

# Primary ACL Repair

*Randy Schwartzberg, M.D.*

Assistant Professor - UCF College of  
Medicine



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*Foundation*



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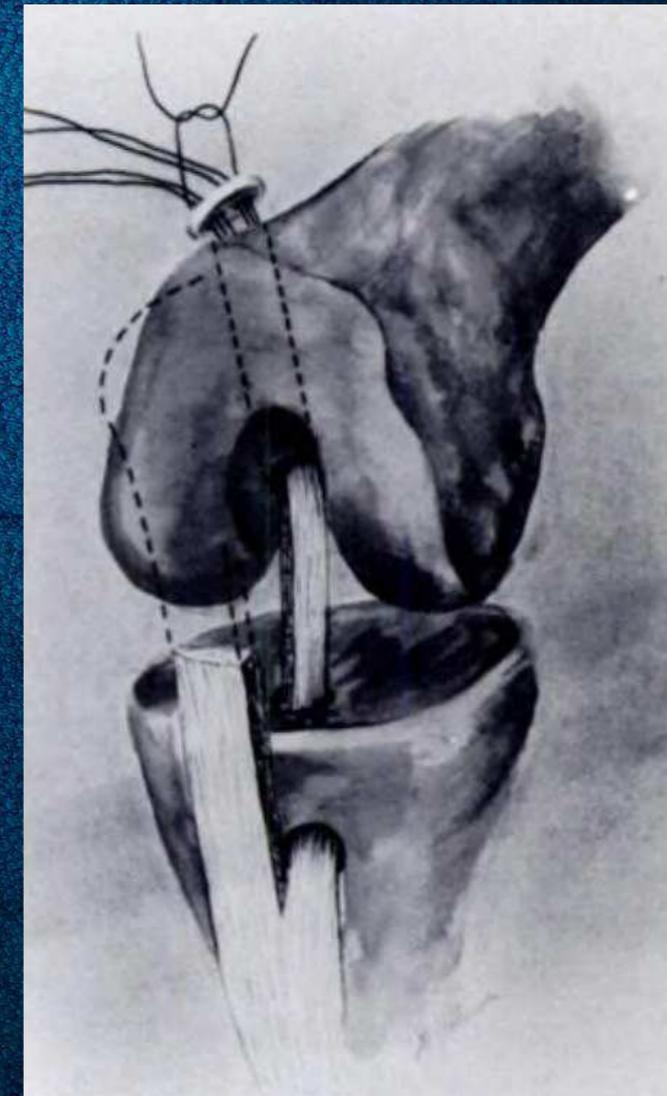
SPORTS MEDICINE

# Anterior Cruciate Ligament Reconstruction using One-Third of the Patellar Ligament, Augmented by Extra-Articular Tendon Transfers

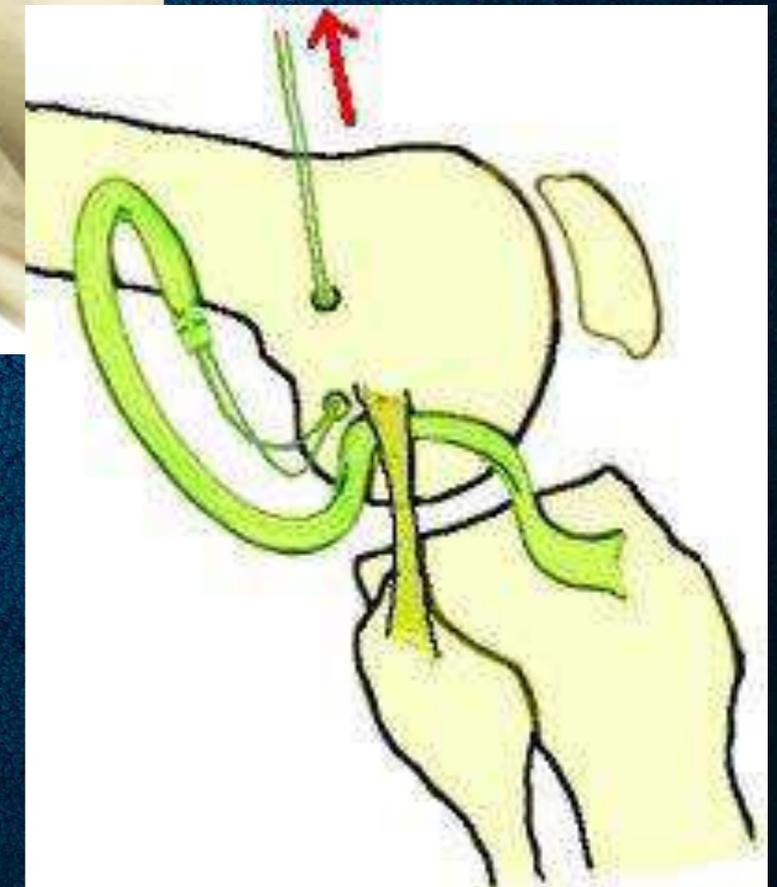
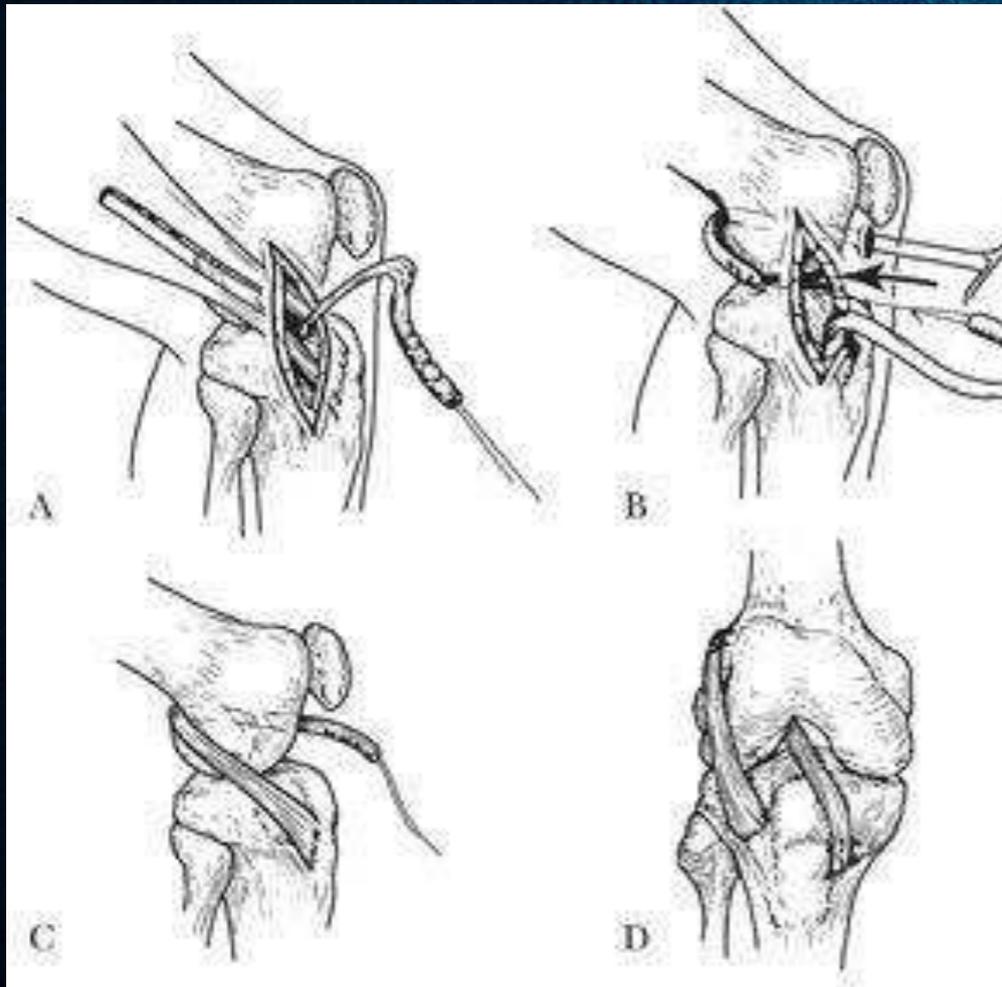
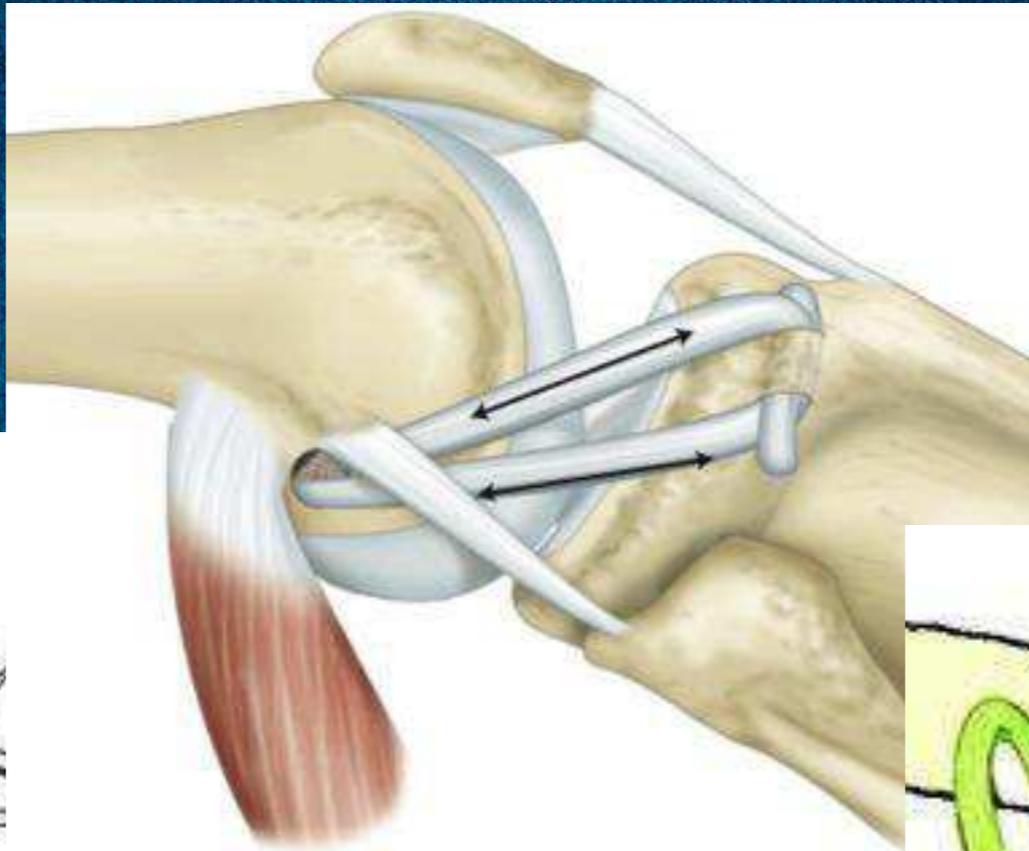
BY WILLIAM G. CLANCY, JR., M.D.\*, DEVON A. NELSON, M.D.\*, BRUCE REIDER, M.D.\*, AND  
RAJESH G. NARECHANIA, M.S.\*, MADISON, WISCONSIN

1983

J B & J S | The Journal of  
Bone and Joint Surgery



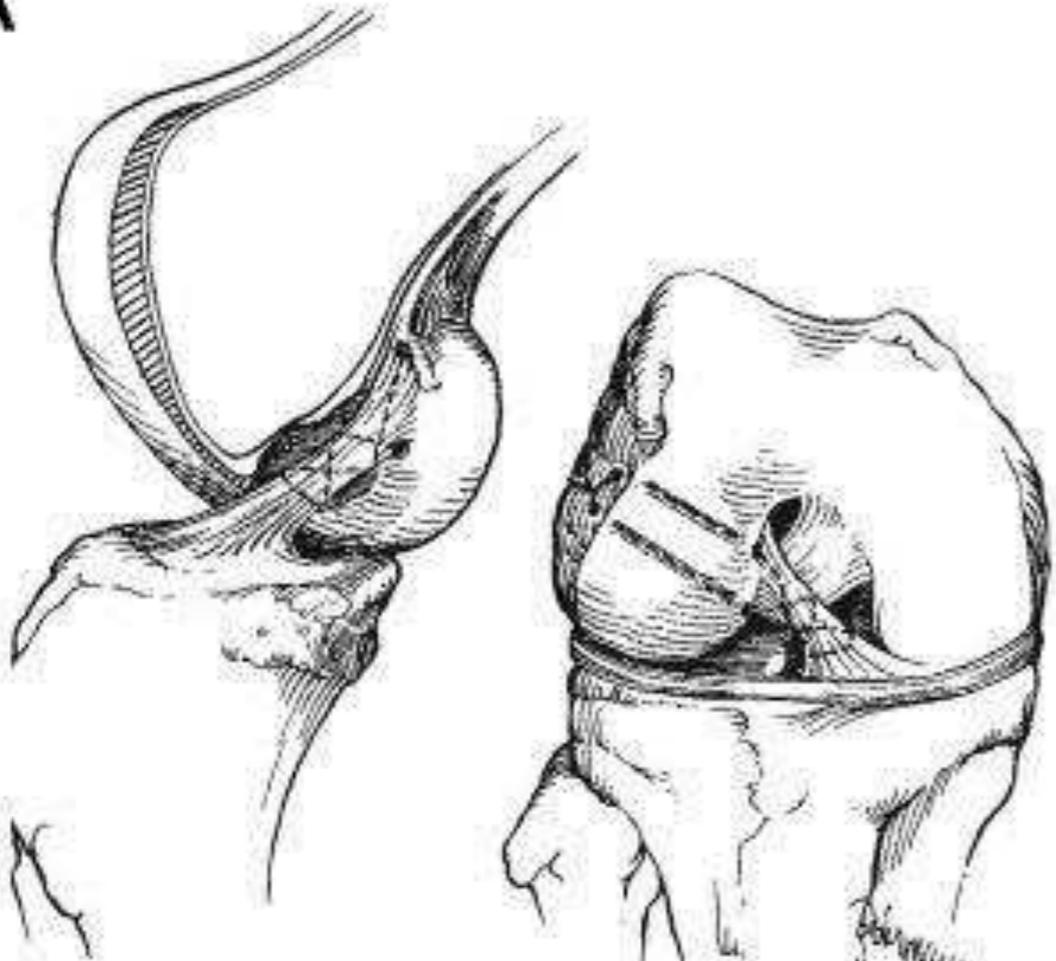
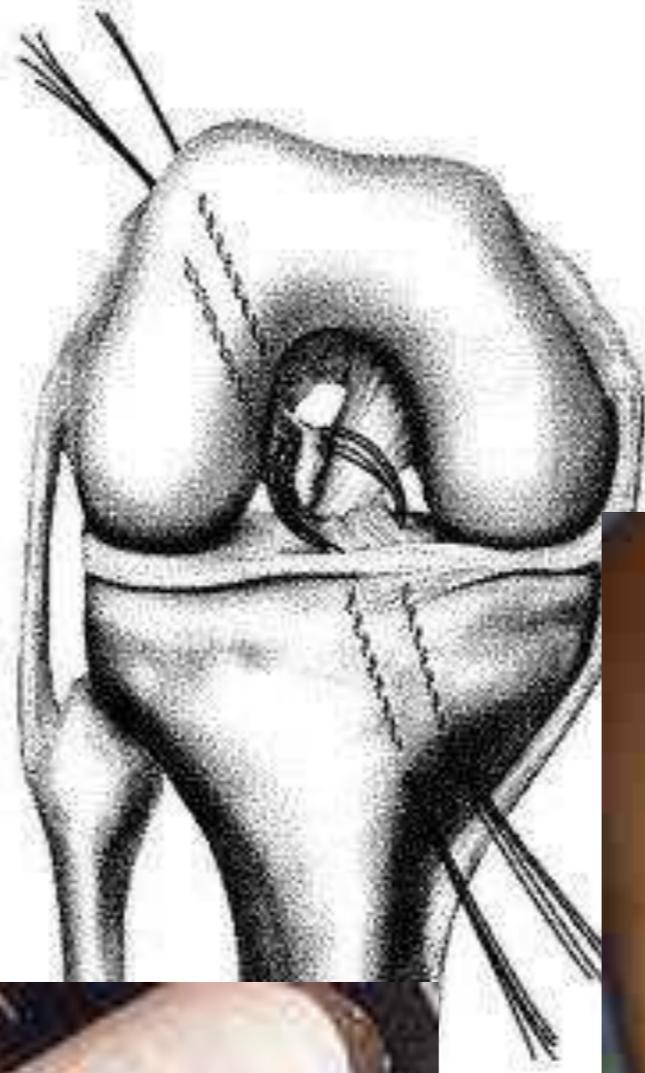
# Prior to this... a plethora of procedures for ACL tears



