LEFT ANKLE MODIFIED BROSTROM PROCEDURE WITH FIBULARIS TENODESIS FOLLOWING CHRONIC ANKLE INSTABILITY: A RETROSPECTIVE CASE REPORT

A Case Report

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By

Richard G. Romeis

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Richard G. Romeis SPT

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Thomas Bevins MS, PT Committee Chair/Advisor

Arie van Duijn EdD, PT, OCS Committee Member

The final copy of this case report has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline
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ABSTRACT

Chronic ankle instability refers to the occurrence of repetitive ankle sprains and persistent residual symptoms post-injury. This case report describes the incidence and prevalence of chronic ankle instability as well as the signs and symptoms of chronic ankle instability, factors that comprise chronic ankle instability, and interventions to treat chronic ankle instability both conservatively and surgically. Diagnostic ultrasound will be discussed by being compared and contrasted to other imaging techniques. The case patient is a 35-year-old woman referred to physical therapy by her orthopedic surgeon after a lateral ankle sprain. Following her initial physical therapy, which did not provide an acceptable outcome, she sought surgical intervention and underwent a modified Broström lateral ankle reconstruction procedure with fibularis (formerly known as peroneal) tenodesis and had subsequent physical therapy rehabilitation. Diagnostic ultrasound will be discussed as a viable imaging technique to use in a clinical setting. In particular, to assess the impaired ankle of the aforementioned case patient following a subjective report of increased ankle pain on the operative side following an episode of increased activity. This case report can be used as an illustration of the use of diagnostic ultrasound in an outpatient physical therapy clinical setting to assess soft tissue morphology for patients with acute reports of pain.
Left Ankle Modified Broström Procedure with Peroneal Tenodesis Following Chronic Ankle Instability: A Retrospective Case Report

The reported incidence of chronic ankle instability varies within the literature with the most conservative estimations of 30% reported by Hubbard, Kramer, Denegar, & Hertel (2007). Other studies have shown the incidence of chronic ankle instability to be as high as 70-80% among people with at least one ankle sprain (Holmes & Delahunt, 2009; Kidgell, Horvath, Jackson, & Seymour, 2007). Of the population of people who suffer an ankle sprain, it is reported in the literature that roughly 55% do not seek medical treatment or evaluation thus predisposing them to developing chronic ankle instability (Guillo, Bauer, Lee, Takao, Kong, Stone, Mangone, Molloy, Perera, Pearce, Michels, Tourne, Ghorbani, & Calder, 2013). Chronic ankle instability is described by the occurrence of repetitive bouts of lateral ankle instability and affects at least 30% of people with a history of ankle sprains (Hubbard et al., 2007). With the incidence rate so high, chronic ankle instability is an area of interest among the Physical Therapy community and there is a large amount of research on the subject. This paper will discuss chronic ankle instability and how diagnostic ultrasound is utilized to aid in diagnosing and treating patients with chronic ankle instability.

Purpose

For a physical therapy student planning to practice in orthopedics and having a strong interest in the ankle joint, further investigation of the ankle joint and the use of diagnostic ultrasound will enhance opportunities for advanced practice in this area. With new research being done in the field of imaging and with imaging being incorporated into physical therapy educational programs, an investigation into the uses and procedures of diagnostic ultrasound regarding ankles will prove quite useful in clinical practice. Being able to use diagnostic
ultrasound in the clinic will provide a skill set that many current clinicians and entry-level clinicians do not have. The purpose of the following case report is to illustrate how diagnostic ultrasound can be utilized in an outpatient physical therapy clinical setting. In this case, diagnostic ultrasound was utilized to assess the left ankle of a patient with an acute episode of increased pain following a left lateral ankle reconstruction and fibularis tenodesis.

**Literature Review**

The literature review was performed using computerized literature searches of the following databases: CINAHL, MedLine, ProQuest, PubMed, and ScienceDirect. Terms used include chronic ankle instability, ankle rehabilitation, lateral ankle instability, diagnostic ultrasound imaging, physical therapy, ankle reconstruction, modified Broström repair, exercise, and diagnostic imaging.

**Ankle anatomy.** The ankle joint, or talocrural joint, is a hinge-type synovial joint located between the distal ends of the tibia and fibula and the superior part of the talus (Moore, Dalley, & Agur, 2010). The medial surface of the lateral malleolus articulates with the lateral surface of the talus, while the tibia articulates with the talus in two places: the tibia’s inferior surface forms the roof of the malleolar mortise and the medial malleolus articulates with the medial surface of the talus (Moore et al., 2010). The joint capsule of the ankle joint is thin anteriorly and posteriorly but is reinforced medially and laterally by strong collateral ligaments. (Moore et al., 2010).

**Capsule and ligaments.** The joint capsule is reinforced laterally by three separate ligaments. The anterior talofibular ligament (ATFL) is a flat, weak band that runs anteromedially from the lateral malleolus of the fibula to the neck of the talus (Moore et al., 2010). The posterior talofibular ligament (PTFL) is thick, fairly strong, and extends horizontally and slightly
posteriorly from the malleolar fossa to the lateral tubercle of the talus. The calcaneofibular ligament (CFL) is a round cord that runs posteroinferiorly from the tip of the lateral malleolus to the lateral surface of the calcaneus. The lateral ligaments of the ankle stabilize the ankle during inversion. Other notable anatomical structures that provide strength to the ankle joint laterally are the superior and inferior extensor retinacula (Levangie & Norkin, 2011). Additionally, the inferior band of the superior fibularis (formerly known as peroneal) retinaculum appears to reinforce the CFL, assisting to prevent excessive inversion of the ankle (p. 447). The medial ankle capsule is reinforced by the large deltoid ligament which attaches proximally from the medial malleolus distally to the calcaneus, talus, and navicular via four adjacent, yet continuous parts: the tibionavicular part, the tibiocalcaneal part, and the anterior and posterior tibiotalar parts (Moore et al., 2010). The deltoid ligament stabilizes the ankle during eversion.

**Motion and muscular action.** The movements of dorsiflexion and plantar flexion occur around a transverse axis passing through the talus. However, there are limited amounts of abduction, adduction, inversion, and eversion possible in the talocrural joint. Dorsiflexion is produced by action of the anterior compartment muscles of the leg, mainly the tibialis anterior. Plantar flexion is produced by muscles of the posterior compartment of the leg, mainly the gastrocnemius and soleus (Moore et al., 2010). The lateral compartment muscles (fibularis longus and brevis) aid in plantar flexion and also produce eversion of the foot (Moore et al., 2010). The ankle (subtalar) invertors include the tibialis posterior, flexor digitorum longus, and flexor hallucis longus. The aforementioned invertor muscles also contribute to plantar flexion of the ankle joint (2010).
**Chronic Ankle Instability**

The main predisposing factor of developing chronic ankle instability is sustaining at least one ankle sprain of any degree of severity (Guillo et al., 2013). Chronic ankle instability is related to several factors that are classified as either functional or mechanical in nature (Hiller, Kilbreath, & Refshauge, 2011; Holmes & Delahunt, 2009; Hubbard et al., 2007). The mechanical instability (MI) impairments include: ligamentous laxity (Hiller et al., 2011), impaired arthrokinematics, and degenerative synovial joint changes (Hubbard et al., 2007). One study examined MI and the ankle joint itself by measuring the talar radius and concluded that the bony configuration of the ankle joint itself can be another intrinsic mechanical factor leading to MI (A. Frigg, R. Frigg, Hintermann, Barg, & Valderrabano, 2007). The functional instability (FI) impairments do not have a universally approved definition (Hiller et al., 2011); however, a common list of deficits include: impaired neuromuscular control, impaired proprioception, strength deficits or subjective complaints of weakness, diminished postural control, recurrent sprains, and a feeling or actual occurrence of giving way (Hiller et al., 2011; Hubbard et al., 2007; Ross, Guskiewicz, Gross, & Yu, 2008). It has been recommended in the current literature that a standard guideline or framework be developed to determine the presence or absence of FI (Docherty, Gansneder, Arnold, & Hurwitz, 2006). Some questionnaires exist to subjectively determine FI, but there is yet to be a definitive tool to determine FI in the clinic (Hiller et al., 2011).

