Football related ACL surgery to maximize outcome

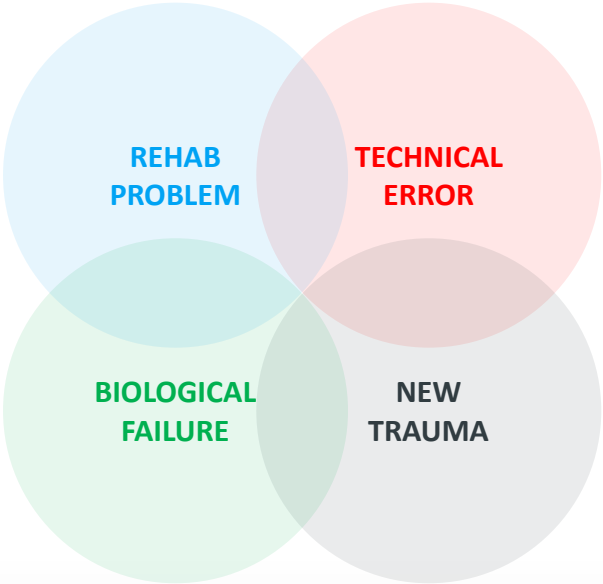
ACL surgery is not just biomechanical !!!!

Prof. Etienne CAVAIGNAC

Clinique Universitaire du Sport

CHU TOULOUSE, France

Why does ACL not work?

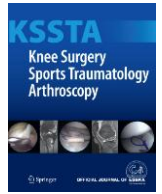


Knee Surg Sports Traumatol Arthrosc (2008) 16:224–231
DOI 10.1007/s00167-007-0474-x

KNEE

"Biological failure" of the anterior cruciate ligament graft

J. Ménétrey · V. B. Duthon · T. Laumonier · D. Fritschy



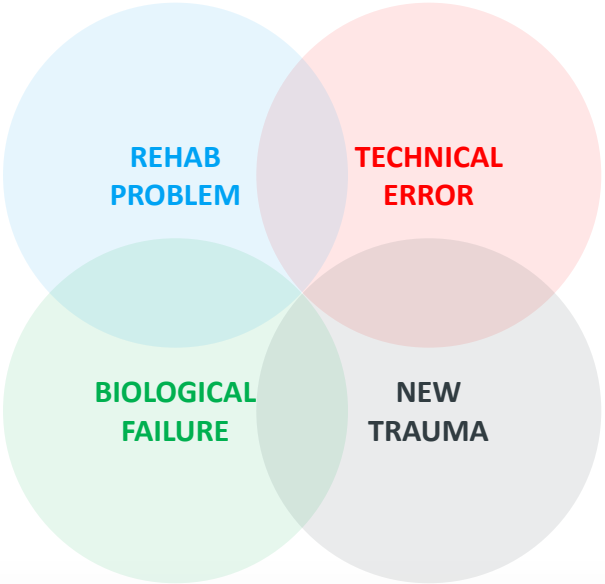
DEFINITION

Without a history of a new trauma, and in the presence of a knee without laxity of the secondary restraints and no detectable technical errors, one can entertain the diagnosis of "biological failure".

But this definition lacks precision, is **not very satisfying**, and is more a diagnosis established by excluding other causes of failure.

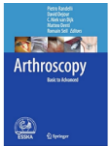
Lack of integration = diagnosis of exclusion

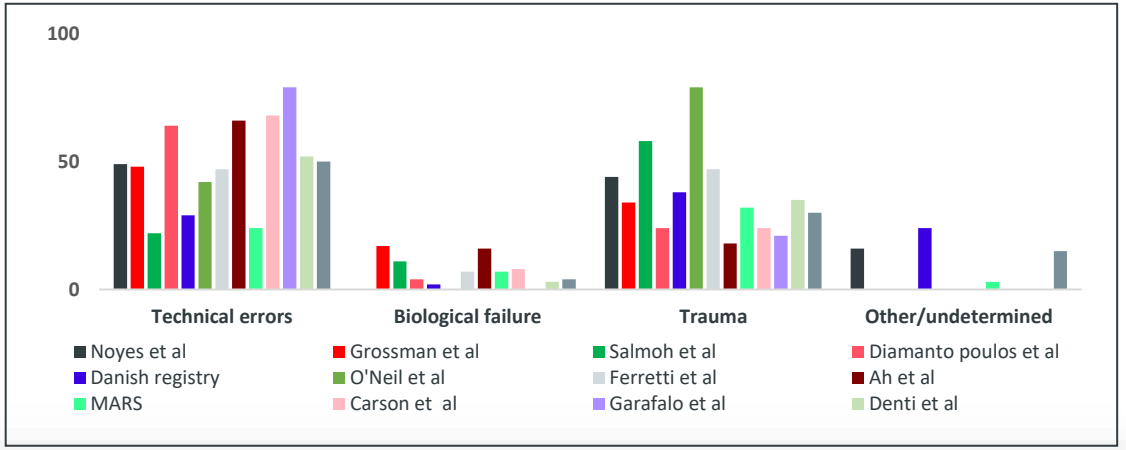
How often does this happen?



