Management of Adolescent ACL Injuries: Treatment Outside of the Operating Room: Prevention

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No Disclosures

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How To Prevent an ACL Injury?

Neuromuscular Training (NMT)

- Plyometric training
- Biomechanical technique training
- Strength training
- Balance training
- Core stability training

AAOS
Management of ACL Injuries CPG

ACL NEUROMUSCULAR TRAINING PROGRAMS

Moderate strength evidence from pooled analyses with a small effect size (Number Needed to Treat=109) supports that neuromuscular training programs could reduce ACL injuries.

Strength of Recommendation: Moderate ★★★☆

Description: Evidence from two or more "Moderate" strength studies with consistent findings, or evidence from a single "High" quality study for recommending for or against the intervention.

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SUMMARY OF FINDINGS

Table 110. Summary of Findings: ACL Injury Prevention (Neuromuscular Training Program)

●:Favors preventive training program ●:Favors usual training ○:Not significant	Gilchrist et al. 2008 *(M)*	Petersen et al. 2005 *(M)*	LaBella et al. 2011 *(M)*	Soderman et al. 2000 *(M)*	Heidt et al. 2000 *(M)*	Olsen et al. 2005 *(M)*	Hewette et al. 1999 *(H)*	Caraffa et al. 1996 *(M)*	Mandelbaum et al. 2005 *(L)*	Meta-Analysis
ACL injury prevention	○	○	○	○	○	●	○	●	●	NA

Overall strength of study; High: *(H)*, Moderate: *(M)*, Low: *(L)*, Very low: *(V)*

Studies that Favor NMT

Olsen et al. 2005 (M)
Caraffa et al. 1996 (M)
Mandelbaum et al. 2005 (L)

- NMT warm-up programs
- All demonstrate significant reduction in ACL injuries after training

Overall strength of study:
M=moderate
L=low

Studies Found Not Signifigant

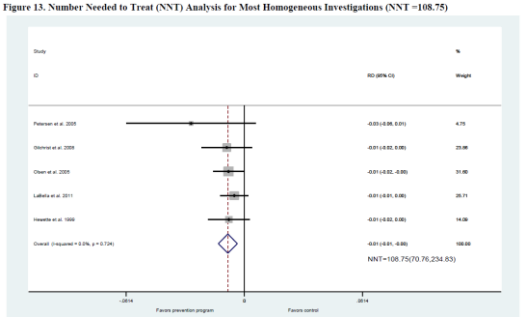
Gilchrist et al. 2008 (M)
Petersen et al. 2005 (M)
LaBella et al. 2011 (M)
Soderman et al. 2000 (M)
Heidt et al. 2000 (M)
Hewett et al. 1999 (H)

Overall strength of study:
M=moderate
H=high

- All suggest NMT can be preventative
- Lack large number of exposures

Small Effect Size (AAOS CPG)

Figure 13. Number Needed to Treat (NNT) Analysis for Most Homogeneous Investigations (NNT =108.75)



More Recent Evidence…

- 72% reduction in ACL injury rates in girls <18 years old vs. 16% risk reduction for those ≥18 years old *(LaBella et al. 2014)*
- Meta-analysis of Level 1 RCTs of soccer players: NMT has protective effect *(Grimm et al. 2014)*
- Neuromuscular and proprioceptive prevention programs reduce ACL injuries by 50.7% *(Donnell-Fink et al. 2016)*

Most Effective NMT Programs

- Duration: minimum of 6 weeks
- Frequency: >1x/week
- Comprehensive (with strength training)
- Combined pre- and in-season training
- Short bursts of activity
- Real-time Feedback with external-focus instructional strategies
- Timing: Early pubertal maturation

Benjaminse et al. 2015, Ford et al. 2015, Sugimoto et al. 2015, Hewett et al. 2006

Bonus!

Participation in NMT can lead to improved sports performance:

- LE and abdominal strength
- Vertical jump height
- Estimated maximal aerobic power
- Speed
- Agility
- Isokinetic strength
- Balance

Noyes et al. 2012, DiStefano et al. 2010

Cost-Effective Analysis

Swart et al. 2014:

On average, the implementation of a universal training program would…

- Save $100 per player per season
- Reduce the incidence of ACL injury from 3% to 1.1% per season

What happens after one NMT session?

Root et al. 2016:

- Landing technique improves (LESS)
- Does not impair sport performance (vertical jump, long jump, shuttle run)

Limitations of NMT Research

- Lack of high-strength, double-blind RCTs
- Low generalizability (i.e. study populations)
- Heterogenous protocols
- Lack of compliance

Future NMT Research

- Multi-site studies using standardized NMT program
- Larger sample sizes of high-risk athletes
- Optimization of protocols
- Improved delivery

Risk Assessment

- Tuck Jump *(Myer et. al 2008)*
- Drop Vertical Jump (DL and SL) *(Redler et al. 2016)*
- Landing Error Scoring System (LESS) *(Padua et al. 2015)*

ACL Injury Prevention Programs

- Prevent Injury and Enhance Performance (PEP)
- Knee Ligament Injury Prevention (KLIP)
- FIFA 11+
- FIFA 11+ Kids
- Sportsmetrics

Thank You!

