BROSTROM PROCEDURE
CLINICAL PRACTICE GUIDELINE

Background

A Brostrom procedure is an anatomical lateral ligament surgical reconstruction commonly performed for lateral ankle instability and/or in case of failure of conservative management for chronic ankle instability. Several factors may contribute to failure of conservative treatments and can be identified as the continued presence of mechanical or functional ankle instability for 6 months following injury and 3 months of conservative treatment. There are two common variations of Brostrom procedures: The Brostrom-Evans (which is not done at Ohio State at this time and will not be detailed here) or the Brostrom-Gould procedure. Each procedure seeks to repair or recreate the anterior talofibular ligament (ATFL) to restore ankle stability. Post-operative outcomes are generally rated as excellent, with 90-95% of patients reporting full return to pre-morbid activity. Additionally, 90-95% of high-level athletes return to sport within 6 months, although longevity of career and performance level have not been well examined.

Brostrom-Gould Procedure
The ATFL is debrided and repaired, and a portion of the inferior extensor retinaculum is stretched over the ATFL to reinforce the ligament.

Intra and extra-articular confounders, such as synovitis and OCD, can be managed with arthroscopic repair. This repair is typically performed in conjunction with the primary repair.

Following a Brostrom repair, the following post-operative changes are considered "normal" and are frequently observed:

- Loss of inversion ROM up to 15 degrees
- Ankle eversion strength deficit of 10% or greater
- Decreased balance, with increased postural sway
- Decreased proprioception

Disclaimer

Progression is time and criterion-based, dependent on soft tissue healing, patient demographics, and clinician evaluation. Contact Ohio State Sports Medicine at 614-293-2385 if questions arise.

Definitions

- *Strong level evidence*: supported by systematic review, meta-analysis, or >5 RCT
- *Moderate level evidence*: supported by 3-4 RCT
- *Low level evidence*: supported in 1-2 RCT or clinical case series
- *Expert opinion*: supported by case studies, expert opinions or opinions of the authors

Summary of Recommendations

Risk Factors for poor outcomes	• Osteochondral defects • Systemic hypermobility & generalized laxity • Synovitis • Impingement • Peroneal tendon dysfunction • Medial ankle instability • Syndesmotic instability • Obesity (BMI ≥ 30 kg/m2) • Hindfoot and midfoot alignment (hindfoot varus, midfoot cavus)
Corrective Interventions	• Modalities for pain & swelling • Patient education • Restore ankle ROM • Ankle and foot intrinsic strengthening • Proprioception and balance training • Hip and core stability • Therapeutic exercise and activity for specific return to sport and work
Precautions	• NWB 10-14 days **based on surgeon specification/recommendation (see below)** ○ Review physician's post-operative note for details on immobilization and WB precautions including progression, and other procedures performed (posterior split, Aircast splint, CAM walking boot) • No active or passive ankle inversion or eversion for **6 weeks** • No ankle inversion at end range ankle PF for **12 weeks**
Manual Therapy	• Gentle midfoot and forefoot mobilizations (Grade I-II); • **DO NOT INCLUDE TALOCRURAL/SUBTALAR JOINT** in order to protect repair • PROM/AAROM ankle DF/PF as tolerated • Soft tissue mobilization PRN
Outcome Tools and Testing	Consider patient reported outcome measures 1. Foot and Ankle Ability Measure (FAAM) 2. The American Orthopaedic Foot & Ankle Score (AOFAS) 3. Foot and Ankle Outcome Score (FAOS) Functional Testing 1. Y-Balance 2. Foot Lift Test **(Appendix A)** 3. Functional Hop Testing **(Appendix B)**
Criteria to Initiate Return to Running and Jumping	1. ROM: 95% symmetry ROM (DF/PF) compared to uninvolved limb 2. Weight Bearing: Normalized gait and jogging mechanics 3. Strength: 25 single leg heel raises without pain or compensation. Consider lateral step down test to assess proximal LE readiness for return to impact activities. 4. Timeframe: Initiate between Weeks 12-16

Criteria for Return to Sport/Discharge	1. Subjective Outcome Measure: > 90% 2. DF Lunge: > 7.5 cm 3. Foot Lift Test: < 5 errors. 4. Strength: <10% plantarflexor asymmetry at 0˚DF and at 20˚PF with handheld dynamometer compared to uninvolved limb **(Appendix C)** 5. Strength: <10% ankle inversion and eversion asymmetry at 0˚DF with handheld dynamometer compared to uninvolved limb **(Appendix D)** 6. Return to Sport: Functional Hop Testing > 90% LSI; Y-Balance > 90% composite 7. Physician clearance (if required)

