Rehabilitation of distal tibiofibular syndesmosis sprains: a case report

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Objective: To present the epidemiology, etiology, diagnostic criteria and therapeutic interventions for an important clinical entity – tibiofibular syndesmosis or "high ankle" sprains.

Clinical Features: The most common mechanism of injury is forced external rotation in a dorsiflexed foot. Pain is located anteriorly over the anterior tibiofibular ligament, and is elicited through a variety of tests designed to stress this articulation through diastatic forces. Pain with ambulation is typical, and is usually present during the push-off phase of gait. Radiographs may be useful in determining the extent of this injury, as syndesmotic sprains with malleolar fractures are more common than those without.

Intervention and Outcome: Convalescence is generally protracted compared with a lateral ankle sprain, and care must be taken to avoid stressing the supporting ligaments during the early course of therapy. Initial treatment is aimed at reducing pain and inflammation using modalities such as microcurrent, electroacupuncture and P.R.I.C.E. principles. Treatment over subsequent weeks involves progressive resistance exercises, proprioceptive challenges, plyometric exercises and sport-specific agility drills, while maintaining cardiovascular fitness.

Conclusion: The practitioner should also be cognizant of the indolent nature of this injury and possibility for sequelae. Anterior ankle pain and pain with a deep squat or during the push-off phase of gait are typical of this injury. Radiographs to rule out fracture and evaluate the extent of the injury may be warranted. Conservative Objectif : Présenter l'épidémiologie, l'étiologie, les critères diagnostiques et les interventions thérapeutiques pour une importante entité clinique – articulation péronéo-tibiale inférieure ou entorse de la « cheville élevée ».

Caractéristiques cliniques : Le mécanisme le plus fréquent de cette blessure se présente sous la forme d'une rotation externe forcée de la flexion dorsale du pied. La douleur est localisée antérieurement au ligament péronéo-tibial et elle est provoquée par une variété de tests conçus pour étirer l'articulation par le moyen d'une force diastatique. Il est habituel que le sujet ressente de la douleur en marchant et elle est généralement présente dans la phase d'appui actif au sol de la démarche. Des radiogrammes pourraient être utiles pour déterminer l'étendue de la blessure puisque les entorses péronéotibiales avec fractures malléolaires sont plus présentes qu'absentes.

Intervention et résultat : La convalescence est toujours prolongée par comparaison avec une entorse latérale à la cheville et il faut bien prendre soin d'éviter d'ajouter du stress aux ligaments de soutien au début de la période de thérapie. Le traitement initial vise à réduire la douleur et l'inflammation en utilisant des éléments tels le microcourant, l'électroacupuncture et les principes de P.R.I.C.E. Le traitement dans les semaines suivantes porte sur la résistance progressive, les exercices, les défis proprioceptifs, des exercices de pliométrie et un entraînement d'agilité propre à un sport tout en maintenant en santé le système cardiovasculaire.

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therapy involving rehabilitation and tissue injury care is appropriate for Grade I and II injuries, while Grade III injuries require a surgical intervention. (JCCA 2007; 51(1):42–49)

KEY WORDS: syndesmosis, tibiofibular.

Introduction

Inversion ankle sprains seldom present a diagnostic dilemma to the experienced practitioner; however injuries to the distal tibiofibular syndesmosis often go unnoticed. Considering the lengthy time until return to full activity, the ability of this condition to mimic or occur in combination with inversion sprains, this entity should be a diagnostic consideration for all physicians and therapists who deal with peripheral joint pathologies. The actual incidence of these injuries is widely varied – most likely a result of the difference in diagnostic criteria and knowledge of its existence as a clinical entity by various health care professionals.

This paper will highlight the diagnostic and therapeutic procedures associated with syndesmotic ankle sprains, in addition to differentiating this condition from the more benign lateral ankle sprain. A case will be presented which underscores the effectiveness of manual therapy, and in particular rehabilitation, in resolving said injury.