Revision Anterior Cruciate Ligament Reconstruction 25

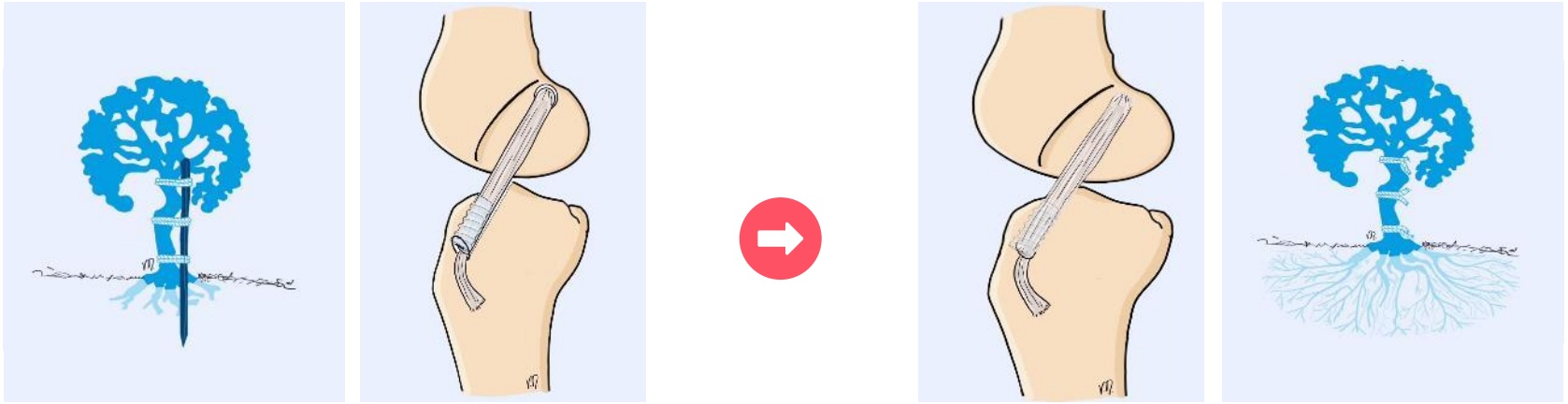
Etienne Cavaignac, Philippe Tscholl, Marco Valoroso, and Jacques Menetrey





Not the most frequent cause, but likely underestimated

Graft integration – How does it work?



Primary fix

Secondary fix

Support then integration

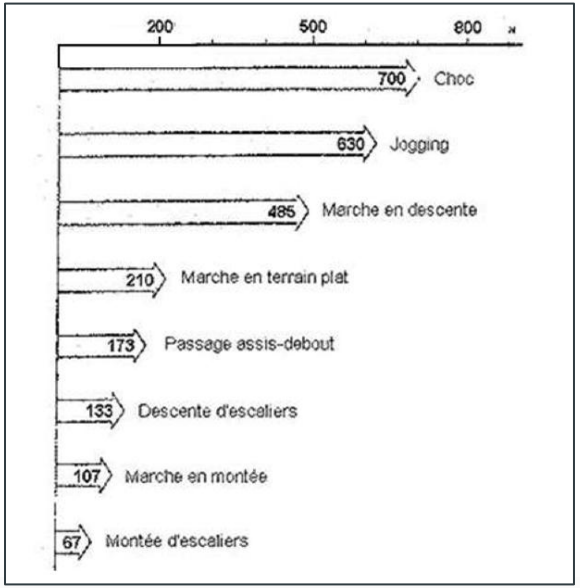
Primary fixation

Must be able to withstand the loads placed on it during the healing period

210 N walking on flat terrain

485 N walking downhill

Easy to understand → the stronger the better



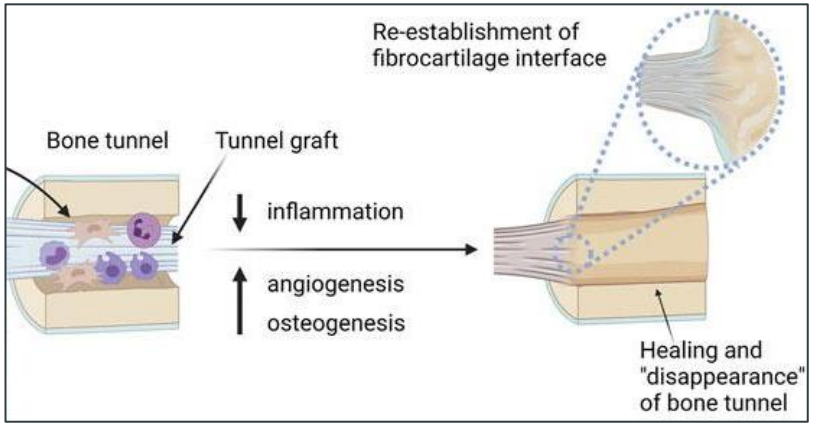
Rodeo SA et al. Tendon-healing in a bone tunnel. A biomechanical and histological study in the dog JBJS 1993

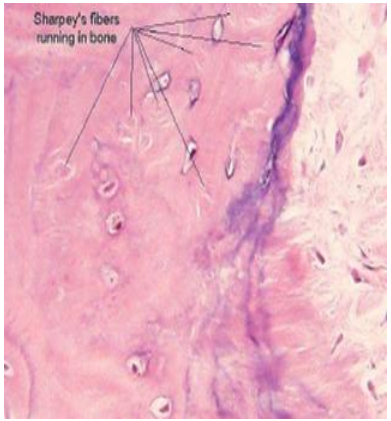
Brand JC Jr et al. Interference screw fixation strength of a quadrupled hamstring tendon graft is directly related to bone mineral density and insertion torque. Am J Sports Med 2000

Secondary fixation

Only in the zone closest to the joint surface (5 mm)

Involves **Sharpey's fibers**





Not so easy to determine…

Lui P, et al. Biology and augmentation of tendon-bone insertion repair J Orthop Surg. 2010

Chen C-H. et al. Graft healing in anterior cruciate ligament reconstruction SMARTT. 2009

How is it measured?

