Infection after an ACL reconstruction

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Epidemiology

- Overall incidence : 0.3% to 1.7%

Mouzopoulos et al *KSSTA* 2009

Study Data

Study	No. of Knees	No. of Infections	Incidence, %	Mean Age (Range), y	Male, % (No. of Males/Females)
Binnet and Basarir[10]	1231	6	0.49	24.5 (20-32)	100 (6/0)
Burks et al[27]	1918	8	0.42	27 (15-40)	75 (6/2)
Fong and Tan[18]	472	7	1.4	23 (19-30)	100 (7/0)
Indelli et al[4]	3500	5	0.14	32.5 (20-51)	83 (5/1)
Judd et al[25]	1615	11	0.68	N/A	N/A
Katz et al[26]	801	6	0.75	27.3 (16-61)	N/A
Sajovic et al[12]	1283	3	0.23	31 (23-48)	100 (3/0)
Schollin-Borg et al[35]	575	10	1.7	28.3 (19-39)	80 (8/2)
Schub et al[20]	831	4	0.48	26 (20-34)	100 (4/0)
Schulz et al[29]	512	4	0.78	35.5 (17-56)	79 (19/5)
Van Tongel et al[5]	1736	15	0.51	31.8 (18-50)	93 (14/1)
Viola et al[28]	1794	14	0.78	21 (17-29)	100 (14/0)
Wang et al[6]	4068	21	0.52	28.6 (16-58)	85 (18/3)
Williams et al[2]	2500	7	0.3	31.3 (17-50)	100 (7/0)
Total	22,836	121	0.5	28.9 (15-61)	88 (111/14)

Abbreviation: N/A, not available.

Kim et al *Orthopaedics* 2014

Risk factors

Factors Associated with Infection Following Anterior Cruciate Ligament Reconstruction

Robert H. Brophy, MD, Rick W. Wright, MD, Laura J. Huston, MS,
Samuel K. Nwosu, MS, the MOON Knee Group*, and Kurt P. Spindler, MD

Investigation performed at Washington University School of Medicine, St. Louis, Missouri, and Vanderbilt University Medical Center, Nashville, Tennessee

n=2198

Characteristic	Odds Ratio	95% CI	P Value
Age	0.956	0.91-1.01	0.106
BMI	0.977	0.87-1.09	0.680
Diabetes mellitus	18.807	3.76-93.97	<0.001
Smoker	2.541	0.68-9.55	0.167
Graft type, relative to BTB autograft			
Hamstring autograft	4.631	1.20-17.91	0.026
Other	4.295	1.02-18.11	0.047

Conclusions: Patients with diabetes undergoing ACL reconstruction have a significantly elevated risk of postoperative infection (18.8-times higher odds) compared with that for patients without diabetes. Use of bone-tendon-bone autograft is associated with a lower risk of infection after ACL reconstruction.

Brophy et al *JBJS* 2015

Risk factors

Tobacco Use Is Associated With Increased Complications After Anterior Cruciate Ligament Reconstruction

Jourdan M. Cancienne,* MD, F. Winston Gwathmey,* MD,
Mark D. Miller,* MD, and Brian C. Werner,*† MD
Investigation performed at the University of Virginia Health System, Charlottesville, Virginia, USA

Cohort study
n=13'358
Odds ratio: 2.3 septic arthritis

Conclusion: ACL reconstruction in patients who use tobacco is associated with significantly increased rates of infection, VTE, and subsequent ACL reconstruction compared with controls. There was no association between tobacco use and postoperative arthrofibrosis after primary ACL reconstruction.

Cancienne et al *Am J Sports Med* 2016

Risk factors

Effect of Graft Selection on the Incidence of Postoperative Infection in Anterior Cruciate Ligament Reconstruction

Joseph U. Barker,* MD, Mark C. Drakos, MD, Travis G. Maak, MD, Russell F. Warren, MD, Riley J. Williams III, MD, and Answorth A. Allen, MD
From Hospital for Special Surgery, New York, New York

n=3126, infection rate of 0.58%

Hamstring tendon has a higher incidence of infection and a trend toward a more common need for graft removal

n=10626, overall infection rate: 0.48%

8.2 times higher risk of surgical site infection was observed with hamstring tendon autograft vs BPTB

Barker et al *Am J Sports Med* 2010
Maletis et al *Am J Sports Med* 2013

Risk factors

A Surgical Technique Using Presoaked Vancomycin Hamstring Grafts to Decrease the Risk of Infection After Anterior Cruciate Ligament Reconstruction

Christopher J. Vertullo, M.B.B.S., F.R.A.C.S, F.A.Orth.A., Mark Quick, M.B.B.S., B.Sc., Andrew Jones, M.B.B.S., F.R.A.C.P., F.R.C.P.A., and Jane E. Grayson, Ph.D.

