

Subtle Syndesmotic Instability

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ABSTRACT

Latent or subtle syndesmotic instability is defined as an injury to the syndesmosis which is not apparent on static radiographs of the ankle. Syndesmotic injuries have also been referred to as high ankle sprains. Injury to the syndesmosis typically occurs with collision sports and often involves an external rotation force to the ankle. Diagnosis can be delayed because of negative initial imaging studies. Physical examination tests including the external rotation test, proximal squeeze test, and fibular shuck test can assist in the diagnosis. Advanced imaging modalities such as MRI and weight-bearing CT have been studied and can provide prognostic indications for management, although arthroscopic stress evaluation remains the benchmark for diagnosis. Both surgical and nonsurgical management techniques have been described, which can assist patients in returning to their preinjury level of function.

Background

In 1984, Delee et al defined chronic syndesmotic injuries as belonging to one of two categories: frank or latent. Frank injuries are those with an obvious diastasis of the syndesmosis apparent on plain radiographs and are commonly recognized and treated by orthopaedic surgeons. Latent syndesmotic injuries are those that are not obvious on plain radiographs and are also referred to as subtle syndesmotic injuries.^{1,2} Although various techniques exist to treat frank syndesmotic instability, there is little debate among orthopaedic surgeons that these injuries require surgical intervention. In latent syndesmotic instability, because the radiographs are negative for clear pathology, the injury is often not recognized acutely and typically presents as a chronic condition. Chronic latent syndesmotic injuries represent a specific and separate pathology that requires a distinct treatment algorithm. This article will review the pathoanatomy, current diagnostic modalities, and evidence-based treatment strategies for chronic latent syndesmotic instability.

Anatomy

The anatomy of the ankle syndesmosis has been well described and is composed of five ligaments that connect the tibia and fibula at the distal tibiofibular

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None of the following authors or any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article: Ryan, Eakin, Goodrum.

J Am Acad Orthop Surg 2024;32:719-727

DOI: 10.5435/JAAOS-D-23-00707

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articulation. Injuries to this complex are often referred to as high ankle sprains because the ligaments that connect the tibia and fibula are located more proximally in the leg than the anterior talofibular (ATFL) and calcaneal fibular ligaments involved in more typical ankle sprains. Sectioning studies have demonstrated increasing diastasis of the syndesmosis with sequential sectioning of the syndesmotom ligaments.³ The posterior inferior tibiofibular ligament (PITFL) provides notable strength to the syndesmosis and is tensioned in dorsiflexion. The transverse tibiofibular ligament can be a separate ligament just inferior to the PITFL or can be an inferior extension of the PITFL (Figure 1). The most anterior syndesmotom ligament is the anterior inferior tibiofibular ligament (AITFL), which originates at the Tillaux-Chaput tubercle of the distal tibia and inserts on the Wagstaff tubercle of the distal fibula. The AITFL is tensioned in plantar flexion. The interosseus ligament (IOL) connects the tibia and fibula just proximal to the tibiofibular articulation while the interosseus membrane connects the tibia and fibula from the IOL to the proximal articulation of the tibia and fibula. As the ankle moves from plantar flexion into dorsiflexion, the syndesmotom ligaments allow the fibula to rotate externally and translate inferiorly to accommodate the wider anterior talus. This provides stability to the ankle mortise throughout the gait cycle. If an excessive external rotation moment is applied to the ankle in dorsiflexion, the fibula is forced to rotate with the talus and the syndesmotom ligaments are injured in sequence. As such, the AITFL is the most commonly injured ligament.⁴⁻⁶

Natural History

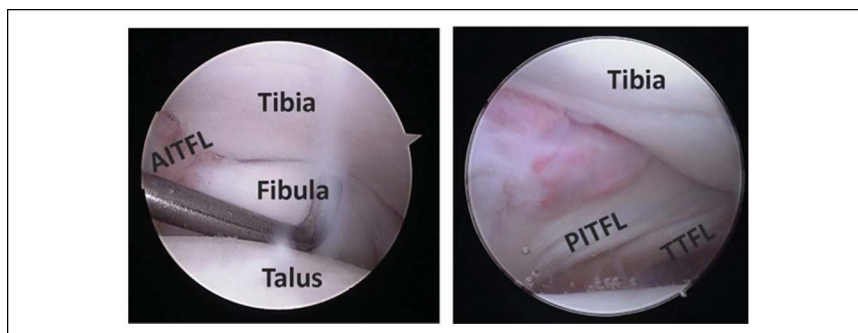
Syndesmotom injuries occur less frequently than low ankle sprains involving the ATFL and calcaneal fibular ligament.

