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REVIEW ARTICLE

Which test is the best? An updated literature review of imaging modalities for acute ankle diastasis injuries

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Abstract

Ankle diastasis injuries, or ankle syndesmotic injuries, are common among athletes who usually experience a traumatic injury to the ankle. Long-term complications are avoidable when these injuries are diagnosed promptly and accurately treated. Whilst ankle arthroscopy remains the gold standard diagnostic modality for ankle diastasis injuries, imaging modalities are still widely utilised due to the treatment having greater accessibility, being less invasive and the most cost effective. There are various imaging modalities used to diagnose diastasis injuries, varying in levels of specificity and sensitivity. These observation methods include; X-ray, computed tomography (CT), magnetic resonance imaging (MRI) and ankle arthroscopy. This article uncovers common criteria and parameters to diagnose diastasis injuries through the implementation of different imaging modalities. The conclusions addressed within this article are deduced from a total of 338 articles being screened with only 43 articles being selected for the purposes of this examination. Across most articles, it was concluded that that plain X-ray should be used in the first instance due to its wide availability, quick processing time, and low cost. CT is the next recommended investigation due to its increased sensitivity and specificity, ability to show the positional relationship of the distal tibiofibular syndesmosis, and reliability in detecting minor diastasis injuries. MRI is recommended when ankle diastasis injuries are suspected, but not diagnosed on previous imaging modalities. It has the highest sensitivity and specificity compared to X-ray and CT.

Introduction

The ankle syndesmosis is a fibrous joint between the distal tibia and fibula, which is held together by the syndesmotic complex. It consists of the anterior inferior tibiofibular ligament (AITFL), posterior inferior tibiofibular ligament (PITFL), transverse tibiofibular ligament (TTFL), and interosseous ligament (IOL).[1] Together, they form a mortise to allow a congruent, stable articulation for the talus, forming the ankle joint.[2]

Diastasis or syndesmotic injuries of the ankle are defined as the disruption of one or more ligaments of the syndesmotic complex, following a traumatic injury to the ankle.[1] These injuries are estimated to occur in 18% of all ankle sprains, 20% of all operative ankle fractures, 50% of Weber B fractures, and all Weber C fractures.[1,3,4] Moreover, acute ankle diastasis injuries are suspected to be associated with 56% of bony avulsion of the posterior malleolus and approximately 70% of Maisonneuve injuries.[5,6] Maisonneuve injuries are spiral fractures of the upper third of fibula with disruption of the distal tibiofibular syndesmosis.[7] These injuries are unstable ankle injuries and early operative management is recommended.[7] Patient subgroups, who are at particular risk of ankle diastasis injuries include; athletes, females, children, adolescents, and patients with previous history of acute ankle sprains.[8,9] Classically, ankle diastasis injuries occur when an external rotation force is applied to the foot in a dorsiflexed position.[10] From here, an abnormal stress is subsequently placed on the syndesmotic ligaments, as the talus forces the fibula to separate from the tibia, rotate externally, and displace posteriorly.[10] This posterior movement will cause ligament damage in the following order: deltoid ligament, AITFL, PITFL, TTFL, IOL, and lastly a spiral fracture of the fibula.[11] Despite a distinct order of injury, these ligaments may also be disrupted in other injury patterns and can be misdiagnosed.

Misdiagnosis of ankle diastasis injuries can have significant short and long term consequences for patients. Short term consequences include repeated episodes of ankle instability and early degenerative changes.[3] Osteoarthritis, syndesmotic soft tissue impingement, and heterotopic ossification are some of the long term complications.[3,11,12] To avoid the aforementioned ramifications, acute ankle diastasis injuries should be diagnosed and managed promptly.

Ankle diastasis injuries can be difficult to diagnose and may be missed due to lack of consensus about the reliability of tests.[2] While ankle arthroscopy has an accuracy of 100% in the diagnosis of ankle diastasis, its invasive nature and associated high cost limit utility and practicality in clinical situations.[13,14] An example of ankle arthroscopy highlighting a patient's diastasis injury, is presented in Figure 1. To address these limitations, a variety of imaging modalities have been utilised to identify diastasis injuries, each with their respective advantages and disadvantages. However, the debate continues as to which modality is most suitable in the acute setting. This article aims to provide a current and comprehensive review of the effectiveness of different diagnostic imaging modalities to identify acute ankle diastasis injuries.

Methods

A multi-database literature search was conducted on PubMed, OVID MEDLINE, and EMBASE from the earliest records in the database to 19th of January 2021 with no restrictions on the article's publication date. The medical subject heading and Boolean operators used were [ankle diastasis injury] AND [imaging modality] OR [X-ray] OR [computed tomography] OR [MRI] OR [magnetic resonance imaging] OR [ankle arthroscopy]. A total of 338 articles of all study designs were yielded from the search. Titles and abstracts were screened for relevance to ankle syndesmosis anatomy, diagnostic imaging capability, and statistics including sensitivity and specificity were included. Articles that specifically focused on treatment, complications, and comparison of surgical repair techniques were excluded. Only published articles in the English language were included. One author undertook the article selection process, and three authors were involved in results synthesis.

Results

After screening, a total of 43 articles were found to be relevant to ankle syndesmosis anatomy, diagnostic imaging capability, and statistics. Three articles explored the anatomy of ankle diastasis injuries. 20 articles investigated the parameters, sensitivity, and specificity of individual diagnostic modalities, namely X-ray (five studies), computed tomography (CT) (seven studies), magnetic resonance imaging (MRI) (six studies), and ankle arthroscopy (two studies); and 20 examined a combination of different imaging modalities.