Retrospective study
n=285, received iv prophylactic antibiotic
n=780, received iv prophylactic antibiotic + soaking in vancomycin
Reduced rate of infection in the vanco group

Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-014-3438-y

KNEE

Autograft soaking in vancomycin reduces the risk of infection after anterior cruciate ligament reconstruction

Daniel Pérez-Prieto · Raúl Torres-Claramunt · Pablo E. Gelber · Tamer M. A. Shehata · Xavier Pelfort · Joan Carles Monllau

n=810 in group no ATB
n= 704 in group ATB
Both groups received iv prophylactic antibiotic
Reduced infection rate in the vanco group

What's the effect of vancomycin on the ligamentization process?

Vertullo et al *Arhtroscopy* 2012
Maletis et al *KSSTA* 2014

Risk factors

Prevalence of Septic Arthritis After Anterior Cruciate Ligament Reconstruction Among Professional Athletes

Bertrand Sonnery-Cottet,*† MD, Pooler Archbold,† MD, Rachad Zayni,† MD, Juliano Bortolletto,† MD, Mathieu Thaunat,† MD, Thierry Prost,‡ MD, Vitor B.C. Padua,§ MD, and Pierre Chambat,† MD
Investigation performed at The Centre Orthopédique Santy, Lyon, France

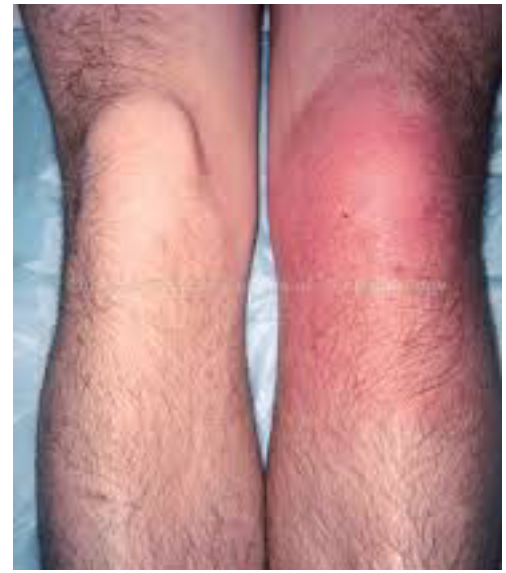
Retrospective study
n=1957
Higher infection rate in pro athletes + lateral tenodesis (OR: 4.8)
All infections occurred in outdoor athletes

Conclusion: Participation in professional sports and having a combined lateral tenodesis are risk factors for the development of infection after ACL reconstruction. We hypothesize that professional athletes may be part of a specific group of patients at higher risk of infection after ACL reconstruction.

Sonnery Cottet et al *Am J Sports Med* 2011

Clinical presentation and diagnosis

- Interval: 19 days (2 - 450 days)
- Variable degrees of:
  - Local knee swelling
  - Pain
  - Fever
  - Local drainage
  - Warmth



Clinical presentation and diagnosis

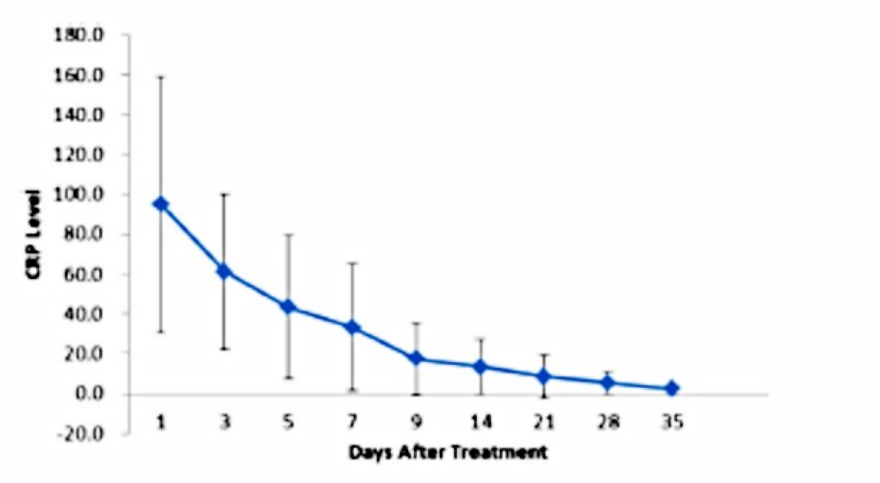
- Systematic review:

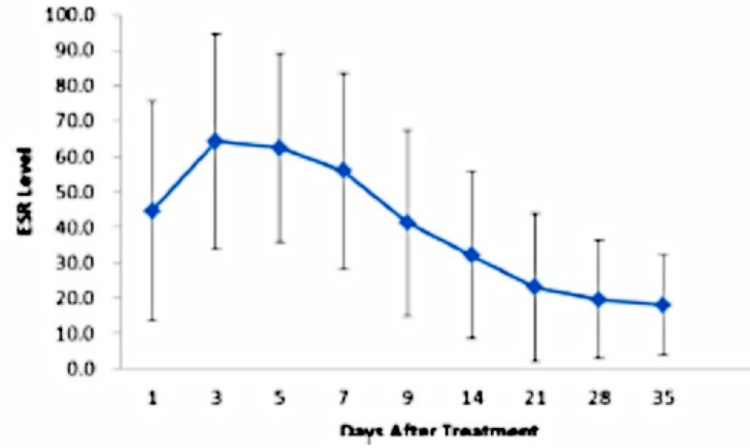
- Mean white blood cells: 9.8 (6-16)
- Mean erythrocyte sedimentation: 67.4 (50-112)
- Mean C-reactive protein(CRP): 49 (4.8-146.6)
- Average cell count of aspirated joint: 73’045 (25’400-136’700)

Kim et al *Orthopaedics* 2014
Wang et al *KSSTA* 2014

C-Reactive Protein and Erythrocyte Sedimentation Rate Changes After Arthroscopic Anterior Cruciate Ligament Reconstruction: Guideline to Diagnose and Monitor Postoperative Infection

Cheng Wang, M.D., Yingfang Ao, M.D., Xiaohua Fan, M.D., Jianquan Wang, M.D., Guoqing Cui, M.D., Yuelin Hu, M.D., and Jiakuo Yu, M.D.





Conclusions: Both CRP and ESR were helpful in determining the presence of a normal or septic joint. The threshold values of 41 mg/L for CRP and 32 mm/h for ESR had the most optimal sensitivity and specificity. The peak CRP level occurred earlier than the peak ESR level after treatment of postoperative infection and returned to normal more quickly. In this study CRP was more useful than ESR to evaluate the response of infection to treatment.

Wang et al *Arthroscopy* 2014

Management

- Intra-articular aspiration
- Arthroscopic irrigation and debridement ASAP ?
- Antibiotics
- NSAID

Management

- Post-operative intra-articular infections is defined as a positive culture from a knee aspiration

- *Staphyloccocus epidermidis* (41%)
- *Staphyloccocus aureus* (35%)

Kim et al *Orthopaedics* 2014

Organisms

Pathogens in ACL Reconstruction

	No.													
Study	SE	SA	ST	PS	PA	EF	SH	SW	SM	CO	EC	EA	Mu	Total
Binnet and Basarir[10]	0	3	0	1	0	0	0	0	0	0	0	0	0	4
Burks et al[27]	0	3	0	1	0	0	0	0	0	0	0	0	0	4
Fong and Tan[18]	0	3	2	0	0	0	0	0	0	0	0	0	2	7
Indelli et al[4]	2	3	1	0	0	0	0	0	0	0	0	0	0	6
Judd et al[25]	8	1	0	0	1	0	0	0	0	0	0	1	0	11
Katz et al[26]	4	0	0	0	0	0	0	0	0	0	0	0	2	6
Sajovic et al[12]	1	1	0	0	0	0	0	0	0	0	0	0	0	2
Schollin-Borg et al[35]	6	1	0	0	1	0	0	0	0	0	0	0	0	8
Schub et al[20]	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Schulz et al[29]	5	12	2	0	0	0	0	1	0	0	0	0	0	20
Van Tongel et al[5]	8	1	1	0	0	1	0	0	0	0	1	0	2	14
Viola et al[28]	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Wang et al[6]	9	2	0	0	0	1	1	0	1	1	0	0	1	16
Williams et al[2]	1	4	0	0	0	0	0	0	0	0	0	0	2	7
Total, No. (%)	46 (41)	38 (34)	6 (5)	2 (2)	2 (2)	2 (2)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	9 (8)	111 (100)

Abbreviations: ACL, anterior cruciate ligament; CO, Corynebacterium*; EA,* Enterobacter aerogenes*; EC,* Enterobacter cloacae*; EF,* Enterococcus faecalis*; Mu, multiple; PA,* Propionibacterium acnes*; PS,* Pseudomonas*; SA,* Staphylococcus aureus*; SE,* Staphylococcus epidermidis*; SH,* Staphylococcus haemolyticus*; SM,* Staphylococcus hominis*; ST,* Streptococcus*; SW,* Staphylococcus warneri.

Joint lavage and drainage

- Arthroscopic lavage and debridement of the 4 cpts of the knee
- As early as possible
  - Extended synovectomy?
  - Graft retained or removed?
  - Overnight ?

