

5<sup>th</sup> course of advanced surgery of the knee  
Val d'Isère, 02-2014

# Management of ACL injuries in the skeletally immature patient

Prof. Romain Seil, MD, PhD

Orthopaedic  
Surgery



Centre Hospitalier  
de Luxembourg

Sports Medicine  
Research Laboratory



Centre de Recherche  
Public – Santé,  
Luxembourg

None !

# Types of pediatric ACL lesions

Cartilaginous avulsions

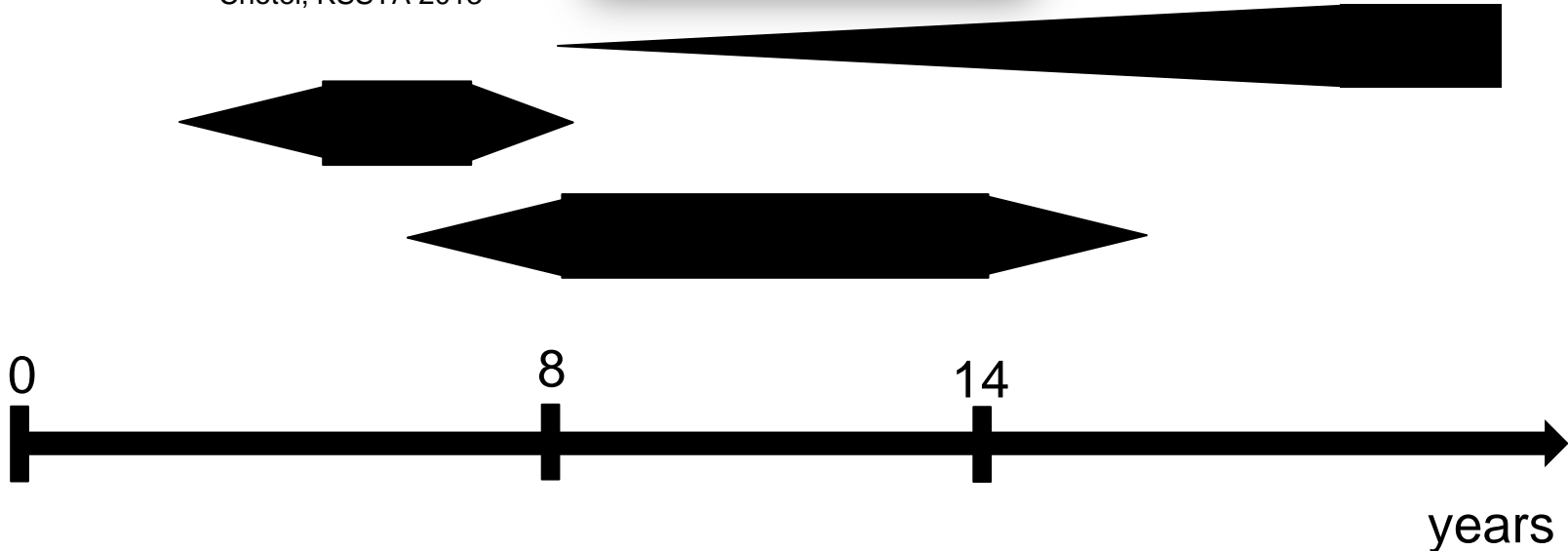
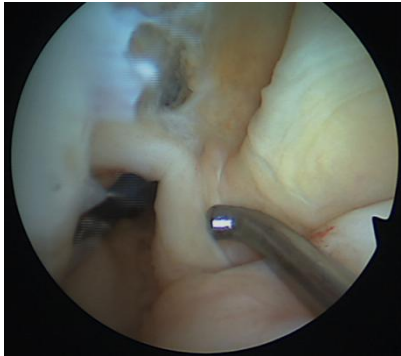


Chotel, KSSTA 2013

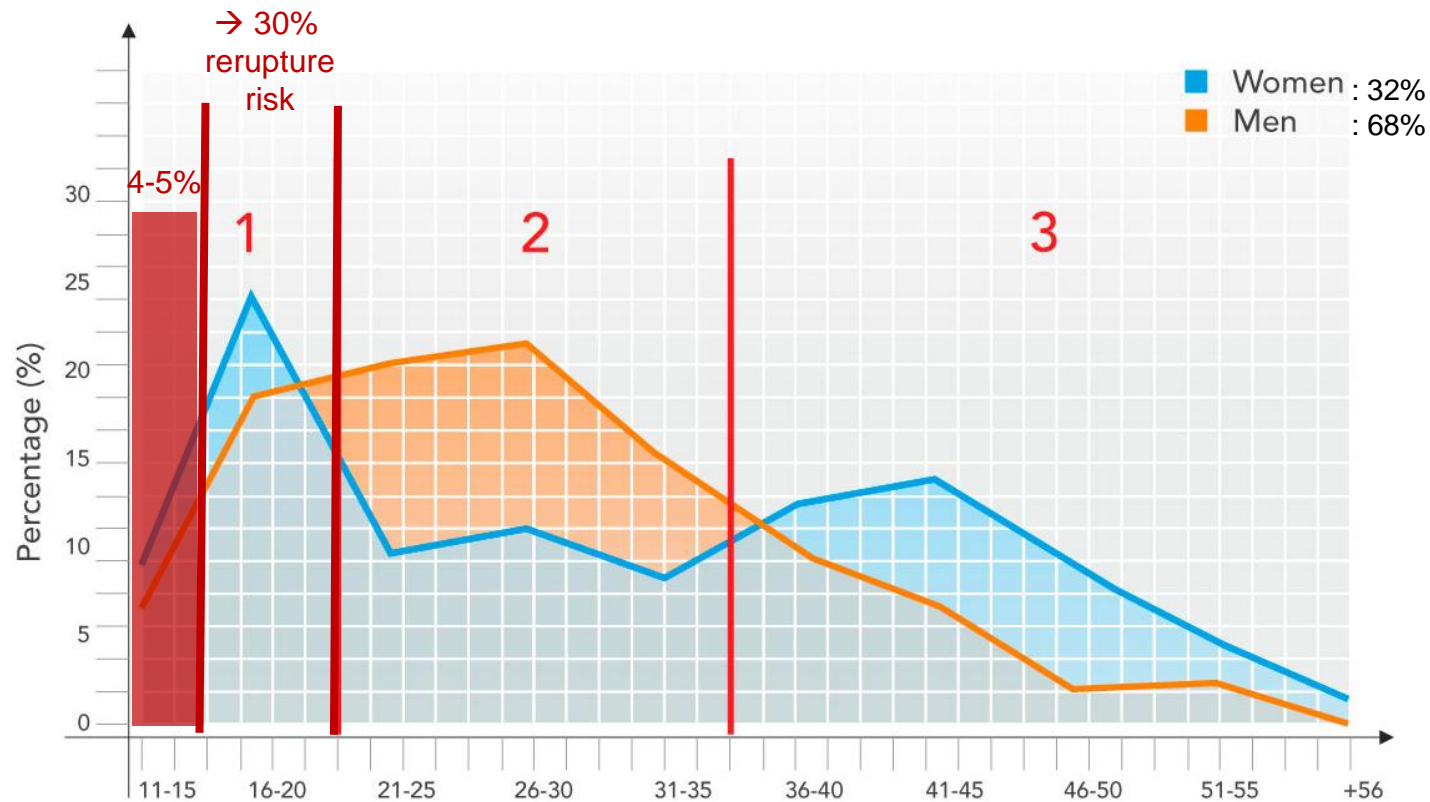
Bony avulsions



Midsubstance tears



# In-house ACL registry: 2011-2012



Competitive sports (%): 76 68 17 (p<0.01)

Leisure sports (%): 15 28 72

Surge (%): 84 84 82 (p<0.01)