**One technique...**

# **Primary ACL Repair**



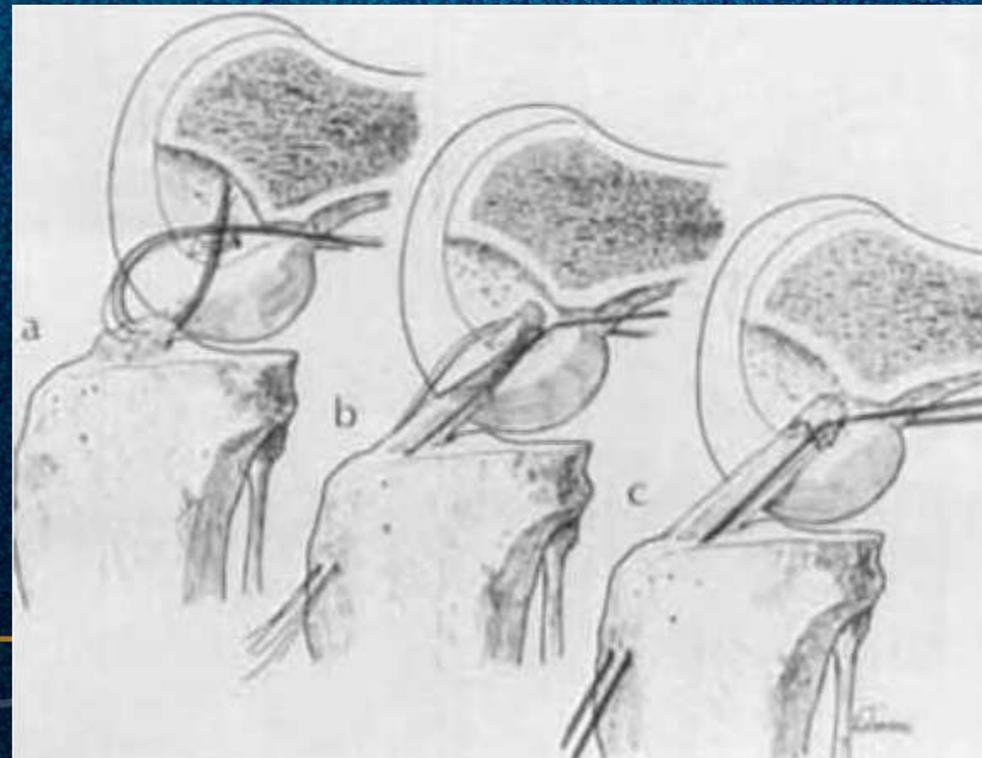
**A****B**

# Primary surgical treatment of anterior cruciate ligament lesions\*

JOHN L. MARSHALL,† DVM, MD, FACS, RUSSELL F. WARREN,‡ MD, FACS,  
AND THOMAS L. WICKIEWICZ,§|| MD

1982

- Average 29 month f/u
- Good results



**The Isolated Tear of the Anterior Cruciate Ligament.** LIEUTENANT COLONEL JOHN A. FEAGIN <sup>48</sup>, DR. HOWARD G. ABBOTT <sup>49</sup>, and DR. JOSEPH R. ROKOUS <sup>50</sup> presented their findings in sixty-four cases of isolated tear of the anterior cruciate ligament diagnosed at operation in sixty-two patients at the United States Military Academy between 1965 and 1971.

## AAOS Annual Meeting

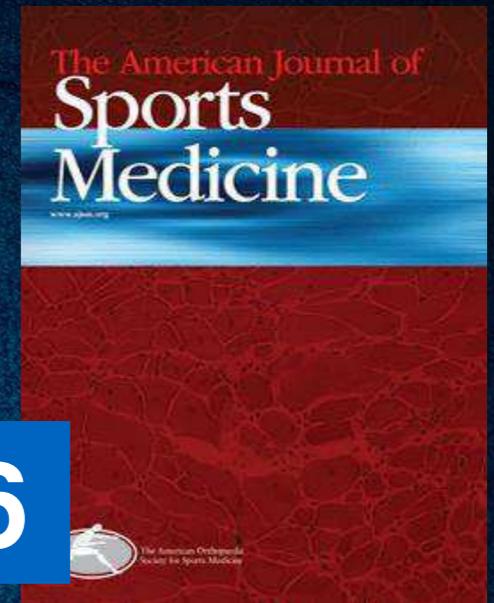
1972

- ACL repair in military cadets
- 25/30 good results at 2 years

# Isolated tear of the anterior cruciate ligament: 5-year follow-up study

JOHN A. FEAGIN, JR., M.D., COLONEL, AND WALTON W. CURRIE, M.D., MAJOR

1976



Poor results at mid-term follow-up

Consider tendon transfer or synthetic substitute.

# Poor Results with Mid-term Follow-up of Same Cohorts

Suture of fresh ruptures of the anterior cruciate ligament: A 5-year follow-up

Magnus Odensten, Jack Lysholm & Jan Gillquist

1984

*Acta  
Orthopaedica*

Primary suture of the anterior cruciate ligament A 6-year follow-up of 74 cases

Lars Engebretsen, PÅL Benum & Svein Sundalsvoll

1989

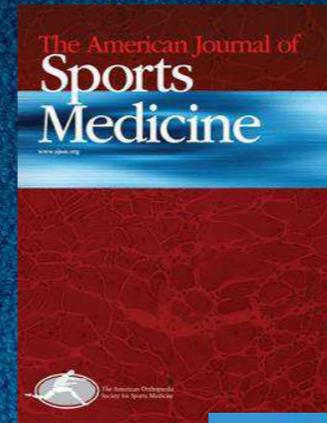
*Acta  
Orthopaedica*

# Poor Results with Long-Term Follow-up

## Primary surgical treatment of anterior cruciate ligament ruptures

A long-term follow-up study

NORMAN KAPLAN, MD, THOMAS L. WICKIEWICZ,\* MD, AND RUSSELL F. WARREN, MD



1990

T. Strand · A. Mølster · M. Hordvik · Y. Krukhaug

Long-term follow-up after primary repair of the anterior cruciate ligament: clinical and radiological results 15–23 years postoperatively



2005

**Unstable knees with osteoarthritis**

## LONG-TERM FOLLOW-UP OF THREE ALTERNATIVE TECHNIQUES FOR THE TREATMENT OF ACUTE RUPTURES OF THE ANTERIOR CRUCIATE LIGAMENT

BY JON OLAV DROGSET, MD, TORBJØRN GRØNTVEDT, MD, PHD, OLE RASMUS ROBAK, MD, ANDERS MØLSTER, MD, PHD, ANNA T. VISET, MD, AND LARS ENGBRETSSEN, MD, PHD

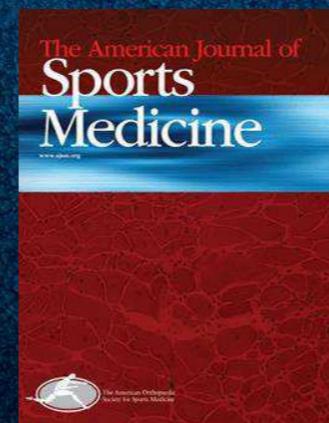


2006

## Isolated Tears of the Anterior Cruciate Ligament

Over 30-Year Follow-up of Patients Treated With Arthrotomy and Primary Repair

COL (ret) Dean C. Taylor,\*† MD, CPT Matthew Posner,‡ MD, COL (ret) Walton W. Curl,§ MD, and COL (ret) John A. Feagin,|| MD



