

Intro by:

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0:00 Introduction

2:12 The ACL Story

1. "The Unholy Triad", O'Donohue 1955
2. Often does not require repair, Turek 1959
3. Non-contact, cutting injury, Hughston JC 1976
4. Direct repair unsuccessful, Feagin JA 1976
5. Extra articular reconstruction, 1970s, early '80s
6. "Anatomic" repair, Eriksson, Fu
7. Pediatric ACL, extremely rare; no mid substance

4:04 Lloyd-Roberts Quote

"Instability of the knee is a very unusual symptom in children. Torn menisci and anterior cruciate avulsion are seen very rarely..."

4:37 Turek SL Orthopaedics Quote

"In youth, the anterior cruciate is strong and, instead of rupturing at the anterior insertion, the bone is avulsed."

5:01 Boston Children's Hospital 2013

Pre-pubescent ACL: Extraphyseal ITB (1976)

Pubescent ACL: Transphyseal hamstring

993 knees; 1995-2008

Presently ~ 150/year

5:14 Knee: Young Athlete

1. Ligament
2. Internal derangement
3. Extensor mechanism
4. Physis
5. Other

5:45 Child: Knee Ligament

1. Collateral
2. Cruciate

6:18 Recent Observations

- The incidence of intrasubstance tears seems to be increasing
- They do not do well untreated
- Adolescents (B.A 14 y/o boys, 13 y/o girls) not problem
- Pre-pubescent ("wide open growth plates") the issue

6:44 Gender (2001 – 2006)

1068 patients: 584 females, 484 males

14 and under = 179 patients

83 males: (83/179) = 46.4%

hypothesis works!

96 females: (96/179) = 53.6%

ages 13–19 = 541 patients

204 males: (204/541) = 37.7%

337 females: (337/541) = 62.3%

477 patients ages 20 and over

7:45 Total Group

8:06 Lachman Test

8:48 Controversy: Pediatric ACL Injuries

- Initial Management

 - Nonoperative vs. operative

- Operative Management

 - Technique

 - Nontransphyseal

 - Partial transphyseal

 - Transphyseal

 - Graft choice/fixation

 - Age/skeletal maturity

- Complications

 - Growth disturbance

10:07 Tanner Staging of Biological Age

Establishing Biological Age

10:11 Left Wrist: Bone Age

10:43 ACL Injury Type

11:29 Pediatric Knee Injuries ACL Injuries

Prognosis of Nonoperative Management (complete tears)

Angel & Hall (Arthroscopy 1989)

- 5/7 failure (ACL reconstruction)

Graf et al (Arthroscopy 1992)

- 7/8 failure (ACL reconstruction, meniscal tears)

Janarv et al (J Pediatr Orthop 1996)

- 16/23 failure (ACL reconstruction)

Mizuta et al (JBJS–B 1985)

- 1/18 return to preinjury sport level, 6/18 meniscal tears

McCarrol et al (AJSM 1988)

- 3/16 return to preinjury sport, 4/16 meniscal tears

12:35 Meniscal and chondral injuries associated with pediatric anterior cruciate ligament tears

13:06 Pediatric Knee Injuries ACL Reconstruction
Extra-Articular, Physeal Sparing, Partial Transphyseal, Complete
Transphyseal

13:24 CASE STUDY: 1978

- 3 y/o boy; congenitally absent ACL
- Bracing unsuccessful
- Modified McIntosh procedure
- Stable knee
- Dartmouth lacrosse
- NY stockbroker
- Helicopter skiing

15:25 Operative Complications

Dramatically under-reported in the medical literature!

15:42 Pediatric Knee Injuries Growth Disturbance In Animals

16:45 Computer Analog Studies

17:28 Femoral Physeal Injury

- Angular deformity
- Leg length

19:02 Have you ever seen a growth disturbance from ACL reconstruction
in a skeletally immature patient?

21:08 Evolution of the ITB Extra / Intra Repair

1972 – Macintosh, “Return lateral loop” for pivot shift

Galway RD, Beaupre A, Macintosh DL. Pivot shift: a clinical sign of
symptomatic anterior cruciate insufficiency. J Bone Joint Surg Br.
1972;54:763–764.