Rehabilitation Recommendations: Acute Phase (0-6 WEEKS)

Weight Bearing
strong level evidence

- May begin PT 3 days - 2 weeks after surgery.
- NWB 0-2 weeks with immobilization
  - **Review physician's post-operative note** for details on immobilization and WB precautions including progression (posterior split, Aircast splint, CAM walking boot)
  - **Dr. Timothy Miller:**
    - **10-14 days:** Progressive weightbearing in the CAM boot
    - **4 weeks:** Begin to wean from CAM boot to lace up ankle brace
  - **Dr. Kevin Martin:**
    - **0-2 weeks:** WBAT in boot
    - **2 weeks:** wean out of boot into lace up ankle brace
    - **6 weeks:** All activities as tolerated in lace up ankle brace
    - **8 weeks:** Walk to Run program
    - **12 weeks:** return to sport as tolerated
- Discontinue boot at 4-6 weeks per surgeon guidance if not specified above or in surgical note
- Continue with lace up ankle brace upon return to FWB for up to 8-12 weeks as tolerated and per surgeon guidance
- Weight shifts: forward, retro, side to side (as tolerated to normalize gait mechanics)
- Gait training: normalize gait mechanics without AD during progression to FWB
- Non-weightbearing proximal lower extremity & core strengthening

ROM Interventions
strong level evidence

Primarily focused on activation of musculature surrounding the ankle.
***No active or passive ankle inversion or eversion for 6 weeks**

All exercises should be pain-free

- Gentle AROM exercises
  - DF/PF
  - **No inversion/eversion**
- Sub maximal ankle isometric
  - PF
  - DF
  - **No Inversion/Eversion**
- Foot intrinsic strengthening:
  - Splaying/Spreading
  - Doming
  - Great toe extension
  - Ankle PF with great toe flexion
  - Toe curls
  - Towel curls

Manual Therapy *low level evidence*	As needed: • Gentle soft tissue mobilization to musculature surrounding the repair • Gentle scar mobilization when incisions closed if appropriate • Low grade (Grade I-II) joint mobilizations of accessory joints surrounding the repair. • **DO NOT INCLUDE TALOCRURAL/SUBTALAR** • PROM ankle DF/PF as tolerated
Modalities *low level evidence*	Should be utilized in the acute stage of rehabilitation to minimize edema • Vasopneumatic compression • Compression sleeve
Criteria to Progress *moderate level evidence*	• Progression into weight bearing with AD • Review physician post-operative note for WB progression (CAM walker, Aircast, brace, or tennis shoe) • Ankle PROM ≥ 75% of uninvolved (excluding inversion/eversion)

Rehabilitation Recommendations: Return to Function Stage (6-12 WEEKS)

Weight Bearing Restrictions	Full weight bearing, progressing to normal gait pattern. Normal ambulation without an AD in tennis shoe no later than **week 9.** *Continue to wear lace up ankle brace for activity for first 12 weeks. May be removed for Physical Therapy and Home Program participation.
ROM Interventions *moderate level evidence*	Active ROM within tolerance • Stationary bicycle • Begin AROM/PROM ankle inversion/eversion at 6 weeks • Utilize kneeling DF stretch

Neuromuscular reeducation *strong level evidence*	**ROM must be restored to begin proprioceptive exercise progressions*
	Evidence supports the improvement of passive and dynamic (reactive) balance for return to activity. Suggested interventions include:
	• BAPS board
	  • Seated→ standing
	• Single leg stance (progress per patient tolerance)
	  • Firm surface
	  • Foam surface
	  • Dynamic surface
	  • Perturbations
	  • Cognitive task
	  • Eyes closed
	  • Dynamic Balance Tasks
	• Step up
	  • Forward & lateral
	  • Progress to unstable surfaces
	• Functional movement training
	  • Squat
	  • Lunge (stationary, multiple directions)
	  • Heel tap
	• Step and Holds (unilateral)
	  • Forward
	  • Lateral
	  • Progress to unstable surfaces & obstacles
	• Weight Shifts
	  • Forward, retro, lateral
	• Gait Training
	  • Normalize gait mechanics

