

Diagnostic accuracy of clinical tests for ankle syndesmosis injury

Amy D Sman,¹ Claire E Hiller,¹ Katherine Rae,² James Linklater,³ Deborah A Black,¹ Leslie L Nicholson,¹ Joshua Burns,¹ Kathryn M Refshauge¹

¹Faculty of Health Sciences, University of Sydney, Lidcombe, New South Wales, Australia
²Sports Clinic, University of Sydney, Camperdown, New South Wales, Australia
³Castlereagh Imaging, St Leonards, New South Wales, Australia

Correspondence to

Amy D Sman,
Faculty of Health Sciences,
University of Sydney,
Cumberland Campus C42,
PO Box 170, Lidcombe,
NSW 1825, Australia;
amy.sman@sydney.edu.au

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ABSTRACT

Objective Our aim was to investigate the diagnostic accuracy of the clinical presentation of ankle syndesmosis injury and four common clinical diagnostic tests.

Design Cross-sectional diagnostic accuracy study.

Setting 9 clinics in two Australian cities.

Participants 87 participants (78% male) with an ankle sprain injury presenting to participating clinics within 2 weeks of injury were enrolled.

Methods Clinical presentation, dorsiflexion-external rotation stress test, dorsiflexion lunge with compression test, squeeze test and ankle syndesmosis ligament palpation were compared with MRI results (read by a blinded radiologist) as a reference standard. Tests were evaluated using diagnostic accuracy, sensitivity, specificity and likelihood ratios (LRs). A backwards stepwise Cox regression model determined the combined value of the clinical tests.

Results The clinical presentation of an inability to perform a single leg hop had the highest sensitivity (89%) with a negative LR of 0.37 (95% CI 0.13 to 1.03). Specificity was highest for pain out of proportion to the apparent injury (79%) with a positive LR of 3.05 (95% CI 1.68 to 5.55). Of the clinical tests, the squeeze test had the highest specificity (88%) with a positive LR of 2.15 (95% CI 0.86 to 5.39). Syndesmosis ligament tenderness (92%) and the dorsiflexion-external rotation stress test (71%) had the highest sensitivity values and negative LR of 0.28 (95% CI 0.09 to 0.89) and 0.46 (95% CI 0.27 to 0.79), respectively. Syndesmosis injury was four times more likely to be present with positive syndesmosis ligament tenderness (OR 4.04, $p=0.048$) or a positive dorsiflexion/external rotation stress test (OR 3.9, $p=0.004$).

Conclusions Although no single test is sufficiently accurate for diagnosis, we recommend a combination of sensitive and specific signs, symptoms and tests to confirm ankle syndesmosis involvement. An inability to hop, syndesmosis ligament tenderness and the dorsiflexion-external rotation stress test (sensitive) may be combined with pain out of proportion to injury and the squeeze test (specific).

INTRODUCTION

Early and accurate diagnosis of ankle syndesmosis injury is essential to facilitate timely, effective and safe treatment. However, ankle syndesmosis injury is difficult to differentiate from lateral ankle sprain.^{1–3} It is often overlooked because clinicians encounter this injury infrequently,^{4–5} with an incidence of ankle syndesmosis injury between 1%⁶ and 24%⁷ of all ankle sprains. Persistent disability and prolonged recovery are commonly reported following ankle syndesmosis injury,^{6–8–9} and could

possibly be due to delayed or missed diagnosis^{4–5} and inappropriate treatment,¹⁰ which emphasises the need for accurate clinical tests to facilitate early detection of ankle syndesmosis injury.