Several natural history studies have demonstrated that syndesmotom injuries account for 20 to 25% of recorded ankle sprains in collision and contact athletes.^{4,6,7} One database study using ICD-9 codes across eight states estimated the incidence to be 2.09 syndesmotom injuries per 100,000 person-years in the general population.⁸ While high top boots, tape, and ankle braces may help stabilize the tibiotalar joint, the syndesmosis extends proximally and remains susceptible to external rotation and dorsiflexion stresses. Syndesmotom injury rates have increased in recent years, and it is possible the increased rate is related to increased protection of the lower ankle with modern braces and boots such that the force is transferred higher in the leg.⁹ If untreated, subtle instability at the syndesmosis can result in functional instability at the ankle, chondromalacia, and degenerative joint disease both at the tibiofibular and tibiotalar articulations due to altered contact pressures secondary to incongruent motion of the talus within the mortise.^{5,10-12}

Physical Examination

The physical examination findings for chronic latent syndesmotom injuries are similar to the findings for acute syndesmotom injuries. Examinations include palpation of the syndesmosis, proximal squeeze test, external rotation test, fibular shuck testing, and taping trials (Figure 2). The proximal squeeze test is performed with the patient in the seated position with the leg hanging free to prevent stabilization of the syndesmosis. The tibia and fibula are compressed in the mid leg and pain elicited at the level of the syndesmosis is considered a positive test. This test can also be performed as a crossed-leg test by having the patient cross the affected leg over the knee of their unaffected leg. A positive test occurs if pain is elicited as the patient pushes down on the knee of the

Figure 1



Arthroscopic images of the syndesmosis demonstrating the congruency of a stable syndesmosis. The AITFL, PITFL, and TTFL are clearly visualized on arthroscopic evaluation. AITFL = anterior inferior tibial fibular ligament, PITFL = posterior inferior tibial fibular ligament, TTFL = transverse tibial fibular ligament

Figure 2

Photographs showing physical examination tests for chronic latent syndesmotom instability: **A**, Palpation of the syndesmosis; **B**, Fibular shuck testing; **C**, Proximal squeeze testing **2D**. Cross leg testing **E** and **F**, Syndesmosis tape testing.

affected side. The external rotation test is also performed with the patient seated. The examiner uses one hand to stabilize the leg proximal to the syndesmosis and then externally rotates the ankle in a dorsiflexed position, which places the wider aspect of the talus into the mortise. Pain at the level of the syndesmosis is considered positive. Fibular shuck testing has also been described as a fibular translation test and is performed by stabilizing the ankle above the level of the syndesmosis with one hand and translating the distal fibula from anterior to posterior with the other hand. Pain at the syndesmosis is considered positive, but translation or subluxation can also be palpated.¹³ A taping trial can be performed in the office by having the patient hop on the affected leg and then repeating that maneuver after the circumferentially taping or wrapping at the level of the syndesmosis. A positive test results when pain is relieved with tape stabilization of the syndesmosis.¹⁴ Patients may perform the tape test out of the office during athletic practice or training to evaluate the relief they achieve with taping. Pain with palpation of the syndesmosis has the highest sensitivity (83%) while the

proximal squeeze test has the highest specificity (89 to 93%). Pain at the syndesmosis with external rotation of the ankle has the highest positive predictive value (75%).^{4,15} The accuracy of any of these physical examination tests is highly dependent on the technique of the examiner and, therefore, is potentially limited.

Imaging

Even with a detailed physical examination, chronic latent syndesmotom injuries present a diagnostic dilemma. Although injury to any of the syndesmotom ligaments can result in pain and disability, plain radiographs will often not demonstrate the injury (Figure 3). Historically, an uninjured syndesmosis on plain radiographs is demonstrated by a tibiofibular clear space (TFCS) of less than 6 mm on both the AP and mortise images, a tibiofibular overlap (TFOL) of greater than 6 mm on the AP image, and a TFOL of greater than 1 mm on the mortise image. These values were based on a cadaveric study with 12 specimens.¹⁶ A larger study including 392 patients without known syndesmotom injury found that 7.7% of

