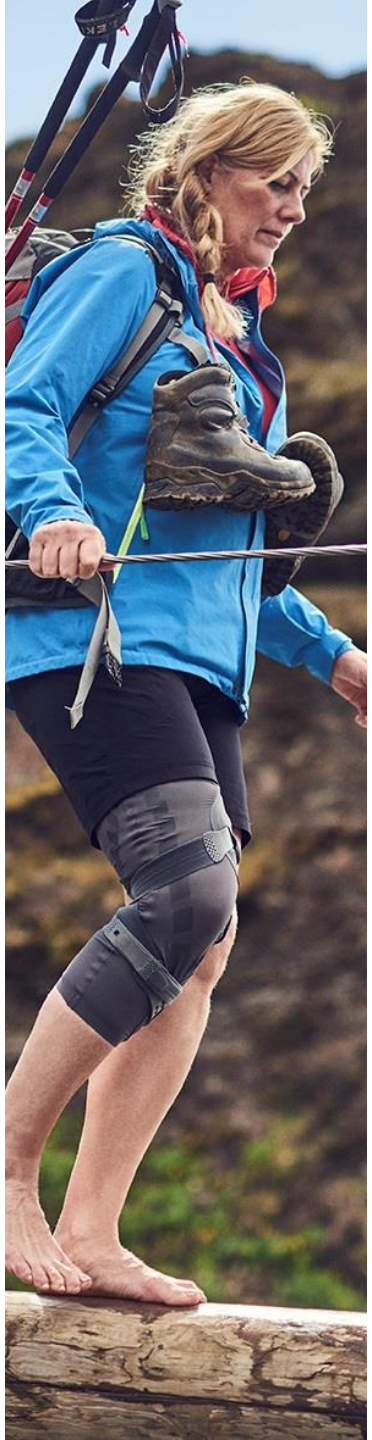


ÖSSUR®

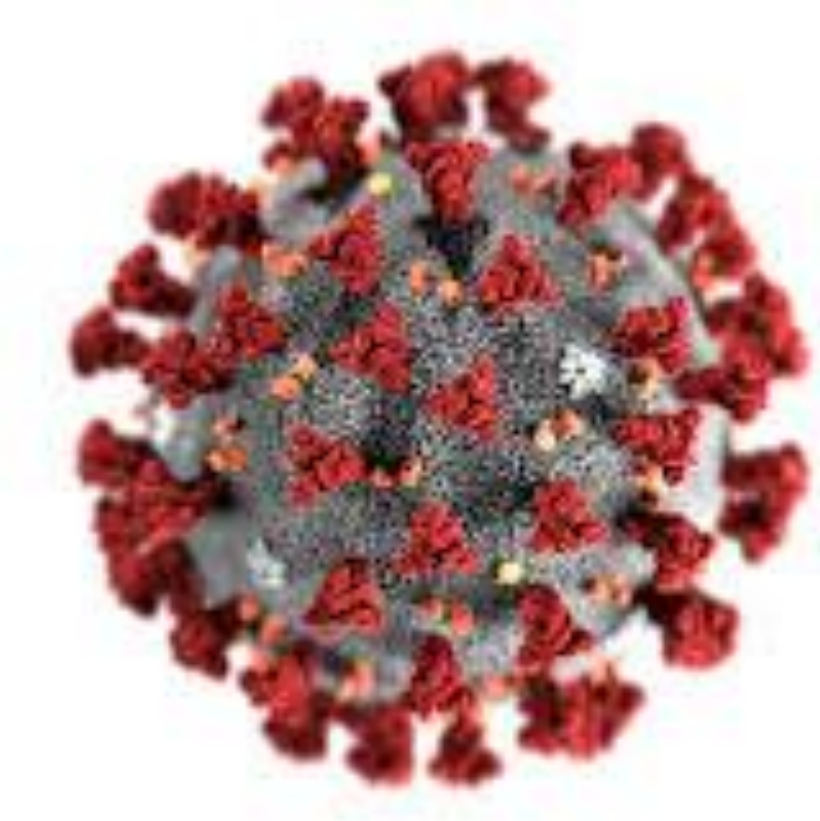
ACADEMY

Functional Healing Solutions
Rebound ACL

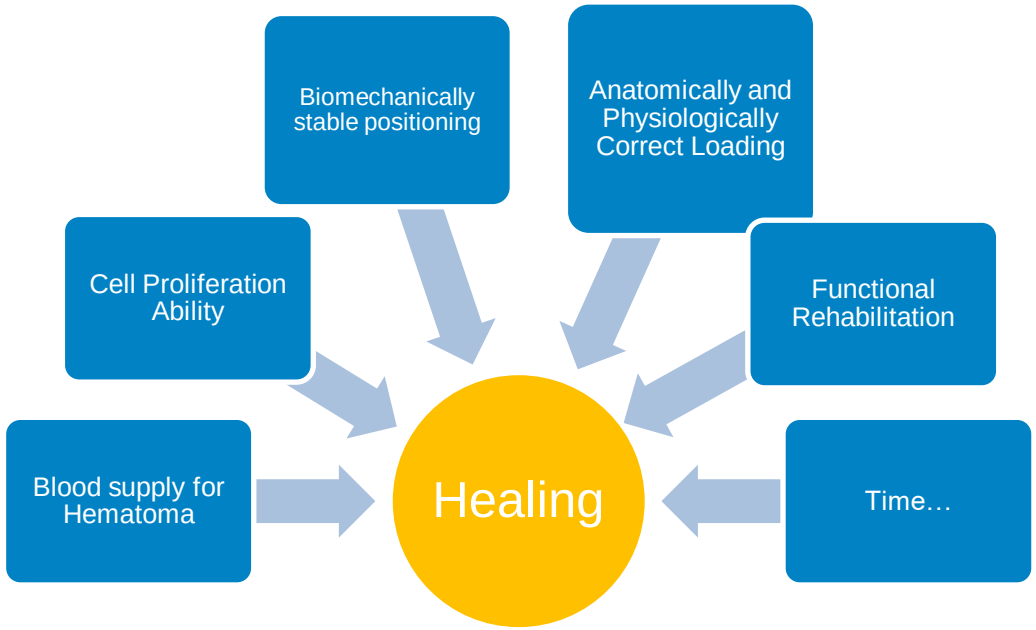
Bret Carter

Director Medical Marketing
Össur Americas

COVID - 19



What is required for proper tissue healing?



History of Dynamic Bracing Rebound PCL

Indications:

-Functional (Non-Surgical) rehabilitation

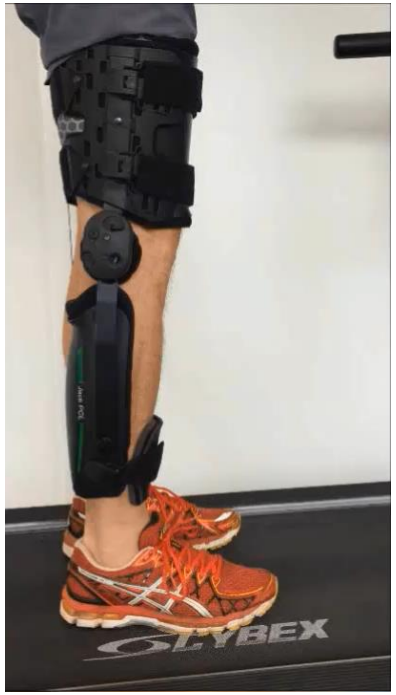
-Rehabilitation after surgical reconstruction