Men  
Wom

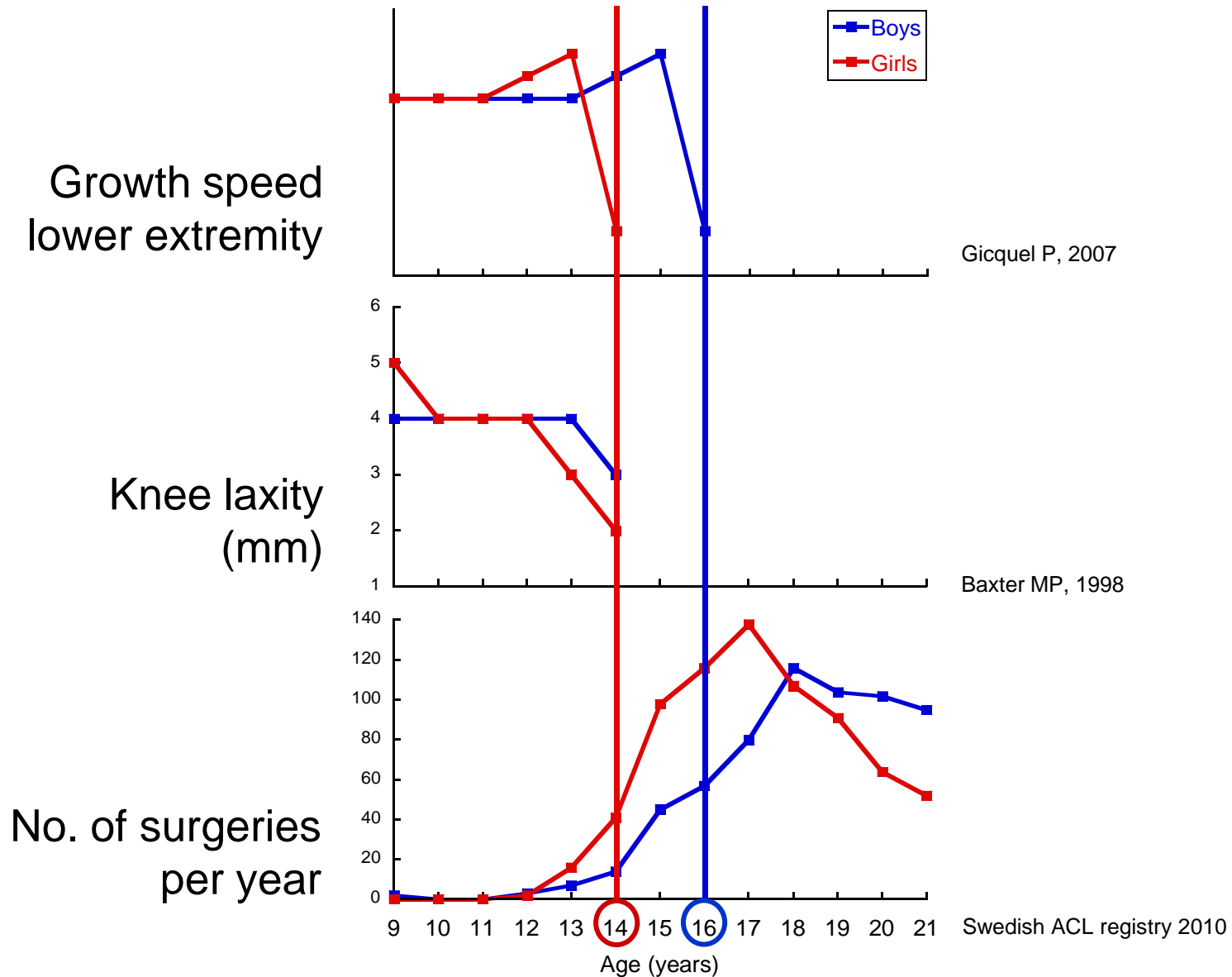
Frobell RB, Scand J Med Sci Sports 2007

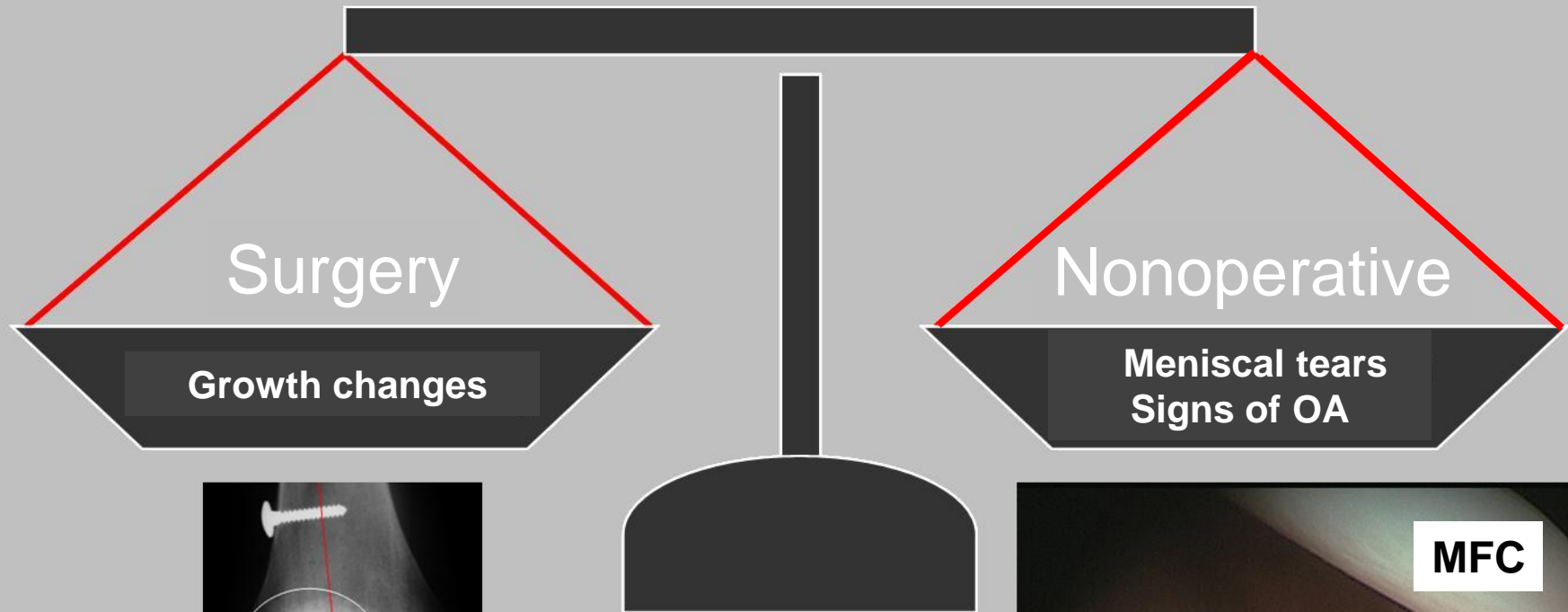
Granat LP, Am J Sports Med 2009

Renstrom P, Br J Sports Med 2012

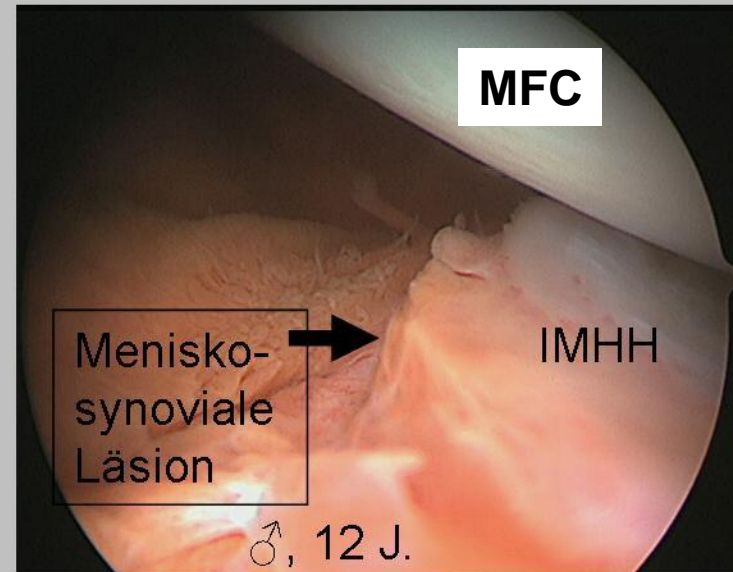
Few precise epidemiological data

# Growth and maturation of knee joint





Courtesy of C. Bonnard,  
Tours, France



## The Current Evidence for Treatment of ACL Injuries in Children Is Low

A Systematic Review **J Bone Joint Surg Am.** 2012;94:1112-9

Håvard Moksnes, PT, MSc, Lars Engebretsen, MD, PhD, and May Ama Risberg, PT, PhD



Low treatment evidence

# Nonoperative treatment debate

Knee Surg Sports Traumatol Arthrosc (2008) 16:214–223  
DOI 10.1007/s00167-007-0469-7

KNEE

Performance-based functional outcome for children 12 years or younger following anterior cruciate ligament injury: a two to nine-year follow-up study

Håvard Moksnes · Lars Engebretsen ·  
May Arna Risberg

Degeneration of the Knee Joint in Skeletally Immature Patients With a Diagnosis of an Anterior Cruciate Ligament Tear

Is There Harm in Delay of Treatment?

J. Todd R. Lawrence,<sup>\*††</sup> MD, PhD, Nina Argawal,<sup>†</sup> BA, and Theodore J. Ganley,<sup>††</sup> MD

**Hypothesis:**

The earlier the surgery, the lower secondary meniscus and cartilage lesions.

