF.
- Controversial-Grade II injuries in high-demand athletes.
- Chronic sx PCL pts w/ complaints of pain or instability.

Isolated PCL Reconstruction

- Acute PCLR outcomes > Chronic
- No graft type superior
  - Achilles Allograft- most popular
- Most PCLR have residual laxity
  - Improve 1+ grade

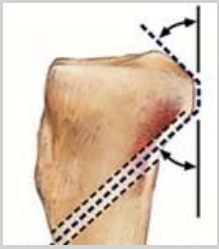
Surgical Decisions:

- Single Bundle PCLR
- Double Bundle PCLR
- Trans-Tibial Technique
- Inlay Technique
- All-Inside Technique



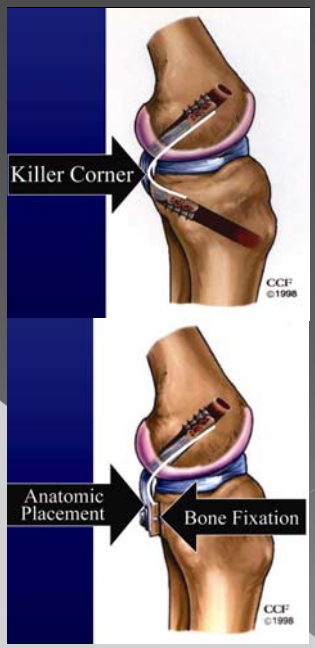
Trans-Tibial-WHY SO BAD ?

- "Killer turn"
  - Difficult to effectively tension graft.
  - predisposes graft to fraying and elongation.



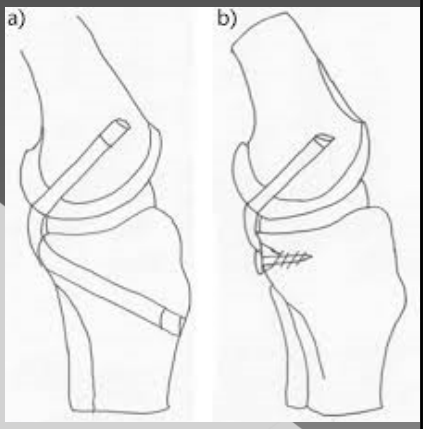
Possible Solutions

- Avoid "Killer turn" → Tibial inlay technique
  - Bergfeld et al: less posterior tibial translation & graft degradation vs Trans-Tibial
  - Biomechanical cadaver model
  - Clinically- no advantage
- Trans-Tibial vs Inlay:
  - Clinical studies-No differences
  - Seon & Song, 2006
  - MacGillivray, 2006
  - Song et al., 2014



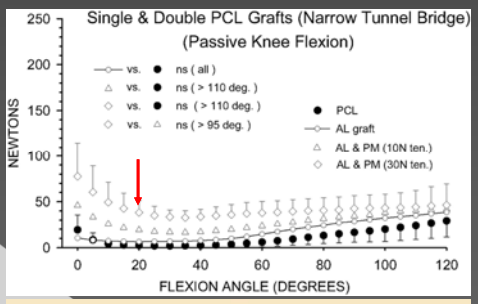
Trans-Tibial SB vs Tibia Inlay SB

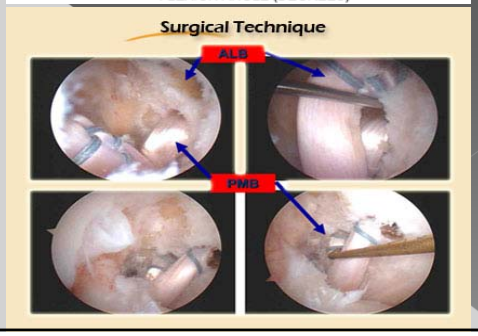
- Shin et al . CORR 2017:
  - 7 studies between 2006-2014
  - No clinically significant outcome differences
  - 26% TT & 27% TI with ≥ Grade II post-op PCL laxity
  - Tegner scores- NS
    - 5.6-6 in TT grp vs 5.8-6.1 in TI grp
  - Lysholm scores –NS
    - 81-91.3 in TT grp vs 76-92.8 in TI grp



