

How to minimize the risk of an immature ACL tear and an evidence based approach to rehab both the non-surgical and surgical repair

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Objectives

- Identify common mechanisms and risk factors for ACL injuries in the skeletally immature athlete
- Discuss functional screening techniques to assist with implementation of prevention programs for young athletes at risk of ACL injury
- Review current rehabilitation guidelines for non-operative treatment and post-operative treatment of an ACL injury

“A lot of the stuff kids used to do in free play was ACL prevention. Now they don’t get that, and they jump into high-level soccer... I wonder what these kids are going to be like 20 to 30 years down the road. Will we have a whole generation of middle-aged adults with early arthritis?”

–Dr. Mininder Kocher

Risk Factors and Common Mechanisms of Injury



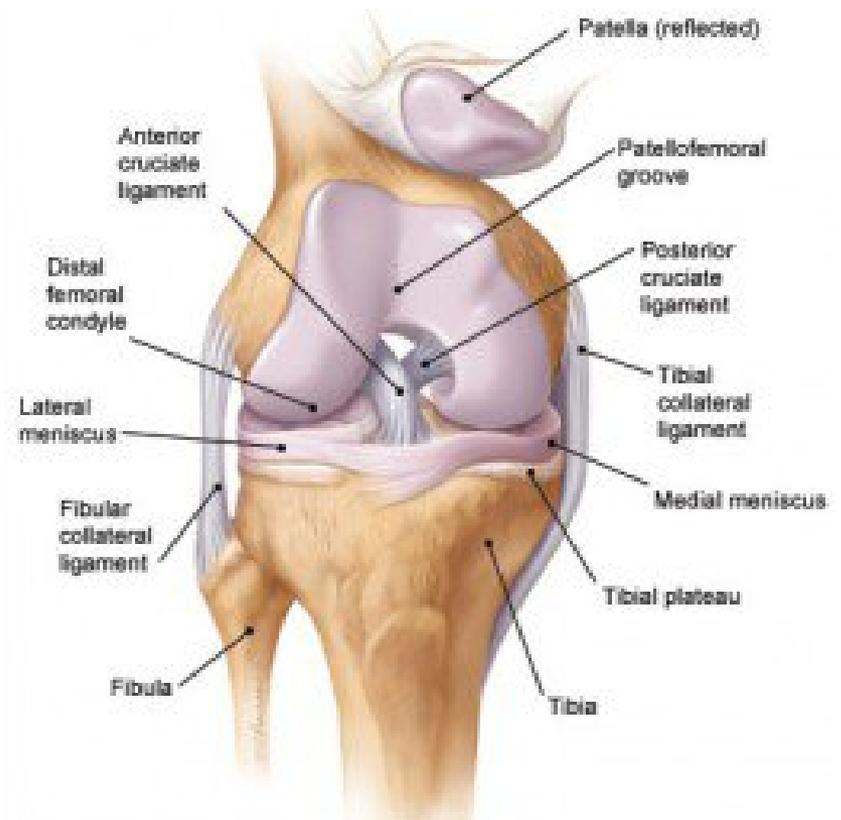
Risk Factors

- Intrinsic
 - Sex
 - Female
 - Hormones (in menstruating female)?
 - Genetics
 - Family history
 - *COL1A1* and *COL5A1* genes
 - Previous injury
 - Generalized joint laxity



Risk Factors

- Intrinsic (cont.)
 - Bony anatomy
 - Decreased intercondylar femoral notch size
 - Decreased depth of concavity to the medial tibial plateau
 - Increased slope of the tibial plateaus
 - Increased anterior-posterior knee laxity



-Gray's Anatomy for Students

Risk Factors

- Extrinsic
 - Weather conditions
 - Cleat design influences
 - Playing surface
- Modifiable
 - BMI
 - Sport selection
 - ***Neuromuscular control***



Risk Factors

- Neuromuscular Control
 - Jump landing mechanics
 - Knee position
 - Hip rotation
 - Quadriceps activation
 - Core stability