Julien Henry · Franck Chotel · Julien Chouteau ·  
Michel Henri Fessy · Jérôme Bérard · Bernard Moyen

**Hypothesis:**  
> 40 % of children do not need surgery !

Knee  
DOI  
KN

Trauma  
in prepubescent athletes

Nikolaus A. Streich · Alexander Barié ·  
Tobias Gotterbarm · Maximilian Keil ·  
Holger Schmitt

- Tanner I or II (median 11 years)
- 42 % of conservatively treated children did not need surgery over a 5-years period
- 58 % developed instability and received an ACL-reconstruction

Streich NA, KSSTA 2010

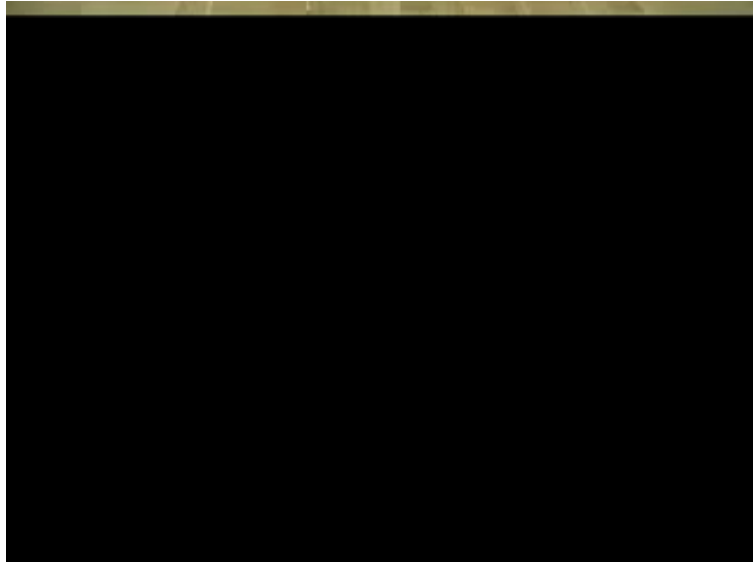
- higher MMT rate in late surgery group

Henry J, KSSTA 2009



# Nonoperative treatment debate

## Functional tests



Reliability ?  
Sensibility ?

Patients' & families' adherence to:

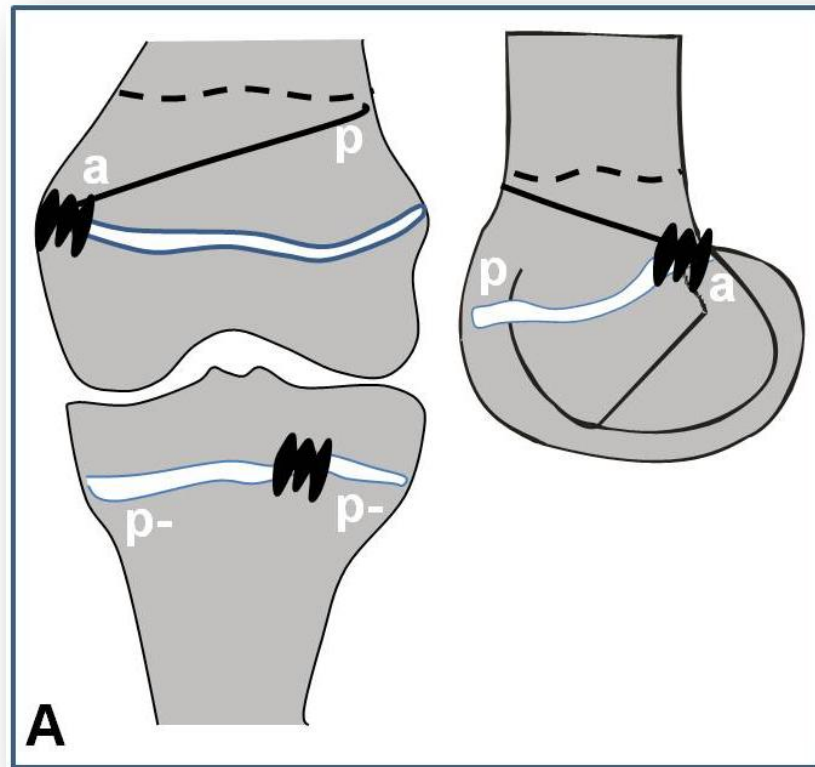
- Less active lifestyle
- Damocles sword of later surgery and subsequent meniscus tear / cartilage lesions
- Level II sports
- Brace

Limited option for some patients & their family

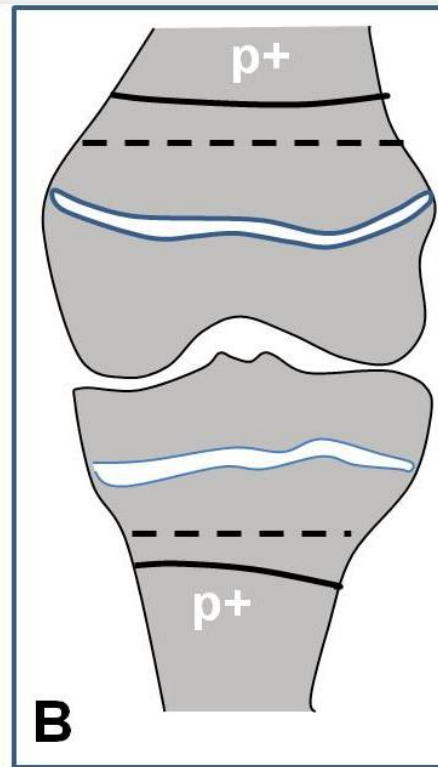
# Operative treatment debate

3 pathophysiological types of growth changes

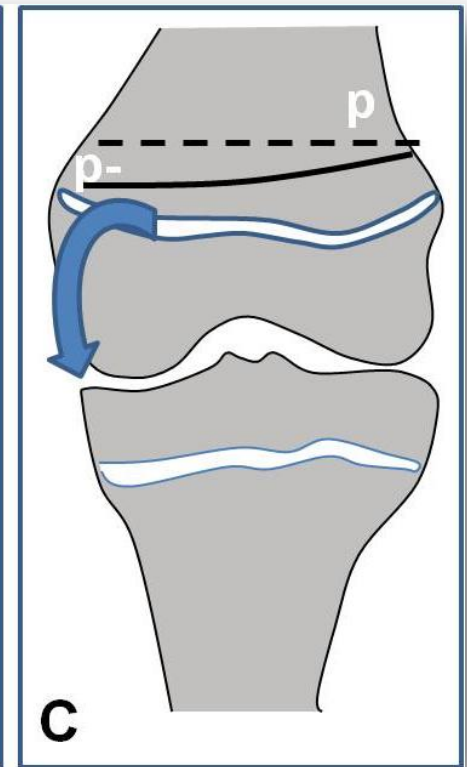
**Arrest**



**Boost**

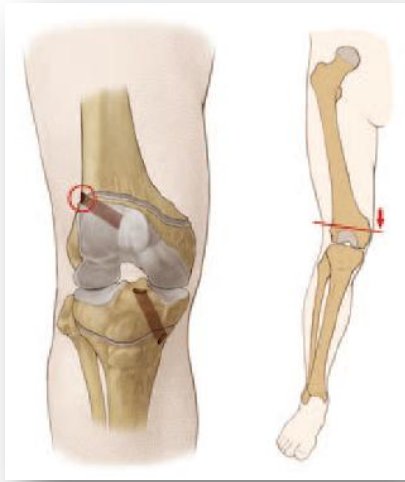


**deCeleration**



Chotel F, KSSTA 2010

# 4 types of gross complications



Arrest distal lateral femur physis:  
valgus knee



Arrest tibial tuberosity:  
recurvatum



Arrest medial proximal tibial physis:  
Varus knee



NO transphyseal hardware placement or synthetic graft

Complications probably underreported

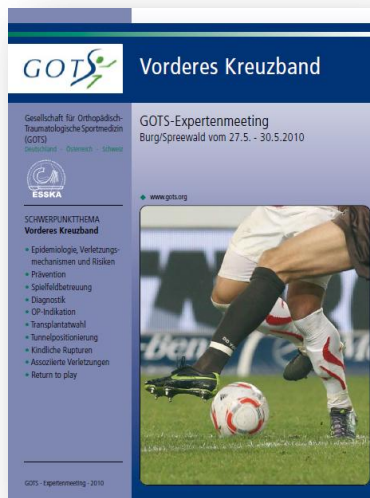
## 2000

17 studies  
(1983– 1999),  
458 knees

TREATMENT	UNSTABLE KNEES (%)
Nonoperative	91
Sutures	73
Extraarticular reconstructions	64
Intraarticular reconstructions	14

Seil R, 2000

## 2013



1. Evaluate remaining growth
2. Know specific anatomy
3. Fill the tunnels with soft tissues
4. Small tunnels (< 9mm)
5. Perpendicular to physis
6. Graft tension not too high
7. No physeal-crossing fixation

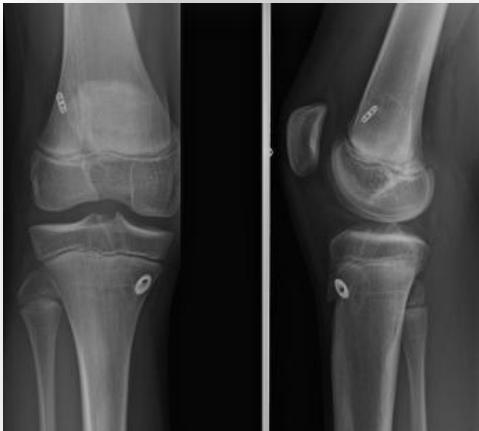
# Treatment algorithm



## Isolated ACL tear:

### NO early reconstruction !

- Explanations +++
- Rehabilitation for 3-6 mo.
- Limitation of physical activity
- Close FU
- (Brace)



## Indication for surgery:

1. If primary meniscal tear
2. @ skeletal maturity
3. If secondary meniscus tear
4. If functional instability
5. High sports demand (?)