Classification

- Stage I: Joint effusion, redness of the synovial membrane, and possible petechial bleeding
- Stage II: Severe inflammation, fibrinous deposition, pus.
- Stage III: Thickening of the synovial membrane, multiple pouches due to adhesions.
- Stage IV: Aggressive pannus with infiltration into the cartilage, radiological sign of subchondral osteolysis, osseous erosions and cysts

Gächter et al *Orthop Traumatol* 1993

Joint lavage and drainage

- 60.2% of patient required one arthroscopic debridement
- 28.7% two debridement arthro
- 8.7% three debridement arthro
- 2.9% four debridement arthro

Wang et al *KSSTA* 2014

Antibiotics

- Cefuroxim 1.5 g
- Amoxicilin / clavunalate 1g

- Antibiogram -> ajusted antibiotic ttr
- Multidisciplinary approach: orthopaedic surgeon and infectiologist

Antibiotics

- According to the antibiogram
- Very often: amo/clavulanate or cefuroxim
  - + sometimes vancomycin

- 1 week iv, then oral for 5 weeks
- 6 wk with material / 3 wk no material

Special situation

- Fungal infection
- Tubercular infection
- Persistent symptoms after several debridement
  - Intravenous antifungal therapy
  - Antitubercular chemotherapy

Schollin-Borg et al *Arthroscopy* 2003
Muscolo et al *CORR* 2009

Graft retension

Functional Outcome and Graft Retention in Patients With Septic Arthritis After Anterior Cruciate Ligament Reconstruction: A Systematic Review

Eric C. Makhni, M.D., M.B.A., Michael E. Steinhaus, B.A., Nima Mehran, M.D., Brian S. Schulz, M.D., and Christopher S. Ahmad, M.D.

- In up to 78%

Makhni et al *Arthroscopy* 2015

Clinical outcome

Functional Outcome and Graft Retention in Patients With Septic Arthritis After Anterior Cruciate Ligament Reconstruction: A Systematic Review

Eric C. Makhni, M.D., M.B.A., Michael E. Steinhaus, B.A., Nima Mehran, M.D., Brian S. Schulz, M.D., and Christopher S. Ahmad, M.D.

- 19 studies, 203 infected knees
  - Mean FU: 44.2 months
  - Mean Lysholm: 82
  - Mean IKDC: 68
  - Mean Tegner: 5.6
  - Laxity: 1.9mm
  - 83% return to daily activities
  - 67% return to pre-injury level of activities
  - 22% evidence of new degenerative changes
  - Mean flexion and extension deficit of 5.8°

Makhni et al *Arthroscopy* 2015

In summary

- High degree of suspicion
- Knee aspiration
- Early onset of ttr
- Arthroscopic debridement + ATB
- High rate of graft retaining
- Average outcome comparable to non-infected patients

In summary

- Reduced IKDC score suggest more severe symptoms and decrease functional outcome

- Limited evidence suggesting early degenerative changes found on imaging

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Thank you for listening

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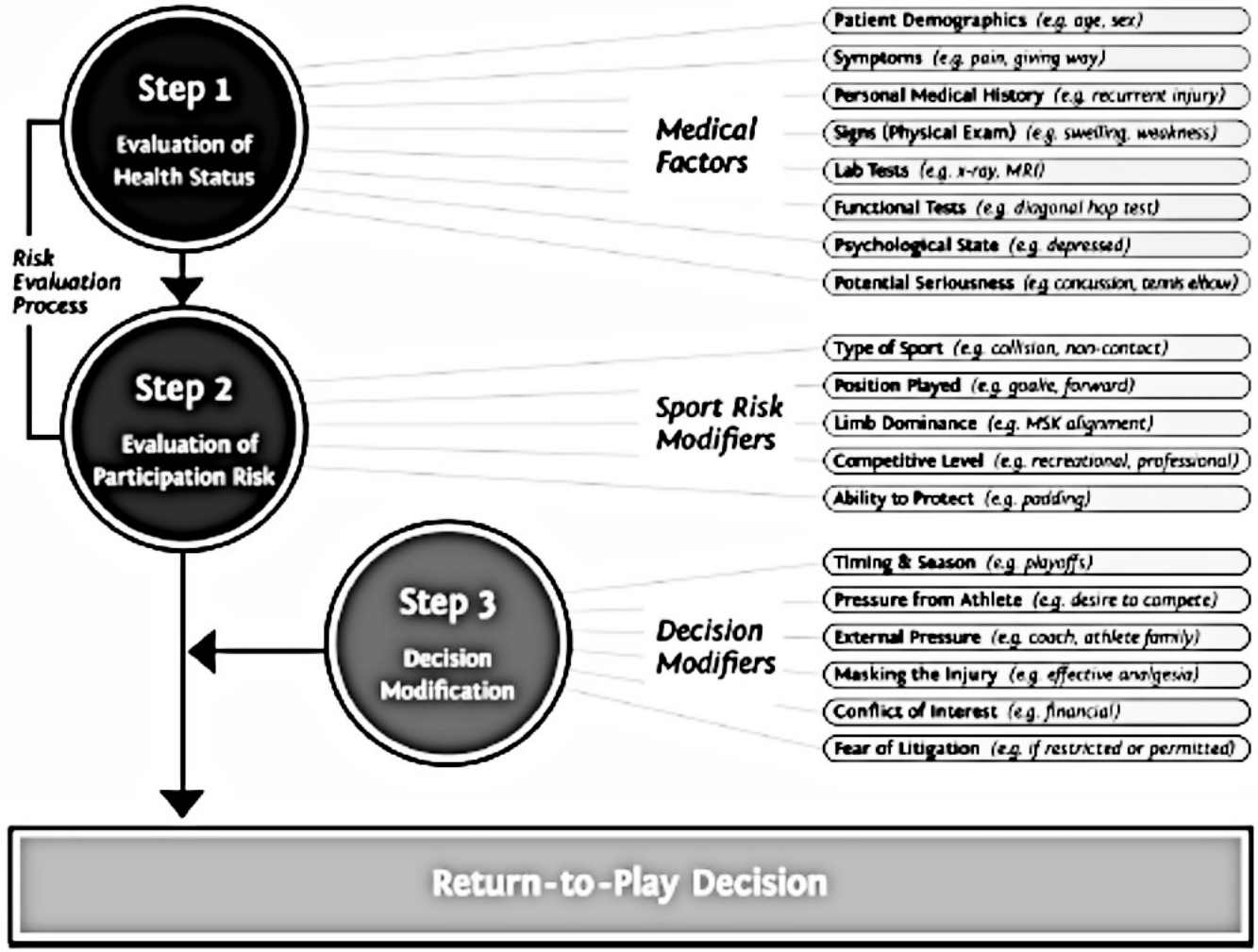
Infection