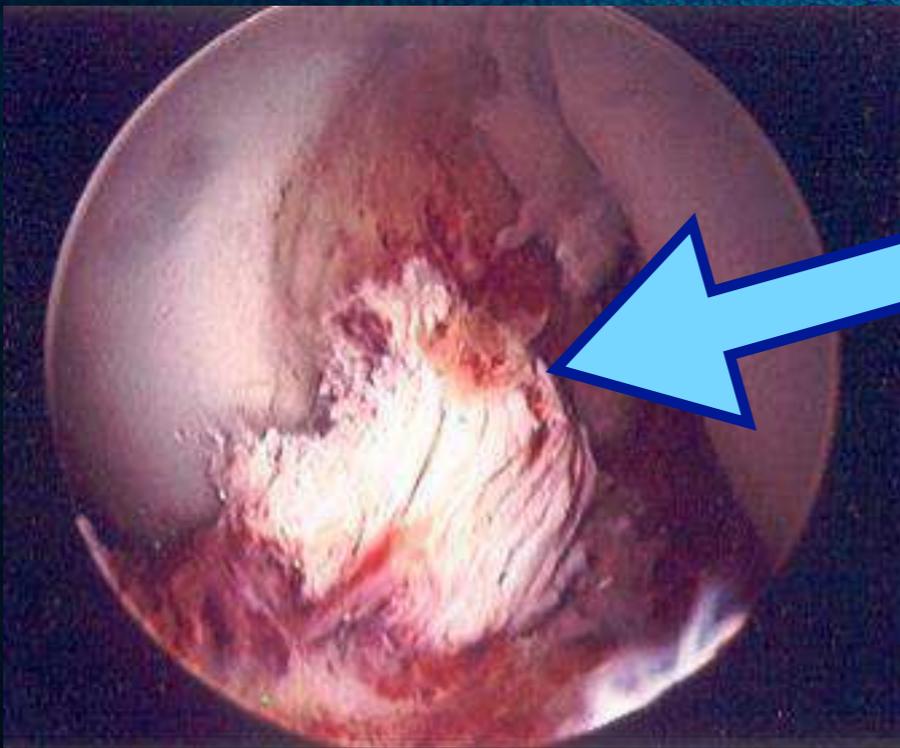
2009

**Why does the ACL not work well when sutured together like other ligaments and tendons in the body?**

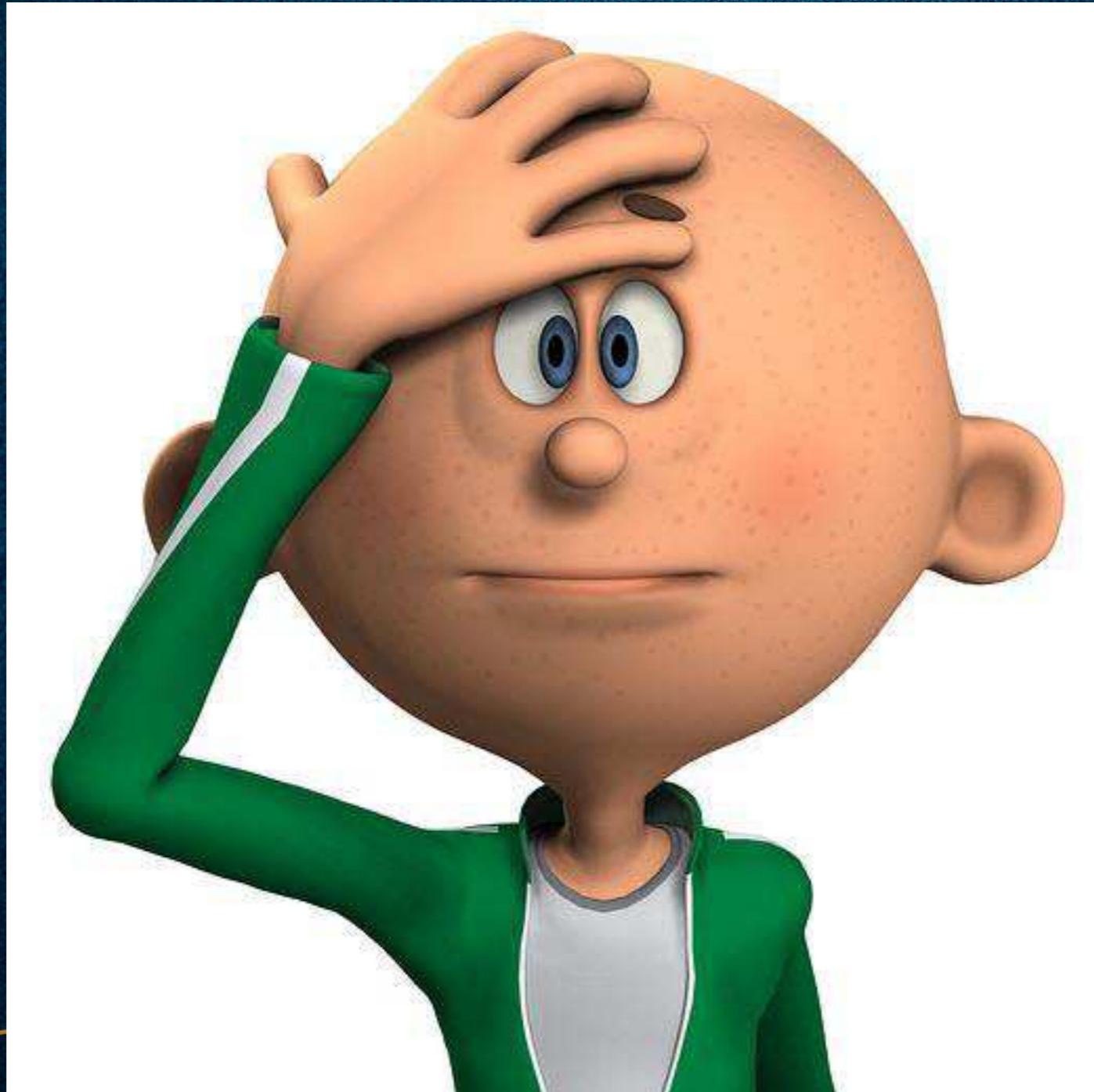


# Proposed Reasons....

- Mop end tears
- Inability to securely repair
- Hyaluronic acid



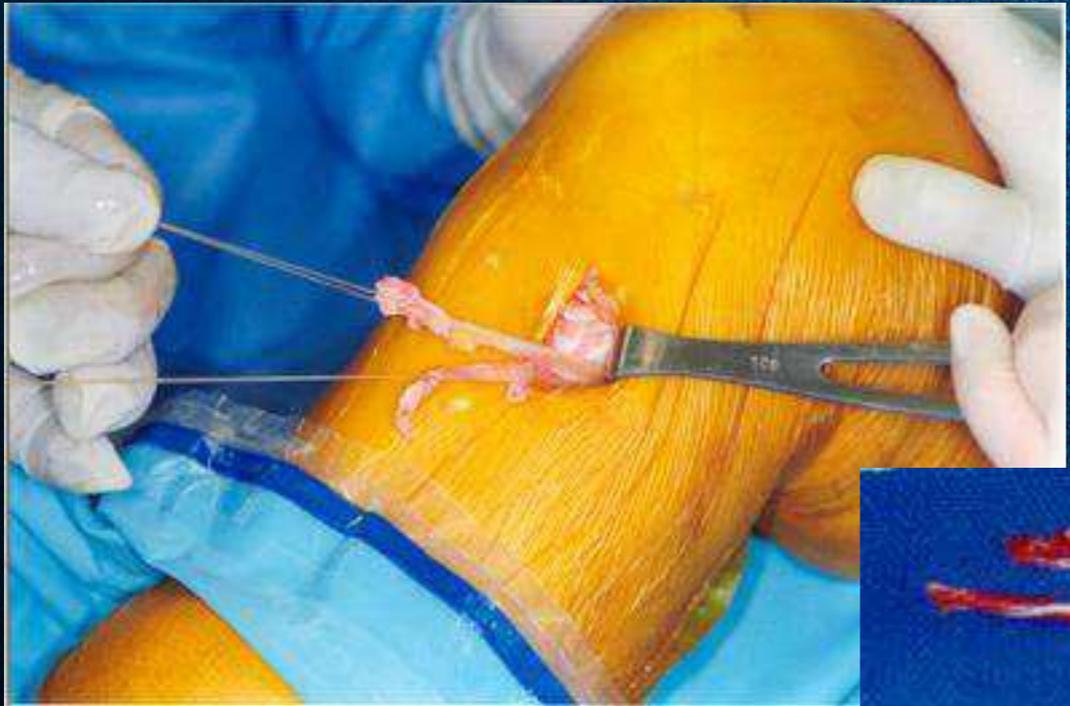
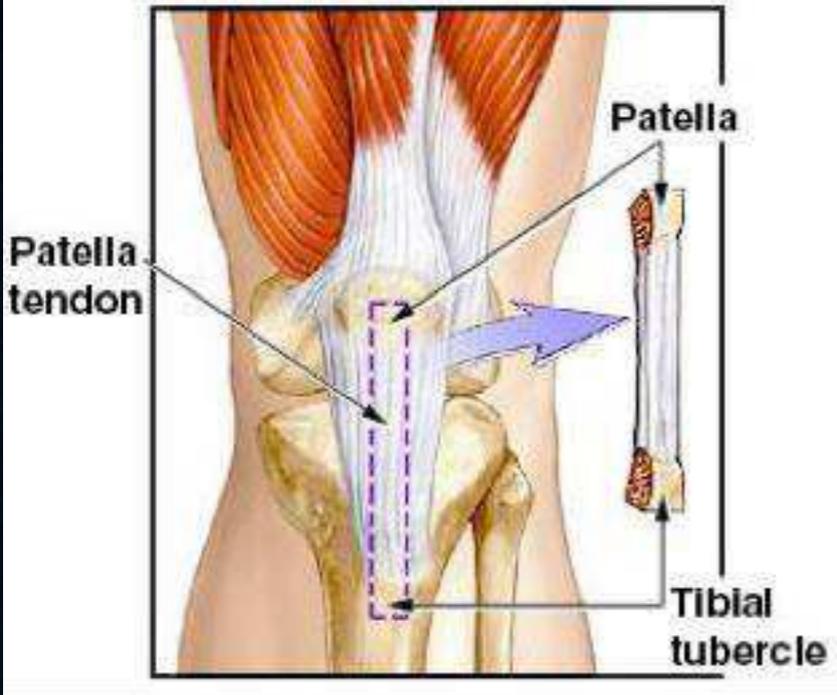
**So, ACL repair is forgotten...**

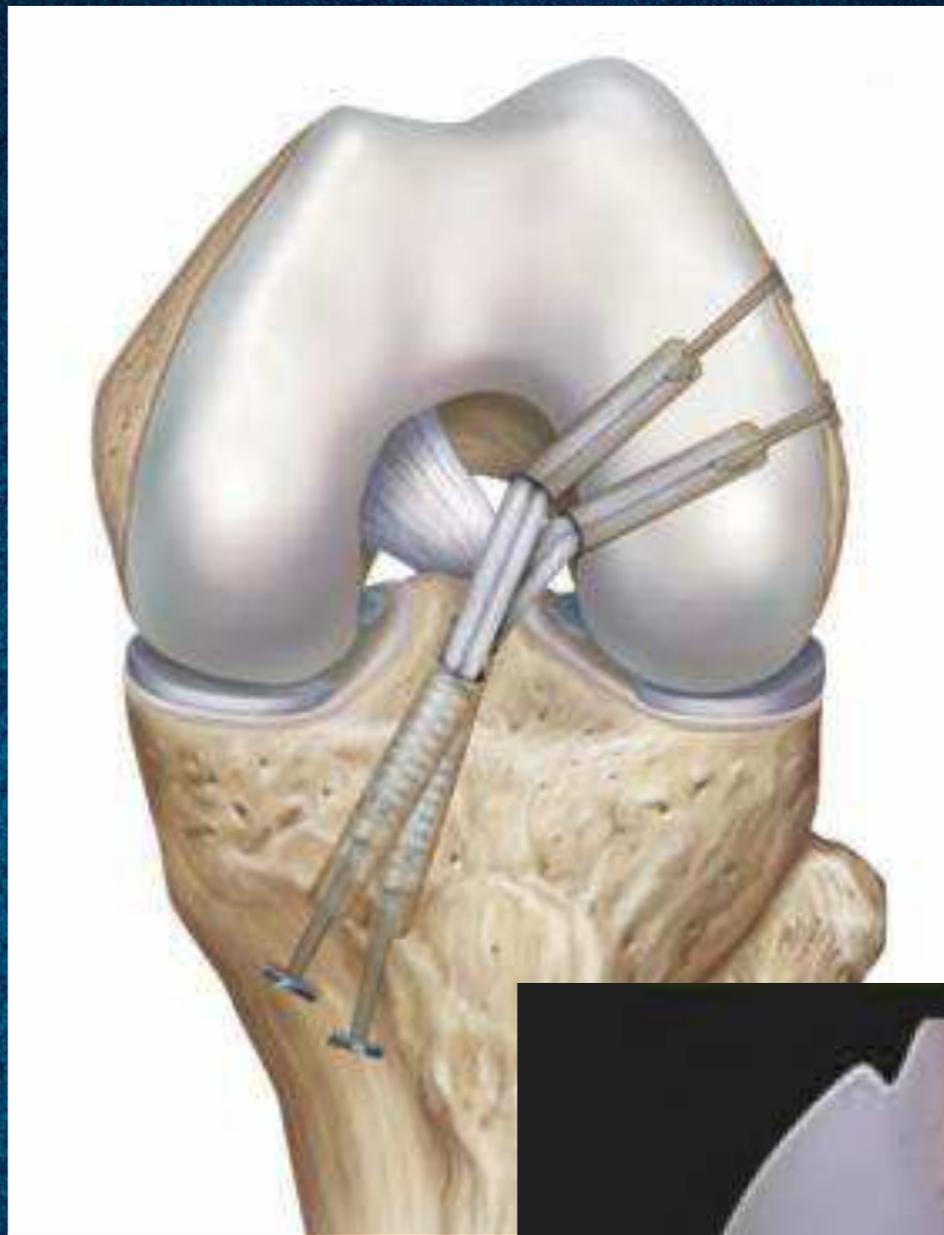


jettison into an era of ACL reconstruct

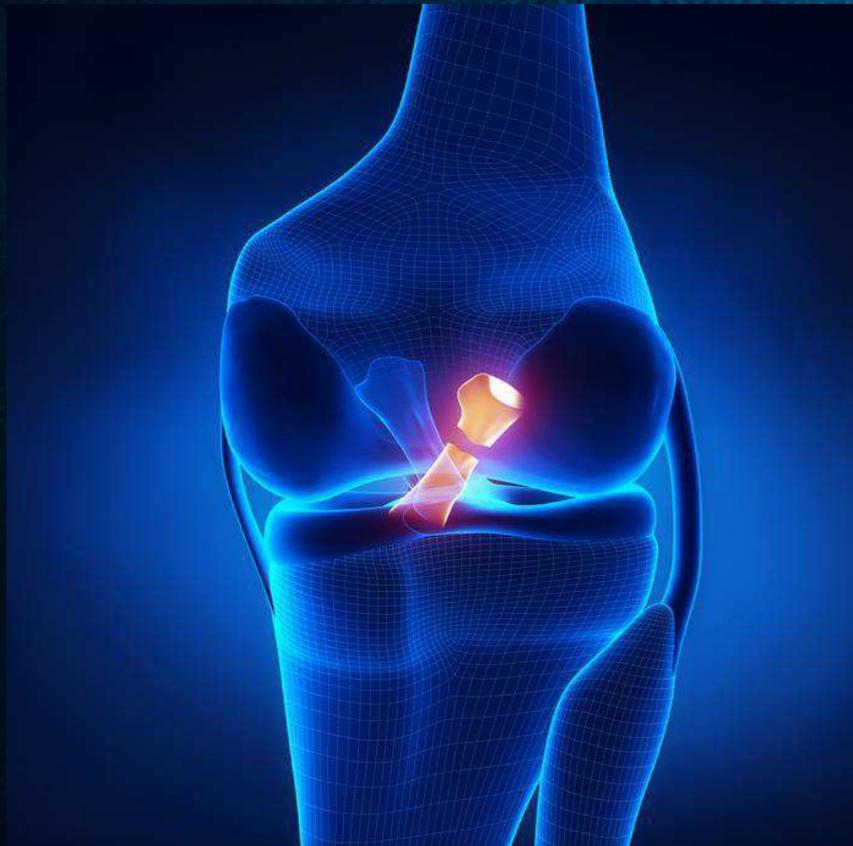


# Years of grafts & techniques...



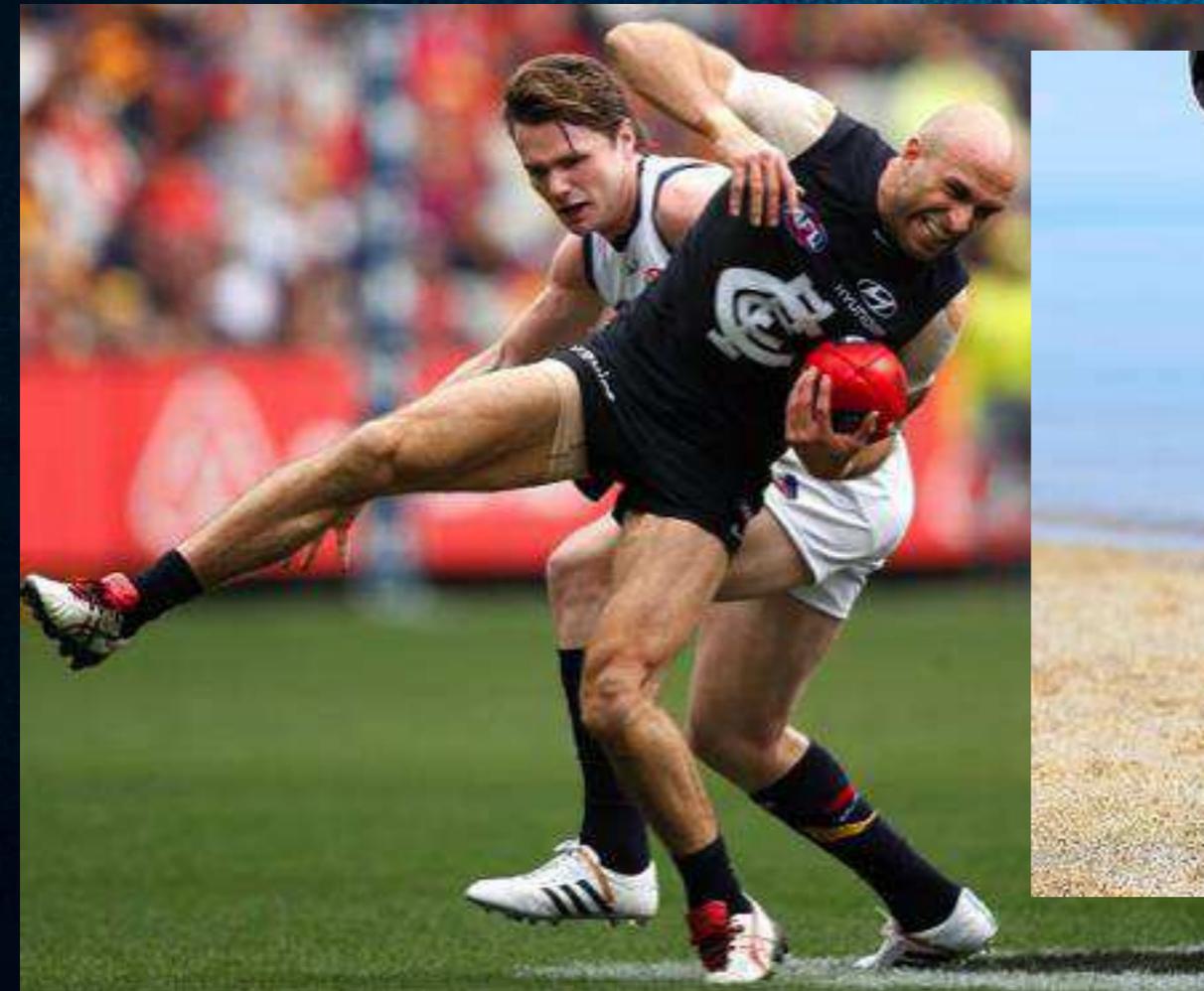


# ACL reconstruction has stood the test of time...



# Imperfections of ACL reconstruction...

- Graft harvest site morbidity
- Persistent instability
- Proprioception
- Knee arthritis