1976–1978 – Lyle J. Micheli, 3 cases, congenital absent ACL,
“modified Macintosh”, age 3–6 years

1978–1999 – ACL tear, meniscus tear

Micheli LJ, Rask B, Gerberg L. Anterior cruciate ligament
reconstruction in patients who are prepubescent. Clin Orthop. 1999;
(364):40–47.

1999–present – ACL instability

Kocher M, Garg S, Micheli L. Physeal Sparing Reconstruction of the
Anterior Cruciate Ligament in Skeletally Immature Prepubescent
Children and Adolescents. JBJS 2005, 87A:11, 2371–2379.

22:26 Follow-up Exam

- 9 of 10
- 2–15 years post-op
- Average 5.3 years

22:53 Results

23:22 Long-Term Outcome?

- Aichroth, P.M et. Al. The Natural History and Treatment...
JBJS (Br): 84B.38-41, 2002

Mean age 13 yr. 25% Unsatisfactory (3 yr)

- Edwards P.H, Grana W.A. ACL Reconstruction in the Immature Athlete: Long term results of intra articular reconstruction...Am J. Knee Surg. 14, 232-237, 2004

Average age 13.7 yrs. 4/21 failures (36 months: Range- 5 yrs.)

- Kocher M, Garg S, Micheli L. Physeal Sparing Reconstruction of the Anterior Cruciate Ligament in Skeletally Immature Prepubescent Children and Adolescents. JBJS 2005, 87A:11, 2371-2379. 4 2/44 success.

2-15.1 yr (5.3 yr mean)

24:39 Complete transphyseal reconstruction of the anterior cruciate ligament in the skeletally immature.

Paletta GA Jr.

Surgical technique

- Vertical tibial tunnel
- 0.5cm reamers
- Avoid oblique femoral tunnel
- Metaphyseal fixation

Presented 50 patients; 2009

3-10 years (4.5 years); chron 7-13 years

25:16 Complete ACL Tear: Child/Adolescent

26:27 Adolescent ACL Tears

Complete: 42%

Partial: 58%

27:54 Tibial Spine Management

1.Stable

-Cast or brace, 4-6 wk @ 30° flexion

2.Unstable

-Arthroscopy, reduction, fixation

29:39 Prevention of ACL Injuries: Young Athlete

- Strength training

30:10 Prevention of ACL Injuries: Young Athlete

- Neuromuscular training

30:40 Prevention of ACL Injuries: Young Athlete

- Bracing ?

31:07 The Future Biologic ACL Repair?

Martha Murray, MD

31:23 Bridge Enhanced ACL Repair: Early Results

31:39 Adolescent ACL Injuries

- High rate of early graft failure
 - Up to 20% in the first 2 years
- High rate of late graft failure
 - At 10 years, graft failure rates 50%²
- High risk of post-traumatic OA
 - 78% OA at 14 years after ACL injury with or without reconstruction³
 - 15Y0 +14 years =29Y0 with OA

32:52 ACL Repair: John Feagin

- 2 year f/u: 83% good/excellent
- 5 year f/u: poor function $\frac{1}{2}$
- 94% had unstable knees

34:55 The BEAR Study

- 20 patient FDA-approved study
- 10 patients with Bridge-Enhanced-ACL-Repair (BEAR procedure)
- 10 patients with autologous hamstring graft
- Outcomes:
 - Safety (primary): Infection, inflammatory response, weakness, pain, implant failure
 - Efficacy (secondary): Knee laxity, patient reported outcomes, muscle strength

37:29 First Bridge-Enhanced ACL Repair Patient

39:35 CASE #1

13 YEAR OLD MALE & PATIENT HISTORY

40:20 WHAT WOULD YOU DO?

1. Arthroscopy
 - ACL repair transphyseal
 - Meniscal repair
2. ACL reconstruction extraphyseal
 - Meniscus repair

41:00 Discussion

43:30 High Failure Rate on ACLR

44:24 IT Band Procedure Long Term Ramifications?

48:40 Conclusion