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Management of Adolescent ACL Injuries: *Work-up*

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- I, nor anyone in my immediate family, have any conflicts of interest, financial or otherwise, regarding any material within my presentation.
- Thank you to VuMedi team, PRiSM, Dr. Ted Ganley, and our research coordinator Vincent D'Angelo.

Work-Up: starts with clinical suspicion

- **ACL rupture is typically caused by rotation/translation of the knee with foot planted; often non-contact**
- **Physical Exam:**
  - **Effusion and decreased ROM common**
  - **Lachman and/or anterior drawer: increased anterior translation of tibia**
  - **Lachman is very sensitive and specific**
  - **Pivot shift**
- **KT-1000**

Imaging: *Plain radiographs*

- Should be done at initial assessment
- Utility: rule out fractures, evaluate physes
- Obtain 4 views: AP, lateral, tunnel, sunrise
- Associated fractures may include:
  - Segond fx: lateral tibial condyle avulsion
  - Lateral femoral condyle impaction
  - Tibial spine avulsion
- In practice, insurance likely requires radiographs prior to advanced imaging

Plain Radiographs

Segond fracture

*carries 75+% chance of ACL rupture

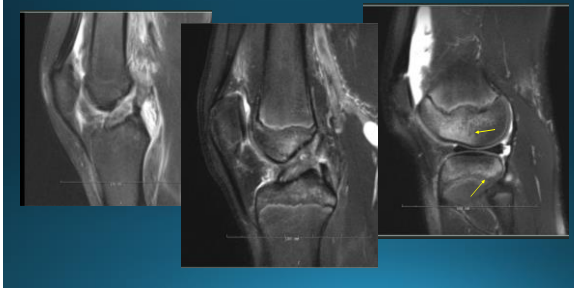
Imaging: *MRI*

- Sensitivity and specificity generally 95+%
- A number of articles describe similar accuracy for clinical evaluation
- MRI is most useful for confirming the diagnosis and defining associated injuries
- In practice it is necessary prior to surgical intervention

MRI in ACL Rupture

- ACL may appear thick with increased intra-substance signal on T2 images
- May see complete rupture with lack of fiber continuity, or possible avulsion type rupture
- Bone bruise pattern: posterior lateral tibial plateau and lateral femoral condyle
- Assess for associated injuries: menisci, articular cartilage

MRI: ACL rupture



Preparing for Surgery

- Starts from the time we suspect ACL tear clinically
- Discuss the importance of attaining normal knee motion and maintaining quad strength pre-operatively
- May need pre-op physical therapy
- Protection: brace, crutches, weight bearing status?
- Consider the emotional impacts
- Know some timelines for your surgeons

ACL Reconstruction

- Graft choice depends on several factors
  - Patient age, skeletal maturity
  - Surgeon experience
- In adolescents the most common options are autograft hamstrings or cadaver graft
- Hamstrings obtained from ipsilateral knee

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Post Operative Physical Therapy

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Disclosures

- None to report

AAOS Guidelines

- Bottom Line Up Front
  - Moderate evidence to support the following post-operative physical therapy guidelines
    - Accelerated vs non-accelerated rehab programs
    - Unrestricted and immediate range of motion (ROM) vs delayed
    - Immediate weight bearing vs delayed
    - Early, but limited range during open kinetic chain (OKC) exercises vs delayed and full motion
    - Early closed kinetic chain (CKC) exercises vs delayed

Accelerated vs Nonaccelerated

- Recommendations based off of 2 studies (Beynnon 2005, 2011)
  - BTB Grafts were used for all subjects
  - Non-adolescent populations: 18-50 years of age
  - Randomized into 2 groups
  - Accelerated program progressed subjects over 19 weeks
    - Exercises thought to produce increased sheer on the graft were initiated earlier
  - Nonaccelerated program lasted 32 weeks
  - Followed out to 24 months
  - Results
    - No differences in almost all outcome measures
      - Knee laxity, activity level, pain, ADLs, quality of life, articular cartilage biomarkers
    - Increased quad strength in accelerated group at 3 month follow up only
    - 1 re-tear (6 months out, nonaccelerated group)
- Aggressive vs nonaggressive hamstring autograft (Christensen 2013)
  - No difference between groups (only followed to 24 weeks)

