# A novel "Bracing Protocol” to manage Acute ACL injury


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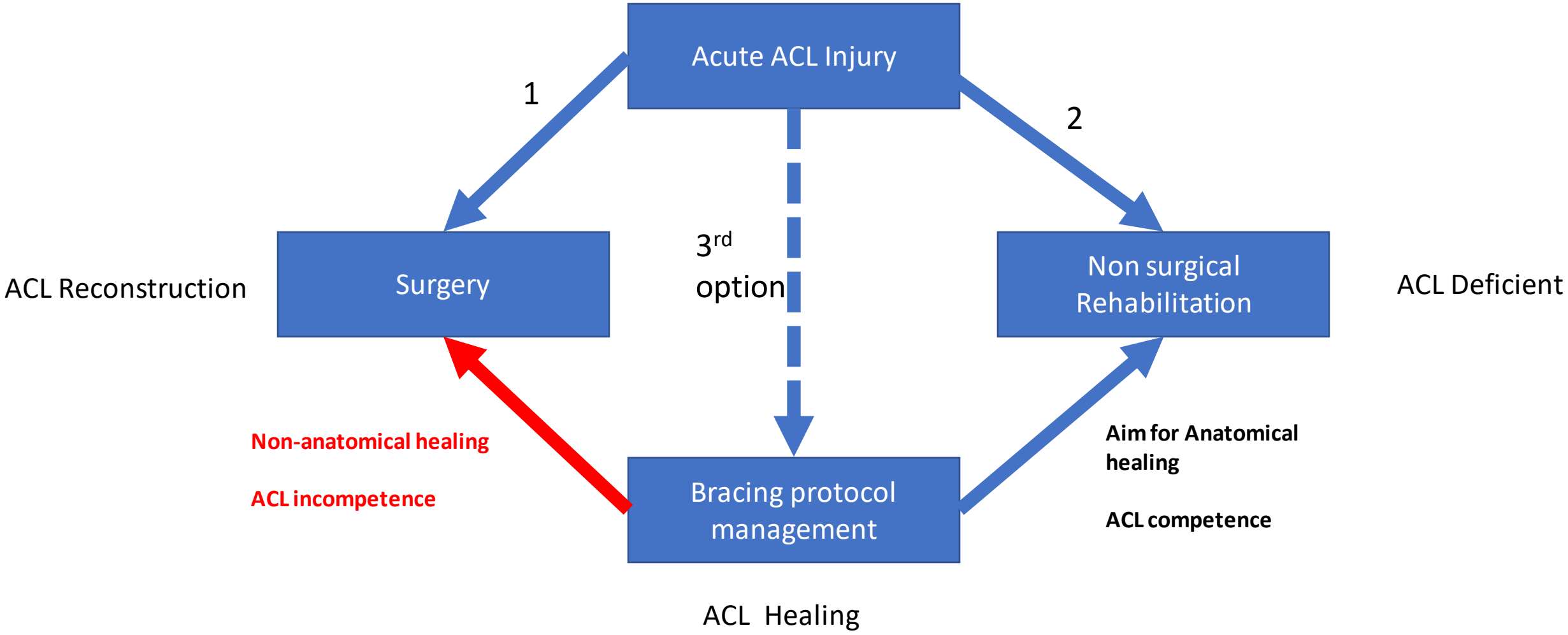
# Options for patient after Acute ACL injury?

# Options for patient after Acute ACL injury




# Bracing the ACL injured knee at 90 degrees

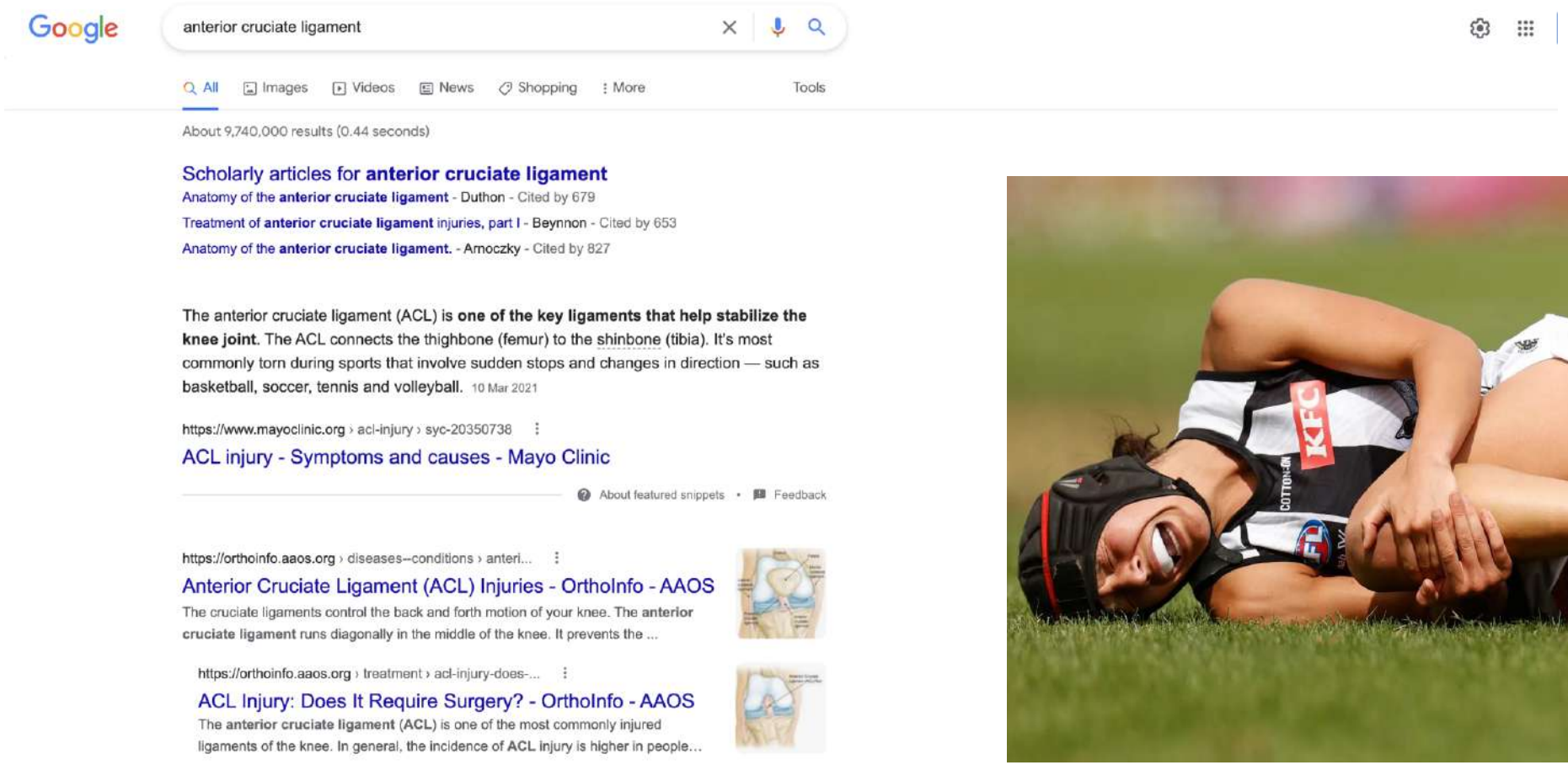
# Can the ACL heal? What does the internet say?

Can a completely torn ACL heal on its own?

The **ACL** doesn't **heal on its own**, but physical therapy **can** strengthen the muscles around the knee enough so they compensate for the nonworking **ACL**. A custom-made knee brace may also be useful for tennis, soccer, or other activities that involve twisting if the person plays occasionally.

But full **ACL tears** cannot be **healed without surgery**. If your activities do not involve making pivoting movements on the knee, physical therapy rehabilitation may be all you need. Special exercises may help train the musculature around the knee to compensate for the **torn ACL** and stabilize the joint. 18 Sept 2019

# Google ACL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anterior cruciate ligament
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Scholarly articles for anterior cruciate ligament
Anatomy of the anterior cruciate ligament - Duthon - Cited by 679
Treatment of anterior cruciate ligament injuries, part I - Beynnon - Cited by 653
Anatomy of the anterior cruciate ligament. - Arnoczky - Cited by 827
The anterior cruciate ligament (ACL) is one of the key ligaments that help stabilize the knee joint. The ACL connects the thighbone (femur) to the shinbone (tibia). It's most commonly torn during sports that involve sudden stops and changes in direction — such as basketball, soccer, tennis and volleyball. 10 Mar 2021
https://www.mayoclinic.org › acl-injury › syc-20350738
ACL injury - Symptoms and causes - Mayo Clinic
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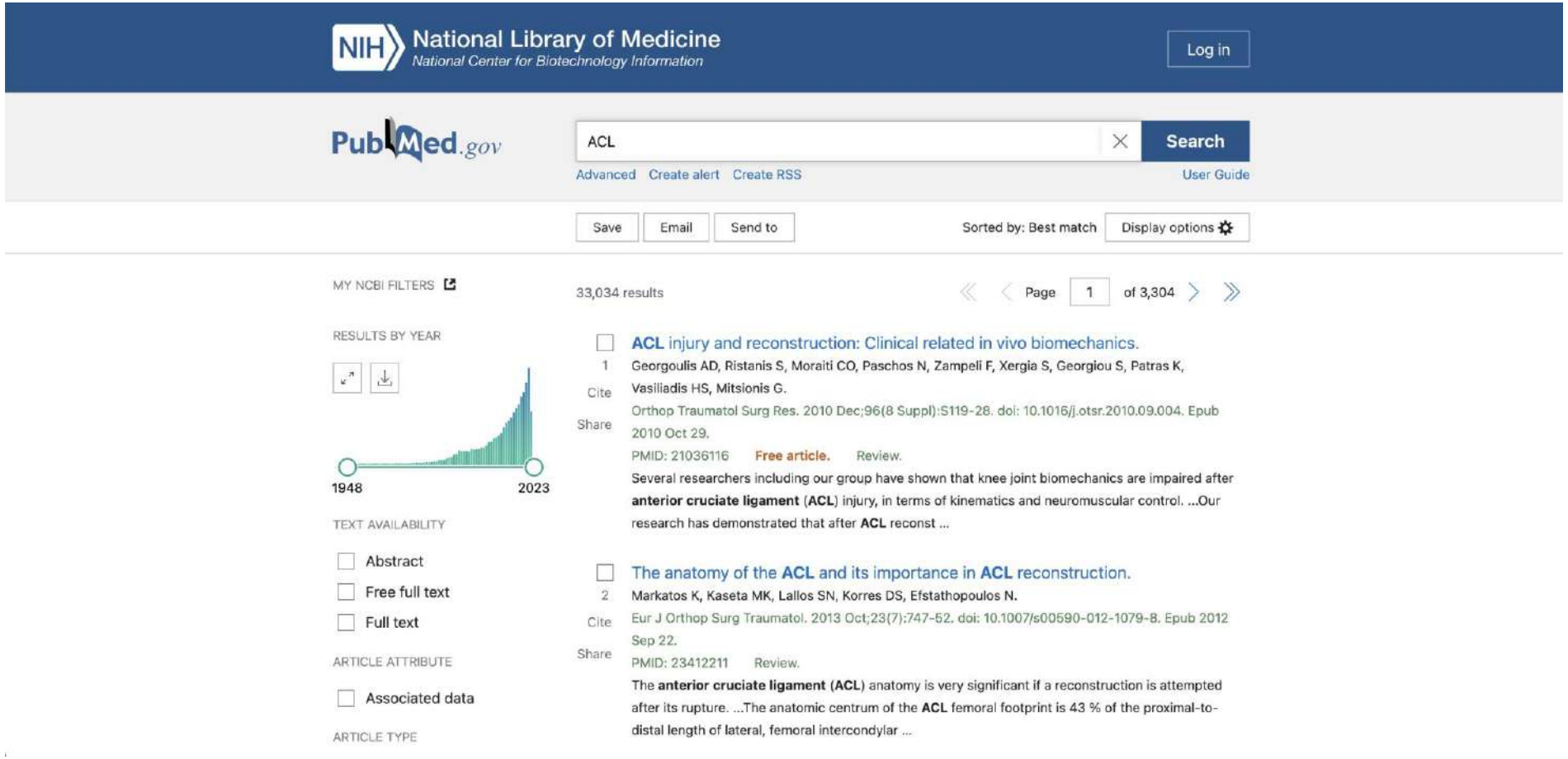
Anterior Cruciate Ligament (ACL) Injuries - OrthoInfo - AAOS
The cruciate ligaments control the back and forth motion of your knee. The anterior cruciate ligament runs diagonally in the middle of the knee. It prevents the ...
https://orthoinfo.aaos.org › treatment › acl-injury-does-...
ACL Injury: Does It Require Surgery? - OrthoInfo - AAOS
The anterior cruciate ligament (ACL) is one of the most commonly injured ligaments of the knee. In general, the incidence of ACL injury is higher in people...


KFC

# Pub Med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TEXT AVAILABILITY
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Associated data
ARTICLE TYPE
1
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ACL injury and reconstruction: Clinical related in vivo biomechanics.
Georgoulis AD, Ristanis S, Moraiti CO, Paschos N, Zampeli F, Xergia S, Georgiou S, Patras K, Vasiliadis HS, Mitsionis G.
Orthop Traumatol Surg Res. 2010 Dec;96(8 Suppl):S119-28. doi: 10.1016/j.otsr.2010.09.004. Epub 2010 Oct 29.
PMID: 21036116 Free article. Review.
Several researchers including our group have shown that knee joint biomechanics are impaired after anterior cruciate ligament (ACL) injury, in terms of kinematics and neuromuscular control. ...Our research has demonstrated that after ACL reconst ...
2
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The anatomy of the ACL and its importance in ACL reconstruction.
Markatos K, Kaseta MK, Lallos SN, Korres DS, Efstathopoulos N.
Eur J Orthop Surg Traumatol. 2013 Oct;23(7):747-52. doi: 10.1007/s00590-012-1079-8. Epub 2012 Sep 22.
PMID: 23412211 Review.
The anterior cruciate ligament (ACL) anatomy is very significant if a reconstruction is attempted after its rupture. ...The anatomic centrum of the ACL femoral footprint is 43 % of the proximal-to-distal length of lateral, femoral intercondylar ...

# ? Spontaneous healing of the ACL

Is this possible?

No surgery

No Brace

The ENIGMA of Spontaneous Healing of the ACL

# Prehistoric theory of “ACL spontaneous healing”

**Pain, bleeding, knee flexed, no ice, no anti-inflammatories, no drainage of the knee + no crutches = the ACL has an opportunity to spontaneously heal**

# Modern Day management?

# Some examples of “Spontaneous healing”

# 25-year-old male professional Rugby player

# 21-year-old female skier

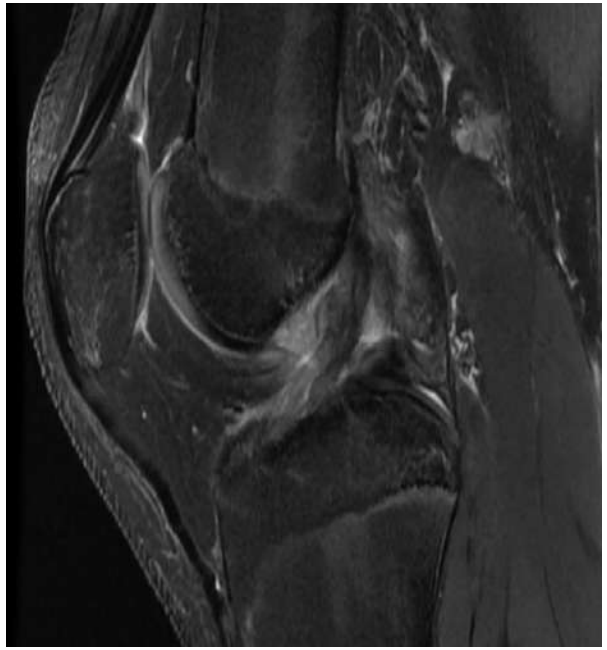
# Spontaneous healing: the literature

- Several Publications
    - Costa-Paz et al : 2012
    - Pitsillides et al: 2021
    - Razi et al: 2021 (combined MCL/ACL)
- Mater Clinic experience: 2014: Armstrong et al
    - 1000 ACLs
    - 21 spontaneous healing
    - 19/21 were combined ACL/MCL

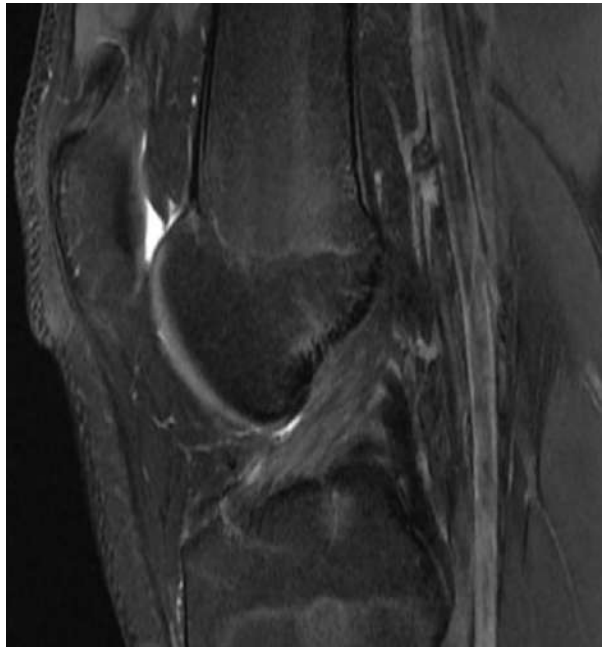
# Some examples of the ACL-heal project

# 16-year-old male rugby player

acute



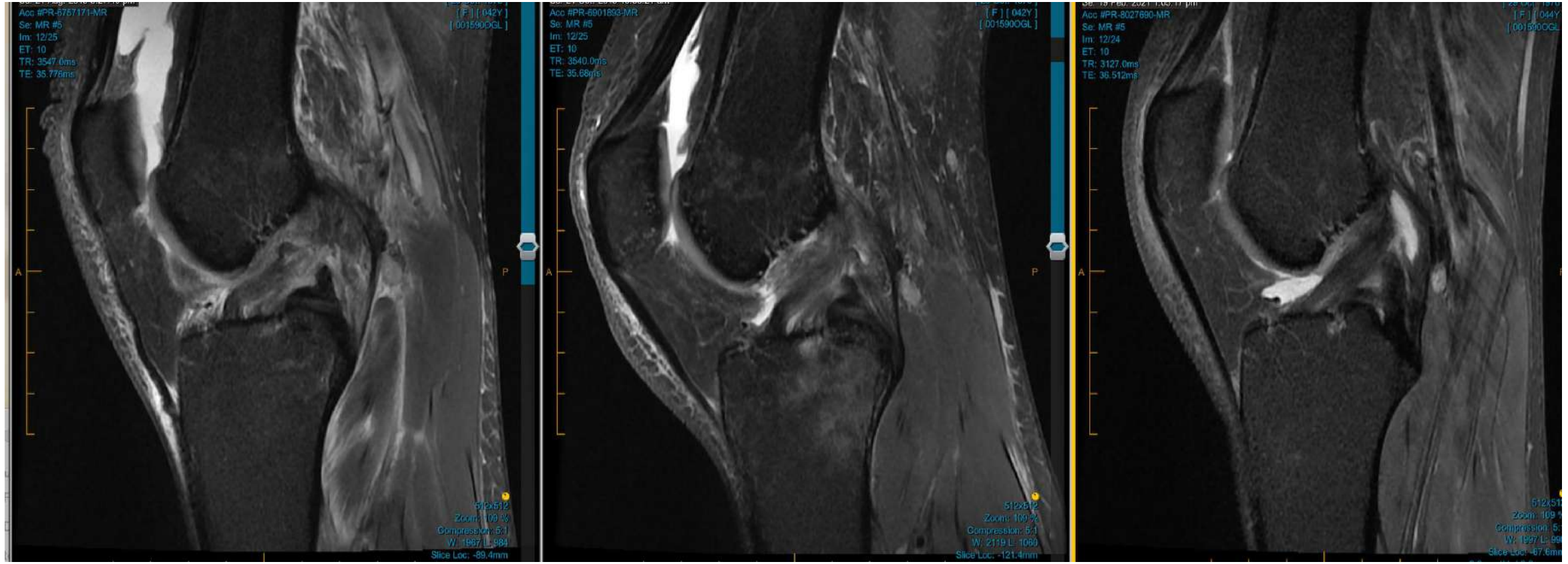
9 weeks



6 months

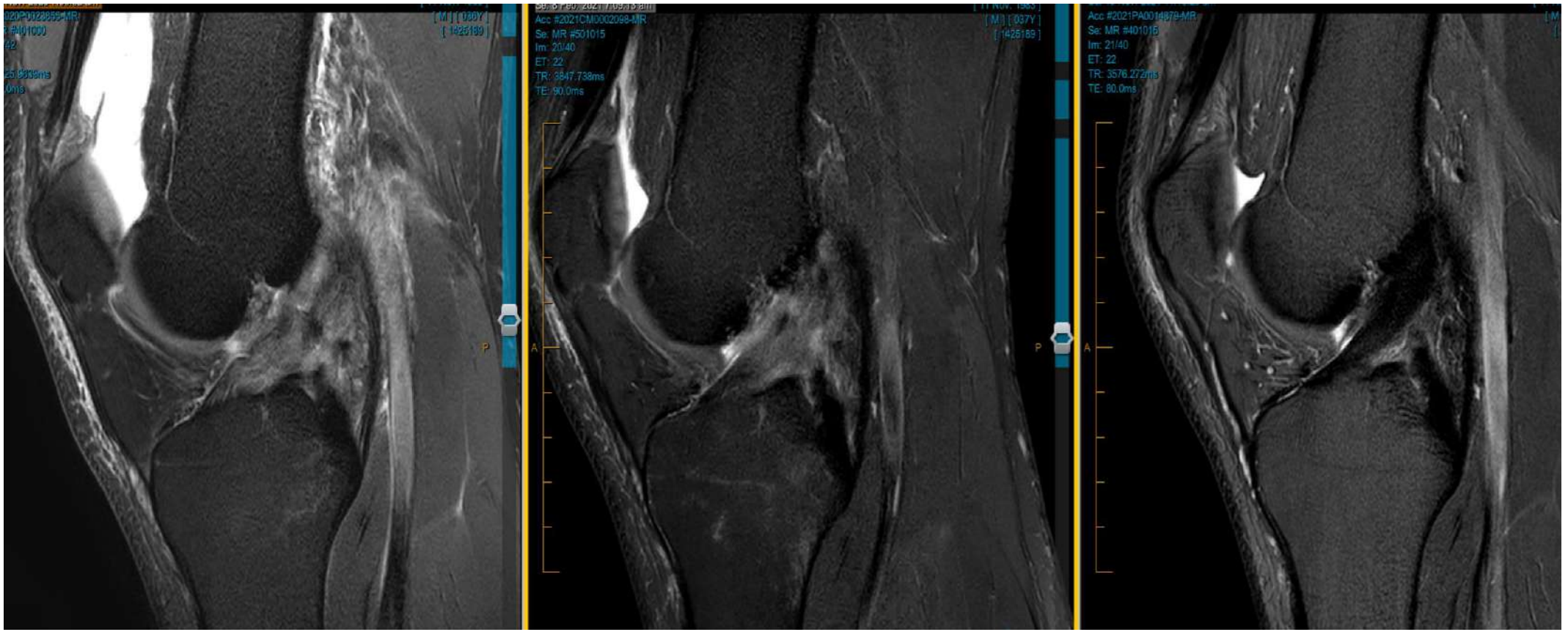
9 months

# 42-year-old female skier



# 48-year-old female netballer

# 37-year-old male soccer player



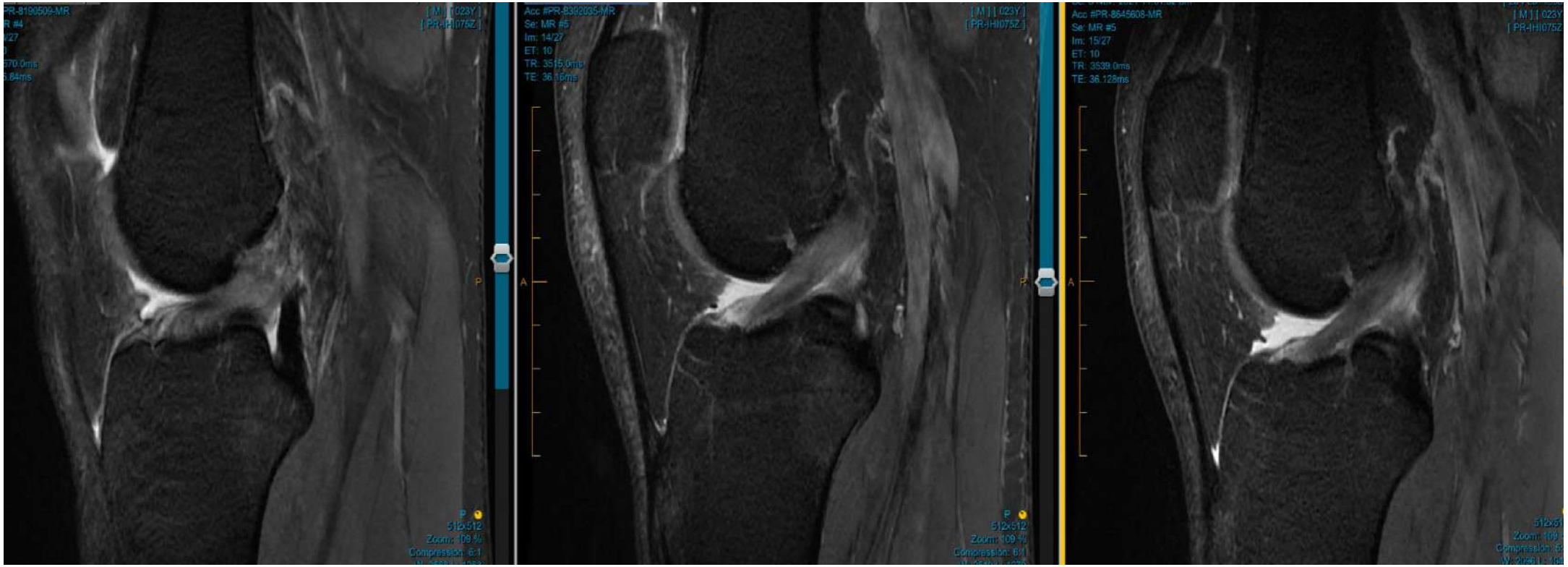
# 17-year-old male Rugby player

# 17-year-old female rugby player

# 28-year-old female AFL

# 27-year-old female netballer

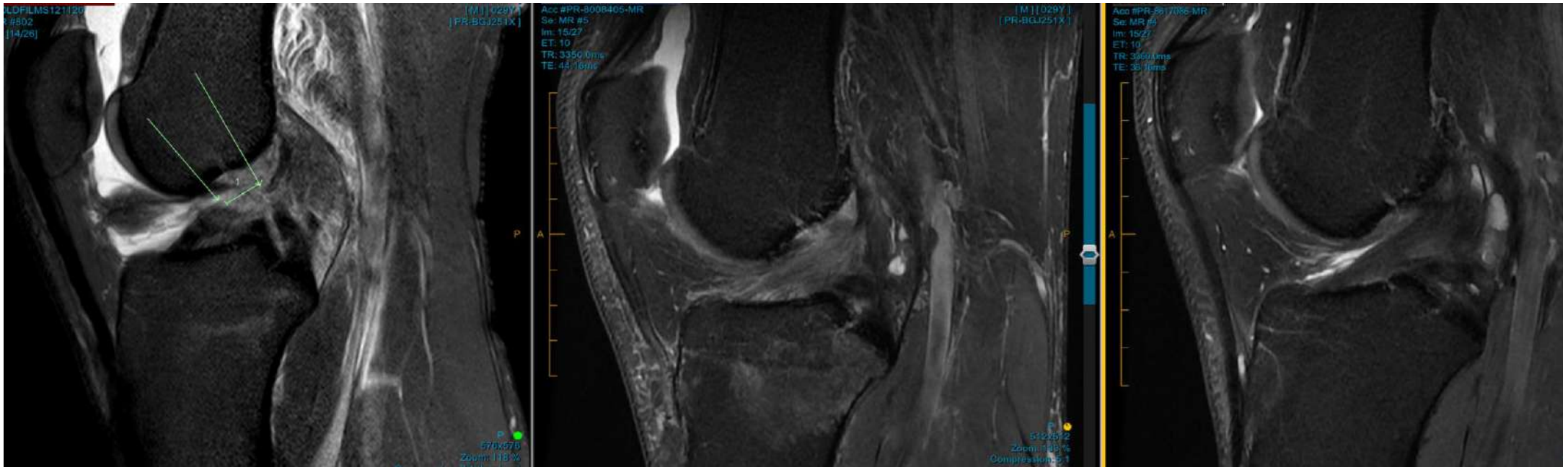
# 23-year-old male Ultimate Frisbee player