Risk Factors



Mechanism of Injury

- Activity at time of injury
 - Competitions – 49.2%
 - Practice – 34.8%
 - Leisure activities – 8.5%
 - Other – 7.5%



-The Washington Post

Mechanisms of Injury

■ Noncontact

- ♀51.5%, ♂69.6%

■ Contact

- Physical contact with another person on body parts other than the LE
- ♀16.0%, ♂11.4%

■ Collision

- Direct physical contact with another person on the affected LE
- ♀15.7%, ♂3.6%

■ Accident

- Particular situations during sports
- ♀16.7%, ♂15.4%



Mechanism of Injury

- Dynamic alignment at time of injury
 - Knee-in & Toe-out: Knee valgus and foot abduction
 - ♀47.8%, ♂51.0%
 - Knee-out & Toe-in: Knee varus and foot adduction
 - ♀9.0%, ♂8.8%
 - Hyperextension: Hyper-extended knee
 - ♀7.6%, ♂4.6%
 - Other
 - ♀1.9%, ♂0.9%
 - Unclear: Injury mechanism not expressed clearly
 - ♀33.8%, ♂34.5%



-the Science PT

Functional Screening Techniques and ACL Prevention



Functional Screening Techniques

■ Single leg hop

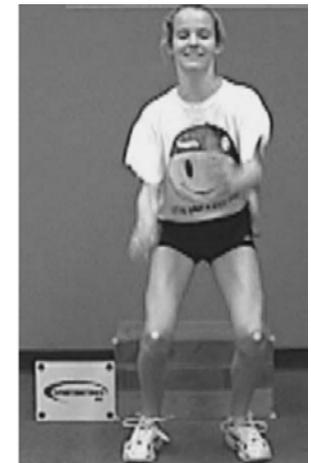
- Stand with toe behind line
- Hop as far forward as possible
- Land on same leg
- Show control of landing (~3 seconds)
- Measure 3 trials from toe-to-toe (cm) and calculate mean
- Repeat with opposite (non-dominant) limb
- Mean of non-dominant limb divided by mean of dominant limb x100 = Limb Symmetry Index
- Score should be $\geq 85\%$

Single Hop



Functional Screening Techniques

- Drop vertical jump
 - Stand on 12 in box with feet shoulder width apart
 - Drop down off box and perform maximum vertical jump
 - Land on both feet
 - Perform 3 trials
 - Assess
 - Foot contact at the same time?
 - Over-pronation?
 - Knee valgus during initial contact?
 - Knee valgus during final landing?



Functional Screening Techniques

- Single leg squat
 - Barefoot, hands on hips, stand on one limb
 - Perform SLS to 30° then return to standing
 - Perform 3x per leg
 - Assess for arms flailing, Trendelenburg sign, or knee valgus
 - Positive test is abnormal movements 2/3 trials



ACL Prevention

- *Neuromuscular* warmup
 - FIFA 11
 - light and quick, 10 minutes, jumping, shuffling and balancing exercises
 - FIFA 11+
 - More intense, repeated sprints and squats, leg lifts and vertical leaps



