Internal Brace and Ligament Reconstruction Case Studies and a UK Perspective

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Tak for at invitere mig !!

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Internal Brace and Ligament Reconstruction
Case Studies and a UK Perspective

Topics:
• Spring Ligament
• Deltoid Ligaments
• Lateral Ankle Collateral Ligaments
**Spring Ligament Pathology:**

- Isolated Spring Ligament Injury
- Associated with Deltoid Ligament Injury
- Spring Ligament involvement in Tibialis Posterior Tendon insufficiency
Spring Ligament Reconstruction

Usually in association with an FDL transfer for Tibialis Posterior insufficiency
Anatomy of the Spring Ligament

Fig. 1. The spring ligament and the acetabulum pedis. Ant, anterior facet of os calcis; I, ICN ligaments; Mid, middle facet of os calcis; N, navicular; Sm, SMCN ligament; Th, Third ligament. (Adapted from Taniguchi A, Tanaka Y, Takakura Y, et al. Anatomy of the spring ligament. J Bone Joint Surg Am 2003;85:217; with permission.)
Patient with Spring Ligament injury:
Activating Tibialis Posterior tendon to restore normal medial arch.

Illustration courtesy of Prof. Beat Hintermann
MRI of 3-week old injury to midfoot in a 20 year old footballer demonstrating an acute partial rupture of the SMCNL and intact ICNL and TCNL.

- Intact ICNL
- Intact TCNL
- Bone oedema inferior talar neck
- Partial rupture of SMCNL
Grade 2/3 disruption of the superficial ligament fibres between the medial malleolus and talar head/spring ligament

Grade 2 disruption of the plantar spring ligament (ICNL) with fluid surrounding the ill-defined ligament fibres

Coronal PD FSE and T2 Fat Sat anterior talar dome
Spring Ligament Surgery - Options

Repair:
• Including repair, resection and shortening

Reconstruction:
• Autograft:
  • Peroneus Longus
  • Tibialis Anterior - split
• Allograft:
  • Semitendinosus
  • Tibialis Anterior
  • Achilles Tendon
• Synthetic:
  • Internal Brace
  • Patches, e.g. Artelon

Use of distal stump of Tibialis Posterior tendon to augment repair or reconstruction

Combination of options
e.g. Resection and shortening
+ Internal Brace

Does placement of FDL transfer through an inferior drill hole help Spring Ligament function?

Cave: NO clinical trials that report outcome of ligament reconstruction alone or in combination with tendon transfer for adult acquired flat foot deformity
Reconstruction of Spring Ligament: Peroneus Longus

- Strongest if 2 elements of SL reconstructed
- Only reproduced in cadavers with biomechanical testing of different construct types

- PL left attached to 1st MT base
- 2 parallel tunnels in os calcis below sustenaculum tali

Reconstruction of Degenerate Spring Ligament:
Stage II Tibialis Posterior tendon with incompetent TPT, symptomatic os naviculare and torn spring ligament.

Medial reconstruction involved excision of the os naviculare, Spring ligament repair with Artelon patch overlaid with the distal TPT and FDL transfer.

Artelon patch overlying repaired spring ligament
FDL transferred through navicular bone tunnel
Distal stump of TPT overlain Artelon patch
Operative Video for Spring Ligament augmentation with Internal Brace and FDL transfer

*InternalBrace™* Ligament Augmentation Repair: Spring Ligament Surgical Technique

*As Presented by:*

**Jorge Acevedo, M.D.**
Royal Palm Beach, Florida
Deltoid Ligament Anatomy

Superficial
- Spans 2 joints – ankle and STJ or TNJ

Deep
- Spans 1 joint
- Shorter and thicker
# Deltoid Ligament Injuries Anatomical Classification

**Hintermann’s Classification of Deltoid Ligament Injuries (2003)**

*(n=54)*

<table>
<thead>
<tr>
<th>Lesion Type</th>
<th>Location</th>
<th>Ligaments most commonly involved</th>
<th>Incidence (%)</th>
</tr>
</thead>
</table>
| I           | Proximal tear or avulsion | o Tibionavicular  
            |                                | o Tibiospring  
            |                                | o (Spring) | 72% |
| II          | Intermediate:     | o Tibionavicular  
            |                                | o Tibiospring  
            |                                | o (Spring) | 9%  |
| III         | Distal            | o Tibionavicular  
            |                                | o Spring      | 19% |

Based on clinical and intraoperative findings

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## Deltoid Ligament Injuries