The ankle syndesmosis includes the interosseous membrane and interosseous ligament, together with the anterior inferior tibiofibular ligament (AITFL), posterior inferior tibiofibular ligament (PITFL) and transverse ligament.^{11–13} The dense ankle syndesmosis ligaments provide the main stability to the distal tibiofibular joint by resisting the axial, rotational and translational forces.^{14–15} When maximal tension of the ligaments is achieved with external rotation of the foot, the tibia and fibula separate and additional dorsiflexion or plantarflexion might result in damage to the ankle syndesmosis ligaments.¹⁴ Injury to the ankle syndesmosis ligaments can occur with or without latent or frank diastasis of the ankle mortise and/or fractures of the distal tibiofibular joint. Specific clinical tests are performed in the clinic to triage ankle injuries for referral for confirmatory imaging tests. These clinical tests assess the integrity of an anatomical structure and generally aim to reproduce symptoms or test function by applying stress to the injured structure. Although there is a controversy around the mechanism of ankle syndesmosis injury, dorsiflexion and external rotation with a firmly planted foot are most commonly hypothesised.^{3–6–8–10} There are a few tests commonly used by clinicians to identify ankle syndesmosis injury: palpatory tenderness of the tibiofibular ligaments,^{10–16–18} dorsiflexion with the external rotation stress test^{4–8–18–19} and the squeeze test.^{6–18–21} A comprehensive history often includes reports of the mechanism of injury, pain at the ankle syndesmosis which may extend proximally, inability to bear weight and swelling.^{22–24} Even though taking a careful history and performance of specific clinical diagnostic tests have formed a critical part of the triage for diagnosis of ankle syndesmosis injury, there are few investigations into the usefulness of these tests, and those studies that have been conducted are small and have methodological flaws.^{10–18–25–26}

The gold standard diagnostic test for ankle syndesmosis injury is arthroscopy.^{4–27–28} However, arthroscopy is invasive and therefore carries risks; it is also expensive and is usually only performed to diagnose and guide treatment of more severe injuries rather than as a routine diagnostic tool.²⁹ Of the available radiographic tools, MRI has been found to have similar specificity and sensitivity to that of arthroscopy,^{28–30–32} but the costs for MRI are still relatively high. No appropriately powered study has been conducted that uses MRI or

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arthroscopy as a reference standard to evaluate diagnostic tests for ankle syndesmosis injury.¹⁸ In addition, no studies have investigated the contribution of the clinical presentation in the diagnosis of ankle syndesmosis injury.²³ Therefore, there remain clear gaps in knowledge about the diagnostic accuracy of the clinical diagnostic tests. The aim of the present study was to investigate the accuracy of four common clinical diagnostic tests for identification of ankle syndesmosis injury. In addition, we investigated whether the clinical presentation has diagnostic value.

METHODS

Participants

Eighty-seven participants (78% male), aged 24.6 ± 6.5 years, with an acute ankle injury were consecutively enrolled into the study between February 2011 and December 2012. Twenty-five participants were involved in recreational sports, 50 in amateur level Rugby Union and 12 participated in professional Rugby League. Thirty-eight participants sustained an ankle syndesmosis injury. All participants who sustained an ankle syndesmosis injury had at least a complete tear of the AITFL, but most participants presented with damage to all three ligaments (AITFL/PITFL/interosseous ligament) on the MRI. Forty-seven participants sustained a lateral ($n=42$), midfoot ($n=4$) or medial ankle sprain ($n=1$). Two participants presented with pain but no damage to the lateral, medial or ankle syndesmosis ligaments. Ethics approval was obtained from the Human Research Ethics Committee at the University of Sydney (Protocol no.: 2012/573) and all participants gave written informed consent prior to the start of the study. For participants under the age of 18 years, parental consent was also obtained.

Inclusion criteria

To be included, participants had to be aged between 16 and 60 years and present to any of the participating podiatry, physiotherapy or sports medicine centres in two Australian cities with an ankle sprain injury within 1 week of the injuring incident. In addition, they had to have a positive result on one or more of the investigated clinical tests, and suspicion of potential ankle syndesmosis involvement.

Exclusion criteria

Exclusion criteria included: (1) suspicion of lower limb fracture, (2) or an isolated anterior talofibular ligament sprain, because tests for ankle syndesmosis and MRI would not normally be prescribed, and the optimal method for determining test validity is to examine the tests in the clinical situation in which they are used,³³ (3) the inability to obtain an MRI scan within 2 weeks of injury.