Therapeutic Exercise *moderate level evidence*	Focused on full ROM with special emphasis on end range training:
	***Maintain neutral ankle positioning (no inversion at end range PF for 12 weeks)**
	• Calf raise series
	  • Double leg
	  • Eccentrics (2 up, 1 down)
	  • Single leg
	  • Seated vs Standing
	  • Progression of forces
	  ▪ Seated
	  ▪ Partial weight bearing (shuttle, leg press)
	  ▪ Body weight
	• Resisted inversion and eversion in neutral ankle dorsiflexion (**8 weeks**)
	• Core strengthening
	• Hip Abductors
	• Hip Extensors
	• Leg press
	• Functional movement training
	  • Squat
	  • Lunge
	  • Heel tap
	  • Step up

Criteria to Progress	• Normalized gait pattern without compensation • PROM: ≥ 90% of uninvolved • Single leg stance : ≥ 90% of uninvolved limb on firm surface • Strength: <10% plantarflexor asymmetry at 0˚DF and 20˚PF with handheld dynamometer compared to uninvolved limb **(Appendix C)** • Or 25 SL calf raises if handheld dynamometer is not accessible • Strength: <10% ankle inversion and eversion asymmetry at 0˚DF with handheld dynamometer compared to uninvolved limb **(Appendix D)** • No edema (figure of 8 or volumetric measurement)

Rehabilitation Recommendations: Return to Sport Stage (12-26 WEEKS)

Criteria to Initiate Return to Running and Jumping	1. ROM: 95% symmetry ROM (DF/PF) compared to uninvolved limb 2. Weight Bearing: Normalized gait and jogging mechanics 3. Strength: 25 single leg heel raises 4. Timeframe: Initiate between Weeks 12-16
Factors to Consider Prior to Return to Play	• Demands of the athlete's sport • Position specific requirements of sport • Competition level

Therapeutic Exercise
strong level evidence

Utilize end range strengthening for ankle plantarflexors, evertors, and invertors. Manipulate training to include both endurance and power considerations based on sport.
Interventions can include:

- Resisted inversion and eversion in end range PF (theraband, ankle weight)
- DL heel raises with theraband pulls into ankle inversion and eversion (progress to SL)
- Toe walking
- Single leg calf raises (Neutral→ start in DF)
- RDL's
- Initiate plyometric progression:
  - Shuttle press: DL → alternating → SL
- FWB: DL straight plane → diagonal plane → rotational → tuck jumps → SL Triple extension exercise
- Planks
- Side planks
- Hip Abductors
- Hip Extensors

*Consider progression to labile surfaces (foam, etc.), and adding neurocognitive tasks for increased proprioceptive training

Agility Training and Sport Specific Drills
low level evidence

Consider periodization (in season v. out of season athlete), power v. endurance and cardiovascular conditioning with these intervention options:

- Return to running progression (if met criteria above)
- Lateral shuffling
- Carioca
- Figure 8 drills
- Cone drills
- Back pedal
- Ladder drills
- Resisted jogging (sport cord)
- Hop training
- Drop counter jump
- Change of direction drills

*Consider progression to labile surfaces (foam, etc.), and adding neurocognitive tasks for increased training for neuromuscular control, and automatic movements

Criteria for Return to Play
moderate level evidence

- Functional Hop Testing
  - LSI ≥90% for all tests
- Star Excursion Balance Test : within 4 cm in anterior direction
- Single leg stance time: 90% of contralateral limb
- Foot lift test: < 5 errors
- Y-Balance: > 90% composite
- Pain ≤ 1/10 with activity
- No reactive edema/effusion in 24 hours post activity
- Ankle ROM: within 90% of contralateral limb using standard techniques
  - DF Lunge > 7.5 cm
- Outcome Tool
  - FAAM with ≤ 1 MCID from full score (9 points)

Appendix A: Foot Lift Test

Begin with patient standing on involved limb on a firm surface, hands on iliac crests. The uninvolved limb is slightly flexed at hip and knee. The patient is to maintain this position for 30 seconds with eyes closed. Instruct patient as follows: “Remain as motionless as possible, if you move out of position please return to original position as quickly as possible.” The examiner will count the number of foot lifts within the 30 second time period. Each foot lift constitutes as 1 error. A foot lift is considered as any part of the foot that loses contact with the ground (eg. lifting toes from the floor). If the uninvolved limb touches the floor it is counted as an error, 1 error added for every second it is out of position. Patient is allowed 1 practice trial, then an average of 3 trials will be calculated. A 30 second rest should be given between each trial.