MRI: signal to noise quotient

$$SNQ = \frac{\text{Signal of graft} - \text{signal of PCL}}{\text{Background signal}}$$

- Comparison MRI / histology slides / biomechanical testing

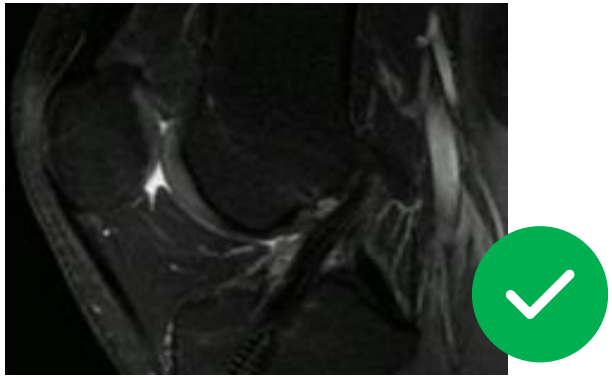
- **Advantages: objective measurement**
- **Limitations: no standard**

Not perfect, but the least bad option! Universally accepted

Weiler A, Peters G, Mäurer J, Unterhauser FN, Südkamp NP. Biomechanical properties and vascularity of an anterior cruciate ligament graft can be predicted by contrast-enhanced magnetic resonance imaging. A two-year study in sheep.

How is it measured?

MRI: signal to noise quotient



When SNQ ↓, graft incorporation ↑

Weiler A, Peters G, Mäurer J, Unterhauser FN, Südkamp NP. Biomechanical properties and vascularity of an anterior cruciate ligament graft can be predicted by contrast-enhanced magnetic resonance imaging. A two-year study in sheep.

Factors affecting SNQ / graft integration

Non-Modifiable

Age

Modifiable

BMI

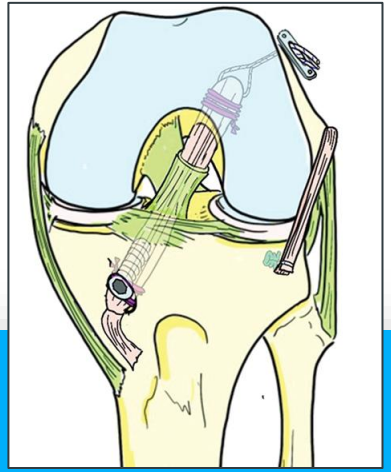
Smoking

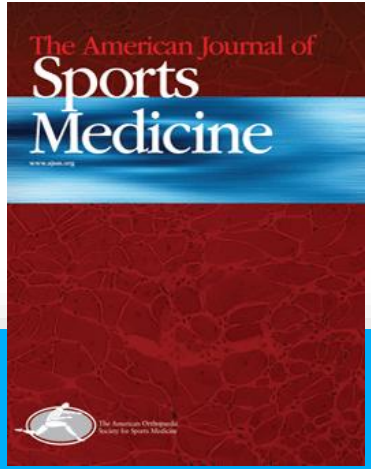
Biological aspects of technique

- Preservation of ligament stump
- Type of fixation
- Attached graft
- Lateral tenodesis

Factors Affecting Graft Remodeling and Anterior Cruciate Ligament Reconstruction

MRI Study of 180 Knees





Factors affecting integration

NON-MODIFIABLE:
AGE

- SNQ ↓ when age ↑

Factors Affecting Graft Remodeling and Anterior Cruciate Ligament Reconstruction

MRI Study of 180 Knees

No direct implication

TABLE 2
Univariate Analysis of Factors Associated With the SNQ at Postoperative 1 Year[a]

	SNQ		
Factor	Mean	SD	*P* Value
Sex			.430
Female	2.31	2.25	
Male	2.67	2.72	
Smoking habits			.432
Smoker	2.80	2.67	
Nonsmoker	2.46	2.52	
Age			.005
Q1	3.10	2.20	
Q2	3.10	3.10	
Q3	1.80	1.80	
Q4	2.20	2.70	

VARI et al.: Factors influencing ACL graft Incorporation. Am J Sports Med. 2023

Factors affecting integration

NON-MODIFIABLE:
AGE

Synovial fluid…
…Pro-Inflammatory

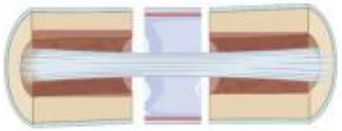
Research Article

Intra-Articular Cytokine Levels in Adolescent Patients after Anterior Cruciate Ligament Tear

Marco Bigoni,[1,2] Marco Turati,[1,3] Giovanni Zatti,[1,2] Marta Gandolla,[4] Paola Sacerdote,[5] Massimiliano Piatti,[1] Alberto Castelnuovo,[1] Luca Rigamonti,[1] Daniele Munegato,[1] Silvia Franchi,[5] Nicola Portinaro,[6] Alessandra Pedrocchi,[4] Robert J. Omeljaniuk,[7] Vittorio Locatelli,[2] and Antonio Torsello[2]