Procedure

We recruited 13 clinicians working at nine sport clubs, sports medicine and physiotherapy practices, with an average of 12 years (range 1–35 years) of clinical experience in treating musculoskeletal injuries. Each clinician underwent at least one training session to standardise performance of the clinical tests protocol. The clinical presentation for each participant was documented, and the four clinical tests for ankle syndesmosis injury were performed during the initial assessment (table 1). The findings of the tests as positive or negative were documented on a standardised data sheet. Initial examination was performed by the patient's health professional 2.5 ± 3.8 days after injury. Following clinical assessment, the clinician made a diagnosis and participants were referred for MRI. Further treatment

Table 1 Initial examination variables

Clinical presentation	Specific clinical diagnostic tests
Mechanism of injury involving dorsiflexion/external rotation	Local tenderness syndesmosis ligaments/membrane
Inability of the participant to continue to play or walk	Local tenderness deltoid ligament
Pain or dysfunction out of proportion to the apparent injury	Squeeze test
Pain felt in the shank and/or the knee during the injury	Dorsiflexion lunge with compression test
Swelling/bruising at or above the anterior inferior tibiofibular ligament	Dorsiflexion with external rotation stress test
Single leg hop test	
Lunge and twist	
Posterior impingement	

was directed by their own healthcare professional. MRIs were obtained for all included participants at the participating MRI centre within 2 weeks of injury to ensure visualisation of pathology prior to healing. A ski-boot type coil was used to stabilise the foot. Images were acquired in the axial, coronal, sagittal and oblique planes with the foot in neutral position as reported by Hermans *et al*.³⁴ All MRIs were read and reported on by a single radiologist with 16 years of experience in musculoskeletal imaging (JL). Continuity of the ankle syndesmosis ligament fibres as well as syndesmosis alignment was assessed. We defined a syndesmosis injury as a complete or partial tear of one or more of the syndesmosis ligaments (AITFL/PITFL/transverse ligament/interosseous ligament) and/or membrane. The radiologist was blinded to the clinical assessment results. No adverse events were reported as a result of the clinical diagnostic tests or the MRI.

Clinical presentation

The documented signs and symptoms regarding the clinical presentation are included in table 1 and involved the participants' reports of mechanism of injury, pain in the shank or in the knee during the injury and walking ability following the injuring incident and pain sensation as interpreted by the examiner for pain or dysfunction out of proportion to the apparent injury (ie, Does the pain seem excessive or minimal related to the history of the injury?). Participants were also asked to perform two functional tests; a single leg hop performed from the toes because an inability to hop is thought to be associated with syndesmosis sprain,¹⁰ and a lunge and twist where the individual stands in a semisquat weightbearing position and rotates the upper body. A reproduction of pain indicates a positive test. In addition, participants were tested for the presence of posterior impingement and we observed the presence of swelling, although this may not always be severe or present in ankle syndesmosis injury.^{22 35} It is important to note that it has been suggested that the absence of swelling may falsely give suspicion of a minor injury when, in fact, a severe injury may have occurred.²² When swelling is present, it will be observed during the acute stage^{8 36–38} and located at or above the anterior tibiofibular ligament.^{5 35}

Clinical diagnostic tests

The clinical diagnostic tests included in this study are the four most commonly used tests: palpatory tenderness along the ankle

syndesmosis ligaments and membrane, the squeeze test, the dorsiflexion lunge with compression test and the dorsiflexion-external rotation stress test. The protocol for each of these tests is included in table 2. In addition, we included palpatory tenderness along the deltoid ligament, because when the mechanism of injury involves a hyperpronation force at the subtalar joint, medial soft tissue damage may occur³⁵ and associated deltoid ligament injury is thought to occur with ankle syndesmosis injury.^{14 39} Therefore, eliciting pain on palpation of the deltoid ligament may contribute to the identification of ankle syndesmosis injury.

Reference standard

Arthroscopy is the gold standard for diagnosis of ankle syndesmosis injury.^{4 27 28} However, arthroscopy is invasive, carries serious risks and is expensive. MRI, however, has diagnostic accuracy similar to arthroscopy while being relatively non-invasive, less costly and having few associated risks.^{28 30–32} MRI was therefore selected for use in our study as the reference standard.