ould preserving the native ACL improve on this





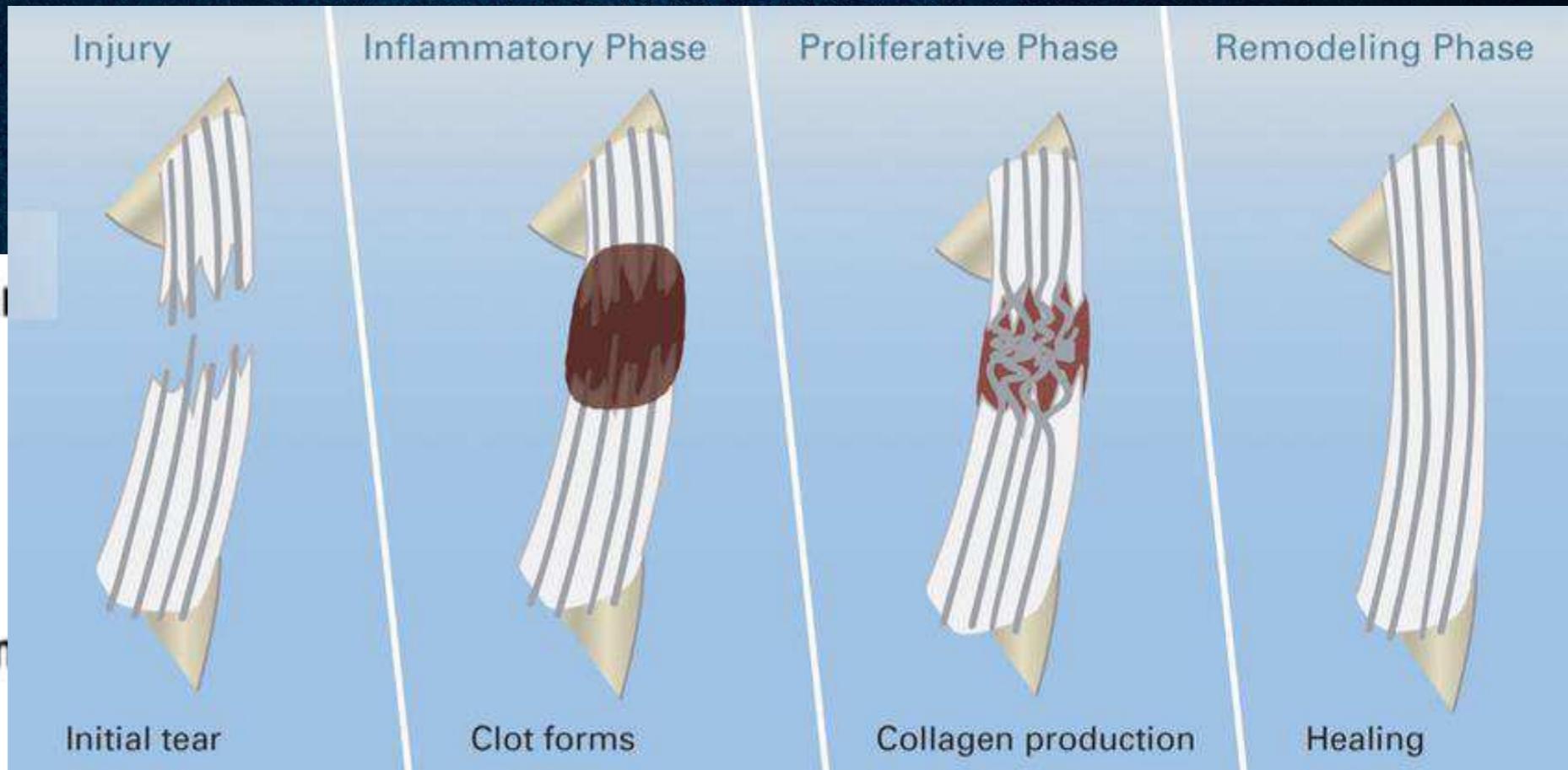
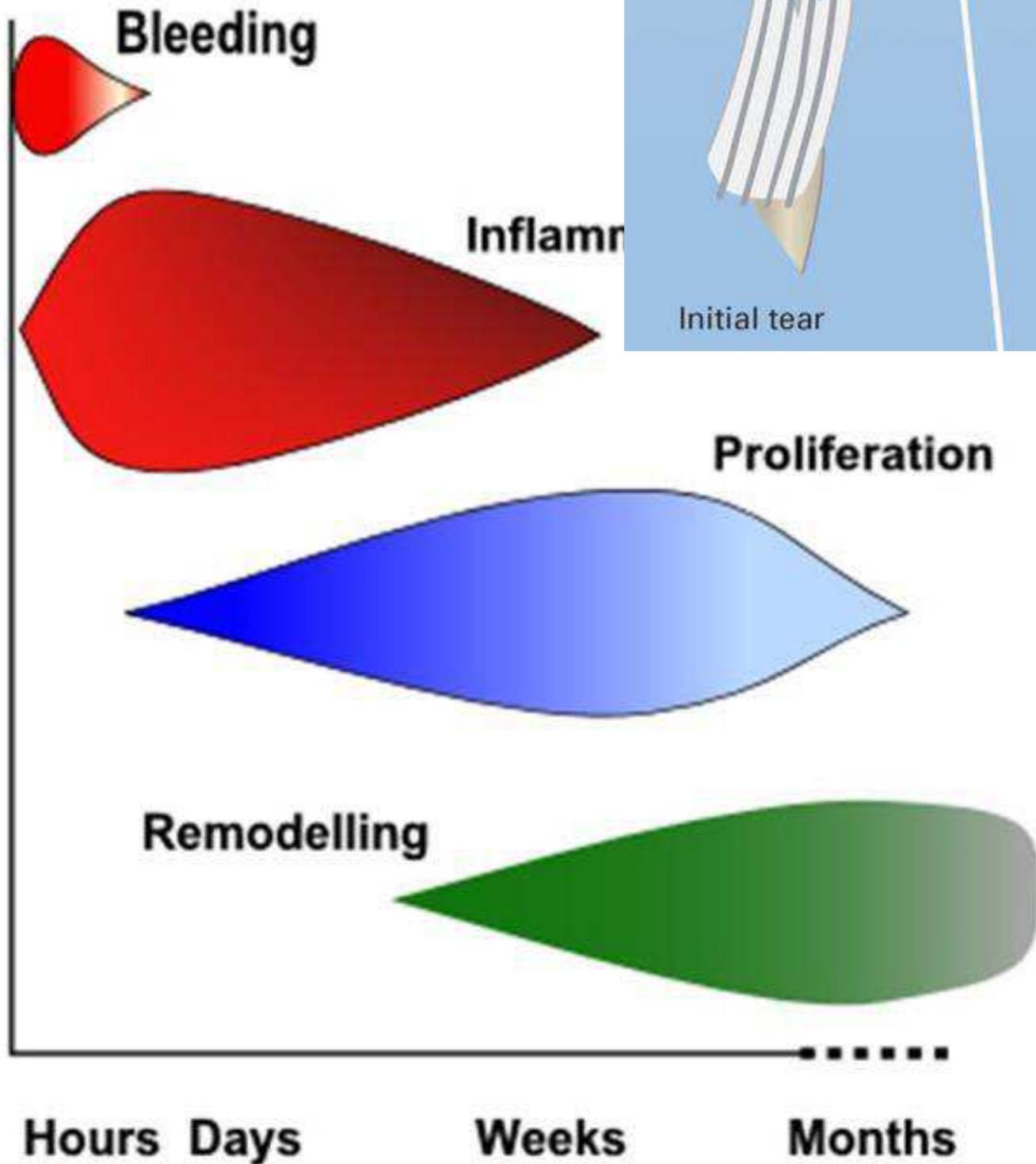
Series of questions to ask....



# 1st Question

**Does the ACL have the potential  
to heal?**

# Tissue Repair Phases and



Expression of Collagen and Matrix Metalloproteinases  
in Ruptured Human Anterior Cruciate Ligament:  
*An In Situ* Hybridization Study

K. P. Spindler, S. W. Clark, \*L. B. Nanne, and †J. M. Davidson



1996

- Ruptured ACL capable of expressing type 1 collagen
- Matrix degrading enzymes not expressed

# Histological Changes in the Human Anterior Cruciate Ligament After Rupture\*

BY M. M. MURRAY, M.D.†, S. D. MARTIN, M.D.†, T. L. MARTIN, M.D.†, AND M. SPECTOR



2000

Characteristics of healing seen in other dense connective tissues...

- Fibroblast proliferation
- Revascularization

## 2nd question

**What prevents the ACL from healing?**

# Compare the ACL & MCL



**vs.**



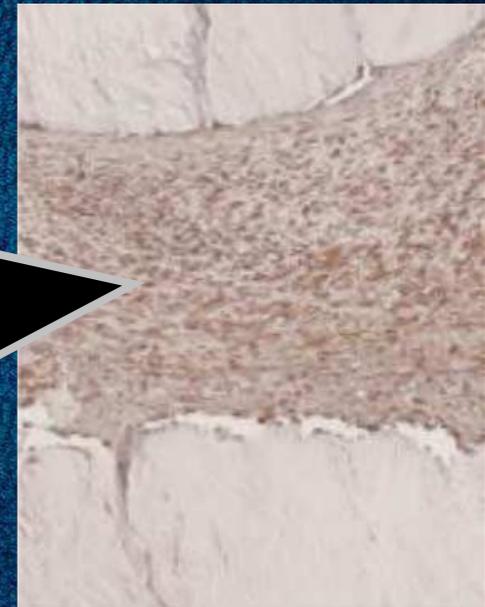
# Enhanced Histologic Repair in a Central Wound in the Anterior Cruciate Ligament with a Collagen-Platelet-Rich Plasma Scaffold

Martha M. Murray,<sup>1</sup> Kurt P. Spindler,<sup>2</sup> Percy Ballard,<sup>1,2</sup> Tyler P. Welch,<sup>1</sup> David Zurakowski,<sup>1</sup> Lillia