No international consensus,  
expert-opinion level discussions

# Preoperative evaluation: diagnostic pitfalls



## Lachman test:

High physiologic laxity in children !

Baxter MP, J Ped Orthop, 1998

## Pivot-shift test:

Hefti F, Muller W 1993

Frequently pathologic  
in healthy children



## Haemarthrosis:

- 1/3 ligamentous tears ( $\text{♂} > \text{♀}$ )
- 1/3 patella dislocations ( $\text{♀} > \text{♂}$ )
- 1/3 meniscal tears

Luhmann SJ, 2003

# Preoperative evaluation: diagnostic pitfalls



♂, 9 y.

sensitivity      specificity

< 12 y.:              62 %              90 %

12-16 y.:             78 %              96 %

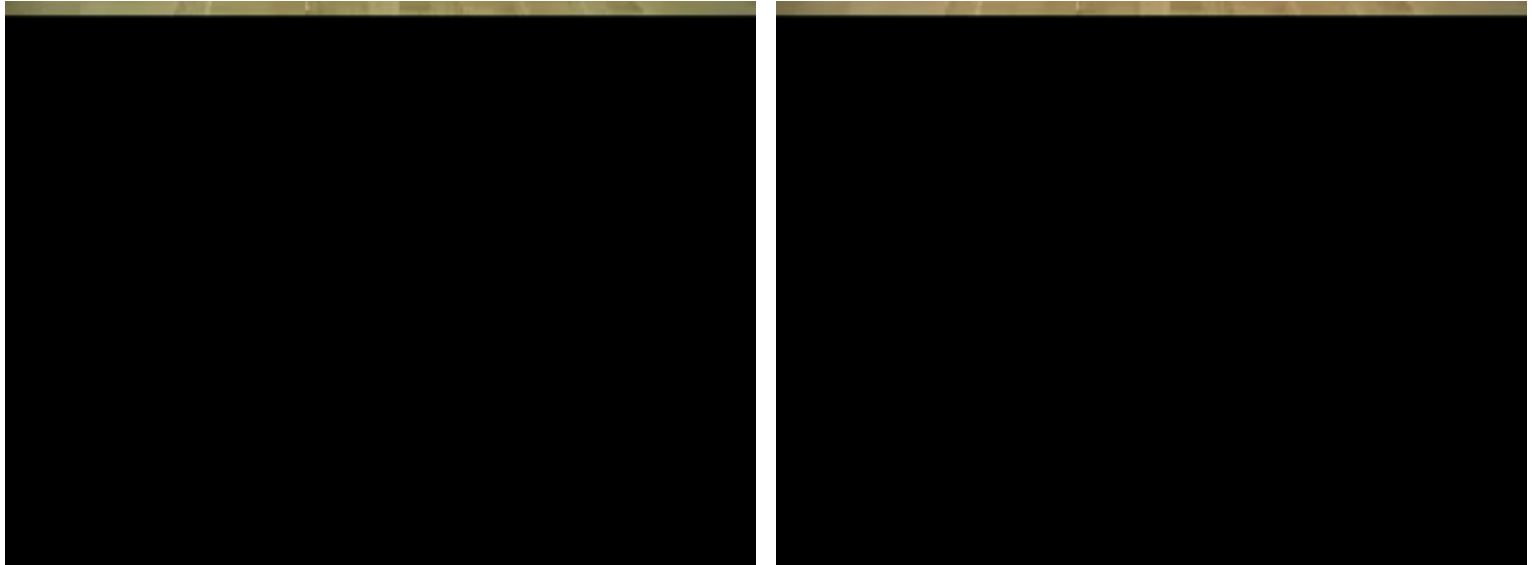
BEWARE false positive  
(up to 25 % !)

Kocher MS, 2001

Lee K, 1999

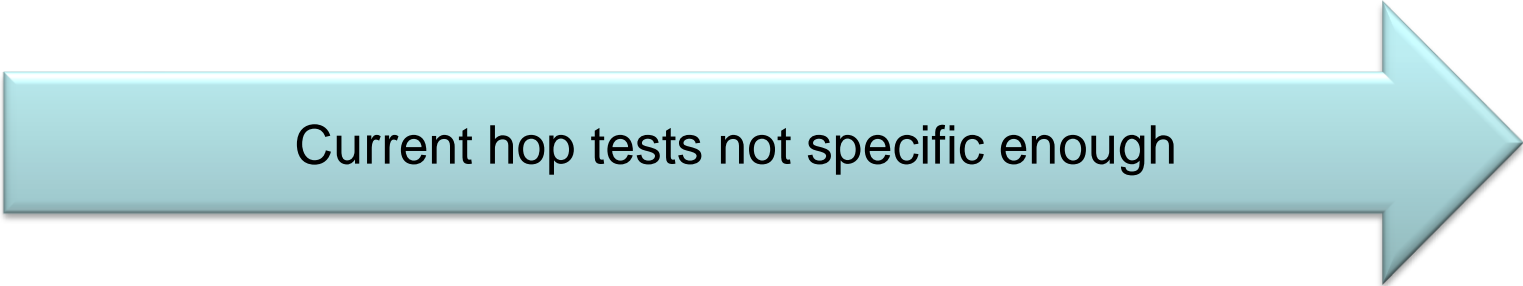
# Preoperative evaluation: functional testing