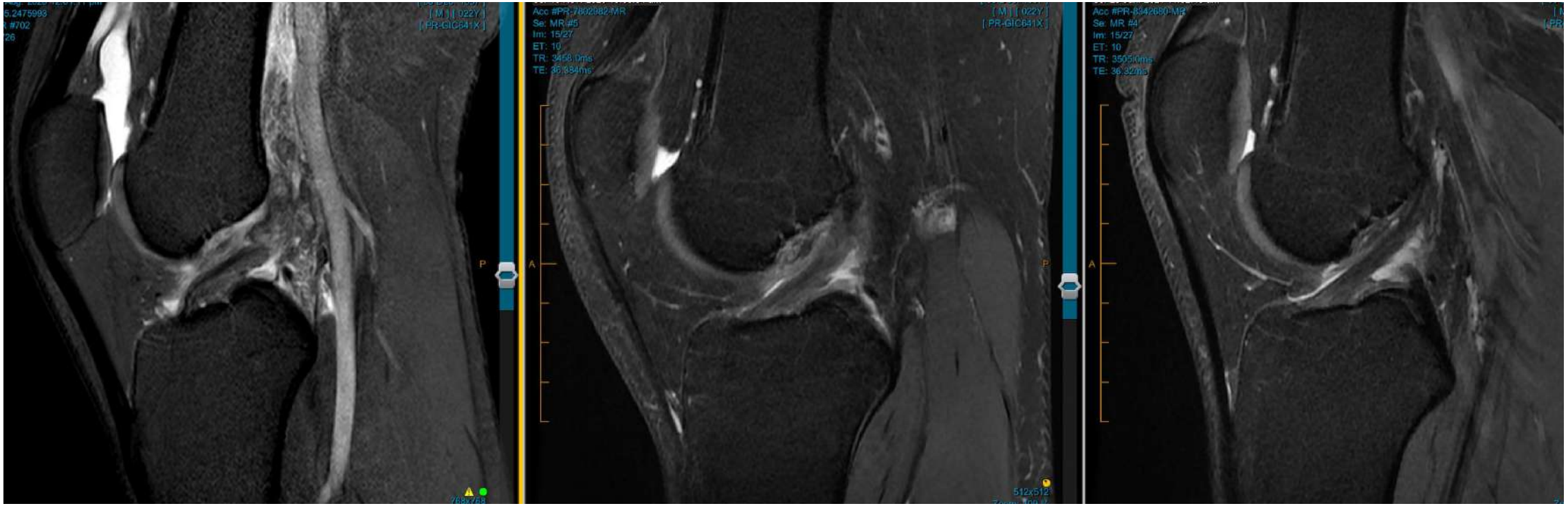
# 25-year-old male soccer

# 43-year-old female skier

# 29-year-old male martial arts



# 22-year-old male AFL



# How did it all start??

- April 2014
- 19-year-old netballer
- Terrified of ACLR surgery

# Dr. Mervyn Cross OAM.MD.MBBS.FRACS

# Patient 1. 19 yr. old female: 2014 intrasubstance proximal ACL disruption

acute

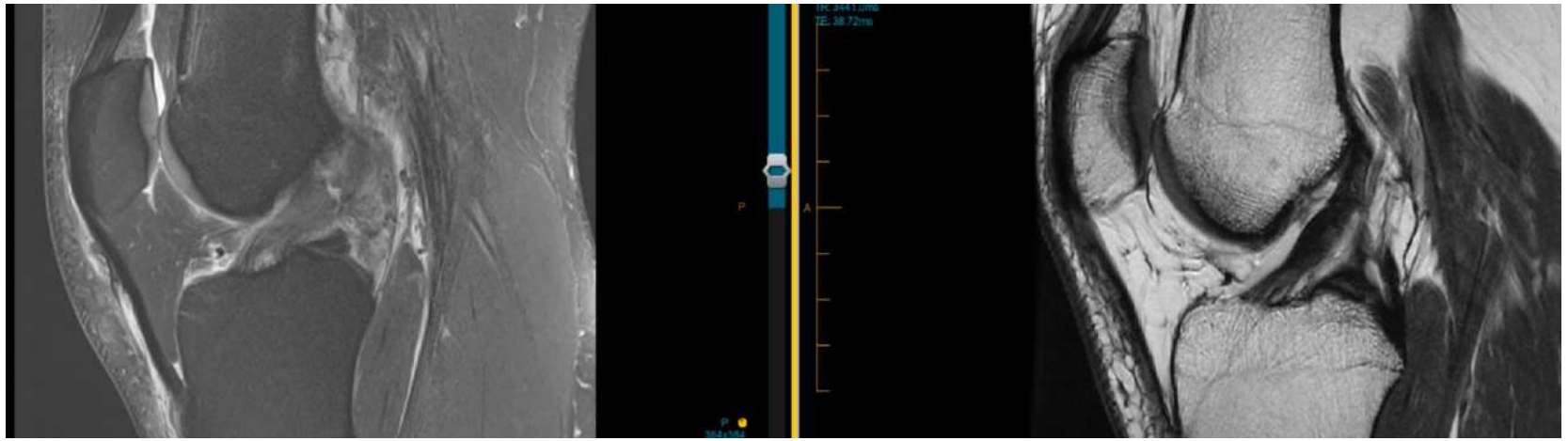

6 months

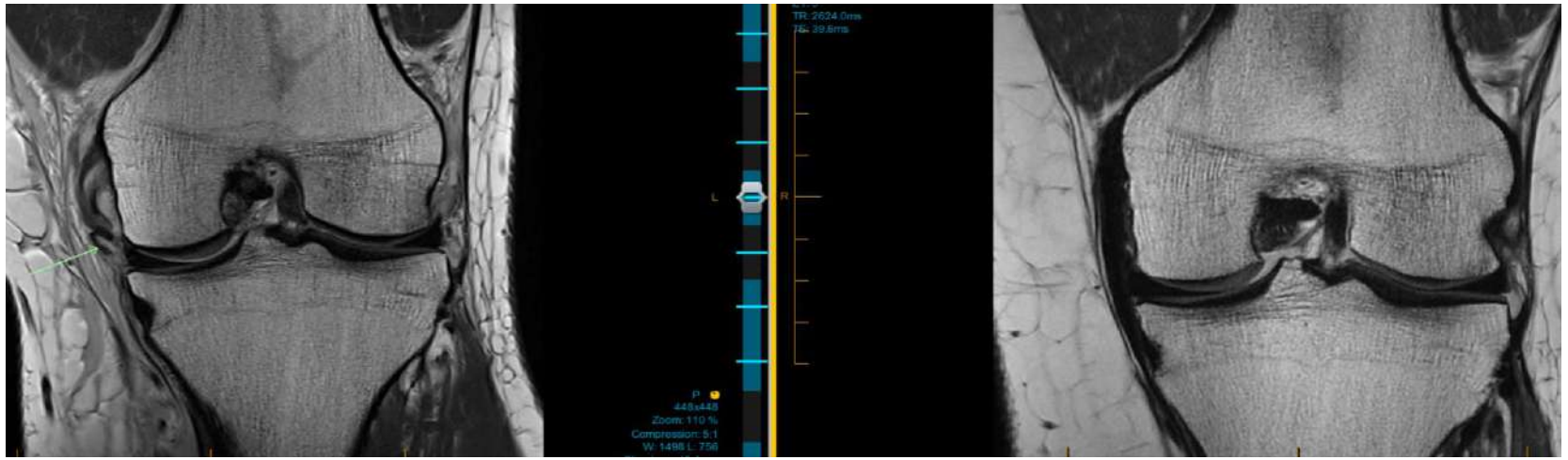
# Patient # 1: Brace fixed at 90 degrees for 4 weeks and then extend over next 4 weeks



# Patient 2: March 2016
# 26-year-old Rugby

# Patient 2 :ACL/MCL

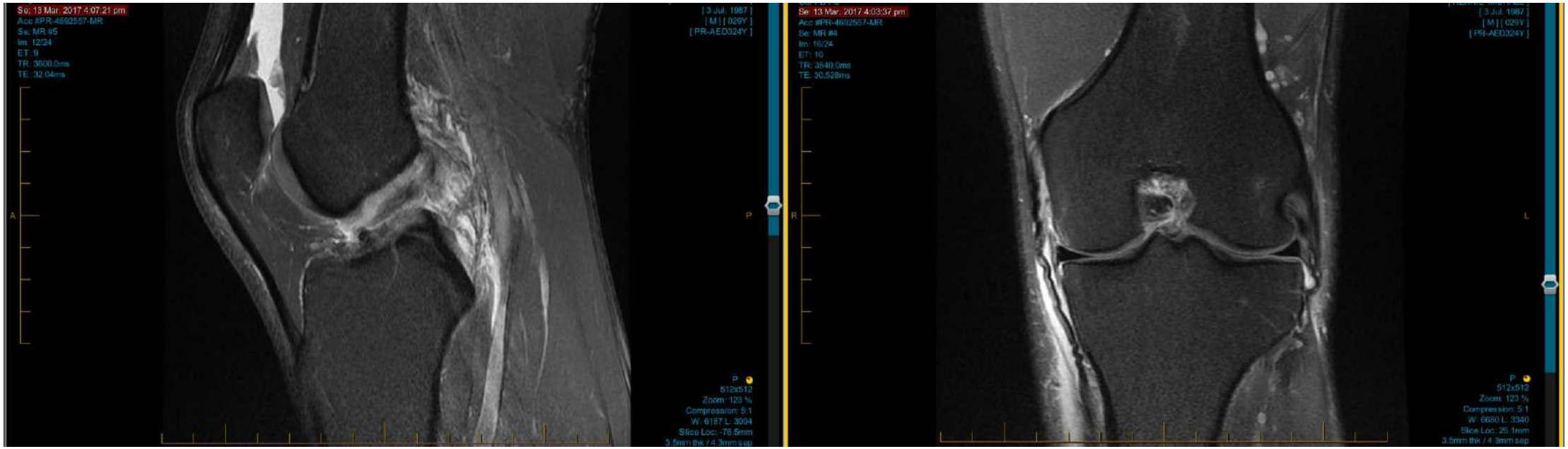




# Patient #2: 9 months post ACL/MCL injury

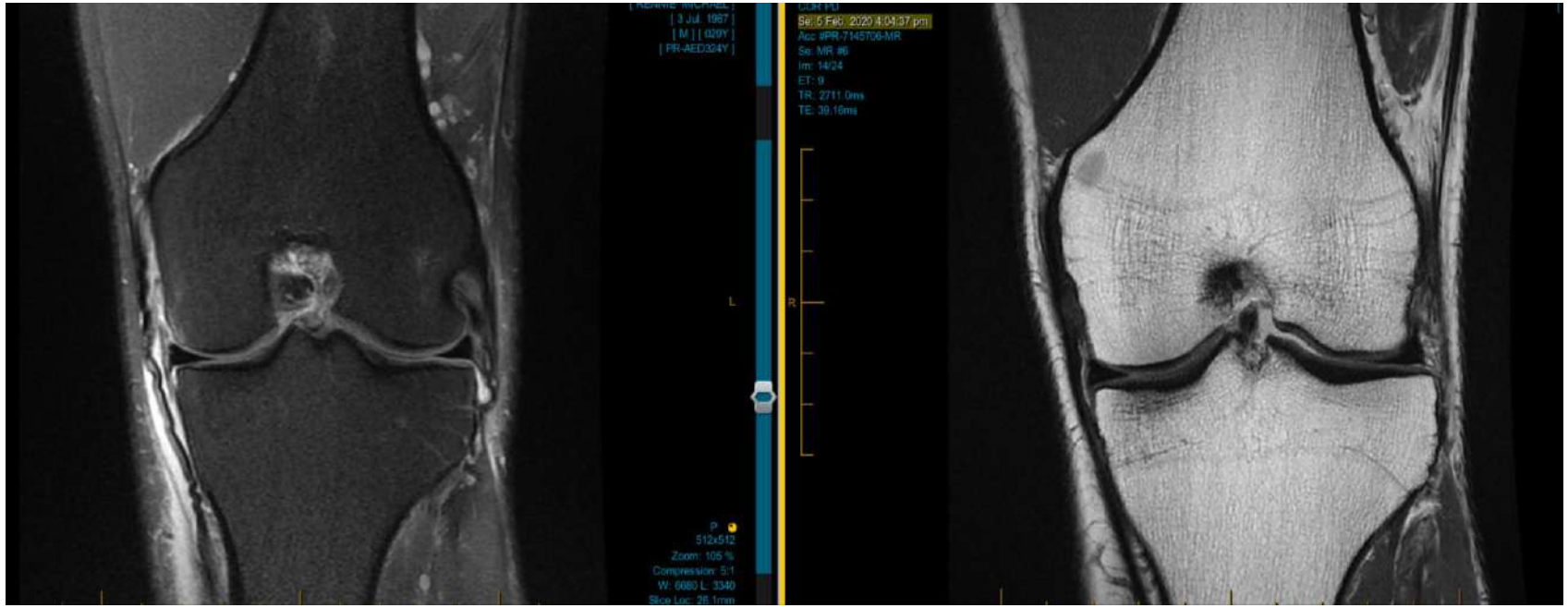
# Patient 3: 29-year-old
# March 2017

# Acute MRI: combined MCL/ACL



# Braced Day 1

# MCL healed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Acc #PR-7145706-MR
Se: MR #6
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ET: 9
TR: 2711.0ms
TE: 39.16ms
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512x512
Zoom: 105 %
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W: 6080 L: 3340

# ACL Healed

# Patient 4: 16-year-old male
# March 2018

# Patient 4: ACL healed

# Patient 5: May 2018

# Patient 5. combined ACL/MCL


# Braced Day 1

# 6 month follow up MRI


BOQ SPECIALIST

# What was the explanation???

# The 3 Orthopaedic Principles!

1. The HISTOLOGY of Ligaments

2. The Synovial Envelope : rich BLOOD SUPPLY

3. Principle of anatomical REDUCTION

# Principle 1: HISTOLOGY

## Ligaments HEAL!!!  The “Epiligament”

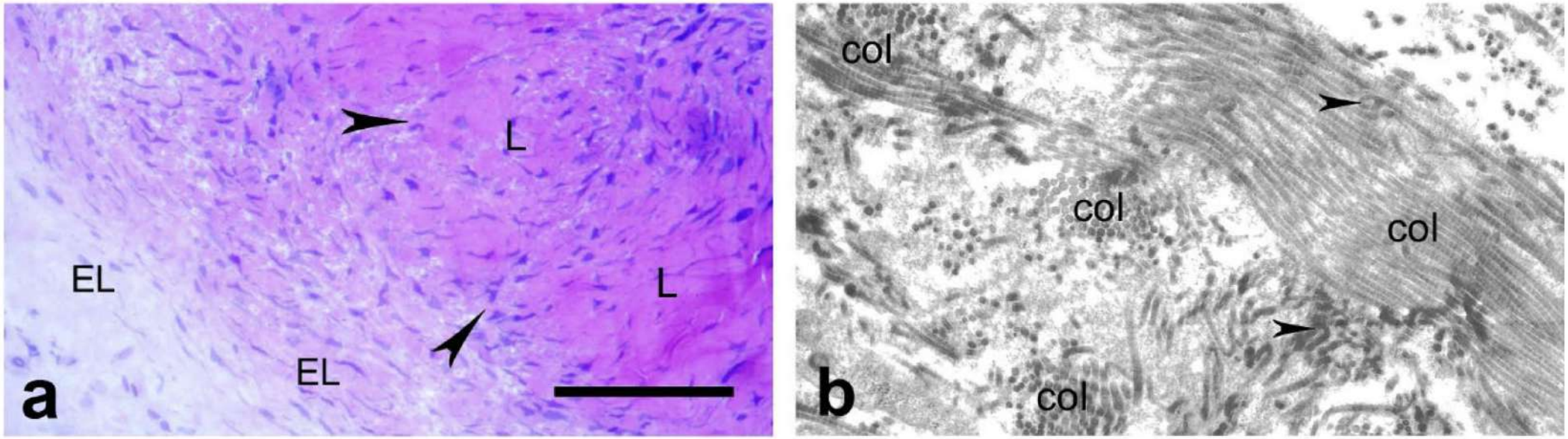
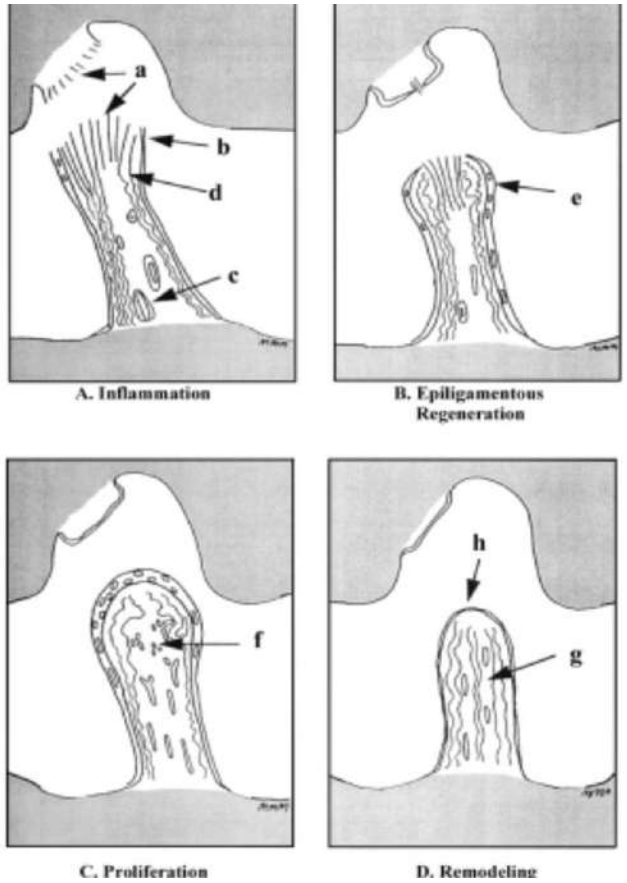



**Figure 5 Epiligament-ligament scar at the sixteenth day after injury**. a) epiligament (EL), consisting fibroblasts (colored in blue), collagen fibers (colored in red) prolonging to endoligament (arrow heads) enveloping the collagen bundles of the ligament (L) (light microscopy). Bar 50 μm; b) electron micrograph of collagen fibers in the EL organized in bundles with different orientations (col) and collagen fibers between bundles, some of them with irregular striation pattern (arrow heads) and also included in the bundles of regularly orientated collagen fibers on the sixteenth day after injury × 12000.

# Principle 1

## Histological justification of Bracing Hypothesis




"Epiligamentization"

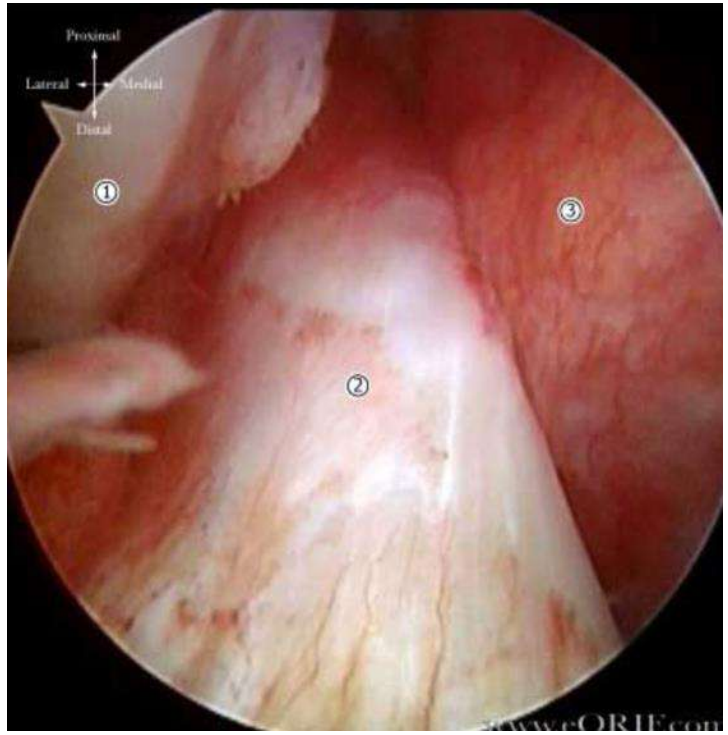
Schematic of the gross and histological appearance of the four phases of the healing response in the human anterior cruciate ligament.
*A:* The inflammatory phase, showing mop-ends of the remnants (a), disruption of the epiligament and synovial covering of the ligament (b), intimal hyperplasia of the vessels (c), and loss of the regular crimp structure near the site of injury (d).
*B:* The epiligamentous regeneration phase, involving a gradual recovering of the ligament remnant by vascularized, epiligamentous tissue and synovial tissue (e).
*C:* The proliferative phase, with revascularization of the remnant with groups of capillaries (f).
*D:* The remodeling and maturation phase, characterized by a decrease in cell number density and blood vessel density (g) and by retraction of the ligament remnant (h).

**"Involution of the stumps"**

# Late presentation: Day 28

# Principle 2: rich blood supply

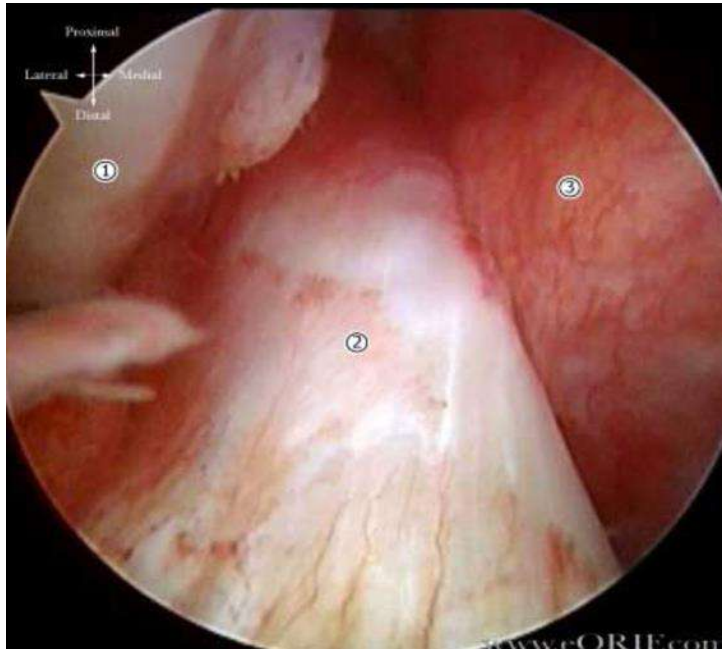
## The SYNOVIAL Envelope of the ACL



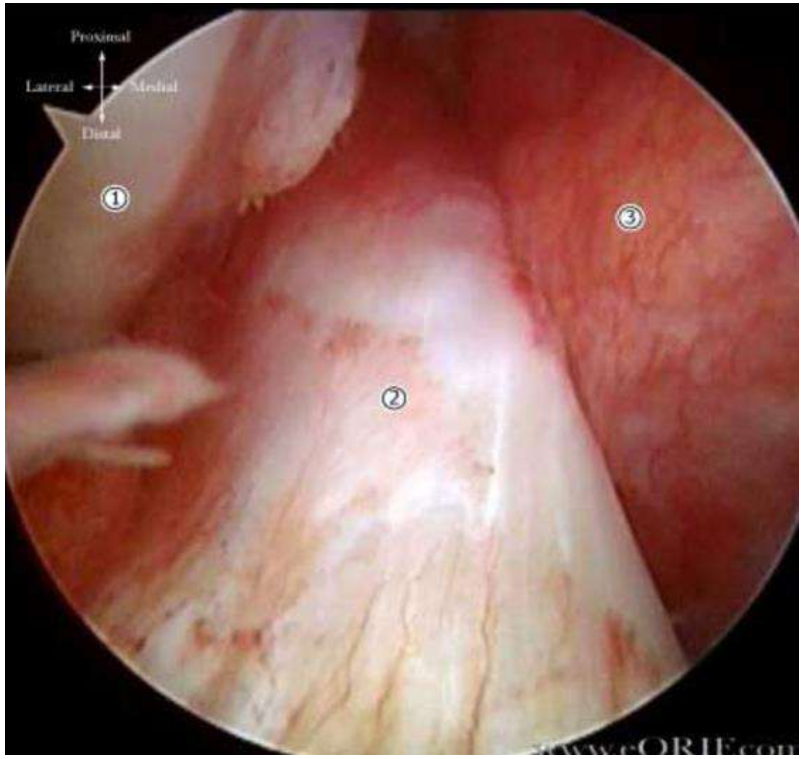

# “Cocoon” of a vascular Synovial envelope

The **ACL** receives its **blood supply** from branches of the middle genicular artery, which from a **vascular** synovial envelope around the ligament. These periligamentous vessels penetrate the ligament transversely and anastomose with a longitudinal network of endoligamentous vessels.

ACL is “Intra-articular” yet “extra-synovial”



# “Cocoon Analogy”: vascular Synovial envelope



# “Sausage analogy”

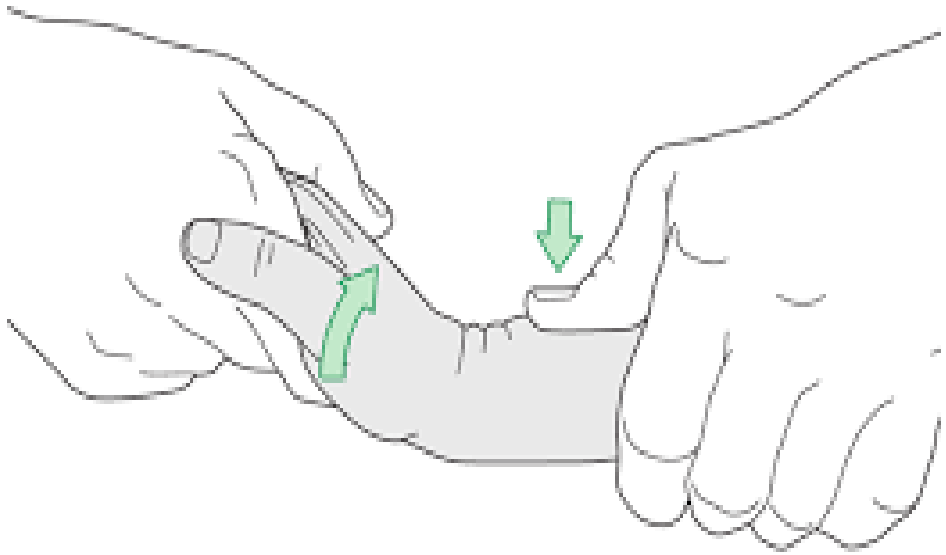
The skin is the Synovial Membrane.

The meat is the ACL

# Principle 3.

The principle of Anatomical REDUCTION?