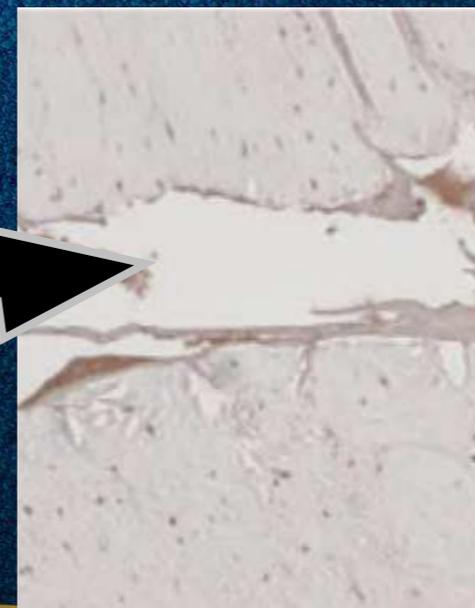


2007

**MCL forms scaffold of fibrinogen & growth factors**



**ACL forms no scaffold**



# Collagen/PRP scaffold placed in ACL

**MCL**



**Untreated ACL**



**Scaffold ACL**



**ACL healing approximated MCL healing**

# Biology of Anterior Cruciate Ligament Injury and Repair: Kappa Delta Ann Doner Vaughn Award Paper 2013

Martha Meaney Murray,<sup>1</sup> Braden C. Fleming<sup>2,3</sup>

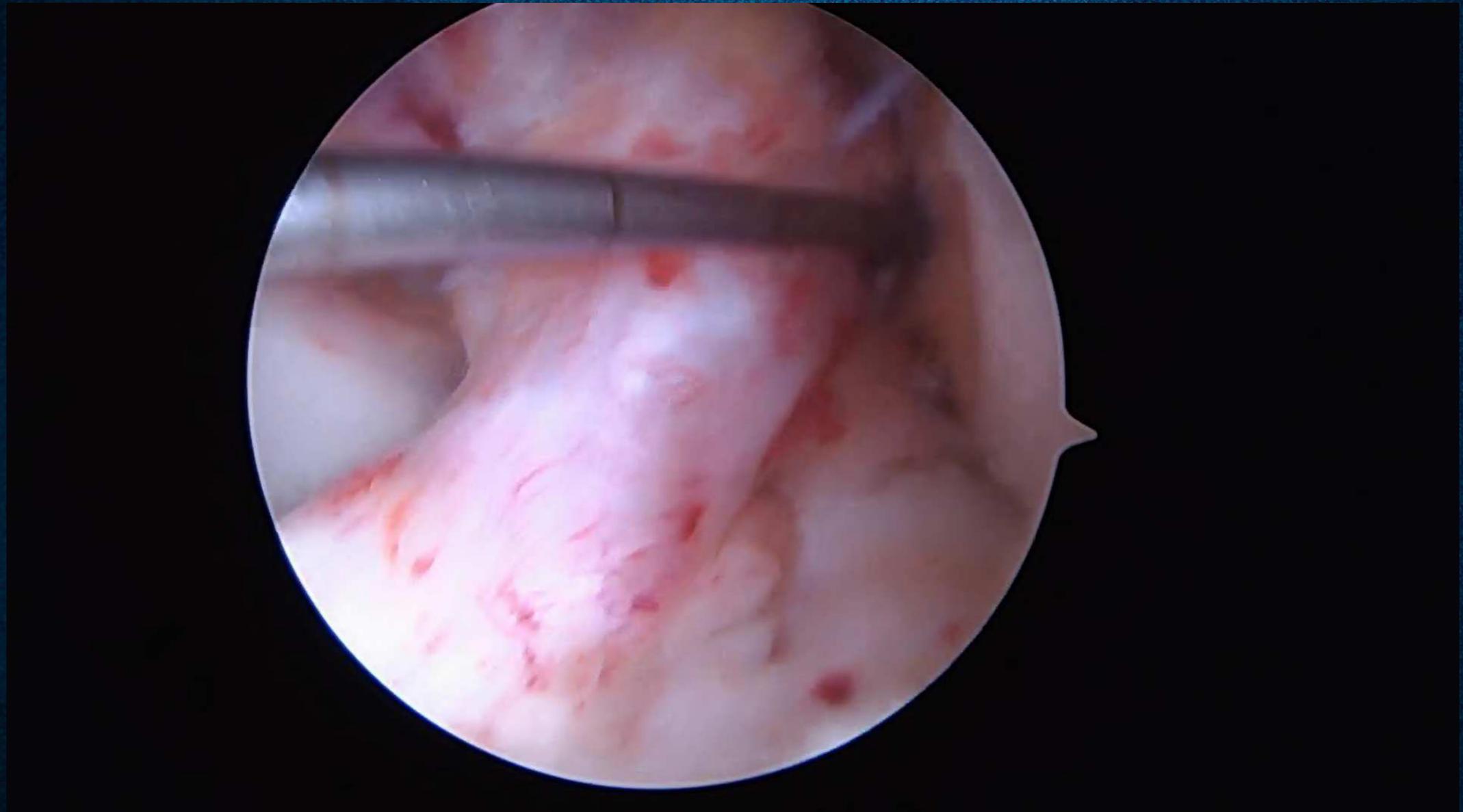
Journal of  
Orthopaedic  
Research®

2013

## Current thoughts...

- ACL has healing potential
- ACL lacks scaffold necessary to heal

**Surgeons see ACL healing not infrequently...**



March 23, 2016

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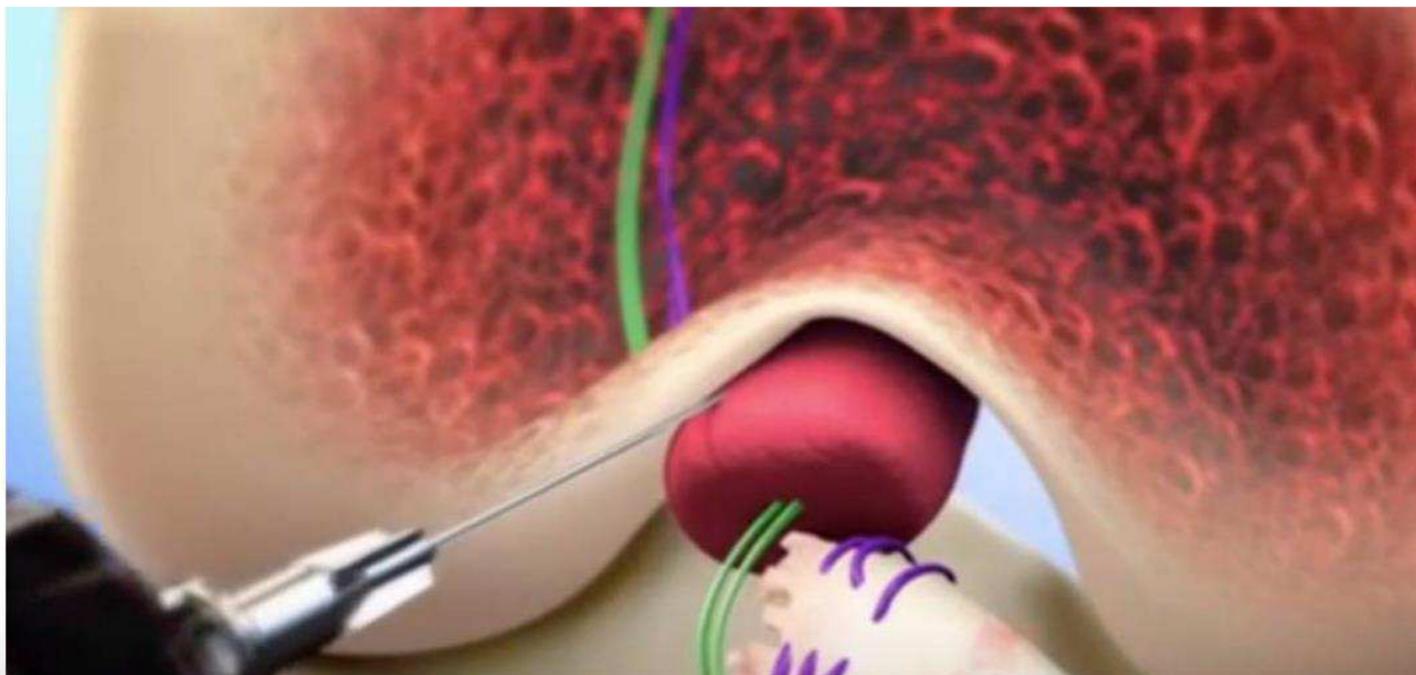
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## A Potential Breakthrough in ACL Surgery

Bridge-enhanced ACL repair allows doctors to use a sponge soaked with the patient's blood to repair a torn ACL rather than replacing it with a tendon from another part of the patient's body



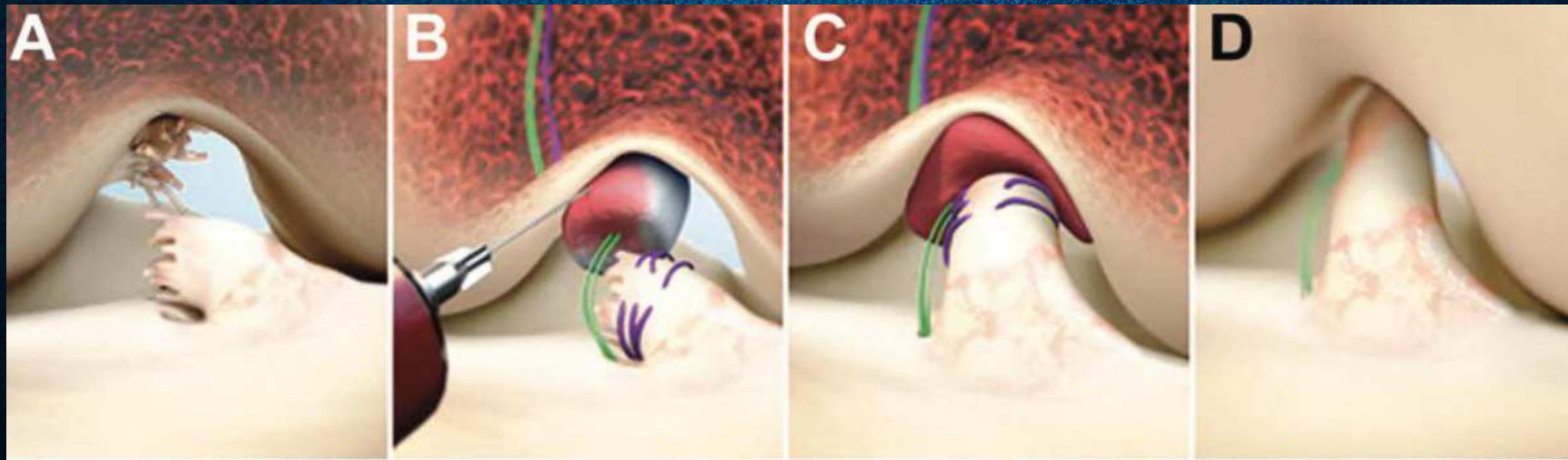
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**DIGITALIZING  
HEALTHCARE**

More effective and efficient  
healthcare systems feature smart  
data integration and seamless

# What is it?

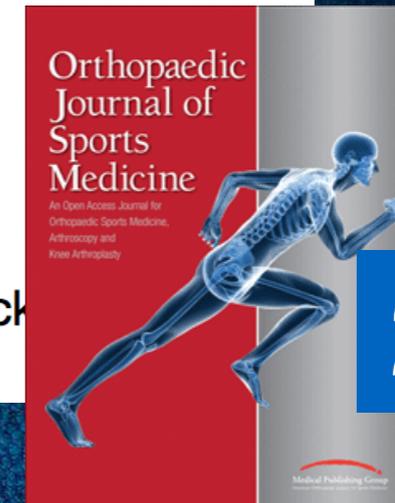
- Bovine collagen scaffold
- Sutured into ACL tear
- Suspension button fixation construct
- Blood injected into scaffold at end



# The Bridge-Enhanced Anterior Cruciate Ligament Repair (BEAR) Procedure

## An Early Feasibility Cohort Study

Martha M. Murray,<sup>\*†</sup> MD, Brett M. Flutie,<sup>†</sup> BA, Leslie A. Kalish,<sup>‡</sup> ScD, Kirsten Eck  
Braden C. Fleming,<sup>||</sup> PhD, Benedikt L. Proffen,<sup>†</sup> MD, and Lyle J. Micheli,<sup>†</sup> MD



2016

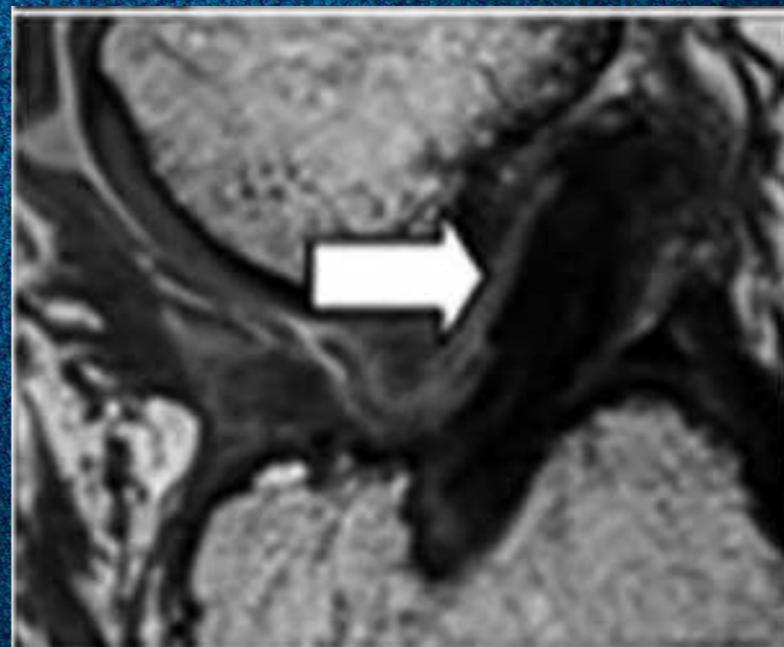
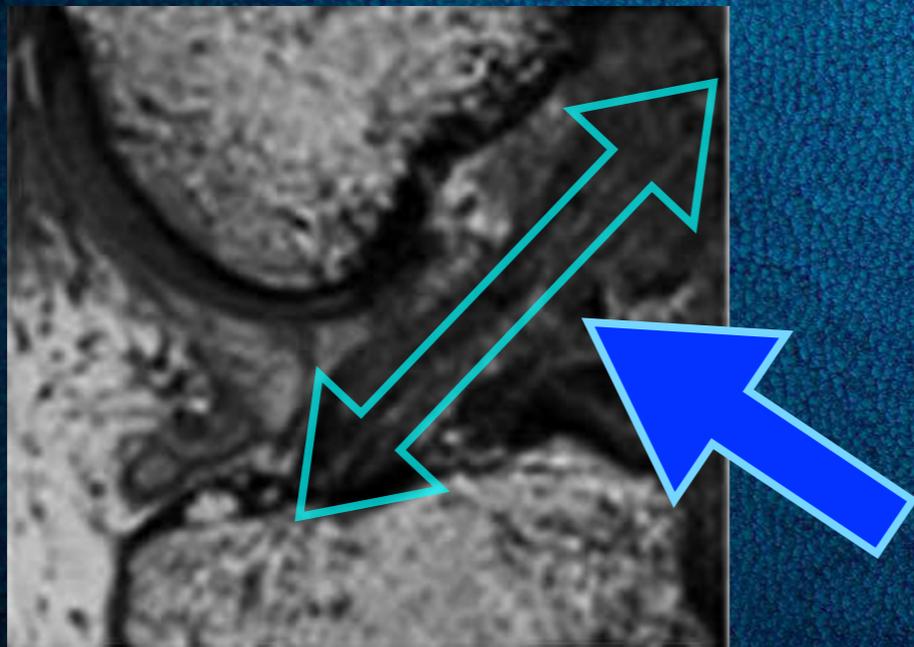
- **First phase human clinical study**
- **FDA approved IDE**
- **20 patients**
- **BEAR vs hamstring autograft ACLR**
- **Non-randomized**