### “An Association Classification”

#### Acute
- **Isolated** Deltoid injuries
- Associated with ankle fractures
- **Combination** ligament injuries with:
  - Lateral collateral ligaments
  - Syndesmotic ligaments
  - Spring ligament

#### Chronic
- **Secondary** to acute injuries
- **Combination** injuries with:
  - TPT insufficiency
  - Insidious Spring ligament injury

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Planning for Surgery

• Is an initial ankle arthroscopy going to aid management of the problem?
• How is the deltoid ligament going to be exposed?
• Can the ligament be repaired and, if so, what equipment is needed to achieve a satisfactory outcome?
• If the ligament needs reconstructing, what techniques can be used?
• What other structures need inspecting?
• Are any additional osseous procedures required?
Is an initial ankle arthroscopy going to aid management of the problem?

- Hintermann:
  - look for intra-articular pathology
  - Grade Deltoid instability

Complete avulsion of Deltoid ligament (Hintermann)

How is the deltoid ligament going to be exposed?

- Gently curving medial incision from behind medial malleolus to TNJ
- Division of lacinate ligament (Flexor retinaculum)
- Inspection and mobilisation of Tibialis Posterior tendon
- Identification of elements of Deltoid Ligament and Spring Ligament
Can the ligament be repaired and, if so, what equipment is needed to achieve a satisfactory outcome?

- Repair and/or reattachment – 72% will be proximal tear or detachment
- Make sure all damaged elements identified – both superficial and deep

- Direct repair – if acute

- Medial imbrication – if chronic. Need sufficient tissue – if not reconstruction

- Can undertake proximal “medial Broström” (Hintermann) – to re-tension Tibio-Navicular and Tibio-Spring Ligament using either
  - Osseous tunnels for sutures
  - Bone Anchors

Treatment of Deltoid Ligament Injuries

If the ligament needs reconstructing, what techniques can be used?

Options:

Free autografts
- hamstring tendon, e.g. semitendinosus,
- plantaris tendon
- FDL tendon

Attached autografts
- split TPT
- Peroneus Longus

Allografts

Synthetic Reinforcement
- Internal Brace

Deltoid Ligament Reconstruction using free tendon graft

Semitendinosus
Treatment of Deltoid Ligament Injuries

What other structures need inspecting?

- Tibialis Posterior tendon pathology
- Spring Ligament Pathology
- Lateral ligaments
- Syndesmosis
- Intra-articular pathology

Treatment of Deltoid Ligament Injuries

Are any additional osseous procedures required?

Osteotomies:
- Medial displacement osteotomy
- Lateral column lengthening (Evans)

Lateral Ankle Instability
Modified Broström Repair and InternalBrace™
ATFL: 50% single band; 50% double band. Originates 14mm from fibula tip.

CFL: Originates 5mm from fibular tip. Clanton, 2014.
Lennart Broström

51 years on..................1966-2017
My own “lateral ligament journey”

1980s
- Evans
- Watson-Jones

1987
- Broström-Gould

1990s
- Jón Karlsson modification
- Periosteal augmentation
  > tri-laminar reconstruction

1994
- Colville

2012
- Augmentation with Internal Brace (Mackay)

c. 2000
- Bone Anchors

Mitek
Arthrex
Fixation for Broström – Suture Anchors

**Arthrex anchors**

- Usually 2 anchors
- +/- 1 specifically for CFL

- Self-drilling
- Better holding power than barbed anchors
- Easier removal
- FiberWire is non-absorbable, very strong material in smaller size
Strength of Broström repairs

Waldrop NE. AJSM. 2012;40(11):2590-2596.; Viens NA et al. AJSM. 2014:42(2);405-411.
Strength of Broström repairs

Broström Repair – Augmentation with the Internal Brace

- FibreWire augmentation secured with Biocomposite SwiveLock anchors
- Not an excuse for undertaking an Anatomic repair – it augments it!
- Differences in technique – usually dependent upon Surgeon preference for Broström repair itself
Strength of Broström repairs

**Broström repair**

With elements of:
- Gould: using free edge of IER
- Karlsson: by detaching at origin from fibula + periosteal reinforcement

**Periosteum / ST**

**Internal Brace**

**IER**

**Capsule + Ligament**

- Curved or vertical approach around distal fibula
- Identify/mobilise IER
- Sharp dissection of capsule/ligaments
- Posteriorly identify Peroneal tendons and CFL
- Mobilise periosteum/soft-tissue
- Arthrex Anchors
  - 2
  - +/- separate anchor for CFL
- Internal Brace
- Tri-laminar Repair of Soft-tissues
- Separate 2/0 Ethibond