# Closed REDUCTION of the ACL



# REDUCTION of injured tissues

- REDUCE the injury
- Approximate the injured ACL tissues!!
- Maintain the REDUCTION and rest first 4 weeks

# Reduction of injured tissue: Mallet finger

# The ACL anatomy and function

- The ACL controls the “screw home” mechanism from 30 degrees to full extension
- Full extension= “close pack” position of knee joint

# Anatomical justification of bracing

Jordon et al.
AJSM (2007)

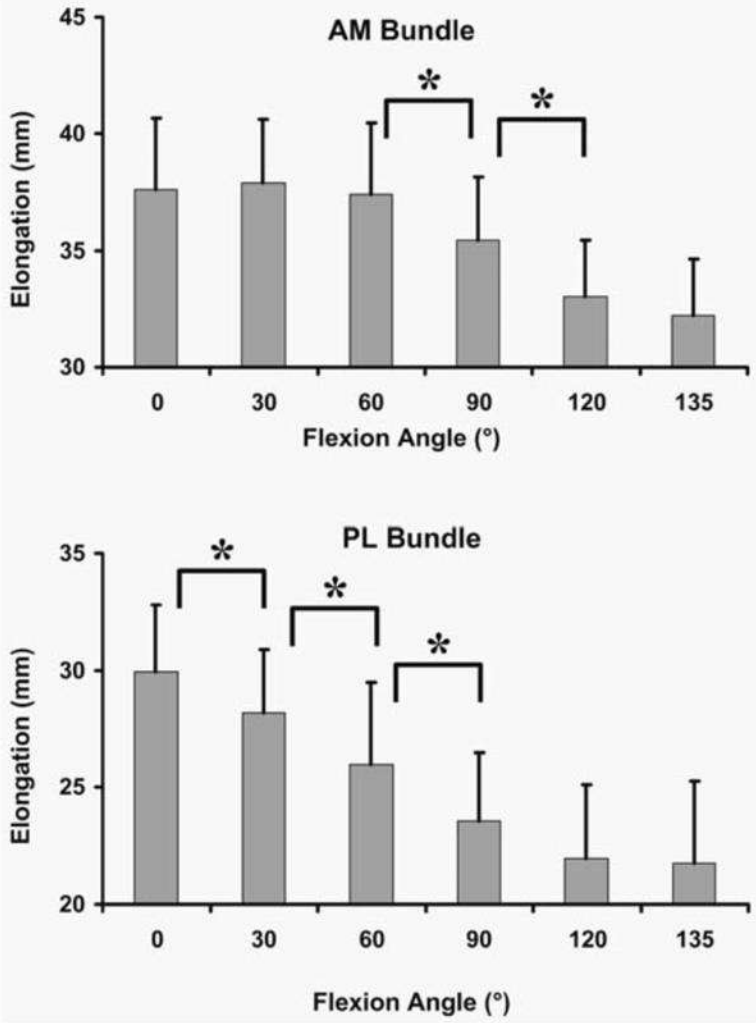
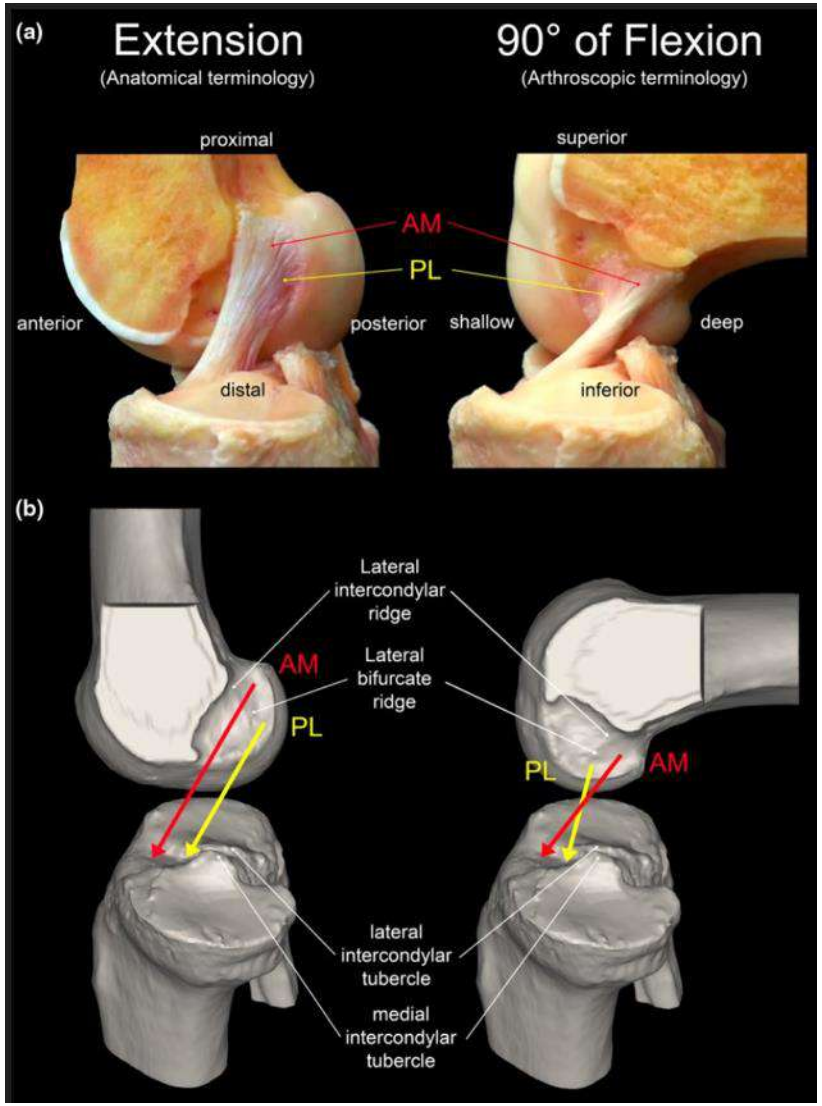
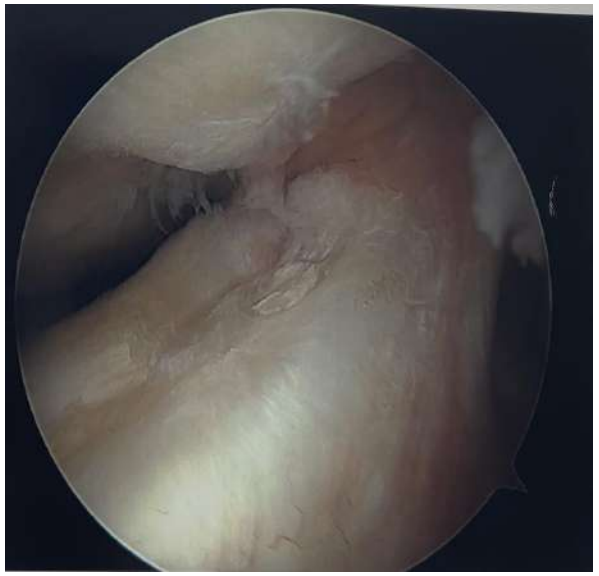



**Figure 5.** The length of the AM and PL bundles as a function of flexion angle during the single-legged lunge. *$P < .05$.



# Arthroscopic Images of the normal ACL

30 degrees flexion



90 degrees Flexion

# Anatomical justification of Bracing: MRI experiment

Full extension


30 mm

60 degrees flexion


26 mm

90 degrees Flexion


24 mm

# Why Brace at 90 degrees? The ACL is most approximated

- Recognize
- REDUCE and maintain REDUCTION
- Rest
- Rehabilitate

- 90 degrees significantly approximated!

- It reduces the “Gap Distance”

# What BRACING studies have been published??


# Other studies involving Bracing : capacity of the ACL to heal!!

- Fujimoto et al: 2002

- Inclusion criteria
  - Minimally injured “contiguous” ACL
  - Low-demand athletic patient
  - No meniscal tears

- Knee braced at 20 degrees Flexion
  - Braced within 4-weeks of injury
  - 2-3 months bracing period

**Fig. 2** This soft brace, which was applied for 2–3 months after the injury, had a 20-deg extension block without any prevention of anterior tibial displacement

# Fujimoto et al: capable of healing but with a “sag”



tachment site through to the tibial attachment site (high intensity area was detected in the ACL, indicating injury).

## Patients and methods

All patients included in this report were seen in our department between April 1993 and March 1997. The diagnosis of acute ACL injury was established by physical examination and MRI (T2-weighted and proton-density images). Neither arthroscopic examination nor an arthrogram was done to aid the diagnosis. Anterior translation was defined using the Lachman test and KT-2000 measurement (MEDmetric, San Diego,Calif.). All patients were seen within 4 weeks of the initial consultation and had no history of a substantial injury to either the affected knee or the contralateral knee. A minimum follow-up period of 6 months was required.

The clinical criteria for inclusion in this study were one or more of the following: a sedentary occupation and low athletic demand, with an injured ACL showing a continuous MR image from the original femoral attachment through the tibial attachment with an area of high intensity detected in the substance of ACL (Fig. 1). Patients who had contralateral knee ligament injuries were eliminated.

The possibility of ACL healing with conservative treatment or delayed ACL reconstruction in the case of treatment failure was initially explained by the senior author (YS). All patients accepted our explanation and chose conservative treatment.

The present study consisted of 31 patients who met the criteria for inclusion. All of these patients were available for regular follow-up. Objective laxity measurements (KT-2000 arthrometer, MEDmetric) and MR images (T2-weighted and proton-density) were obtained during the follow-up (3, 6, 12, 24, and 36 months after the injury).

The average age at the time of injury was 33 years (range 15–56 years). Ten patients were men and 21 were women. All patients were athletically active before the injury, and 25 (81%) injured the knee during a sports activity. No meniscal injury requiring treatment was detected in association with the ACL tears by either physical examination or MRI.

**Fig. 2** This soft brace, which was applied for 2–3 months after the injury, had a 20-deg extension block without any prevention of anterior tibial displacement

that had a 20-deg initial range of motion restriction (Fig. 2). The soft brace used had a single hinge without an anterior strap and is the brace traditionally used for patients after ACL reconstruction (Nakamura brace, Shimane, Japan). Weight-bearing was also allowed, as tolerated, with crutches initially. Full weight-bearing without the use of crutches was generally achieved within 4 weeks after the trauma. At 3 months after trauma, patients were evaluated by the authors and examined by KT-2000 measurements and MRI, and were allowed to take off the brace. Jogging was started 5 months after surgery.

ACL healing with “SAG”



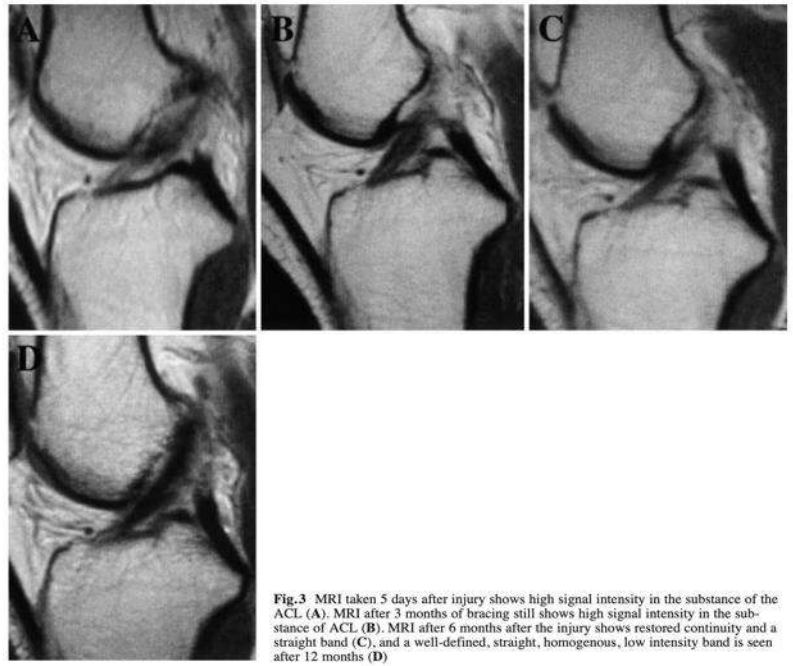



**Fig. 3** MRI taken 5 days after injury shows high signal intensity in the substance of the ACL (**A**). MRI after 3 months of bracing still shows high signal intensity in the substance of ACL (**B**). MRI after 6 months after the injury shows restored continuity and a straight band (**C**), and a well-defined, straight, homogenous, low intensity band is seen after 12 months (**D**)

# ACL “Jack Brace”: combined Swiss and USA collaboration

Allowed full ROM!!
Allowed weight bearing
Braced up to 3 weeks post injury

Dr. Roland Jacob et al 2016

FIGURE 1: Photograph of the ACL-Jack brace.

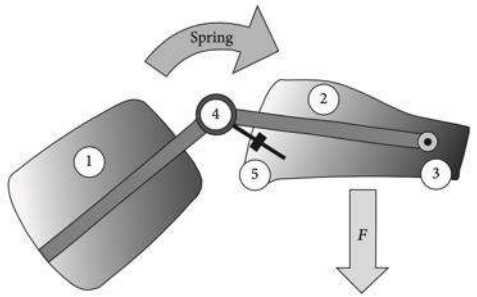



FIGURE 2: Diagram showing that the brace consists of an upper thigh (1) and a leg part (2) connected through a hinge at the ankle (3) and knee (4). The load is applied through a relocatable load arm (5) from the hinge to the leg part, which rotates around the distal hinge (3). $F$ = force.

# ACL “Jack Brace”: capable of healing but with a “sag”

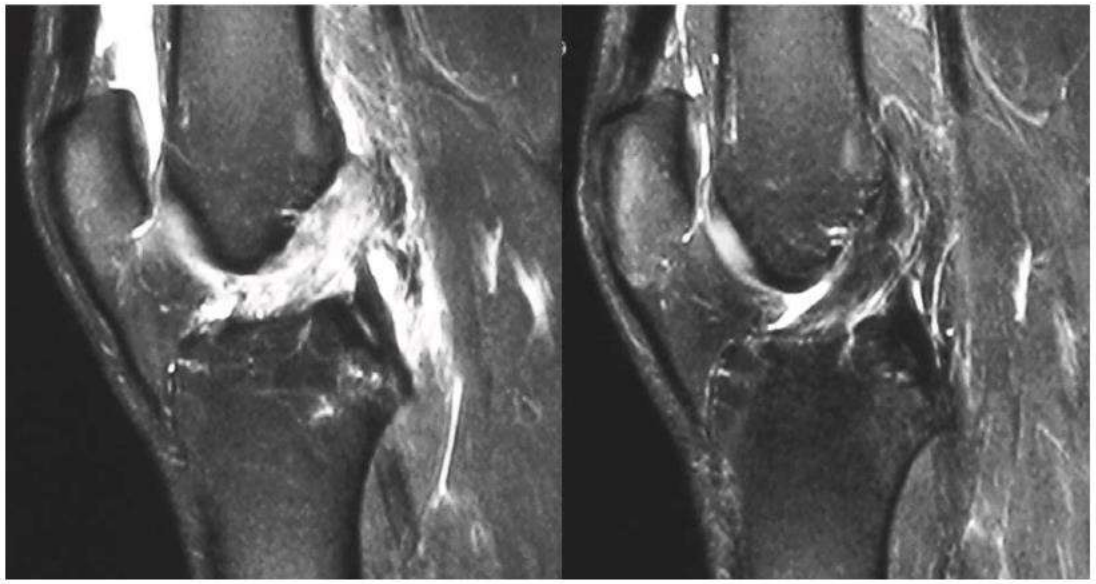


FIGURE 4: Initial and follow-up MRI six months after treatment with the ACL-Jack brace.

ACL heals but heals in a LENGTHENED state= “SAG”

# When did the ACL-Heal research start??

- The Landmark patient= Patient #6
- The first ISOLATED COMPLETE disruption of the ACL
- April 2019
- Now have braced 173 patients

# The “landmark patient”

- Isolated rupture ACL
- 17-year-old Rugby Union football player
- Mother and 2 brothers ACLR surgery

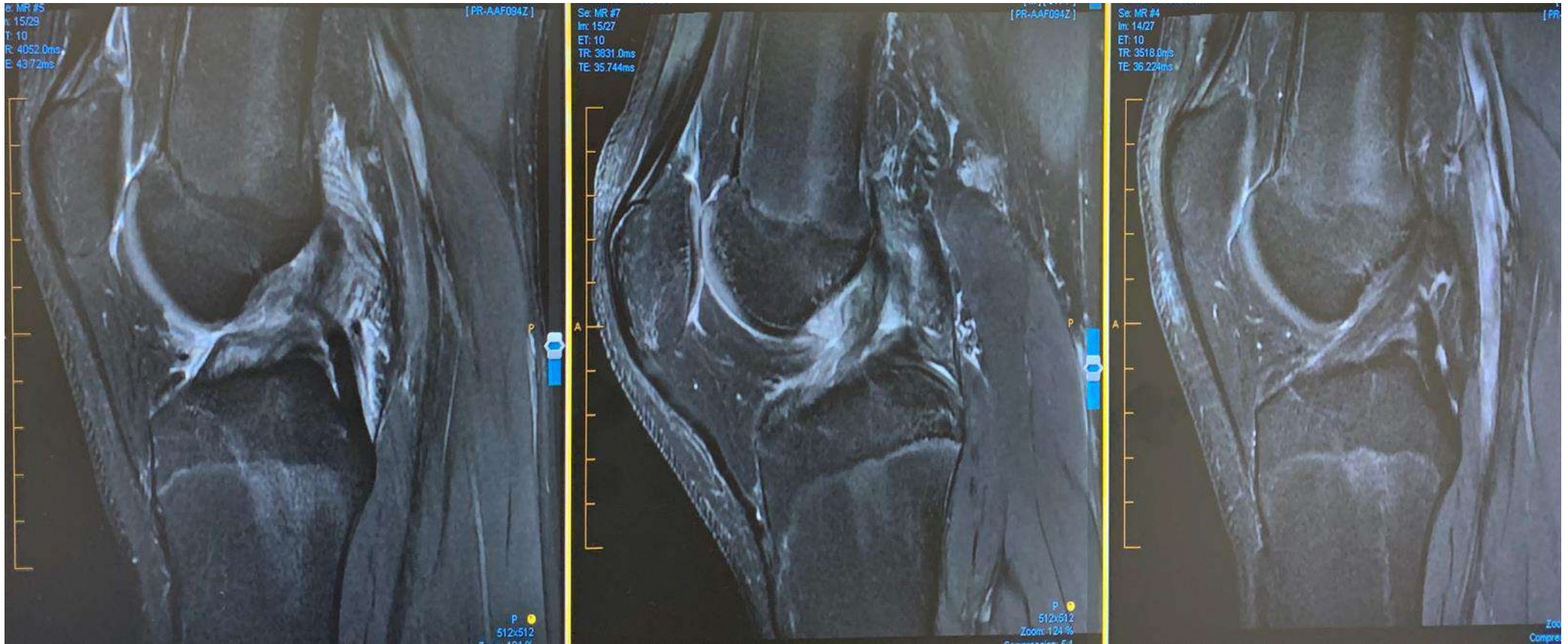
# Patient 6. 17 yr. old male: rugby union:

## acute injury April 2019

acute

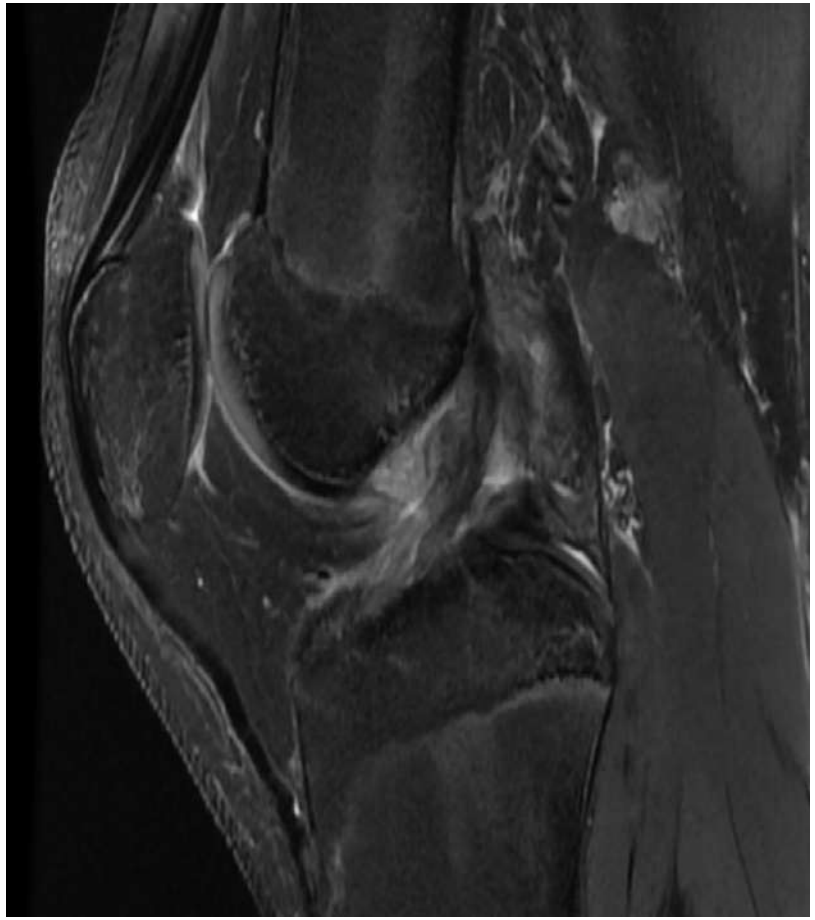
9 weeks

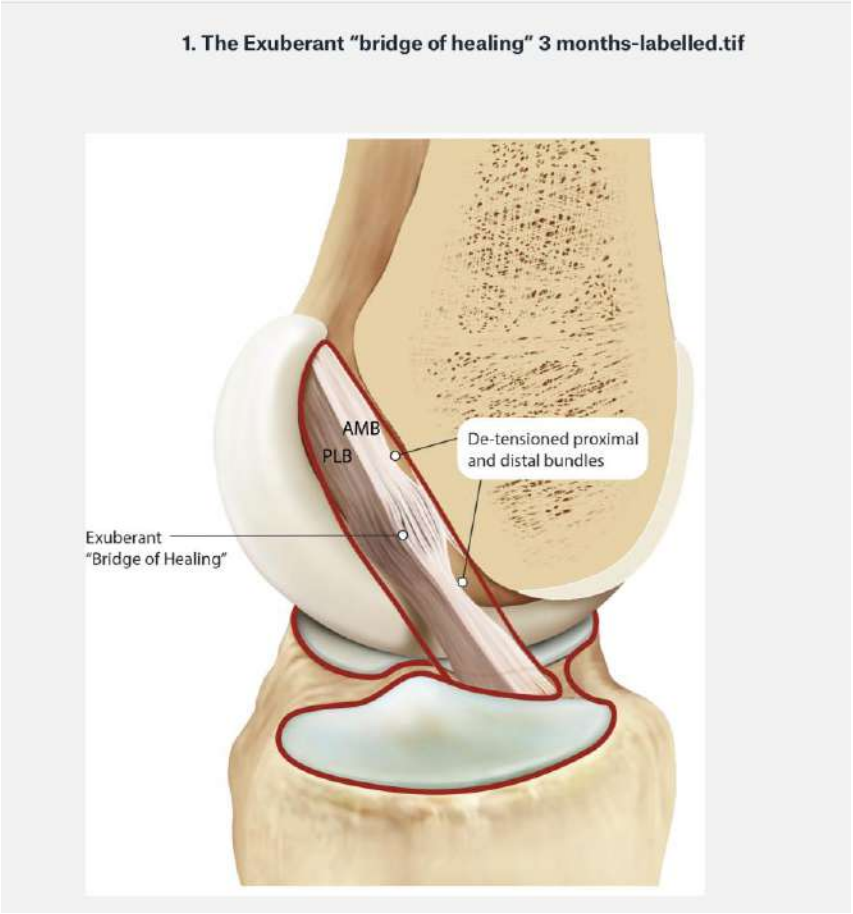
6 months



# Patient # 6 : research commenced

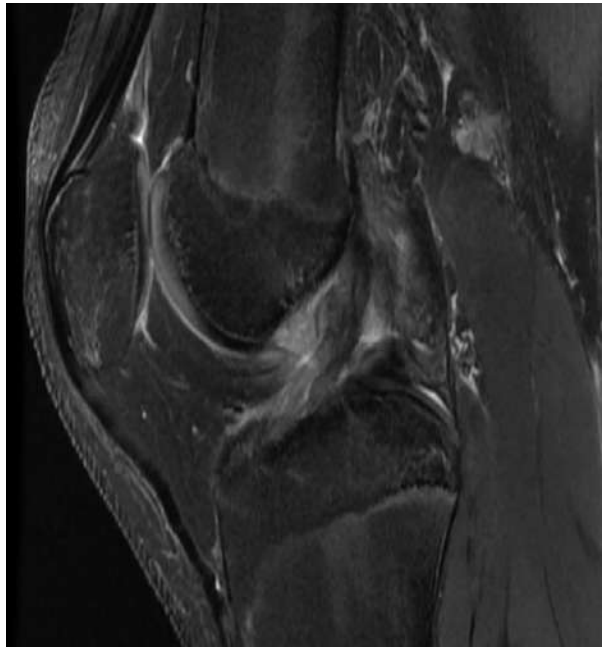
# ”Exuberant Bridge of Healing”



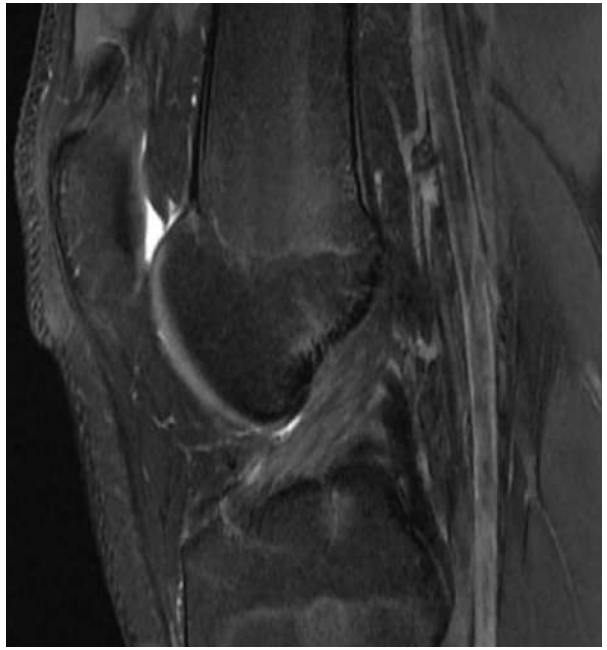


# ”Remodeling” of The Bridge of Healing

Acute:
“Rupture Zone”



9 weeks
“Healing Zone”



6 months
“Remodelling”

9 months
“Maturity”

# How many patients so far?

- 235 patients

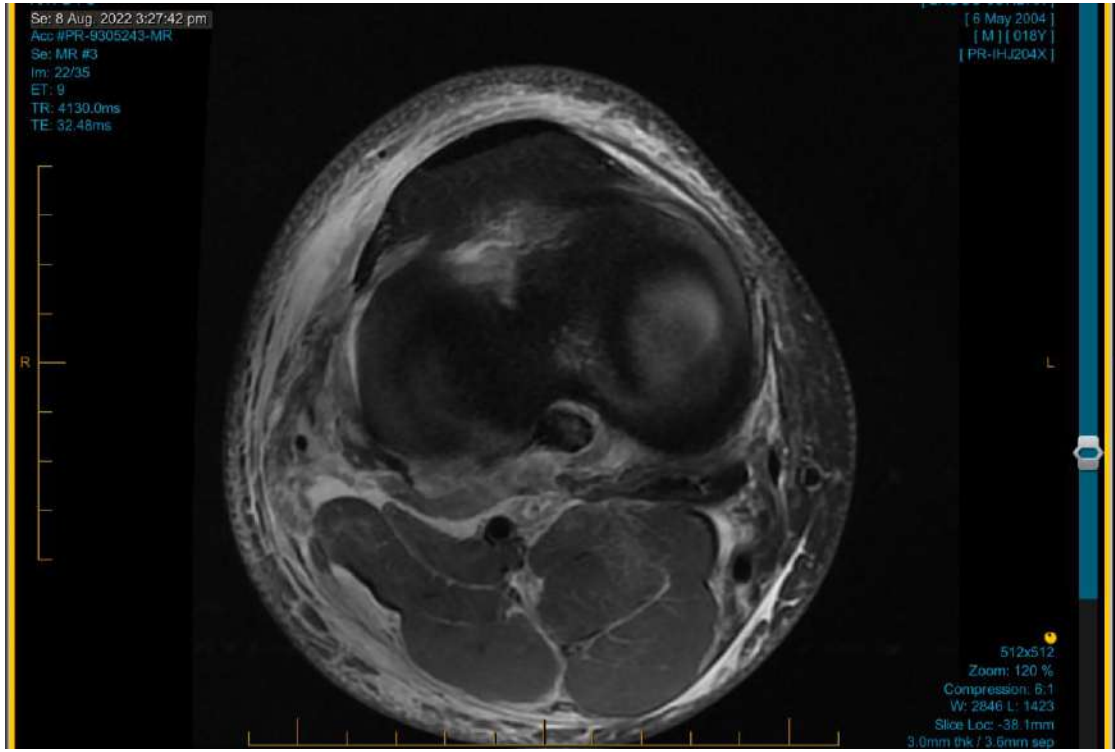
- 26 New Zealand
- 1 South Africa
- 208 Australia