# Selection Criteria

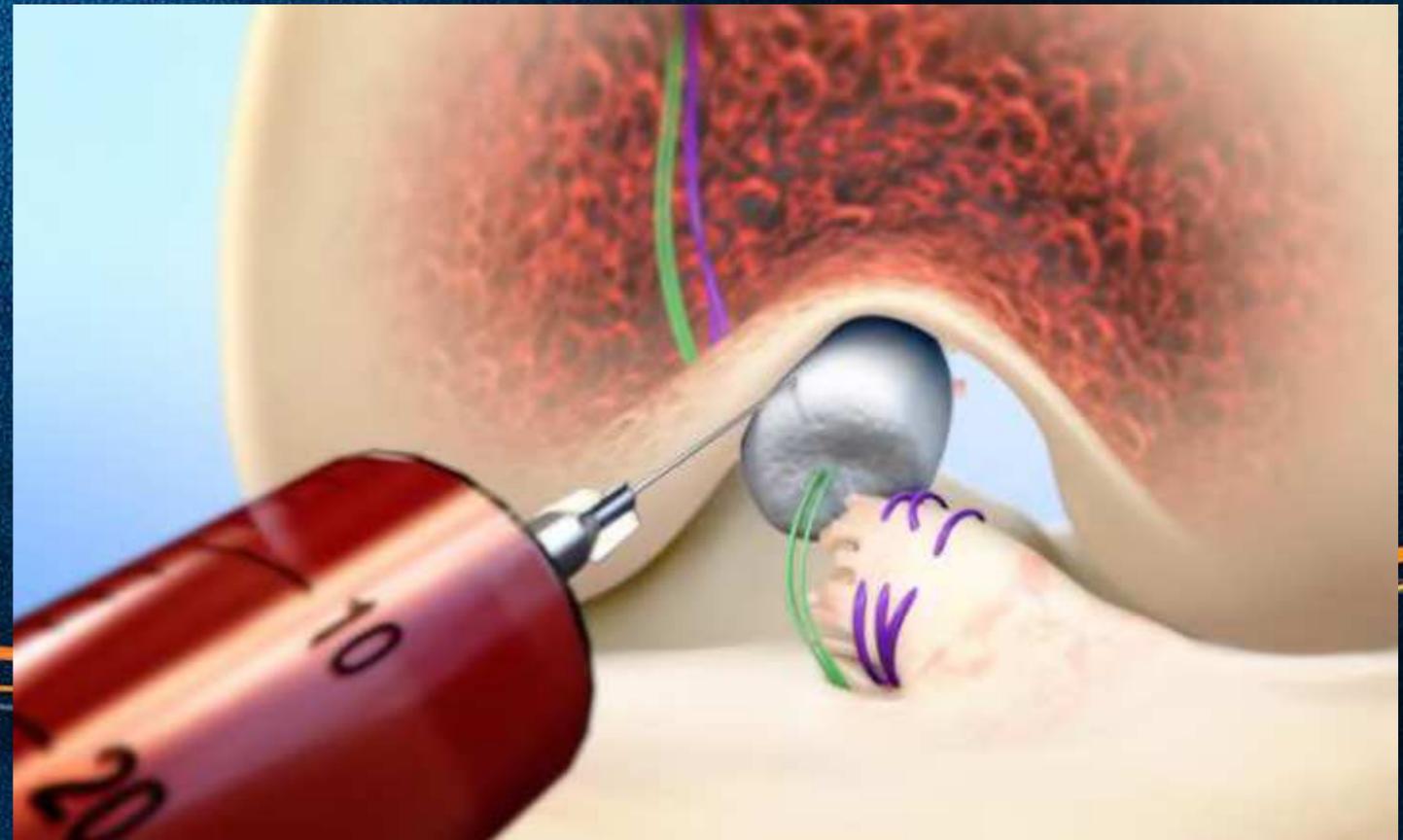
- **Ages 18-35**
- **Injury < 1 month prior to surgery**
- **Minimum 50% of ACL length attached to tibia**

# Results

- **3 month follow-up**
- **No Lachman test differences**
- **All constructs intact by MRI**



**Next steps...**



## 3rd question

**Can ACL repair minimize the development of arthritis?**

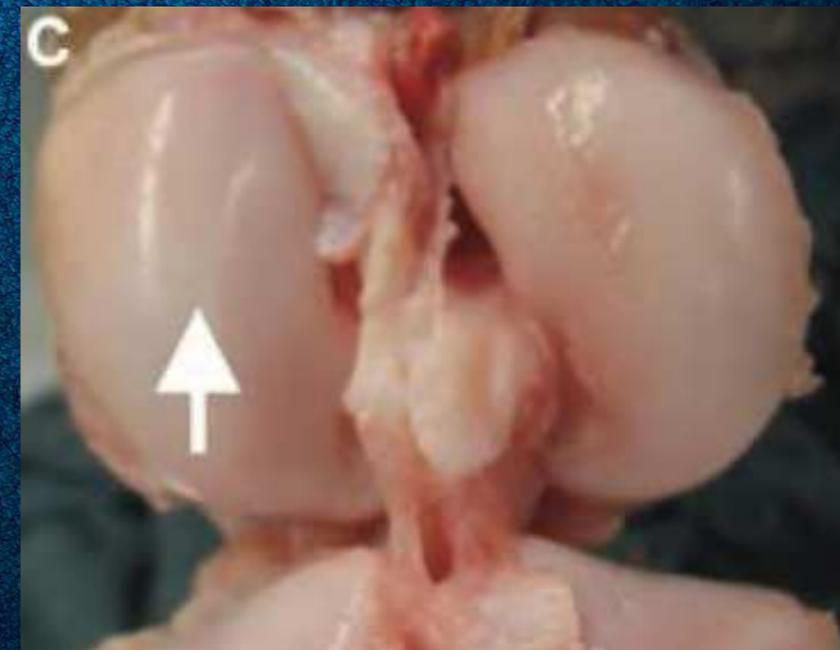
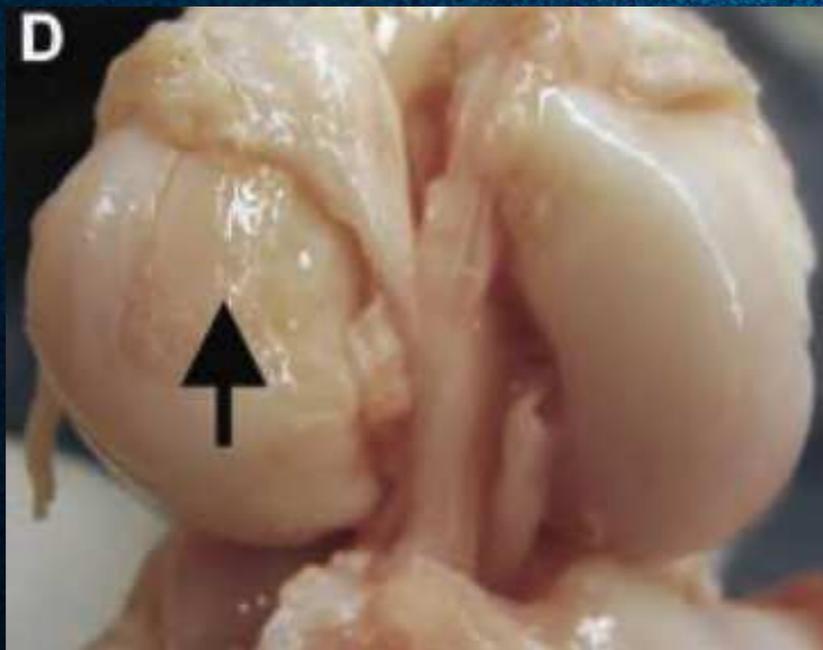
# Use of a Bioactive Scaffold to Stimulate Anterior Cruciate Ligament Healing Also Minimizes Posttraumatic Osteoarthritis After Surgery

Martha M. Murray,\* MD, and Braden C. Fleming,<sup>†‡§</sup> PhD



2013

- ACL repair vs reconstruction in pigs
- Less OA at 12 months with repair



**Oodles more work required for mid-substance ACL tears**

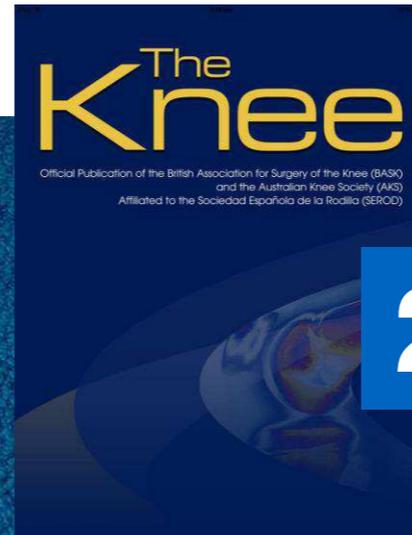
**but we don't have to wait for all ACL tears...**

# 4th question

**Can we improve upon the surgeries  
from the 1970s?**

# Role of tear location on outcomes of open primary repair of the anterior cruciate ligament: A systematic review of historical studies

Jelle P. van der List\*, Gregory S. DiFelice<sup>1</sup>



2017

- Review of old ACL repair studies
- Good results for proximal tears



**We know that the ACL can heal.**

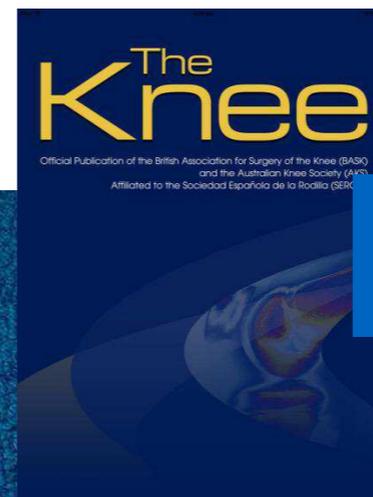
**But can we fix the proximal tears well?**

**Do we need a scaffold?**



# Gap formation following primary repair of the anterior cruciate ligament: A biomechanical evaluation

Jelle P. van der List\*, Gregory S. DiFelice



2017

- **Cadaveric biomechanics study**
- **Suture anchor vs button fixation**
- **1mm gap with cyclic loading (100 cycles)**
- **Max failure mean - 243 N**

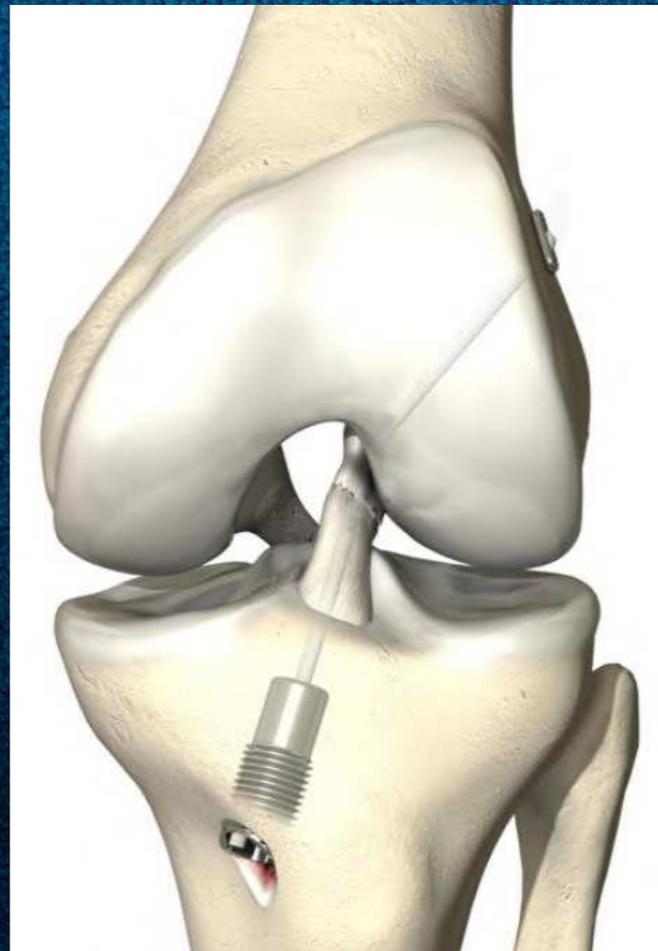
A novel technique, dynamic intraligamentary stabilization creates optimal conditions for primary ACL healing:  
A preliminary biomechanical study

Sandro Kohl<sup>a,b</sup>, Dimitrios S. Evangelopoulos<sup>a,c,\*</sup>, Sufian S. Ahmad<sup>a</sup>, Heindrik Kohlhof<sup>a</sup>, Gudrun Harald Bonel<sup>e</sup>, Stefan Eggli<sup>a</sup>

The  
**Knee**  
Official Publication of the British Association for Surgery of the Knee (BASK)  
and the Australian Knee Society (AKS)  
Affiliated to the Sociedad Española de la Rodilla (SEROD)

2014

**Addition of braided stabilizing stent to ACL repair approximated ACL stability with cyclic loading.**

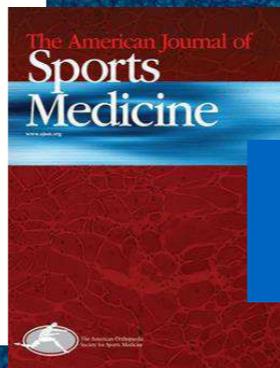


# Proximal ACL repair has been successful...

## Primary Repair Combined With Bone Marrow Stimulation in Acute Anterior Cruciate Ligament Lesions

Results in a Group of Athletes

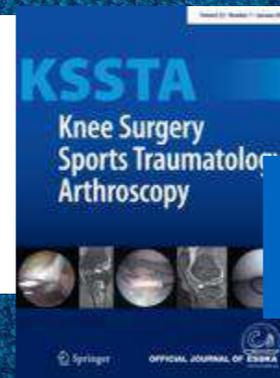
Alberto Gobbi,\* MD, Lyndon Bathan, MD, and Lorenzo Boldrini, MD



2009

## Late results following proximal reinsertion of isolated ruptured ACL ligaments

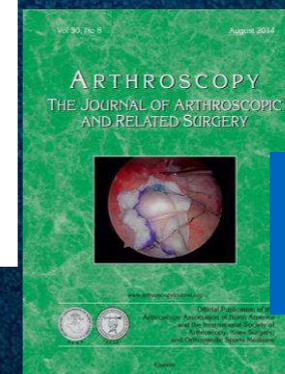
F. Genelin, A. Trost, C. Primavesi, P. Knoll



1993

## Anterior Cruciate Ligament Preservation: Early Results of a Novel Arthroscopic Technique for Suture Anchor Primary Anterior Cruciate Ligament Repair

Gregory S. DiFelice, M.D., Christine Villegas, M.B.S., and Samuel Taylor, M.D.