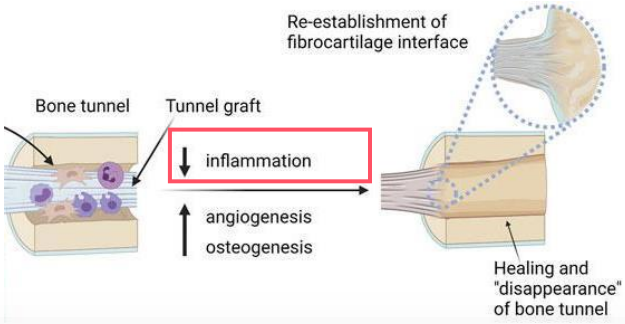
Resolvin E1 and Cytokines Environment in Skeletally Immature and Adult ACL Tears

Marco Turati[1,2,3,4,5*†], Silvia Franchi[6†], Giulio Leone[2,3,4], Massimiliano Piatti[1,3,4], Nicolò Zanchi[2,3,4], Marta Gandolla[7], Luca Rigamonti[2,8], Paola Sacerdote[5], Laura Rizzi[2], Alessandra Pedrocchi[7], Robert J. Omeljaniuk[9], Giovanni Zatti[1,2,3,4], Antonio Torsello[2] and Marco Bigoni[1,2,3,4]



EARLY HEALING PHASE

Host response: inflammation
Graft response: cell necrosis

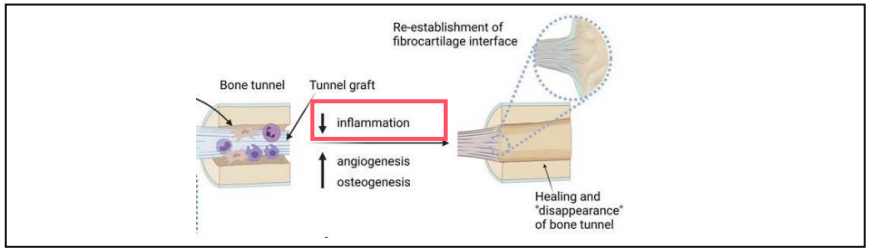


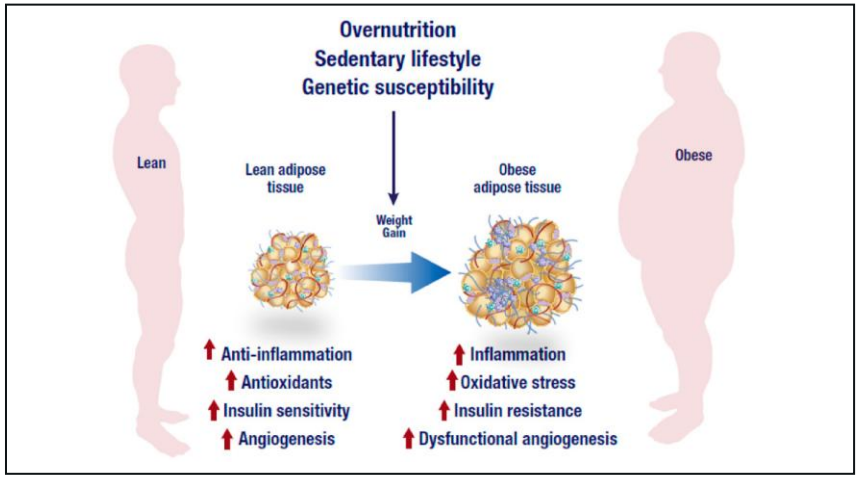
No solutions at this stage…

Factors affecting integration

MODIFIABLE:
BMI

SNQ ↑ when BMI ↑ Influence of inflammatory state





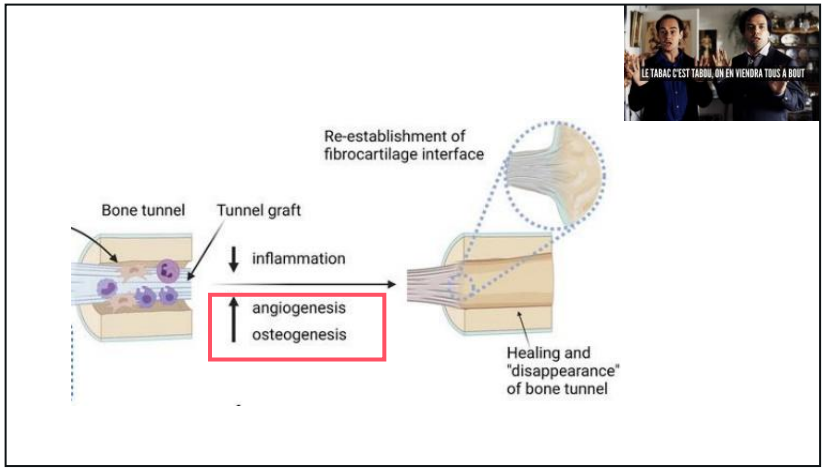
Successful ACL reconstruction requires treating the whole patient!