    - 193 NSW
    - 8 Victoria
    - 5 Queensland
    - 1 ACT
    - 1 South Australia

# What are the exclusion criteria??

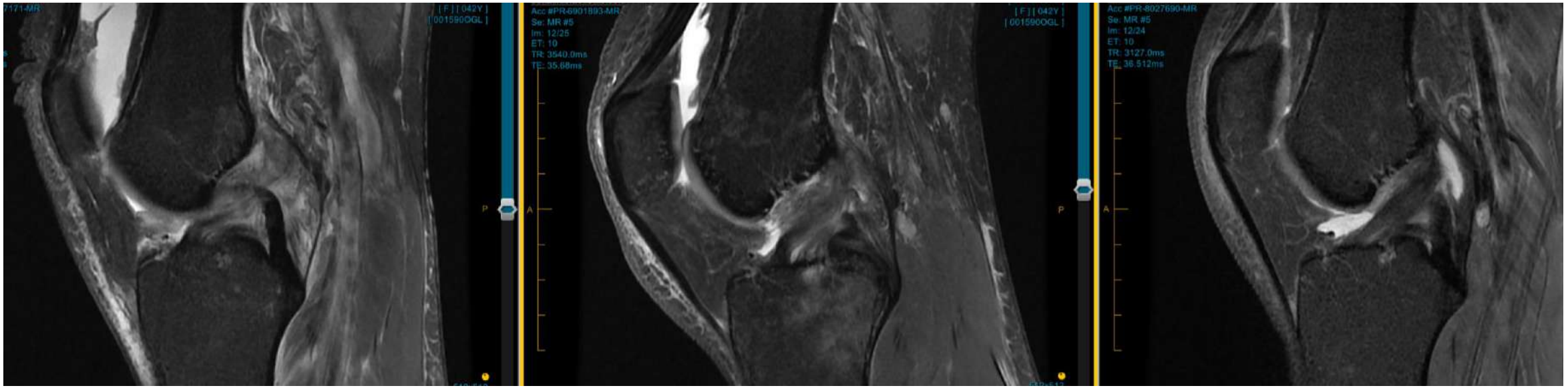
- Absolute Contraindications
    - Displaced Bucket-handle tear meniscus
    - Osteochondral Loose Body
    - Severe PLC injury
    - Past or Present DVT
    - Strong family history of Thrombosis/Thromboembolism
    - Presenting 3 weeks or more after acute ACL injury
- Relative Contraindications
    - Medical conditions
    - Mobility
    - Social support
    - Right knee and Driving

# Severe PLC injury




# Meniscal tears

- Patient 9: ACL evolution of healing

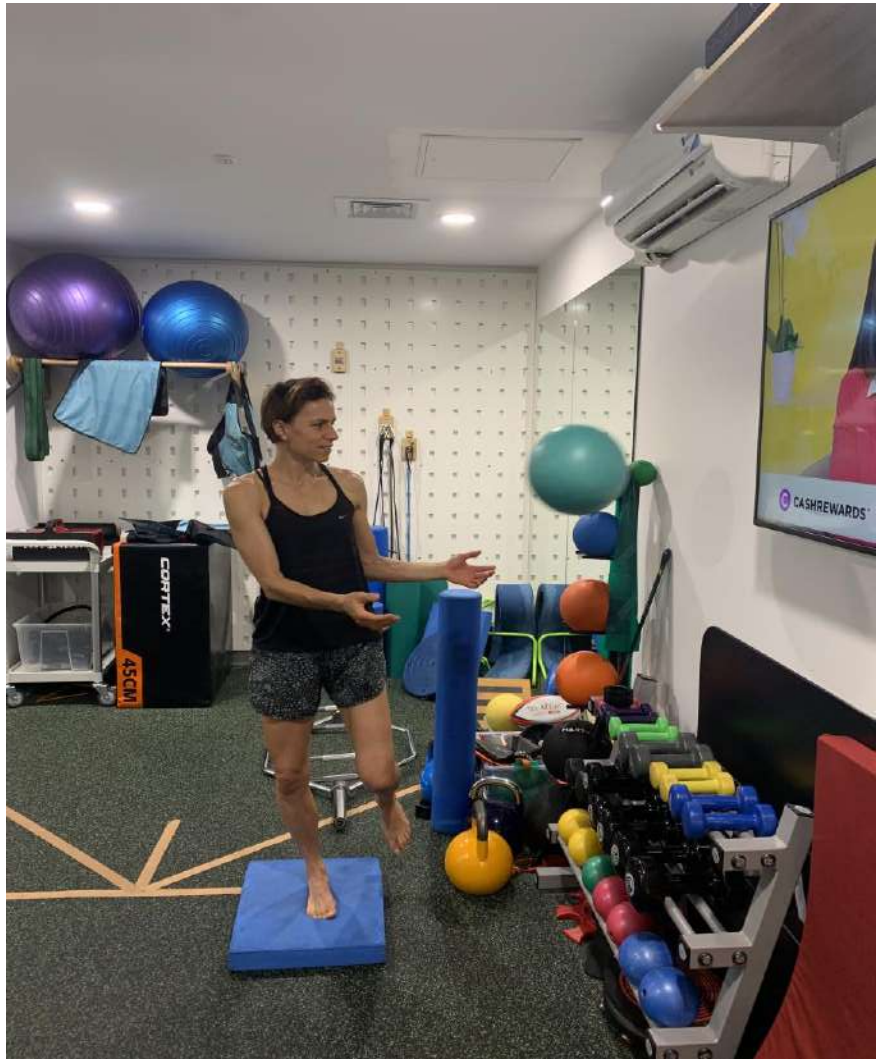


# Meniscal tears

- Patient 9: evolution of MM tear healing

# ACL + meniscal tears

- Patient 9



# Doppler Ultrasound: to exclude DVT

# Commence Xarelto anti-coagulation day 1

- Xarelto (Rivaroxaban) 10mg daily
- Commence Day 1 of CBP
- Week 1-8 inclusive
- Aim is to mitigate risk of DVT


- Children do not need this medication as very low risk of DVT in young children

# Delay in diagnosis of ACL injury

- The Ruptured ACL we hypothesize should be considered a “FRESH Wound”. The “clock is ticking” to REDUCE the injured ACL tissues to we hypothesize facilitate healing.
- If there is a delay greater the 21 days, the novel CBP is not an option unfortunately for the ACL injured patient.
- The “ruptured ACL” should be considered like any other Orthopaedic injury. If there is a delay in REDUCTION of the injured tissues, they will NOT heal. The “window of tissue healing opportunity” is lost.
- For example,

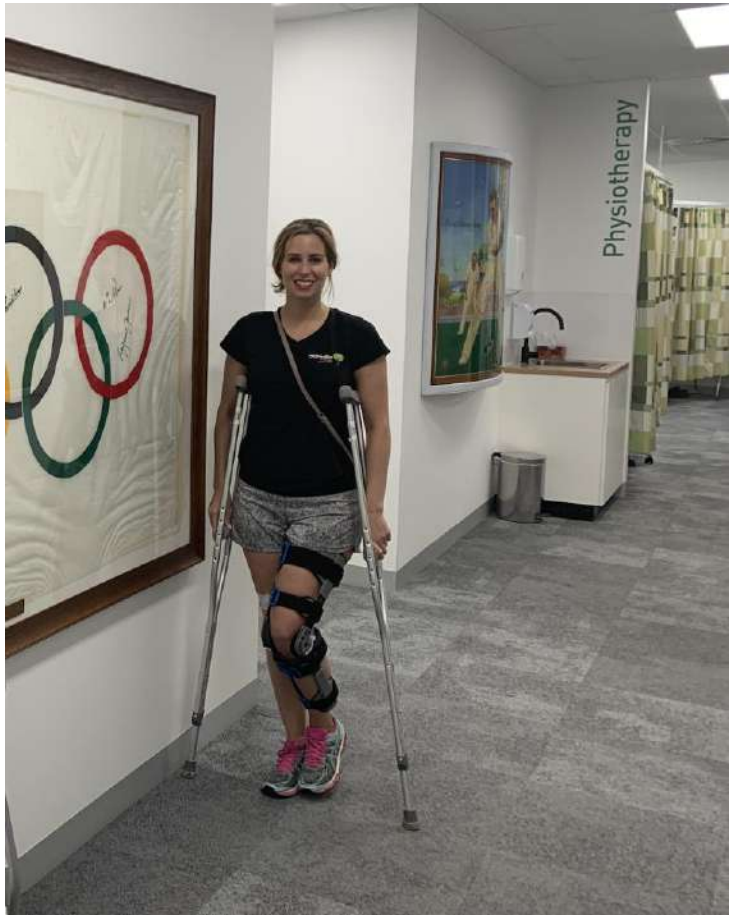
  - Displaced Fractures of bone
  - Displaced Tendon injuries. E.g., Mallet finger
  - Significant Lacerations of skin and soft tissue where the tissues are separated/displaced

# Delayed Presentation : 16 female day 28

ACL stumps starting to INVOLUTE

# Fitting the Brace

# Fitting the Brace

# Fitting the Brace

# ?? PRP injection


# What exactly is the protocol? First 4 weeks

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## The "Cross ACL Bracing Protocol"

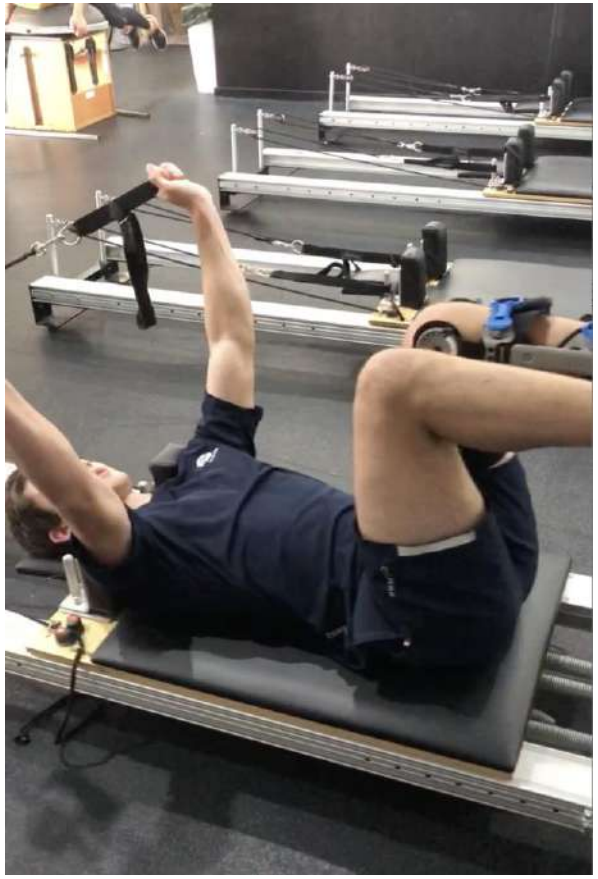
| Week | Brace ROM & Criteria for Progression | Aims | Physio treatment | Exercises | Functional |
|---|---|---|---|---|---|
| 1-4 | - Locked 90˚ NWB with crutches.<br><br>- No NSAIDs medications<br>- No aspiration injections of knee | - Maintain knee flexion at 90˚ in brace 24/7.<br><br>- Minimise local and global muscle atrophy.<br><br>- Control swelling and pain<br><br>Mitigate risk of DVT with anti-coagulation Xarelto 10mg daily for entire period of NWB/crutches being first 8 weeks of protocol + compression below knee sock + foot & ankle calf pump | - Manual therapy weekly, while maintaining 90˚ knee flexion<br>- Cryotherapy<br>- Exercises. | - Quadriceps and hamstring co-contractions.<br>- Calf Theraband plantarflexion<br>- Hip abduction and extension<br>- Contralateral limb; single leg press, leg extension, hamstring curls, calf raise, glute bridge, core activation. | - Upper body gym.<br><br>- Grinder |



# Training in the first 4 weeks

# Training while navigating the Bracing protocol: Week 1-4

# Training while navigating the Bracing protocol



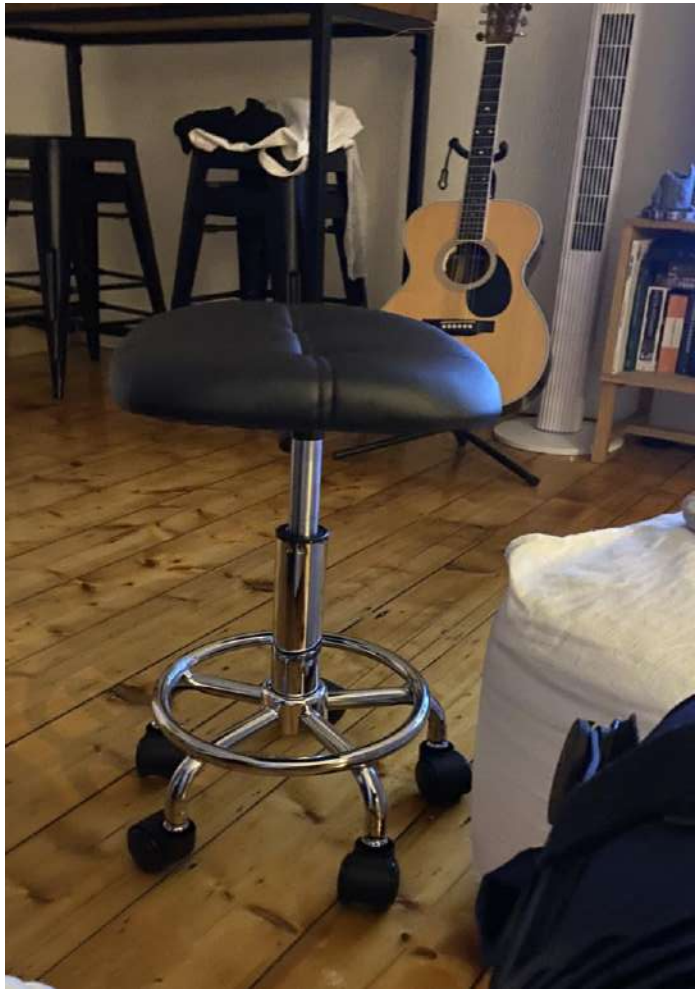
# Training in the first 4 weeks

# Hydrotherapy

# Muscle stimulation

# ? Mobility Aids

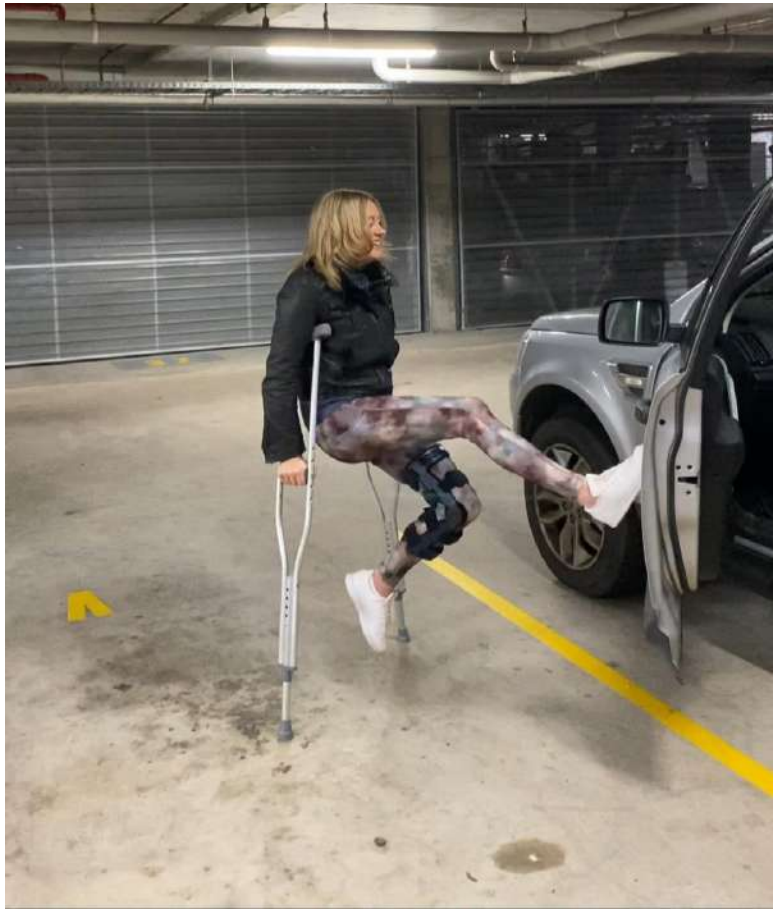
# Mobility aids



# Showering

# Embracing Life


# Embracing Life

# Embracing Life


# Embracing Life

# Embracing Life

# Weeks 6-8

| | | | | | |
|---|---|---|---|---|---|
| 5-6 | Week 5= 75˚-FULL FLEXION˚<br><br>Week 6= 60˚-FULL FLEXION<br><br>NWB with crutches | - Minimise local and global muscle atrophy.<br><br>- Maintain specified knee ROM<br><br>-ongoing DVT risk mitigation strategies | - Manual therapy and exercises weekly in specified range (Brace can come off for physio); | Quadriceps and hamstring co-contractions at varying angles.<br>- Continue Calf Theraband plantarflexion<br>- Hip abduction and extension with ankle weights or Theraband<br>- Continue Contralateral limb; single leg press, leg extension, hamstring curls, calf raise, glute bridge, core activation | - Upper body gym.<br><br>- Grinder. |
| 7-8 | Week 7= 45˚-FULL FLEXION˚<br>Week 8= 30˚-FULL FLEXION˚<br><br>Week 8= PWB with crutches | - Minimise local and global muscle atrophy.<br>- Maintain specified knee ROM<br><br>-ongoing DVT risk mitigation strategies | - Manual therapy and exercises weekly in specified range;<br>- Gait retraining. | - As above plus;<br>- Wall squats/holds (Week 7=45˚, Week 8= 30˚).<br>- Body weight Squats within brace limits | - Upper body gym.<br><br>- Grinder. |

# Training during the Bracing protocol

# Weeks 9-12

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| | | | | | |
|---|---|---|---|---|---|
| 9 | Week 9= 15˚-full flexion if brace allows.<br><br>Otherwise Unrestricted ROM brace (i.e 0-120˚+)<br><br>Full weight bearing | - Maintain specified knee ROM<br><br>- Increase knee range of motion.<br><br>- Increase muscle strength of lower limbs<br><br>- Improve proprioception. | - Manual therapy and exercises weekly in specified range.<br><br>- Gait retraining. | - Knee range of motion exercises (heel slides).<br>- Pilates reformer/ leg press<br>- Body weight squats<br>- Bridges- hamstring and gluteal<br>- Crab walks/ monster walks<br>- Calf raises<br>- Static balance exercises | - Exercise bike if able to achieve over 100˚ flexion.<br><br>- Upper body gym.<br><br>- Grinder. |
| 10-12 | Unrestricted ROM brace<br><br>Full weight bearing<br><br>Wean off crutches | - Increase knee range of motion.<br>- Increase muscle strength.<br>- Improve proprioception. | - Weekly manual therapy and exercises.<br><br>- Gait retraining. | As above plus;<br>- Leg press (single leg)<br>- Hamstring curl machine<br>- Standing and seated calf raise machine<br>- Static balance exercises. | - Exercise bike.<br><br>- Upper body.<br><br>- Grinder. |

# Follow-up at 12 weeks

- Clinical examination

- MRI examination

# Clinical and MRI result at 12 weeks

# Clinical and MRI result at 12 weeks

# Post Bracing: best Practice ACL Rehabilitation

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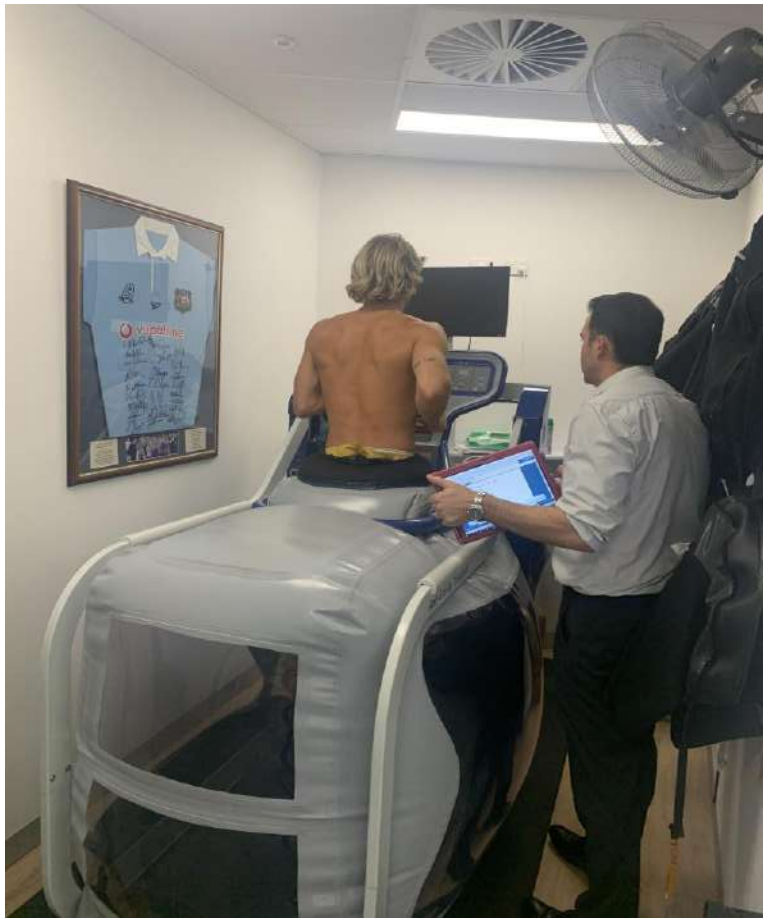
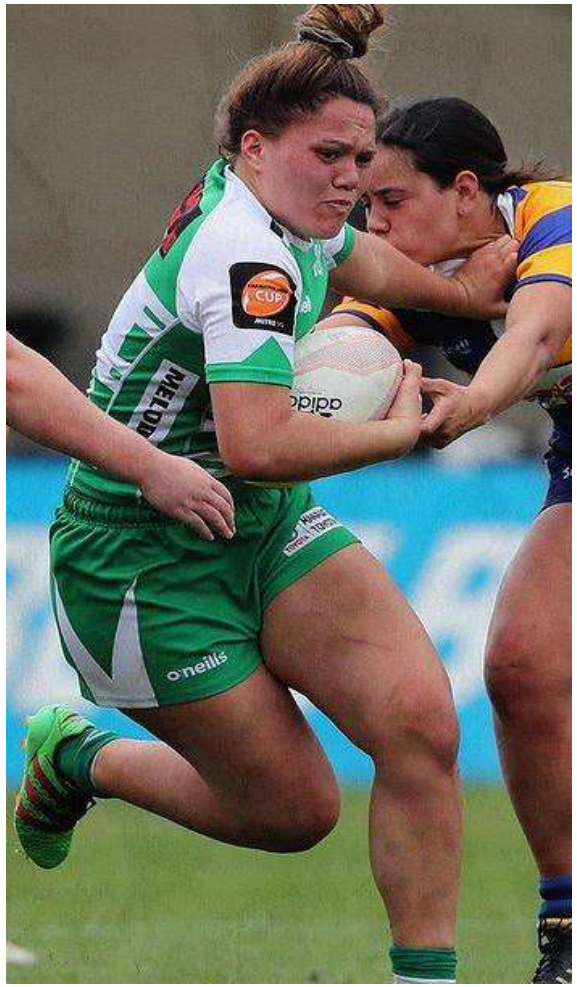
| | | | | | |
|---|---|---|---|---|---|
| | | - Improve proprioception<br>- Introduce Hopping | | | |
| 20 | No Brace | - 6 weeks of training | - Manual therapy as required | Return to training if;<br>- Single leg hop 90% of other side<br>- Knee extension strength 90% of other side<br>- Hamstring 90% of other side<br>- Good dynamic knee control on single leg land from step<br>- SEBT 90% of other side | |
| 26 | No Brace | - Return to play | | Return to play (minimum requirements, add sports specific tests/contact);<br>- If SEBT 95% of other side<br>- Triple Hop/lateral hop/ single hop 90% of other side<br>- Single leg press 1.8x BW | |

# Alter-G running

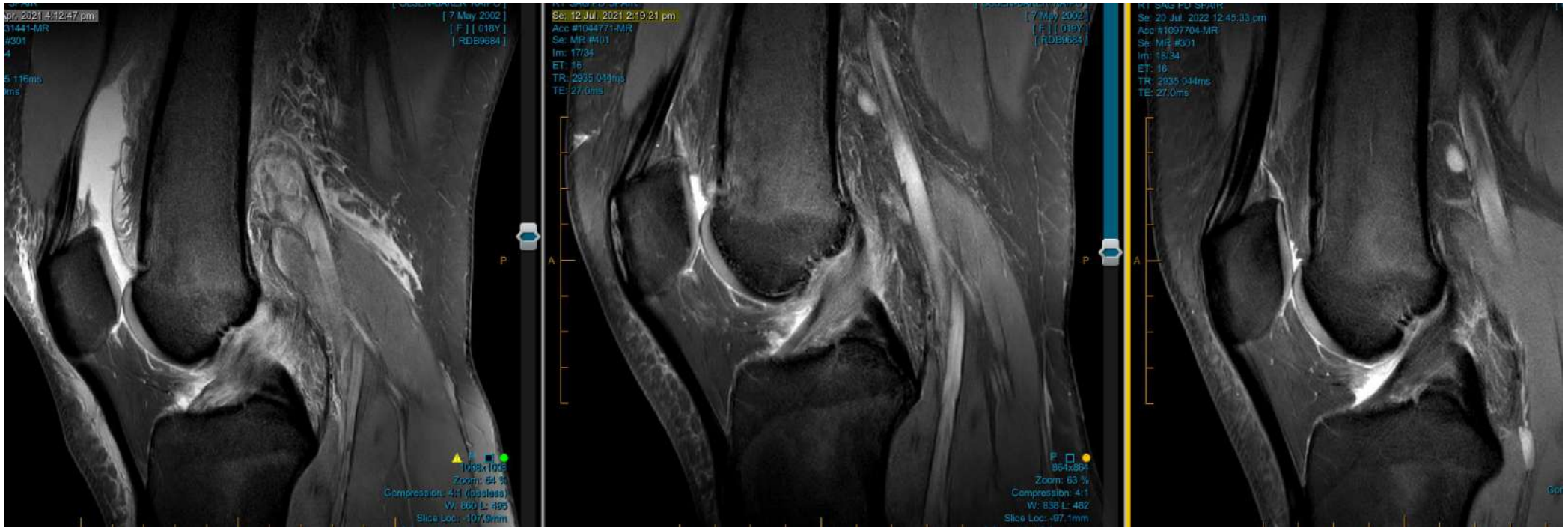



# Running and Agility

# Return to Sport: 9-12 months

# Serial MRI for New Zealand elite female Rugby player



# What are the Results so far???

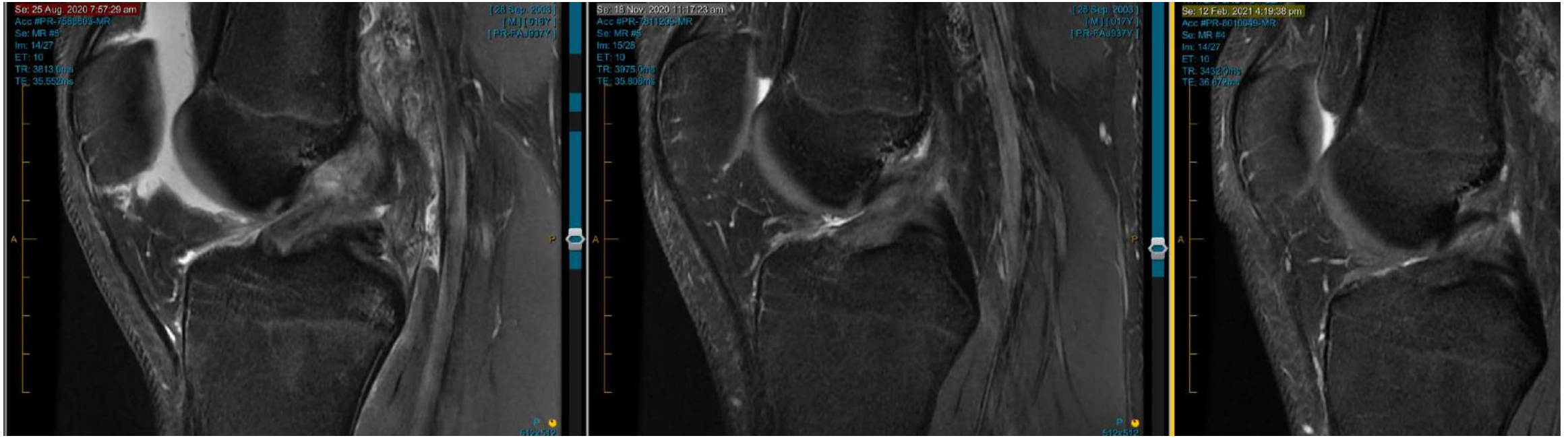
- Recognition that certain types of acute ACL injuries “heal better” than others!