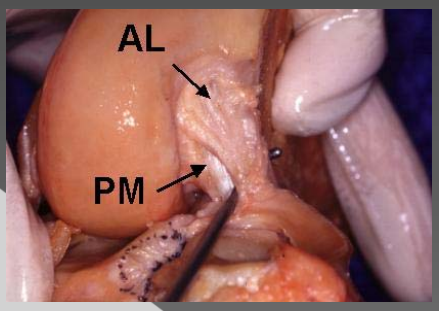
Double Bundle PCL Reconstruction

- More closely reproduces native PCL biomechanics
- Biomechanical studies- improved vs single bundle
  - Adding PMB graft improves laxity over 0-30° flexion (Markolf JBJS 2006)
- Bergfeld et al. (AJSM 2005)-
  - Tibial inlay technique
  - SB = DB





Double vs Single Bundle Grafts



- Clinical comparative studies
- No significant differences
  - Houe & Jorgensen
  - Nyland et al
  - Wang et al
  - Hatayama et al
  - Qi et al. BMC Musculoskeletal Disorder, 2016
    - 7 of 8 studies – functional & subjective outcomes (N.S.)

Single-Bundle and Double-Bundle Posterior Cruciate Ligament Reconstructions: A Systematic Review and Meta-analysis of 441 Patients at a Minimum 2 Years' Follow-up

Jorge Chahla, M.D., Ph.D., Gilbert Moatshe, M.D., Mark E. Cinque, B.S., M.S., Grant J. Dornan, M.Sc., Justin J. Mitchell, M.D., Taylor J. Ridley, M.D., and Robert F. LaPrade, M.D., Ph.D.

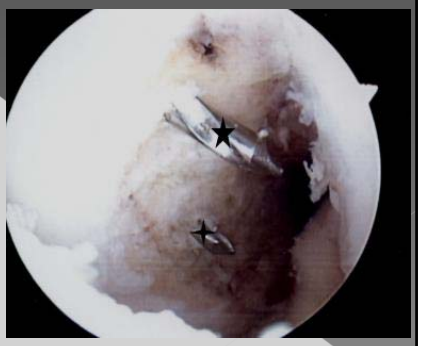
Arthroscopy, 2017

- 11 studies – 441 pts; 3 PRCT & 8 case control studies
- 232 SB PCLR/ 209 DB PCLR
- No differences in Tegner & Lysholm scores
- *DB PCLR better posterior translation stability vs SB* PCLR (via Telos)
- Most common technique : Arthroscopic TT
- Achilles tendon allograft primary used in both SB & DB PCLR's

Biomechanical Comparison of Single-Bundle and Double-Bundle Posterior Cruciate Ligament Reconstruction

A Systematic Review and Meta-Analysis — Lee et al. JBJS 2017

- 10 studies 1998-2016
- Mix of TT/ TI ; SB & DB and graft types
- Results: Posterior laxity tested by PD
  - DB better than SB graft
  - No difference in ER, varus rotation or coupled ER with PD
  - Study limitations:
    - time zero study
    - Lack of heterogeneity of surgical technique, graft type, rehab



Comparison of the Clinical Results of Three Posterior Cruciate Ligament Reconstruction Techniques

By Sung-Jae Kim, MD, Tae-Eun Kim, MD, Seung-Bae Jo, MD, and Yun-Pei Kung, MD

Investigation performed at the Department of Orthopaedic Surgery and the Arthroscopy and Joint Research Institute, Yonsei University Health System, College of Medicine, Seoul, South Korea

- 29 patients with PCLR w/ FU > 2 yrs
- 3 PCLR techniques: TT-SB, ATI-SB & ATI-DB
- Achilles Tendon allograft used in all cases
- Results: Posterior laxity via Telos
  - *ATI-DB better than TT-SB group*
  - No statistical difference ATI-SB vs TT-SB
  - ROM & Lysholm scores all similar

	Group T	Group I1	Group I2
Side-to-side difference in posterior translation† *(mm)*	5.6 ± 2.00	4.7 ± 1.62	3.6 ± 1.43
Side-to-side difference in range of motion *(deg)*	2.8 ± 0.70	4.1 ± 2.59	3.4 ± 0.84
Lysholm score *(points)*	86.8 ± 7.53	79.7 ± 11.67	84.3 ± 9.74

*The values are given as the mean and standard deviation. †As measured on posterior stress radiographs made with use of the Telos device.