- Arthrite septique
  - Germe le plus courant: Staph. Aureus (cave:germes nosocomiaux)
  - Traitement: Lavage arthroscopique itératifs +/- synovectomie
  - Antiobiothérapie *sélective* de

Enraidissement articulaire !!

It is time for consensus on return to play after injury: five key questions

Clare L Ardern,[1,2] Mario Bizzini,[3] Roald Bahr[1,4]



Ardern et al *BJMS* 2015

Successful outcome

- Indication — Patient & Surgeon
- Surgical technique
  - Tunnel positioning
  - Graft choice
  - Graft tensioning
  - Fixation

- Proper and effective rehabilitation — Patient & Rehab team
- Return to play — Patient & Surgeon & PT

Technique in ACL Auto versus Allo

A Meta-analysis of Patellar Tendon Autograft Versus Patellar Tendon Allograft in Anterior Cruciate Ligament Reconstruction

Aaron J. Krych, M.D., Jeffrey D. Jackson, M.D., Tanya L. Hoskin, M.S., and Diane L. Dahm, M.D.

In this meta-analysis, graft failure and functional outcome as measured by single-leg hop test favored ACL reconstruction with BPTB autograft over BPTB allograft. However, when irradiated and chemically processed grafts were excluded, no significant differences were found in all measurable outcomes.

- Delayed "ligamentisation"
- Higher failure rate (4x)

Krych et al *Arthroscopy* 2008
Scheffler et al *Arthroscopy* 2008
Kaeding et al *Sports Health* 2011

Associated lesion

Effect of Gender and Sports on the Risk of Full-Thickness Articular Cartilage Lesions in Anterior Cruciate Ligament–Injured Knees

A Nationwide Cohort Study From Sweden and Norway of 15 783 Patients

Jan Harald Røtterud,[*†‡] MD, Einar A. Sivertsen,[†] MD, PhD, Magnus Forssblad,[§‖] MD, PhD, Lars Engebretsen,[¶#] MD, PhD, and Asbjørn Årøen,[¶#] MD, PhD

	Females (n = 6699)		Males (n = 9084)		Total (N = 15 783)	
Sport/Activity	No.	%[b]	No.	%[b]	No.	%[b]
Soccer	87	4.2	259	5.9	346	5.3
Team handball	50	4.6	24	7.8	74	5.3
Skiing[c]	72	6.4	71	7.8	143	7.0

- Football: 4 to 5 % grade III-IV cartilage lesion

Rotterud et al *Am J Sports Med* 2011

BPTB

- Anterior knee pain

4 - 40%

Breifuss et al *Knee Surg Sports Traumatol Arthrosc* 1996
Kartus et al *Knee Surg Sports Traumatol Arthrosc* 1997
Otto et al *Am J Sports Med* 1998
Plancher et al *J Bone Joint Surg* 1998
Shelbourne et al *Am J Sports Med* 1997
Mothadi et al *Cochrane Rev* 2011

Hamstring

Rotational Muscle Strength of the Limb After Anterior Cruciate Ligament Reconstruction Using Semitendinosus and Gracilis Tendon