- Feb 2021: Patient 38

    - 6-month clinical and MRI review

# Patient 38

- Patient 1-38
- 11 poorer outcomes
- ?? Why

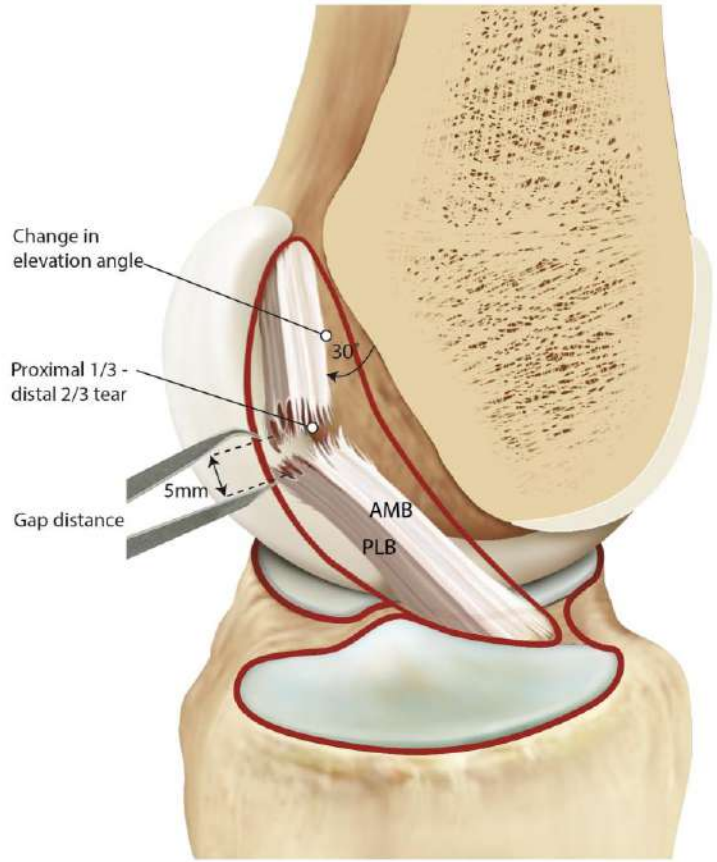


# Acute MRI Classification system

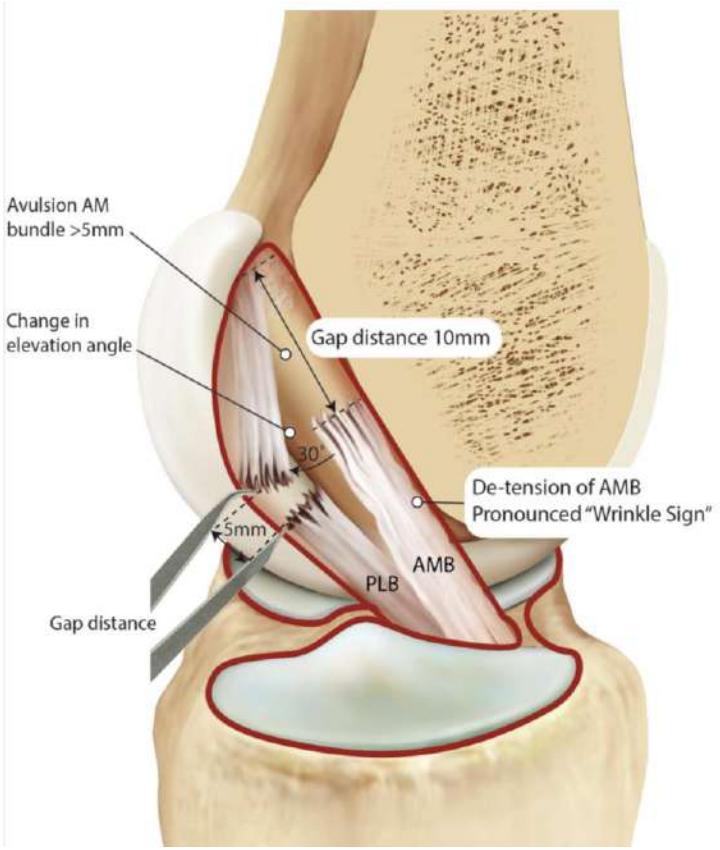
- It is all about ANATOMY!
- This obeys the “KISS principle”

    - Type 1- no avulsion
    - Type 2- partial Femoral avulsion
    - Type 3- complete Femoral avulsion

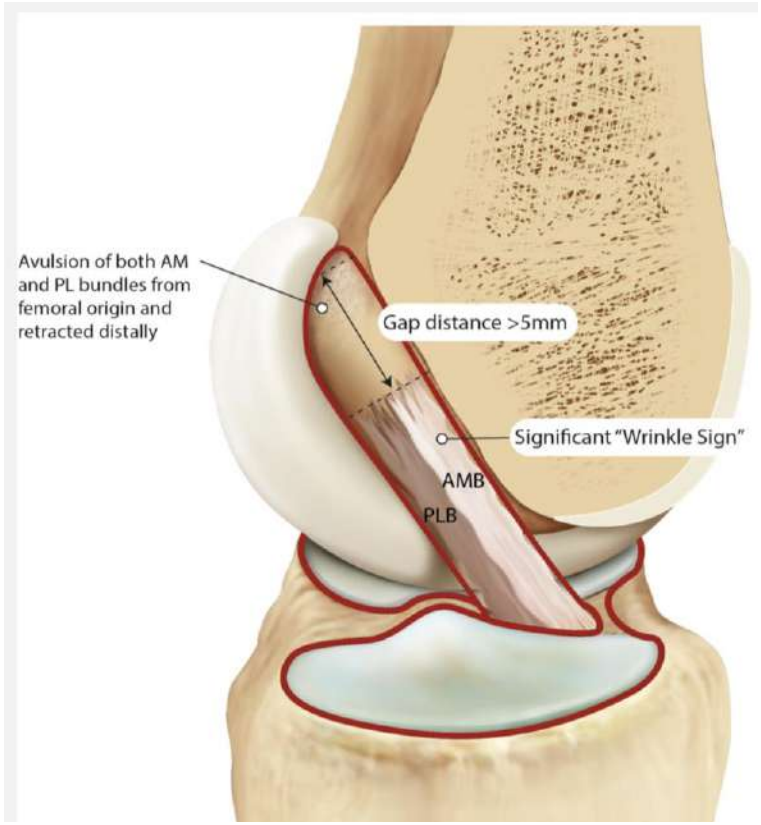
# Type 1 ACL injuries: no avulsion



# Type 2 ACL injuries: partial femoral avulsion

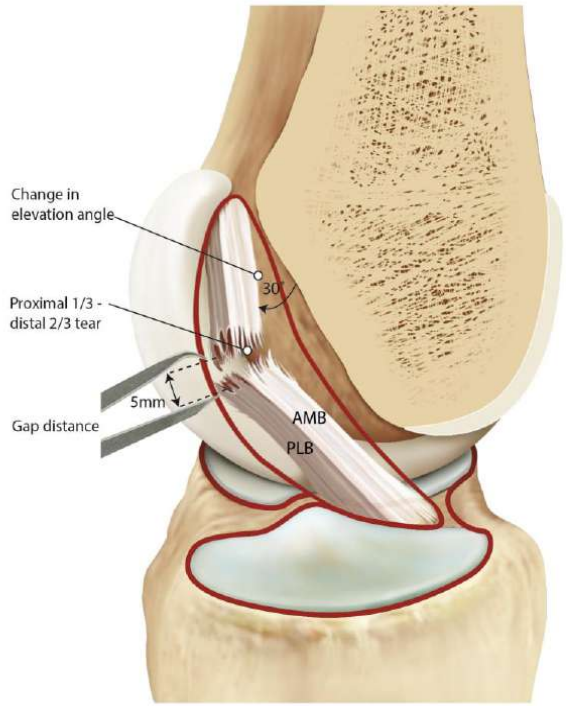


# Type 3 ACL injury: complete femoral avulsion

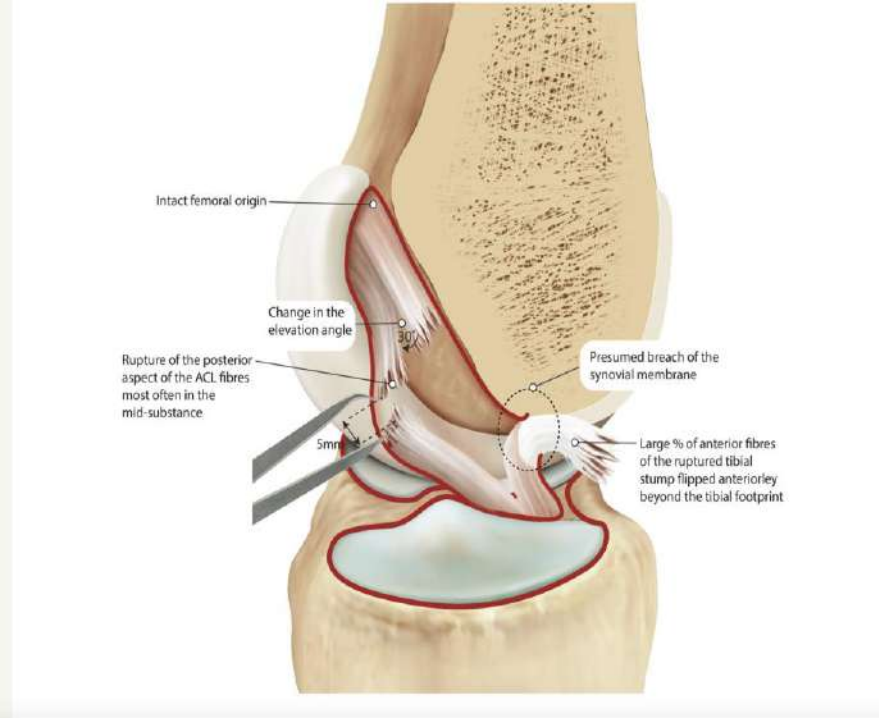


# Displaced and Non-displaced ACL injuries

- Non-displaced ACL= all ACL tissue is within the intercondylar notch



- Displaced ACL = variable % of ACL tissue “outside” the intercondylar notch



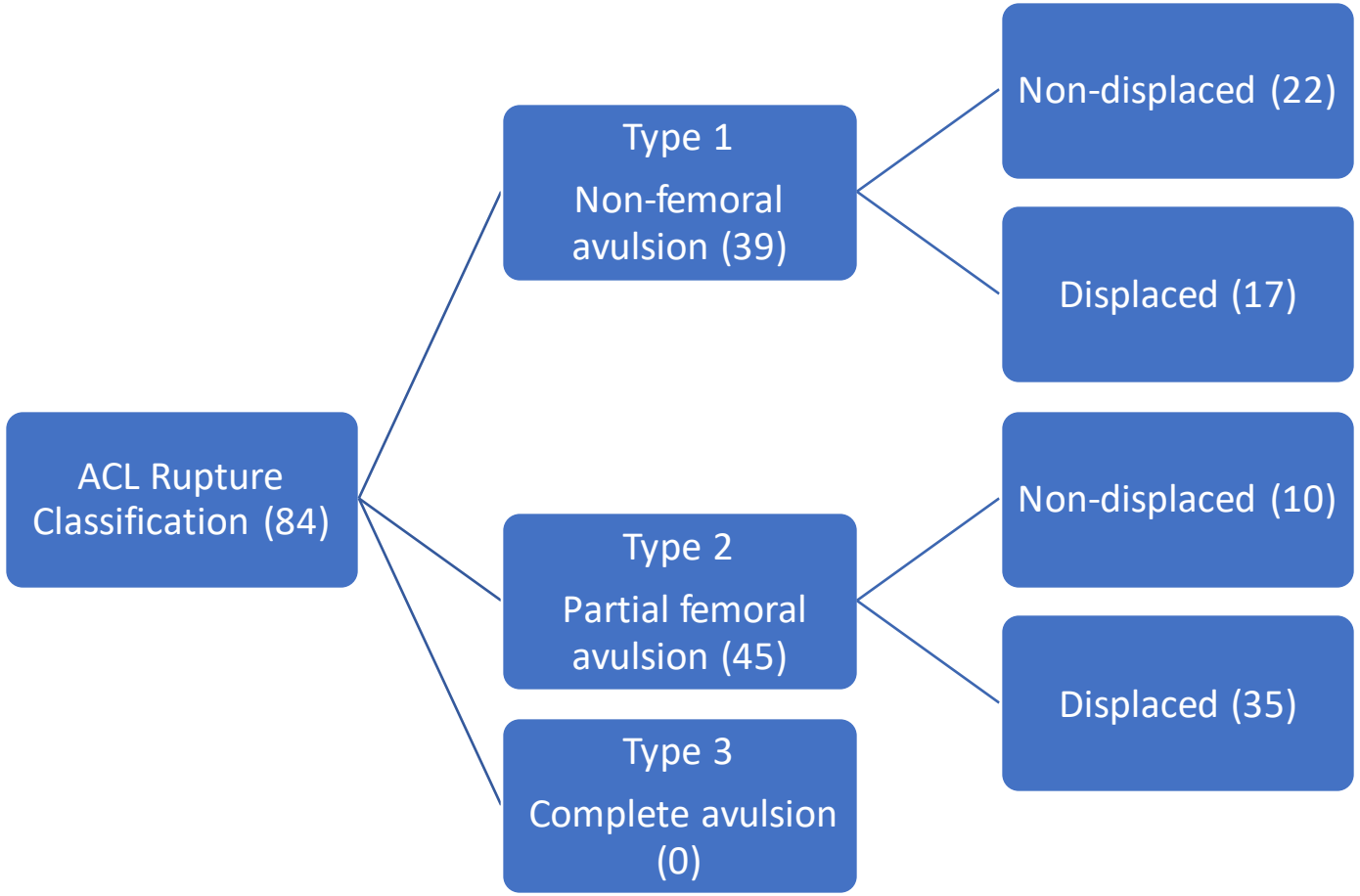
# There is a SPECTRUM of INJURY!!