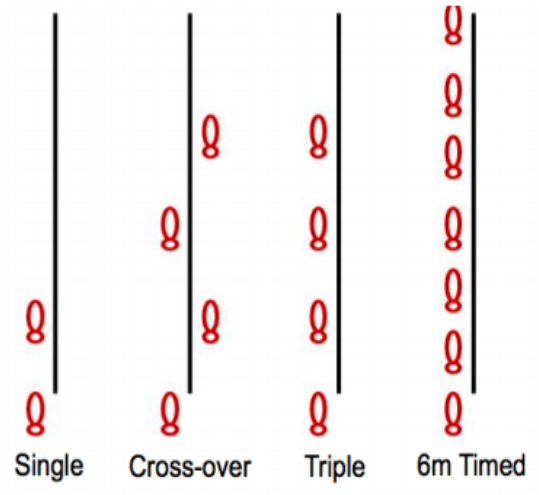
*Discharge and return to sport criteria: < 5 errors

1) **Single hop for distance:** Have the subject line their heel up with the zero mark of the tape measure, wearing athletic shoes. The subject then hops as far as he/she can, landing on the same push off leg, for at least 3 seconds. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

2) **Cross-over hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot, crossing fully over the center line each time. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

3) **Triple hop for distance:** The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

4) **Timed 6-meter hop:** The subject lines their heel up at the zero mark of the tape measure and hops, on cue with the tester, as fast as they can the length of the 6-meter tape. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distanced hopped for each limb. The Limb Symmetry Index: Involved limb time/Uninvolved limb time X 100%.



Appendix C: Hand-Held Dynamometry for Ankle Plantarflexion

Position	• Patient in long-sit position on non-slip floor with foot against wall; barefoot • Knee is fully extended
Placement	• Hand-held dynamometer placed between wall and foot, against plantar surface of foot just proximal to the metatarsal heads • Stabilize lower leg just proximal to ankle as needed
Protocol	• Testing performed at 0° DF and 20° PF • 3 contractions performed in each position lasting 3-5 seconds each • Minimum 10 second rest between trials, 1 minute rest between testing angles • Take average of the 3 trials at each angle • Determine symmetry index for each angle: (involved/uninvolved)*100 = % symmetry
Goal	• 0° DF: ≤ 10% asymmetry between limbs • 20° PF: ≤ 10% asymmetry between limbs

0° dorsiflexion

20° plantarflexion

*Measurements obtained via hand-held dynamometry with always yield lower values than formal Biodex testing. The numbers obtained from hand-held dynamometry are best utilized to determine level of symmetry between involved and uninvolved limbs versus as an accurate representation of force production.

Appendix D: Hand-Held Dynamometry for Ankle Inversion and Eversion

Position	• Patient in long-sit position on plinth with ankle off the edge; barefoot • Knee is fully extended
Placement	• Inversion: Hand-held dynamometer placed on the medial border of the foot at the midpoint of the shaft of the first metatarsal • Eversion: Hand-held dynamometer placed on the lateral border of the foot at the midpoint of the shaft of the fifth metatarsal • Stabilize lower leg just proximal to ankle as needed
Protocol	• Testing performed at 0° DF • 3 contractions performed in each position lasting 3-5 seconds each • Minimum 10 second rest between trials • Take average of the 3 trials • Determine symmetry index for each position: (involved/uninvolved)*100 = % symmetry
Goal	• 0° DF: ≤ 10% asymmetry between limbs

Ankle Eversion

Ankle Inversion

*Measurements obtained via hand-held dynamometry with always yield lower values than formal Biodex testing. The numbers obtained from hand-held dynamometry are best utilized to determine level of symmetry between involved and uninvolved limbs versus as an accurate representation of force production.

Authors: Claire Such, PT, DPT, SCS, AT
Reviewers: Kristy Pottkotter, PT;
Completion Date: June 2022

References

Anatomical reconstruction for chronic lateral ankle instability in the high-demand athlete: functional outcomes after the modified Brostrom repair using suture anchors. Li X, Killie M, Guerrero P, Busconi BD. Am J Sports Med. 2009;37:488–494.