Case

A 27-year-old male professional football running back, whose permission was requested and given to reproduce the details of his treatment for the purpose of this case report, presented with a chief complaint of acute onset left ankle pain, that began two hours previously during practice. He indicated that just over half way through the stance phase of gait, with his left foot planted, he atConclusion : Le professionnel de la santé doit aussi être au courant de la nature indolente de cette blessure et de la possibilité de séquelles. La douleur à la cheville antérieure et la douleur lors de flexions de jambes intenses ou durant l'étape de l'appui actif au sol de la démarche sont typiques de cette blessure. Des radiogrammes pour écarter toute fracture et évaluer l'étendue de la blessure peuvent être nécessaires. Une thérapie conventionnelle composée de réadaptation et de soin des tissus convient dans les blessures de niveau I et II alors que pour les blessures de niveau III, il faut avoir recours à la chirurgie. (JACC 2007; 51(1):42–49)

MOTS CLÉS : syndesmose, péronéo-tibiale.

tempted to pivot and push off medially to avoid being tackled. At the time of injury he was wearing grass cleats, although he was practicing on artificial turf. He denied hearing a pop or snap, but did relate that while assuming his three-point stance and sprinting the pain in his ankle was recreated. Non-weight bearing and immobility eliminated the pain. When asked to characterize and localize his symptoms he pointed to the dorsum of the foot (approximately the level of the talar dome) and described the pain, when present, as sharp in nature having an intensity of 7 out of 10. He has experienced numerous sprains of the same ankle, and reported that it is "weak." These previous occurrences have been treated with courses of passive physiotherapy modalities, active strengthening and proprioceptive drills. His systems review was unremarkable.

On examination the patient walked with a slightly shorter stance phase when the left leg was bearing weight, and rather than heel strike, he initiated contact with the metatarsal heads instead. Upon inspection there appeared to be no effusion in the injured area. Lighttouch was unaffected, and a strong pedal pulse was evident. Active and passive ranges of ankle motion were pain free, with the exception of passive dorsiflexion, which caused him pain in the region of the anterior tibiofibular ligament. Palpation of the medial and lateral malleoli, styloid process of the fifth metatarsal and medial calcaneus, navicular and talar dome were not tender. The anterior drawer and inversion stress tests revealed laxity, with a distinct hard end-feel, in the left ankle. The eversion stress test created pain in the anterolateral ankle, but not in the deltoid ligament. The external rotation stress test, forced dorsiflexion and squeeze tests all reproduced the patient's chief complaint of ankle pain across the dorsum of the foot, which spread proximally approximately one inch. In addition, palpation of the anterior tibiofibular ligament also reproduces the dorsal ankle complaint, although no tenderness was present over the anterior talofibular and calcaneofibular ligaments.

An AP ankle mortise with external rotary stress to the foot and lateral ankle radiographs were taken, with no evidence of fracture or alterations in the tibiofibular clear space or overlap.

The patient was diagnosed with a grade I sprain of the distal tibiofibular syndesmosis. He was given crutches and an air-cast to facilitate progressive weight bearing until he could walk without discomfort, and treated with microcurrent and P.R.I.C.E. principles every day for the first three days. He declined the use of electroacupunture. He was encouraged to perform active range of motion exercises four times per day in the form of drawing the alphabet in the air using the great toe as the focal point. He also maintained his cardiovascular fitness with 30 minutes of upper extremity pedaling on an inverted stationary bicycle every day throughout his rehabilitation. On the fourth day he began contrast bath therapy (5 cycles at a 3:1 ratio), as well as five minutes on the BAPS board and progressive resistance exercises in all ranges of motion with tubing (2 sets, 20 repetitions/set). By the eighth day the patient was able to ambulate without pain, so he had 10 pounds added to the BAPS board and began proprioceptive work on the mini-trampoline (10 sets, 30 seconds/set) as well as single leg stance exercises with the unsupported leg moving between flexion, extension, abduction and adduction (10 sets, 30 seconds/set).

At the end of two weeks he began strengthening with dumbbell squats (2 sets, 15 repetitions/set), lunges (2 sets, 15 repetitions/set), step-ups (2 sets, 15 repetitions/ set) which gradually increased in weight and depth as he progressed. To increase the proprioceptive challenges, we performed the squats, lunges and step-ups first on stability disks, and then on a BOSU ball after one week. Further challenges after that two week period included single leg hops on and off of a rocker board (progressing from angling the board in the A-P, lateral, and then diagonal planes for 3 sets, 15 repetitions/set).

He also began high-intensity aerobic conditioning interval training (15 sets, 30 second intervals) which mimicked his sport requirements, in addition to agility ladder, zig-zag, figure "8" and lateral slide drills for agility. Plyometric drills (bounding, single leg hop, lateral hop) were incorporated during the third, fourth and fifth weeks, progressing from 60, to 80, to 100 foot contacts during each week respectively.