Spontaneous Healing

?Heal with a Bracing Protocol

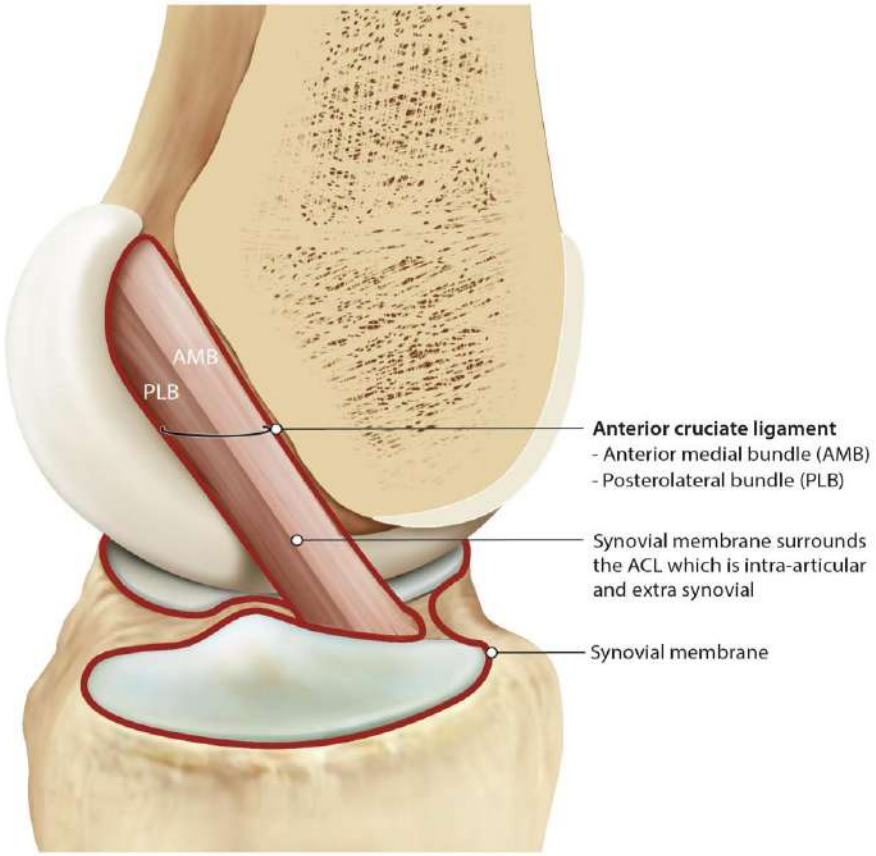
ACLR Surgery or repair

# Acute ARC results

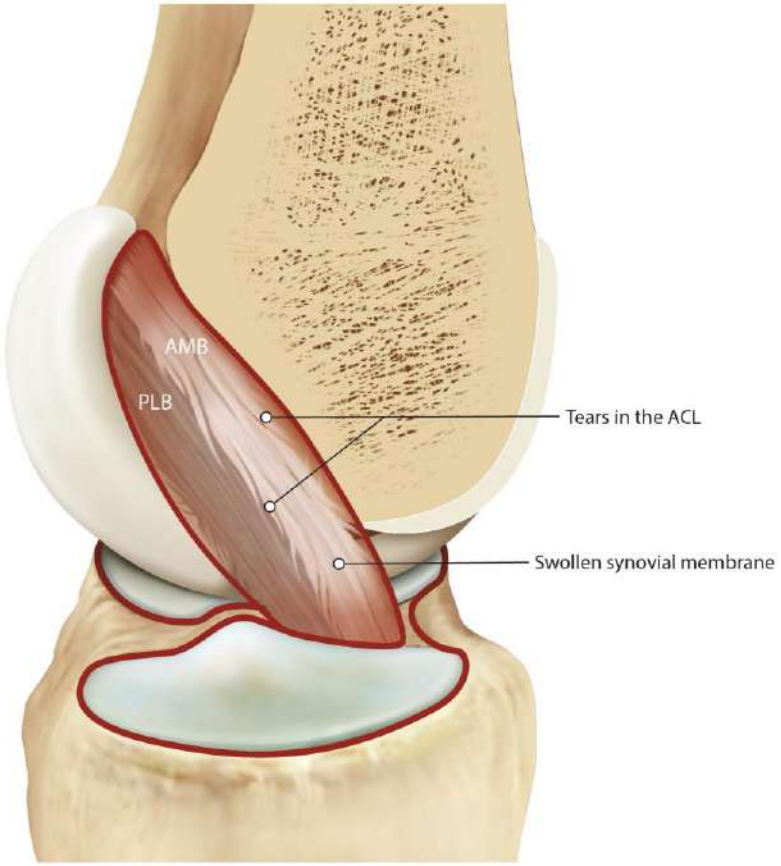


# Type 1 injuries: Intra-substance injury

- Non-displaced



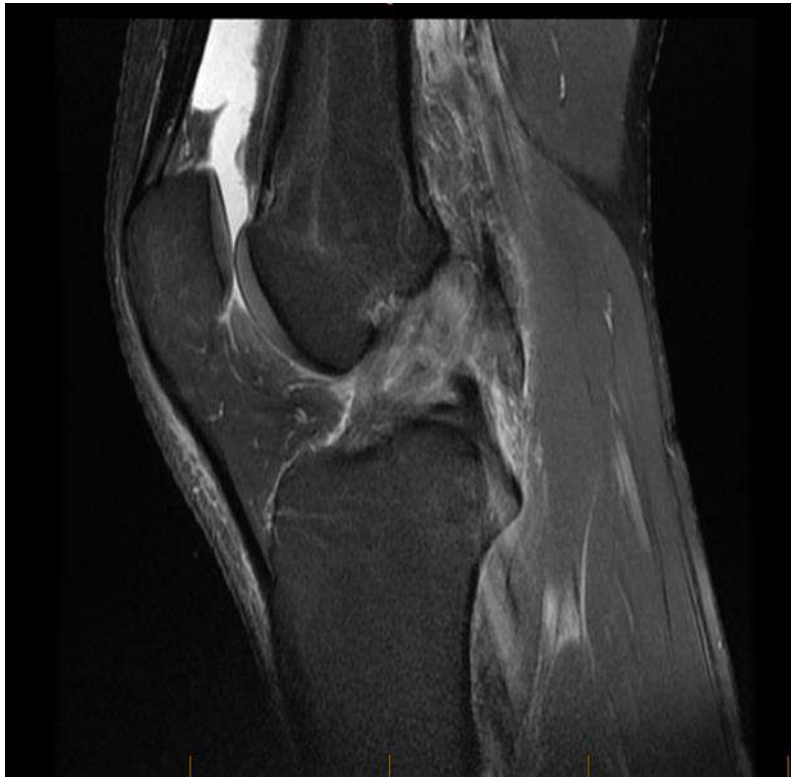
# Type 1- intrasubstance



# Type 1 intrasubstance

## 22-year-old male AFL footballer

acute

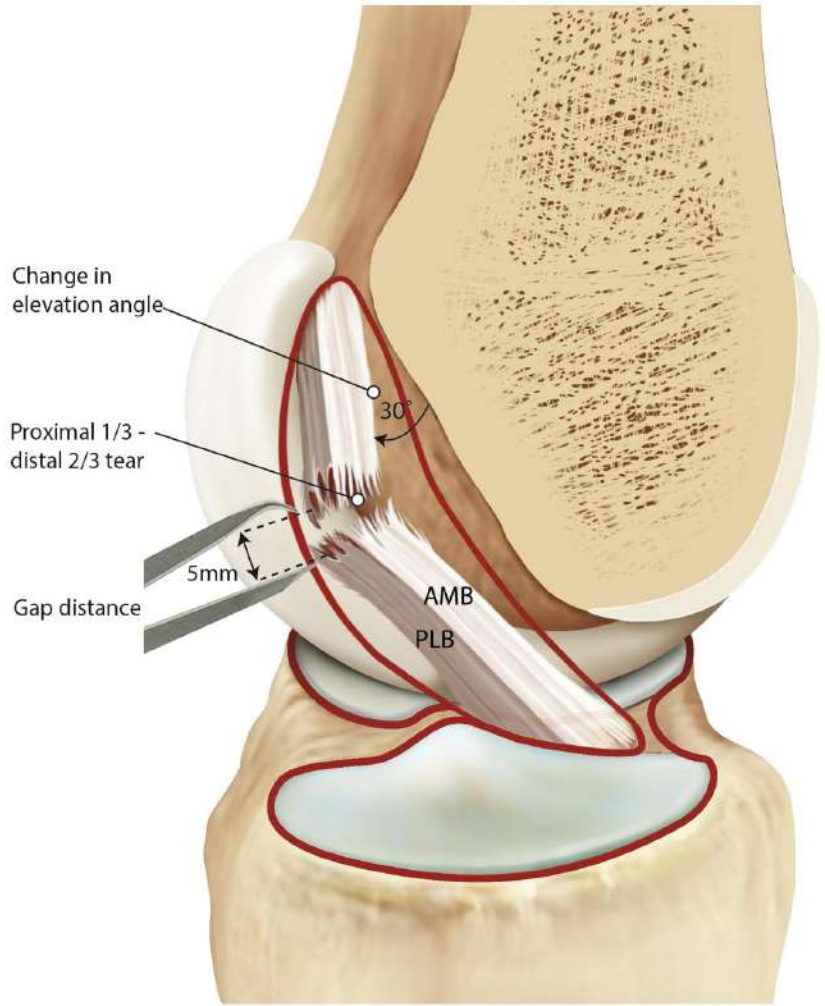


9 weeks

6 months

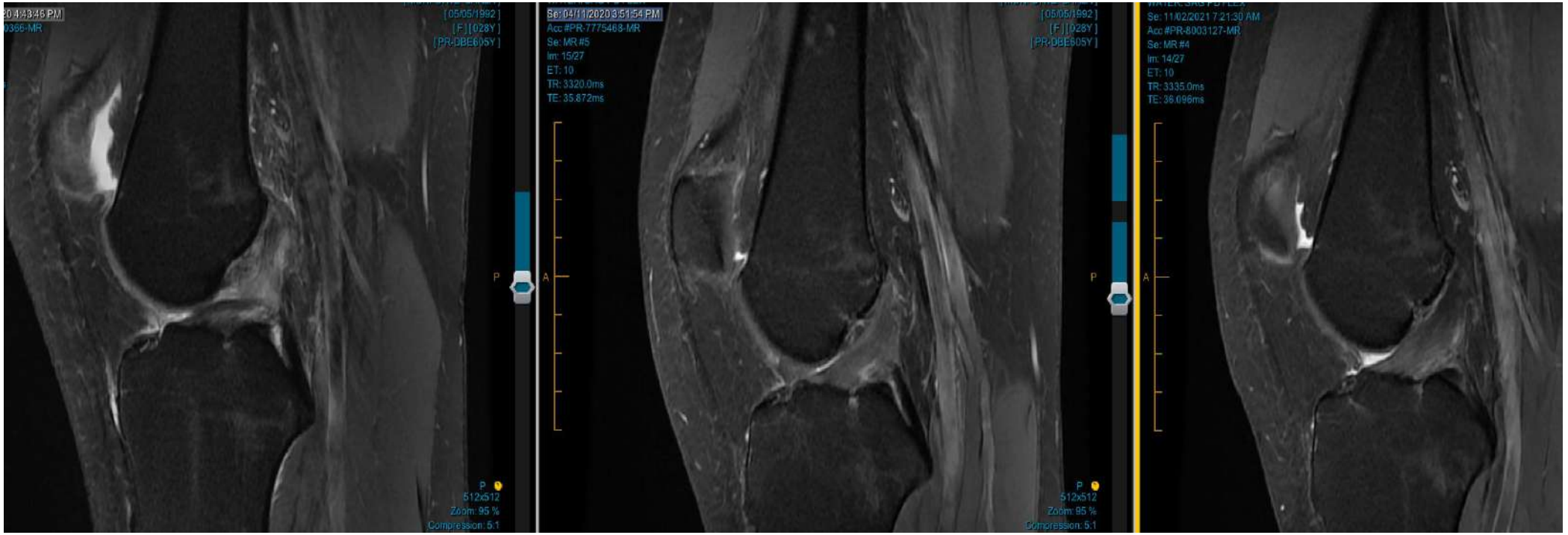
# Patient 10: return to sport

# Type 1 Rupture: proximal injury



# Type 1 Rupture:

28 yr. old female AFL footballer

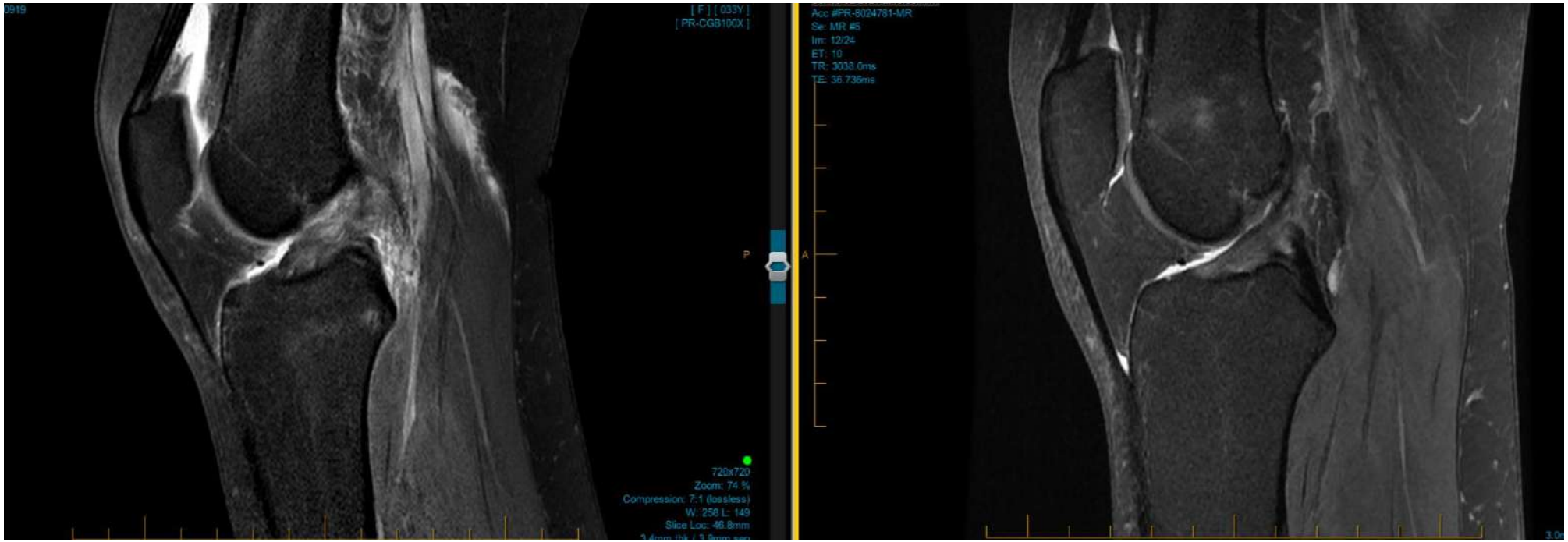


# Type 1Rupture:

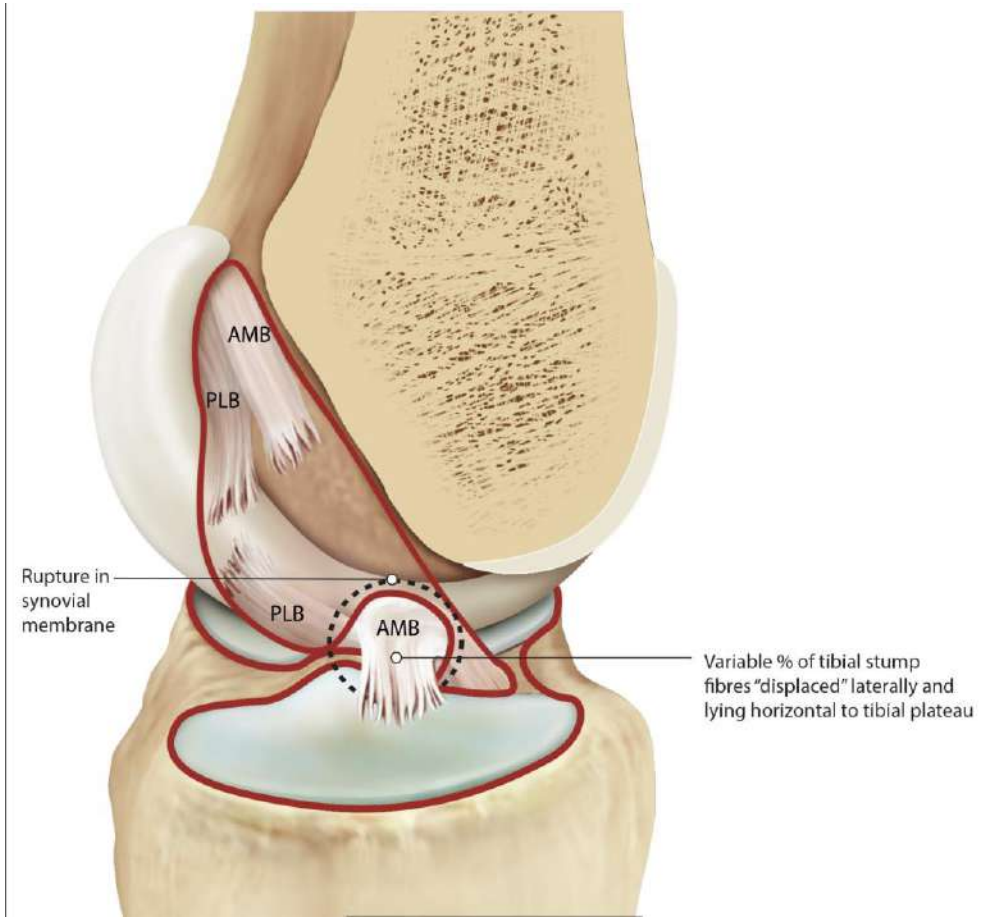
24 Male skier

# Type 1Rupture:

33 female skier



# Type 1 Displaced lateral



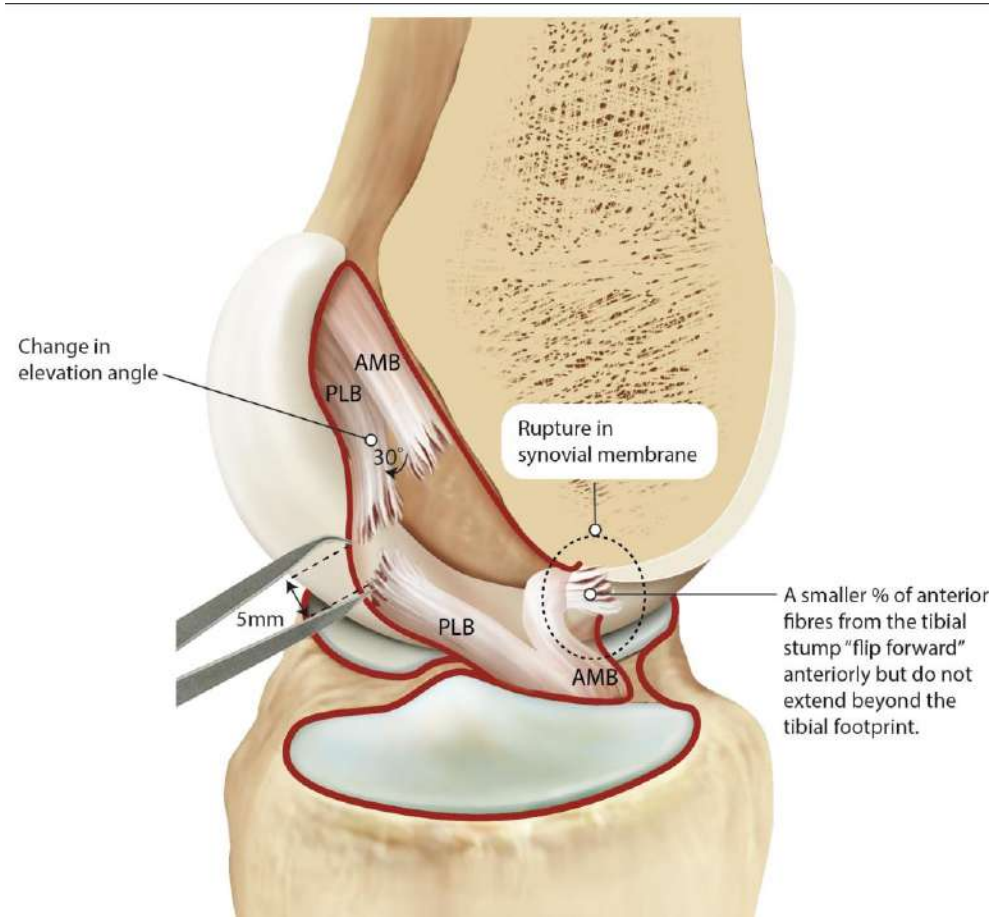
# Type 1Displaced lateral:

37 Male soccer player

# Type 1Displaced :lateral

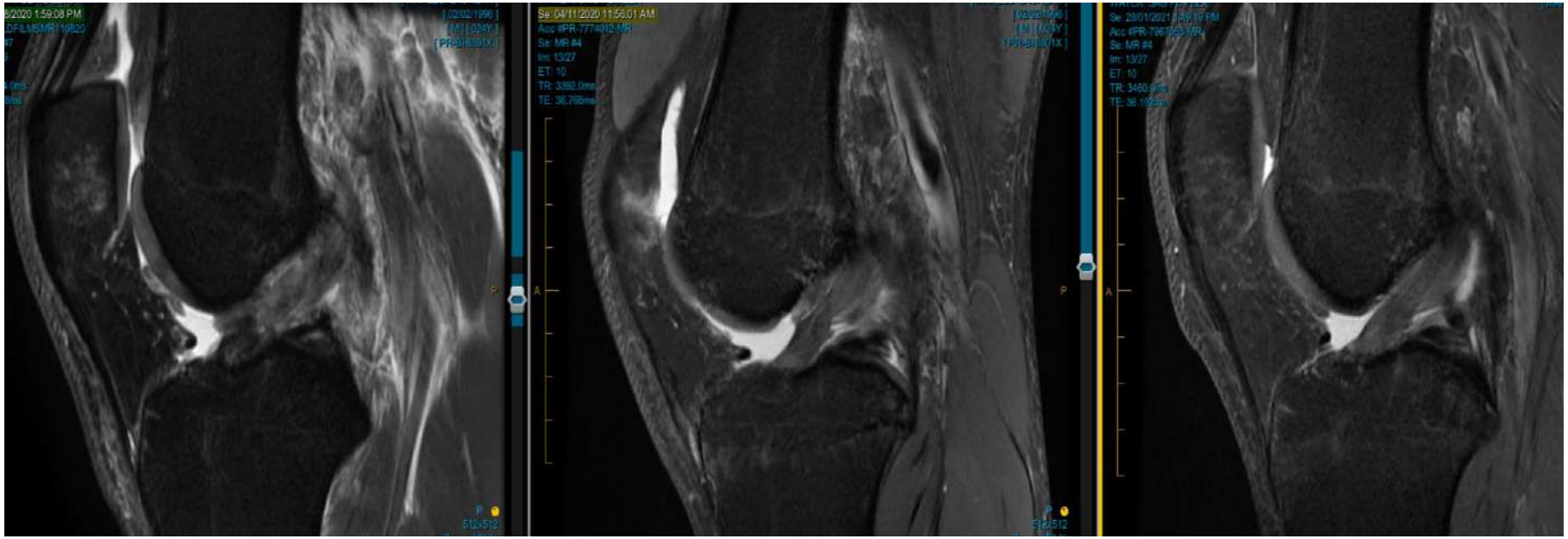
20 Male rugby player

# Type 1 Displaced anterior: small “flipped bundle”

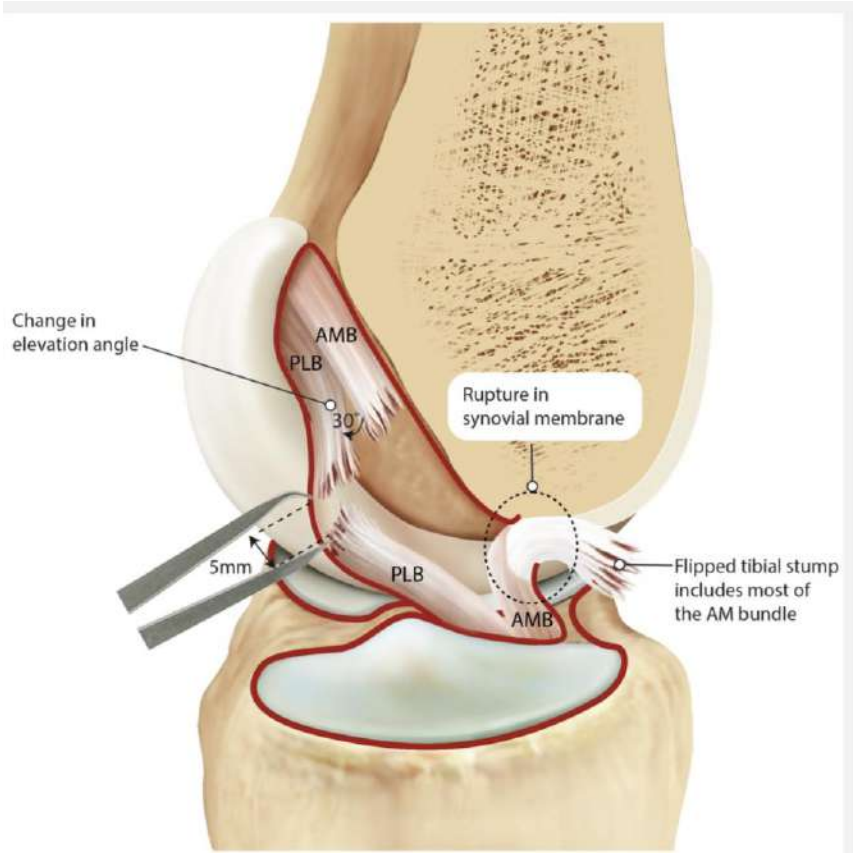


# Type 1 Displaced anterior: Flipped-small:

23 Male AFL



# Type 1 Displaced anterior: large “flipped bundle”



# Type 1 Flipped-large :

35 female soccer

# Type 1 Flipped- large :

Female 49 soccer

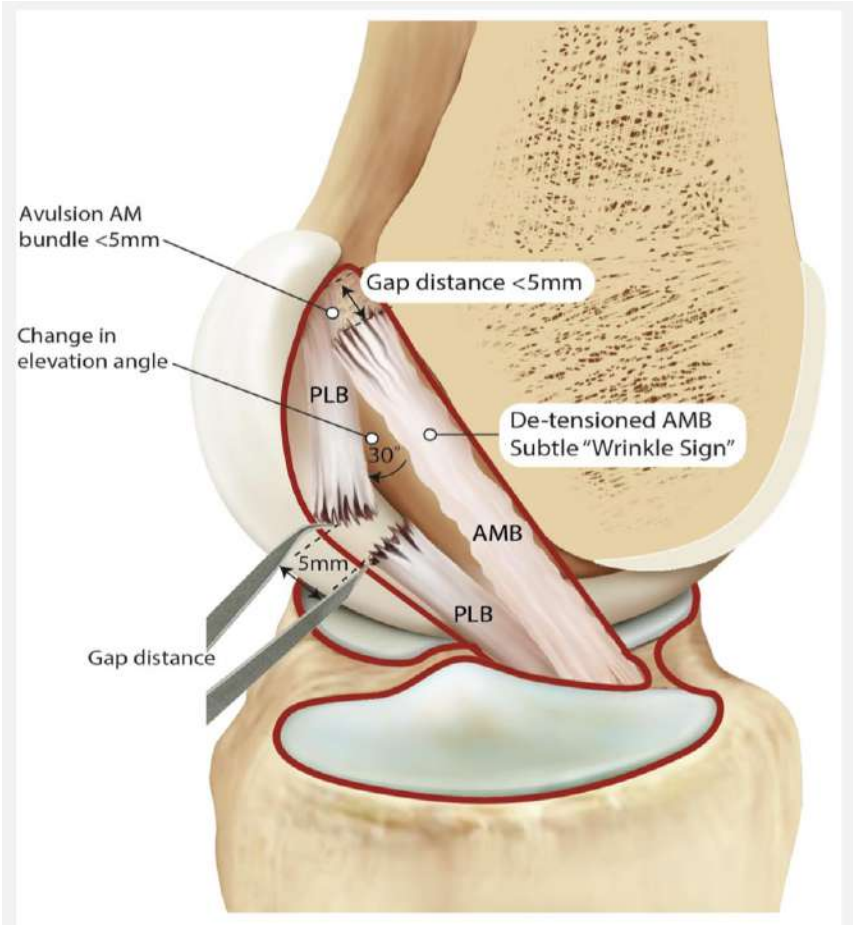
# Type 2 acute ACL injuries:

## partial FEMORAL avulsion injuries

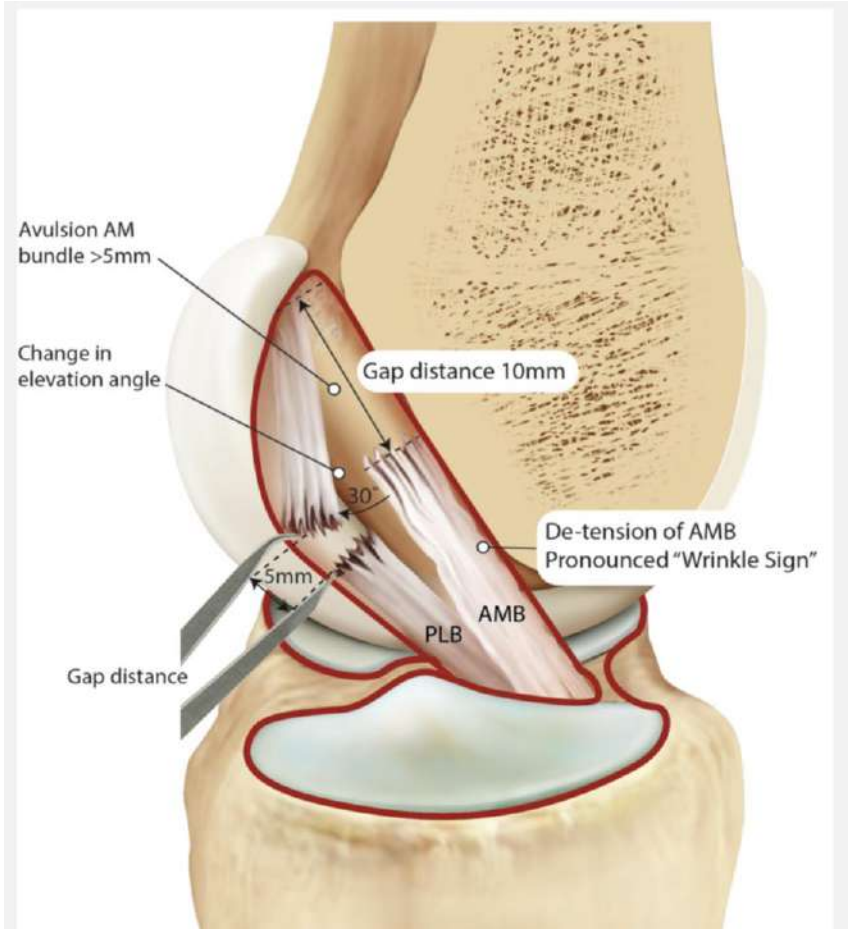
Non-displaced

Displaced

# Type 2 Rupture: non-displaced

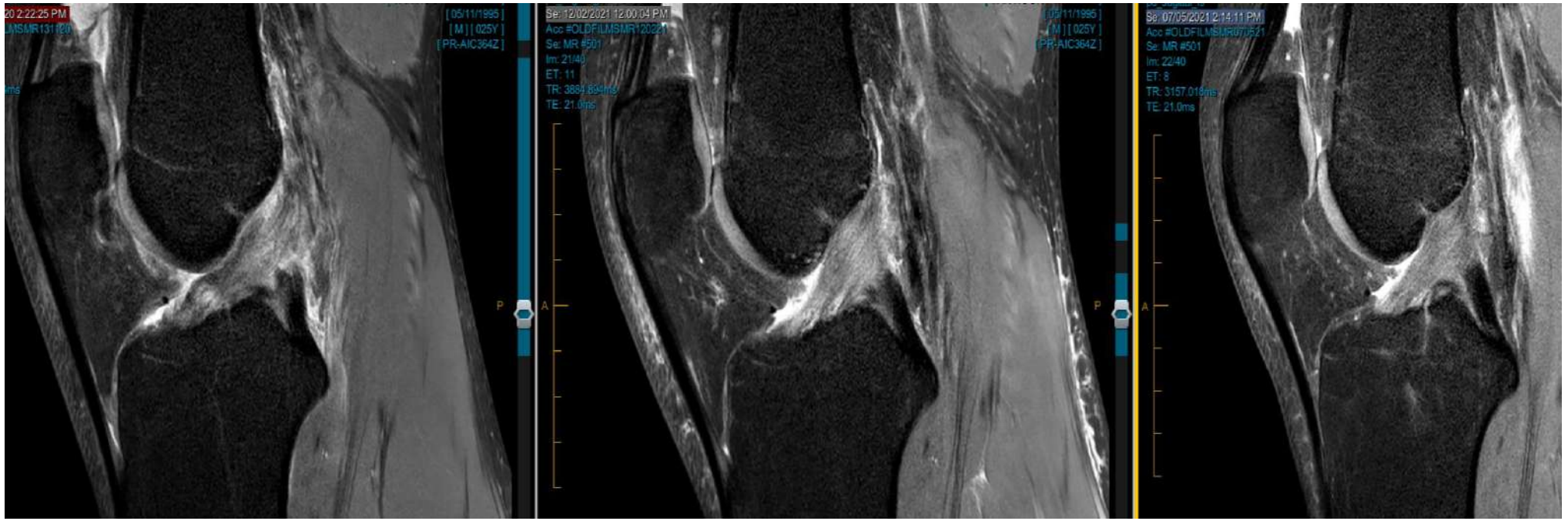


# Type 2 Rupture: non-displaced



# Type 2Rupture:

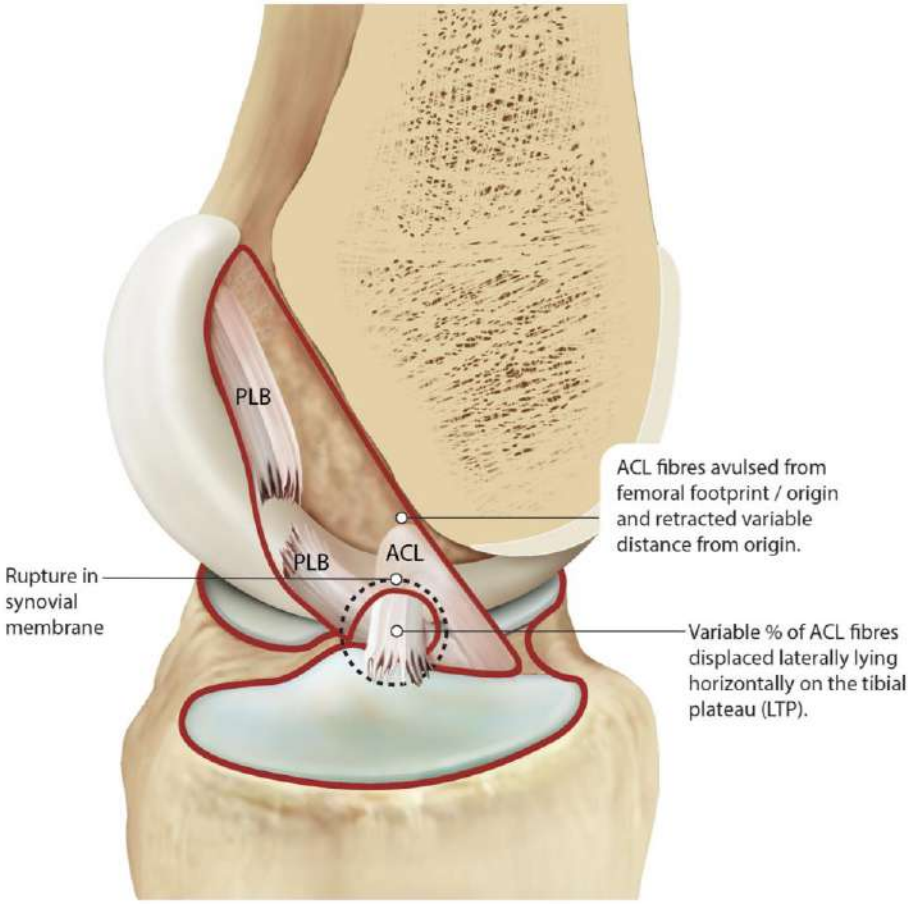
25 Male soccer



# Type 2Rupture:

Male 21 soccer

# Type 2 Displaced : lateral

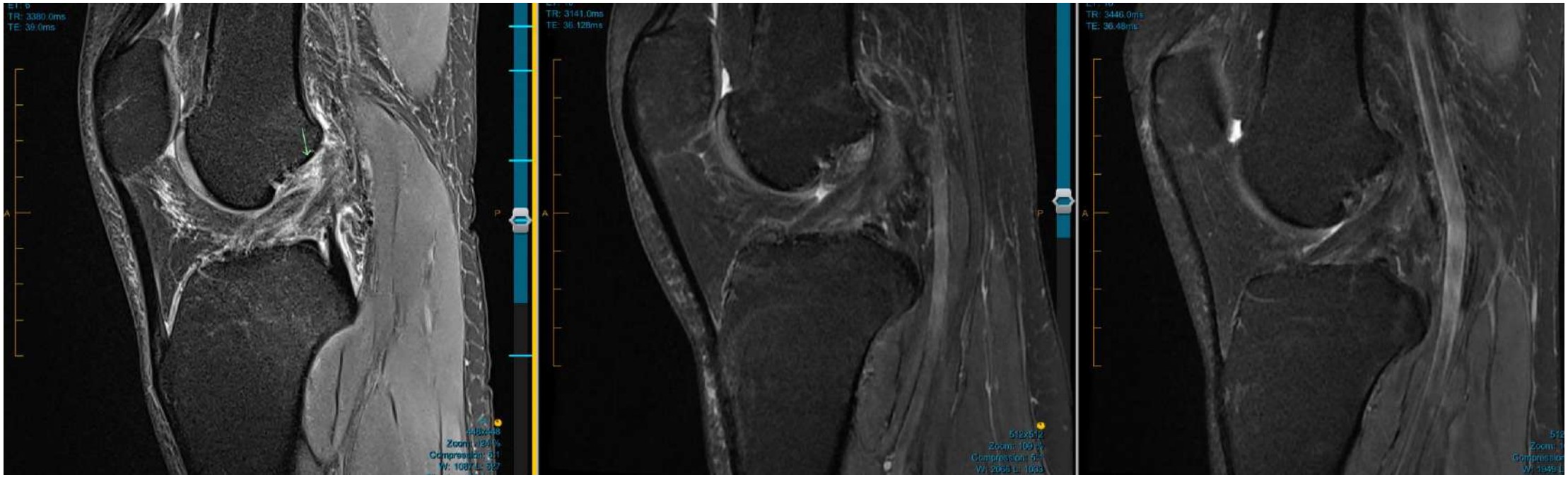


# Type 2 Displaced: lateral

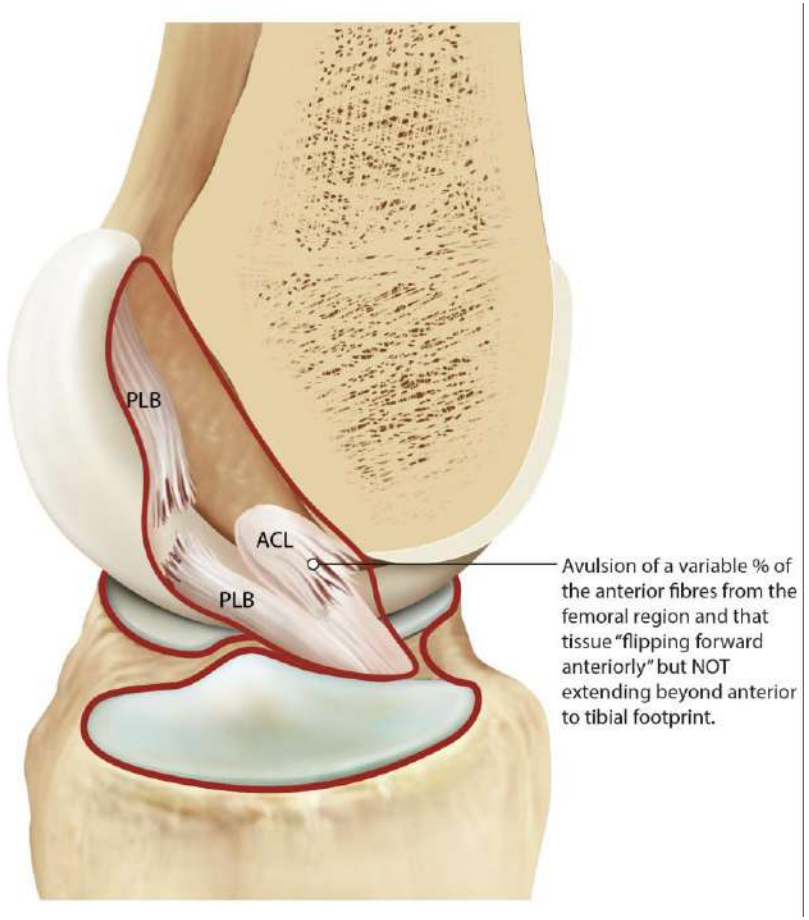
Male 58 soccer

# Type 2 Displaced : lateral

female 25 skateboarding



# Type 2 Displaced : anterior :Flipped-small

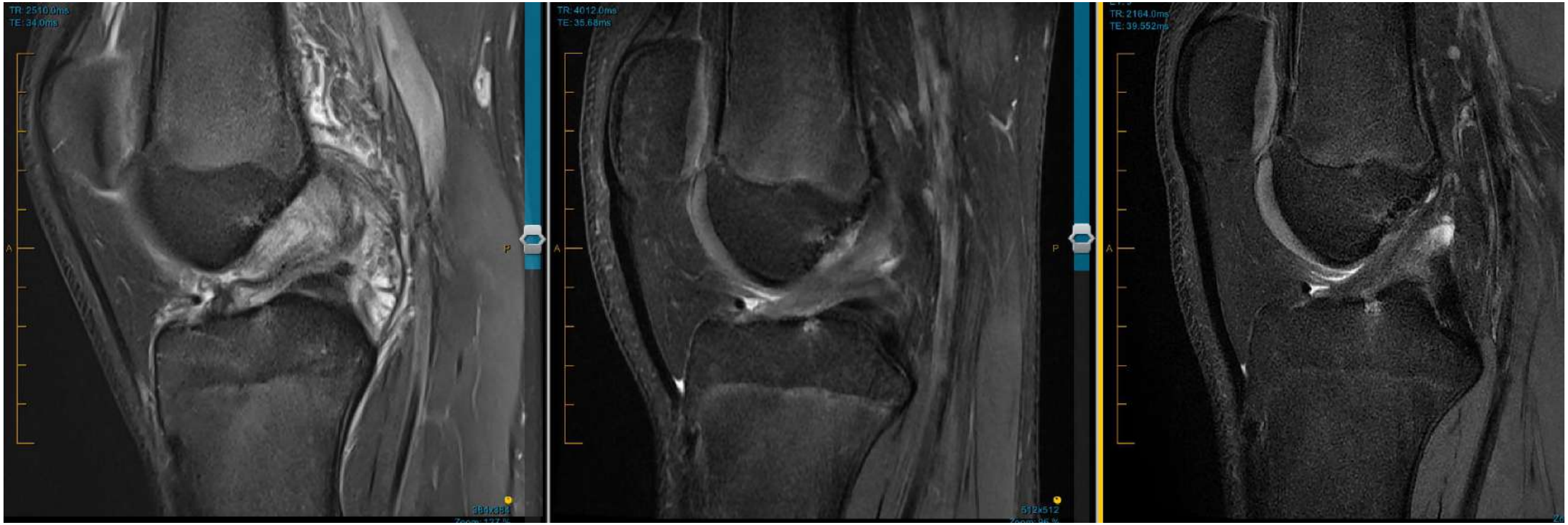


# Type 2Flipped-small

Female 14 skiing

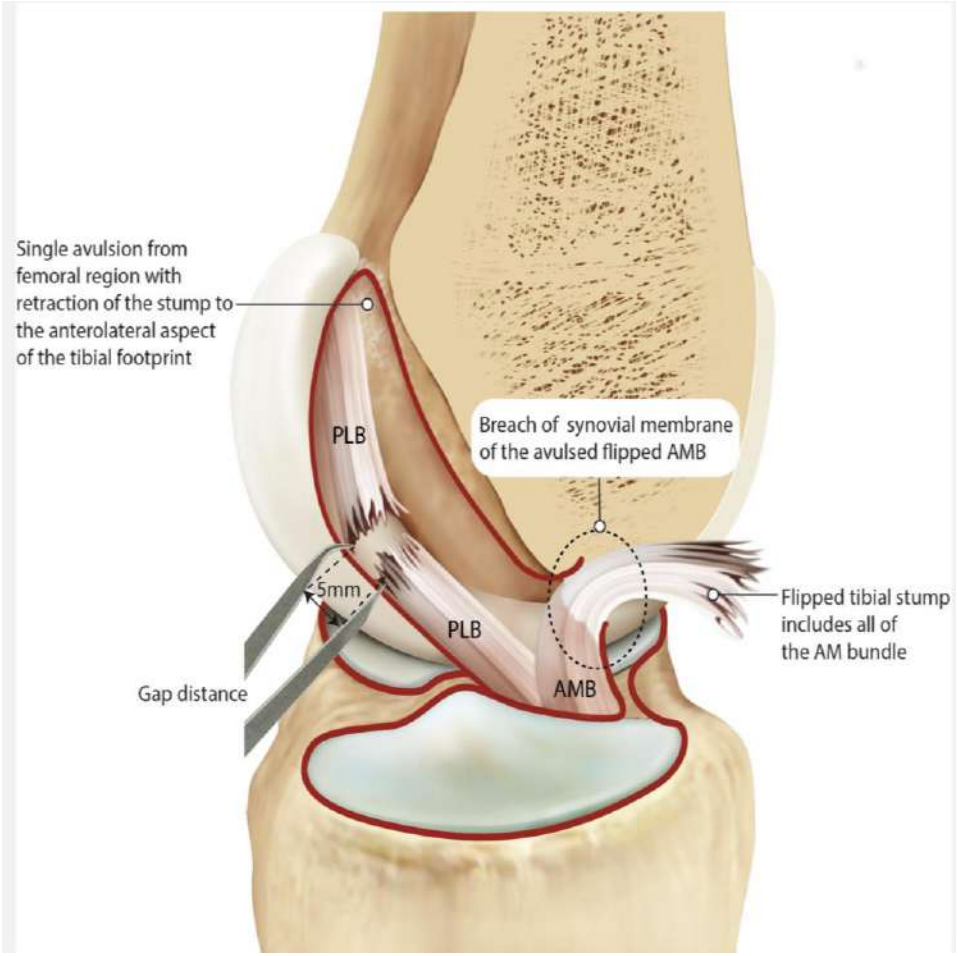
# Type 2 Flipped-small :

Male 15 soccer



Single-bundle heal : stable

# Type 2 Displaced : anterior :Flipped-large



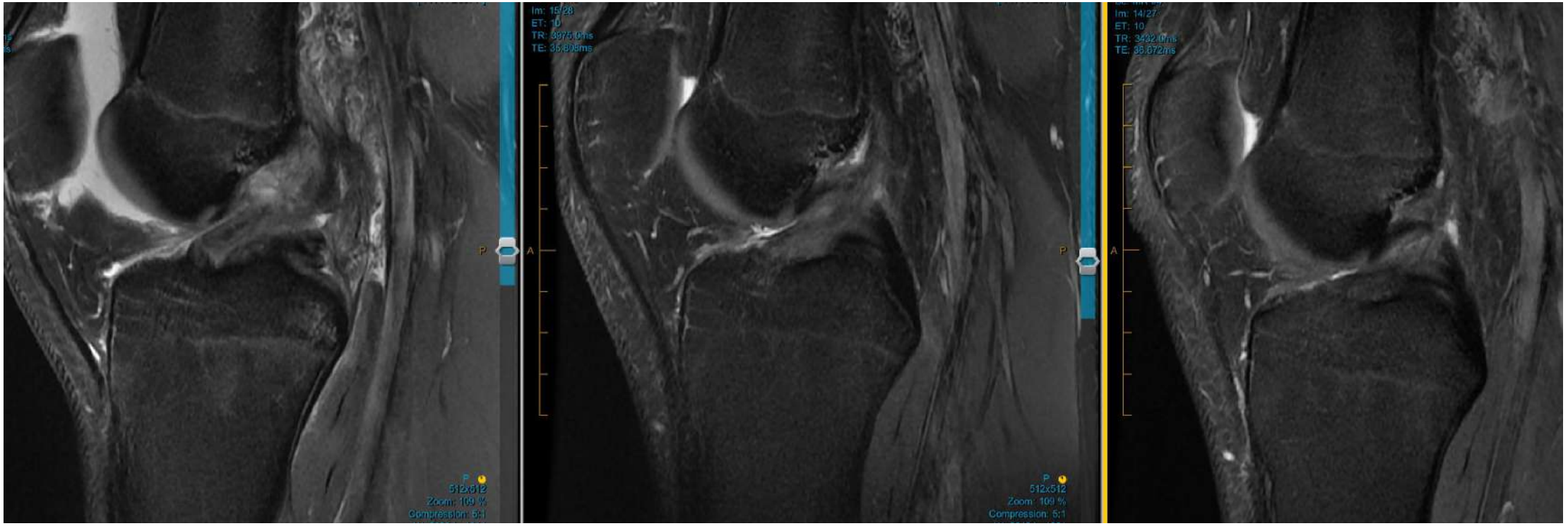
# Type 2 Flipped-large:

## Female 20  Netballer

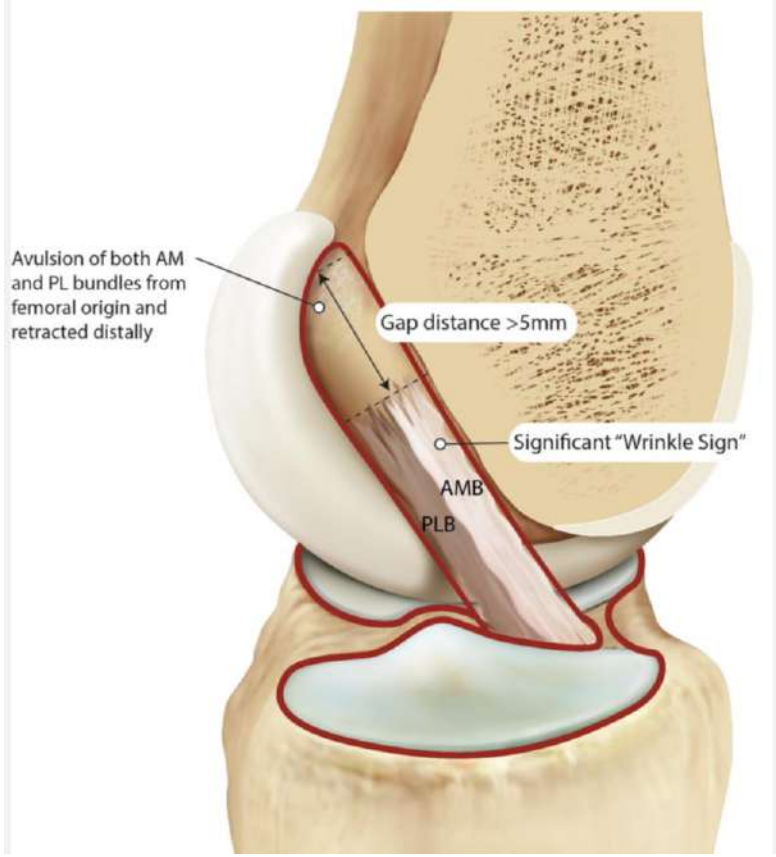
Single bundle Heal: unstable

# Type 2Flipped-large

Male 17 rugby



# Type 3 complete Femoral avulsion



# Type 3: complete Femoral avulsion

- Type 3
- Not Braced
- Referred for ACLR

# There is a SPECTRUM of INJURY!!


Spontaneous Healing

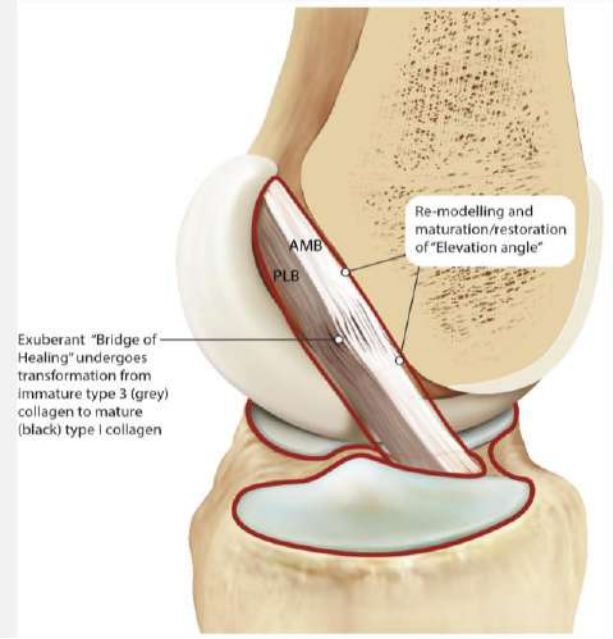
?Heal with a Bracing Protocol

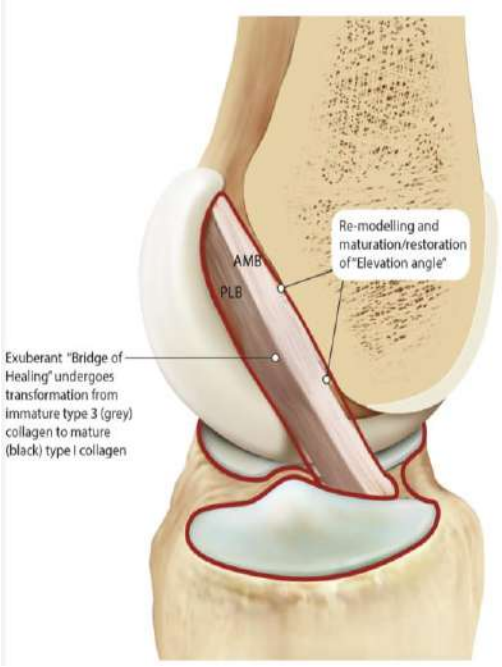
ACLR Surgery or repair

# Spectrum of Healing

# There is a “Spectrum of healing”

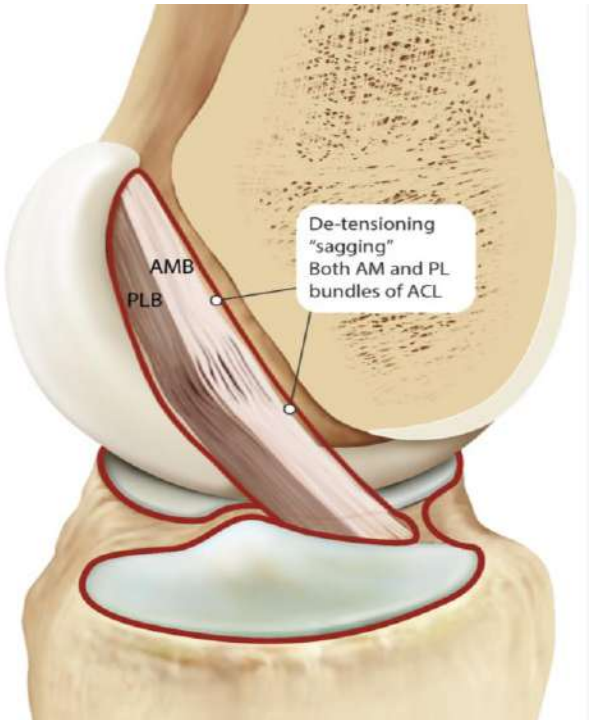
- Normal Thickness- Taut



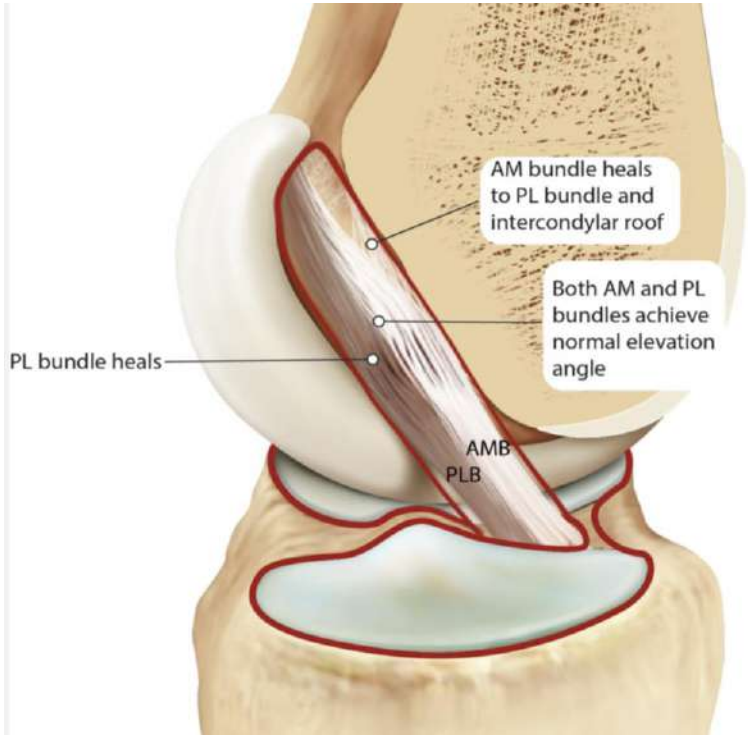
# Spectrum of Healing

- Normal Thickness - SAG



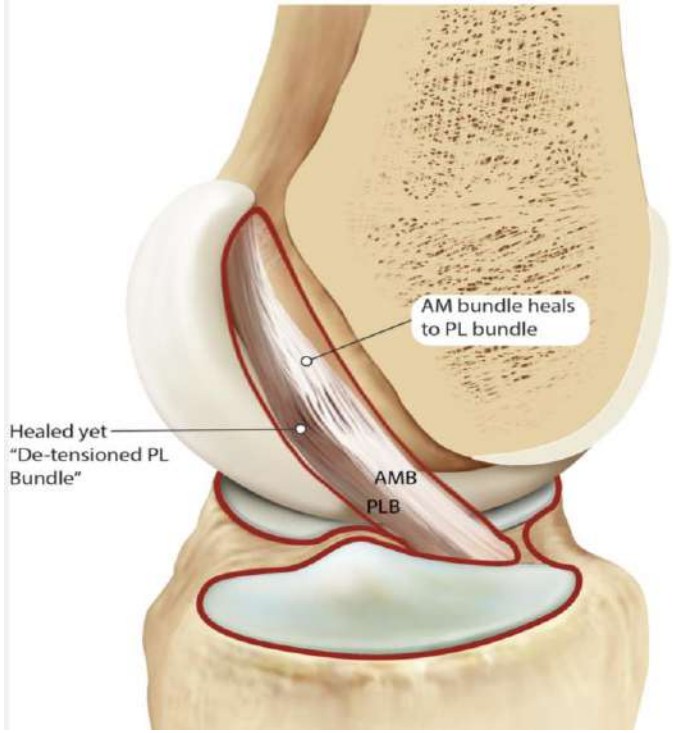
# Spectrum of healing

- Reduced Thickness-Taut



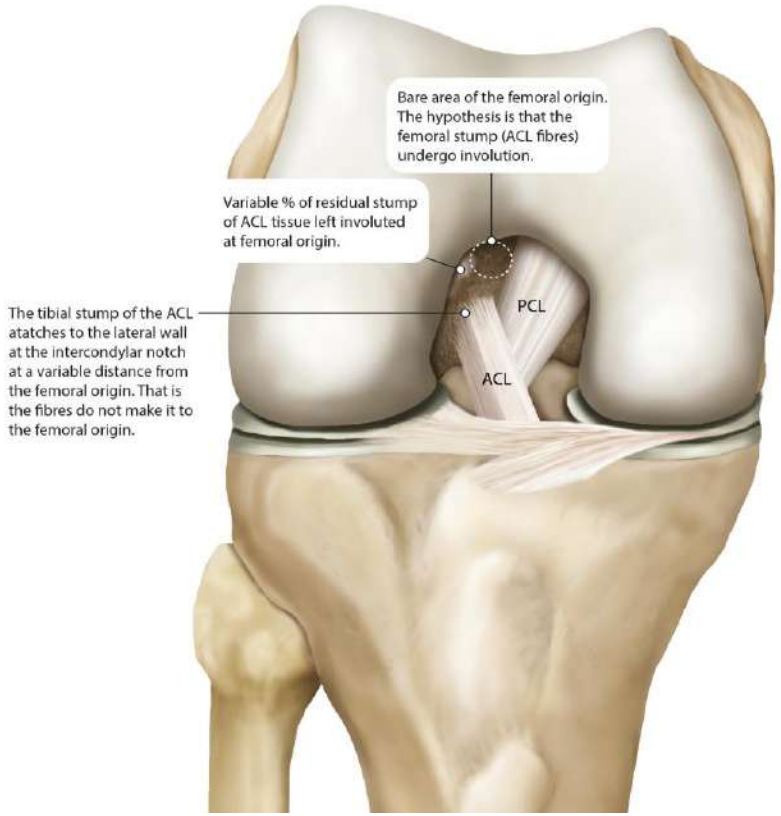
# Spectrum of Healing

- Reduced Thickness-SAG



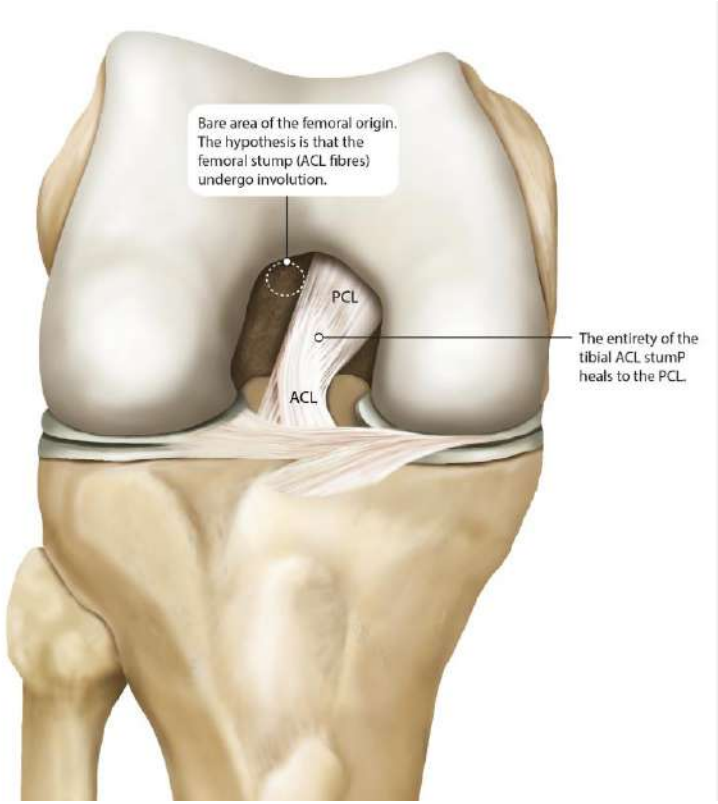
# Non-contiguous healing: “mal-union” healing