Miyamoto W, Takao M, Yamada K, Matsushita T. Accelerated versus traditional rehabilitation after anterior talofibular ligament reconstruction for chronic lateral instability of the ankle in athletes. Am J Sports Med. 2014;42(6):1441–1447

Pearce, C.J., Tourné, Y., Zellers, J. et al. Knee Surg Sports Traumatol Arthrosc (2016) 24: 1130. https://doi.org/10.1007/s00167-016-4051-z

Lee K, Jegal H, Chung H, Park Y. Return to Play after Modified Broström Operation for Chronic Ankle Instability in Elite Athletes. Clin Orthop Surg. 2019 Mar;11(1):126-130. https://doi.org/10/4055/cios.2019.11.1.126c

Cao Y, Hong Y, Xu Y, Zhu Y, Xu X. Surgical management of chronic lateral ankle instability: a meta-analysis. *J Orthop Surg Res*. 2018;13(1):159. Published 2018 Jun 25. doi:10.1186/s13018-018-0870-6

So, E., Preston, N., & Holmes, T. (2017). Intermediate- to Long-Term Longevity and Incidence of Revision of the Modified Broström-Gould Procedure for Lateral Ankle Ligament Repair: A Systematic Review. The Journal of Foot and Ankle Surgery, 56(5), 1076-1080. doi:10.1053/j.jfas.2017.05.018

Hsu, Andrew R., et al. “Intermediate and Long-Term Outcomes of the Modified Brostrom-Evans Procedure for Lateral Ankle Ligament Reconstruction.” Foot & Ankle Specialist, vol. 9, no. 2, 2015, pp. 131–139., doi:10.1177/1938640015609970.

Shakked RJ, Karnovsky S, Drakos MC. Operative treatment of lateral ligament instability. *Curr Rev Musculoskelet Med*. 2017;10(1):113–121. doi:10.1007/s12178-017-9391-x

Cao Y, Hong Y, Xu Y, Zhu Y, Xu X. Surgical management of chronic lateral ankle instability: a meta-analysis. *J Orthop Surg Res*. 2018;13(1):159. Published 2018 Jun 25. doi:10.1186/s13018-018-0870-6

Wikstrom EA, McKeon PO. Predicting balance improvements following STARS treatments in chronic ankle instability participants. *J Sci Med Sport*. 2017;20(4):356–361. doi:10.1016/j.jsams.2016.09.003

Thompson, C., Schabrun, S., Romero, R. et al. Factors Contributing to Chronic Ankle Instability: A Systematic Review and Meta-Analysis of Systematic Reviews. *Sports Med* (2018) 48: 189. https://doi.org/10.1007/s40279-017-0781-4

Sousa ASP, Leite J, Costa B, Santos R. Bilateral Proprioceptive Evaluation in Individuals With Unilateral Chronic Ankle Instability. *J Athl Train*. 2017;52(4):360–367. doi:10.4085/1062-6050-52.2.08

Wright CJ. A randomized controlled trial comparing rehabilitation efficacy in chronic ankle instability. *Journal of sport rehabilitation*. 07/2017;26(4):238-249. doi: 10.1123/jsr.2015-0189.

Doherty C, Bleakley C, Delahunt E*, et al*. Treatment and prevention of acute and recurrent ankle sprain: an overview of systematic reviews with meta-analysis. *British Journal of Sports Medicine* 2017;51:113-125.

McGovern RP. Managing ankle ligament sprains and tears: Current opinion. *Open access journal of sports medicine*. 2016;7:33-42. doi: 10.2147/OAJSM.S72334.

Shakked R. Acute and chronic lateral ankle instability diagnosis, management, and new concepts. *Bulletin of the Hospital for Joint Diseases (2013)*. 01/2017;75(1):71-80.

Smith BI. Effects of hip strengthening on neuromuscular control, hip strength, and self-reported functional deficits in individuals with chronic ankle instability. *Journal of sport rehabilitation*. 07/2018;27(4):364-370. doi: 10.1123/jsr.2016-0143.

Gribble PA, Bleakley CM, Caulfield BM, et al. Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. doi:10.1136/bjsports-2016-096189.

Herring SA, Neill LB, Park O, Franks R, Indelicato P. The team physician and the return-to-play decision: A consensus statement - 2012 update. Med Sci Sports Exerc. 2012;44(12):2446-2448. doi:10.1249/MSS.0b013e3182750534.