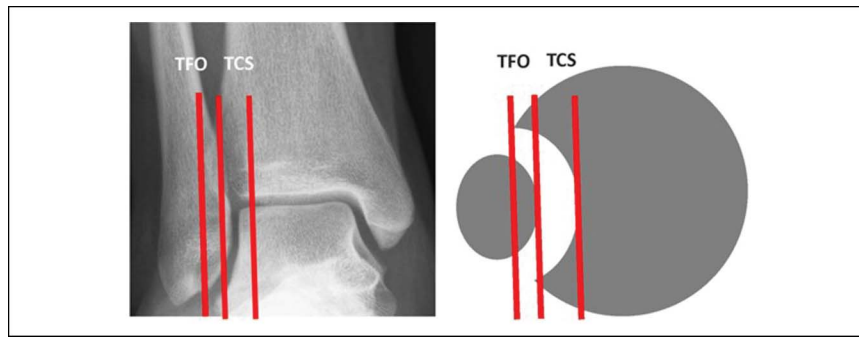
Figure 3

Illustration depicts the inability of a mortise radiograph to accurately demonstrate syndesmosis reduction. The fibula is able to translate anteriorly or rotate without changing values seen on the mortise view.

those evaluated had less than 1 mm of TFOL on the mortise view and 4.9% had no overlap. Similarly, 7.1% of those evaluated had greater than 6 mm of TFCS on the AP view.¹⁷

While stress radiographs can be diagnostic, sectioning studies have demonstrated that notable diastasis of the syndesmosis is required before the injury is visible on radiographs. A sectioning study conducted by Xenos et al¹⁸ demonstrated that dividing the AITFL and 8 cm of the interosseus membrane can produce less than 1 mm of syndesmotom diastasis on mortise radiographs. If a fluoroscopic or radiographic external rotation stress test is performed, a medial clear space (MCS) of greater than 5 mm has been shown to be highly sensitive. Notably, however, a widened MCS can occur with a deltoid injury or syndesmotom injury.¹⁹ A lateral fibular stress test or Cotton test is more specific for the syndesmotom.²⁰ A positive lateral fibular stress test may show an increased MCS and demonstrate an increase in the TFCS or a decrease in the TFOL. Positive stress radiographs are diagnostic, but there are concerns about the variability of force applied. Ingall et al²¹ published a study evaluating the consistency of force applied by surgeons when performing a stress test of the syndesmotom. The authors found excellent intraobserver reliability but poor interobserver reliability and concluded that variable force can lead to inconsistent detection of syndesmotom instability. Owing to the inconsistent results demonstrated with plain radiographs, a great deal of attention has been focused on advanced imaging modalities to include CT, MRI, dynamic ultrasonography (US), and weight-bearing CT (WBCT).

US is a promising modality for evaluation of subtle syndesmotom instability because of its ability to evaluate syndesmotom motion during stress testing. Shoji et al conducted a cadaveric sectioning study in which US was

used to measure the anterior tibiofibular distance just above the AITFL. With an external rotation stress applied, the tibiofibular distance increased by 2.0 mm after sectioning the AITFL alone ($P = 0.015$).²² While the results are promising, US has not been directly compared with other modalities or with arthroscopic evaluation.

Multiple studies have evaluated the use of MRI in the detection of syndesmotom injuries. MRI has the ability to depict specific ligament disruptions. In a study by Mollon et al, a prospective injury database from the National Hockey League was used to identify MRI findings in 21 players who missed more than 8 games due to syndesmotom injuries. Although the authors were able to identify the specific injured ligaments, they were unable to clinically correlate the findings with return to play.⁶ The lack of correlation between ligament injury on MRI and clinical instability has been demonstrated in other studies. A retrospective study comparing 23 patients with syndesmotom instability confirmed arthroscopically with 40 control subjects found no statistical significance when comparing MRI findings of AITFL or PITFL injuries with arthroscopic diastasis of the syndesmotom. The same study did find that fluid or increased signal seen at the level of the syndesmotom had a sensitivity of 75% and specificity of 63% ($P = 0.012$).¹⁵

A recent meta-analysis compared the sensitivity and specificity of radiograph, CT, and MRI found in studies that used intraoperative findings as the benchmark. The authors concluded that MRI was more sensitive than the other two modalities with a sensitivity of 0.93 ($P = 0.004$), and they found no difference in specificity.²³ The meta-analysis did not include WBCT. It has been argued that WBCT can detect subtle syndesmotom instability using volume measurements rather than area measurements. A study by Esfahani et al compared volume