Statistical analysis

Power and sample size calculation

Our power calculations and requisite levels of sensitivity and specificity were based on data reported by Arkin and Wachtel.⁴¹ MRI has a reported sensitivity of 100% and specificity of 93.1% for detection of ankle syndesmosis injury,^{28 30–32} although some variability exists. Taking this variability into account, we based sample size calculations on an MRI sensitivity of 95% and specificity of 90%. We determined that we required 75% sensitivity and 70% specificity with 80% certainty (power=0.80) to enable recommendation of a clinical diagnostic test for use in clinical practice. That is, we determined a priori that the test should have sensitivity not more than 20% less than that for MRI. Since the sensitivity used for MRI was 95%, we determined that the sensitivity of the clinical diagnostic test should be at least 75%. By selecting a power of $\alpha=0.05$ to minimise false rejection of useful tests, a sample size of 38 participants with ankle syndesmosis injury (disease positive) was required. Additionally, specificity used for MRI was 90%, and therefore we determined that specificity of the clinical diagnostic

tests should be at least 70%. With a type I error of $\alpha=0.05$ and 80% power, we required 49 lateral sprains (disease free). Therefore, we required a total of 87 participants to have sufficient power to determine the diagnostic accuracy of clinical tests.

Analysis

Participant characteristics, including age, height and weight, were summarised using means and SDs. Diagnostic tests were evaluated by calculating diagnostic accuracy and sensitivity, specificity and likelihood ratios (LRs) with 95% CIs. Diagnostic accuracy was evaluated with the method described by Portney and Watkins,⁴² that is, (true positive+true negative)/total number of cases. LRs are considered to be clinically useful statistics^{43 44} as well as the best indices of diagnostic accuracy if the incidence in the population under study is known.⁴⁵ Guidelines described by Jaeschke *et al*⁴⁶ and Ebell⁴⁷ were used to interpret the LRs: greater than 0.5 and less than 2 are considered a very small or irrelevant decrease or increase in the likelihood of the target condition, 0.2–0.5 or 2–5 is a small decrease or increase, 0.1–0.2 or 5–10 is a moderate decrease or increase and <0.1 or >10 is a large, often conclusive increase or decrease in the likelihood of the target condition. There were missing data for dorsiflexion lunge with compression test (n=5) and for a number of aspects of the clinical presentation: pain out of proportion (n=3), pain felt in the shank or the knee (n=4), mechanism of injury (n=5), inability to walk (n=1), swelling (n=3), tenderness over the deltoid ligament (n=1), due to an inability of the patient to recall the information or inability to perform the test due to significant pain. The lunge and twist (n=27) and posterior impingement (n=28) tests were included later in the recruitment phase of the study and are therefore missing data. We performed a secondary analysis to determine whether a combination of clinical tests improved diagnostic accuracy. For this we used a backwards stepwise Cox regression model with four individual variables: the dorsiflexion/external rotation stress test, the squeeze test, the ankle syndesmosis ligament palpation and dorsiflexion lunge with compression test. Missing data were imputed using the most common result for five participants for the dorsiflexion lunge with compression test.

Table 2 Protocol for the specific clinical diagnostic tests

	Protocol	Positive findings	Rationale
Dorsiflexion-external rotation test	Leg is stabilised in 90° knee flexion, the ankle in maximal dorsiflexion and an external rotation stress to the injured foot and ankle is applied ^{25 35}	Reproduction of anterolateral pain over the syndesmosis area	The test is thought to reproduce pain over the ankle syndesmosis ligaments by mimicking the commonly described mechanism of injury
Dorsiflexion lunge with compression test	Patient performs a lunge forward on the injured leg as far as possible. The lunge is repeated with manual compression provided by the examiner across the ankle syndesmosis ²⁵	Increase in the ankle range of motion or decreased pain when compression added	Manual compression is thought to increase stability at the distal tibiofibular joint and so reduces pain during dorsiflexion and/or enables an increase in the ankle range of motion ²⁵
Squeeze test	Patient sitting over the side of the bed. Compression of the fibula to the tibia above the midpoint of the calf using one or both hands ^{25 35}	Replication of pain in the area of the ankle syndesmosis ^{25 35}	Biomechanical analysis confirmed that the test causes separation at the distal tibiofibular joint. ²⁰ It is thought to increase tension in the remaining ankle syndesmosis ligament fibres, resulting in pain at the ankle ²⁹
Syndesmosis ligament palpation	Palpation AITFL/PITFL-transverse ligament/interosseous ligament/interosseous membrane ³⁵ Palpation of the deltoid ligament	Report of pain after pressing the ligament/membrane	The classic feature of ankle syndesmosis injury is thought to be palpatory tenderness over the anterior and posterior tibiofibular ligaments and between the tibia and fibula. ³⁵ Tenderness proximally along the interosseous membrane was indicative of a longer time to recovery ¹⁰ and a more severe injury ⁴⁰