Jeong BO, Kim TY, Song WJ. Effect of Preoperative Stress Radiographic Findings on Radiographic and Clinical Outcomes of the Modified Broström Procedure for Chronic Ankle Instability. J Foot Ankle Surg. 2016. doi:10.1053/j.jfas.2015.08.010.

Kim JS, Young KW, Cho HK, Lim SM, Park YU, Lee KT. Concomitant syndesmotic instability and medial ankle instability are risk factors for unsatisfactory outcomes in patients with chronic ankle instability. Arthrosc - J Arthrosc Relat Surg. 2015. doi:10.1016/j.arthro.2015.02.021.

Li HY, Zheng JJ, Zhang J, Hua YH, Chen SY. The Effect of Lateral Ankle Ligament Repair in Muscle Reaction Time in Patients with Mechanical Ankle Instability. Int J Sports Med. 2015. doi:10.1055/s-0035-1550046.

Li HY, Zheng JJ, Zhang J, Cai YH, Hua YH, Chen SY. The improvement of postural control in patients with mechanical ankle instability after lateral ankle ligaments reconstruction. Knee Surgery, Sport Traumatol Arthrosc. 2016. doi:10.1007/s00167-015-3660-2.

Matsui K, Takao M, Tochigi Y, Ozeki S, Glazebrook M. Anatomy of anterior talofibular ligament and calcaneofibular ligament for minimally invasive surgery: a systematic review. Knee Surgery, Sport Traumatol Arthrosc. doi:10.1007/s00167-016-4194-y

McCriskin BJ, Cameron KL, Orr JD, Waterman BR. Management and prevention of acute and chronic lateral ankle instability in athletic patient populations. World J Orthop. 2015;6(2):161-171. doi:10.5312/wjo.v6.i2.161.

Pfile KR, Hart JM, Herman DC, Hertel J, Kerrigan DC, Ingersoll CD. Different exercise training interventions and drop-landing biomechanics in high school female athletes. J Athl Train. 2013;48(4):450-462. doi:10.4085/1062-6050-48.4.06.

Richie DH, Izadi FE. Return to play after an ankle sprain: Guidelines for the podiatric physician. Clin Podiatr Med Surg. 2015;32(2):195-215. doi:10.1016/j.cpm.2014.11.003.

Shibuya N, Issac Baz an D, Evans AM, Agarwal MR, Jupiter DC, Professor A. Efficacy and Safety of Split Peroneal Tendon Lateral Ankle Stabilization. 2016. doi:10.1053/j.jfas.2015.07.017.

White WJ, McCollum GA, Calder JDF. Return to sport following acute lateral ligament repair of the ankle in professional athletes. Knee Surgery, Sport Traumatol Arthrosc. 2016. doi:10.1007/s00167-015-3815-1.

Yasui Y, Murawski CD, Wollstein A, Kennedy JG. Reoperation rates following ankle ligament procedures performed with and without concomitant arthroscopic procedures. Knee Surg Sport Traumatol Arthrosc. doi:10.1007/s00167-016-4207-x.

van Ochten JM, van Middelkoop M, Meuffels D, Bierma-Zeinstra SM a. Chronic Complaints After Ankle Sprains: A Systematic Review on Effectiveness of Treatments. J Orthop Sports Phys Ther. 2014;44(11):1-52. doi:10.2519/jospt.2014.5221.

Hadadi M, Ebrahimi I, Mousavi ME, Aminian G, Esteki A, Rahgozar M. The effect of combined mechanism ankle

support on postural control of patients with chronic ankle instability. Prosthet Orthot Int. 2015. doi:10.1177/0309364615596068.

Gilbreath JP, Gaven SL, Van Lunen BL, Hoch MC. The effects of Mobilization with Movement on dorsiflexion range of motion, dynamic balance, and self-reported function in individuals with chronic ankle instability. Man Ther. 2014;19(2):152-157. doi:10.1016/j.math.2013.10.001.

Wright CJ, Arnold BL, Ross SE, Ketchum J, Ericksen J, Pidcoe P. Clinical Examination results in individuals with functional ankle instability and ankle-sprain copers. J Athl Train. 2013;48(5):581-589. doi:10.4085/1062-6050-48.3.15.

Chan KW, Ding BC, Mroczek KJ. Acute and chronic lateral ankle instability in the athlete. Bull NYU Hosp Jt Dis. 2011;69(1):17-26. doi:10.1016/S0278-5919(03)00095-4.