- Healing to Lateral Wall



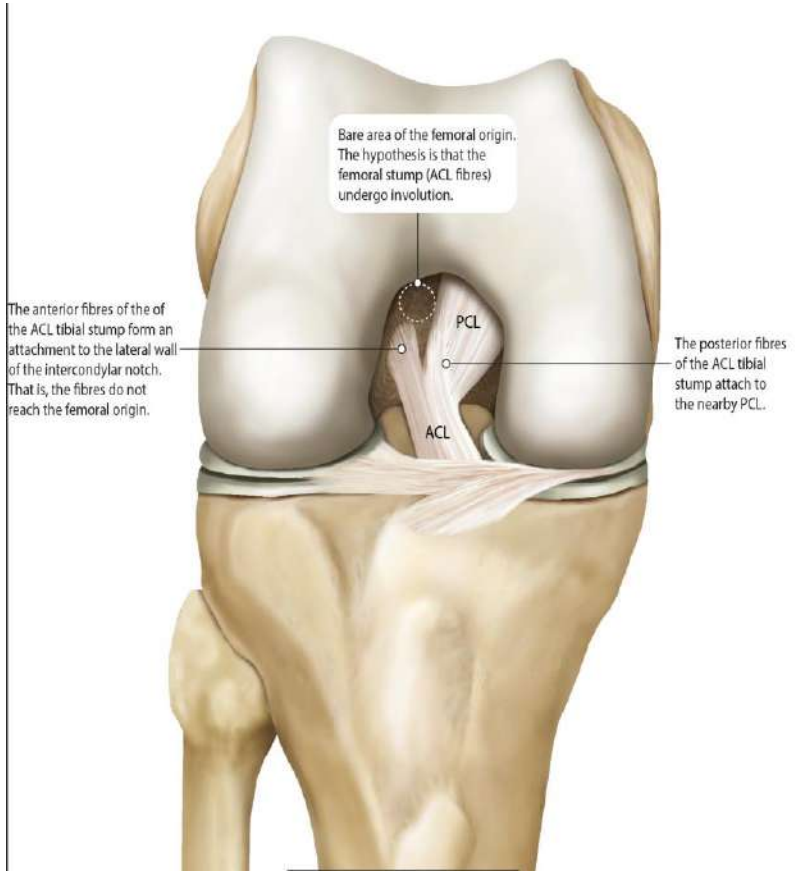
# Non-Contiguous healing

- Healing to PCL

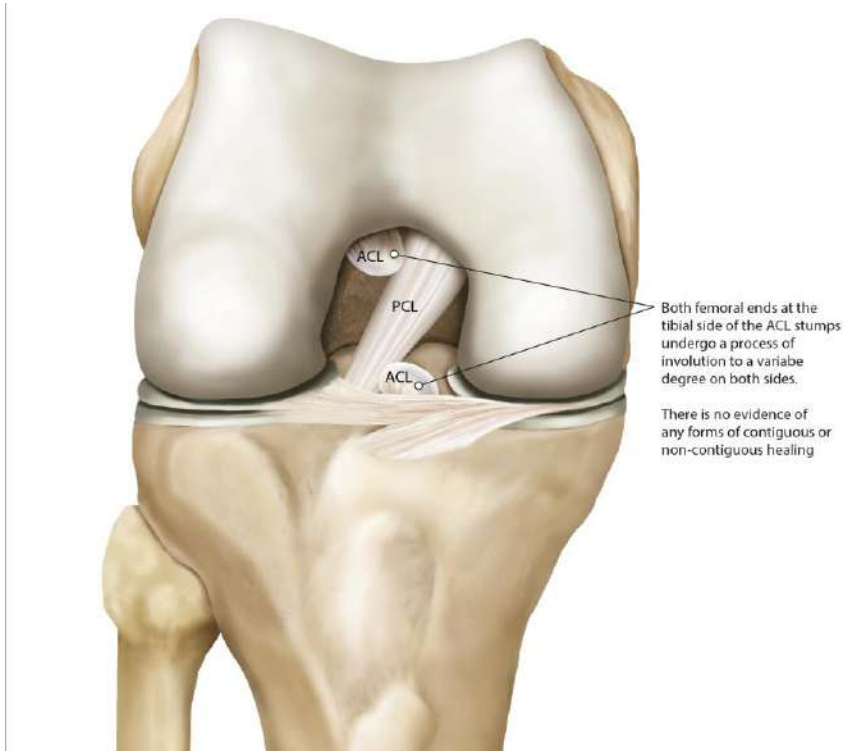


# Non-contiguous healing

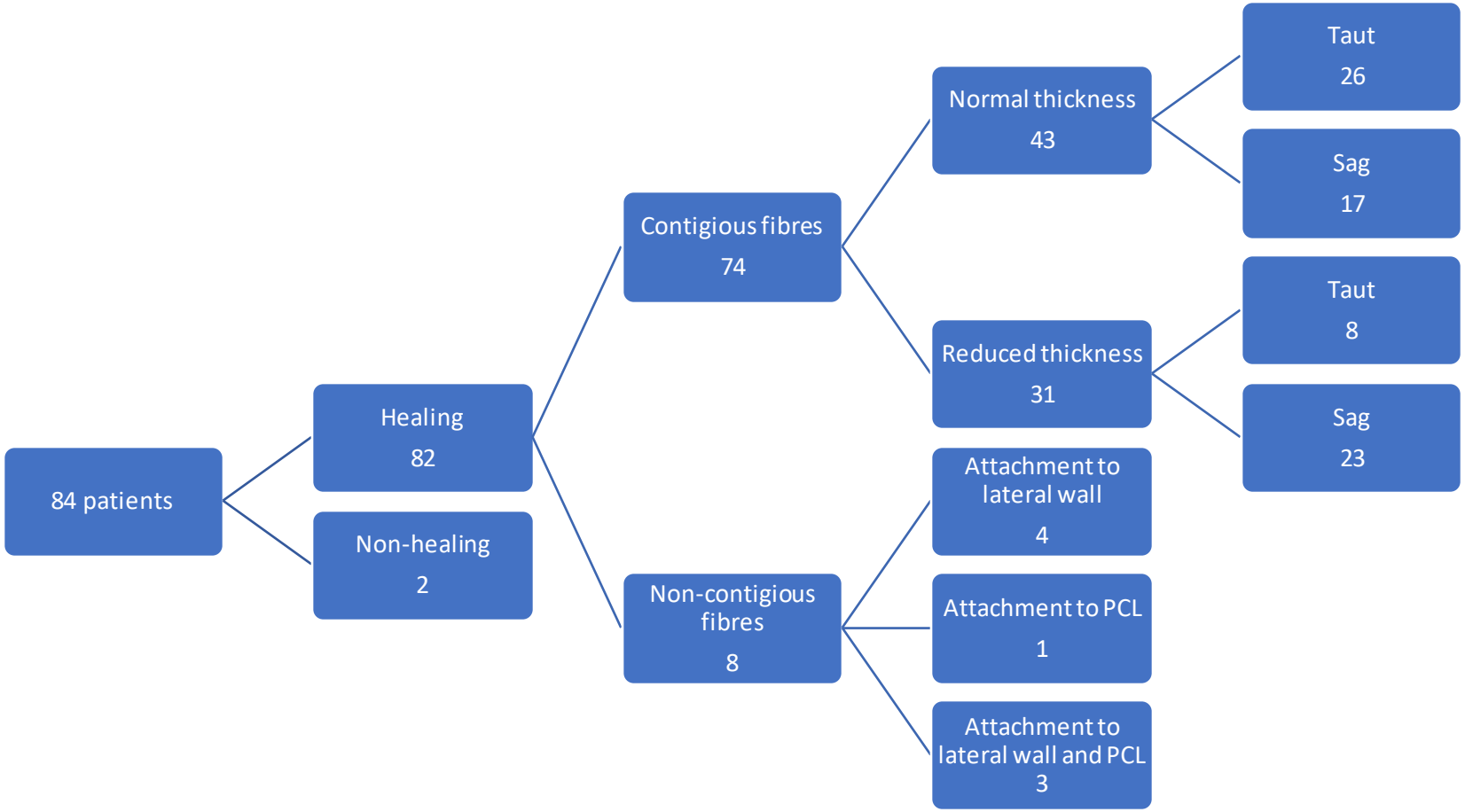
- Lateral Wall and PCL



# No healing= “Non-Union”



# Follow-up ACL Repair Classification



# ACLOAS: "Roemer et al" 2014

- Is a published and validated Radiological classification system

*ACL*: The native ACL is scored from 0 to 3 for all visits following the baseline visit:

0 = Normal ligament with hypointense signal and regular thickness and continuity

1 = Thickened ligament and/or high intraligamentous signal with normal course and continuity

2 = Thinned or elongated but continuous ligament

3 = Absent ligament or complete discontinuity

# ACLOAS : Kanon study

- Rehabilitation alone

- N=26 patients
- Definition of healed= ACLOAS score of 0,1 or 2.

  - 56% healed ACL at 2 years
  - 58% healed ACL at 5 years

# ACLOAS results for CBP + rehabilitation

**ACLOAS**

3 months

| ACLOAS | Number of patients | Number of patients | Percentage of patients |
|---|---|---|---|
| 0 | 3 | 70 | 90% |
| 1 | 38 | | |
| 2 | 29 | | |
| 3 | 8 | 8 | 10% |
| Total | 78 | 78 | |

6 months

| ACLOAS | Number of patients | Number of patients | Percentage of patients |
|---|---|---|---|
| 0 | 7 | 67 | 88% |
| 1 | 35 | | |
| 2 | 25 | | |
| 3 | 9 | 9 | 12% |
| Total | 76 | 76 | |

# CBP + rehabilitation

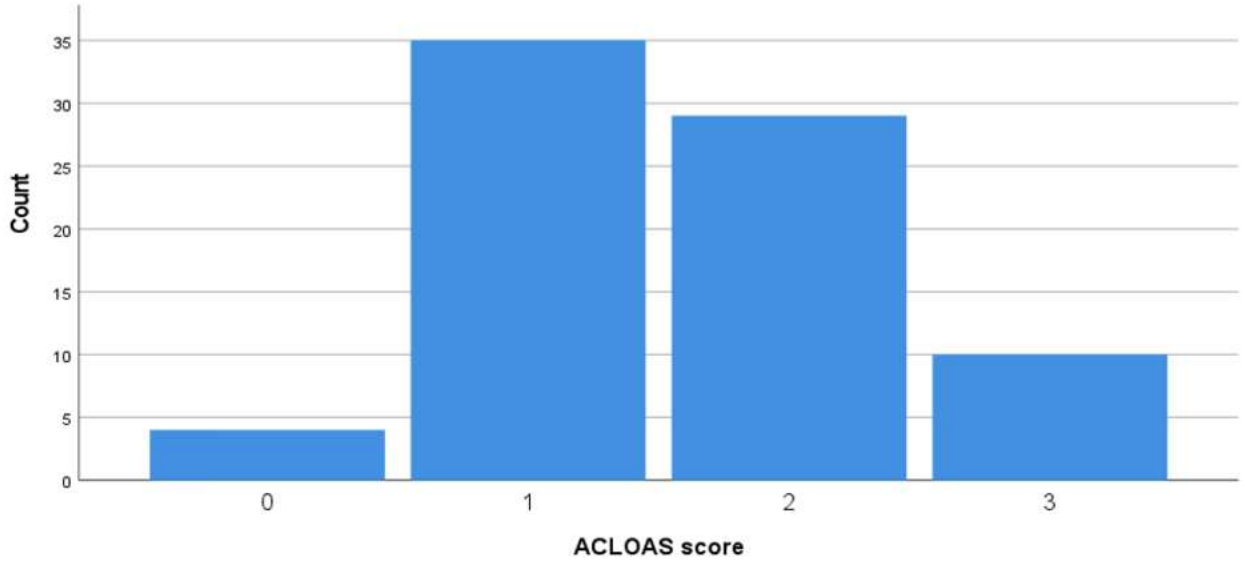
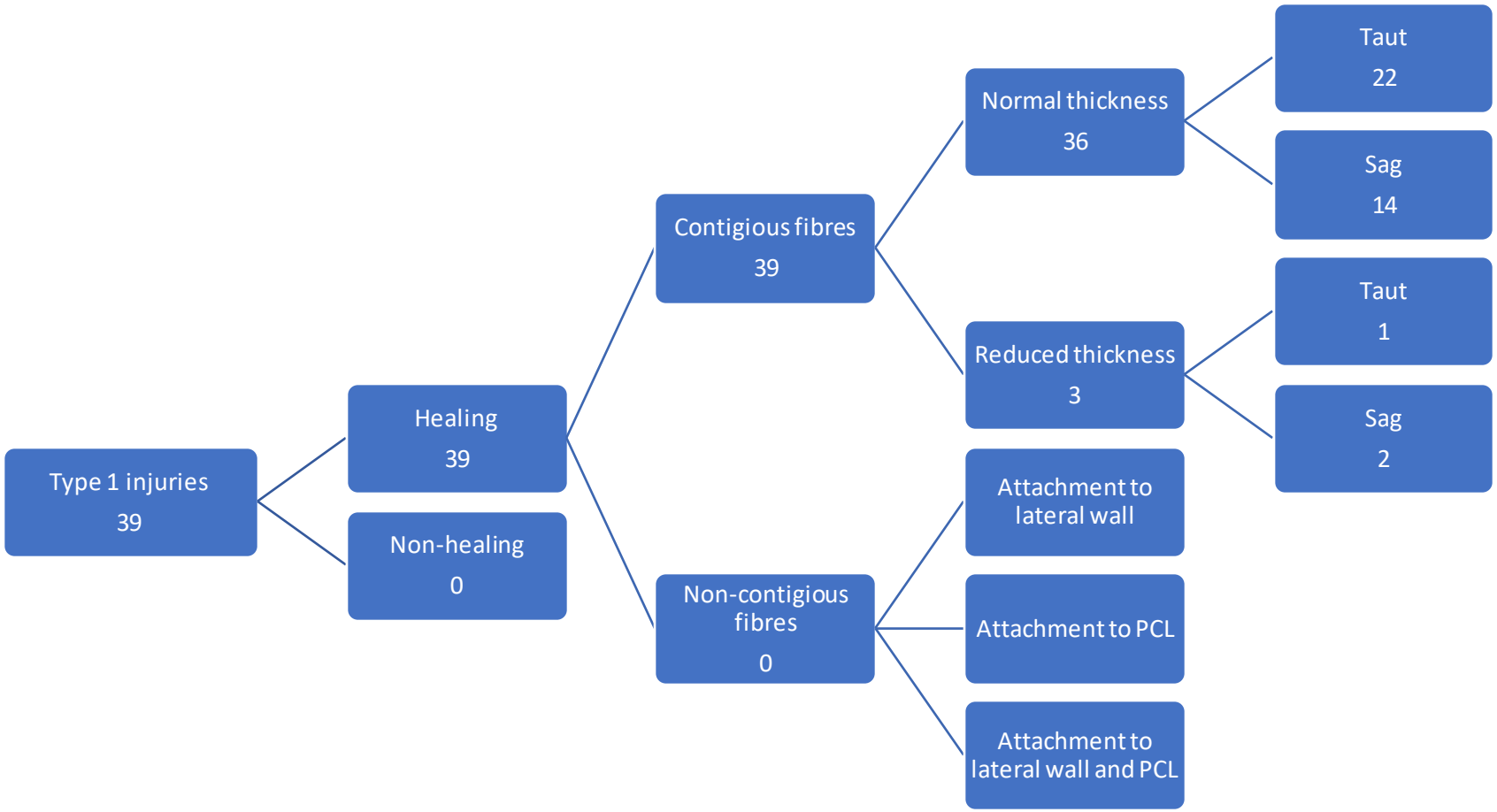
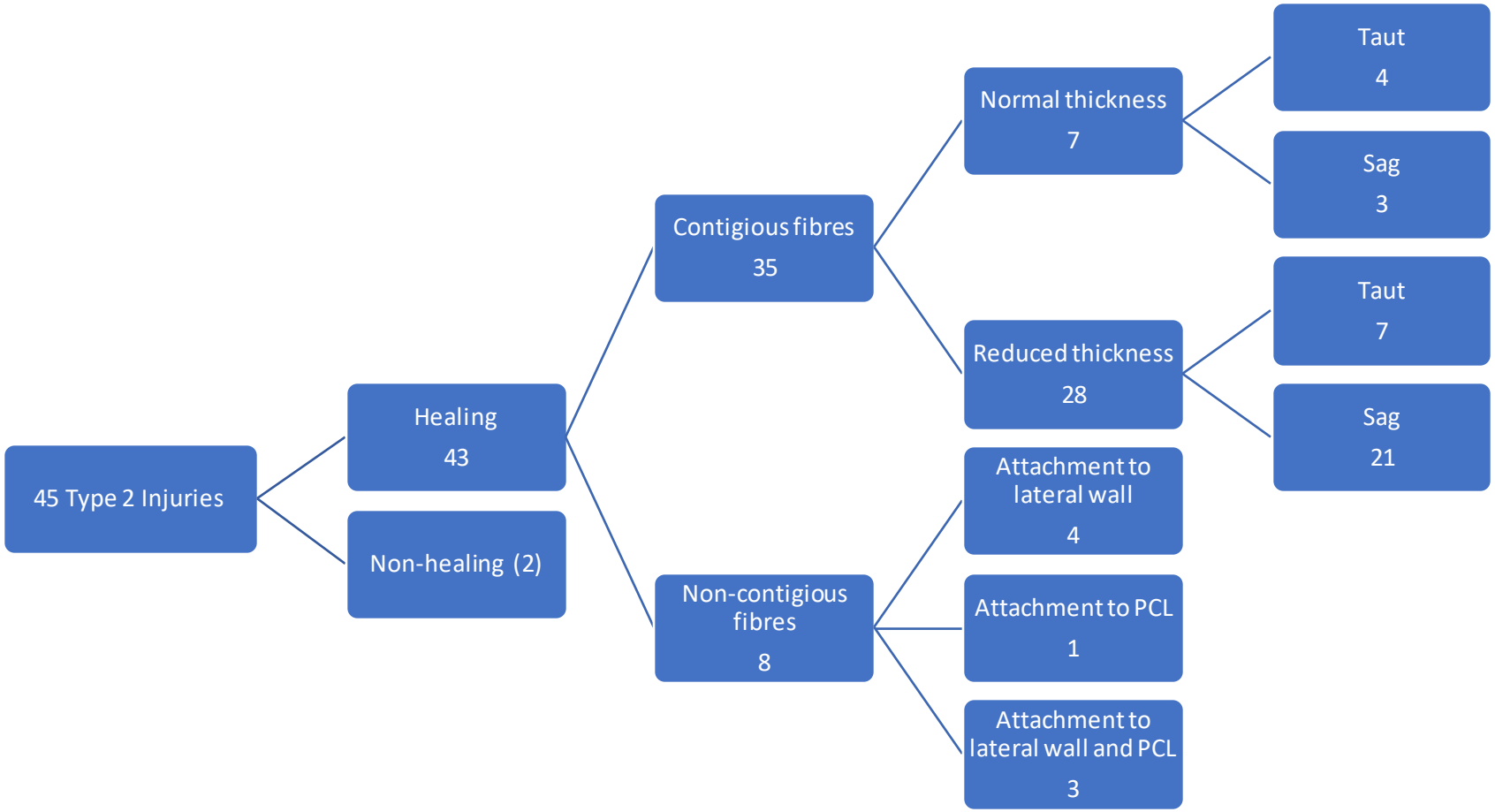



***Figure 2.*** Number of patients populating each ACLOAS score at six-months after initiating the CBP.

# Type 1 ACL injury: healing outcomes

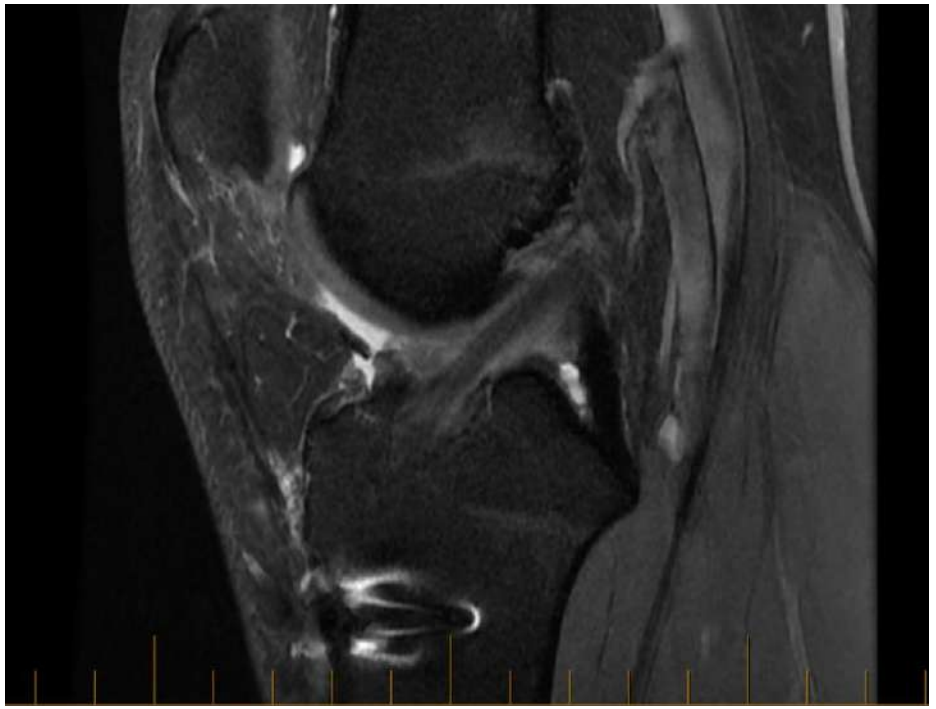


# Type 2 ACL injury: healing outcomes



# How many “crossed over” to Surgery?

- 14 ACLR
  - 11 Type 2 displaced
  - 3 Type 1
- 1 Arthroscopy : Partial LM
- 1 Arthroscopy: “cyclops lesion”

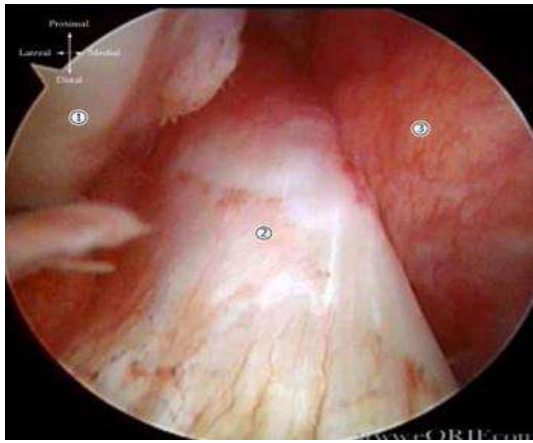


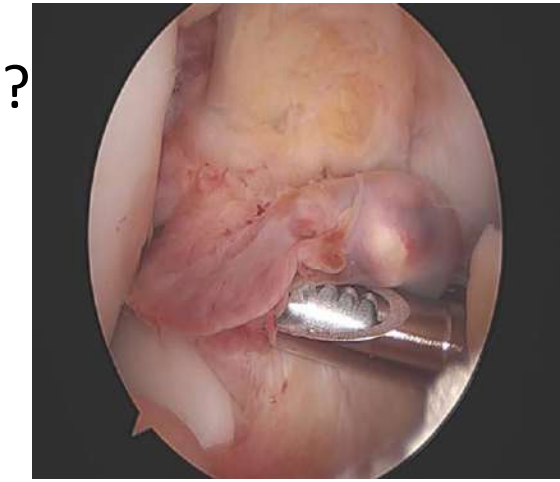
# Conclusions

- The ACL has great capacity to heal
- Certain acute ACL injuries heal better than others!
- Bracing the knee at 90 degrees flexion makes the healing even better!
- There is a subset of acute ACL injuries that can achieve “anatomical healing”
- There is a subset that will still need either ACL repair surgery acutely or ACL reconstructive surgery

# Hypotheses: MRI factors

- Is there a femoral avulsion?
- How displaced are the ACL tissues??
- Will the minimally injured ACL heal with rehabilitation alone?
- Can the moderately injured ACL be “resuscitated by closed reduction?
- The severely injured/”moribund” ACL needs open reduction/surgery.



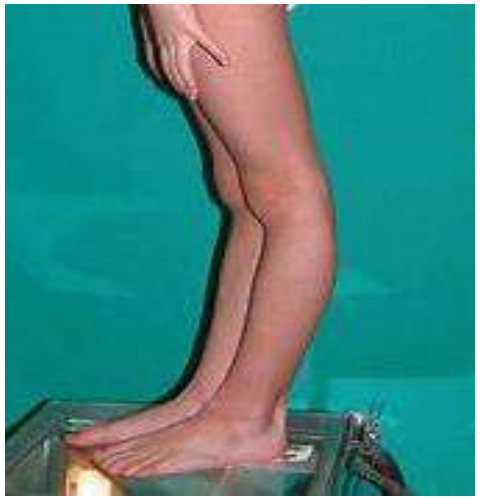


# 3D MRI: will enhance diagnostic accuracy!

3D MRI Heart

# Hypothesis: “Patient factors”

- Patient Factors
    - How acutely are they braced? “Time to brace”
    - If delayed……. “malunion” or “non-union” of the ACL injury
    - Beighton’s score and recurvatum



# Prospective “multi-centre” RCT trial


- Commence 2023
- Ethics approval: University of Melbourne
- RCT comparing Rehabilitation alone Versus CBP + Rehabilitation

# Thank-you

- Dr. Stephanie Filbay
- Matthew Dowsett
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- James Kazaglis
- Justin Merlino
- Michael Moran
- Dr. Maggie Allwright
- Dr. Donald Kuah
- Dr Ra Durie
- Dr Rohan Sabharwal
- Dr Andrew Van Den Heever
- Dr Phil Lucas
- Dr Elliot Palmer
- Dr. Greg Roger
- Dr Mervyn Cross
- Dr Tom Cross

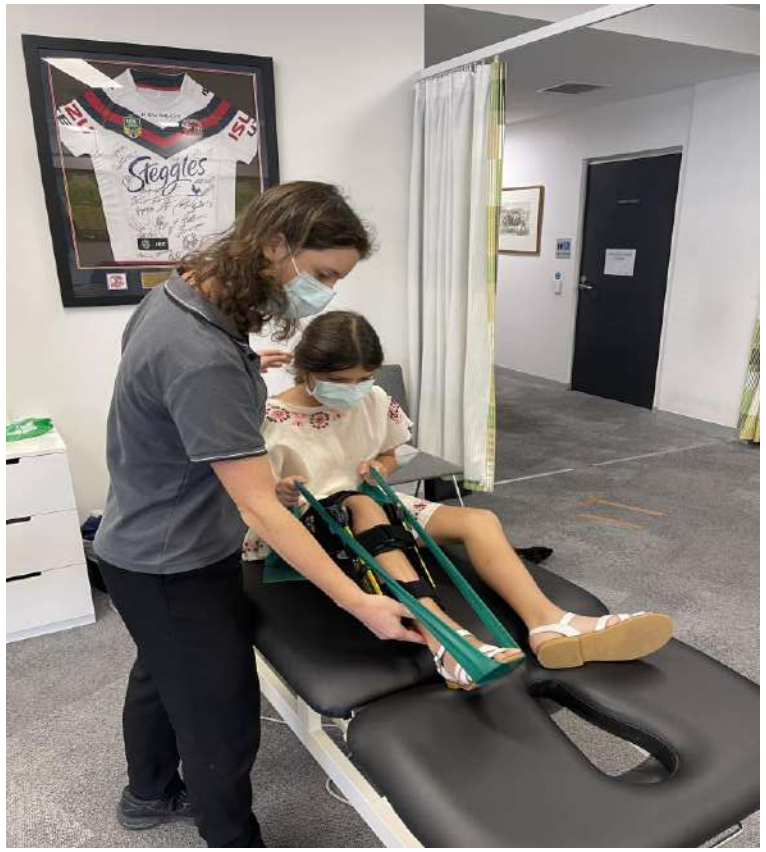
# Thank the patients

# Thank the patients

# Thank the patients

# Thank the patients

# Thank the patients

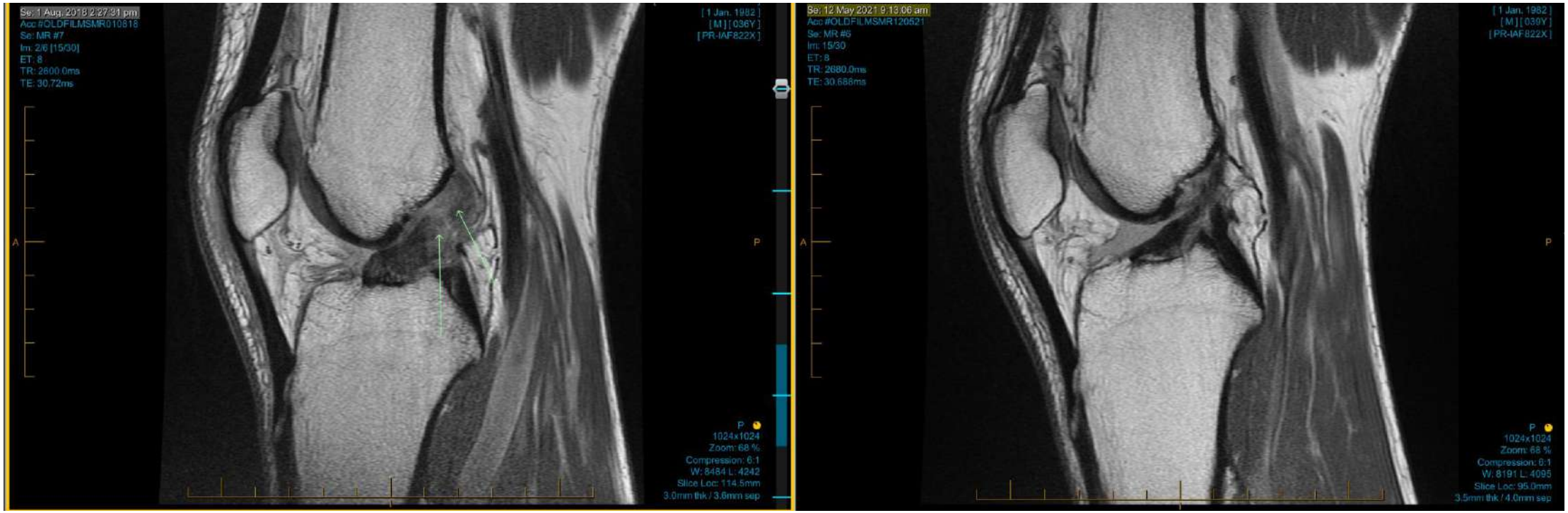



# Rehabilitation alone- No Brace

## Type 1 Rupture and non-displaced- 3-year follow-up MRI

Type 1 Rupture and non-displaced acute injury

ACL deficient clinically and MRI



# There is a SPECTRUM of INJURY!!


Spontaneous Healing

?Heal with a Bracing Protocol

ACLR Surgery or repair

# Minimally disruptive ACL injuries

No avulsion

Intra-substance injury

Continuity of variable amount of ACL ligamentous tissue

Minimal de-tensioning

Arguably may not need a Brace?

Do NOT need ACLR surgery

# Moderately disrupted ACL injuries

No femoral avulsion injury

Complete disruption/fracture of ACL

Variable degree of De-tensioning of femoral and tibial stumps

Variable “Gap Distance” between the stumps

Injured ACL remains within the synovial envelope

Arguably can be “resuscitated” and healed with a Bracing Protocol

# Severely disrupted ACL

Partial or complete Avulsion at femoral origin

Large % of the ruptured ACL displaced anteriorly or laterally

"FLIPPED BUNDLE"

The displaced Flipped Bundle cannot by definition be reduced and participate in healing

This injury is moribund and cannot be resuscitated to full healing

Options

1. Non anatomic healing
2. ACL repair
3. ACLR