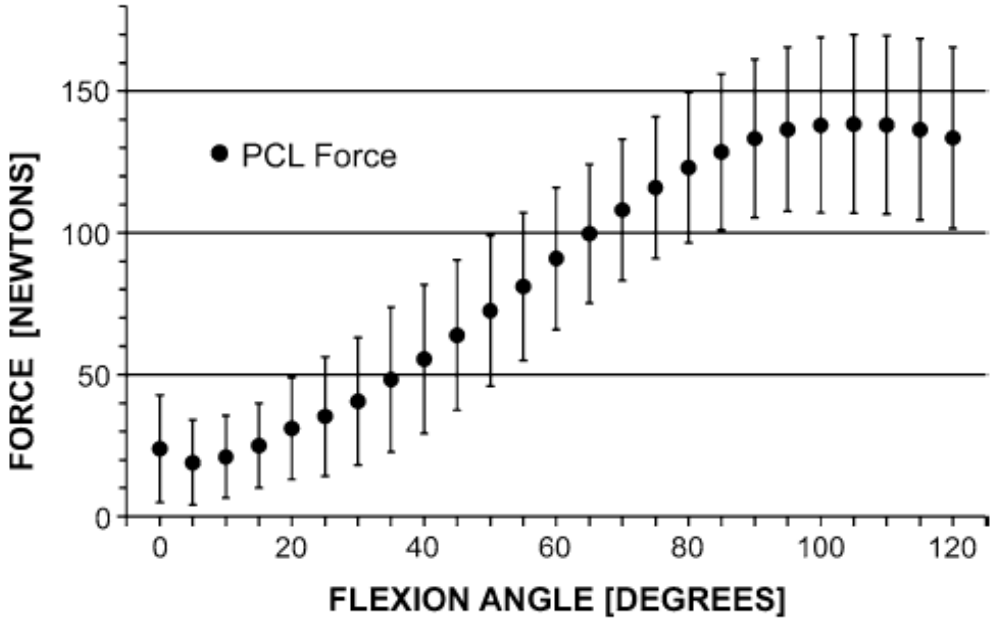
- **Complex Knee Injuries**

Form 20

Understanding of dynamic PCL bracing

Rebound PCL-dynamic force.
Applying biomechanical correct support of the healing PCL during knee flexion





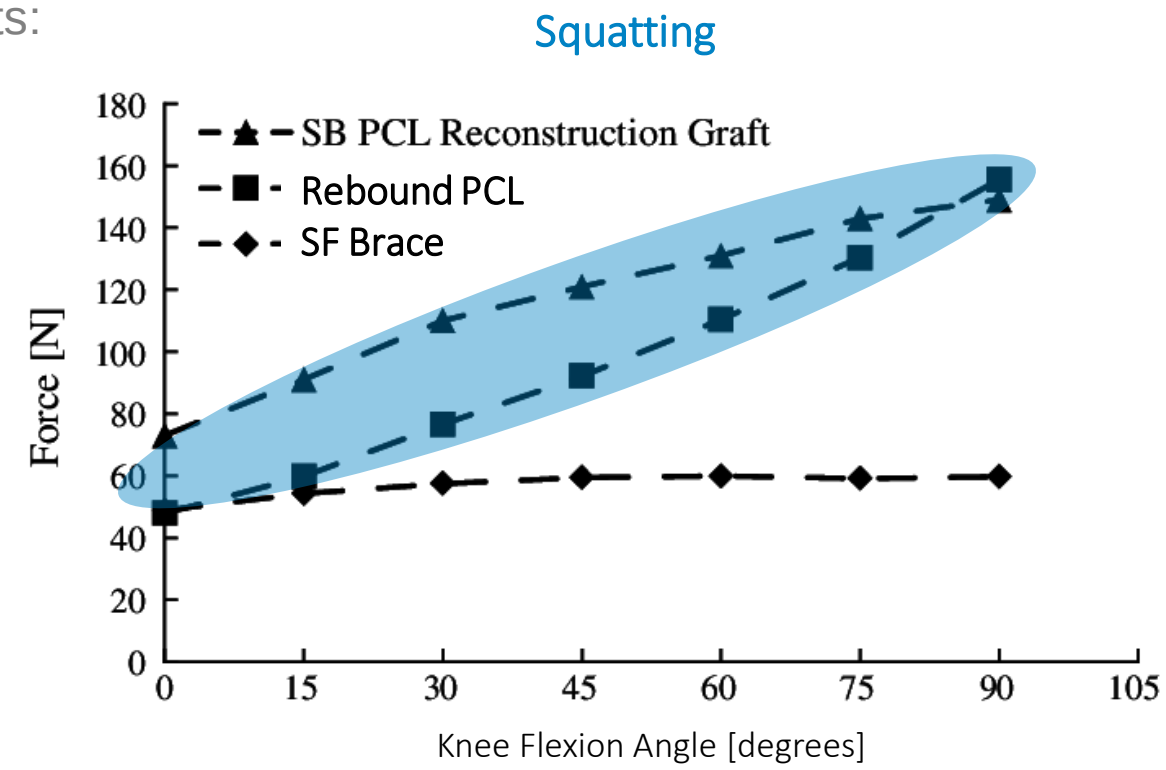
Rebound PCL
Dynamic force

Jack PCL, Albrecht
(Example force set at 70N)

Markolf KL, Feeley BT, Tejwani SG, Martin DE, McAllister DR (2006) Changes in knee laxity and ligament force after sectioning the posteromedial bundle of the posterior cruciate ligament. Arthroscopy 22(10):1100–1106

Biomechanical Evaluation

- Results:



Comparison of single bundle PCL graft forces in response to a 134-N-posterior tibial load with forces generated by the Rebound PCL and the Jacks Brace at the highest force setting during squatting

LaPrade RF, Smith SD, Wilson KJ, Wijdicks CA. Quantification of functional brace forces for posterior cruciate ligament injuries on the knee joint: an in vivo investigation. Knee Surg Sports Traumatol Arthrosc. 2014 Aug 22. [Epub ahead of print]

Double-Bundle Posterior Cruciate Ligament Reconstruction in 100 Patients at a Mean 3 Years' Follow-up

Outcomes Were Comparable to Anterior Cruciate Ligament Reconstructions

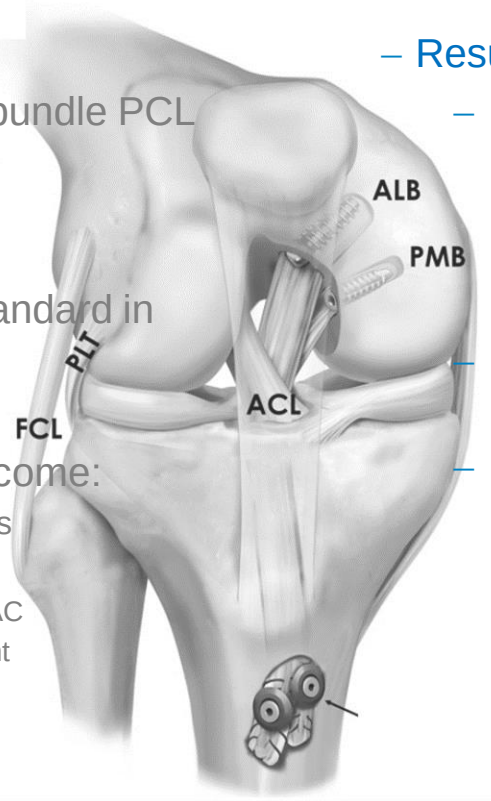
Robert F. LaPrade,*†‡ MD, PhD, Mark E. Cinque,† BS, Grant J. Dornan,† MSc, Nicholas N. DePhillipo,‡ MS, ATC, OTC, Andrew G. Geeslin,† MD, Gilbert Moatshe,‡§‖ MD, and Jorge Chahla,† MD, PhD
Investigation performed at Steadman Philippon Research Institute, Vail, Colorado, USA

Conclusion: Significantly improved functional and objective outcomes were observed after anatomic DB PCLR at a mean 3 years' follow-up, with low complication rates, regardless of concomitant ligamentous injury or timing to surgery. Additionally, contrary to previous reports, comparable subjective and functional clinical outcomes were achieved compared with an isolated ACL reconstruction control cohort.