Hiller et al. examined some of the different models used to determine chronic ankle instability. One of the models examines the possibility that FI and MI are not mutually exclusive, but rather part of a continuum of chronic ankle instability with recurrent sprains occurring when both conditions are present (Hiller et al., 2011). In order to better understand chronic ankle
instability, the different functional and mechanical aspects of the condition must be further studied to gain a better understanding of the condition as a whole. Mechanical instability will be the first topic of discussion.

**Mechanical Instability**

As previously stated, mechanical instability is caused by a variety of factors. These factors include ligamentous laxity (Hiller et al., 2011), impaired arthrokinematics, degenerative synovial joint changes (Hubbard et al., 2007), and a large talar radius (Frigg et al., 2007). The aforementioned factors usually develop or present post-injury, but the talar radius can be present before any injury. Frigg et al. examined 104 subjects – 52 people who had past history of recurrent ankle sprains, and 52 people who had no such history. Of all of the studies in this literature review, this particular study has one of the higher sample sizes and the widest age range making it a relatively strong study. To determine the talar radius, Frigg et al. had their subjects’ ankles radiographed and after finding the center of the talus, circles were digitally superimposed over the radiographs to measure the radius of the tibio-talar surface as well as another measurement referred to as the sector. The sector is defined in this study as the angle between the lines drawn from the center of the talus and the anterior and posterior margins of the distal tibia (Frigg et al., 2007). According to the research findings, chronic ankle instability is determined by having a small sector and a large talar radius, while a typical stable ankle has a large sector and small radius (Frigg et al., 2007). The aforementioned measurements would be measuring a mechanical aspect of chronic ankle instability previously described in this study. A limitation of the research was the use of the sagittal, two dimensional ankle movement model to describe the ankle joint since the ankle can be clearly described as three-dimensional in movement (Frigg et al., 2007).
Hubbard et al. also examine mechanical instability in their study comparing it to functional instability. They examined the relationships between MI and FI. The sample consisted of only thirty college-aged people. Thus, the results can only be generalized to younger adults and recreational athletes, as is true with most of the studies in this literature review. The strongest direct relationship between FI and MI was that the addition of anterior ligament laxity led to impaired dorsiflexion (Hubbard et al., 2007).

**Functional Instability**

As previously mentioned, the common list of impairments includes: impaired neuromuscular control, impaired proprioception, strength deficits or subjective complaints of weakness, diminished postural control, recurrent sprains, and a feeling or actual occurrence of giving way (Hiller et al., 2011; Hubbard et al., 2007; Ross et al., 2008). While the presence of FI can occur without the presence of MI, Arnold and Docherty propose that FI can stem from ligamentous damage and deafferentation, which would impair proprioception (Arnold & Docherty, 2006). As indicated with the list above, the liberal measure (Docherty et al., 2006) of a “feeling of giving way” is a subjective measure (Hiller et al., 2011) and presents with a limitation of the current functional instability standards if subjects self-report improperly. Arnold and Docherty, speculate that this feeling of giving way is associated with eversion force sense being damaged after an injury to the ankle (2006). According to Holmes & Delahunt, the consensus in the literature is that subjects with functional instability do not all present with evotor weakness (2009). However, ankle muscular strength and proprioception impairments are present in subjects with chronic ankle instability according to Arnold & Docherty (2006), Hiller et al. (2011), Holmes & Delahunt (2009), and Hubbard et al. (2007).
It is common knowledge that the musculature of the ankle joint plays an integral role in the dynamic stabilization of the ankle joint. This dynamic stabilization is achieved by co-contraction of the musculature surrounding the joint (Holmes & Delahunt, 2009). Subjects with functional instability show strength and proprioceptive deficits in their ankle invertors (Holmes & Delahunt, 2009), and/or evertors, and dorsiflexors (Holmes & Delahunt, 2009; Docherty, Gansneder, Arnold, & Hurwitz, 2006). Being able to properly assess and treat these muscle deficits is an important part of a comprehensive treatment strategy.

The Ross et al. study used an assessment tool designed to discriminate between subjects with FI and subject with healthy ankles (2008). This tool is called the Ankle Joint Functional Assessment Tool (AJFAT) and is used to quantify functional limitations (Ross et al., 2008). Ross et al.’s study determined that the AJFAT successfully identified functional limitations in 100% of the participants with FI in their study (2008). Hiller et al. developed their own new model of chronic ankle instability in order to better understand the impairments, restrictions, and limitations of people with chronic ankle instability (2011). Furthermore, Hiller et al. in their study proposed that the term “functional instability” be replaced with “perceived instability” based on the fact that historically all definitions of functional instability have included the perception of instability (2011). Hiller et al.’s model categorizes subjects into more subgroups, which in turn makes their model more clinically relevant for identifying functional deficits. The case patient to be discussed later in this paper fits into each subgroup, thereby confirming the presence of chronic ankle instability according to the model used by Hiller et al. Their model may also be used to create a clinical prediction rule in the future (Hiller et al., 2011).

Another tool used to objectively identify the presence of functional ankle instability is the Ankle Instability Instrument (AII) (Docherty, Gansneder, Arnold, & Hurwitz, 2006). In their
study, Docherty et al. developed a tool which accurately identifies FI using subjective measures. Although this study was the pilot study for the instrument, Docherty et al. determined that the AII can be used by both researchers and clinicians in the future (2006). While not using either of the aforementioned ankle instability tools, the Hubbard et al. study utilized the Foot and Ankle Disability Index (FADI). Furthermore, Hubbard et al. performed MI and FI tests such as the Star Excursion Balance Test (SEBT). Strong correlations among the FI measures led the researchers to the conclusion that one functional deficit can be the cause of other deficits, therefore, the researchers propose that if strength is impaired in one direction that perhaps strengthening should be conducted in all directions due to the strong relationship between other variables with deficits (Hubbard et al., 2007). Other common functional performance tests to determine the presence of FI or the improvement of FI post-intervention are the single-limb hopping test and the single-limb hurdle test (Buchanan, Docherty, & Schrader, 2008). The aforementioned functional performance tests are high level activities and require a significant amount of muscular strength and power. The case patient to be discussed was not tested using either of these measures as she was receiving physical therapy to return to her previous level of function following a surgical intervention.

Clinicians can use the objective information gleaned from the aforementioned tests and measures to implement prevention techniques and intervention techniques as needed. By interpreting the results of the patient’s test, a clinician can determine whether the patient presents with instability, and the clinician can tailor an intervention program to treat the patient and improve in the areas where deficits are noted in the test results. By tailoring intervention programs to improve the patient’s deficits, prevention of further damage to the ankle structures can be achieved. While the studies discussed in this review mostly included studies with
relatively small sample sizes, there is an understanding that common sports medicine research typically utilizes smaller sample sizes (Docherty et al., 2006).

**Physical Therapy Exercise Interventions for Chronic Ankle Instability**

Exercise interventions are an integral part of a conservative approach to treat chronic ankle instability to avoid surgery. In order to achieve the best outcomes for patients when prescribing exercise, therapists should focus on goal-oriented rehabilitation rather than task-oriented rehabilitation (Wickstrom, Hubbard-Turner, & McKeon, 2013). Wickstrom et al. go on to add that the tasks performed in the sub-acute and later phases of rehabilitation should be meaningful to achieve better outcomes (2013). In this case, Wickstrom et al. discuss that “better outcomes” involve more functional improvement and return to prior level of function when meaningful tasks are incorporated into rehabilitation protocols versus standard later phase rehabilitation protocols (2013).