During the third through fifth weeks, the patient also began exercises aimed at increasing the time to onset and full contraction of the gluteus maximus, beginning with prone manual activation of the gluteus maximus and hip extension exercises (3 sets, 15 repetitions per set), progressing to the use of balance sandals (3 sets of 3 minute intervals) and pelvic bridging with manual resistance applied downwards through the ASIS of the ipsilateral side (starting with double leg contacts and progressing to single leg, 3 sets of 15 repetitions/set).^{1,2}

The player was taped before every practice and game (lateral ankle restraint in addition to four circumferential strips proximal to the distal tibiofibular joint) for the remainder of the season, and did not suffer re-injury or have persistent pain, swelling or loss of function.

Discussion

The ligamentous anatomy of the distal tibiofibular complex can be succinctly categorized into: anterior (anterior tibiofibular ligament), posterior (posterior tibiofibular ligament and, inferior to that, the transverse tibiofibular ligament) and internal ligaments (interosseous ligament).^{3,4,5,6} [Figure 1 and 2] The latter structure is the primary restrictor of diastasis of this complex, and blends proximally with the interosseous membrane.^{3,4,5,6} Yet while the anatomical complexity is minimal, the diagnostic efficacy with respect to this condition appears to be suspect, as evidenced by the large discrepancy of incident data.

Hopkinson estimated the overall incidence to be 1%, while Gerber and Boytim proposed 17% and 18.4% incidence rates, respectively.^{7,8,9} The primary reason for this inconsistency is the lack of standardized diagnostic criteria. In addition to physical determinants, several studies have not included radiographic criteria, which is crucial in ascertaining the extent of these injuries. Amendola pro-



Figure 1 Posterior Syndesmosis Ligaments Images Copyright and Courtesy of Primal Pictures Ltd www.primalpictures.com: http://www.primalpictures.com/

posed two broad categories into which syndesmotic sprains could be fit - sprains with fracture, and sprains without.¹⁰ The latter poses a significantly greater diagnostic dilemma, and is generally considered to occur with less frequency than the former. Sprains without fracture can be further sub-classified into those which are "latent", and thus diastasis appears only with stress radiographs, and those which are "frank", necessitating that widening of the distal tibiofibular joint space be visible with unstressed radiographs.^{4,10,11} [Figure 3] Sprains with fracture are more common, more obvious, and more serious than their counterparts.³ Either of two systems can be employed to further classify these injuries: The Lauge-Hansen and Danis and Weber models^{4,10,11} (see Table 1). The progressive severity involves fractures of the medial, lateral, or bilateral malleoli with damage to the interosseous membrane and fracture of the shaft of the fibula.^{4,10,11}

The mechanism by which the majority of the injuries occur is thought to be forced external rotation of the foot.⁶ Hopkinson and Edwards reported out of eight syndesmosis injuries three were due to hyperdorsiflexion, three were



Figure 2 Anterior Syndesmosis Ligaments Images Copyright and Courtesy of Primal Pictures Ltd www.primalpictures.com: http://www.primalpictures.com/

due to inversion, one was due to forced plantarflexion and one to dorsiflexion with external rotation.^{8,12} In fact, Brosky contends that when maximal tension with external rotation is reached, either plantar or dorsiflexion may result in injury.⁶ Conceptually, external rotation with dorsiflexion is plausible as the widest part of the talus fills the ankle mortise and does not allow for talar motion in the snug ankle mortise joint. However, practitioners should be aware of the other possible mechanisms of injury. The ankle mortise joint, which accommodates primarily dorsiflexion and plantarflexion, is anatomically incapable of accommodating rotation of the talus in the mortise. The result is that these rotary forces cause a diastatic stress of the distal tibiofibular syndesmosis.

The main findings with this type of injury include one of the aforementioned mechanisms of injury, a globally decreased range of motion, minimal swelling, as well as toe-to-heel walking and possibly circumduction of the hip on the effected side in order to avoid dorsiflexion at the ankle mortise joint.^{4,6} In addition to a core ankle examination, there are four orthopedic tests which are able



Figure 3 Normal Radiographs with Clear Space and Overlap Labeled

to stress the distal tibiofibular joint and its associated ligaments. The squeeze test, which involves approximating the tibia and fibula together in the proximal 1/3rd of the calf, has a positive predictive value of 6% and an interexaminer reliability of .50.^{3,14} The external rotation stress test, whereby the foot is externally rotated while the leg, with knee flexed to 90, remains stable has a positive predictive value of 34% and an inter-examiner reliability of 0.75.^{13,15} Ligament palpation, in particular the anterior tibiofibular ligament, has a positive predictive value of 70% and an inter-examiner reliability of 0.35.¹³ Passive dorsiflexion, in which the examiner forcefully and maximally dorsiflexes the ankle, has a positive predictive value of 47% and an inter-examiner reliability of 0.35.¹³