Clinical outcomes Rebound PCL @ double bundle PCL reconstruction

Methods

- 100 patients with double bundle PCL reconstruction
  - 31 isolated PCL injuries
  - 69 combined PCL injuries
- Rebound PCL used as standard in Rehabilitation
- 2.9 year follow up
- Evaluation of surgical outcome:
  - Kneeling stress radiographs
  - Scores investigated:
    - Tegner, Lysholm, WOMAC
    - SF12 physical component

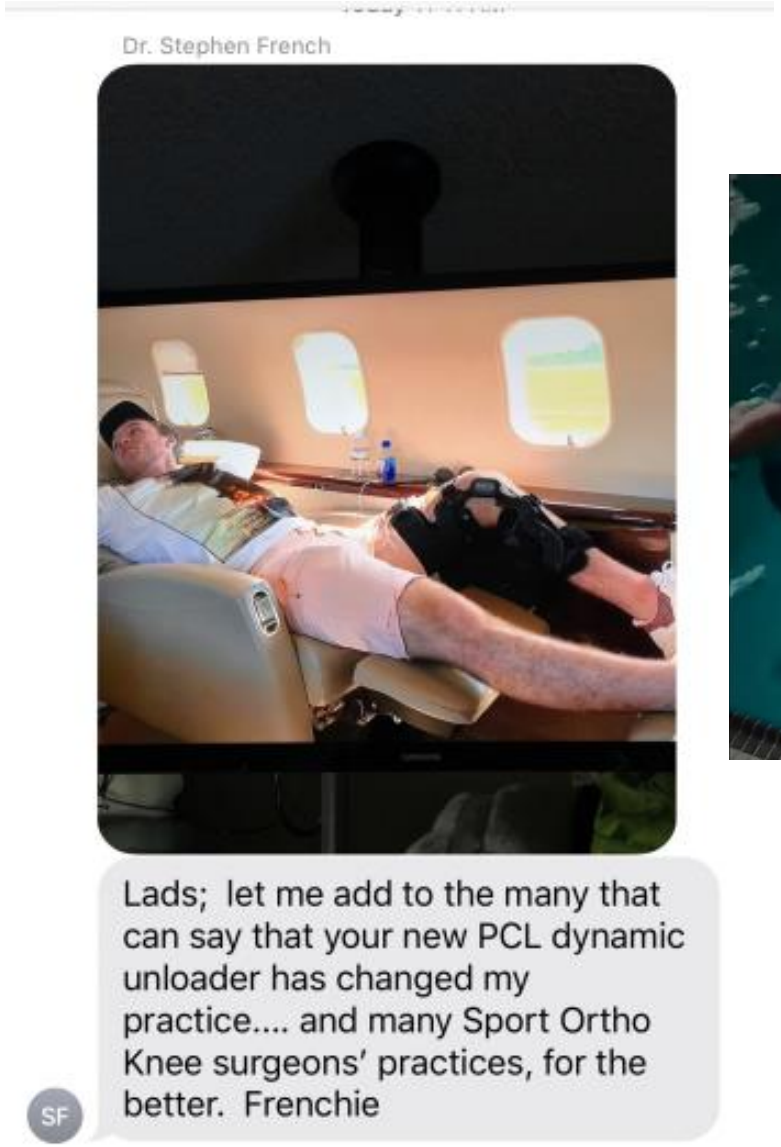


Results

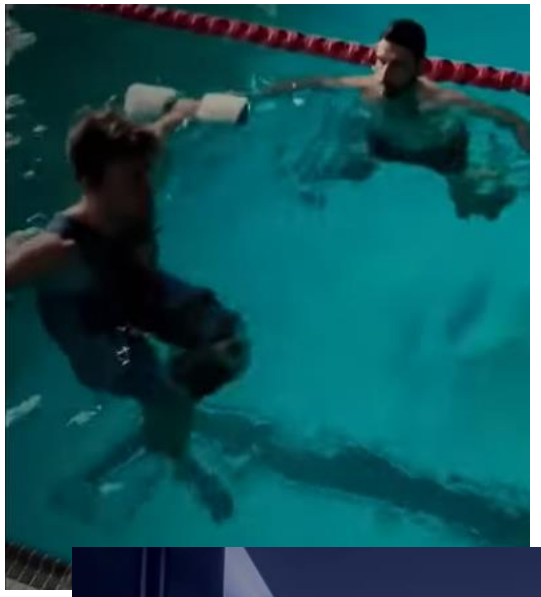
- Side-to-side difference in posterior tibial translation on kneeling stress radiographs improved from 11.0 +/- 3.5 mm preoperatively to 1.6 +/- 2.0 mm postoperatively (P<.001)
- Significant improvements in all scores (p<0.001)
- no differences in postoperative functional scores
  - between isolated PCL reconstructions and PCL-based multi-ligament reconstructions
  - and isolated ACL reconstruction cohort

Dynamic Bracing with Rebound PCL has been described as one potential reason for superior outcome vs. former studies

Conservative Treatment Isolated PCL – complete full thickness tear

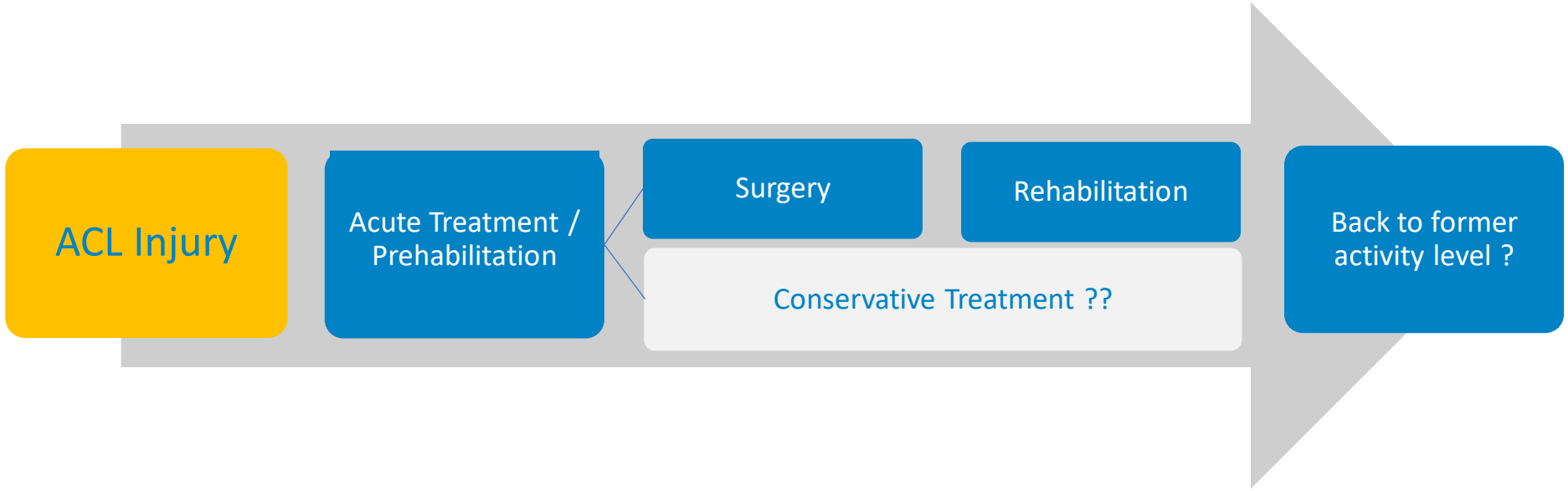


Conner McDavid - $100 Million NHL hockey player
Date of injury April 6, 2019
Return to NHL game October 2, 2019



INTRODUCTION

Treatment of ACL injuries

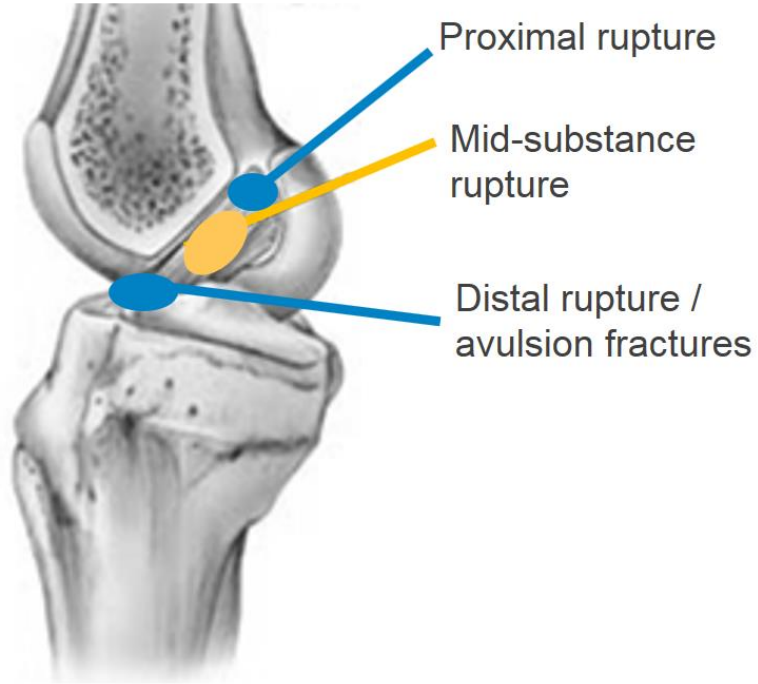


ACL Injuries

Partial ACL tears
Complete ACL rupture

ACL Injuries can lead to:

- unsatisfactory knee function
- decreased activity
- many patients develop osteoarthritis of the knee irrespective of treatment



Opportunity – Rebound® ACL

Primary reconstruction: not a target for Rebound ACL

- Advances in primary ACL reconstruction techniques are pushing trends away from bracing post-surgery
- Static bracing is generally acceptable for most patients

The Rebound ACL provides a unique solution for growing techniques / populations:

Secondary reconstructions / revisions

- Failure rates are as high as 25%
- Candidates will not be eligible for additional surgeries

ACL Repair

- Growing trend toward repair with bio-compatible scaffolding
- BEAR technique lead by Dr. Martha Murray in USA

Conservative treatment

- For cases where surgery is not an option
- Example: adolescents who still have open growth plates, adults who are not surgical candidates

ACL Revision

- A revision ACL reconstruction is a second (or more) surgery needed to repair a torn anterior cruciate ligament.
  - This is a more challenging operation for the orthopedic surgeon. Primary ACL reconstructions are performed using different techniques, so the surgeon must take multiple factors into account when planning for the much more complex procedure. Rates of success in revision cases are lower, 75% rather than 95%.
- The main reasons for Revision:
  - Complications from original surgery/technique - technical errors
  - Untreated instabilities (PLC, mesical root)
  - Re-injury
  - Failure of reconstructed ligament to heal correctly (biologic complications)
- Single Stage and Two stage revision
  - Bone grafting tunnels, osteotomy, PLC, root repair, meniscal transplant

ACL Repair

- B.E.A.R. Procedure
  - Bridge Enhanced ACL Repair – 300 subject clinical study (pilot results were promising – similar results as ACLR with autograft), led by Dr Martha Murray at Boston Childrens Hospital. In the BEAR procedure, a scaffold is placed between the torn ends of the ACL and the patient's own blood is added to the scaffold to stimulate ligament healing. There is no graft or graft harvest, remaining ACL tissue is preserved, small incision to implant the sponge but mostly arthroscopic.
- Functional Repair
  - Historically Repairs have had very low success rates with similar failure rates as conservative care. the exception to this would be a proximal avulsion fracture without full thickness ACL rupture.
- Repair graph strength – Chahla, et al - 2018
  - Repair failure rates are as high as 30%. However, the repaired ACL functioned more like the native ACL versus the ACLR. Most repaired failures occur immediately (within 24 months) - but ACL strength after 24 months is consistent with ACLR graft.

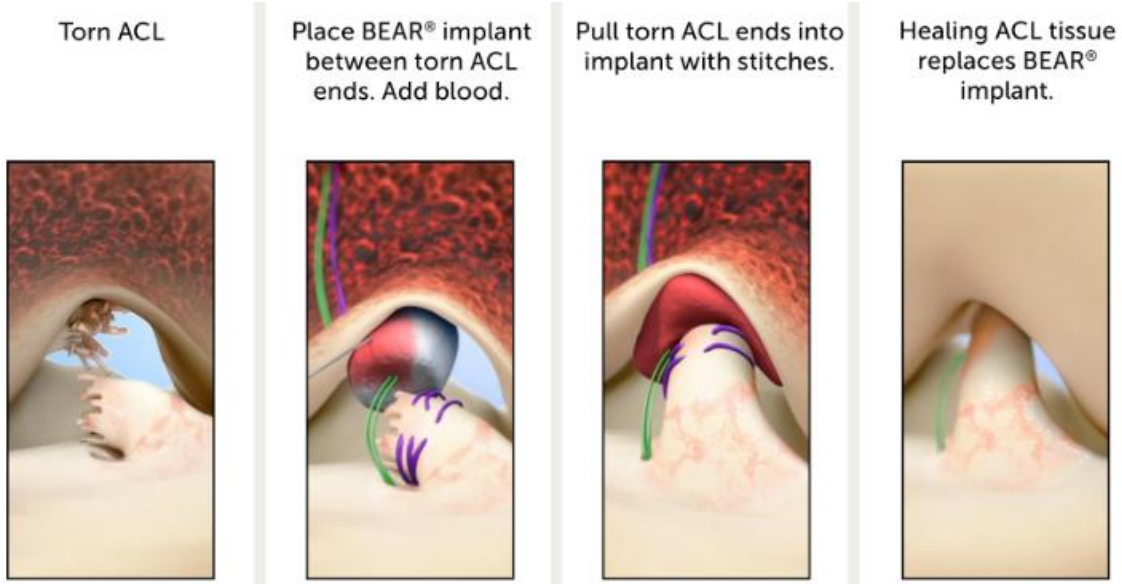


Illustration of an A) ACL repair and B) ACL reconstruction

Allograft

- What is an **allograft**?
  - An **allograft** is tissue from an organ donor that has been sterilized and processed. The cadaver tissue is obtained from a tendon that closely matches the structural properties of your own ACL. Common allografts include the Hamstring tendon, achilles tendon, and patellar tendon.

- **Why is ACL reconstruction using Allograft indicated for Rebound ACL?**
  - Allograft reconstructions have been shown to have significantly higher failure rates than reconstructions using autograft. Especially in young active patients. The main disadvantages to allograft tissue are the increased cost, availability, longer incorporation time, and secondary sterilization with irradication that alters the biomechanical properties of the graft. These can lead to allograft elongation and rupture.

- Why use Allograft at all?
  - It's not all bad news for allografts!
  - No donor site morbidity, less post-operative pain.
  - Faster sugery
  - Suitable for multi-ligament reconstructions
  - Mutiple ACL ruptures – patient runs out of donor sites!