Range of motion is a standard of care addressed in rehabilitation of chronic ankle instability. Oftentimes ankle dorsiflexion is limited in patients with chronic ankle instability and the restoration of dorsiflexion needs to be one of the primary goals for patients with limited motion (Terada, Pietrosimone, & Gribble, 2013). Patients who lack adequate dorsiflexion are more likely to have an inversion episode, functional limitation, and chronic pain (Terada et al., 2013). Dorsiflexion is of such high importance because only with adequate dorsiflexion can the ankle reach the closed-packed position and subsequently be stable and less likely to suffer an inversion episode (Terada et al., 2013). The case patient to be discussed later demonstrated a lack of dorsiflexion following her surgical intervention which may have been a precipitating cause for some of her consistent ankle pain. In their systematic review, Terada et al. (2013) report that the intervention which best improved ankle dorsiflexion was static stretching as part of a home
exercise program. A common finding in patients post inversion injury is decreased muscle length in the gastrocnemius and soleus, thus limiting dorsiflexion of the ankle and predisposing to further injury (Terada et al., 2013). Terada et al. also discuss Maitland joint oscillations and mobilization with movement (MWM) to improve ankle dorsiflexion range of motion and report that there were small effect sizes for the MWM group which were clinically not significant, but the evidence collected showed that Maitland oscillatory mobilizations are effective at restoring motion (2013). Joint mobilizations are also shown to be effective in yielding mechanical and functional benefits addressing joint restrictions as well as sensorimotor function commonly dealt with in patients with chronic ankle instability (Rodriguez-Merchan, 2011). Due to the sensorimotor deficits that accompany chronic ankle instability, some authors suggest that the exercise intervention approach for ankle rehabilitation be focused on a more global and central level versus a local and peripheral level (Rodriguez-Merchan, 2011). Improving sensorimotor deficits is imperative due to the fact that sensorimotor deficits lead to injury, which in turn causes further sensorimotor deficit (Wickstrom et al., 2013). Therefore aside from the aforementioned range of motion maintenance, strengthening, balance, and proprioception exercises are common areas of treatment in patients with chronic ankle instability. Once pain free range of motion is regained, strengthening exercises can occur.

As mentioned earlier in this review, the ankle musculature is an integral part of the dynamic stabilization of the ankle joint and ankle strengthening should be performed in all planes (Hubbard et al., 2007). Wickstrom et al. state that exercise progression should involve increasing task complexity while maintaining quality of movement in order to challenge the sensorimotor system (2013). Ross (2007) proposed a theory that strengthening the ankle musculature in turn increases gamma-efferent activity which could make the muscle spindle cells
more sensitive to stretch, resulting in better proprioception and joint sense. Eils and Rosenbaum (2001) reported in their study that multistation proprioceptive training produced significant improvement in joint position sense, postural sway, and muscle reaction times with a follow-up survey one year later showing continued improvement in subjective feeling of stability and decreased inversion episodes. According to Wickstrom et al. (2013), the goal of balance activities should be to restore the sensorimotor system’s ability to cope with change during movement which would subsequently improve functional performance. Wickstrom et al. propose a constraints-based balance program which when utilized produces significant self-reported functional improvements in patients who suffer inversion injuries and patients with chronic ankle instability (2013). Kidgell et al. (2007) reported significant improvements in balance and postural sway following a six week training in exercise groups on either dura disc or mini trampoline. The authors state that this improvement could be in fact due to the endurance nature of the intervention program in the study. Similar effects can be produced on a wobble board to improve neuromuscular deficiencies and balance (Holmes & Delahunt, 2009). It can be postulated that any form of compliant surface would suffice in providing improvements in ankle balance strategy and proprioception provided the surface allowed for proper engagement of the ankle musculature. The wobble board is also commonly used for strengthening and coordination (Han, Ricard, & Fellingham, 2009). Han et al. state that in addition to the aforementioned interventions, strengthening can be achieved with weights or elastic resistance exercises (2009). Han et al. describe the inherent advantages for elastic resistance training being the ease of use, low cost, high versatility, and ability to impose a weight-bearing overload on the joint being rehabilitated (2009). Han et al. go on to describe that when using elastic tubing to train, the tubing is attached to the unaffected ankle in order for the affected ankle to experience the weight-
bearing overload during resistance of the perturbation forces (2009). In their randomized controlled trial, Han et al. (2009) used the elastic tubing in the exercise group and exercises were performed in four different directions: front pull, back pull, crossover, and reverse crossover. The subjects in the exercise group performed three sets of fifteen repetitions three times a week for four weeks. Final balance assessment using a force plate to measure the total excursion from the center of balance showed significant improvement in the exercise group compared to the control group. Han et al. also explain that the exercises incorporate multiple joints in the support limb which adds to the challenge of balance (2009).

**Diagnostic Ultrasound**

With almost any ankle injury, a set of rules known as the Ottawa Ankle Rules for Ankle/Foot Trauma is referred to in order to determine whether or not radiographs need to be ordered (McKinnis, 2010). The Ottawa Ankle Rules require a radiograph if a patient reports pain in the posterior tip of either malleolus, pain at the base of the fifth metatarsal, pain at the navicular bone, pain in the midfoot, pain around the medial or lateral malleolus, and cannot bear weight immediately following an injury (McKinnis, 2010). The radiograph will then be interpreted and the results will rule in or out any bony pathology and allow clinicians to focus their assessment on soft tissue structures that may have been incurred. For patients with chronic functional and/or mechanical ankle symptoms, radiographs, stress radiographs, magnetic resonance imaging, arthrography, computerized tomography, ultrasonography, and/or bone scan/scintigraphy can be used to assess the soft tissues and bony anatomy (Martin, Davenport, Paulseth, Wukich & Godges, 2013). It is a well-known fact that soft tissue injuries are very common in the ankle. Ultrasound is becoming quite useful in the clinic for imaging soft tissues and has the added benefit of allowing dynamic studies necessary for assessing tendinous and
ligamentous integrity (Mansour et al., 2011). Ultrasound has a clear advantage of imaging the soft tissue structures that normal radiographs cannot show (McKinnis, 2010). Additionally, ultrasound studies can pinpoint structures and elicit high-quality images to better determine the shape and size of tendons or ligaments which MRIs cannot always illustrate (Margetic et al., 2008). Ultrasounds can also be done in real time with movement of the structures being viewed to assess for any disruptions of soft tissues (Margetic et al., 2008). Of all the ligaments in the lateral ankle, the anterior talofibular ligament (ATFL) is the most commonly torn during inversion sprains (Oae, Takao, Uchio, & Ochi, 2010). The ATFL, commonly implicated in ankle sprains, is nothing more than a thickening of the anterior joint capsule and the fibers run from the neck of the talus to the anterior border of the lateral malleolus (Yu & Cody, 2009). On ultrasound, the normal anterior talofibular and calcaneofibular ligaments appear as hyperechoic bands, with acutely damaged ligaments showing as an amorphous hypoechoic mass with tears being evident as interruptions in ligament continuity (Mansour et al. 2011), depending on severity of injury. Chronic cases could show ligamentous thickening, attenuation, or absence (Mansour et al., 2011). As for ultrasound scanning, typical positioning for ultrasound would include the patient in supine with the knee bent, foot flat on the table with the ankle in moderate plantar flexion and inversion for patient comfort. In this position, the ATFL is slightly stretched, which allows good visualization (Oae et al., 2010). ATFL injury can be classified into three types: type 1 is defined as having the injury at the attachment to the fibula, type 2 is at the mids substance, and type 3 is at the attachment to the talar neck (Oae et al., 2010). Oae et al. focused on the ATFL injury in both acute and chronic cases to compare imaging techniques (2010). During the study by Oae et al., each patient had stress radiographs, US, and MRI which were all compared to arthroscopic findings – with the arthroscopic findings being the gold
standard for the study. Oae et al. found that the stress radiographs were accurate for chronic cases with 12 true positive cases, 2 true negative cases, 0 false positive cases, and 1 false negative case, making the accuracy for radiograph diagnosis of chronic ATFL injury 93% (2010). For the acute cases utilizing stress radiographs, there were only 8 true positive cases, 2 true negative cases, zero false positive cases, and nine false negative cases making the overall radiograph accuracy of ATFL injury 53%. For MRI results of ATFL injury, Oae et al. found that for the acute cases, there were no false positives making the accuracy of MRI 100% for diagnosis of acute ATFL injury. For chronic cases utilizing MRI, Oae et al. found 12 true positive cases, 2 true negative cases, 0 false positive cases, and 1 false negative case with the overall accuracy of diagnosing ATFL injury to be 93% (2010). Oae et al. found that US showed that there were 17 true positive cases, 1 true negative case, 1 false positive case, and 0 false negative cases making the accuracy of ATFL injury 95% for acute cases (2010). For chronic cases, US showed 13 true positive cases, 0 true negative cases, 2 false positive cases, and 0 false negative cases, making the ATFL chronic injury accuracy 87% (Oae et al., 2010). As for the portion of the ligamentous injury, the location determined by US and cross-checked arthroscopically was only accurate to 63% (Oae et al., 2010). With this, Oae et al. determined the in their study involving 34 patients that the US sensitivity is 100% for Acute and Chronic cases, specificity is 50% for acute cases and 0% for chronic, and accuracy is 95% for acute cases while being 87% as discussed previously for chronic cases (2010). Table 1 summarizes the above information.
Table 1. Diagnostic Value of Different Imaging Modalities When Assessing ATFL Injury

The diagnostic value of Stress radiographs, US, and MR imaging. According to the arthroscopic diagnosis as a gold standard, the ATFL injury was seen in 30 out of 34 cases.