AITFL, anterior inferior tibiofibular ligament; PITFL, posterior inferior tibiofibular ligament.

Table 3 Clinical diagnostic tests: diagnostic accuracy, sensitivity, specificity, positive and negative likelihood ratios (95% CI), χ^2 and p value

N	Test	Diagnostic accuracy (%)†				Specificity	LR+	LR–	χ^2	p Value
		True +ve	False +ve	False –ve	True –ve					
87	Dorsiflexion with external rotation stress test	27	18	11	31	0.63 (0.49 to 0.83)	1.93 (1.28 to 2.94)	0.46 (0.27 to 0.79)	8.77	0.00*
87	Local tenderness syndesmosis ligaments	35	35	3	14	0.92 (0.79 to 0.97)	1.29 (1.06 to 1.58)	0.28 (0.09 to 0.89)	4.58	0.03*
87	Squeeze test	10	6	28	43	0.26 (0.15 to 0.42)	2.15 (0.86 to 5.39)	0.84 (0.68 to 1.04)	1.96	0.16
82	Dorsiflexion lunge with compression	25	27	11	19	0.69 (0.53 to 0.82)	1.18 (0.86 to 1.64)	0.74 (0.41 to 1.35)	0.60	0.44

*Significant at $p \leq 0.05$ level.†(True positive+true negative)/number of cases, as described by Portney and Watkins.⁴²
+ve, positive; –ve, negative.

RESULTS

Clinical diagnostic tests

Overall, the diagnostic accuracy for the four clinical diagnostic tests was moderate. Syndesmosis ligament tenderness reached the predetermined sensitivity of >75% and the squeeze test reached the predetermined specificity of >70%. Diagnostic accuracy was highest for the dorsiflexion external rotation stress test (66.7%) and the squeeze test (60.9%). In addition, syndesmosis ligament tenderness (92%) and the dorsiflexion-external rotation stress test (71%) had the highest sensitivity. The squeeze test had the lowest sensitivity (26%). Specificity ranged from 88% for the squeeze test to 29% for local tenderness of the syndesmosis ligaments. Furthermore, the squeeze test had a positive LR (LR+) of 2.15 (95% CI 0.86 to 5.39), indicating a small increase in the likelihood of the disease with a positive test. The negative (LR–) for the dorsiflexion/external rotation stress test (LR–=0.46, 95% CI 0.27 to 0.79) and local tenderness over the ankle syndesmosis ligaments (LR–=0.28, 95% CI 0.09 to 0.89) indicate a small decrease in the likelihood of the disease with a negative test. The dorsiflexion lunge and compression test had LR close to 1, indicating that the test is unhelpful in the clinic (table 3).

The results of the regression analysis (table 4) showed that only two of the four clinical tests and no interactions made a significant contribution to the model. The model correctly classified 69% of cases. People with positive ankle syndesmosis ligament tenderness were four times more likely (OR 4.036, $p=0.048$) to have an ankle syndesmosis injury and people with a positive dorsiflexion/external rotation stress test were almost four times (OR 3.889, $p=0.004$) as likely to have an ankle syndesmosis injury, controlling for all other factors in the model.