measurements with area measurements using WBCT for 24 patients with subtle syndesmotic injuries using surgical findings to confirm instability. To measure volume, the authors calculated the area between the fibula and the tibia for each CT cross-section and multiplied this number times the thickness of each CT cross-section. This allowed for a three-dimensional measurement of syndesmotic volume along the entire distal syndesmosis rather than a two-dimensional measurement of area at a specific location. All patients in the study group had negative plain radiographs. WBCT measurements were compared with the uninjured ankle and with 24 control subjects without ankle injury. While prior studies have demonstrated low side-to-side symmetry, the authors found that comparison with the uninjured ankle was more accurate than comparison with control subjects or normative values.²⁴ When using the uninjured side as a control for volumetric measurements, the authors reported a sensitivity of 95.8%, specificity of 83.3%, and accuracy of 90%.²⁵ Other studies have argued that WBCT may not be as accurate as CT because of physiologic widening of the syndesmosis in the contralateral limb in stance. Hamard et al²⁶ evaluated CT versus WBCT, but used measurements comparing the anterior, posterior, and minimal tibial-fibular distances. The authors found statistical differences between injured and uninjured ankles in all three measurements on non-weight-bearing images but did not record statistical differences on WBCT. In addition to physiologic widening on the noninjured side, the authors reported concerns that injured patients may not have placed their full weight on the injured side.

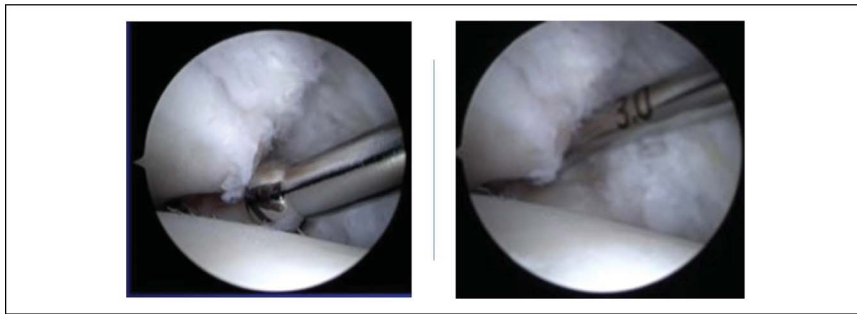
Arthroscopy has long been considered the benchmark for evaluation of subtle syndesmotic instability. Several arthroscopic sectioning studies have been conducted to determine normal values for syndesmotic diastasis using both spherical probes and calibrated probes (Figure 4).²⁷⁻²⁹ Guyton et al found that the uninjured syndesmosis could accommodate a 1.5-mm sphere in all specimens and that the 2-mm sphere could be accommodated in half of the intact specimens. A 3-mm probe could be passed in only two of the 10 intact specimens.² In a similar study evaluating five cadaveric specimens, Teramoto et al found that uninjured specimens could accommodate up to a 2-mm probe and that sectioning the ATFL resulted in 3 mm of syndesmotic diastasis as measured with a spherical probe.²⁹ The syndesmosis may also be unstable in the sagittal plane.^{28,30} Sagittal plane translation has been measured in a cadaveric arthroscopic sectioning study by Watson et al. In the seven intact specimens evaluated, the mean translation

in the sagittal plane was 0.4 mm with a range of 0 to 2 mm. Sectioning the AITFL and IOL resulted in a mean sagittal plane translation of 1.87 mm with a range of 2 to 6 mm.²⁸ Arthroscopy is an invasive evaluation and is recommended only when there is a clinical suspicion that subtle syndesmotic injury exists.¹⁵

Treatment

Once a chronic latent syndesmotic injury is suspected, the recommended treatment can vary. There remains a role for nonsurgical management. DeFroda et al described the return-to-play rate for National Football League athletes who were identified in public databases as sustaining a syndesmotic injury. The specifics of the diagnosis and duration of injury before treatment were not recorded. The authors found that nonsurgical management for acute injury was successful in 90% of athletes with a mean recovery time of 11 weeks.⁷ While algorithms for the nonsurgical management of acute syndesmotic injuries have been described, protocols and outcomes for chronic syndesmotic injuries have not been published.^{4,13} Multiple surgical techniques have been described for patients who present chronically or have failed nonsurgical treatments.

Many studies describing surgical treatment of chronic injuries involve arthroscopic evaluation, débridement, and anatomic reduction. Reducing the diastasis with a clamp under fluoroscopic guidance without arthroscopic validation can result in malunion and chronic pain if rotation and translation are not corrected. Gardner et al conducted a retrospective study comparing postoperative radiographs with CT scans and determined that radiographs alone were inaccurate in evaluating syndesmotic reduction.³¹ Other authors have attempted to improve the accuracy of the reduction with fluoroscopy despite the inherent limitations of a two-dimensional imaging. Cosgrove et al evaluated a series of 72 patients who were reduced with a clamp under lateral fluoroscopy. The authors compared the intraoperative position of the clamp with post-reduction CT scans. In patients for whom the medial tine of the clamp was placed on the anterior third of the medial malleolus, the greatest malreduction rate was 11%. When the clamp was placed on the middle third or posterior third, the greatest malreduction rates were 19% and 60%, respectively.³² To avoid malreduction with clamp fixation, Harris et al recommended reducing the syndesmosis and holding the reduction with a Kirschner wire to provide a glide path before clamp application. The