<table>
<thead>
<tr>
<th>Stress Radiograph</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
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<tbody>
<tr>
<td>Acute</td>
<td>47%</td>
<td>100%</td>
<td>53%</td>
</tr>
<tr>
<td>Chronic</td>
<td>92%</td>
<td>100%</td>
<td>93%</td>
</tr>
<tr>
<td>All</td>
<td>67%</td>
<td>100%</td>
<td>71%</td>
</tr>
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<table>
<thead>
<tr>
<th>US</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute</td>
<td>100%</td>
<td>50%</td>
<td>95%</td>
</tr>
<tr>
<td>Chronic</td>
<td>100%</td>
<td>0%</td>
<td>87%</td>
</tr>
<tr>
<td>All</td>
<td>100%</td>
<td>33%</td>
<td>91%</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>MR Imaging</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Chronic</td>
<td>92%</td>
<td>100%</td>
<td>93%</td>
</tr>
<tr>
<td>All</td>
<td>97%</td>
<td>100%</td>
<td>97%</td>
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</table>

Limitations of the Oae et al. study to mention briefly are the absence of a second reader of the images and the lack of any intraobserver test for reliability (2010). A third limitation of the Oae et al. study is the lack of ability by the researchers to detect partial tears arthroscopically due to the nature of partial tears being difficult to detect by the human eye. Since US can detect partial tears, the data could be slightly skewed by the researchers reporting that US shows false positives which may in fact be true positives (2010). Despite the minor limitations, the Oae et al. study is the only study found comparing diagnostic ultrasound imaging with arthroscopy.
Aside from ligamentous damage, morphology of musculotendinous structures and pathologies associated with chronic ankle instability can be easily detected with diagnostic ultrasound. Dynamic ultrasound can differentiate tendinosis from partial tear by stretching and compressing the tendon. With this technique discontinuity is readily appreciated (Girish, Finlay, Landry, O’Neill, & al., 2007). It is also possible to evaluate the entire tendon in its longitudinal plane irrespective of its course. Extended field-of-view imaging technology enhances the ability of ultrasound to document tendon and muscle disorders. The diagnosis of partial split longitudinal tears of the tendons is effectively made using ultrasound, particularly in the medial and lateral tendons with their curved orientation around the malleoli (Girish et al., 2007). This is clinically applicable as many patients with serious tendon pathologies may go undiagnosed. Additionally, subluxation or dislocation of fibularis (formerly known as peroneal) tendons, as well as laxity of the overlying fibularis retinaculum, can be easily demonstrated with dynamic ultrasound (Girish et al., 2007). Advantages of diagnostic ultrasound include its cost-effectiveness and its capacity for real-time dynamic imaging, contralateral limb comparison, multiplanar scanning, and a targeted bedside examination (Girish et al., 2007). Noted disadvantages of diagnostic ultrasound include the long learning curve, operator related issues, and intraobserver variability (Girish et al., 2007); which is all the more reason to learn the skill set in order to progress the field of physical therapy and more effectively treat patients.

**Surgical Procedures to Treat Chronic Ankle Instability**

Following a lateral ankle sprain, there may be bony and/or soft tissue disruptions along with subsequent functional and mechanical impairments which may lead to chronic ankle instability. Recent research suggests that operative repair of acutely torn ligaments in elite athletes with severe ankle sprain can reduce the risk of chronic ankle instability (Guillo et al.,
2013). Some patients who develop chronic ankle instability may undergo a lateral ankle reconstruction when conservative methods fail (Martin, Davenport, Paulseth, Wukich & Godges, 2013). In his article, Murphy discusses that before undergoing a surgical procedure, a patient with chronic ankle instability should undergo conservative treatments first. The conservative treatments include ankle proprioception exercises, fibularis (evertor) strengthening, and occasional use of ankle supports (1999). Additional conservative treatments include mobilizations and static stretching exercises (Terada et al., 2013) If the conservative treatment fails, then surgical intervention may be indicated following a careful examination with the following findings: a positive anterior drawer test, a positive talar tilt test, and positive stress radiographs (Murphy, 1999). While there are multiple methods of repairing the lateral ankle complex, the Broström procedure is widely recognized as the most common anatomical repair (Murphy, 1999; Brotzman & Wilk, 2007).

Lennart Broström (1966) first developed the surgical repair of the lateral ankle to correct for chronic ankle instability and described his procedure as locating the ends of the ruptured ATFL and after removing any scar tissue, he directly repaired the ligament back together (Murphy, 1999). Modifications to the procedure were performed by Gould et al. in 1980 and then Karlsson et al. in 1988 (Murphy, 1999) leading to the “modified Broström procedure” techniques being commonly performed. In his article, Murphy (1999) states that Gould et al. added a major modification to the Broström procedure by suturing the most proximal edge of the inferior extensor retinaculum to the fibula to reinforce the stability of the repair. Murphy (1999) then states that Karlsson et al. modified the initial Broström procedure by shortening the ATFL and CFL and suturing them to the distal fibula. Murphy (1999) continues to explain that the attachment of the [inferior extensor] retinaculum to the fibula not only allows for a more stable
talocrural joint, but also improves stability of the subtalar joint as well. Despite the efficacy of the Broström procedure, a few scenarios exist where the Broström procedure may be suboptimal: 1) if a patient has generalized ligamentous laxity, 2) a long duration from initial injury (with ten years being a cutoff), and 3) in an ankle that has already been reconstructed, especially with a tendon harvesting procedure (Brotzman & Wilk, 2003; Murphy, 1999). If there is to be a revision of a lateral ankle repair, then the use of the fibularis brevis tendon would be indicated to augment the repair (Brotzman & Wilk, 2003) with more recent literature also discussing the use of autograft gracilis or allograft using the anterior tibialis tendon (Brotzman & Wilk, 2007). The goal of the lateral ankle repair is to improve ankle stability while preserving normal talocrural and subtalar motion (Brotzman & Wilk, 2003). The Broström procedure is shown to have excellent outcomes postoperatively with improved talar stability (Murphy, 1999), overall function, return to sports in the athletic population, contralateral limb comparison, and improved range of motion at one and two year follow-ups (Li, Killie, Guerrero & Busconi, 2009). Surgical reconstruction has also been associated with a lower rate of re-injury; however, surgical repair has been associated with a higher incidence of post-traumatic osteoarthritis (Martin et al., 2013).

**Rehabilitation Following Lateral Ankle Repair**

Proper rehabilitation is needed to regain strength and range of motion following a lateral ankle reconstruction using the modified Broström procedure. The more aggressive consensus among the literature involves a minimum of two weeks non-weightbearing (Brotzman & Wilk, 2007; Li et al., 2009; Nery, Raduan, Del Buono, Asaumi, Cohen & Maffulli, 2011) with the more conservative weightbearing protocols involving four weeks non-weightbearing, partly due to osteochondral anomalies or microfractures during the surgery (Okuda, Kinoshita, Morikawa, Yasuda & Abe, 2005; Choi, Lee, Han, Kim & Lee, 2008). Following the two to four weeks of
non-weightbearing, the patient is allowed to progress weightbearing with the ankle in neutral position while either wearing a removable cast boot, walking cast, or protective ankle brace (Brotzman & Wilk, 2007; Choi et al., 2005; Li et al., 2009; Murphy, 1999; Nery et al., 2011). According to the literature reviewed for this paper, there is a consensus to begin active assisted range of motion exercises (Li et al., 2009) and strengthening four weeks following the progression to full weightbearing (Choi et al., 2005; Murphy, 1999; Nery et al., 2011; Okuda et al., 2005). According to Murphy (1999) strengthening consists of isometric ankle dorsiflexion and plantarflexion, with inversion and eversion not started until six weeks post operatively. Li et al. included plyometric training in their rehabilitation program at the eight week post-operative mark (2009). In addition to strengthening and range of motion, proprioception exercises were a common type of ankle rehabilitation exercises (Brotzman & Wilk, 2007; Li et al., 2009; Murphy, 1999; Nery et al., 2011).