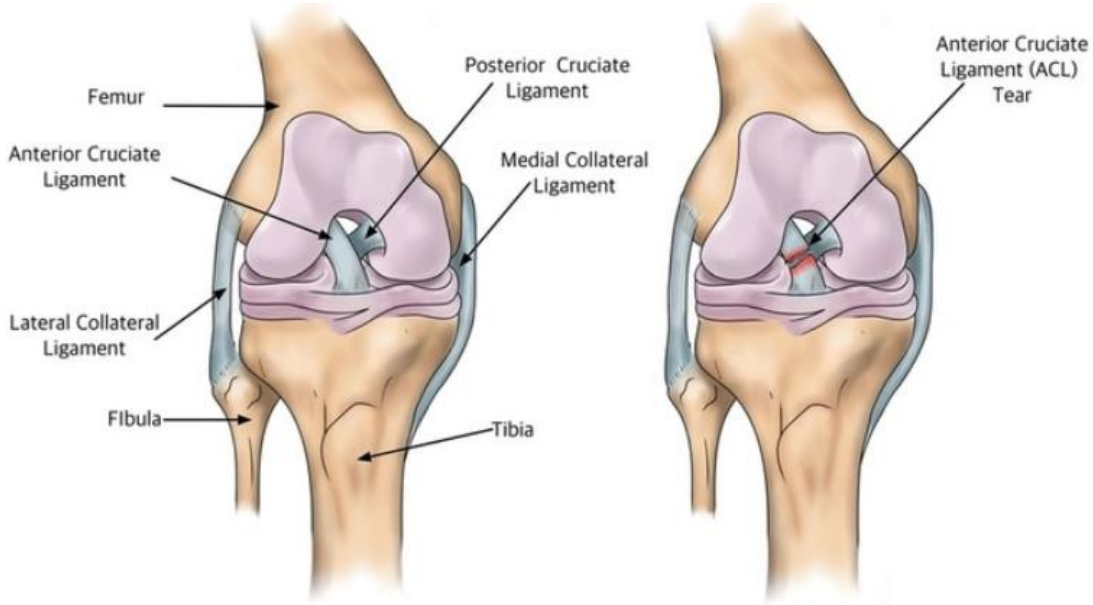
A. *Achilles tendon*

B. *Hamstring tendon*

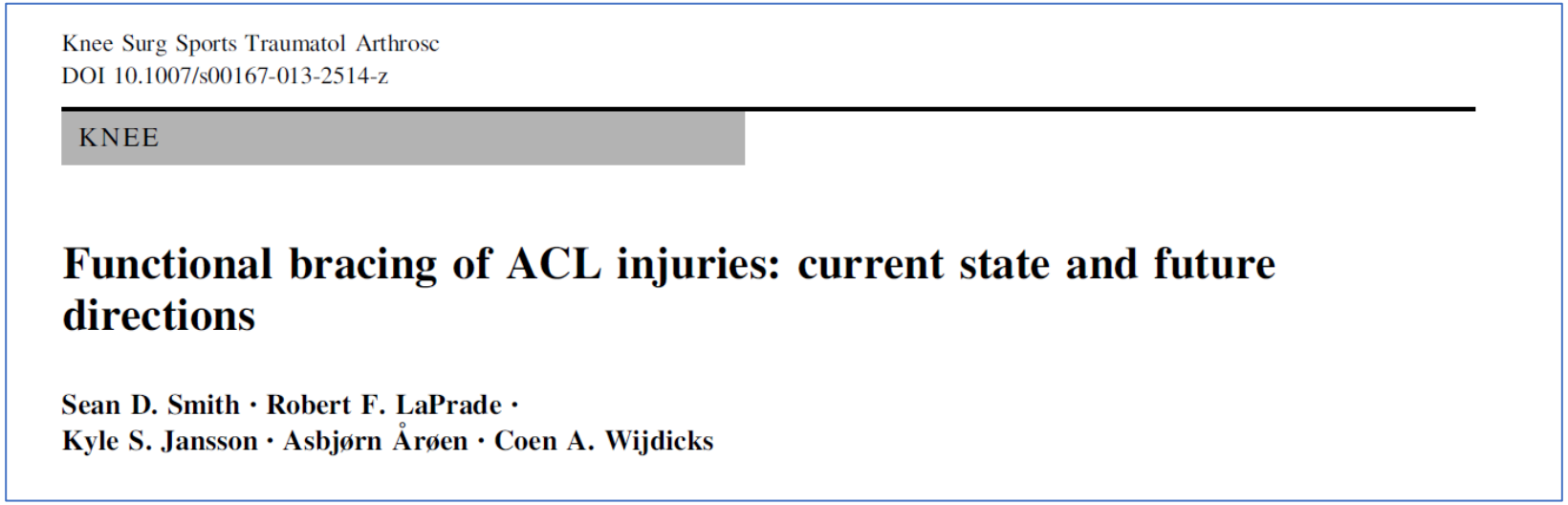
C. *Patellar tendon*

Rebound ACL Indications – “at Risk patient”

- Non-surgical treatment of ACL ruptures
- Post-surgical rehabilitation for:
  - Partial ACL tears
  - ACL repair/augmentation
  - ACL revision
  - Allograft
  - Increased Posterior Tibial Slope
  - Hyper laxity



Current status of ACL bracing



Knee Surg Sports Traumatol Arthrosc
DOI 10.1007/s00167-013-2514-z

KNEE

Functional bracing of ACL injuries: current state and future directions

Sean D. Smith · Robert F. LaPrade ·
Kyle S. Jansson · Asbjørn Årøen · Coen A. Wijdicks

… Our review of the ACL biomechanical literature demonstrates that the ACL is a dynamically loaded ligament that experiences varying levels of force as a function of flexion angle and activity.

These findings may explain why current bracing technologies, which do no replicate the loading characteristics of the native ACL, have been reported in the literature to be unsuccessful. …

Smith SD, LaPrade RF, Jansson KS, Asbjørn A, Wijdicks CA. Functional bracing of ACL injuries: current state and future directions. Knee Surg Sports Traumatol Arthrosc 2014; 22: 1131–1141.

ACL – Biomechanics during knee Flexion

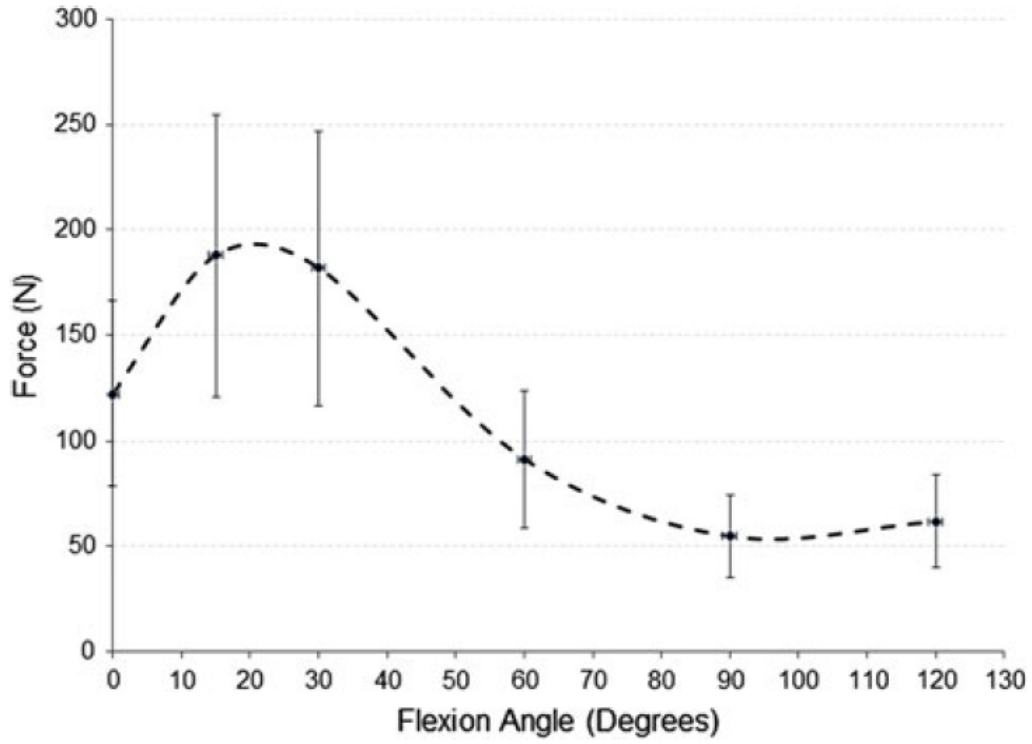
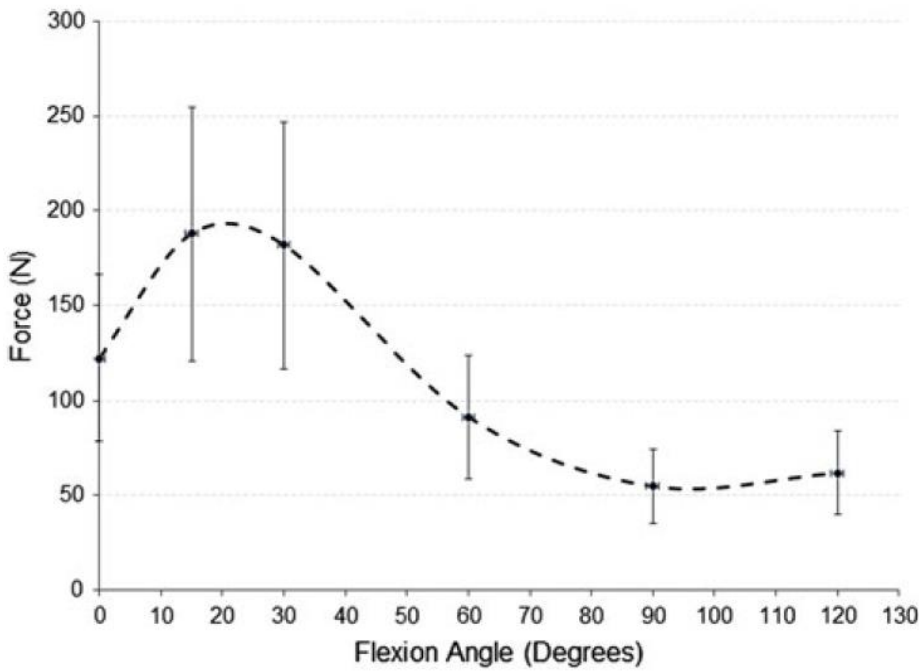


Fig. 2 Graph of the average anterior–posterior in situ force of the ACL in vivo experienced during walking, squatting, single leg lunge, isometric extension, and isokinetic extension

Smith SD, LaPrade RF, Jansson KS, Asbjørn A, Wijdicks CA. Functional bracing of ACL injuries: current state and future directions. Knee Surg Sports Traumatol Arthrosc 2014; 22: 1131–1141.