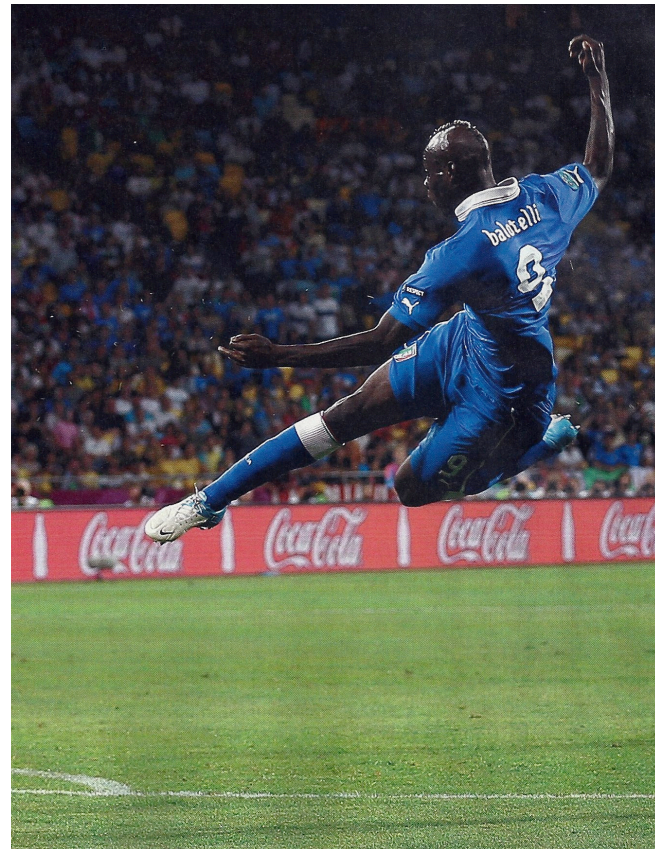
Hiroyuki Segawa, M.D., Go Omori, M.D., Yoshio Koga, M.D., Touru Kameo, P.T., Satoshi Iida, P.T., and Masaei Tanaka, P.T.

Isokinetic Evaluation of Internal/External Tibial Rotation Strength After the Use of Hamstring Tendons for Anterior Cruciate Ligament Reconstruction

Tanya Armour,*‡ PhD, Lorie Forwell,‡ MSc, PT, Robert Litchfield,‡ MD, FRCSC, Alexandra Kirkley,† MD, FRCSC, Ned Amendola,§ MD, FRCSC, and Peter J. Fowler,‡ MD, FRCSC
From the ‡Fowler Kennedy Sport Medicine Clinic, London, Ontario, Canada, and the §University of Iowa, Iowa City, Iowa

Conclusions: We have shown through our study that patients who undergo surgical intervention to repair a torn anterior cruciate ligament with the use of autogenous hamstring tendons demonstrate with weaker internal tibial rotation postoperatively at 2 years when compared to the contralateral limb.

- Decrease IR torque and control



Segawa et al *Arthroscopy* 2002
Armour et al *Am J Sports Med* 2006

Hamstring

Knee Surg Sports Traumatol Arthrosc
(2006) 14: 310–317

KNEE

DOI 10.1007/s00167-005-0701-2

Yukiko Makihara
Akie Nishino
Toru Fukubayashi
Akihiro Kanamori

Decrease of knee flexion torque in patients with ACL reconstruction: combined analysis of the architecture and function of the knee flexor muscles

- n=16 patients, ACLR with HT
- Decrease torque in deep flexion
  > 100° of knee flexion

The decrease of deep knee flexion torque, after ACL reconstruction, could be due to the atrophy and shortening of the semitendinosus after its tendon has been harvested, as well as the lack of compensation from the semimembranosus and biceps femoris, due to the architectural differences between the semitendinosus and the semimembranosus and biceps femoris.