Postoperative PCLR Rehab

- PHASE I: 0-4 wks
  - Knee brace locked in full extension
  - NWB with crutches (6 wks)
  - PROM Prone 0-90° (start @ 0-2 wks)
  - Quad sets/SLR
  - Avoid active HS contraction
- PHASE II: 4-12 wks
  - Unlock brace for ambulation
  - Dynamic PCL brace x 24 + wks
  - Progress WB @ 6-8 wks
  - Stationary bike at 8 wks
  - Aquatic therapy

PHASE III: 3- 5 mos

Goal – full pain free ROM
Last 10-15° extension may take up to 5 mos
Improve functional strength & proprioception

PHASE IV: 5- 6 mos

Introduction of sports-specific training

PHASE V: 6-12 mos

Straight line jogging progression; multiplanar agility exercises; return to pre-op activities

Outcomes PCLR

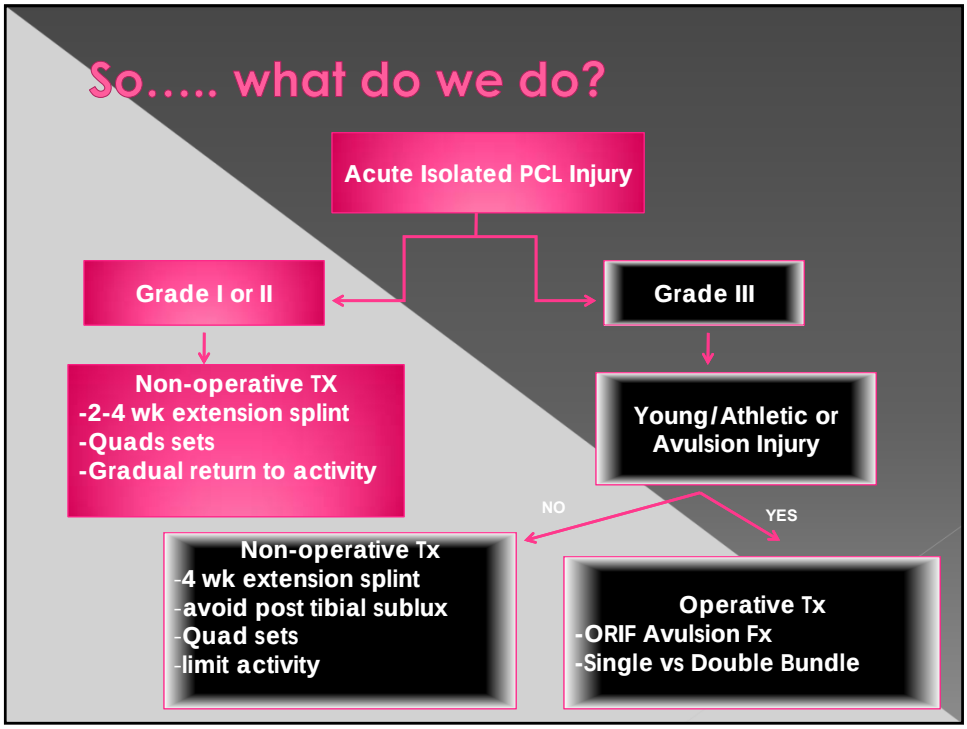
- Trend toward poorer results with chronic injury
  - Sekiya et al:
    - 75% N/NN acute/subacute grp
    - 40% N/NN chronic group
- Worse functional scores with chondrosis at time of injury
  - PCLR does not prevent progression
  - 60% pts with OA after SB PCLR @ 9.1 yrs post-op
    (Hermans et al. AJSM 2009)
  - Strobel et al:
    - 45% chondral injury with PCL
    - 37% MFC/ 34% patella