Goal by designing the Rebound® ACL

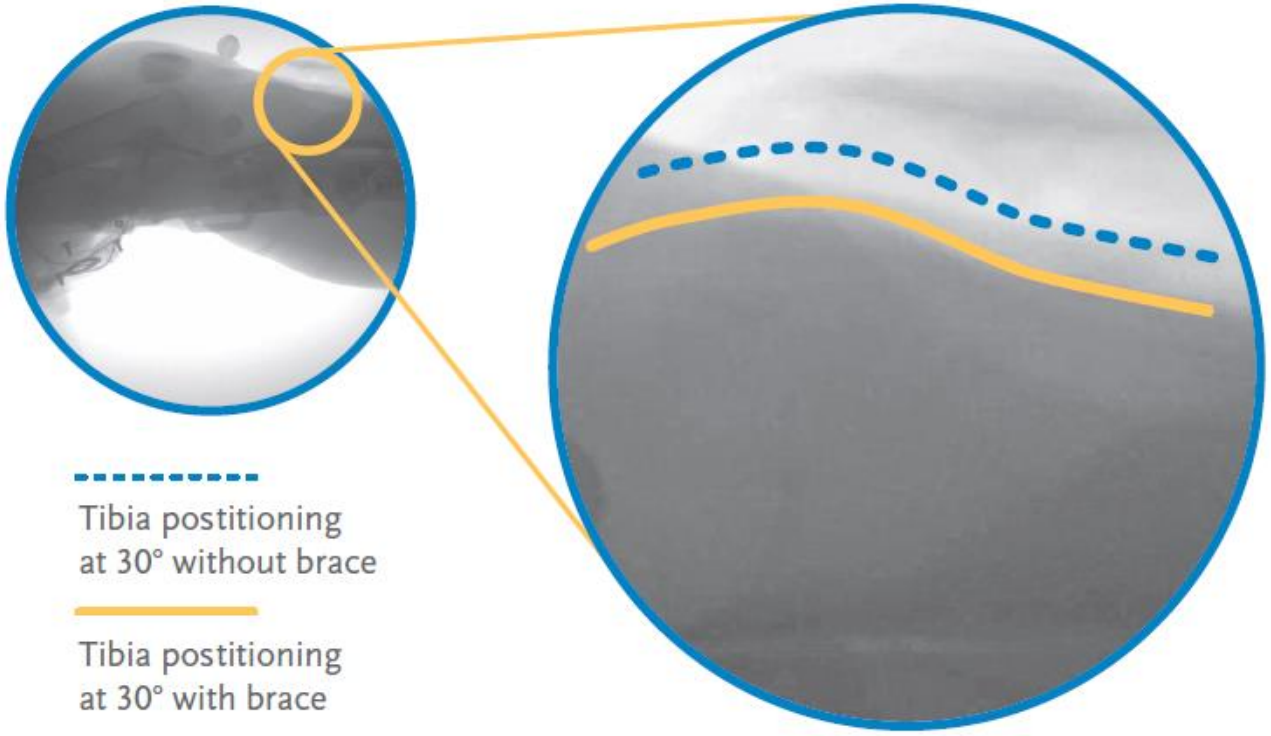


Rebound ACL
Dynamic force

Smith SD, LaPrade RF, Jansson KS, Asbjørn A, Wijdicks CA. Functional bracing of ACL injuries: current state and future directions. Knee Surg Sports Traumatol Arthrosc 2014; 22: 1131–1141.

Biomechanical Validation

Gait fluoroscopy demonstrated Dynamic posterior tibial shift from 20°-35° of knee flexion in an ACL deficient patient



Biomechanical Data Summary

2014: SPRI published a review of functional bracing of ACL injuries (Smith et al.)

- stating the need for a dynamic brace

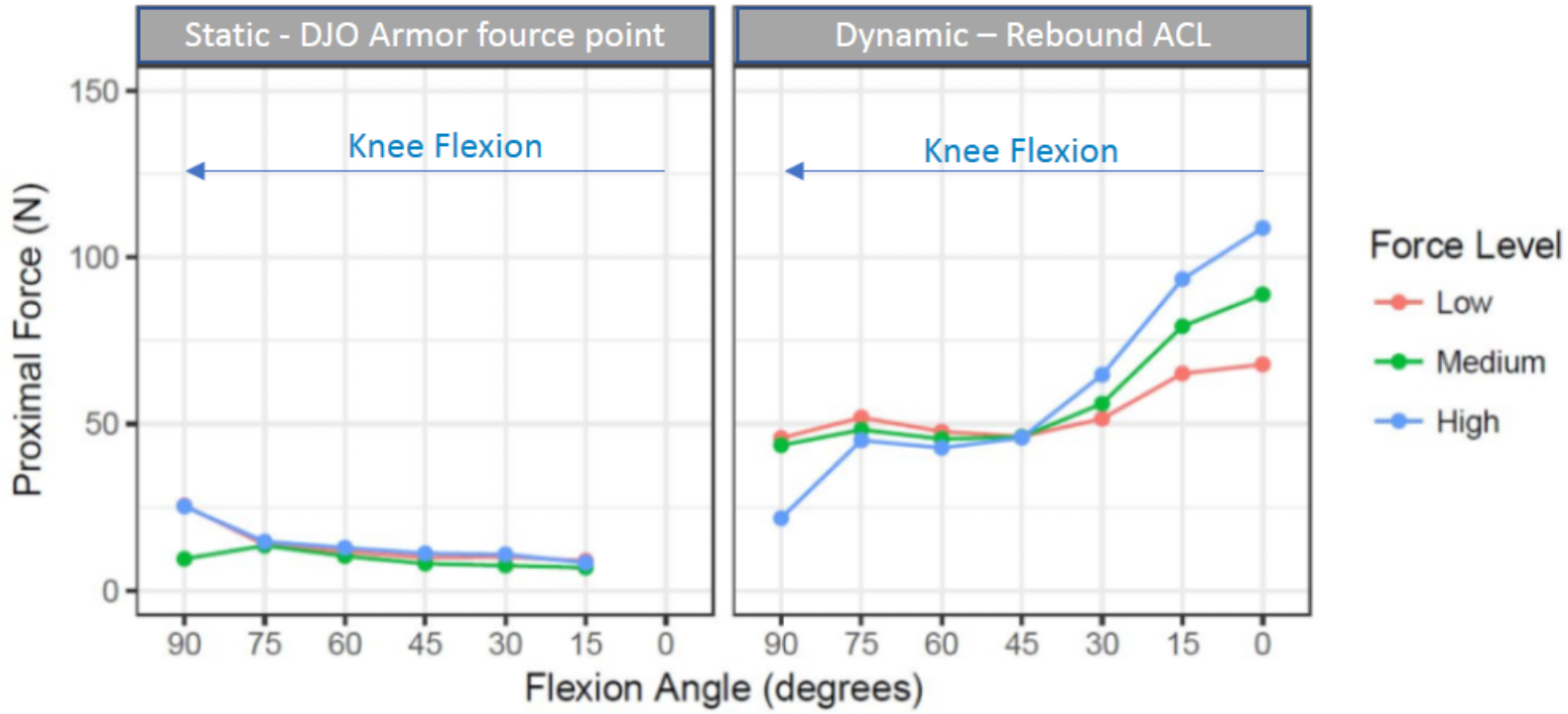
2017: SPRI recently published a biomechanical study showing the dynamic effect of the Rebound ACL (v1) (LaPrade et al.)

- An agonistic dynamic force to the ACL is applied to the lower limb by the brace throughout flexion and extension
- The dynamic force ACL brace, compared with the static force brace, applied significantly larger posteriorly directed forces to the anterior proximal tibia in extension, where the ACL is known to experience larger in vivo forces

2017: Tomescu et al.