Chung KA, Lee E, Lee S. The effect of intrinsic foot muscle training on medial longitudinal arch and ankle stability in patients with chronic ankle sprain accompanied by foot pronation. 2016:78-83.

Hershkovich O, Tenenbaum S, Gordon B, et al. A large-scale study on epidemiology and risk factors for chronic ankle instability in young adults. J Foot Ankle Surg. 2015;54(2):183-187. doi:10.1053/j.jfas.2014.06.001.

Orr JD, Robbins J, Waterman BR. Management of Chronic Lateral Ankle Instability in Military Service Members. Clin Sports Med. 2014;33(4):675-692. doi:10.1016/j.csm.2014.06.011.

Marmon, Adam R, Federico Pozzi, Ali H Alnahdi, and Joseph A Zeni. (2013). “The Validity of Plantarflexor Strength Measures Obtained through Hand-Held Dynamometry Measurements of Force.” *International journal of sports physical therapy* 8(6): 820–27.

Spink, Martin J., Mohammad R. Fotoohabadi, and Hylton B. Menz. (2010). “Foot and Ankle Strength Assessment Using Hand-Held Dynamometry: Reliability and Age-Related Differences.” *Gerontology* 56(6): 525–32.

Porter M, Shadbolt B, Ye X, Stuart R. Ankle lateral ligament augmentation versus the modified Brostrom-Gould procedure. A 5-year randomized controlled trial. *Am J Sports Med*. 2019;47:659-666

J.G. DeVries et al. Ankle Stabilization With Arthroscopic Versus Open With Suture Tape Augmentation Techniques. *J Foot Ankle Surg.* 2019: 58; 57−61

Kulwin R, Watson TS, Rigby R, Coetzee JC, Vora A. Traditional Modified Brostrom vs Suture Tape Ligament Augmentation. *Foot Ankle Int.* 2021;42(5):554-561.

Coetzee JC, Ellington JK, Ronan JA, Stone RM. Functional Results of Open Brostrom Ankle Ligament Repair Augmented with Suture Tape. *Foot Ankle Int*. 2018;39:304-310

Camacho LD, Roward ZT, Deng Y, Latt LD. Surgical Management of Lateral Ankle Instability in Athletes. *J Athl Train.* 2019 Jun; 54(6):639-649.

Kong DH, Lee GS, Park SH, Joo MC, Lee SH, Kim MS. Effectiveness of Hospital-Based Systeic Rehabilitation in Improving Ankle function after Surgery in Chronic Ankle Instability Patients. *BioMed Res Int.* 2021 Jan 28;2021:6695096.doi: 10.1155/2021/6695096. eCollection 2021.

Attia AK, Taha T, Mahmoud K, Hunt KJ, Labib Saa, d'Hooghe P. Outcomes of Open Versus Arthroscopic Brostrom Surgery for Chronic Lateral Ankle Instability: A Systematic Review and Meta-analysis of Comparative Studies. *Ortho J Sports Med*. 2021 Jul;9(7): 23259671211015207. Published online 2021 Jul 21. doi: 10.1177/23259671211015207

Wittig U, Hohenberger G, Ornig M, Schuh R, Rein bacher P, Leithner A, Holweg P. Improved Outcome and Earlier Return to Activity After Suture Tape Augmentation Versus Brostrom Repair for Chronic Lateral Ankle Instability? A Systematic Review. Arthrosc: *J Arthroscop & Rel Surg.* 2022;38(2):597-608.

Vega J, Montesinos E, Malagelada F, Baduell A, Guelfi M, Dalmau-Pastor M. Arthroscopic all-inside anterior talo-fibular ligament repair with suture augmentation gives excellent results in case of poor ligament tissue remnant quality. *Knee Surg Sports Traumatol Arthrosc* 2020;28:100-107.

Ulku TK, Kocaoglu B, Tok O, Irgit K, Nalbantoglu U. Arthroscopic suture-tape internal bracing is safe as arthroscopic modified Brostrom repair in the treatment of chronic ankle instability. *Knee Surg Sports Traumatol Arthrosc.* 2020;28:227-232.

Saleem A, Khan IA, Crouser NJ, Martin D. Utilizing A Percutaneous Versus Open Achilles Tendon Repair Technique for Treating Acute Achilles Tendon Ruptures in Physically Active Adults: A Critically Appraised Topic. *J Sport Rehabil.* 2022: https://doi.org/10.1123/jsr.2021-0330. First Published Online: Apr. 12, 2022.