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Moksnes H 2008

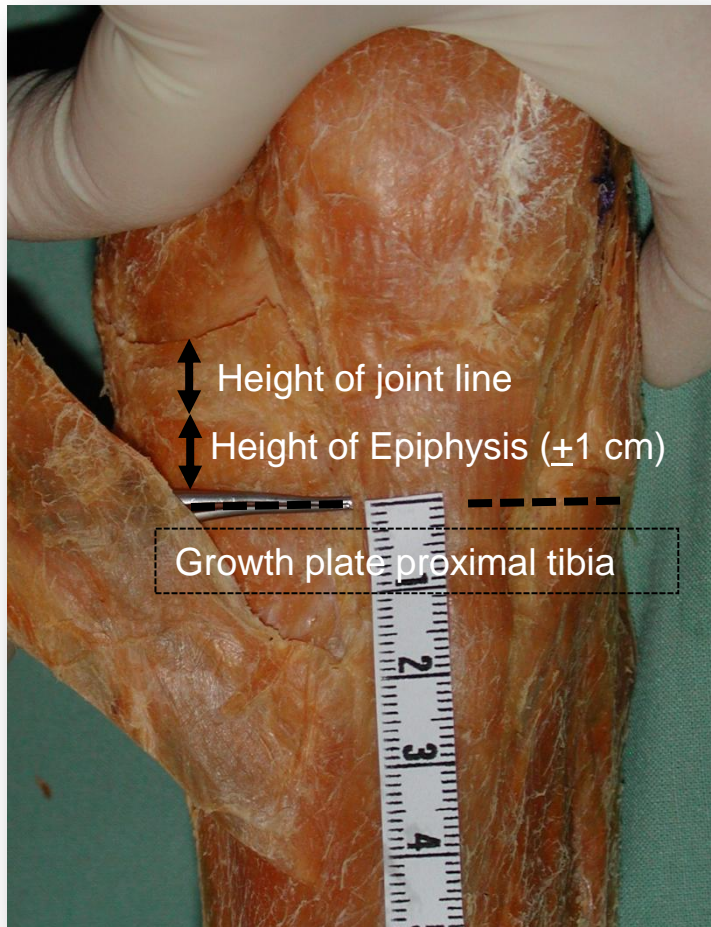
Current hop tests not specific enough



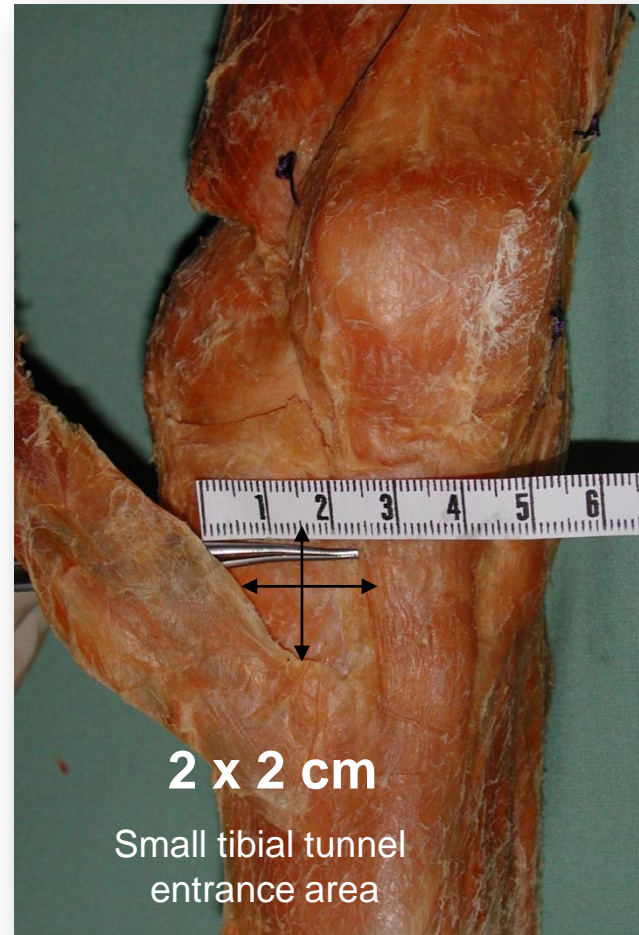


# Preoperative planning: anatomy

## Tibia

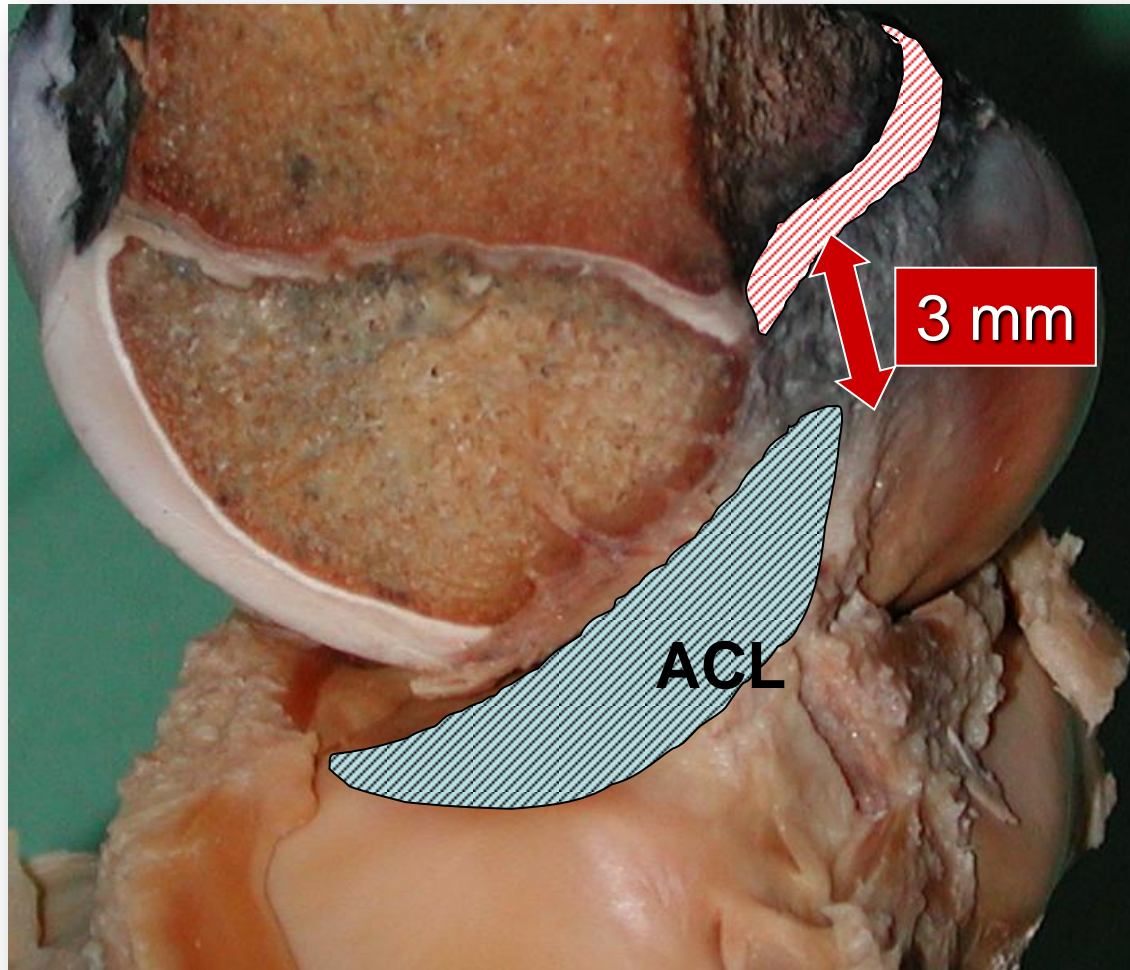


Left knee, specimen of 10 yrs old girl



# Preoperative planning: anatomy

## Femur



# Preoperative planning



- Remaining knee growth
- Leg length
- Alignment
- Skeletal age
- Tanner staging non reliable