- A combination in-vivo / in-silico / in vitro study support for the use of a brace equipped with a dynamic tensioning system to lower meniscal strain in ACL-deficient knees.
- Reduced ACL strain in DLS (83%), SLS (38%), and 6% in gait
- Significant difference in peak meniscal strain, especially with ACL deficient (-74%) and ACL reconstructed (-60%) knees.

Rebound® ACL - Dynamic ACL bracing – biomechanical outcome



Mean posteriorly directed force applied by each brace to the proximal tibia during sit-to-stand as a function of flexion angle at each force setting. Biomechanical evaluation on 7 healthy subjects.

Rebound ACL proven to reduce ACL and meniscal strain

LaPrade et al. (2017) Functional Brace in ACL Surgery Force Quantification in an In Vivo Study, The Orthopaedic Journal of Sports Medicine, 5(7), 2325967117714242 DOI: 10.1177/2325967117714242

Rebound® ACL - Significant reduction of meniscal and ACL strain

KNEE

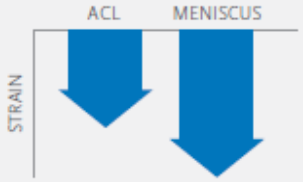
Dynamically tensioned ACL functional knee braces reduce ACL and meniscal strain

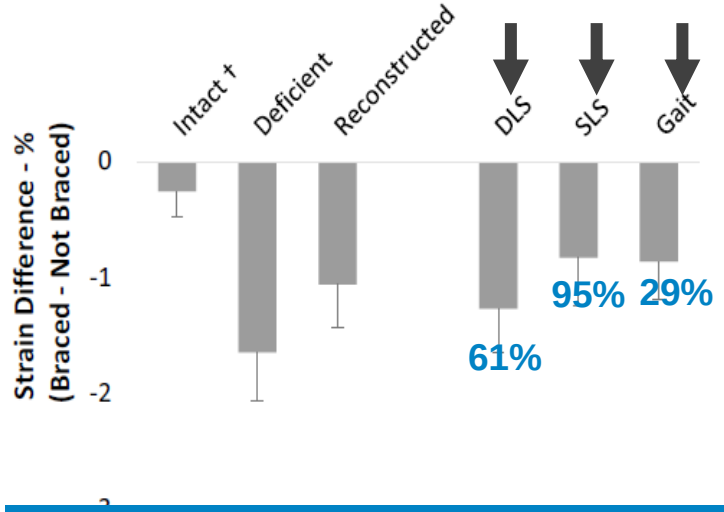
Sebastian Tomescu[1,2] · Ryan Bakker[2] · David Wasserstein[1] · Mayank Kalra[2] · Micah Nicholls[3] · Cari Whyne[1] · Naveen Chandrashekar[2]

- 7 cadaveric specimens
- Evaluated strain reduction on ACL and posterior horn medial meniscus
- 3 simulated activities

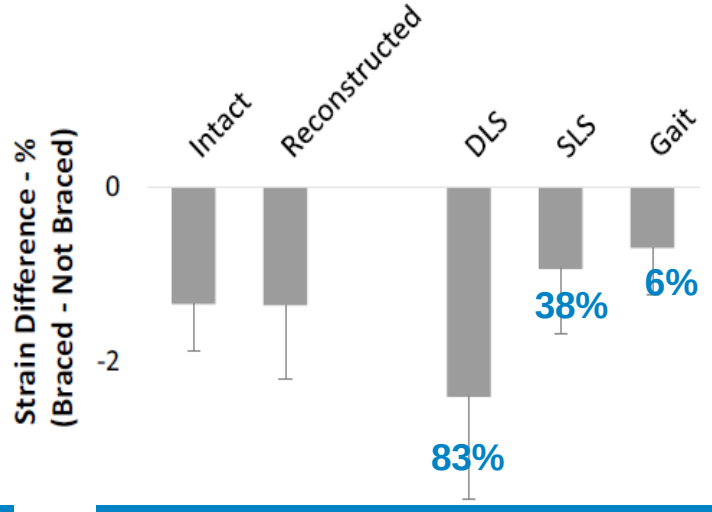
Supported by Clinical & Biomechanical Studies

Rebound ACL is shown to reduce ACL strain
& **SIGNIFICANTLY** reduce meniscus strain[2]





Peak meniscal strain difference between braced & unbraced



Peak ACL strain difference between braced & unbraced

STABILITY (ISAKOS/AOSSM AWARDS 2019)

Getgood et al. BMC Musculoskeletal Disorders (2019) 20:216
https://doi.org/10.1186/s12891-019-2589-x

BMC Musculoskeletal Disorders

STUDY PROTOCOL

The Stability study: a protocol for a multicenter randomized clinical trial comparing anterior cruciate ligament reconstruction with and without Lateral Extra-articular Tenodesis in individuals who are at high risk of graft failure

Alan Getgood[1], Dianne Bryant[2], Andrew Firth[3*] and Stability Group

[3]Fowler Kennedy Sport Medicine Clinic, 3M Centre, University of Western Ontario, 1151 Richmond St, London, ON N6A 3K7, Canada
Full list of author information is available at the end of the article

Anterolateral Complex Reconstruction: Another Fad or Method to Improve ACL Outcomes?

Ryan Wood, BMBCh, MA, FRCS (Tr&Orth), Jacquelyn Marsh, PhD,† and Alan Getgood, MPhil, MD, FRCS (Tr&Orth) DipSEM**

Techniques in Orthopaedics® • Volume 33, Number 4, 2018

Classify instability as failure not just rupture. Helps focus on high risk patients.

Published Literature Regarding “at risk” Patient Population

Tibial Slope and Its Effect on Force in Anterior Cruciate Ligament Grafts

Anterior Cruciate Ligament Force Increases Linearly as Posterior Tibial Slope Increases

Andrew S. Bernhardson,[†] MD, LCDR, MC, USN, Zachary S. Aman,[*] BA, Grant J. Dornan,[*] MSc, Bryson R. Kemler,[*] MS, Hunter W. Storaci,[*] MS, Alex W. Brady,[*] MSc, Gilberto Y. Nakama,[*] MD, and Robert F. LaPrade,[†‡] MD, PhD
Investigation performed at the Department of BioMedical Engineering, Steadman Philippon Research Institute, Vail, Colorado, USA

The American Journal of Sports Medicine
2019;47(2):296–302
DOI: 10.1177/0363546518820302

Posterior Medial Meniscus Root Tears Potentiate the Effect of Increased Tibial Slope on Anterior Cruciate Ligament Graft Forces

The American Journal of Sports Medicine

20-Year Outcomes of Anterior Cruciate Ligament Reconstruction With Hamstring Tendon Autograft

The Catastrophic Effect of Age and Posterior Tibial Slope

Lucy J. Salmon,[*†] PhD, Emma Heath,[†] MPhty, Hawar Akrawi,[†] MBChB, MSc, FRCS(Tr&Orth), Justin P. Roe,[†] MBBS, FRACS, James Linklater,[‡] FRANZCR, and Leo A. Pinczewski,[†§] MBBS, FRACS
Investigation performed at North Sydney Orthopaedic & Sports Medicine, Wollstonecraft, Australia

The American Journal of Sports Medicine
2018;46(3):531–543
DOI: 10.1177/0363546517741497

Generalized Hypermobility, Knee Hyperextension, and Outcomes After Anterior Cruciate Ligament Reconstruction: Prospective, Case-Control Study With Mean 6 Years Follow-up

Christopher M. Larson, M.D., Asheesh Bedi, M.D., Mark E. Dietrich, M.D., Jennifer C. Swaringen, M.D., Corey A. Wulf, M.D., David M. Rowley, M.D., and M. Russell Giveans, Ph.D.