VARI et al.: Factors influencing ACL graft Incorporation Am J Sports Med. 2023

Factors affecting integration

MODIFIABLE:
ACTIVE SMOKER

- Smokers vs. non-smokers: 36% greater risk of failure
- Negative influence of nicotine:
  - Angiogenesis
  - Cellular repopulation
  - Micro-vascularization



Stop doing ACL reconstruction in smokers?

Menetrey et al. "Biological failure" of the anterior cruciate ligament graft. KSST 2008
VARI et al. Factors influencing ACL graft Incorporation Am J Sports Med. 2023

Factors affecting integration

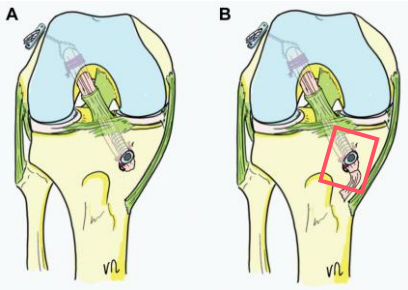
MODIFIABLE:
BIOLOGICAL ASPECTS OF SURGICAL TECHNIQUE

ATTACHED GRAFT

- Vascularization
- Innervation
- Double tibial fixation

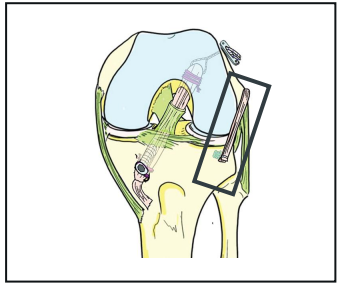
Preserving the Semitendinosus Distal Attachment Is Associated With Improved Graft Remodeling After ACL Reconstruction

Nicolas Vari,* MD, Vincent Marot,† MD, Thomas Ripoll,‡ MD, Thais Dutra Vieira,§ MD, Vincent Martinel,‖ MD, Emilie Bérard,¶ MD, PhD, and Etienne Cavaignac,*# MD, PhD
Investigation performed at the Musculoskeletal Institute, Hôpital Pierre Paul Riquet, CHU Toulouse, Toulouse, France



Preserve the distal attachment ++++++

Factors affecting integration



MODIFIABLE:
BIOLOGICAL ASPECTS OF SURGICAL TECHNIQUE

LATERAL TENODESIS

50/50 load sharing

Effect of Lateral Extra-articular Tenodesis on Anterior Cruciate Ligament Graft Incorporation

Etienne Cavaignac,*†‡ MD, PhD, Timothée Mesnier,† MD, Vincent Marot,† MD, Andrea Fernandez,† MD, Marie Faruch,§ MD, PhD, Emilie Berard,‖ MD, and Bertrand Sonnery-Cottet,¶ MD

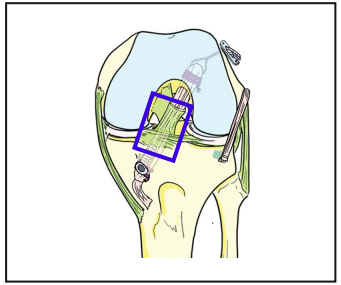
Investigation performed at the Department of Orthopedic Surgery and Trauma, Hôpital Pierre-Paul Riquet, Centre Hospitalier Universitaire de Toulouse, Toulouse, France

The effect of an iliotibial tenodesis on intraarticular graft forces and knee joint motion

LARS ENGEBRETSEN,* MD, WILLIAM D. LEW,†‡ MS, JACK L. LEWIS,† PhD, AND ROBERT E. HUNTER,† MD

ACL does not work alone… secondary stabilizers matter!!!!

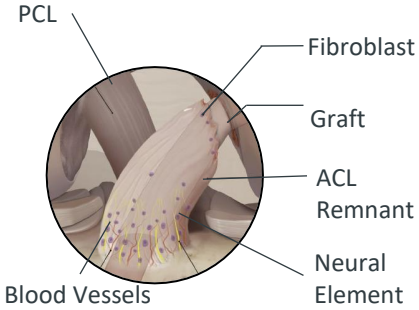
Factors affecting integration

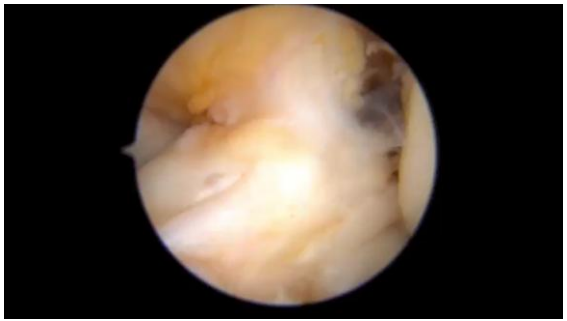


MODIFIABLE:
BIOLOGICAL ASPECTS OF SURGICAL TECHNIQUE

PRESERVATION OF STUMP

Faster ligamentization





Preserve the original tissues!