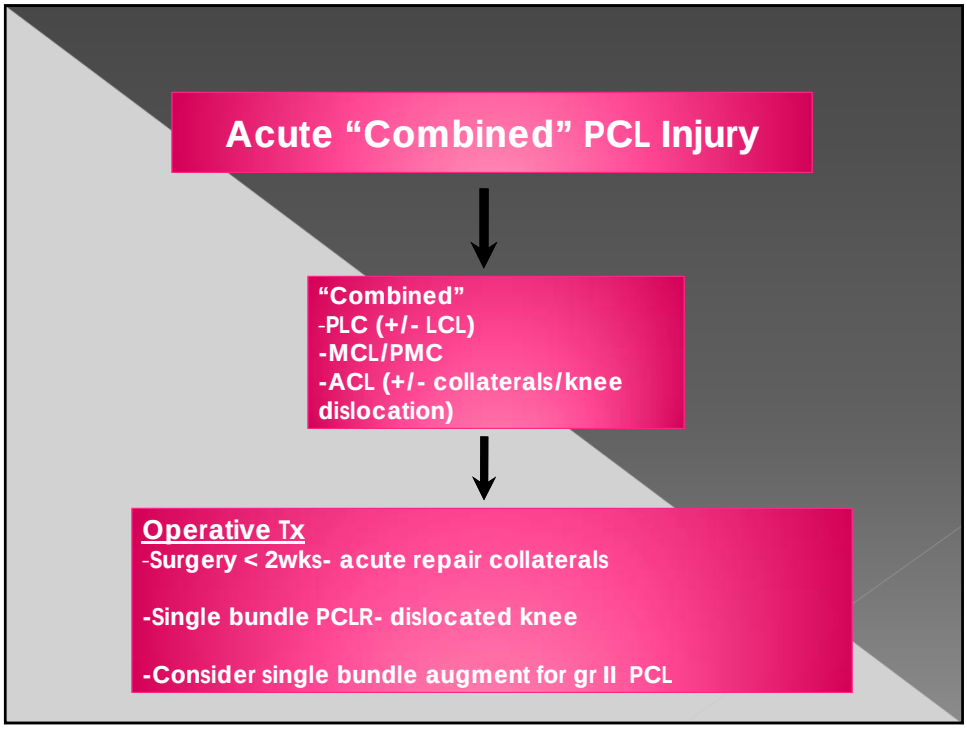
Criteria for Return to Play (PCLR)

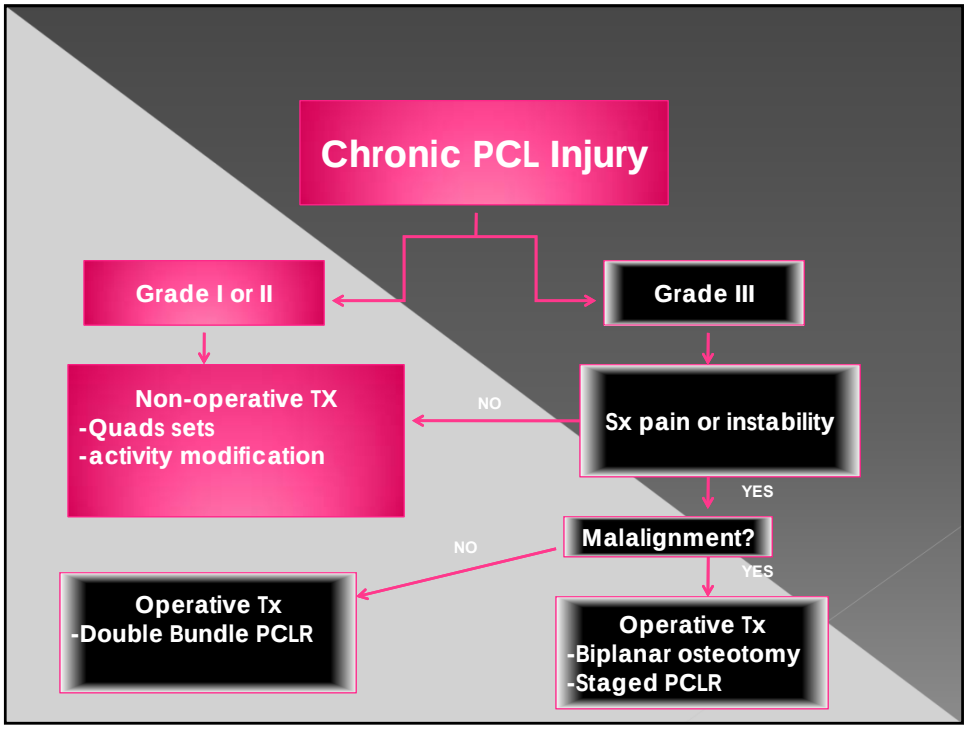
- Full , pain-free ROM
- Normal gait
- Quadriceps control & HS flexibilty
- No PF sx's
- Sports specific proprioception & endurance
- Time frame ≈ 9 – 12 mos
- Functional brace.

Failure of PCLR

- Most common causes:
  - Posterolateral Corner deficiency (40%)
  - Improper graft placement (33%)
  - Associated varus mal-alignment (31%)
  - Primary suture repair (25%)







Summary

- PCL Injuries less common than ACL
- Presentation, mechanism of injury & disability- unlike ACL
- Grade I/II injuries- tx' d effectively w/o surgery
- Post-surgery functional results not as consistent as ACLR
- Beware of combined ligamentous injuries
- "Best" technique unclear though recent literature substantiates DB PCLR

THANK YOU