Figure 4

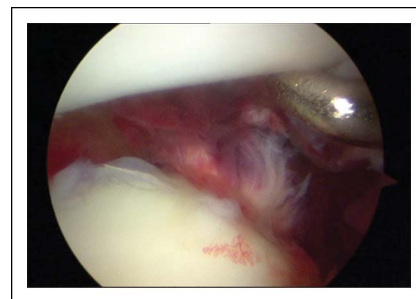
An arthroscopic image of a 3-mm spherical probe demonstrating syndesmosis diastasis.

authors in this study also used fluoroscopy to verify the reduction. Sixteen patients in the glide path cohort were compared with 25 patients treated without a glide path. The authors evaluated the reductions with postoperative CT and found a malreduction rate of 12.5% in the glide path cohort versus 44% in the control group.

The use of arthroscopy for evaluation and treatment of chronic latent syndesmotic injuries has been well described (Figure 5). Instability of the syndesmosis can be tested during visualization of the tibiofibular articulation while performing an external rotation test or while translating the fibula in the transverse or sagittal plane. The degree of translation or displacement can be measured with a calibrated arthroscopic probe or a spherical ball with a known diameter.^{2,27-29,33} Once the diagnosis is confirmed, the treatment often is dictated by the degree of instability. As noted previously, cadaveric sectioning studies have been conducted demonstrating that intact specimens can have up to 2.5 mm of diastasis of the syndesmosis and up to 2 mm of sagittal plane translation.² Although an absolute value demonstrating clinically relevant syndesmotic instability has not been established, several clinical studies have described treatment of symptomatic patients with greater than 2 mm of instability.^{10,30,34,35} Han et al presented a series of 20 symptomatic patients who were diagnosed with 2 mm or greater of syndesmotic instability on arthroscopic evaluation. The authors did not provide a mean or range for the arthroscopic syndesmotic diastasis. All patients underwent débridement. Ten of the patients were treated with stabilization using a transcortical screw, and ten were treated with débridement of the scar tissue at the syndesmosis alone. At a mean of 22 months, the authors noted no difference in outcomes using a patient survey and the American Orthopaedic Foot and Ankle Score (AOFAS). The authors concluded that the pain experienced by patients with chronic latent syndesmotic instability was likely secondary to hypertrophic scar

tissue and impingement.³⁴ Weaknesses of the study include the use of a nonvalidated patient-reported outcome score and the potential inclusion of patients with 2 mm of diastasis, which may represent the upper limits of normal in some cadaveric studies.^{2,27} Ogilvie-Harris et al presented similar findings in a series of 17 patients diagnosed with chronic syndesmotic instability of 2 mm or greater treated with arthroscopic débridement alone. All patients had pain at the syndesmosis with arthroscopic confirmation of ligament damage and instability. The authors reported that all 17 patients returned to sport at 3 months after surgery with clinical resolution of pain as tested with external rotation stress testing. Of note, four of the patients had heterotopic ossification in the interosseous membrane, but subgroup analysis demonstrated no difference in outcome for these four patients.³⁵ Similar to the study by Han et al, the authors may have included patients with 2 mm of diastasis, which can be seen in uninjured cadaveric specimens.^{2,27}

Although an upper limit of diastasis or translation has not been established for the successful treatment of chronic latent syndesmotic injury with débridement alone, multiple authors have described a role for stabilization in patients with greater degrees of

Figure 5

An arthroscopic image of an unstable syndesmosis. A 4-mm probe is inserted between the fibula and the tibia during intraoperative external rotation stress testing.