A useful adjunct to the physical examination is imaging, and should include radiographs of the non-injured, as well as injured, side for comparison. The practitioner should be concerned with the tibiofibular overlap and tibiofibular clear space values on these x-rays.^{6,16} The clear space should be less than 6 mm, while the overlap on an ankle mortise view should be greater than 6 mm, and the overlap on the AP ankle should be less than 1 mm.¹⁶ However, absolute values such as these do not allow for differences in size or gender. To account for these discrepancies, Ostrum et al. introduced the concept of measurements based on a ratio.¹⁷ They concluded that there was an injury to the syndesmosis if the ratio of the tibiofibular clear space: fibular width was greater than 24%, or if the clear space: fibular width ratio was less than 44%.¹⁷ Far superior to the plain film radiograph is a CT scan, which can accurately detect changes as small as 1 mm, while x-rays had difficulty reliably detecting 3–4 mm changes.¹⁸ Diagnostic ultrasound is also quite valuable in ligament injuries, and in comparison to MRI was found to have a sensitivity of 66%, specificity of 91%, a positive predictive value of 86%, and a negative predictive value of 77%.¹⁹

The treatment of these injuries is based purely on experience, as the highest level of evidence currently is the case report. Grade I and II injuries in the acute phase (0-4 days) are treated with active range of motion exercises (30 repetitions, 4 times daily), P.R.I.C.E. principles, pain control modalities (i.e. microcurrent, IFC, TENS), crutches, and, where applicable, 20 mg doses of prednisone.^{4,6} P.R.I.C.E. is an acronym which stands for Protection (i.e. bracing, in order to prevent further injury to the area), Relative Rest (allowing as much motion and activity as possible to counter the deleterious effects of disuse while not unnecessarily stressing the healing tissues), Ice, Compression, and Elevation. More information on diagnosing and treating soft tissue can be found in the review of muscle biology and injuries recently been published by Jarvinen et al.²⁰ Medical acupuncture can be an invaluable adjunctive therapy for all soft-tissue injuries in general, and in particular sprains of the lateral ankle and syndesmosis. A study performed by Koo et al. found a 40% recovery in stepping force (using weight bearing as a proxy for pain) after a 30 minute application of electroacupuncture to the point SI 6.21 During the sub-acute phase (4–14 days), the patient receives contrast baths (5 cycles, 3:1 ratio), stretching for the thigh and lower leg, progressive weight-bearing with an air-cast, BAPS board training, anterior to posterior rocking on a rocker board (5 minutes) and progressive resistance exercises with tubing (2 sets of 20 repetitions).^{4,6} During advanced healing (14– 28 days), the patient will progress to full weight bearing, and in addition to the aforementioned activities in the subacute stage, they will engage in mini-trampoline and sin-

Lauge-Hansen Model	
Supination-Adduction	Stage 1 – Lateral malleolar fracture below the tibial plafond and possible lateral
	ligament rupture
	Stage 2 – Vertical or oblique fracture of the medial malleolus
Supination-External Rotation	Stage 1 – Rupture of anterior inferior tibiofibular ligament
	Stage 2 – Oblique fracture or spiral fracture of the lateral malleolus
	Stage 3 – Rupture of posterior tibiofibular ligament or fracture of the posteriro medial malleolus
	Stage 4 – Transverse (possibly oblique) fracture of medial malleolus
Pronation-External Rotation	Stage 1 – Rupture of the deltoid ligament or transverse fracture of the medial malleolus
	Stage 2 – Bony avulsion or rupture of the anterior inferior tibiofibular ligament
	Stage 3 – Oblique or spiral fracture of the fibula above the level of the syndesmosis
	Stage 4 – Fracture of the posterior malleolus or rupture of the posterior inferior tibiofibular ligament
Pronation-Abduction	Stage 1 – Rupture of the deltoid ligament or transverse fracture of the medial malleolus
	Stage 2 – Bony avulsion or rupture of the anterior and posterior inferior
	tibiofibular ligaments
	Stage 3 – Oblique fibular fracture at the level of the syndesmosis
Danis and Weber Model	
Type A	Fibular fracture below the syndesmosis
Type B	Fibular fracture at the level of the syndesmosis
Type C	Fibular fracture above the level of the syndesmosis

Table 1 Lauge-Hansen and Danis and Weber Classification Models

gle leg stance exercises to train their proprioception.^{4,6} From days 28 to 56 there should be incorporation of dumbbell squats (1 sets of 15 repetitions), lunges (1 sets of 15 repetitions) and step-ups (1 sets of 15 repetitions).^{4,6} High-intensity aerobic interval work, as well as agility drills (zig-zag, figure "8", lateral slides) are included to return the athlete to sport. Note that maintenance of cardiovascular fitness is imperative throughout any rehabilitative program, including this one. In the case just presented, an inverted stationary bike was used so that the arms could pedal and fitness could be preserved.