In the athletic population, patients are allowed to begin running and sporting activities by eight to twelve weeks provided strength is normal (Brotzman & Wilk, 2007). More intense cutting activities are not allowed until sixteen weeks to six months post-operatively (Li et al., 2009; Nery et al., 2011). Murphy (1999) states in his article that his patients are restricted from cutting and jumping sports until the affected calf is within one centimeter of the same diameter of the unaffected calf. It is suggested in the literature that athletes wear some sort of ankle brace or splint during sporting activities for at least six months following their lateral ankle reconstruction (Brotzman & Wilk, 2007; Murphy, 1999; Okuda et al., 2005).

Summary

An understanding of the terminology and current knowledge of the best evidence-based treatment approaches are important to understand. This literature review has covered the basic
anatomy and physiology of the ankle joint, the prevalence and incidence of chronic ankle instability, the pathophysiology of chronic ankle instability, treatments for chronic ankle instability, and rehabilitation after surgical ankle reconstruction. In addition, diagnostic ultrasound has been introduced as an imaging technique to assess the structures of the ankle joint. The results of this literature review supported the management of the case report patient and provided evidence supporting the use of diagnostic ultrasound imaging.

**Case Description**

The patient was referred by her orthopedic surgeon, to an outpatient physical therapy clinic with an initial diagnosis of left lateral ankle sprain with peroneal tendonitis (more correctly known as fibularis tendonitis). After a week of therapy, the patient reported a worsening of symptoms to the referring physician and set plans for a lateral ankle modified Broström procedure with fibularis tendon repair of the fibularis brevis and retinacular repair. Following a six week period of non-weightbearing, the patient began progressive weightbearing and initiated postoperative physical therapy. The examining therapist had two years of previous clinical outpatient orthopedic experience, and performed the examination described: subjective pain assessment, initial observation, history and interview, structural inspection, palpation, active motion, passive motion, strength assessment, sensation assessment, and gait assessment followed by summary of findings, prognosis, and treatment plan.

**Examination**

**Subjective pain assessment.** Ankle pain intensity was assessed using a numeric pain rating scale (NPRS) of 0-10. The patient reported that her left ankle pain at the worst was 7-8/10. The patient reported her minimal level of left ankle pain to be a 3-4/10. At the time of evaluation, self-reported functional deficits which she reported as being limited by left ankle pain
include trouble sleeping, pain with rolling in bed and getting in and out of bed due to the boot, pain with any activity weightbearing on the affected extremity including prolonged standing, walking, getting in and out of the shower, and cleaning; she also reported pain with lifting/carrying objects while weightbearing, and pain while performing yard work/gardening and recreational activities. The patient was limited to the extent as discussed above due to the patient’s pain level being constant between a 3/10 and an 8/10 due to noncompliance with the proper weightbearing protocol as set by the surgeon and lack of motion due to the six week immobilization period. The patient’s self-reported functional limitation was not assessed with a standardized scale or tool such as the LEFS or FADI and the retrospective nature of the case report does not allow this researcher to determine an exact amount of functional deficit incurred.

Initial observation. The patient presented at the initial visit in a walking boot and an antalgic gait and no ambulatory assistive device when entering the physical therapy department.

Patient history. The patient was a 35-year-old Caucasian female who was employed in the billing department at a local orthopedic surgeon’s office. She had a previous history of chronic ankle instability and suffered an ankle sprain in late September 2013. After failed conservative treatment with physical therapy and a subjective worsening of perceived instability, she elected to undergo a lateral ankle reconstruction using the modified Broström procedure in conjunction with a fibularis tenodesis. Following the surgery, it is worth noting that the patient had a fall and sustained a forced dorsiflexion moment on her affected ankle in the hard cast with an increase in pain, but without permanent damage. It is suspected that this is one reason that the patient had a constant amount of pain and such high amounts of pain in her left ankle. In addition, the patient reported a burning pain in the distal third of her lateral incision. The patient made an appointment with the surgeon for her surgical site to be assessed. An infection was not
suspected, but oral antibiotics were ordered prophylactically to prevent any possible infection. Additionally, a course of Neurontin was ordered to reduce the burning pain sensation. The patient initiated therapy following six weeks of non-weightbearing. At that point in time, the patient had begun progressive weightbearing and use of a walking boot.

**Structural inspection.** Initial observation and inspection of the ankle shows a lateral incision originating slightly anterior and distal to the lateral malleolus on the foot traversing along the lateral leg along the fibularis tendon to the musculotendinous junction. The scar was intact and dry with no signs of infection. There was moderate swelling of the lateral ankle and hindfoot, though there were no circumference measurements obtained. There was no discoloration or ecchymosis noted. Mild atrophy of the left ankle musculature was noted: gastroc, soleus, fibularis muscles, and tibialis anterior.

**Palpation.** Tenderness to palpation was noted along the incision site, along the fibularis muscle bellies proximal to the incision, at the site of the reconstructed ATFL, and at the CFL. The skin at the lateral ankle, lateral calf, and hindfoot felt warm to the touch. There was decreased scar mobility noted in a medial-lateral direction and superior-inferior direction along the distal half of the scar. Increased tone was noted in the fibularis musculature, triceps surae, and tibialis posterior.

**Active motion assessment and passive motion assessment.** Active and passive range of motion assessment was performed using a standard four inch goniometer with techniques described by Norkin & White (2003). Goniometry has been found to be a valid measure of joint range of motion measurement, and has good-to-excellent reliability when the measurements are performed in a standard manner (Norkin & White, 2003). See Table 2 for bilateral ankle active
range of motion at time of initial evaluation. See Table 3 for bilateral ankle passive range of motion at time of initial evaluation.

**Table 2. Ankle Active Range of Motion at Initial Evaluation**

<table>
<thead>
<tr>
<th>Ankle Motion</th>
<th>Left</th>
<th>Normal Motion</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsiflexion</td>
<td>3°</td>
<td>20°</td>
<td>20°</td>
</tr>
<tr>
<td>Plantar Flexion</td>
<td>35°</td>
<td>50°</td>
<td>50°</td>
</tr>
<tr>
<td>Inversion</td>
<td>12°</td>
<td>35°</td>
<td>35°</td>
</tr>
<tr>
<td>Eversion</td>
<td>9°</td>
<td>15°</td>
<td>15°</td>
</tr>
</tbody>
</table>

**Table 3. Ankle Passive Range of Motion at Initial Evaluation.**

<table>
<thead>
<tr>
<th>Ankle Motion</th>
<th>Left</th>
<th>Normal Motion</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsiflexion</td>
<td>4°</td>
<td>20°</td>
<td>20°</td>
</tr>
<tr>
<td>Plantar Flexion</td>
<td>40°</td>
<td>50°</td>
<td>50°</td>
</tr>
<tr>
<td>Inversion</td>
<td>13°</td>
<td>35°</td>
<td>35°</td>
</tr>
<tr>
<td>Eversion</td>
<td>10°</td>
<td>15°</td>
<td>15°</td>
</tr>
</tbody>
</table>

**Strength assessment.** Strength assessment was graded on a 0-5 scale as described in Hislop & Montgomery (2007) for all ankle planes of motion. The patient displayed normal 5/5 strength in the right ankle musculature and 3+/5 strength in the left ankle musculature, indicating that she was able to maintain end position against mild resistance (Hislop & Montgomery, 2007). Reliability and validity of manual muscle testing have been shown to be satisfactory for clinical
use, however, the subjective nature of manual muscle testing indicates that there will always be inherent differences in inter-rater reliability (2007).

**Sensation assessment.** Sensation was decreased at the incision site with mild numbness noted. Sensation was otherwise unremarkable.

**Balance assessment.** There were no standardized formal balance tests, nor informal balance assessments administered or reported.

**Gait assessment.** Patient is able to fully weight bear in the walking boot and demonstrates an antalgic gait pattern, left compensatory trunk lean, and significantly decreased stance time on the left side.