Figure 6

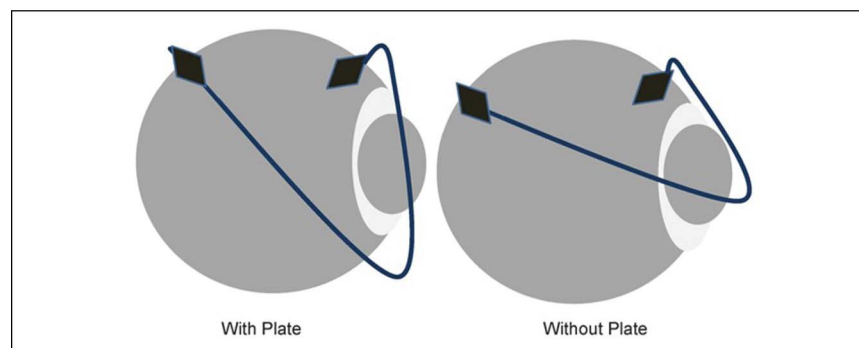
Radiograph showing an example of a patient treated with divergent flexible fixation for chronic latent syndesmosis instability.

instability.^{3,10,36-38} Ryan et al conducted a retrospective review of 19 patients with 4 mm or more of diastasis or translation at the syndesmosis on arthroscopic evaluation. All patients were treated with arthroscopic débridement, followed by reduction and stabilization of the syndesmosis with suture buttons (Figure 6). Reduction was considered successful if there was less than 1 mm of translation or diastasis on arthroscopic external rotation stress testing after fixation. With 24 months of follow-up, the authors reported that the Visual Analog Scale (VAS) score decreased from a preoperative score of 6.0 to a postoperative score of 0.6 ($P = 0.012$). Fourteen patients answered a survey at their final follow-up, and 79% (11/14) were able to return to their preinjury level of sport after treatment.

Other studies have recommended graft augmentation for greater degrees of instability. In a retrospective review of 32 patients diagnosed with latent syndesmotom instability on arthroscopic evaluation, Colcuc et al performed

an autogenous plantaris tendon graft augmentation for those patients with greater than 2.5 mm of diastasis of the syndesmosis on intraoperative stress evaluation. The authors compared these 10 patients with 22 patients who were diagnosed with less than 2.5 mm of instability treated with an open reduction and repair of the syndesmosis with either sutures or a periosteal flap. The repair group also had a tricortical screw and a quadracortical suture button used to support the repair. While all patients had improvements in their AOFASs, the patients in the tendon reconstruction cohort had lower postoperative scores (86 ± 5 , $P = 0.019$).³⁹ Han-Lin Xu et al conducted a systematic review of five studies reporting outcomes of autograft reconstruction for patients with chronic latent syndesmotom instability. In addition to the plantaris tendon, studies used the semitendinosus tendon, gracilis tendon, and peroneus longus tendon. The study populations ranged from six to 16 patients. Four of the five studies confirmed syndesmotom instability arthroscopically. Only one of the studies provided a measurement of instability and defined instability as greater than 2 mm of diastasis. The reported results were heterogeneous but were generally optimistic. All techniques involved reconstruction of the AITFL, IOL, or both (Figure 7). The authors found that the VAS score was reported in 14 patients across two studies and decreased from 82.4 to 12.6. The AOFAS was reported in 16 patients across two studies and improved from 53 preoperatively to 89 postoperatively.

The final method of treatment of chronic syndesmotom instability involves fusion of the syndesmosis and should be considered a salvage procedure (Figure 8). Sun et al described outcomes for a series of eight patients who presented with chronic frank syndesmotom instability. The follow-up ranged from 1 to 5 years. The authors reported that seven of the eight patients returned to

Figure 7

Illustrations describing different options to reconstruct the syndesmotom ligaments with allograft. Most techniques involved reconstruction of the anterior tibial fibular ligament, interosseus ligament, or both.

Figure 8

Radiographs showing an example of a patient with chronic frank syndesmosis instability complicated by degenerative changes in the syndesmosis. Fusion provided more symmetric alignment of the mortise.

previous sporting activities. The VAS pain score decreased from 4.4 to 1.1 ($P = 0.002$), and the AOFAS increased from 62 to 96 ($P = 0.002$). Four of the patients reported no loss in dorsiflexion while four had losses of 10 to 30%. The authors concluded that syndesmosis fusion can provide good results in certain patients but should not be recommended for healthy or physically active patients.

Rehabilitation

Prospective studies and randomized trials have not been conducted to evaluate rehabilitation protocols for syndesmotom injuries.⁴⁰ A recent literature review found that most surgeons surveyed treated acute syndesmotom injuries and repairs with a period of non-weight bearing.⁴ In studies where the treatment of chronic latent syndesmotom injury involved isolated arthroscopic débridement, the authors allowed early motion and early weight bearing.^{34,35} The studies wherein the syndesmotom was repaired or reconstructed were mixed in terms of immobilization but all used a period of non-weight bearing between four and 6 weeks.^{3,10,30,34,36-38}

Conclusions

Chronic latent syndesmotom instability is a distinct diagnosis wherein physiologic and clinical instability exists that is not apparent on plain radiographs. Detailed physical examination is required because of the vast differential diagnosis associated with chronic ankle pain. Advanced imaging modalities including US, CT, WBCT,

and MRI have been evaluated with high rates of sensitivity and specificity, but none of these noninvasive modalities have approached the accuracy of arthroscopic evaluation. Débridement alone is recommended for patients with minor instability and evidence of hypertrophic scar tissue found on arthroscopic evaluation. Both repair and reconstruction techniques for instability at the level of the syndesmotom have been described and evaluated with good results. Comparative studies have not been conducted to define degrees of instability that would best be treated by débridement alone versus repair or reconstruction.