**Fibula**

**Proximal** — **Distal**

**Tri-Laminar Repair**
Internal Brace Broström Augmentation – 6/52 post-op
**Internal Brace construct**

FibreTape attached to a 3.5mm BioComposite SwiveLock (above) for fibula attachment. 4.75 mm BioComposite SwiveLock (below) to which the FibreTape is attached for talus attachment.
Trilaminar Broström with *Internal* Brace

**Incision**

- Case illustrated for combined lateral ligament and peroneal pathology
- Development of tissue planes
Trilaminar Broström with *Internal* Brace

**Identification of structures**
- ATFL and CFL
- Raising of periosteum
- Identification of distal fibula irregularities
Trilaminar Broström with Internal Brace

Preparing the distal fibula surface and Anchor placement

• Rasping irregularities
Trilaminar Broström with *Internal*Brace

Fibula Drill Hole for *Internal*Brace.
2.7 mm drill at the ATFL origin
(IER omitted for clarity)
Attachment of Internal Brace to fibula.
FibreTape attached to a 3.5mm BioComposite SwiveLock Inserted into drill hole (IER omitted for clarity)
Trilaminar Broström with *Internal* Brace

**Placement of Anchors:**
- 2-3 anchors
- FibreTape attached to a 3.5mm BioComposite SwiveLock

FibreTape attached to fibula

Fibrewire attached to ligaments and capsule
Tapping of drill hole at talar insertion of ATFL.
(IER not shown)
Trilaminar Broström with *Internal* Brace

- Tightening of Fibrewire
- Fibre Tape passed distally deep to fat pad
Trilaminar Broström with *Internal/Brace*

Periosteum and IER overlapped to complete Trilaminar repair
Distal *Internal/Brace* secured with 4.75 mm BioComposite SwiveLock
Insertion of 4.75mm Biocomposite SwiveLock into Talus with attached Internal Brace. Haemostat placed under FibreTape to prevent excessive tension during attachment.
Internal Brace fixed to talus with 4.75mm BioComposite SwiveLock
Internal Brace placed deep to fat using a longitudinal skin incision
## Internal Brace – Pros and Cons

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Biomechanically stronger</td>
<td>• Cost</td>
</tr>
<tr>
<td>• Allows quicker rehabilitation</td>
<td>• Avoid intra-articular (synovitis) or subcutaneous position (skin irritation)</td>
</tr>
<tr>
<td>• Protects repair</td>
<td>• Does it stress-shield autogenous tissue?</td>
</tr>
<tr>
<td>• Useful in revision cases and poor tissue quality</td>
<td>• Can over-restrain</td>
</tr>
<tr>
<td>• Bioabsorbable fixation</td>
<td>• NOT an excuse for doing a PROPER procedure!</td>
</tr>
<tr>
<td>• Knotless</td>
<td></td>
</tr>
<tr>
<td>• Flat tape</td>
<td></td>
</tr>
<tr>
<td>• Biocompatible (?)</td>
<td></td>
</tr>
<tr>
<td>• Avoids morbidity of harvesting autogenous tissue, e.g. tendons</td>
<td></td>
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</tbody>
</table>
FibreTape- collagen ingrowth.
Illustrations courtesy of Peter Millett

Repaired cuff with FibreTape

Healed cuff at 4 months
Indications for the use of the *Internal* Brace for Lateral Ligament Instability

- For ALL?
- High demand athletes with need for expeditious rehabilitation?
- Large ossicles and/or poor quality tissue?
- Revision cases?
A Review of Ligament Augmentation with the Internal/Brace™: the Surgical Principle Is Described for the Lateral Ankle Ligament and ACL Repair in Particular, and a Comprehensive Review of Other Surgical Applications and Techniques Is Presented

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Techniques in Foot and Ankle Surgery

The Addition of an “Internal Brace” to Augment the Broström Technique for Lateral Ankle Ligament Instability

Gordon M. Mackay, BSc, FRCS(Orth), FFSEM(UK), MD* and
William J. Ribbons, PhD, FRCS(Orth), FFSEM(UK)†
Tibialis Posterior Tendon and Deltoid and Spring Ligament Injuries in the Elite Athlete

William John Ribbons, PhD, FRCSOrth, FFSEM(UK)\textsuperscript{a,}\textsuperscript{,*},
Ajit Garde, FRCSOrth\textsuperscript{b}

Spring Ligament Reconstruction + FDL Transfer
Fixation for Broström

Arthrex Suture Bridge

- Larger footprint on fibula for attachment of ligament
- Increased strength for anchor pullout
- 5 anchors provide 37% greater torsional rigidity than 3 anchors
- Allows for potentially earlier rehabilitation

Skin markings for Procedure.

a Anterolateral incision made 1cm distal to fibula
b Incision from lateral malleolus to sinus tarsi.