Slough JM MedSciSportsExerc 2013



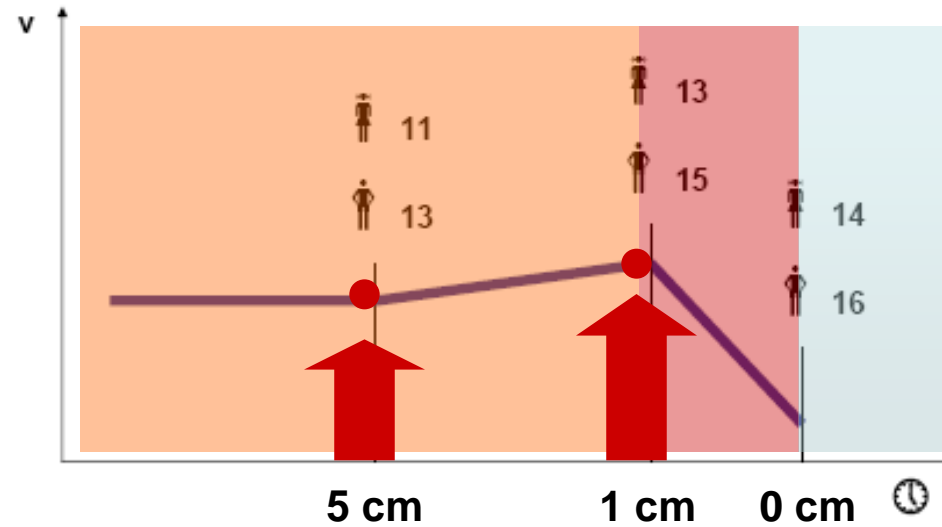
No international consensus

Greulich & Pyle Atlas  
Anderson M, JBJS 1963

# Preoperative evaluation: growth assessment

## Growth and maturation of knee joint

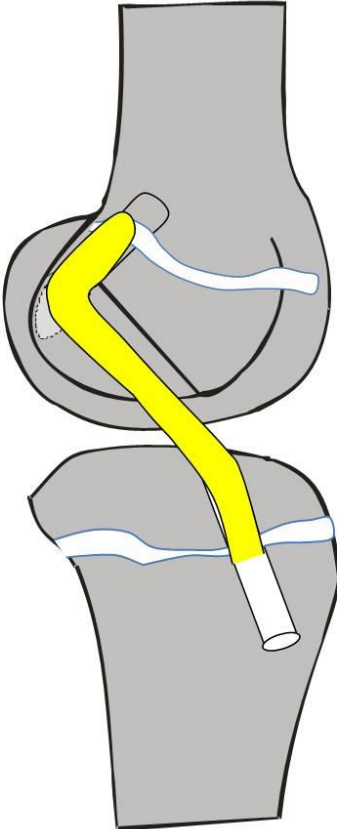
3 physiological stages



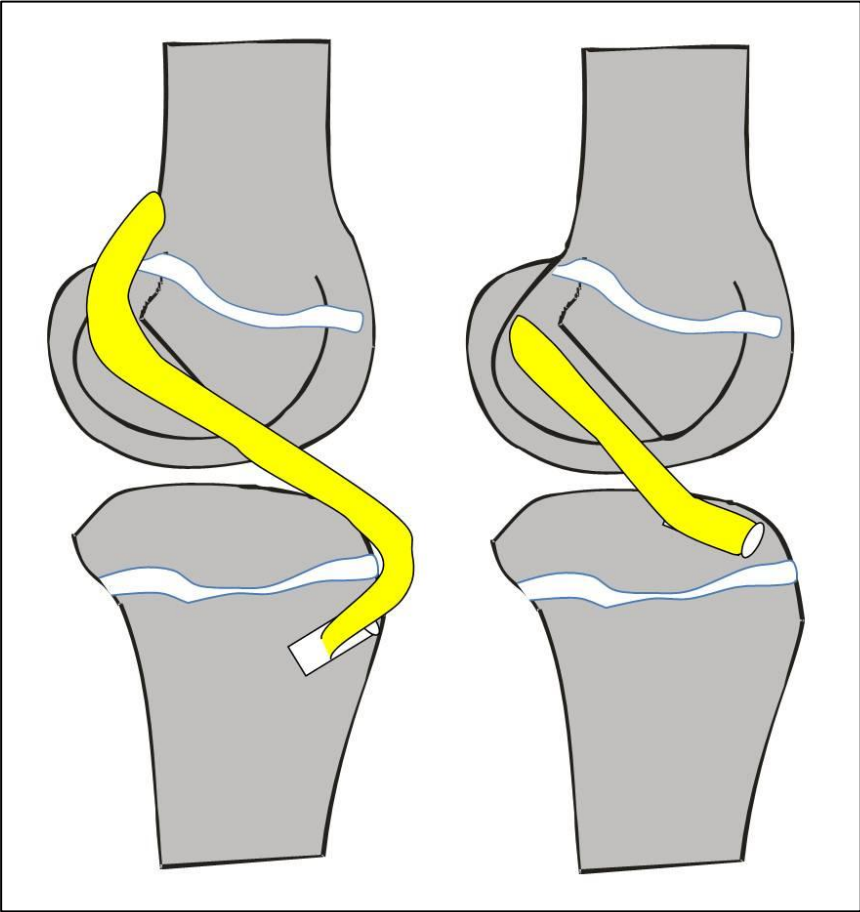
- ♂ ACL tear @ 12
- Chronological age: 14,9 y.
- Skeletal age: 12,9 y.