Clinical presentation

The clinical presentation seems to provide the best indication of ankle syndesmosis injury, with a number of characteristics reaching the predetermined sensitivity and specificity values. Overall, pain out of proportion to injury showed the highest diagnostic accuracy with 72.6%. This was followed by pain felt in the shank or knee during the injury with a diagnostic accuracy of 61.4%. Sensitivity was highest for the inability to perform a single leg hop and inability to walk after injury (both 89%) followed by the mechanism of injury (83%). Local tenderness over the deltoid ligament presented the worst sensitivity value (43%). Specificity was highest for pain out of proportion to the apparent injury (79%) followed by pain felt in the shank or the knee during the injury (70%) and was lowest for the inability to walk after injury (21%). In addition, we found an LR+ for pain out of proportion to the apparent injury of 3.05 (95% CI 1.68 to 5.55) and an LR– of 0.45 (95% CI 0.28 to 0.71). The inability to hop showed a negative likelihood of 0.37 (95% CI 0.13 to 1.03). LR+ and LR– for pain felt in the shank or knee during injury, mechanism of injury, inability to walk after injury, swelling at or above the AITFL, local tenderness over the deltoid ligament, lunge and twist and posterior impingement ranged from LR+ 0.66 to 1.68 and LR– 0.51 to 1.64, respectively (table 5).

DISCUSSION

Clinical diagnostic tests

The diagnostic accuracy of the four common clinical tests is moderate and clinicians should not rely on a single test alone to make a diagnosis of ankle syndesmosis injury. Syndesmosis ligament tenderness presented with sufficiently high sensitivity

Table 4 Backwards stepwise Cox regression

Variables	OR	SE	95% CI for OR	p Value
Syndesmosis ligament palpation tenderness	4.04	0.71	1.01 to 16.09	0.048*
Dorsiflexion/external rotation stress test	3.89	0.48	1.53 to 9.89	0.004*
Constant	0.12	0.71		0.002

*Significant at $p \leq 0.05$ level.

(>75%) values to recommend its use in the clinic and the squeeze test reached the specified specificity value (>70%). No combinations of the four clinical tests entered into the Cox regression model remained in the model, but the dorsiflexion with external rotation stress test and syndesmosis ligament tenderness as individual tests were significant predictors of ankle syndesmosis injury. A recent systematic review¹⁸ showed that the external rotation stress test as used by Beumer *et al*²⁵ had very low overall diagnostic accuracy and low sensitivity; however, the test was performed without dorsiflexion. Dorsiflexion produces a slight widening of the ankle mortise,¹² thereby stressing the syndesmosis, and should therefore be integral to test performance. This is consistent with reports that dorsiflexion with external rotation is thought to be one of the most commonly described injuring mechanisms.^{3 6 8 10} Our results showed that the combined dorsiflexion and external rotation test had the highest diagnostic accuracy and sensitivity and that the test was also a significant individual predictor for ankle syndesmosis injury. This emphasises the need to add dorsiflexion to the external rotation test. The discrepancy between the results of

Beumer *et al*²⁵ and our study is also likely to be associated with the lack of statistical power. Beumer *et al*²⁵ had only three participants with arthroscopically diagnosed ankle syndesmosis injury with the remaining participants being healthy controls.

Although the sensitivity and specificity for the dorsiflexion-external rotation test and specificity for syndesmosis ligament tenderness did not reach the predetermined level, the Cox regression model showed that an injury was almost four times more likely to be an ankle syndesmosis injury in the presence of positive ankle syndesmosis ligament tenderness and a positive dorsiflexion/external rotation stress test. However, sensitivity was moderate and the negative LR indicated that a negative test resulted in a small decrease in the likelihood that ankle syndesmosis injury was present. Therefore, although clinicians should not rely on these tests alone, we do recommend the use of these tests. We recommend that the tests be performed to reject or confirm the diagnosis. When the sensitive clinical tests are negative, it is unlikely to be ankle syndesmosis injury. However, when positive, we recommend that clinicians perform a test with high specificity, such as the squeeze test to differentiate between ankle syndesmosis injury and lateral ankle sprain. When the specific test is also positive, the injury is likely to involve the ankle syndesmosis.