The course of superficial peroneal nerve (SPN) marked superiorly and sural nerve inferiorly.
Insertion of 4.75mm Biocomposite SwiveLock into Talus with attached Internal Brace.
a. Haemostat placed under FibreTape to prevent excessive tension during attachment.
b. Schematic representation of 11b (IER omitted for clarity).
Internal Brace fixed to talus with 4.75mm BioComposite SwiveLock

a. Internal Brace placed deep IER retracted using a curved skin incision

b. Internal Brace placed deep to IER using a longitudinal skin incision
Results – Reviewed 1st 20 patients (2.2013-7.2014)

20 patients
• 5 male; 15 female
• Average age: 31.6 years (17-63)

19 primary
1 revision

Sports:
• 15 regular sport
• 5 not regular sport

Follow-up:
• 13-32 months
• Average: 23 months

ALL 15 athletes:
• ALL return to running <12 weeks
• ALL RTS at same level <26 weeks

Complications:
• 1 superficial wound infection @5/52 – antibiotics. On holiday in USA.
• 1 reported re-”sprain” at 6 months (Taekwondo international) – ok with PT
The Broström Continuum
What is a Broström in 2016?
Development of Anatomic (Broström) repair

Tightening of the restraining tissues on the lateral side of the ankle (and subtalar joint)

Location?
- Mid-substance imbrication of ATFL +/- CFL - Broström (1966)
- Detachment at origin and proximal reattachment of ATFL +/- CFL - Broström (1966); Karlsson (1988)

Fixation?
- Ligament suturing - Broström (1966)
- Osseous tunnels - Broström (1966); Karlsson (1988); Murphy (1999)
- Bone Anchors and Suture Bridges – Paden (1994); Li (2009); Curry (2011)
- Lat TC lig – Broström (1966)

How many ligaments?
- ATFL alone
- ATFL + CFL

Augmentation?
- Fibula periosteum – Kuner (1986); Zwipp (1990); Sjolin (1991)
- Tendon autograft
- Tendon allograft
- Synthetic – Internal Brace – Mackay (2012)
- Thermal capsular shrinkage – Berlet (2002)
- Arthroscopic Broström-Gould with anchors – Acevedo (2011); Minimally invasive - (Cho,2015)

Modifications?
- Open – various incisions
- Patient positioning
- Open – various incisions
- Synthetic – Internal Brace – Mackay (2012)
Development of Anatomic (Broström) repair – where am I in 2016?

Tightening of the restraining tissues on the lateral side of the ankle (and subtalar joint)

Location?
- Detachment at origin and proximal reattachment of ATFL +/- CFL - Broström (1966); Karlsson (1988)

How many ligaments?
- ATFL alone
- ATFL + CFL

Fixation?
- Bone Anchors – Paden (1994); Li (2009); Curry (2011)
- Fibula periosteum – Kuner (1986); Zwipp (1990); Sjolin (1991)

Augmentation?
- Synthetic – Internal Brace - Mackay (2012)

Open – mid lateral

Modifications?
- Mid lateral
- Internal brace
Drill hole at talar insertion of ATFL.

a. Talar drill hole accessed through a curved incision
b. Schematic diagram of talar drill hole (IER omitted for clarity)
c. Talus drilled at 45 degrees to sagittal plane with foot in neutral
Sinus probe used to ensure blind end to talar tunnel and no subtalar joint encroachment
Internal Brace and Broström repair completed.
(IER not shown)
Fibula fixation of Internal Brace and Bone Anchors prior to performing the Broström reconstruction.

The mobilised periosteum is held with forceps in preparation for the tri-laminar repair.
Broström Augmentation with Autograft or Allograft

- Autograft or allograft tendon
  - e.g. semitendinosus, gracilis

- Can be used to augment ATFL +/- CFL
Semitendinosus free graft for Lateral Ligament Reconstruction

- Michael Coughlin technique