References

1. Edwards GS Jr., DeLee JC: Ankle diastasis without fracture. *Foot Ankle* 1984;4:305-312.
2. Guyton GP, DeFontes K 3rd, Barr CR, Parks BG, Camire LM: Arthroscopic correlates of subtle syndesmotom injury. *Foot Ankle Int* 2017; 38:502-506.
3. Morris MW, Rice P, Schneider TE: Distal tibiocalcaneal syndesmotom reconstruction using a free hamstring autograft. *Foot Ankle Int* 2009;30: 506-511.
4. Fort NM, Aiyer AA, Kaplan JR, Smyth NA, Kadakia AR: Management of acute injuries of the tibiocalcaneal syndesmotom. *Eur J Orthop Surg Traumatol* 2017;27:449-459.
5. Xu HL, Song YJ, Hua YH: Reconstruction of chronic injured distal tibiocalcaneal syndesmotom with autogenous tendon graft: A systematic review. *Biomed Res Int* 2021;2021:1-10.
6. Mollon B, Wasserstein D, Murphy GM, White LM, Theodoropoulos J: High ankle sprains in professional ice Hockey players: Prognosis and correlation between magnetic resonance imaging patterns of injury and return to play. *Orthop J Sports Med* 2019;7:2325967119871578-5.
7. DeFroda SF, Bodendorfer BM, Hartnett DA, et al: Defining the contemporary epidemiology and return to play for high ankle sprains in the National Football League. *Phys Sportsmed* 2022;50:301-5.