Clinical presentation

A careful assessment of the clinical presentation of the injury proved to be of high diagnostic value. We recommend that clinicians ask about pain intensity at the time of injury, as pain out of proportion to the apparent injury and pain felt in the shank or the knee during the injury reached the predetermined 70% specificity. This suggests that these symptoms are most useful to use to confirm ankle syndesmosis injury. High sensitivity values were found for an inability to perform a single leg hop, a

Table 5 Clinical presentation: diagnostic accuracy, sensitivity, specificity, positive and negative likelihood ratios (95% CI), χ^2 and p value

N	Test	True +ve	False +ve	False -ve	True -ve	Diagnostic accuracy (%)†	Sensitivity	Specificity	LR+	LR-	χ^2	p Value
84	Pain out of proportion to the apparent injury	24	10	13	37	72.6	0.65 (0.49 to 0.78)	0.79 (0.65 to 0.88)	3.05 (1.68 to 5.55)	0.45 (0.28 to 0.71)	14.57	0.00*
83	Pain felt in the shank or the knee during injury	18	14	18	33	61.4	0.50 (0.34 to 0.66)	0.70 (0.56 to 0.81)	1.68 (0.97 to 2.90)	0.71 (0.49 to 1.04)	2.71	0.10
87	Inability to hop	34	35	4	14	55.2	0.89 (0.76 to 0.96)	0.29 (0.18 to 0.42)	1.25 (1.02 to 1.54)	0.37 (0.13 to 1.03)	3.22	0.07
82	Mechanism of injury‡	30	36	6	10	48.8	0.83 (0.68 to 0.92)	0.22 (0.12 to 0.36)	1.07 (0.87 to 1.32)	0.77 (0.31 to 1.91)	0.09	0.77
86	Inability to walk	34	38	4	10	51.2	0.89 (0.76 to 0.96)	0.21 (0.12 to 0.34)	1.13 (0.94 to 1.36)	0.51 (0.17 to 1.49)	0.98	0.32
84	Swelling at or above the anterior inferior tibiofibular ligament	17	28	19	20	44.0	0.47 (0.32 to 0.63)	0.42 (0.29 to 0.56)	0.81 (0.53 to 1.23)	1.27 (0.80 to 2.00)	0.62	0.43
86	Local tenderness deltoid ligament	16	32	21	17	38.4	0.43 (0.29 to 0.59)	0.35 (0.23 to 0.49)	0.66 (0.43 to 1.01)	1.64 (1.02 to 2.63)	3.31	0.07
60	Lunge and twist	13	23	11	13	43.3	0.54 (0.35 to 0.72)	0.36 (0.22 to 0.52)	0.85 (0.55 to 1.32)	1.27 (0.69 to 2.35)	0.23	0.63
59	Posterior impingement	14	17	10	18	54.2	0.58 (0.39 to 0.76)	0.51 (0.36 to 0.67)	1.20 (0.74 to 1.94)	0.81 (0.46 to 1.44)	0.22	0.64

*Significant at $p \leq 0.05$ level.†(true positive+true negative)/number of cases, as described by Portney and Watkins.⁴²

‡Mechanism of dorsiflexion and/or external rotation.

+ve, positive; -ve, negative.

LR, likelihood ratio.

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mechanism of injury involving dorsiflexion/external rotation and the inability to walk after injury. That is, if a patient is unable to perform a single leg hop, the injury may involve the ankle syndesmosis and specific signs/symptoms are recommended to confirm this, such as pain out of proportion to the apparent injury or pain felt up the shank or in the knee. This is in agreement with Nussbaum *et al*¹⁰ who noted that all ankle syndesmosis injuries, identified only by clinical tests, were unable to perform 10 single leg hops without significant pain. Finally, the presence of swelling, posterior impingement, tenderness over the deltoid ligament and the dorsiflexion lunge with compression and lunge and twist test were not of diagnostic value. Their use for the diagnosis of ankle syndesmosis injury is not recommended.