**Summary of findings.** The patient presented with atypical orthopedic post-operative signs and symptoms inconsistent with being six weeks status post left modified Broström ankle reconstruction with fibularis tenodesis. Her elevated pain level with concurrent subjective decreased functional mobility due to pain were abnormal given her extended time non-weightbearing. This patient presented with the following impairments relevant to subsequent treatment planning:

1. Pain in the left ankle and calf.
2. Edema of the left ankle.
3. Decreased active and passive range of motion of the left ankle.
4. Decreased left ankle strength in all planes.
5. Antalgic gait pattern with decreased stance time on the left due to pain resulting in hesitation to bear weight through the left lower extremity and inability to evenly weight shift, which affects her ability to stand for prolonged periods.
Prognosis. The patient’s signs and symptoms pre-operatively were consistent with chronic ankle instability of the left ankle. The patient then underwent a surgical reconstruction which provided stability of the ankle which would prevent further re-injury in theory. Given the patient’s younger age, good health, the nature of the orthopedic procedure, and the patient’s high degree of motivation, the initial prognosis would seem to be good to be able to return to pre-surgical level of activity. Functional goals for the identified impairments were as follows:

1. Within 2-4 weeks, the patient will be able to verbalize and demonstrate HEP.
2. Within 4-6 weeks, the patient will be able to ambulate with the endurance to walk for 60 minutes before requiring rest.
3. Within 4-6 weeks, the patient will be able to ascend and descend 12” stairs with no pain.
4. Within 4-6 weeks, the patient will be able to ambulate with change in direction without hesitation or apprehension.
5. Within 4-6 weeks, the patient will be able to maintain stable bipedal and/or unipedal stance for upper extremity reaching tasks.
6. Within 4-6 weeks, the patient will be able to stand for eight hours with 0/10 pain to be able to work.
7. Within 4-6 weeks, the patient will be able to return to recreational activity with 0/10 pain.

Treatment plan. The plan was to see the patient twice a week for four to six weeks and perform the following interventions:

1. Therapeutic exercises to increase strength, ROM, flexibility, and endurance.

3. Ultrasound at 3 MHz, 1W/cm², 20% duty cycle to decrease pain.

4. Electrical stimulation to decrease pain.

5. Cold pack to decrease pain, spasm, and inflammation.

6. Neuromuscular reeducation to improve movement, balance, coordination, posture, and proprioception.

7. Gait training to improve stride length and stance time on the left lower extremity.

8. Distribute a home exercise program to augment the clinical program.

This treatment plan has inconsistencies with the treatments to be performed and the functional limitations previously described by the patient. The actual treatments rendered did not focus on neuromuscular reeducation or gait training specifically. In addition, there were no formal reassessments to determine if all of the goals were met. Due to the retrospective nature of this case report, it is unknown as to why the treating therapist did not address functional activities as part of the therapeutic regimen.

**Intervention**

The interventions used in the treatment of this patient are summarized in Table 4 in Appendix A. Techniques used to improve mobility of the ankle joint included: seated calf stretch with a towel (Figure 1 Appendix B), first ray stretch (Figure 2 Appendix B), and soleus stretches with a towel to improve triceps surae flexibility, as well as improve dorsiflexion range of motion. Static stretching has been shown to be a reliable method of regaining ankle range of motion, especially ankle dorsiflexion (Terada et al., 2013). Other exercises that will improve range of motion and flexibility at the ankle are the standing incline board with knees straight to target the
gastroc, and knees bent to target the soleus. Soft tissue mobilizations (STM) and passive range of motion (PROM) techniques were aimed at improving muscle tone, decreasing pain, reducing edema and by extension improving range of motion of the left ankle. Much of the exercise program for this patient involved recovery of range of motion. As previously mentioned by Terada et al. (2013), recovering full dorsiflexion is essential for proper recovery for patients with ankle dysfunction. A lack of dorsiflexion can lead to forced inversion episodes, functional limitations, and chronic pain (Terada et al., 2013).

Theraband elastic resistance tubing was performed to improve strength of the left ankle plantar flexors and dorsiflexors. The advantages of the use of elastic resistance for ankle rehabilitation for balance discussed by Han et al. (2009) relate to the ankle strengthening component using Theraband. As previously mentioned in this case report, strengthening of the musculature is hypothesized to also result in increased gamma-efferent activity which could make the muscle spindle cells more sensitive to stretch, resulting in better proprioception and joint sense (Ross, 2007). The wobble board was used for this patient to improve proprioception and dorsiflexion range. The wobble board is commonly used in the rehabilitation of proprioception (Holmes & Delahunt, 2009) as well as strengthening and coordination (Han et al., 2009). In addition to the Theraband and wobble board, seated calf raises (Figure 3 Appendix B) and towel crunches (Figure 4 Appendix B) were used to improve strength of the ankle and foot musculature. The towel crunches in particular are an exercise which is ideal for patients with balance deficits due to the fact that the intrinsic foot musculature aids in proprioception and provides dynamic support of the foot during balancing activities (Mulligan & Cook, 2013). This musculature was not formally tested for strength, although following a foot/ankle surgery and six
week period of immobilization these muscles will not have normal strength or proprioception
due to disuse atrophy.

While in the third week of therapy following the second treatment session, the patient
was complaining of increased pain in her left ankle and hindfoot after reporting that she had been
coaching soccer and ran the evening before. The patient denied any inversion injury which may
have put her surgical repair at risk, but reported sharp pain rated 8/10 on the NPRS in the lateral
hindfoot and anterolateral ankle. It is worth noting that the activity causing exacerbation of the
patient’s pain was not yet recommended at this point in the patient’s rehabilitation and the
patient was not judicious regarding concern for her healing repaired tissues. A decision was
made to use diagnostic ultrasound to rule out damage to the repair, or to discover other
pathology. The diagnostic ultrasound machine was set to scan at a frequency of 12 MHz and a
linear probe was utilized as a higher frequency is often utilized to assess superficial structures
and small or complex joints (Jacobson, 2013). Proper scanning technique and body positioning
was performed as described in Jacobsen’s Fundamentals of Musculoskeletal Ultrasound (2013).

The initial approach to scanning the patient’s ankle was as is described in 2010
Musculoskeletal Ultrasound for the Extremities: A Practical Guide to Sonography of the
Extremities by Randy E. Moore (2007). The patient could not tolerate the supine position during
the approach and remained long-sitting on a plinth in approximately 60 degrees of hip flexion,
approximately 90 degrees of knee flexion, and her foot flat on the plinth. The patient was very
sensitive to the pressure of the probe, but enough pressure was maintained to preserve quality of
images during scanning. After careful manipulation of the probe to ensure elimination of
anisotropy artifact, the anterior talo-fibular ligament (ATFL) repair was located and showed no
disruption. Anisotropy artifact is defined as not having equal appearances on all axes and is
produced when the transducer is not perpendicular to the structure being assessed (Moore, 2010). Anisotropy can occur with as little as a five degree deviation off the correct perpendicular plane. Anisotropy occurs in tissues which are more fibrillar in nature. This would include tendons, ligaments, and to a smaller extent, muscle (Jacobsen, 2013). No images were saved of the ATFL during this imaging assessment. The examination then moved to assessment of the fibularis tendons in short-axis view and long-axis view. The starting position of the fibularis assessment was as is described by Moore (2010) in long-axis, posterior to the lateral malleolus along the fibularis tendons of the left ankle. Following slow, careful scanning of the fibularis musculature, the exact site of the fibularis tenodesis was unclear to the researcher as well as the patient. Following the images being captured of the fibularis, the examination moved to the final structure of concern given the patient’s history and previous surgery: the calcaneofibular ligament (CFL). The researcher began in an oblique coronal plane as described by Jacobsen (2013). Following a 90 degree turn to show the CFL in short-axis, through careful manipulation of the transducer, a clear image could be taken of the midsubstance of the CFL (Figure 5).

This image showed the CFL to be intact and partially surrounded by edema as noted by the black hypoechoic (fluid-filled) area on the screen. An image was captured of this structure to be compared upon reassessment at a later date. The edema surrounding the CFL was thought to be a result of an acute inflammatory exacerbation due to overuse of the structures still recovering from the patient’s surgical procedure. The referring orthopedic surgeon prescribed oral and topical NSAIDs to relieve the increased pain and inflammation after seeing the patient two days later.
Figure 5. Short-axis view of the patient’s left CFL (white arrow) mid-substance with surrounding edema present (gray arrows).