# Surgical techniques

## Physeal sparing



Transphyseal



Extraphyseal

Epiphyseal

# Graft selection

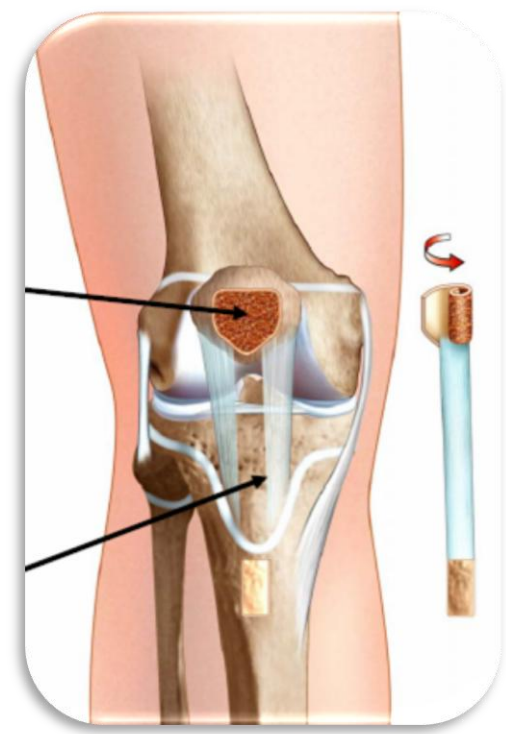
Quadriceps tendon



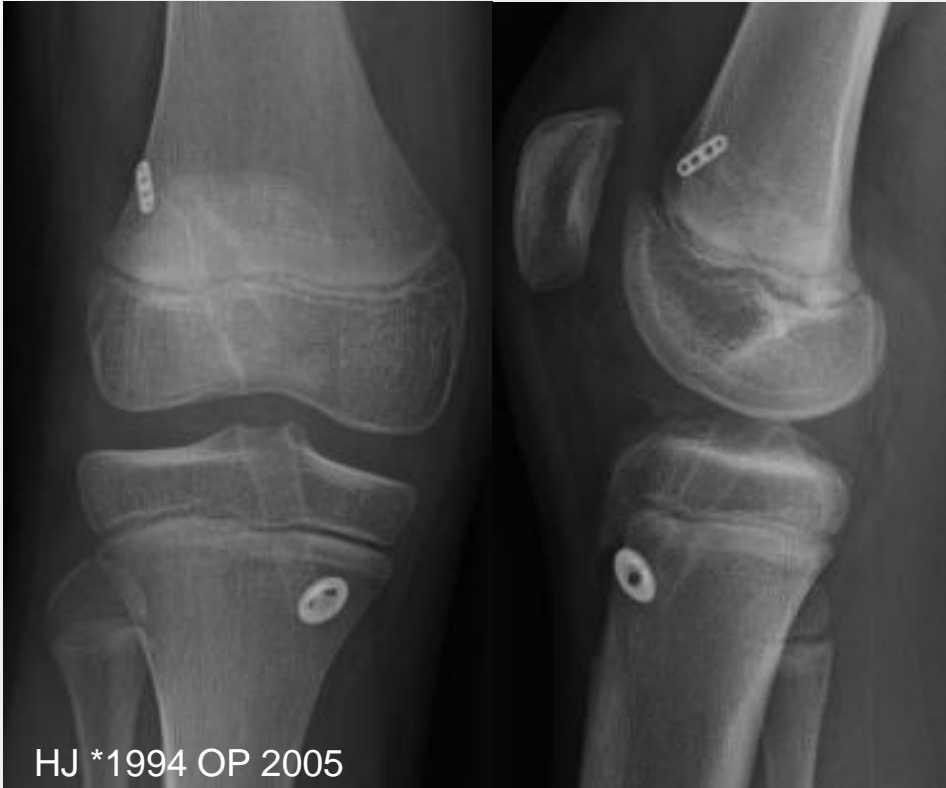
Hamstrings



Patellar tendon without bone blocks



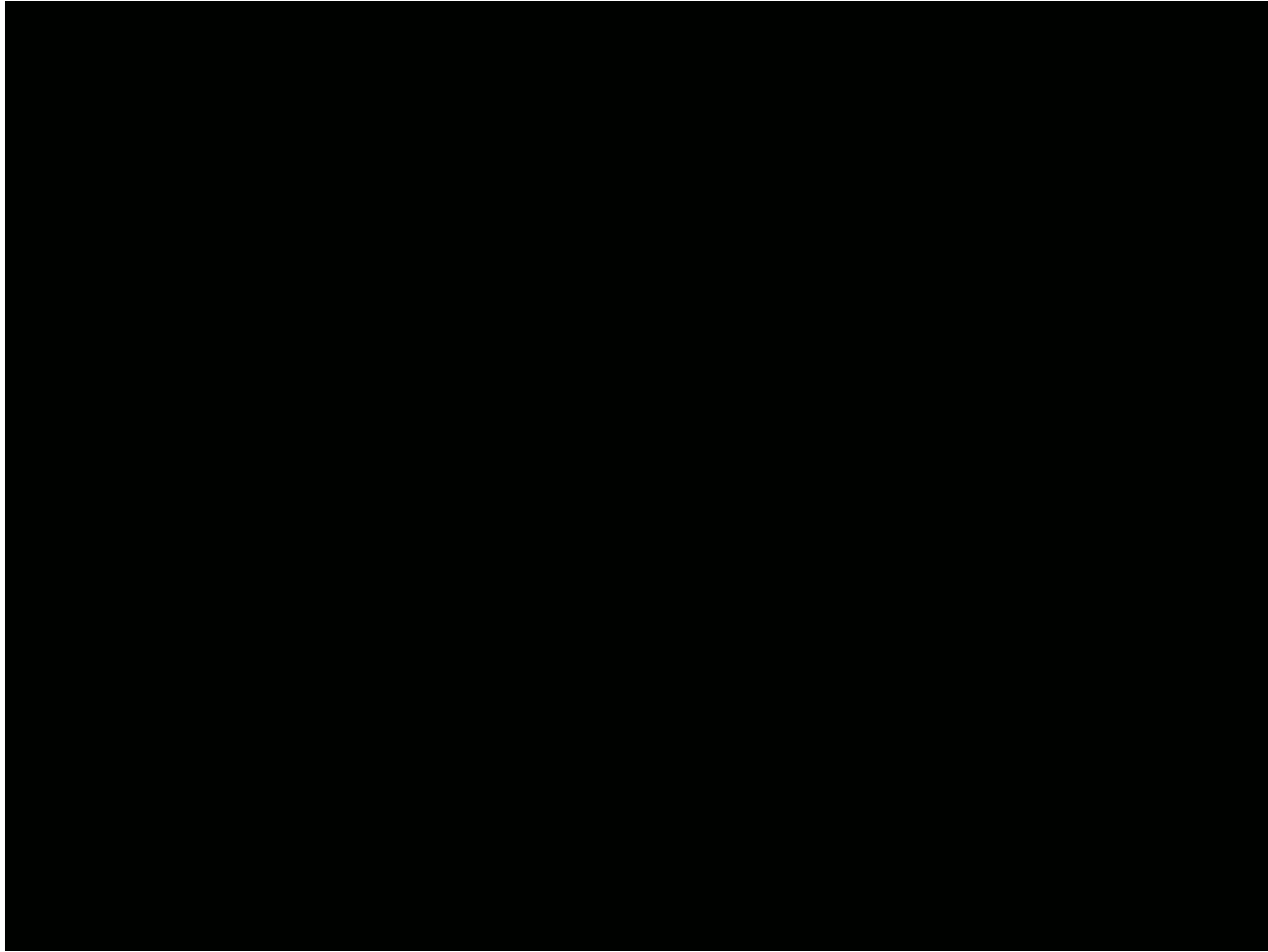
# Surgical technique



- Transphyseal 4-fold-Semi-tendinosus/Gracilis graft
- 6-8 mm (< 9 mm!!)
- distal fixation
- femoral tunnel over anteromedial portal

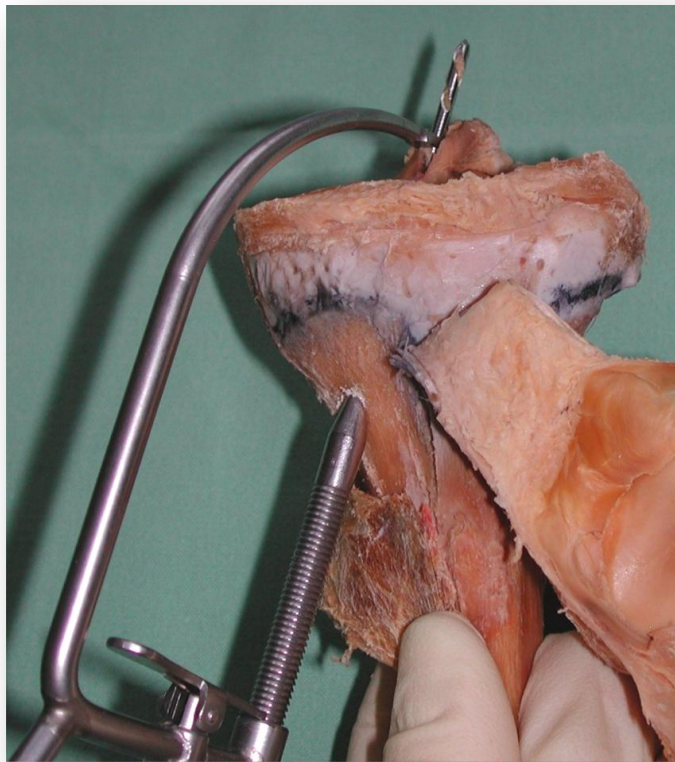
# Surgical technique

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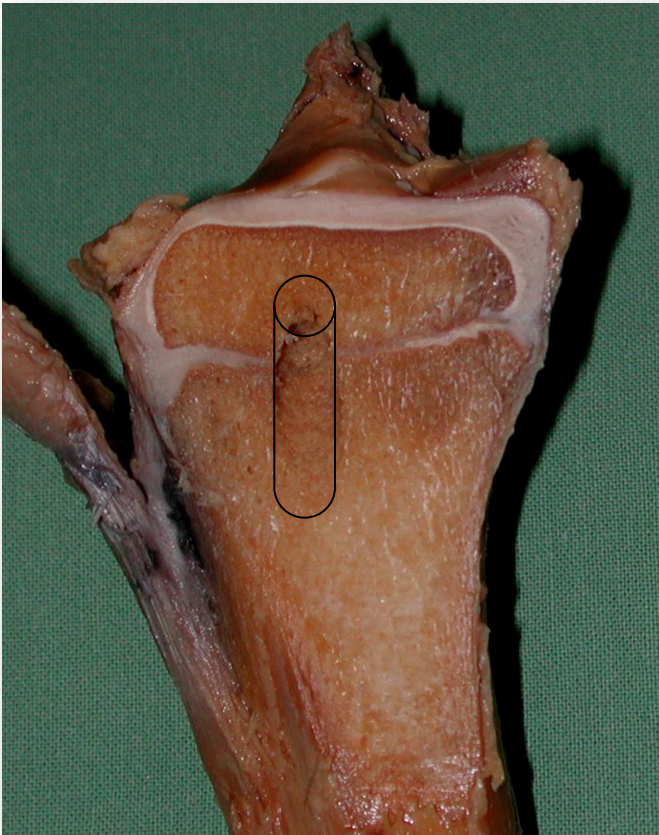