PHYS ED

How a Warm-Up Routine Can Save Your Knees

By GRETCHEN REYNOLDS MARCH 19, 2014 12:01 AM 53



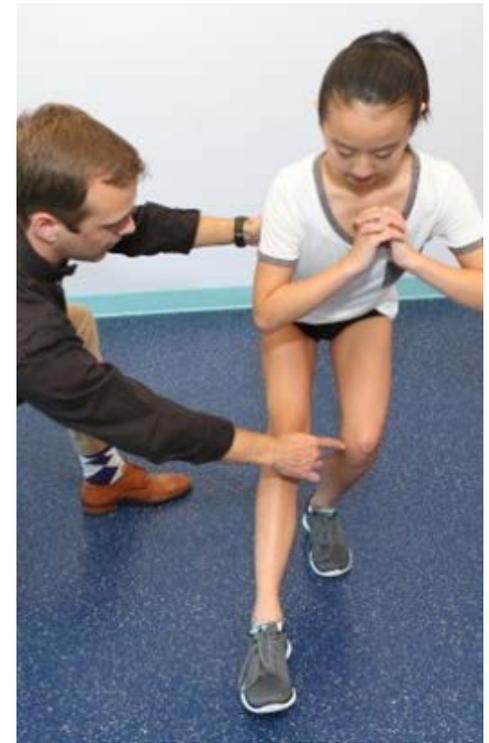
ACL Prevention

- 1999 study of female high school soccer, volleyball, and basketball athletes (366 in the intervention group, 463 in the control group)
- 6 week pre-season program that incorporated supervised exercises working on flexibility, plyometrics, weight training and proper landing patterns (squat jumps, double-legged cone jumps, tuck jumps, and hop-hop-stick landing).
- 60–90 minutes per session, 3x/week
- Female control group sustained a 3.6x higher rate of total knee injuries compared with the female intervention group
- No noncontact ACL injuries in the intervention group; the 2 ACL injuries sustained in this group were specifically via a contact mechanism



ACL Prevention

- 2005 study of PEP program (Prevent Injury and Enhance Performance Program) in a large group of female club soccer players
- 1041 athletes in intervention group, 1905 in the control group in the 1st year
- 844 athletes in intervention group, 1913 in control group in the 2nd year
- 20 minute exercise regimen, 2–3x/week x12 weeks
- Athletes watched an educational video on safe and unsafe landing patterns, and participated in team workouts of stretching, strengthening, plyometrics, and soccer-specific agility drills, which replaced the team's warm-up during soccer practice.
- 1st year- 2 ACL injuries in intervention group vs 32 in control group = 88% reduction
- 2nd year- 4 ACL injuries in intervention group vs 35 in control group = 74% reduction



ACL Prevention

- Work towards external focus of attention – promotes unconscious/automatic processes
- Internal focus may hinder athletic performance
- Motor control of alignment needs to be automatic



Current Rehabilitation Guidelines: Non-Op and Post-Op



Non-Operative Management: “The Coper”

- ACL deficient knee is at risk for
 - Chronic instability
 - Osteochondral and meniscal pathology
 - Pain and/or effusion
 - Degenerative changes of the articular surfaces

Increased activity of this age group renders the menisci and the articular structures of the knee more vulnerable to further damage.



Non-Operative Management: “The Coper”

- 1994 comprehensive study of the natural history of ACL tears in skeletally immature patients
 - 38 athletes who were treated conservatively by modification of activity, bracing and rehabilitation – all underwent arthroscopically assisted ACL reconstruction at a later point
 - 97% had episodes of instability prior to ACL reconstruction, 71% had symptomatic meniscal tears at the time of surgery, and 50% had attempted to return to their previous level of activity before reconstruction
- Several other studies in young patients consistently show that conservatively treated patients develop knee instability which leads to secondary meniscal or chondral injuries especially if activity levels are not modified



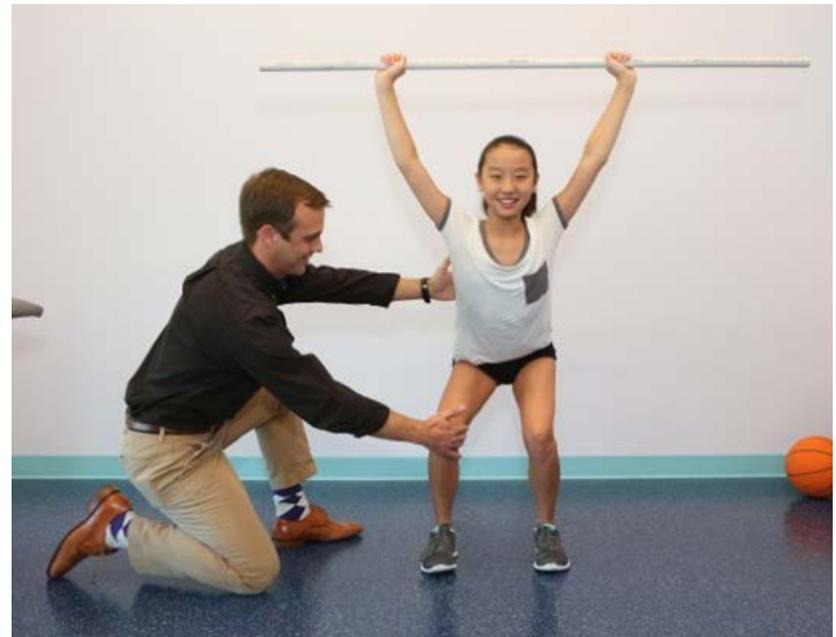
Non-Operative Management: “The Coper”

