Functional Healing Solutions
Rebound ACL

Bret Carter
Director Medical Marketing
Össur Americas
What is required for proper tissue healing?

- Blood supply for Hematoma
- Cell Proliferation Ability
- Biomechanically stable positioning
- Anatomically and Physiologically Correct Loading
- Functional Rehabilitation
- Time…

Healing
History of Dynamic Bracing Rebound PCL

Indications:

- Functional (Non-Surgical) rehabilitation

- Rehabilitation after surgical reconstruction

❖ Complex Knee Injuries
Understanding of dynamic PCL bracing

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

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.

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

Lads; let me add to the many that can say that your new PCL dynamic unloader has changed my practice.... and many Sport Ortho Knee surgeons' practices, for the better. Frenchie
INTRODUCTION
Treatment of ACL injuries

ACL Injury → Acute Treatment / Prehabilitation → Surgery → Rehabilitation → Back to former activity level?

Conservative Treatment ??
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
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
- 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
• **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.
**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 irradiation 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!
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
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 not replicate the loading characteristics of the native ACL, have been reported in the literature to be unsuccessful. ...
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

Goal by designing the Rebound® ACL

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

Rebound® ACL - Significant reduction of meniscal and ACL strain

- 7 cadaveric specimens
- Evaluated strain reduction on ACL and posterior horn medial meniscus
- 3 simulated activities
Rebound ACL is shown to reduce ACL strain & SIGNIFICANTLY reduce meniscus strain²

Peak meniscal strain difference between braced & unbraced

Peak ACL strain difference between braced & unbraced

Supported by Clinical & Biomechanical Studies
Anterolateral Complex Reconstruction: Another Fad or Method to Improve ACL Outcomes?

Ryan Wood, BMBCCh, 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, LCMC, MC, USN, Zachary S. Aman, BA, Grant J. Dorman, MSc, Bryson R. Kamber, MS, Hunter W. Storaci, MS, Alex W. Brady, MSc, Gilbert Y. Nakama, MD, and Robert F. LaPrade, MD, PhD

Investigation performed at the Department of BioMedical Engineering, Stanford Philipson Research Institute, Vall, Colorado, USA

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

The Catastrophic Effect of Age and Posterior Tibial Slope

Lucy J. Salmon, MBBS, MSci, FRACS(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

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

Christopher M. Larson, MD, Ashesh Bedl, 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.

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The Dallas Morning News

Why are torn ACLs happening so frequently to Dallas-area girls basketball players? A look at an epidemic with no easy answers
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
- **Blue Is You™:** blue patient touch points
- **ActiveGrip** calf liner and strap pad
- **Tibial pad, and optional** *Hex Pad accessory*
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

2 different shear knobs for 2 different tensioning options:

• White: Standard, breaks at 125 Newton
• Black: Low, breaks at 88 Newton
USER FITTING VIDEO - REBOUND® ACL FITTING VIDEOS

PRACTITIONER FITTING - Rebound ACL

Ensure that the cable covers are on the outside of the brace and floating free of obstruction.

Do not adjust the back calf strap (#5).

ACCESSORIES- Rebound ACL

Click the ‘Youtube’ arrows to watch

Any combination of pads can be used to achieve a more comfortable fit.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>PHASE I (1 - 6 WEEKS) Acute Management &amp; Early Motion</th>
<th>PHASE II (7 - 12 WEEKS) Basic Strength &amp; Proprioception</th>
<th>PHASE III (13 - 18 WEEKS) Dynamic Neuromotor Strength, Endurance &amp; Coordination</th>
<th>PHASE IV (19-24 WEEKS) Athletic Enhancement &amp; Return to Activity</th>
<th>PHASE IV (24 WEEKS) Sports Performance &amp; Injury Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebound ACL</td>
<td>Day &amp; night</td>
<td>Day &amp; night</td>
<td>Use for all activities</td>
<td>Use for all activities</td>
<td>Use for all activities</td>
</tr>
</tbody>
</table>
| 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 2 crunches  
 • 2 - 4 weeks: Partial weight bearing  
 • 4 - 6 weeks: Weight bearing as tolerated extension lag.  
 | • PW/BAT -> FWB  
 • 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  
 | 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 cardiovascular fitness while wearing Rebound ACL  
 | • Proproprioceptive 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 cardiovascular fitness while wearing Rebound ACL  
 | • Maintain full ROM  
 • Maximize strength, proprioceptive and balance exercises  
 • Maximize neuromuscular control (CKC & OCK)  
 • Initiate plyometrics and light jumping, single leg hop endurance test  
 • Isokinetics to guide straight line running, test single leg balance (at Biodes)  
 | Sport specific program should be goal oriented  
 | 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  

## ACL RUPTURE - FUNCTIONAL (NON-SURGICAL) REHABILITATION PROTOCOL

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<th>ITEM</th>
<th>PHASE I (1 - 6 WEEKS)</th>
<th>PHASE II (7 - 12 WEEKS)</th>
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<th>PHASE IV (&gt;19 WEEKS)</th>
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<tr>
<td>Rebound ACL</td>
<td>Day &amp; night</td>
<td>Use for all activities</td>
<td>During exercises</td>
<td>Wean off as tolerated</td>
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<td>ROM (Ext./Flex.)</td>
<td>• 0/0/60 during first week (avoid anterior shear to the knee)</td>
<td>• Work towards full ROM</td>
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<td></td>
<td>• 0/0/120 week 4-6</td>
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<tr>
<td></td>
<td>• Regain active extension 0°</td>
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<tr>
<td>Weightbearing</td>
<td>• PW/BAT with crutches &amp; progress to FWBAT &amp; dc crutches when patient can demonstrate normal gait mechanics</td>
<td>• Active Physiotherapy</td>
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<tr>
<td>Physiotherapy</td>
<td>• Control pain and swelling, prevent infection (PRICE)</td>
<td>• Proprioceptive and balance exercise (focus on CKC)</td>
<td>• Maintain Full ROM</td>
<td>• Sport specific program should be goal oriented</td>
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<td>• Restore pain free (passive) ROM</td>
<td>• Increase muscle strength and endurance</td>
<td>• Maximize strength, proprioceptive and balance exercises</td>
<td>• Continue dynamic strengthening and proprioceptive exercises</td>
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<td>• Restore normal gait mechanics</td>
<td>• Progress strengthening LE</td>
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<td>• Establish good quadriceps activation</td>
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<td>• Initiate plyometrics and light jogging, single leg hop endurance test</td>
<td>• Progress sport specific drills</td>
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<td>• When 90° flexion is pain free, start with strengthening exercises LE up to 90°</td>
<td>• Train core stability, hip strength, and cardiovascular fitness while wearing Rebound ACL</td>
<td>• Isokinetics to guide straight line running, single leg balance (at Biodes)</td>
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<td>• Avoid patellofemoral joint stress and anterior translation</td>
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<td>• Initiate return to sport/work activities with physician approval</td>
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<td>• Train core stability, hip strength and cardiovascular fitness while wearing Rebound ACL</td>
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Complex ACL Injury Continuum of Care

Ligament Injury  Post-Op Rehab  Functional Recovery

Rebound®
Post-Op Knee

Cold Rush®

Rebound®
ACL

Rebound®
DUAL ST
WE IMPROVE PEOPLE’S MOBILITY