0749-8063/16522/$36.00

The Dallas Morning News

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HIGH SCHOOL SPORTS › BASKETBALL

Why are torn ACLs happening so frequently to Dallas-area girls basketball players? A look at an epidemic with no easy answers

Rebound® ACL

Dynamic Tension System - Clinically proven load Application

Physiologically correct, dynamic force	Individually adjustable load by shear knobs	Reproducible load application

Two different **shear knobs** for different tensioning options:

White: 125N (Standard)
Black: 88N (Allograft)

Product Features

REBOUND® ACL - FEATURES

Dark Grey matte powder coated **aluminum frame**

Steel gear reinforced polycentric hinge

Tibia strap D-rings for easy donning and doffing

Dynamic Tension System
- EVA molded island
- Positioning feature

ActiveGrip calf liner and strap pad

Blue Is You™; blue patient touch points

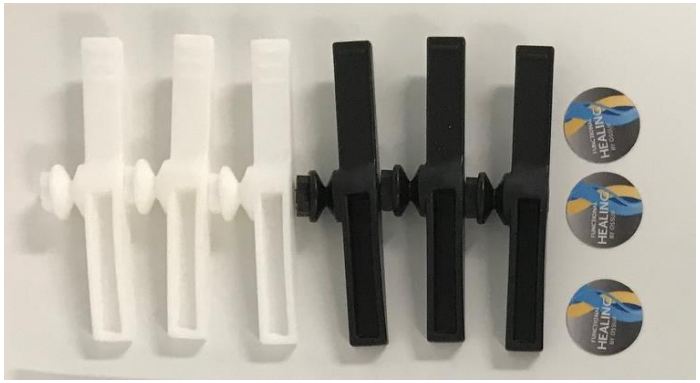
Tibial pad, and optional *Hex Pad accessory

DTS PRESCRIPTION

Spool
Turn with shear knob to apply tibia load

2 different **shear knobs** for 2 different tensioning options:

- White: Standard, breaks at 125 Newton
- Black: Low, breaks at 88 Newton

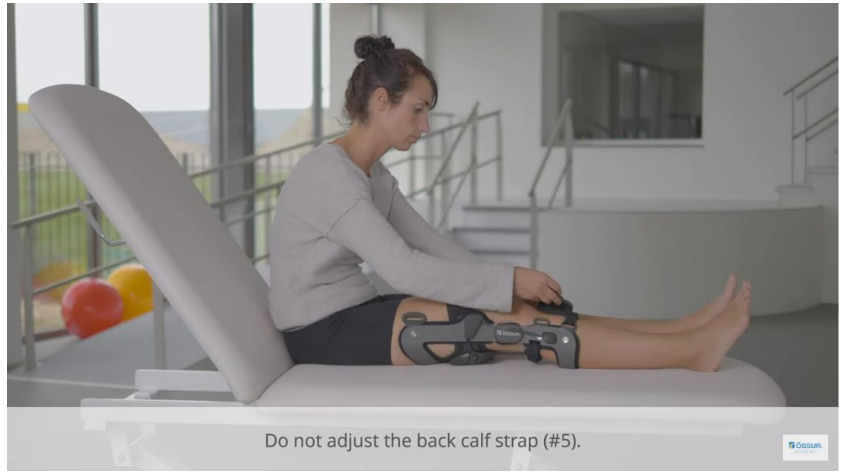


Össur advice based on Dr. LaPrade's study (Smith et al, 2013):

- For chronic ACL and allograft reconstructions use the black shear knob
- For other indications use the white shear knob, and only switch to black when patient complaints about too much pain
- Revise tension 2 weeks after the initial fitting

USER FITTING VIDEO - REBOUND® ACL FITTING VIDEOS

PRACTITIONER FITTING - Rebound ACL



ACCESSORIES- Rebound ACL

Click the ‘Youtube’ arrows to watch

Rebound® ACL - Post-surgical Rehab Protocol

ACL RUPTURE - FUNCTIONAL (SURGICAL) REHABILITATION PROTOCOL

ITEM	PHASE I (1 - 6 WEEKS) Acute Management & Early Motion	PHASE II (7 - 12 WEEKS) Basic Strength & Proprioception	PHASE III (13 - 18 WEEKS) Dynamic Neuromotor Strength, Endurance & Coordination	PHASE IV (19-24 WEEKS) Athletic Enhancement & Return to Activity	PHASE IV (>24 WEEKS) Sports Performance & Injury Prevention
Rebound ACL	Day & night	Day & night	Use for all activities	Use for all activities	Use for all activities
ROM (Ext./ Flex.)	• 0/0/60 during first week (avoid anterior shear to the knee) • 0/0/90 week 2 - 4 • 0/0/120 week 4 - 6 • Regain active extension 0° • By week 6 ROM should be full extension to at least 135° flexion	• Work towards full ROM	• Maintain full ROM and optimize LE flexibility	• Maintain full ROM and optimize LE flexibility	• No limitations
Weightbearing	• 0 - 2 weeks: Touch down weight bearing with two crutches • 2 - 4 weeks: Partial weight bearing • 4 - 6 weeks: Weight bearing as tolerated	• PWBAT --> FWBAT • Discontinue daily use of brace and crutches as allowed by physician when the patient has full extension and can straight leg raise (SLR) without extension lag	• FWB	• FWB	• FWB --> transfer to functional brace (CTi) for prophylactic use during sports
Physiotherapy	• Control pain and swelling (PRICE) • Protect Graft Fixation • Full active and passive extension/flexion as is allowed < 90° (graft protection) • Restore normal gait mechanics • Establish good quadriceps activation • Avoid patellofemoral joint stress and anterior translation • Train core stability, hip strength, and cardio vascular fitness while wearing Rebound ACL	• Proprioceptive and balance exercise (focus on Closed Kinetic Chain) • Increase muscle strength and endurance • Progress strengthening LE • Improve neuromuscular control • Train core stability, hip strength, and cardio vascular fitness while wearing Rebound ACL	• Maintain full ROM • Maximize strength, proprioceptive and balance exercises • Maximize neuromuscular control (CKC & OCK) • Initiate plyometrics and light jogging, single leg hop endurance test • Isokinetics to guide straight line running, test single leg balance (at Biodex) • Initiate return to sport / work activities with physician approval	• Sport specific program should be goal oriented • Continue dynamic strengthening and proprioceptive exercises • Plyometric activities as appropriate to patient's goals • Progress sport specific drills	Criteria for return to sports: • Quadriceps strength at least 80% of the normal leg • Hamstring strength at least 80% of the normal leg • Ability to complete a running program • Continue plyometrics and initiate agility training • Maintenance program for strength and endurance

Rebound® ACL - Conservative Treatment Rehab Protocol

ACL RUPTURE - FUNCTIONAL (NON-SURGICAL) REHABILITATION PROTOCOL

ITEM	PHASE I (1 - 6 WEEKS)	PHASE II (7 - 12 WEEKS)	PHASE III (13 - 18 WEEKS)	PHASE IV (>19 WEEKS)
Rebound ACL	Day & night	Use for all activities	During exercises	Wean off as tolerated
ROM (Ext./ Flex.)	• 0/0/60 during first week (avoid anterior shear to the knee) • 0/0/90 week 2 -4 • 0/0/120 week 4 - 6 • Regain active extension 0°	• Work towards full ROM	• Maintain full ROM & optimize LE flexibility	• No limtitations
Weightbearing	• PWBAT with crutches & progress to FWBAT & d/c crutches when patient can demonstrate normal gait mechanics	• Active Physiotherapy	• Active Physiotherapy	• Active Physiotherapy
Physiotherapy	• Control pain and swelling, prevent infection (PRICE) • Restore pain free (passive) ROM • Restore normal gait mechanics • Establish good quadriceps activation • When 90 ° flexion is pain free, start with strengthening exercises LE up to 90 ° • Avoid patellofemoral joint stress and anterior translation • Train core stability, hip strength and cardiovascular fitness while wearing Rebound ACL	• Proprioceptive and balance exercise (focus on CKC) • Increase muscle strength and endurance • Progress strengthening LE • Improve neuromuscular control • Train core stability, hip strength, and cardiovascular fitness while wearing Rebound ACL	• Maintain Full ROM • Maximize strength, proprioceptive and balance exercises • Maximize neuromuscular control (CKC & OCK) • Initiate plyometrics and light jogging, single leg hop endurance test • Isokinetics to guide straight line running, single leg balance (at Biodex) • Initiate return to sport/work activities with physician approval	• Sport specific program should be goal oriented • Continue dynamic strengthening and proprioceptive exercises • Continue plyometrics and initiate agility training • Progress sport specific drills

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