- Can we delay surgery until skeletal maturity?
- One study followed a protocol to delay reconstruction
 - Rehabilitation, absolute avoidance of pivoting activities, full time brace wear while awake; control group received acute reconstructions,
 - Found no increase in intra-articular injuries despite a mean delay of 70 weeks until ACL reconstruction
- Another study delayed ACL reconstruction until skeletal maturity with extensive rehabilitation and return to activities as tolerated with brace wear
 - 65% were able to return to previous activities without reconstruction and only 9.5% suffered a secondary meniscus injury

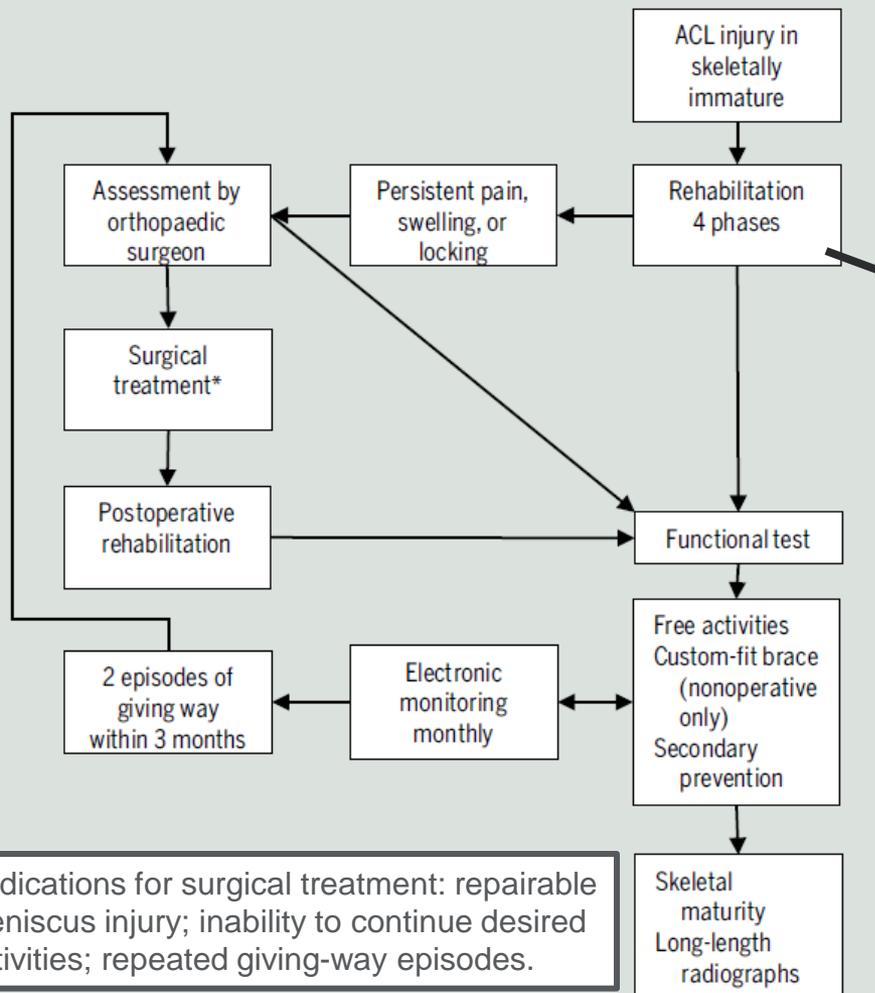


Non-Operative Management: “The Coper”