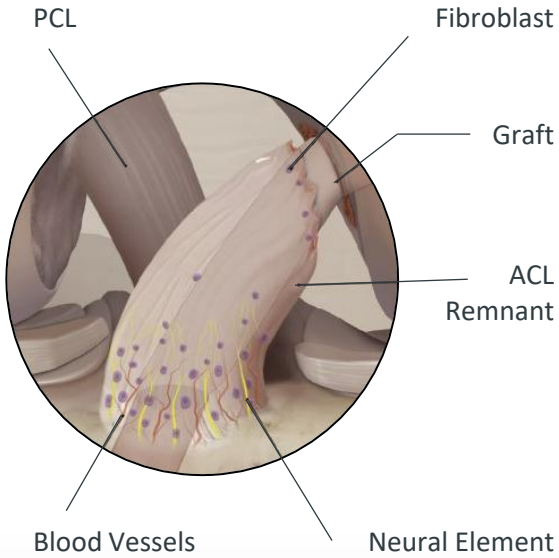
Lee et al. Does the tibial remnant of the anterior cruciate ligament promote ligamentization? Knee 2016

Andriolo et al. PRP Augmentation for ACL Reconstruction. Biomed Res Int 2015

Sonnery-Cottet et al: Anterior Cruciate Ligament Reconstruction and Preservation: The Single–Anteromedial Bundle Biological Augmentation (SAMBBA) Technique

Why not keeping it ?

- Graft vascularization,
- Preservation of proprioceptive nerve fibers,
- Potentially reduced rates of graft re-rupture



ACL Reconstruction Preserving the ACL Remnant Achieves Good Clinical Outcomes and Can Reduce Subsequent Graft Rupture

Yuji Takazawa,*† MD, PhD, Hiroshi Ikeda,† MD, PhD, Takayuki Kawasaki,† MD, PhD, Muneaki Ishijima,† MD, PhD, Mitsuaki Kubota,† MD, PhD, Yoshitomo Saita,† MD, PhD, Haruka Kaneko,† MD, PhD, Sung-Gon Kim,‡ MD, PhD, Hisashi Kurosawa,§ MD, PhD, and Kazuo Kaneko,† MD, PhD

Investigation performed at the Department of Orthopaedics, Juntendo University School of Medicine, Tokyo, Japan

Preservation of the Tibial Stump During Anterior Cruciate Ligament Reconstruction Surgery Did Not Increase the Rate of Surgery for Symptomatic Cyclops Lesions

Kate E. Webster,*† PhD, Jerome Murgier,‡§ MD, Julian A. Feller,†‡ MB, BS(Hons), Haydn J. Klemm,‡ BFSc, Nutr(Hons), Brian M. Devitt,‡ PhD, and Timothy S. Whitehead,‡ MB, BS

Investigation performed at OrthoSport Victoria and La Trobe University, Melbourne, Victoria, Australia

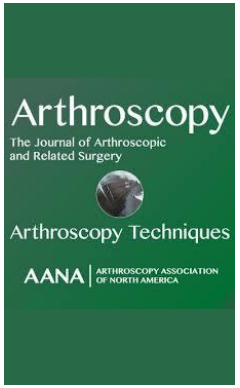
Clinical Outcomes of Single Anteromedial Bundle Biologic Augmentation (SAMBBA) Technique for Anterior Cruciate Ligament Reconstruction With Consideration of Tibial Remnant Size

Hervé Ouanezar, M.D., William G. Blakeney, M.B.B.S., M.Sc., M.S., F.R.A.C.S., Levi Reina Fernandes, M.D., Amrut Borade, M.B.B.S., M.S., Charles Latrobe, M.D., Eduardo Frois Temponi, M.D., and Bertrand Sonnery-Cottet, M.D.

A lot of evidence !!!!!!!

Remnant assessment

Check general appearance, length, vascularity



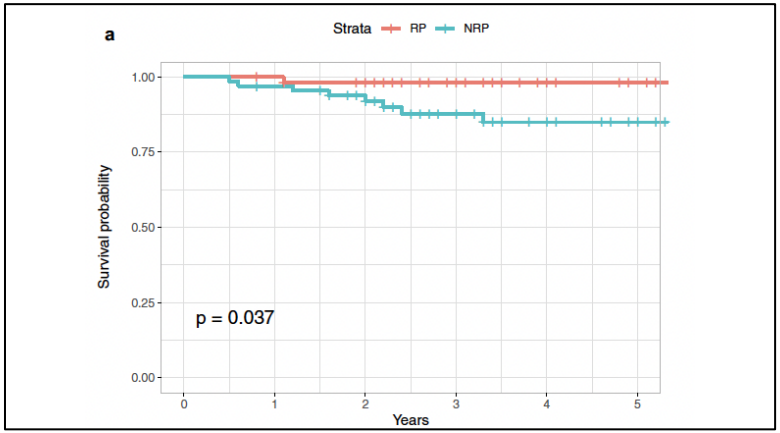
Arthroscopy: The Journal of Arthroscopic and Related Surgery
Anatomical Inside-out Remnant Preserving Anterior Cruciate Ligament Reconstruction: A Surgical Technique For Biological ACL Reconstruction
--Manuscript Draft--

Results

SAME PROMS

- Better stability
- Less re rupture

= COMPLICATIONS



Knee Surgery, Sports Traumatology, Arthroscopy (2021) 29:3763–3772
https://doi.org/10.1007/s00167-020-06406-6

KNEE

Remnant preservation provides good clinical outcomes after anterior cruciate ligament reconstruction

Hui Huang[1,5] · Masashi Nagao[1,2,3,4] · Hirofumi Nishio[4] · Haruka Kaneko[1] · Yoshitomo Saita[1] · Yuji Takazawa[1,4] · Hiroshi Ikeda[1] · Kazuo Kaneko[1,5] · Muneaki Ishijima[1,5]

Comparing Clinical Outcomes and Knee Stability in Remnant-Preserving ACL Reconstruction Versus Standard ACL Reconstruction

A Systematic Review and Meta-analysis

Felicitas Allende,* MD, Sachin Allahabadi,† MD, Divesh Sachdev,‡ BS, Varun Gopinatth,§ BS, Rodrigo Saad Berreta,* BA, Robert F. LaPrade,‖ MD, PhD, and Jorge Chahla,*¶ MD, PhD

Keep it !