In a paper published by Janda, Saxton and Bullock-Saxton, patients with previous ankle sprains were shown to have bilateral delays in onset of activation of the gluteal muscles versus non-injured subjects. The implications of this deactivation on gait, given the stabilizing

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effect of the gluteus maximus on sacroiliac joints stability thigh extension warrants a therapeutic intervention aimed at restoring normal function of this muscle.¹ Altered recruitment has also been linked to low back pain, thus the importance of re-establishing pre-injury activity is crucial.² The same authors researched the ability of a labile surface (in particular, the use of "balance shoes", which are a cork-bottom sandal with half of a rubber ball affixed to it under the metatarsal heads) to facilitate cerebellovestibular circuits and alter the activity of the gluteal muscles. They found that after several weeks of training (3 minutes, 5 times per day), there were significant decreases in time to 75% maximum contraction and increases in gluteal activity.²

Grade III injuries necessitate a surgical consult. Stabilized medial and lateral fractures do not require a syndesmotic screw, however for fibular fractures that occur greater than 3–4 cm proximal to the syndesmosis a screw is needed.^{10,22,23,24} Current evidence suggests the use of bioabsorbable screws for this procedure, as they allow for the gradual transfer of weight to bone during the absorption process and negates the post-surgical screw removal several months after the first procedure.^{25,26}

Determining when to return the athlete to sport is always a tenuous decision, which is made increasingly difficult by a condition without a known natural history. The general recommendation is four to eight weeks post injury for grade I and II injuries, presuming that athletes meet the following conditions: a single leg broad jump, single leg vertical jump, and 10 times single leg crossover hop that is greater than 80% of the uninvolved side.^{4,6} It is recommended that the athlete be taped or braced for the first year so as to prevent re-injury.^{4,6} Hopkinson concluded that syndesmosis injuries took twice as long to return to play from as did grade III inversion sprains (56 versus 28 days).⁸ A mathematical formula has also been proposed which relates interosseous membrane tenderness to recovery time as follows: $5+(.93 \times \text{Tenderness})$ length in cm) +/- 3.72 days.²⁷ This seems appropriate, as the most common factor limiting return is pain with push-off during the latter half of the supported phase of gait.⁵ The measurement was taken from the distal tip of the fibula to the most proximal portion of the area of tenderness along the anterior portion of the interosseous membrane.²⁷ Of note if that the time to full return to athletic activities was 13.4 on average, markedly different from the Hopkinson study, where the average was 56 days.^{8,27} Several possibilities exist for explaining this discrepancy, including the rigorous daily therapeutic regiment in the Nussbaum study, or the small sample sizes (8 athletes and 60 athletes) in the Hopkinson and Nussbaum studies, respectively.²⁷

In a follow-up survey of patients post-injury, Taylor found that 41% ranked their ankle function as excellent, 45% as good and 14% as fair.⁵ He also found that 37% and 23% still experienced residual stiffness and pain respectively, the latter usually with activity.⁵ The presence of enduring symptoms may be related to the possible sequella of syndesmotic sprains, namely adhesions within the distal tibiofibular syndesmosis and tibiofibular synostosis.^{5,28,29} The former responds quickly to surgical resection of the fibrous adhesion, while the latter, which is an ossification of the interosseous membrane, actually has no correlation to pain. 5,28,29

Conclusion

Injuries to the distal tibiofibular syndesmosis may be more common than previously reported if the correct measures for achieving the diagnosis are utilized. The most common mechanism is external rotation of the foot with ankle dorsiflexion, however external rotation with movement in the plantar or dorsal direction may cause injury. Additional orthopedic testing (squeeze test, ligament palpation, external rotation stress test and forced dorsiflexion) in conjunction with radiographs to examine the tibiofibular clear space and overlap will allow for an accurate diagnosis. Rehabilitation of grade I and II injuries involves increasing range of motion, strength, endurance and proprioception while maintaining cardiovascular fitness. The practitioner should also be cognizant of the indolent nature of this injury and possibility for sequelae.

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