Unrestricted and Immediate Extension ROM

- Early active extension after anterior cruciate ligament reconstruction does not result in increased laxity of the knee. (Isberg 2006)
  - 22 BTB Subjects
  - Randomized into 2 groups
    - Full passive or active extension immediately vs delayed
  - Follow up at 6 months and 2 years
  - Results
    - No difference between groups in any outcome measure
      - Laxity
      - Self reported scores
      - Hop testing

Early but limited motion during OKC strengthening

- OKC in restricted range 90-45° shown to be safe (Fleming 2005, Escamilla 1998)
- Early OKC exercises in hamstring autograft may increase laxity (Heinji 2007)
  - Early vs late start of OKC in both BTB and HS ACLR (4 groups)
  - Early hamstring group demonstrated significantly increased AP laxity
  - No other differences between groups were found (strength, pain, function)
- Best time to implement safe OKC exercises? (Fukuda 2013)
  - Early start (4 weeks) vs Late start (12 weeks)
    - Restricted motion at knee extension machine from 45-90
  - Results
    - No difference in knee joint laxity
    - Earlier group had quicker return of quad strength
    - No difference in function

Future Research in Post-Op Therapy

- Shift focus from differences in early rehab to later rehab guidance
  - Identify optimal return to play, duty or work measures and benchmarks to guide rehab
  - Improve long term tracking of ACLR patients
    - What is re-tear or contralateral tear rate in specific populations
    - Better describe those who re-tear vs those who don't
    - Repeat functional testing in "graduates" to identify regression
- Is there sufficient evidence to support Neuromuscular Electrical Stimulation (NMES)?
  - Seems promising in ACLR and other post-op populations (Erlandson 2014)
- Rehab trends to keep an eye on in the literature
  - Blood Flow Restriction Training (BFR)
  - Force plates for training and evaluation

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Management of Adolescent ACL Injuries: Bracing

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Sports Medicine: Outreach Athletic Training

Disclosers:

Presenter: Opal Griffin, LAT, ATC

With respect to the following presentation, there has been no relevant (direct or indirect) financial relationship between the party listed above (and/or spouse/partner) and any for-profit company in the past 24 months which could be considered a conflict of interest.

All images that are included are for clarification purposes only, not a suggestion of the "best brace" or the type that was specifically tested.

Prophylactic Bracing:

- Ortho Guidelines from the AAOS (5, 6)
  - Limited evidence supports Preventative braces might not be prescribed
  - Studies showed no reductions in ACL injuries with Bracing
    - Only tested American HS and Collegiate FB players.
  - Future Research
    - Would this be different in other populations?
      - Female Soccer has the highest rate of ACL injury per the AAOS
    - Greater population size?
    - Younger population?

Postoperative Functional Bracing:

- Ortho Guidelines from the AAOS (1, 2, 3)
  - Moderate evidence does not support routine use
    - not proven effective when compared to neoprene knee sleeve and no bracing.
  - Routine use cannot be supported
    - There was lack of efficacy following ACL reconstruction..

Types of Braces Studied (examples)

Functional Bracing

Neoprene sleeve

Postoperative Functional Bracing:

- 2015 Review published in Sports Health (4)

  Anterior Cruciate Ligament Reconstruction Rehabilitation: MOON Guidelines
- Postoperative bracing did NOT improve: pain, swelling, range of motion or safety
- "Eleven studies… no study demonstrated a clinically significant or relevant improvement in safety, range of motion including extension, or other outcome measures.[7,15,19,25,27,31,36,43,47,50,57,67]"
  - Supported by 17 studies that the MOON group considered to be level 1 or 2 evidence

Postoperative Bracing: Exception

- Meniscal Injury with about half of all ACL injuries. Per the AAOS.
  - Meniscal repair requires support post surgically.

References:

- Functional knee braces after ACLR

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5. Sitler M, Ryan J, Hopkinson W et al. The efficacy of a prophylactic knee brace to reduce knee injuries in football. A prospective, randomized study at West Point. Am J Sports Med 1990;18:310-315.
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Questions…

Thank you for joining us!

Return to Sport after ACL Reconstruction: How Objective is your Decision?

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Objectives

1. Review current evidence regarding RTS after ACL reconstruction
2. Discuss current criteria used to determine readiness to RTS.
3. Identify potential opportunities to improve RTS decision making in this population

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AAOS
American Academy of Orthopaedic Surgeons

MANAGEMENT OF ANTERIOR CRUCIATE LIGAMENT INJURIES

EVIDENCE- BASED CLINICAL PRACTICE GUIDELINE

Adopted by the American Academy of Orthopaedic Surgeons Board of Directors
September 5, 2014

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ACL RETURN TO SPORTS

Limited strength evidence does not support waiting a specific time from surgery/ injury, or achieving a specific functional goal prior to return to sports participation after ACL injury or reconstruction.