Results

Preservation of the Tibial Stump During Anterior Cruciate Ligament Reconstruction Surgery Did Not Increase the Rate of Surgery for Symptomatic Cyclops Lesions

Kate E. Webster,*† PhD, Jerome Murgier,‡§ MD, Julian A. Feller,‡‡ MB, BS(Hons), Haydn J. Klemm,‡ BFSc, Nutr(Hons), Brian M. Devitt,‡ PhD, and Timothy S. Whitehead,‡ MB, BS
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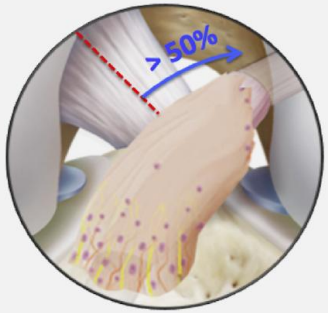

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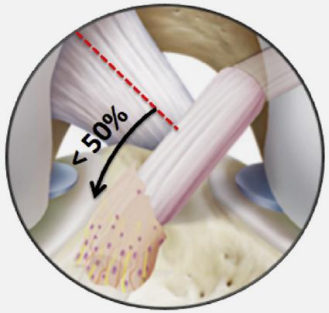
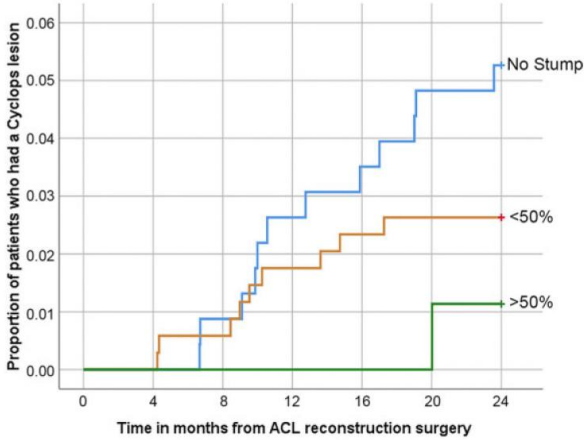


B

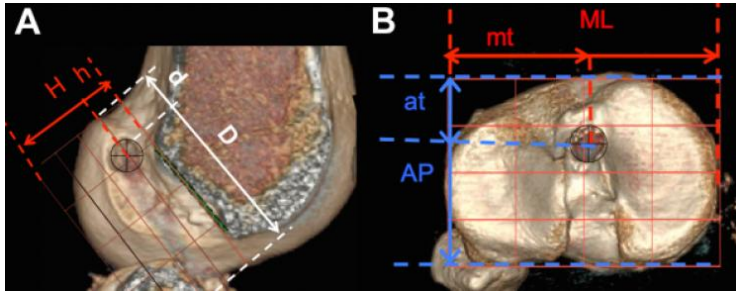
50%



Keep it as much as you can !

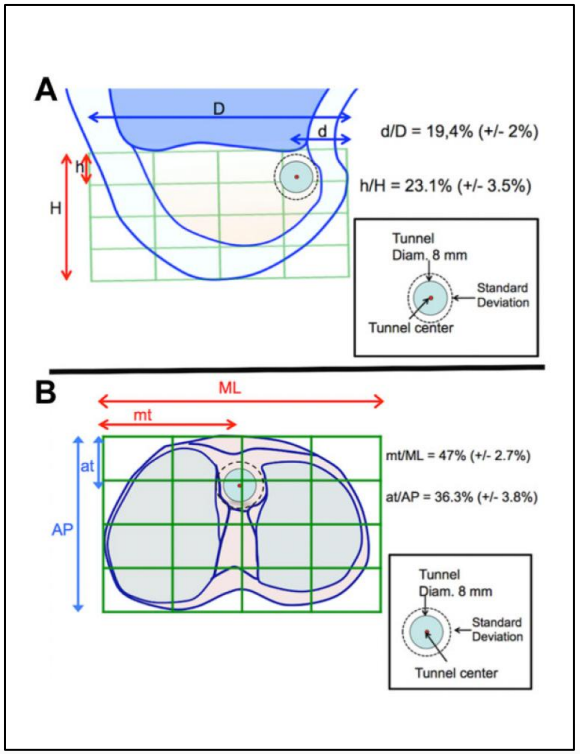
Results

GOOD LOCATION !