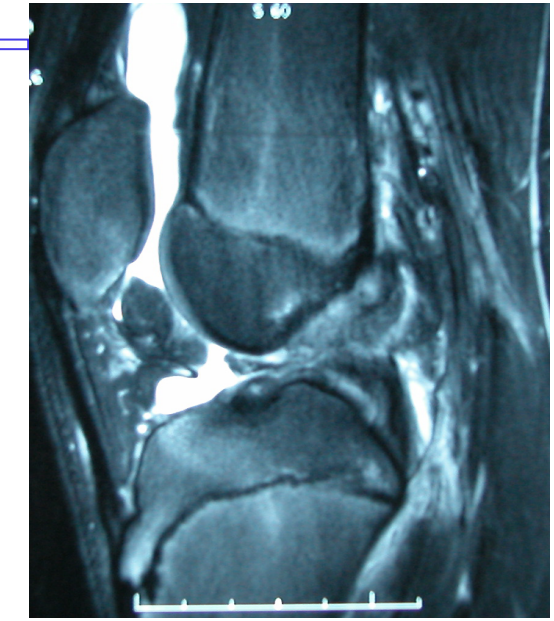
Masikhara et al *KSSTA* 2006

Timing of the reconstruction

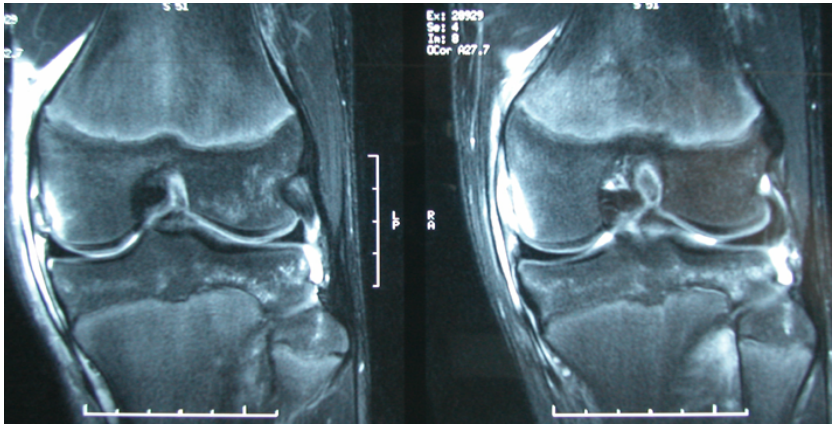
- Time elapsed between injury and surgery
  - The odds of a cartilage and/or a meniscal lesion in a young adult increase by 1% for each month
  - Cartilage lesion twice as frequent if there is a meniscal tear, and vice versa

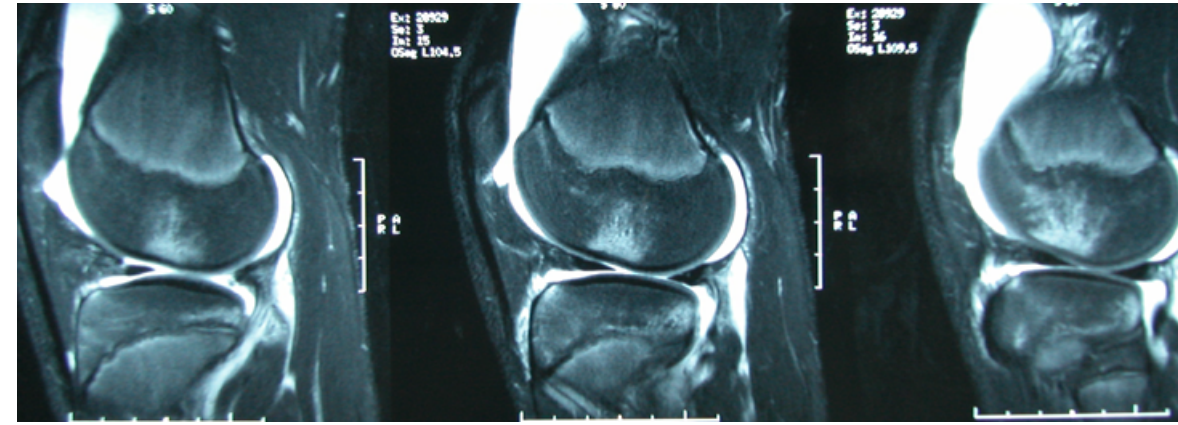
Granan et al *Am J Sports Med* 2009

Personnalized treatment



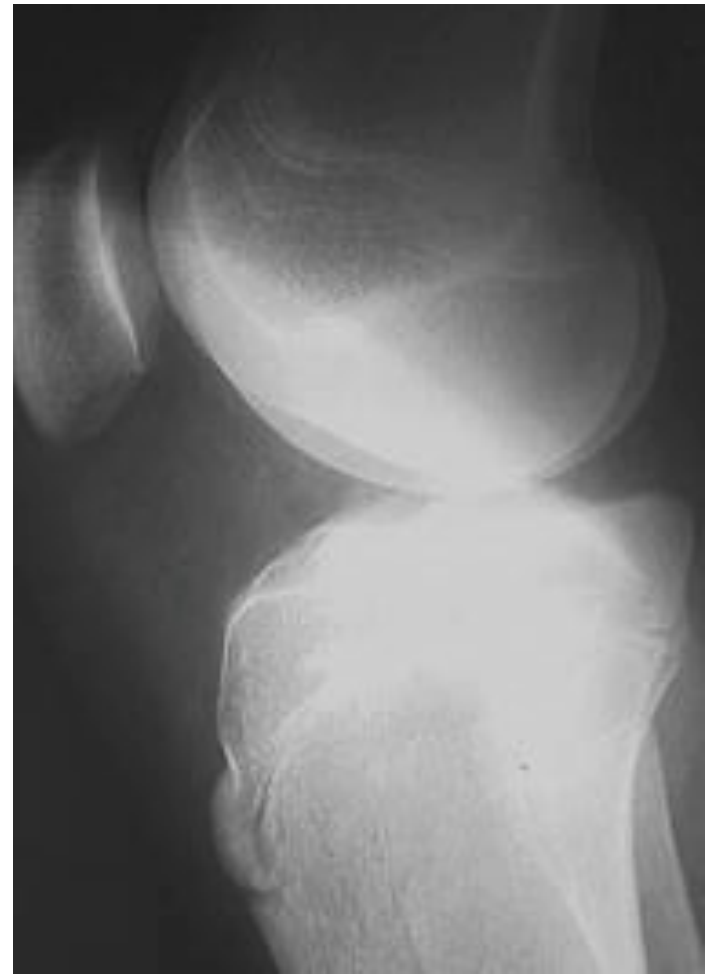
- Mr R., 17 years old
- ACL rupture 6 months ago
- Lachman: ++, laximetry: 8mm SSD
- Pivot: 10mm
- Ant drawer: 10mm
- Unstable in life and in recreational sports