2015

# Why can current ACL repair outperform 1970s repairs?

- **Selection of only proximal tears**
- **Arthroscopic procedure**
- **Modern & more secure fixation**
- **No cast immobilization**
- **Modern rehab principles**

# What is the prevalence of proximal ACL tears?

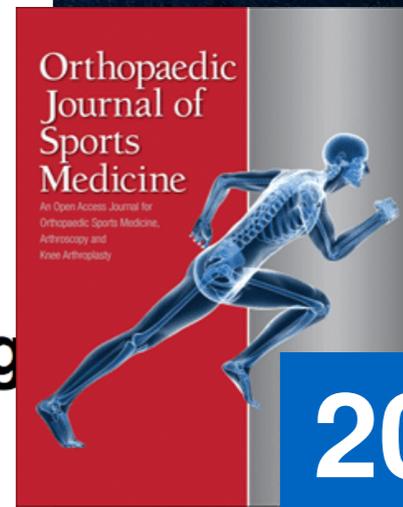


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NE

# The Location of Anterior Cruciate Ligament Tears

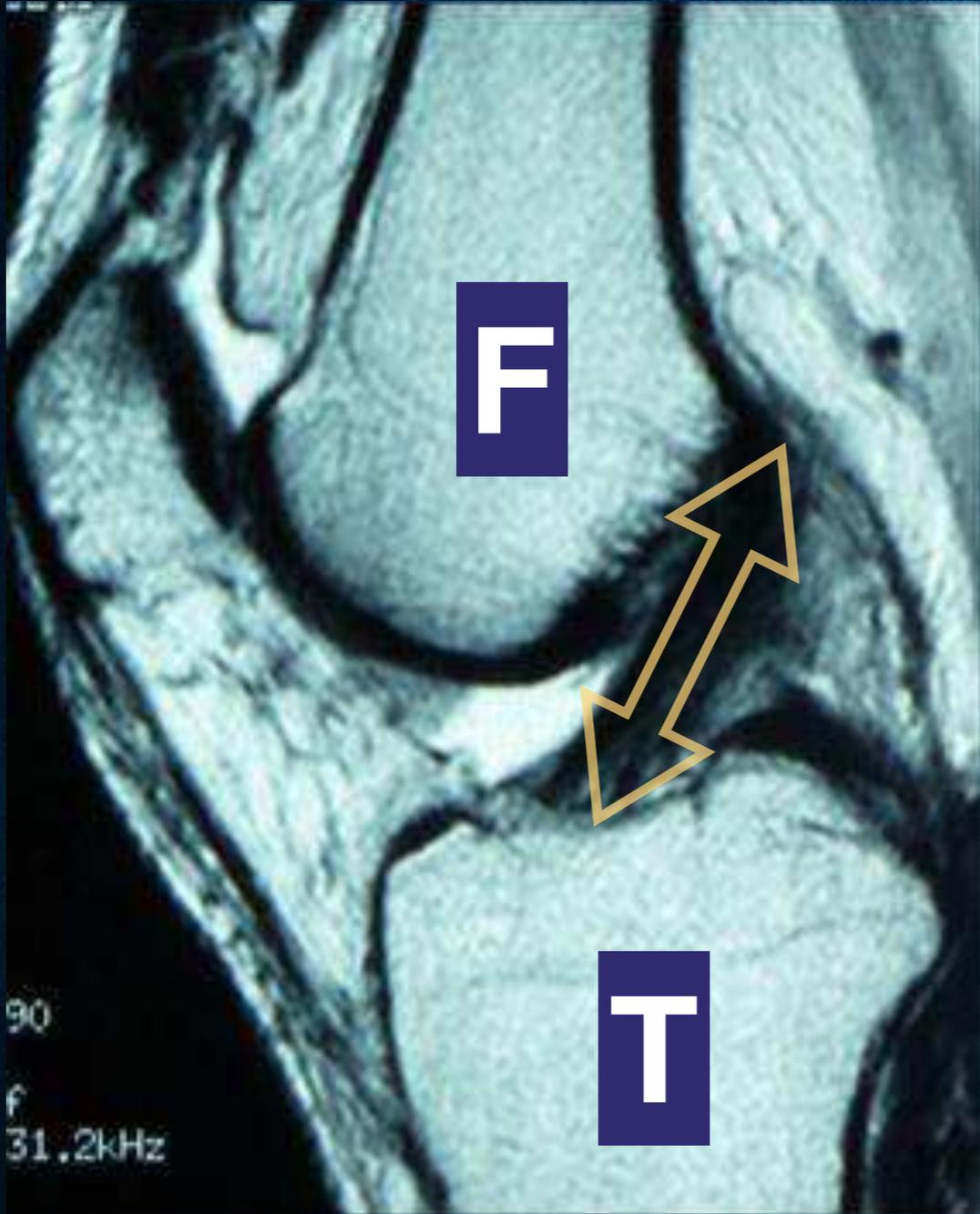
## A Prevalence Study Using Magnetic Resonance Imaging

Jelle P. van der List,<sup>\*†</sup> MD, Douglas N. Mintz,<sup>‡</sup> MD, and Gregory S. DiFelice,<sup>†</sup> MD



- Proximal tears - Type 1
- Distal remnant  $> 90\%$  total length
- 16%

**Age  $< 35$  - 8%**



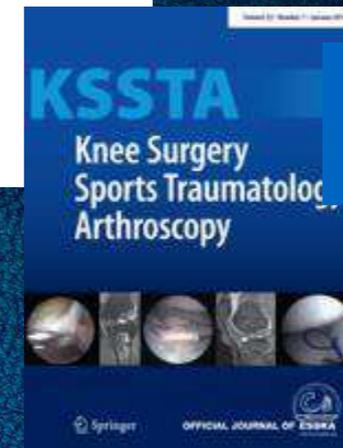


n we identify the proximal tears pre-o



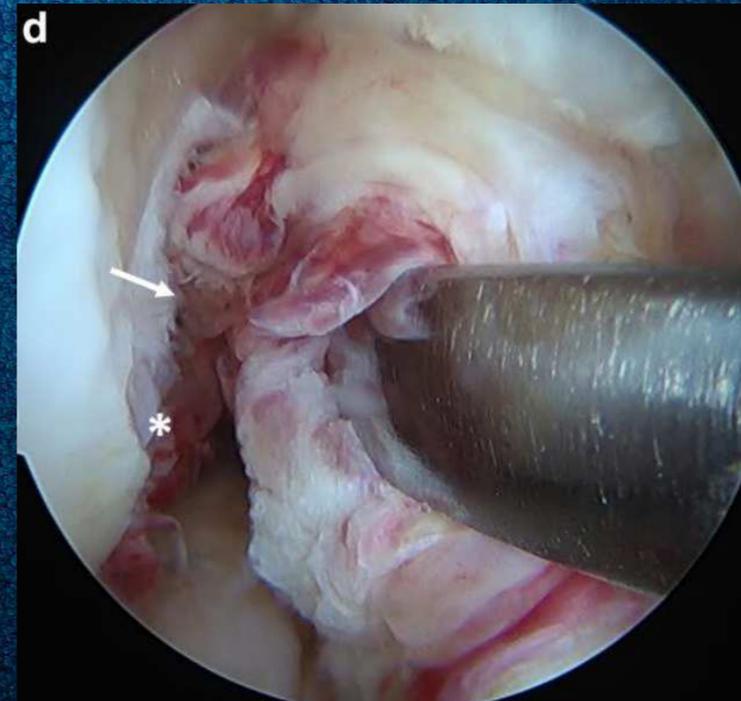
# Preoperative magnetic resonance imaging predicts eligibility for arthroscopic primary anterior cruciate ligament repair

Jelle P. van der List<sup>1</sup> · Gregory S. DiFelice<sup>1</sup>



2017

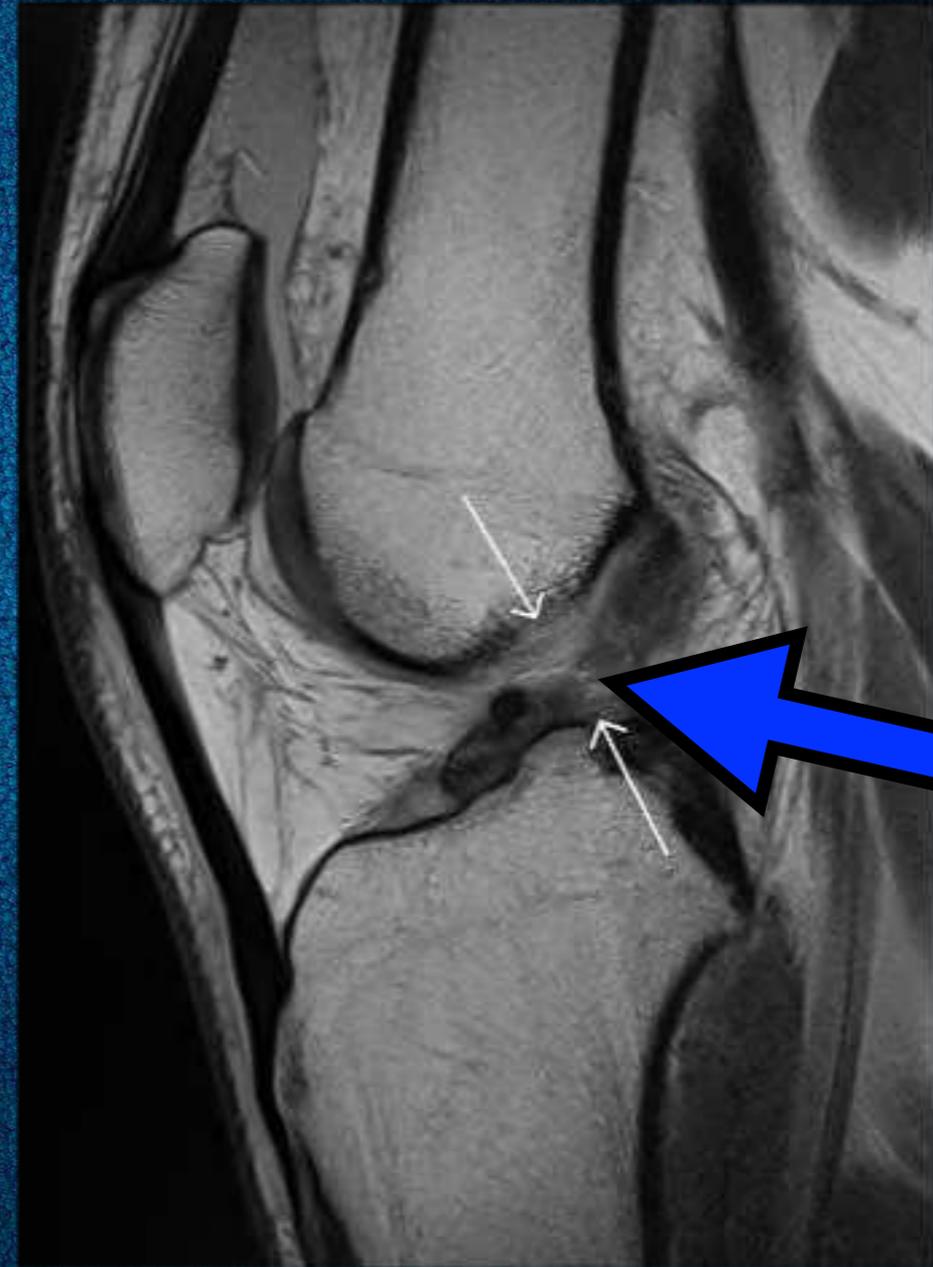
## Repairability predicted for 90% type 1 tears



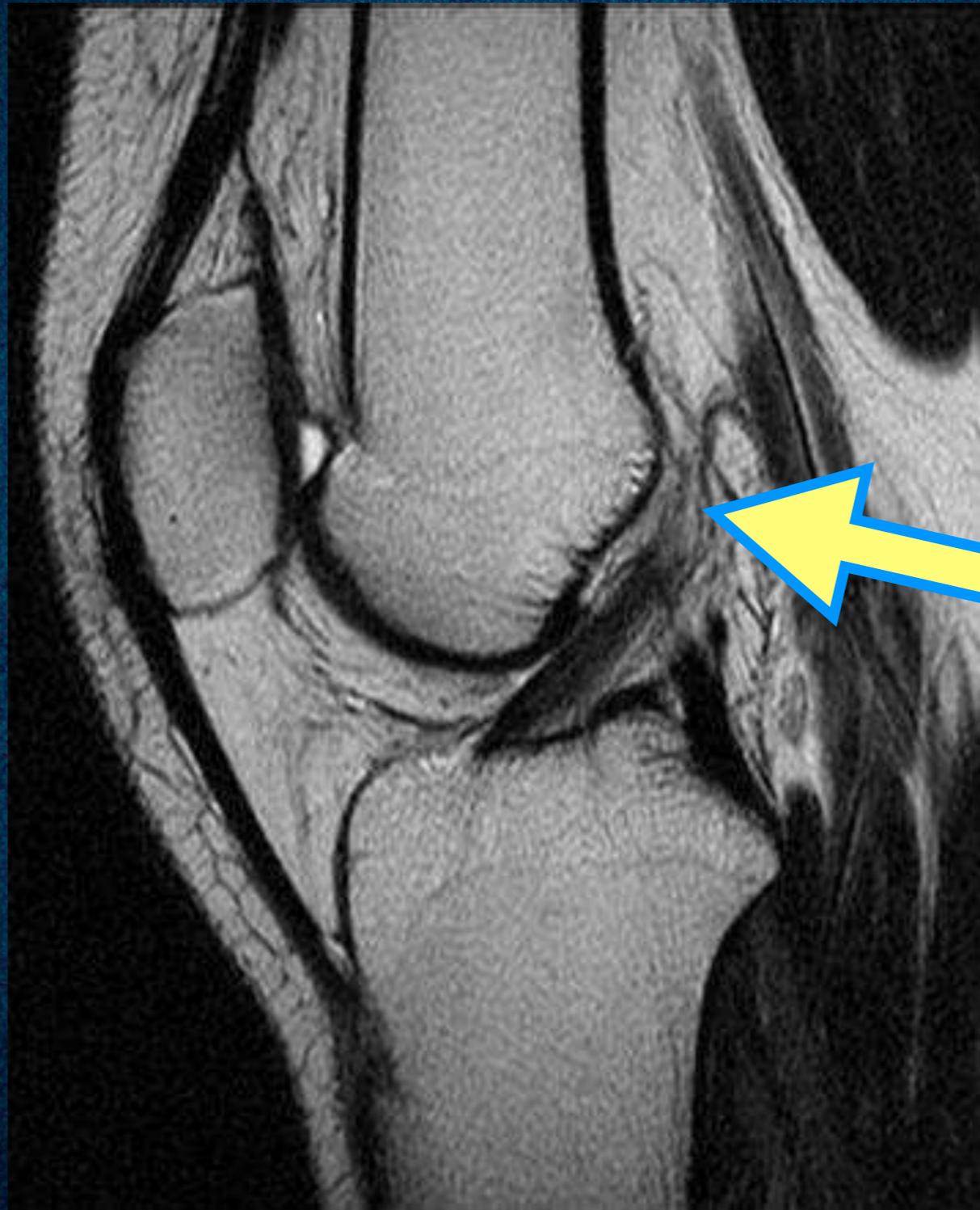
# Indications for ACL Repair

- **ACL avulsion from femur**
- **Quality ACL tissue**
- **The more recent... the better**