Strength of Recommendation: Limited ★★☆☆

RATIONALE

The rationale for return to play and secondary injury risk was based on one low and one very low strength study.[37,104] Early return (mean five months) versus late return (mean nine months) to sport was not different for subsequent ipsilateral ACL injury, subjective and objective functional outcomes or knee laxity. [37] Similarly, early return to sports (<6 months versus >6months) was not associated with increased incidence of either contralateral or ipsilateral ACL injury. [104]

The rationale for return to play based on achieving functional criteria was based on one low strength study.[11] This study reported similar potential return to pre-injury sport levels in those who attempted to return before 12 months relative to those who returned after 12 months.

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CLINICAL QUESTION:
When is it safe to return to sports (RTS) after ACL Reconstruction?

1. What is "safe"?
2. What are the functional demands of the sport?

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RTS: When is it safe?

1. Incidence of 2nd ACL injury after ACLR and RTS
   - Ipsilateral Graft Re-tear *(Wright et al JBJS 2011)*
   - Contralateral ACL Injury *(Wright et al JBJS 2011)*
2. Incidence of Secondary Injury after ACLR and RTS
3. Incidence of Osteoarthritis after ACLR and RTS
   - 50-100% of patients develop OA after ACL injury
   - *Lohmander et al 2004*

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RTS: When are you able to return to your prior level of function?

What factors are necessary to insure success:

- Strength
- Balance/Postural Stability
- Mechanical Stability/Functional Stability
- Power
- Endurance
- Agility
- Etc….

ACL Return to Sport: Systematic Review

Kvist J. "Rehabilitation Following Anterior Cruciate Ligament Injury: Current Recommendations for Sports Participation." Sports Med 2004: 34(4): 269-280.

34 articles between 1998-2003

ACL Return to Sport: Systematic Review- *Kvist Sports Med 2004*

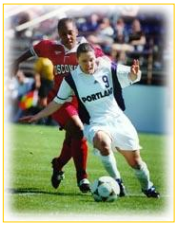
Outline of criteria reported:

- 13/34 assessed isokinetic strength
- 25/34 used jump testing
- 14/34 reported some clinical criteria (i.e. ROM, knee stability etc.)
- 4/34 had no assessment of strength or performance

ACL Return to Sport: Systematic Review- *Barber-Westin et al 2011*

Systematic Review (n=264)

- 40% : no criteria
- 13% : objective criteria



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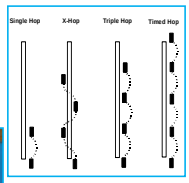
Current Return to Sport Measures

1. Time from surgery
2. Strength
3. Knee Laxity
4. Functional Performance Testing



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Current Return to Sport Measures

"…low correlations between various hop test scores and self-reported measures of function may indicate that neither of these methods can stand alone as an adequate assessment of knee function."

Fitzgerald GK et al
"Hop Tests as Predictors of Dynamic Knee Stability"
JOSPT 2001

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Return to Sport Assessment: What are we missing?

1. Patient reported outcomes
2. Assessment of movement quality
3. Patient readiness to return to activity

RTS: Patient Reported Outcomes

1. Patient Reported Quality of Life Measure
2. Region Specific Assessment
   - IKDC: *Zwolski et al AJSM 2015*
   - KOOS: *Wasserstein et al Osteo Cart 2015 (MOON Data)*
   - Others

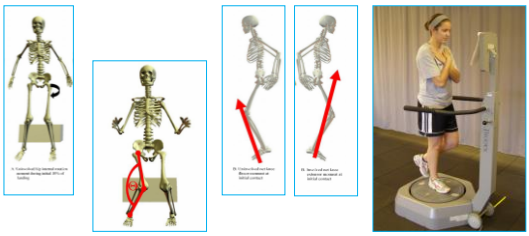
RTS: Assessment of Movement Quality

RTS: Assessment of Movement Quality

"Biomechanical Measures during Landing and Postural Stability Predict Second Anterior Cruciate Ligament Injury after ACL Reconstruction and Return to Sport"

Paterno et al AJSM 2010

RTS: Predictors of 2nd ACL Injury



Paterno et al AJSM 2010

RTS: Patient Readiness to RTS

1. Fear of Reinjury/Lack of Confidence
   - *Lentz et al JOSPT 2012*: Athletes who RTS had lower level of kinesiophobia
   - *Lentz et al AJSM 2015*: Athletes who did not RTS due to fear of reinjury was older, lower quad strength and lower IKDC
2. Other Factors

Summary

1. Limited evidence exists regarding RTS decision making after ACLR
2. Current criteria used to determine readiness to RTS may not identify those at high risk for injury or likely to maintain pre-injury level of function
3. Future work needs to better identify critical factors to use to determine readiness to safely return to sport

Thank you!!

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