- Non-operative treatment may be indicated for an isolated ACL injury if the patient wishes to modify their lifestyle to avoid activities causing pain, effusion, or instability. The patient should not plan to return to sports that require running, jumping, twisting, or cutting without extensive therapy and use of a functional brace.
- 6-9 months of physical therapy, at a minimum



Non-Operative Management: “The Coper”



- Phase 1 – regain ROM, resolve swelling, reactivate quad
- Phase 2 – normalize ADLs (stair climbing, mobility without swelling)
- Phase 3 – run without deviations and swelling and perform single leg hop
- Phase 4 – neuromuscular maintenance

*Indications for surgical treatment: repairable meniscus injury; inability to continue desired activities; repeated giving-way episodes.

Operative Management

- Surgery is indicated in the following situations
 - Inability to be active in preferred activity
 - Repeated episodes of instability
 - Secondary repairable meniscal injuries
- Transphyseal technique that uses a hamstring graft is preferred
- Physeal sparing, combined intra-articular and extra-articular reconstruction with use of an autogenous IT band graft in younger patients (mean age of 10)



"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."

Operative Management

- Main differences between post-op rehabilitation in skeletally immature patients as compared to adults are
 - a slower progression toward jumping and running to reduce the impact loading of the physis
 - less use of external loads
 - primarily home-based functional exercises
 - a later return to pivoting sport (after 9 to 12 months)



Operative Management

- Limited research for rehabilitation of physeal sparing reconstruction
- Initiate running around 16 weeks
- Begin sport specific training around 24 weeks
- Full return to sport no earlier than 9 months but likely closer to 12 months



Case Study #1

- 12yo female (skeletal age 10yo), double bounced on trampoline and fell, non-contact R knee injury with “twisting” mechanism of injury and audible pop
- MRI diagnosed ACL tear with posterior horn lateral meniscus tear
- Partial meniscectomy roughly one month after injury (regained ROM pre-op)
- Placed in hinge knee brace initially, ultimately transitioned to a functional brace
- Completed 6 months of PT
- Released to swimming and non-pivoting, non-contact activities in functional brace



Case Study #1

- No major problems x3 years but restricted on activity level
- Returned for ACL reconstruction with hamstring autograft at 16yo
- NWB x1 month
- Developed abscess at 4 weeks that required I&D
- Progressed through therapy well and was discharged after 7 months
 - (U) Squat R=102%, (U) triple hop R=107%, (U) 4" step hop R=100%
- Required medial meniscal repair two years later due to new injury (playing lacrosse)



Case Study #2

- 10yo male, sliding into 3rd base and hyperextended knee.
- Initial x-rays showed no damage, cleared to return to play (*not by physicians at CCMC*).
- Had frequent episodes of knee giving out, MRI ordered
- No signs of meniscal damage on MRI
- Underwent physeal sparing ACLr as well as lateral meniscal repair and partial medial meniscectomy 6 weeks post-injury



Case Study #2

- NWB x6 weeks
- By 14 weeks post-op, Y-balance scores of
 - Forward: 90 %
 - Posterior Medial: 82.4 %
 - Posterior Lateral: 95.8 %.
- Surgeon allowed running after 12 weeks (as cleared by rehab), initiated running at 16 weeks
- Met functional hop test goal ~30 weeks
- Discharged from PT at ~34 weeks



Summary

- Many factors contribute to ACL injuries, of intrinsic, extrinsic, and modifiable origins
- ACL prevention programs should target training neuromuscular control of dynamic alignment with an external focus (task becomes subconscious)
- Rehab should be considered in immature ACL tears prior to surgery to attempt to delay reconstruction until skeletally mature
- *Take it slow* when rehabilitating

Questions?



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