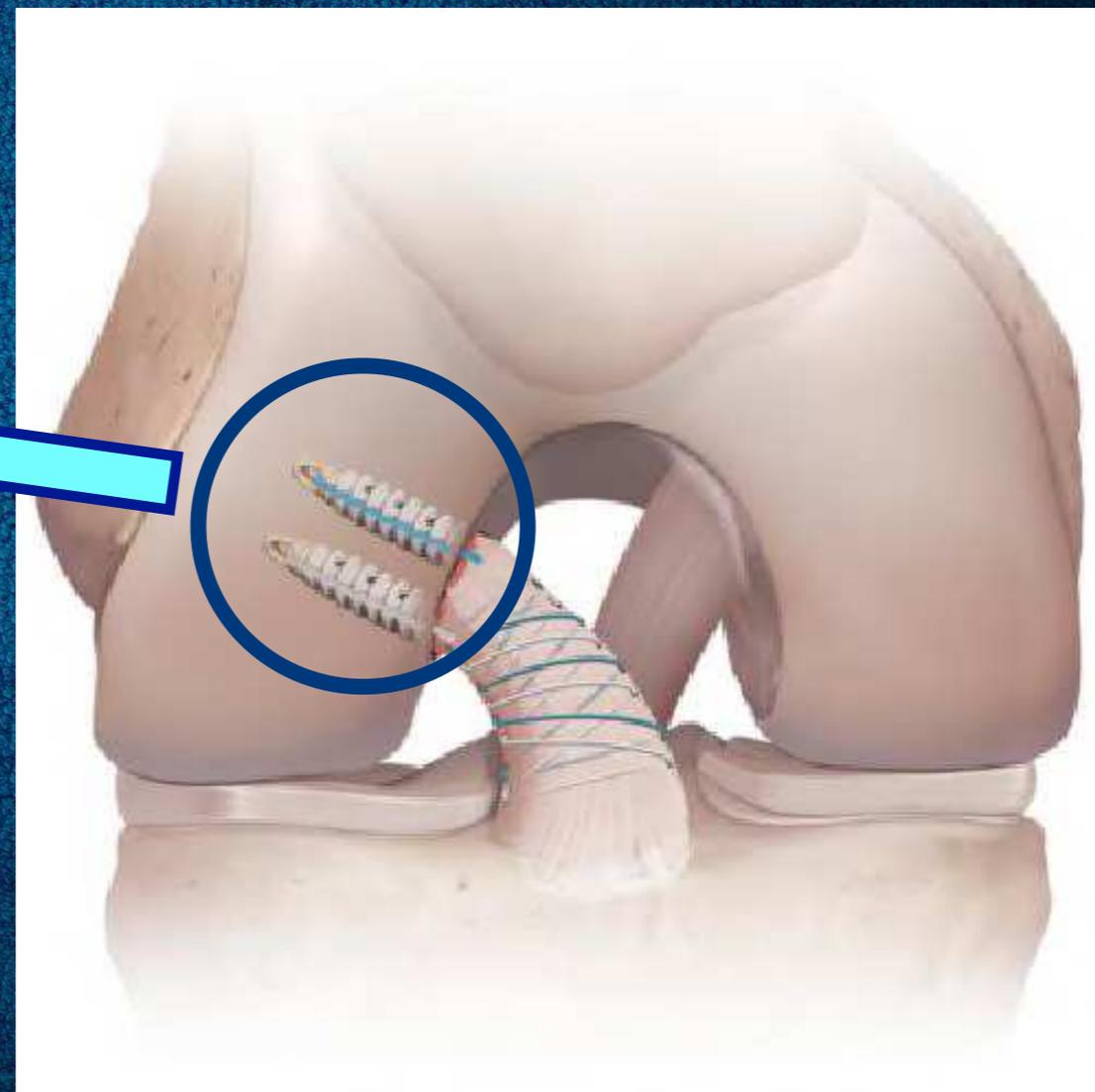
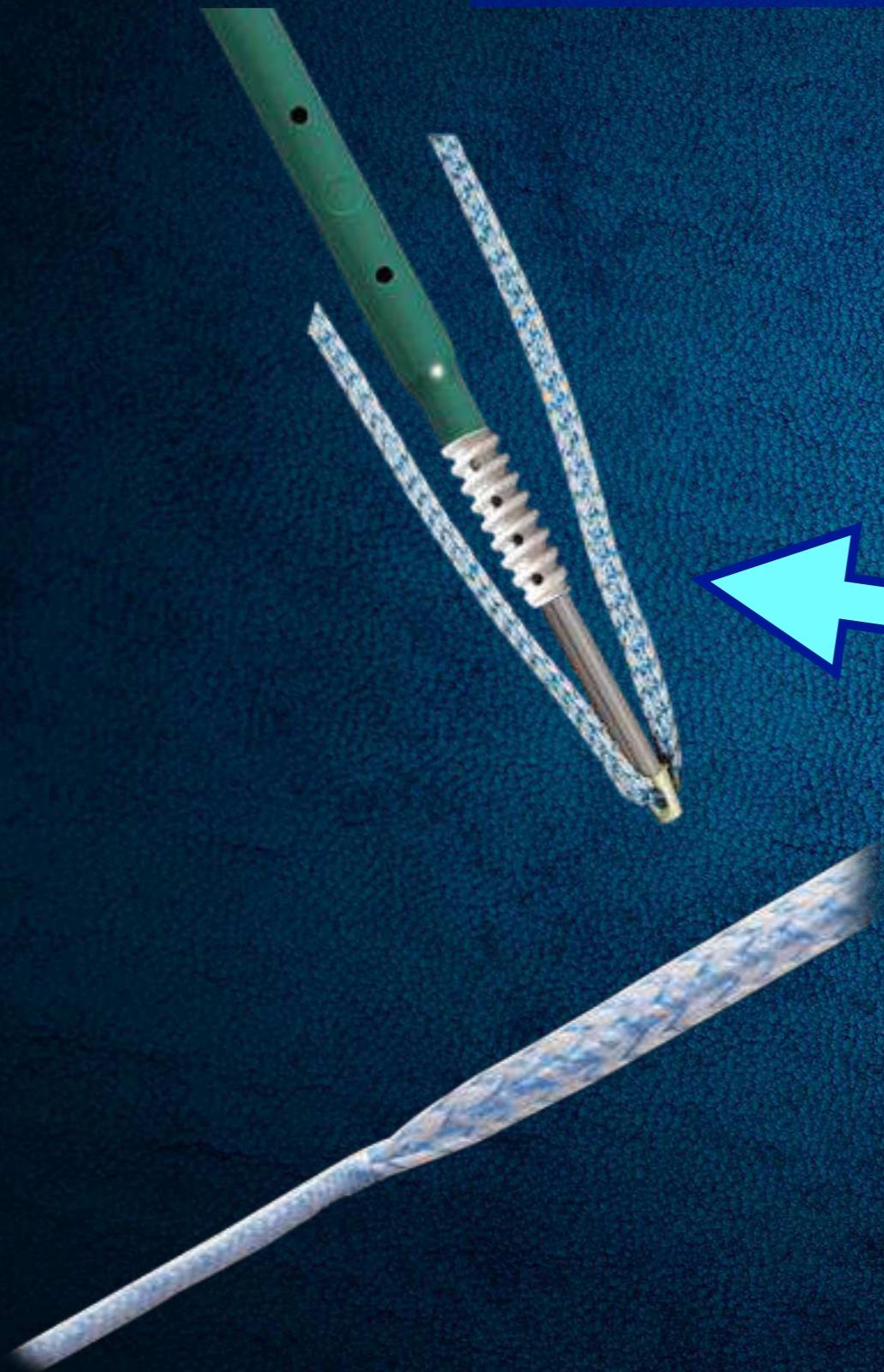
Not good...







# How it's done...



# **Arthroscopic ACL Repair**

*Randy Schwartzberg, M.D.*

# Rehab - Same as ACL reconstruction



# Rationale

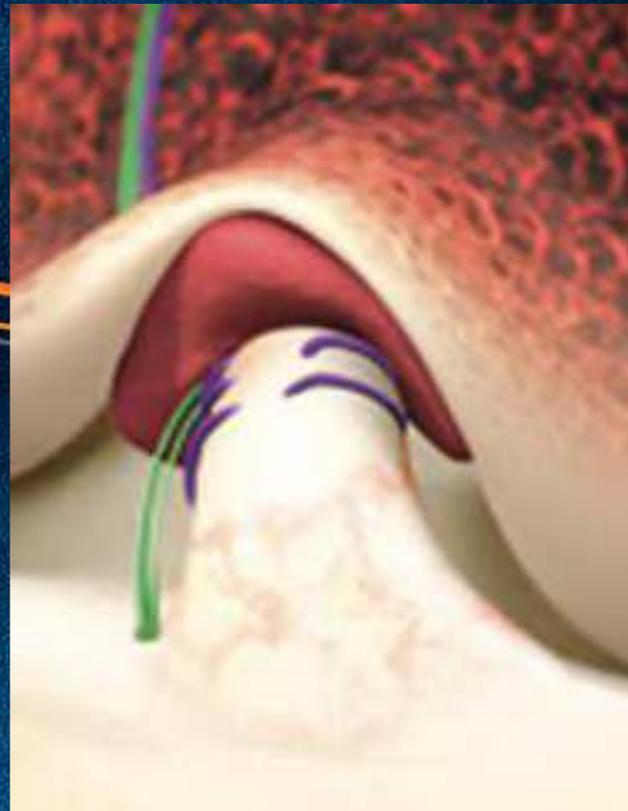
- **Strong/stiff suture tape fixation**
- **Significant ACL healing within 2 weeks**
- **Optimized ACL healing by 3 months**

# Summary



**ACL tears do have the capacity to heal**

**Mid-substance tears need help from  
a scaffold**

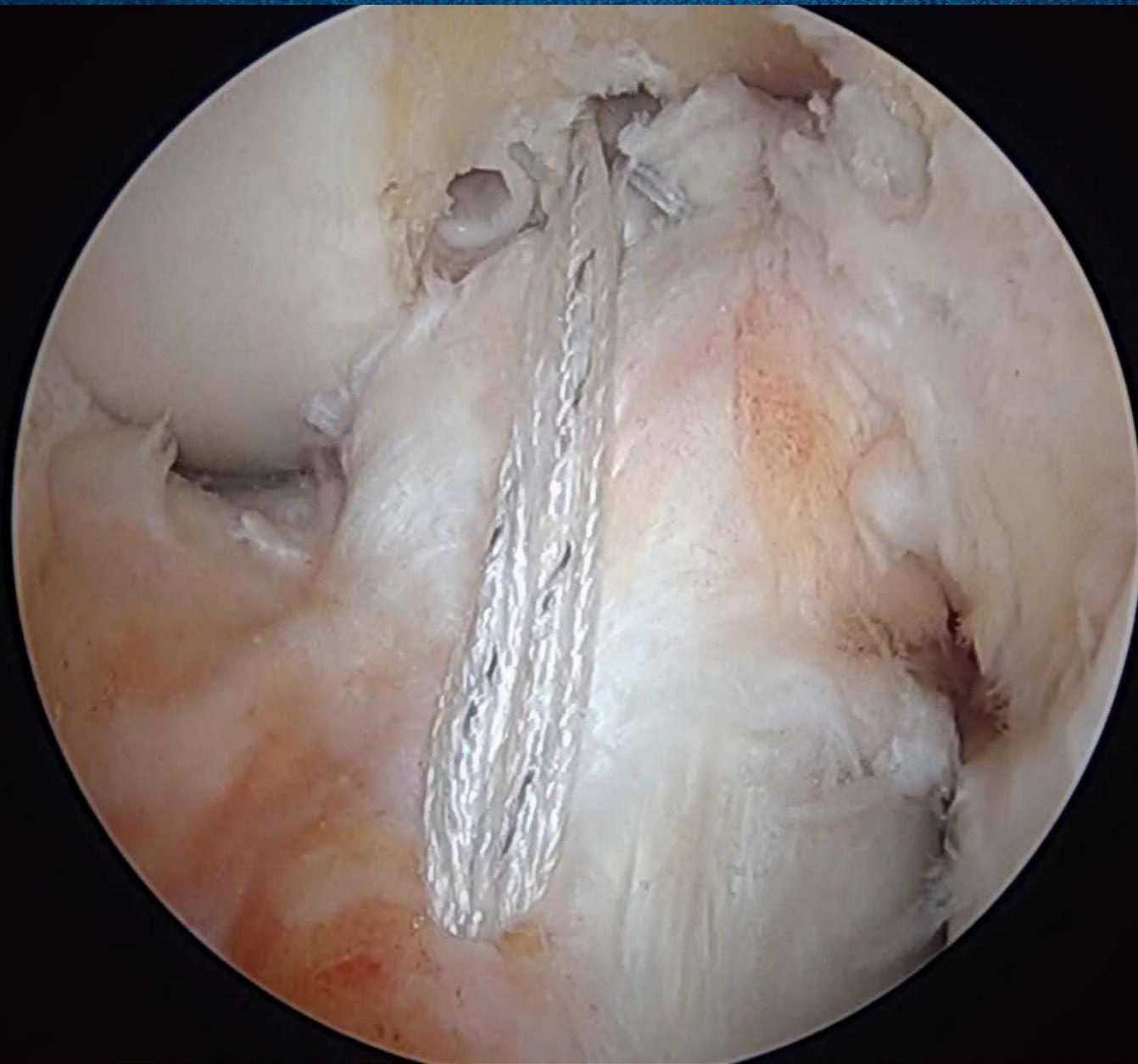


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**Repair (BEAR) is a promising start to ACL repair**



**Proximal ACL tears can be successfully repaired now!**



**Thank You**