Following the ultrasound assessment and the appointment with the physician, the therapy program was adjusted to prevent further exacerbation of the fibularis and inversion and eversion activities were ceased. The patient continued progressing with exercises as shown in Table 3. The patient was reassessed in Week 4 of her regimen and had achieved full left ankle PROM. The patient’s strength was not formally reassessed at this time. The patient had a complaint of left knee pain in Week 5 and underwent a left knee evaluation in the first visit of that week. The patient suffered a minor setback during Week 6 in which she tripped while ascending stairs and experienced increased pain at 7/10 on the NPRS. The patient was discharged from therapy for her left ankle following Week 7 with measures listed in Table 3. The patient continued therapy to treat her left knee following discharge for her left ankle because the left knee was more painful and problematic than her left ankle at the time.
Outcome

The patient was seen for a total of 13 visits over a 7-week period of time for her left ankle. The treatment frequency was two times per week throughout the episode of care. At time of discharge, the patient still had reports of left ankle pain at 4/10 on the NPRS which was a decrease from the initial rating of 8/10 at the maximum. The location of remaining pain was in the lateral ankle. Her goals of being able to perform recreational activity with 0/10 pain on the NPRS and stand for 8 hours for job requirements were unmet at the time of discharge. Range of motion of the left ankle had normalized. Strength of the left ankle had improved to 4+/5 in all planes by the end of week 7. Gait assessment still revealed decreased left stance time and antalgic gait, but this was likely due to the left knee pain that became the primary complaint in week 5 rather than any left ankle dysfunction. The goal of ambulating without antalgia was not met, but this may have been due to the left knee pain especially since the patient suffered a fall at the end of week 6 which elevated her pain to 7/10. Edema had normalized. The patient’s goals of being able to demonstrate the HEP, ambulate with change in direction and no hesitation, and stable bipedal stance with UE reaching tasks were met by the end of treatment for her left ankle. The goals which were met were expected outcomes based on the information from current literature states regarding rehabilitation following a lateral ankle reconstruction surgery.

The patient was contacted six months after the first diagnostic ultrasound scan of her ankle and she reported an episode of increased pain after competing in a 10 kilometer obstacle course. The patient was asked to participate in a follow-up scan of her left ankle and she agreed. The scan was performed by the same operator with the same machine and same settings with one exception: The scan initially began with the frequency set to 10 MHz, and following the first image capture, the frequency was adjusted to 12 MHz which the same frequency previously
used. The patient was placed on a plinth in the same position as the first diagnostic scan as mentioned above. The patient’s left ankle was warm to the touch and she was tender to palpation along the fibularis, lateral ankle, and hindfoot. The scan procedure was performed with the same technique and positioning as previously performed during the first scan, with the only difference being the order of structures scanned. This assessment began with imaging of the CFL first. The same location of the CFL was found after a 90 degree rotation from the oblique coronal plane. The short-axis view showed that the CFL was found to be intact, with slight edema noted in the image captured (Figure 6), but the edema was not as significant when compared to the first image captured six months prior.

The ATFL was then assessed using the same scanning technique described in the first diagnostic ultrasound assessment, followed by the fibularis tendons and muscles. Images were captured of the ATFL and the fibularis at nearly the exact same points as the first scan. Unfortunately, there was no standardization of scanning technique using landmarks for these structures. Therefore ensuring comparable images of the exact same locations was not achieved and the images are unusable for comparison, however the images still reveal information about the structures assessed.

![Image](image.png)

*Figure 6.* Short axis view of the patient’s left CFL (white arrow) mid-substance with edema (gray arrow), second scan.
After learning a method to standardize how to capture images in an exact location using measured markings on the skin, the student examiner asked the patient to participate in a third scan of her left ankle at approximately nine months after her first diagnostic ultrasound assessment. The patient informed the student examiner that she still had complaints of deep pain in the left fibularis. Using a ball-point pen, markings were drawn on the skin at the following locations: at the tip of the lateral malleolus, 4 centimeters proximal to the lateral malleolus along the fibula and fibularis, 8 centimeters proximal to the lateral malleolus along the fibula and fibularis, 12 centimeters proximal to the lateral malleolus along the fibula and fibularis, at the most lateral portion of the base of the fifth metatarsal, and halfway between the base of the fifth metatarsal and the lateral malleolus.

The first image captured was long-view along the fibula with the transducer head approximately between three and eight centimeters proximal to the lateral malleolus. This image was captured and showed suspected pathology of the periosteum of the left fibula (Figure 6) due to the non-uniformity of the bone surface in the image. The second image captured was long-view over the ATFL to obtain a clear image of a repaired ATFL (Figure 7) following a lateral ankle modified Broström procedure.

Figure 7. Long-axis view of the patient’s left ATFL with evidence of previous tear (white arrows) and healing.
The image illustrates the fibula on the right, the anterior talus on the left, and a clear view of the now healed and reconstructed ATFL with evidence of previous complete tear of the structure. The prior tear is seen as a thin jagged hypoechoic line with granular tissue present from the previous tissue healing. The evidence of the healed previous tear of the ATFL is only apparent due to the fact that the surgeon used the patient’s ATFL during the reconstruction. The surgeon reinforced the ligament with FiberWire and the extensor digitorum brevis along the fibularis retinaculum (not seen in the image). The next image captured was short-axis over the fibularis tendons at the level of the lateral malleolus (Figure 8).

![Image](image.png)

**Figure 8.** Short-axis view of the left fibularis brevis (deep, black & white arrow) and longus (superficial, gray arrow) with the lateral malleolus (left, white arrow).

The image shows the fibularis brevis (bottom) and longus (top) with clear swelling surrounding the longus tendon and “increased through transmission” artifact of the structure immediately deep to the swelling as is common when the sound waves are focused over fluid (Jacobsen, 2013). The last image captured was at the same level of the previous image, at the lateral malleolus, and was long-axis over the fibularis tendons. This image was not kept due to
excessive artifact evident following further inspection of the image. The CFL was not reported as being painful to palpation by the patient, nor were her pain complaints regarding the area near this structure, therefore assessment of the CFL was not performed. The scan of the patient’s lateral ankle and lateral leg showed possible left fibular periosteal pathology as well as clear swelling surrounding the fibularis tendons indicating an inflammatory process. If used in the clinical setting, the physical therapist could combine the imaging results and clinical judgment to direct treatments to address the impairments found. Swelling of the fibularis tendons may not be evident from an observational viewpoint without the use of diagnostic ultrasound, however, tenderness to palpation and pain with selective tissue tension testing may produce clinical evidence supporting the same underlying pathological process.

**Discussion**

This case report describes the physical therapy management and outcomes of a patient who underwent a left modified Broström procedure with fibularis tenodesis. Additional diagnostic ultrasound assessment of the left ankle was performed on three separate occasions by this student examiner. The patient was a 35-year-old woman referred by her orthopedic surgeon status post left ankle surgical procedure mentioned above. The patient presented with moderate left ankle edema, decreased range of motion, decreased strength, increased pain, and an antalgic gait pattern with decreased stance time on the left. It is worth noting that the patient’s pain level was very high at the time of her initial evaluation despite having been non-weightbearing and immobilized for six weeks. Her pain was exacerbated by a near fall and forced weightbearing through her cast on the affected side as mentioned previously, and as noted earlier, the patient reported increased pain and decreased function at the time of evaluation. Another possible reason for he increased pain is due to her improperly progressing her weightbearing faster than the
surgeon’s recommendations, thus also decreasing her functional ability. Post-surgical management consisted of therapeutic exercise, soft tissue mobilizations, and passive range of motion into end range, therapeutic ultrasound, and modalities to control pain. At discharge, the patient demonstrated clinically significant improvements with regard to motion and strength of the ankle, however, she had not met all of her goals at time of discharge. The patient was discharged from therapy for her left ankle due to the fact that she had regained functional strength and range of motion in her left ankle, but her left knee had become a new area of pain and dysfunction which was unrelated to the post-surgical treatment of the patient’s left ankle. The retrospective nature of the case report does not include information as to why the patient was discharged from physical therapy for her left ankle, however, it is suspected that the discharge of therapy for the left ankle was in order to focus treatment on the patient’s left knee.