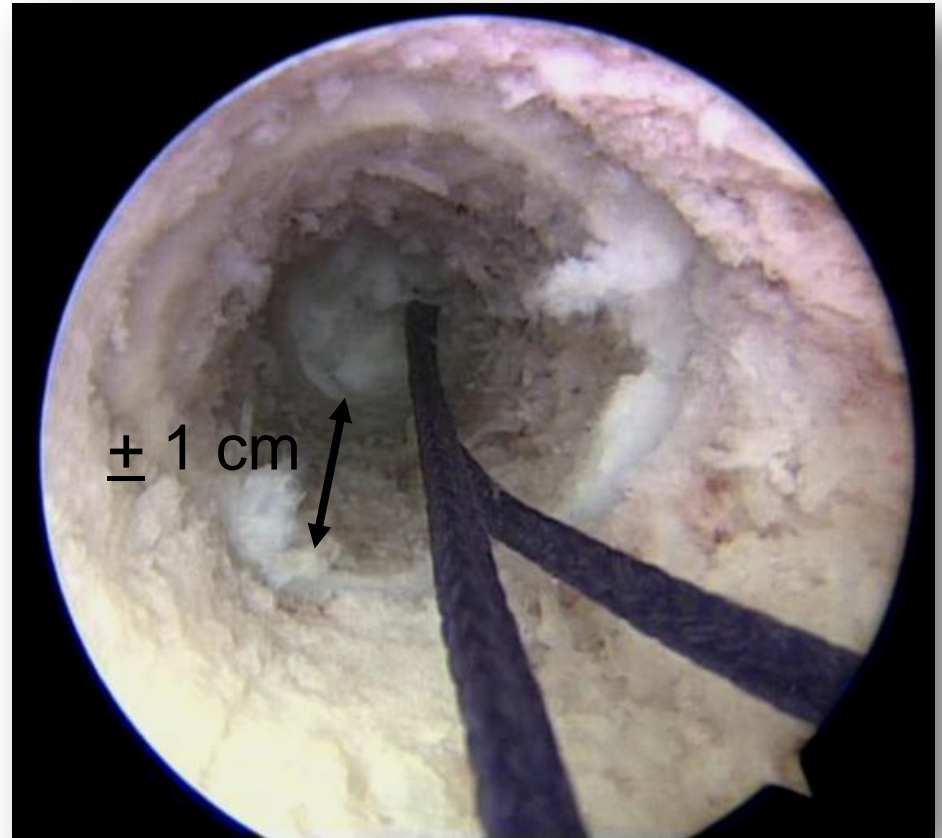
## Tibial tuberosity apophysis



# Tibial drill injury

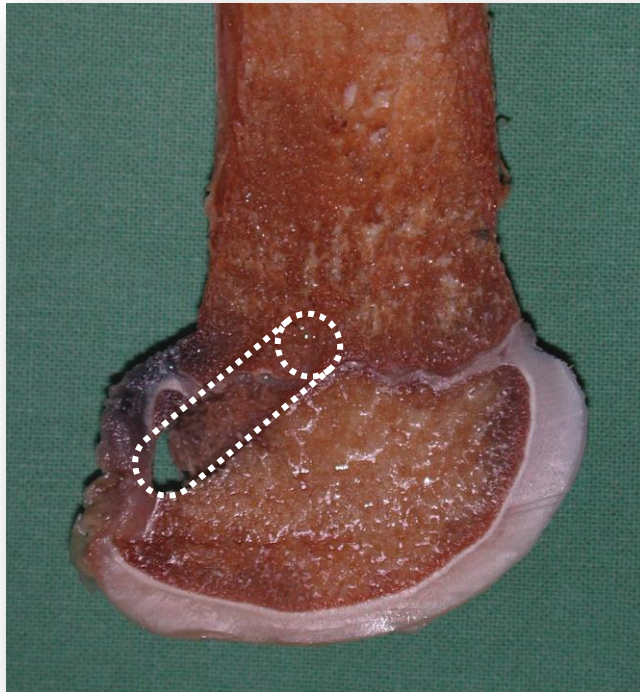


central

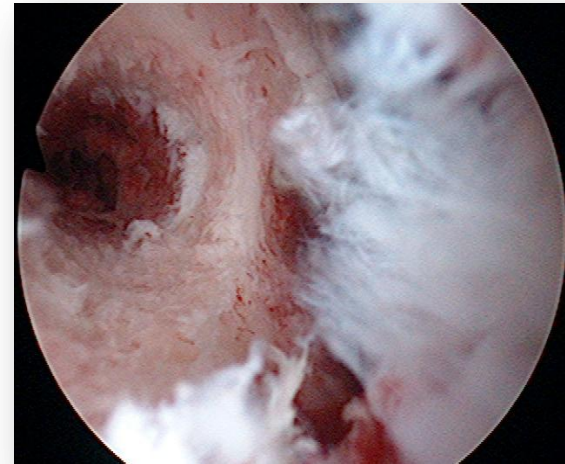


♂ 10 y

# Femoral drill injury



posterolateral



♂ 11 y



♂ 11 y

# Femoral drill injury



Transtibial

Anteromedial

7 mm tunnel :

42 mm<sup>2</sup>

x 3,5 =

148 mm<sup>2</sup>

9 mm tunnel :

70 mm<sup>2</sup>

x 3,5 =

245 mm<sup>2</sup>

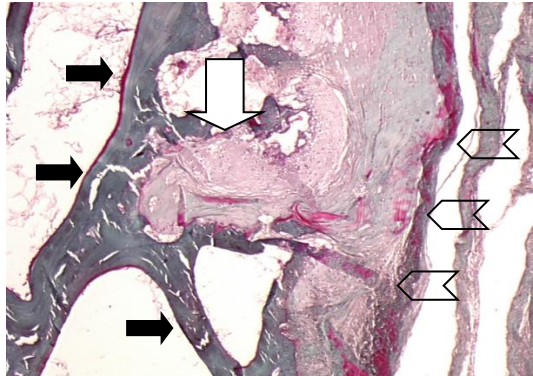
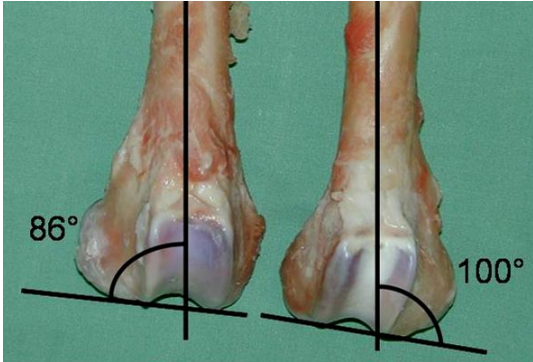
# Principles of physeal injuries



Peripheral damage



Axial deviation

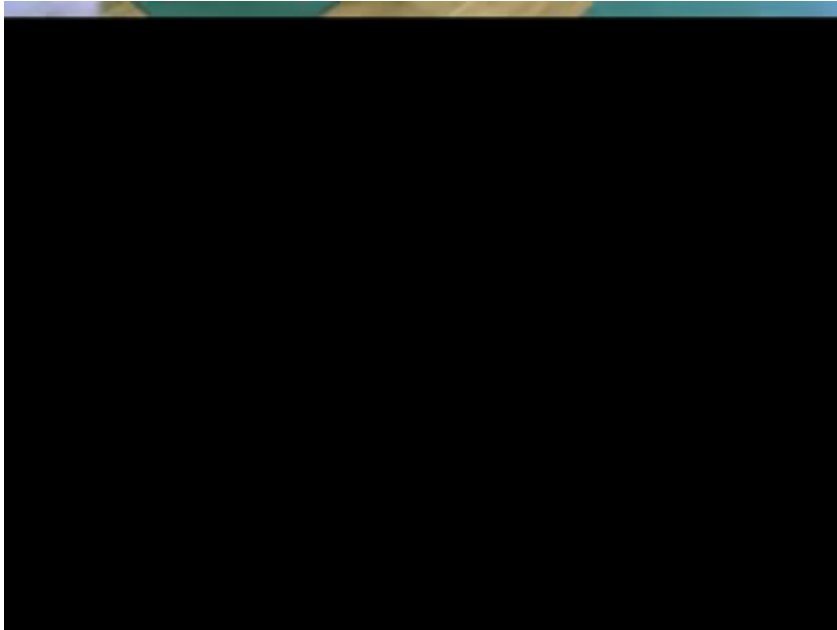


Masson-Goldner, 25 x

3-4% of surface

Ford & Key, JBJS-A, 1956

Seil R, 2008



1 y. postop.

## Isolated ACL replacement:

- 6 weeks brace
- FWB
- Free ROM
- Return to pivoting sports 9-12 months

## Meniscal repair:

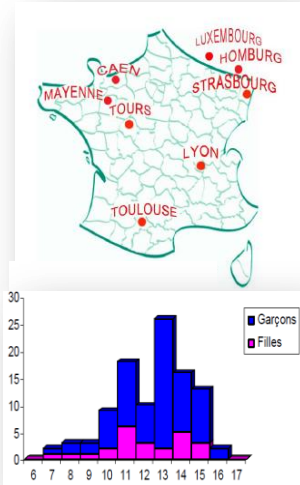
- 6 weeks brace
- 6 w. 0-0-90°
- 6 w. FWB in extension

# The Current Evidence for Treatment of ACL Injuries in Children Is Low

A Systematic Review JBJS 2012

Håvard Moksnes, PT, MSc, Lars Engebretsen, MD, PhD, and May Ama Risberg, PT, PhD

## Results



- IKDC A&B: 84 %
- Retears: 5 %
- Return to sports: 91 %

Bonnard C, Chotel F, RCO 2007



Results less predictable than in adults

Topic	Problem	Need for further investigation
Epidemiology	No register	Yes
Growth / maturation / evolution of laxity	Little investigations	Yes
Prevention	No studies for children	Yes
Injury risk factors	No studies for children	Yes
Treatment indications / algorithms	No consensus	Yes
Surgical techniques	/	(No)
Surgical risk factors	Types of complications Reported complications	(No) Yes
Outcome	Graft evolution Knee function Reoperations Return to sports Long term outcome	Yes Yes Yes Yes Yes



Pediatric ACL reconstructions are safe if technically correct

**But**

Complications may occur

Some children do not need an immediate ACL reconstruction

## **The art of pediatric ACL management is to choose:**

- The right child & family
- The right indication
- The right moment for reconstruction
- The right technique

# Pediatric ACL Monitoring Initiative (PAMI)



Håvard Moksnes  
Lars Engebretsen  
Romain Seil



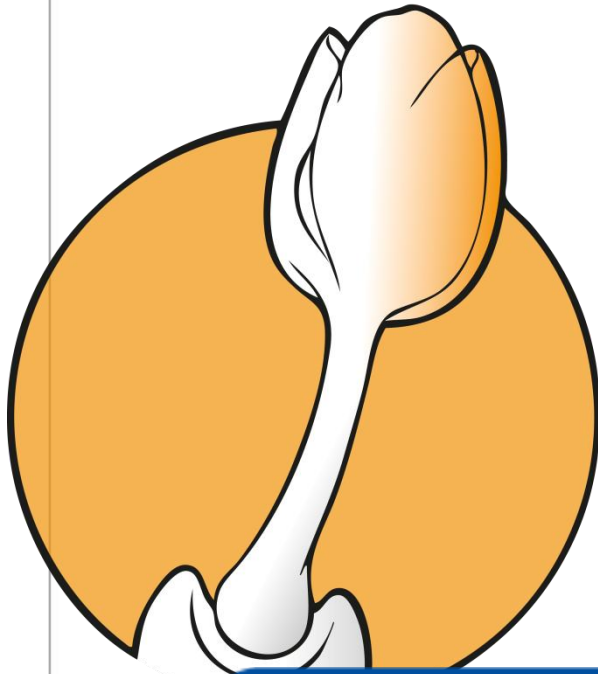
- Online survey on the current treatment of pediatric ACL injuries
- Planned submitted to ESSKA members and affiliates
- 2500 recipients, 500 answers

AMSTERDAM / THE NETHERLANDS



# 16th ESSKA Congress

## May 14-17, 2014



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