Overall, when during the clinical presentation a high index of suspicion is raised for ankle syndesmosis injury by a dorsiflexion-external rotation mechanism of injury, an inability to walk following injury and/or an inability to perform a single leg hop at initial examination, the clinical diagnostic tests are recommended to reject or confirm the diagnosis. When both the sensitive (ankle syndesmosis ligament tenderness and/or a positive dorsiflexion-external rotation stress test) and specific clinical tests (squeeze test) are positive, it is likely to be ankle syndesmosis injury. When the clinical tests are negative, it is unlikely to be ankle syndesmosis injury and we recommend that clinicians monitor the rehabilitation and take a conservative approach. Recent unpublished data from 62 participants with MRI confirmed ankle injury (32 ankle syndesmosis sprains and 30 lateral ankle sprains) showing that ankle syndesmosis injury took a median of 62 days to recover, which was four times as long as lateral ankle sprain (15 days). Therefore, when recovery from the ankle injury seems delayed after 2 weeks postinjury, it is quite likely that the injury involves the ankle syndesmosis and confirmatory diagnostic imaging is recommended.

There were limitations to this study. Our primary focus was to evaluate the four most commonly used clinical diagnostic tests, and therefore only these tests were entered into the regression model. However, given that only syndesmosis ligament tenderness reached the predetermined sensitivity, only the squeeze test reached the predetermined specificity and the clinical presentation was of high diagnostic value, it is quite likely that combining the clinical tests and the clinical presentation (ie, the symptoms) will increase the ability to correctly diagnose ankle syndesmosis injury. Furthermore, syndesmosis ligament tenderness involved all ankle syndesmosis structures combined. With the high sensitivity and low specificity found, future studies are advised to investigate the diagnostic accuracy of syndesmosis ligament tenderness for the individual ligamentous structures. It is possible that some clinical tests might be more useful to identify less severe injuries, and others to identify more severe injuries or isolated ligament versus combination ligament injuries. We did not include severity of disease in this study because until now there is no uniform grading system for ankle syndesmosis injury without associated fracture. We recommend that future studies concentrate on the design and validation of a grading system and use prediction models that include a combination of factors such as clinical signs and symptoms and clinical diagnostic tests. This would enable investigation of the ability of clinical diagnostic tests to determine the severity of the injury.

CONCLUSION

It is not possible to rely on a single clinical test for diagnosis of ankle syndesmosis injury. A careful assessment of the clinical

presentation of the injury will provide the first index of suspicion for ankle syndesmosis involvement. Clinicians are advised to combine sensitive signs, symptoms and tests (inability to hop, inability to walk after injury, tenderness of the syndesmosis ligaments and the dorsiflexion-external rotation stress test) with specific signs, symptoms and tests (pain out of proportion to the apparent injury, pain felt up the shank or in the knee and the squeeze test) to raise the level of suspicion of ankle syndesmosis injury. A combination of sensitive and specific signs, symptoms and clinical diagnostic tests may raise the level of suspicion of ankle syndesmosis injury and assist in the decision-making process to refer for further investigations. Referral for MRI is advised when clinicians are suspicious that an ankle syndesmosis injury is present.

What is already known on this subject?

- ▶ Ankle syndesmosis injury is difficult to differentiate from lateral ankle sprain and is often overlooked because clinicians encounter this injury infrequently.
- ▶ Although specific clinical tests have formed a critical part of the triage for diagnosis of ankle syndesmosis injury, the usefulness of these tests has not been adequately evaluated: no appropriately powered study has been conducted that used an adequate reference standard to evaluate these diagnostic tests.
- ▶ Persistent disability and prolonged recovery are commonly reported following ankle syndesmosis injury and could possibly be due to delayed or missed diagnosis.

What this study adds?

- ▶ This is the first study to evaluate the diagnostic accuracy of the clinical presentation and the four most common clinical diagnostic tests for ankle syndesmosis injury using MRI as the reference standard.
- ▶ It is not possible to rely on a single test for diagnosis of ankle syndesmosis injury and clinicians are advised to combine sensitive (inability to hop, inability to walk, tenderness of the syndesmosis ligament and the dorsiflexion-external rotation stress test) with specific (pain out of proportion to the apparent injury and the squeeze test) signs, symptoms and tests to raise the level of suspicion of ankle syndesmosis injury and assist in the decision-making process to refer for further investigations and guide treatment.

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Amy D Sman, Claire E Hiller, Katherine Rae, et al.

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