This case report illustrates how diagnostic ultrasound can be used in a clinical setting to examine soft tissues for possible pathologies following acute exacerbations and subjective reports of increased pain. This student examiner was able to take part in the use of diagnostic ultrasound to assess the lateral ankle complex and surgical site to reassess such a patient. The significance of this ability to assess the patient using diagnostic imaging illustrates the importance of how diagnostic ultrasound can be used in clinic to assess the integrity of soft tissue structures following complaints of increased pain. In order to use the diagnostic ultrasound, it would have to be assumed that physical therapists would have access to musculoskeletal ultrasound imaging machines, know how to operate musculoskeletal ultrasound machines, and know how to interpret the images. Currently in the field of physical therapy, the use of diagnostic ultrasound imaging is only emerging and more information needs to be gathered in order to further promote the use of imaging techniques in the clinical setting.
This student examiner performing the examination procedure has in-depth knowledge of the musculoskeletal system, however, it must be stated that this student examiner had no prior experience performing musculoskeletal ultrasonography before this time. This student examiner performing the examination procedure has in-depth knowledge of the musculoskeletal system, however, it must be stated that this student examiner had no prior experience performing musculoskeletal ultrasonography before the training and literature review conducted as part of this student’s independent study. This student examiner undertook the study of musculoskeletal ultrasound and had purchased two separate texts to learn imaging techniques and the basics of musculoskeletal ultrasonography. A limitation of this case report is the initial lack of standardization of the diagnostic ultrasound process in addition to the student examiner’s lack of musculoskeletal ultrasonography experience and interpretation of the captured images. A second limitation of this case report is that functional disability was not formally assessed with a standardized tool, and upon discharge the patient’s subjective functional impairments were not recorded. A third limitation of this case report is an incomplete record of information regarding the patient’s episode of care for the ankle and whether or not all of her initial goals of the plan of care were met due to the fact that she had a separate episode of care for the left knee which overlapped with her therapy for her ankle. This is a common problem encountered in a retrospective review of patient records. A fourth limitation of this case report is the lack of evidence in the literature regarding use of diagnostic ultrasound in a clinical setting for the ankle. Multiple sources address the non-weightbearing status, being between two weeks to at least four weeks of non-weightbearing, and proper weightbearing progression thereafter in either a walking boot or some other sort of supportive ankle brace (Brotzman & Wilk, 2007; Choi et al., 2008; Li et al., 2009; Murphy, 1999; Nery et al., 2011; Okuda et al., 2005). In this case, the patient
remained non-weightbearing for a total of six weeks per the surgeon’s protocol. The studies then go on to discuss the rehabilitation by beginning with range of motion and strengthening (Brotzman & Wilk, 2007; Murphy, 1999, Okuda et al., 2005). In addition to strengthening and range of motion, proprioception exercises were a common type of ankle rehabilitation exercises (Brotzman & Wilk, 2007; Li et al., 2009; Murphy, 1999; Nery et al., 2011).

**Conclusion**

This case report illustrates the physical therapy management and outcomes of a patient following a left modified Broström procedure with fibularis tenodesis. More importantly, this case report illustrates the clinical use of diagnostic ultrasound to assess soft tissue for possible pathological disruptions following the patient’s complaints of increased pain. This patient presented post-operatively with decreased left ankle range of motion, decreased muscle strength of the left ankle, increased pain, increased edema, and an antalgic gait with decreased stance time on the left lower extremity. A multimodal physical therapy treatment approach was used based on evidence in the literature and it included therapeutic exercise, therapeutic ultrasound, and soft tissue mobilization with manual static stretching. Clinically meaningful short and long term improvements with regard to range of motion and strength were reported. When problems were encountered during the recovery period, diagnostic ultrasound imaging was performed to assess the soft tissue of the ankle for any disruptions or pathologies. Diagnostic ultrasound has been shown to be quick, accurate, and effective for assessment of the soft tissue structures of the ankle (Girish et al., 2007; Mansour et al., 2011; Margetic et al., 2008; Oae et al., 2010). A need for further research exists in the area of diagnostic ultrasound imaging of the ankle in a physical therapy outpatient clinical setting.
References


### Appendix A. Interventions During Physical Therapy Management

**Table 4. Interventions during physical therapy management**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>INTERVENTIONS</th>
<th>MEASURES</th>
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<tbody>
<tr>
<td>1</td>
<td>Seated calf stretches, towel crunches (left), Wobble board DF-PF, seated DF-PF Theraband ankle strengthening, seated calf raises; Soft tissue mobilization (STM) to left ankle musculature and left ankle passive range of motion (PROM) 10 minutes; Ultrasound 1.0 W/cm², 3 MHz, 20%; IFC and CP</td>
<td>Pain constant in left ankle on numeric pain rating scale (NPRS) 7-8/10 highest. Muscle tone increased in fibularis, triceps surae, and tibialis posterior. Tenderness to palpation (TTP) left heel.</td>
</tr>
<tr>
<td>2</td>
<td>Held wobble board secondary to patient refusal. Discontinued seated calf raises.</td>
<td>Pain remains 7-8/10 on NPRS. PROM left ankle DF to 5°. TTP at left fibularis tendons. Minimal-moderate left ankle swelling.</td>
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<tr>
<td>3</td>
<td>Re-added wobble board DF-PF. Added circle board clockwise-counter clockwise. Progressed towel crunches by adding time. Soft tissue imaging assessment performed using Diagnostic Ultrasound following therapy visit 6. Performed by student examiner prompted by patient reporting subjective exacerbation.</td>
<td>Pain level 5/10 on NPRS on visit 5, and 7/10 on visit 6. TTP left heel and fibularis tendons. Moderate left ankle and hindfoot swelling. Warm to the touch at lateral hindfoot and fibularis tendons. Scan showed evident edema surrounding the CFL at the midsubstance of the ligament. Scan did not show any gross disruption.</td>
</tr>
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<td>4</td>
<td>Discontinued circle board due to fibularis tendonitis exacerbation and patient ordered to discontinue active inversion and eversion. Modified Theraband strengthening to DF-PF only progressed by adding repetitions. Added 5 minutes to STM and ankle PROM.</td>
<td>NPRS pain level at 4-5/10. PROM left ankle normal except for DF: 14° Minimal edema left ankle and hindfoot. TTP left lateral heel and fibularis.</td>
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<tr>
<td>5</td>
<td>Added recumbent bicycle 5 minutes. Added standing calf stretch on incline board. Progressed wobble board by performing in standing bilateral DF-PF only. Progressed Theraband by increasing resistance, decreasing repetitions. Reduced STM to 10 minutes.</td>
<td>NPRS pain level at 2-3/10. Minimal edema left ankle and hindfoot. TTP left fibularis. Slight antalgic gait.</td>
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Table 4. Interventions during physical therapy management continued

<table>
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<th>WEEK 6</th>
<th>INTERVENTIONS</th>
<th>MEASURES</th>
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<tbody>
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<td></td>
<td>Added SLR left LE hip abduction, adduction, flexion, as well as hamstring curls and knee extensions secondary to knee evaluation performed. Added SL balance on foam. Re-added calf raises.</td>
<td>NPRS pain level at 4/10 during the first session. NPRS pain level pain at 7/10 at presentation of the second session. Slight to no edema in the left ankle and hindfoot. Slight antalgic gait.</td>
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<tr>
<th>WEEK 7</th>
<th>INTERVENTIONS</th>
<th>MEASURES</th>
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<td></td>
<td>Same as above.</td>
<td>NPRS pain level at 4/10. Left ankle strength 4+/5 all planes. Left ankle ROM WNL. Gait still antalgic, likely due to left knee pain. D/C from therapy for left ankle.</td>
</tr>
</tbody>
</table>
Appendix B. Intervention Images and Descriptions

**Figure 1.** Calf stretch with a towel. The patient is instructed to wrap the towel around the bottom of the forefoot and gently pull until a stretch is felt. Hold the stretch for a duration of 20 seconds and repeat 5 repetitions.

![Calf stretch with a towel](image1.png)

**Figure 2.** First ray stretch. Patient can either use their hand or a strap/towel. Patient is instructed to gently pull until a stretch is felt. Hold the stretch for a duration of 20 seconds and repeat 5 repetitions.

![First ray stretch](image2.png)

**Figure 3.** Seated calf raises. Can be performed edge of bed or in a chair. The feet are positioned flat on the floor and the patient is asked to raise their heels, then slowly lower their heels back to the floor. Repeat as prescribed per the therapist.

![Seated calf raises](image3.png)
**Figure 4.** Toe crunches with towel (towel not shown). The patient is instructed to curl their toes and pull the towel underneath their foot. Repeat as prescribed per the therapist.