Post-ado technique

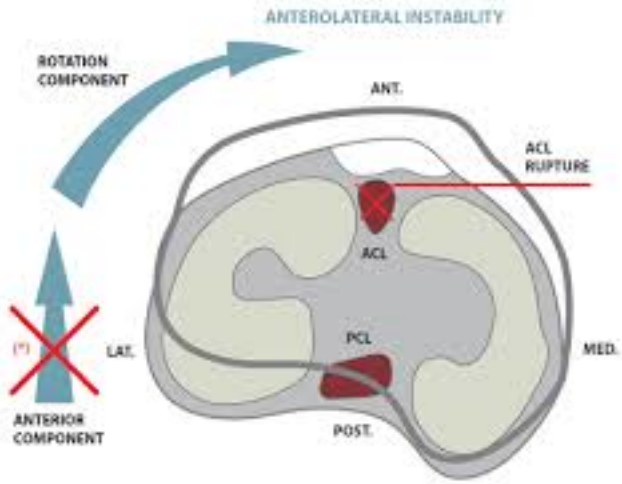
- Preserving the TT
- Quad tendon vs HT
- Vertical & more oblique tunnels

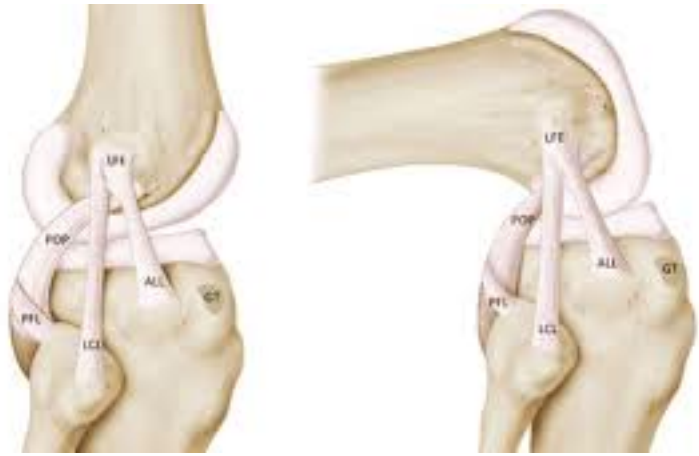


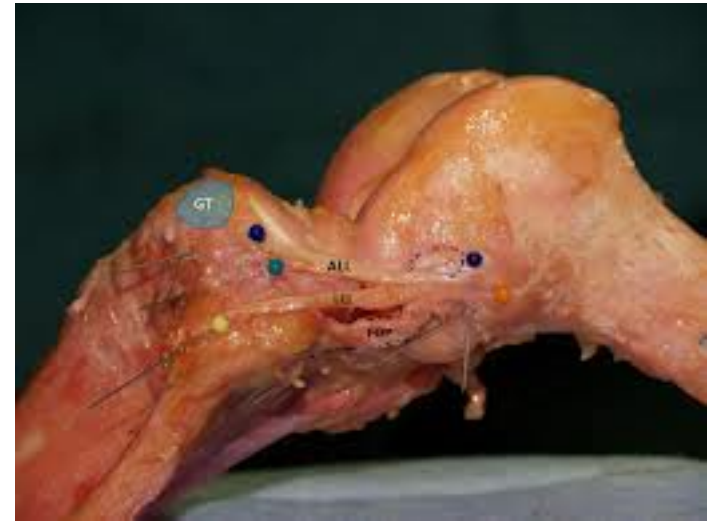
Henry J, Chotel F et al *KSSTA* 2010

Subtle lesions

- Anterolateral laxity







Outline

- Epidemiology
- Return to sports: data
- How to assess it ?
  - Graft healing
  - Musculoskeletal performance
  - Psychological
- Protocol
- Decision making process