Three-Dimensional CT Evaluation of Tunnel Positioning in ACL Reconstruction Using the Single Anteromedial Bundle Biological Augmentation (SAMBBA) Technique

Florent Buscayret,* MD, Eduardo Frois Temponi,† MD, Adnan Saithna,‡§ MBChB, DipSEM, MSc, FRCS(T&O), Mathieu Thaunat,‖ MD, and Bertrand Sonnery-Cottet,‖¶ MD

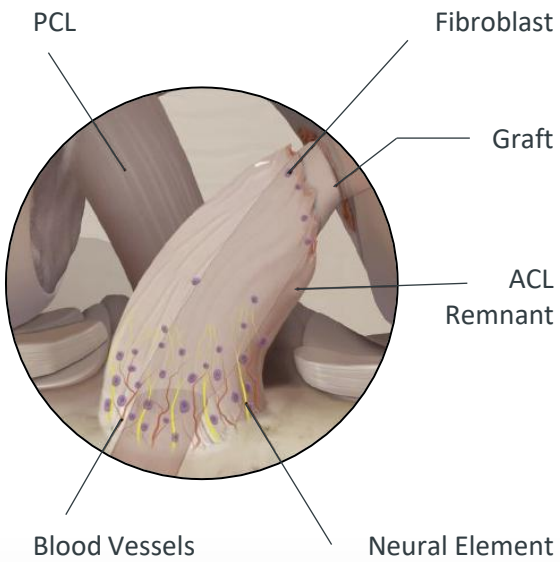


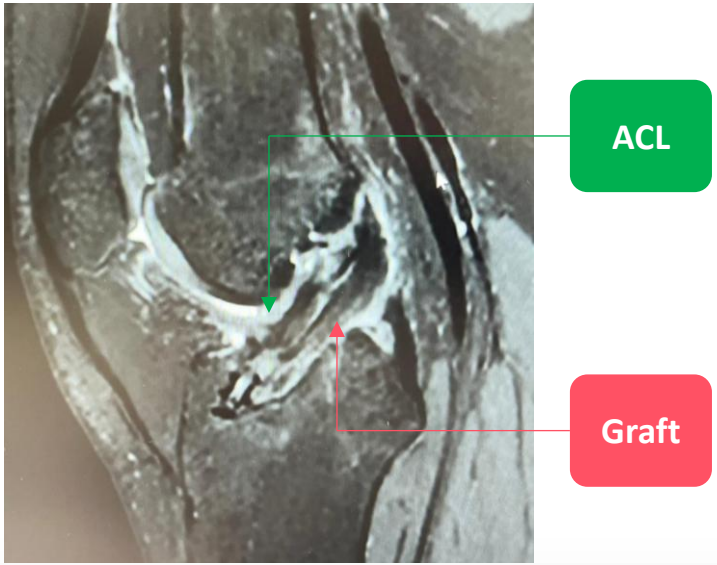
Keep it as much as you can !

Conclusion

RIGHT LOCATION !

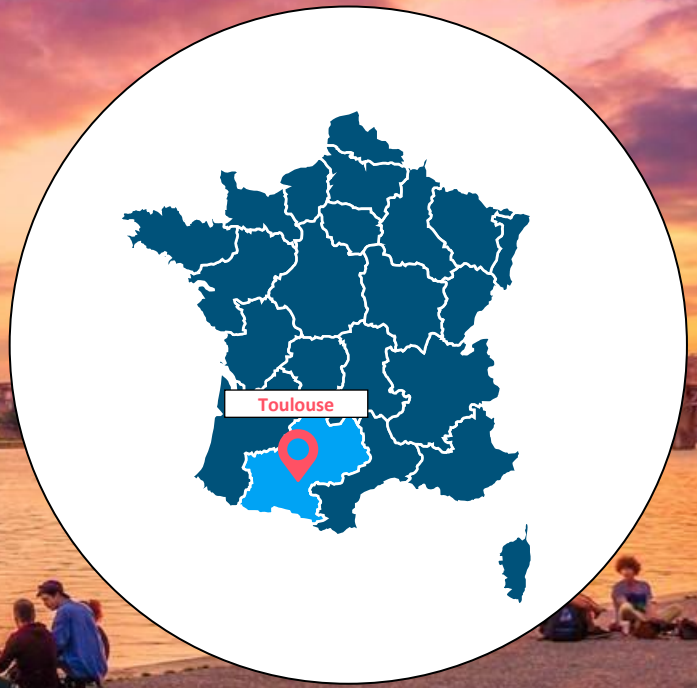
Sleeve





BIOLOGICAL ASPECT OF SURGICAL TECHNIQUE

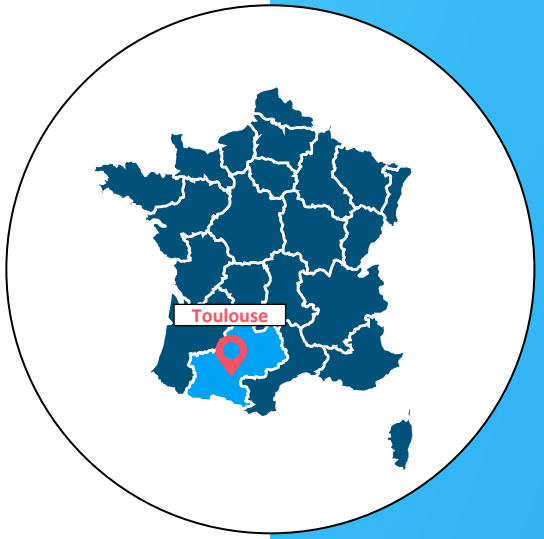
Thank You



Prof. Etienne CAVAIGNAC
Hôpital Pierre Paul Riquet CHU Toulouse
Email: cavaignac.e@chu-toulouse.fr

#PC025

PRACTICAL COURSE ORTHOPEDICS



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