8. Vosseller JT, Karl JW, Greisberg JK: Incidence of syndesmotic injury. *Orthopedics* 2014;37:e226-9.
9. Beumer A: Chronic instability of the anterior syndesmosis of the ankle. *Acta Orthop Suppl* 2007;78:4-36.
10. Zamzami MM, Zamzani MM: Chronic isolated distal tibiofibular syndesmotic disruption: Diagnosis and management. *Foot Ankle Surg* 2009;15:14-9.
11. Thomas B, Yeo JM, Slater GL: Chronic pain after ankle fracture: An arthroscopic assessment case series. *Foot Ankle Int* 2005;26:1012-6.
12. Su T, Du MZ, Parekh SG, et al: Effect of arthroscopically confirmed syndesmotic widening on outcome following isolated brostrom operation for chronic lateral ankle instability. *Foot Ankle Int* 2023;44:270-8.
13. Hogan MVBL, James NA, Brown CL, Yan AA: Syndesmosis injury. *Oper Tech Sports Med* 2021;29:1-6.
14. Wolf BRAA, Amendola A: Syndesmosis injuries in the athlete: When and how to operate. *Curr Opin Orthopaedics* 2002;13:151-4.
15. Ryan LP, Hills MC, Chang J, Wilson CD: The lambda sign: A new radiographic indicator of latent syndesmosis instability. *Foot Ankle Int* 2014;35:903-8.
16. Harper MC, Keller TS: A radiographic evaluation of the tibiofibular syndesmosis. *Foot Ankle* 1989;10:156-60.
17. Shah AS, Kadakia AR, Tan GJ, Karadsheh MS, Wolter TD, Sabb B: Radiographic evaluation of the normal distal tibiofibular syndesmosis. *Foot Ankle Int* 2012;33:870-6.
18. Xenos JS, Hopkinson WJ, Mulligan ME, Olson EJ, Popovic NA: The tibiofibular syndesmosis. Evaluation of the ligamentous structures, methods of fixation, and radiographic assessment. *J Bone Joint Surg Am* 1995;77:847-56.
19. Ng NOJ, Onggo JR, Nambiar M, et al: Which test is best? An updated literature review of imaging modalities for acute ankle diastasis injuries. *J Med Radiat Sci* 2022;69:382-93.
20. Stoffel K, Wysocki D, Baddour E, Nicholls R, Yates P: Comparison of two intraoperative assessment methods for injuries to the ankle syndesmosis. A cadaveric study. *J Bone Joint Surg Am* 2009;91:2646-52.
21. Ingall EM, Kaiser P, Ashkani-Esfahani S, Zhao J, Kwon JY: The lateral fibular stress test: High variability of force applied by orthopaedic surgeons in a biomechanical model. *Foot Ankle Orthop* 2022;7:1-6.
22. Shoji H, Teramoto A, Murahashi Y, Watanabe K, Yamashita T: Syndesmotic instability can be assessed by measuring the distance between the tibia and the fibula using an ultrasound without stress: A cadaver study. *BMC Musculoskelet Disord* 2022;23:261-267.
23. Chun DI, Cho JH, Min TH, et al: Diagnostic accuracy of radiologic methods for ankle syndesmosis injury: A systematic review and meta-analysis. *J Clin Med* 2019;8:968-982.
24. Schon JM, Brady AW, Krob JJ, et al: Defining the three most responsive and specific CT measurements of ankle syndesmotic malreduction. *Knee Surg Sports Traumatol Arthrosc* 2019;27:2863-76.
25. Ashkani Esfahani S, Bhimani R, Lubberts B, et al: Volume measurements on weightbearing computed tomography can detect subtle syndesmotic instability. *J Orthop Res* 2022;40:460-7.
26. Hamard M, Neroladaki A, Bagetakos I, Dubois-Ferriere V, Montet X, Boudabbous S: Accuracy of cone-beam computed tomography for syndesmosis injury diagnosis compared to conventional computed tomography. *Foot Ankle Surg* 2020;26:265-72.
27. Massri-Pugin J, Lubberts B, Vopat BG, Guss D, Hosseini A, DiGiovanni CW: Effect of sequential sectioning of ligaments on syndesmotic instability in the coronal plane evaluated arthroscopically. *Foot Ankle Int* 2017;38:1387-93.
28. Watson BC, Lucas DE, Simpson GA, Berlet GC, Hyer CF: Arthroscopic evaluation of syndesmotic instability in a cadaveric model. *Foot Ankle Int* 2015;36:1362-8.
29. Teramoto A, Shoji H, Anzai K, Kamiya T, Watanabe K, Yamashita T: Tibiofibular space widening assessment with a ball-tipped probe in a syndesmosis injury model. *J Foot Ankle Surg* 2020;59:1215-8.
30. Ryan PM, Rodriguez RM: Outcomes and return to activity after operative repair of chronic latent syndesmotic instability. *Foot Ankle Int* 2016;37:192-7.
31. Gardner MJ, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG: Malreduction of the tibiofibular syndesmosis in ankle fractures. *Foot Ankle Int* 2006;27:788-92.
32. Cosgrove CT, Putnam SM, Cherney SM, et al: Medial clamp tine positioning affects ankle syndesmosis malreduction. *J Orthop Trauma* 2017;31:440-6.
33. Krahenbuhl N, Weinberg MW, Hintermann B, Haller JM, Saltzman CL, Barg A: Surgical outcome in chronic syndesmotic injury: A systematic literature review. *Foot Ankle Surg* 2019;25:691-7.
34. Han SH, Lee JW, Kim S, Suh JS, Choi YR: Chronic tibiofibular syndesmosis injury: The diagnostic efficiency of magnetic resonance imaging and comparative analysis of operative treatment. *Foot Ankle Int* 2007;28:336-42.
35. Ogilvie-Harris DJ, Reed SC: Disruption of the ankle syndesmosis: Diagnosis and treatment by arthroscopic surgery. *Arthroscopy* 1994;10:561-8.
36. Yasui Y, Takao M, Miyamoto W, Innami K, Matsushita T: Anatomical reconstruction of the anterior inferior tibiofibular ligament for chronic disruption of the distal tibiofibular syndesmosis. *Knee Surg Sports Traumatol Arthrosc* 2011;19:691-5.
37. Grass R, Rammelt S, Biewener A, Zwipp H: Peroneus longus ligamentoplasty for chronic instability of the distal tibiofibular syndesmosis. *Foot Ankle Int* 2003;24:392-7.
38. Schuberth JM, Jennings MM, Lau AC: Arthroscopy-assisted repair of latent syndesmotic instability of the ankle. *Arthroscopy* 2008;24:868-74.
39. Colcuc C, Fischer S, Colcuc S, et al: Treatment strategies for partial chronic instability of the distal syndesmosis: An arthroscopic grading scale and operative staging concept. *Arch Orthop Trauma Surg* 2016;136:157-63.
40. Williams GN, Allen EJ: Rehabilitation of syndesmotic (high) ankle sprains. *Sports Health* 2010;2:460-70.