Discussion

Diagnosis of ankle diastasis injuries is challenging. However, being able to recognise ankle diastasis injuries is vital as treatment vastly differs from an ankle sprain injury. The following sections will discuss the various imaging modalities used in diagnosing ankle diastasis injuries. It will include the commonly used parameters, measurements, sensitivity, and specificity of each imaging modality.

Plain radiographs

Plain radiography (X-ray) is the most common modality used to diagnose acute ankle diastasis injuries due to their wide availability, minimal cost, reduced risk, and limited radiation exposure.

There are three main parameters that are often measured in the anterior posterior(AP) mortise X-ray view when diagnosing ankle diastasis injuries. They include medial clear space (MCS), tibiofibular overlap (TFO), and tibiofibular clear space (TCS). These measurements are presented in Figure 2.

Shah et al. performed a study reviewing both weight bearing and non-weight bearing radiographs of 392 patients to determine normal radiographic values of distal tibiofibular syndesmosis.[15] The radiographic values are outlined in Table S1. The study highlighted a lack of

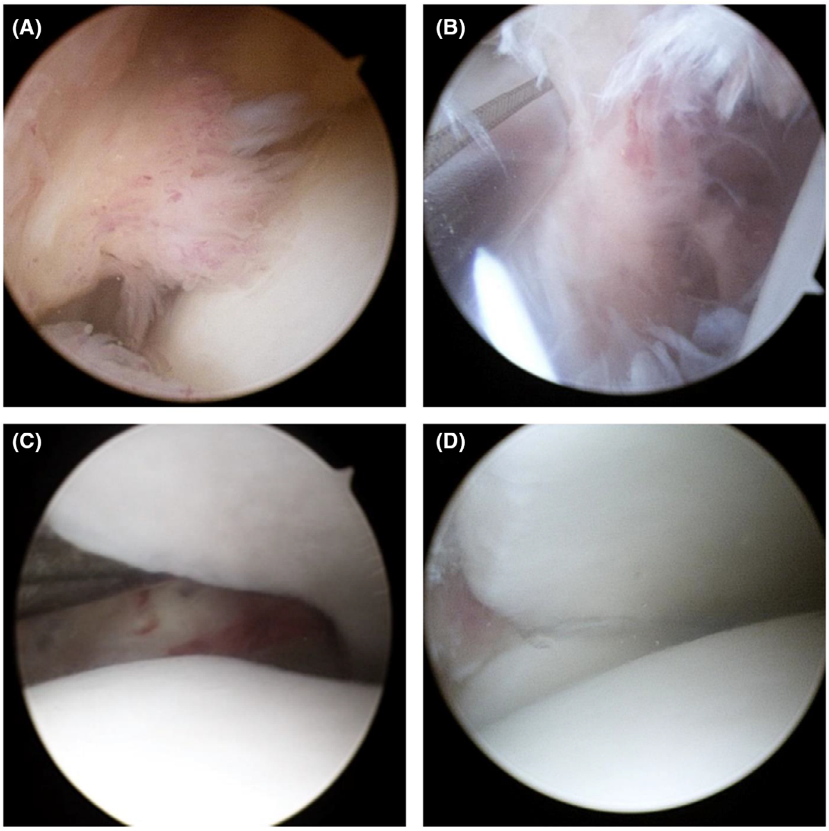

Figure 1. Ankle arthroscopy showing initial diastasis injury and post-surgical fixation. (A) Initial arthroscopic findings (B) Post debridement of torn anterior inferior tibiofibular ligament and synovitis. (C) Probe test (probe fits in syndesmosis and able to be rotated freely) (D) Post fixation.

overlap on mortise view may be a normal anatomical variant resulting from a small anterior tibial tubercle.[15]

Medial clear space

The MCS is the widest distance between the medial surface of the talus and lateral surface of the medial malleolus. A measurement of 4 mm or less is considered to be normal.[16] MCS should be less or equal to the superior clear space which is between the talar dome and tibial plafond on the mortise views.[16,17] An increased MCS is highly suggestive of syndesmotic instability and deltoid ligament disruption.[11,18]

Sclafani reviewed 186 X-rays and reported the range for MCS to be 2–5 mm with an average of 2.9 mm[19]. Gibson et al. defined normal MCS to be 5 mm or less after an external rotation stress exam, but considers a MCS of 4–5 mm to be abnormal if there is a lateral shift of more than 2 mm on manual external rotation stress examination.[20] Schottel et al. similarly reported that a normal MCS should be 5 mm or less on stress radiographs, but recommended further studies should be performed for MCS between 4–5.5 mm if the diastasis injury was associated with supination-external rotation ankle fractures.[21]

Schottel et al. found that the sensitivity and specificity of 5 mm was only 66% and 77%, respectively, when comparing X-ray to MRI.[21] This study also illustrated the sensitivity and specificity of various MCS values, claiming that those which show an MCS value of 4 mm have the highest sensitivity of 92.3% while 5.5 mm has the highest specificity of 92.3%. These values are summarised in Table S2.

Tibiofibular overlap

The TFO is measured between the medial border of the fibula and lateral border of anterior distal tibial tubercle.[11] A measurement of 6 mm or less on an AP view is considered normal, though this measurement can be greatly affected by positioning.[11,22]

Shah et al. reported average TFO values in patients without ankle diastasis injuries on AP and mortise views to be 8.3 and 3.5 mm respectively.[15] Schoennagel et al.

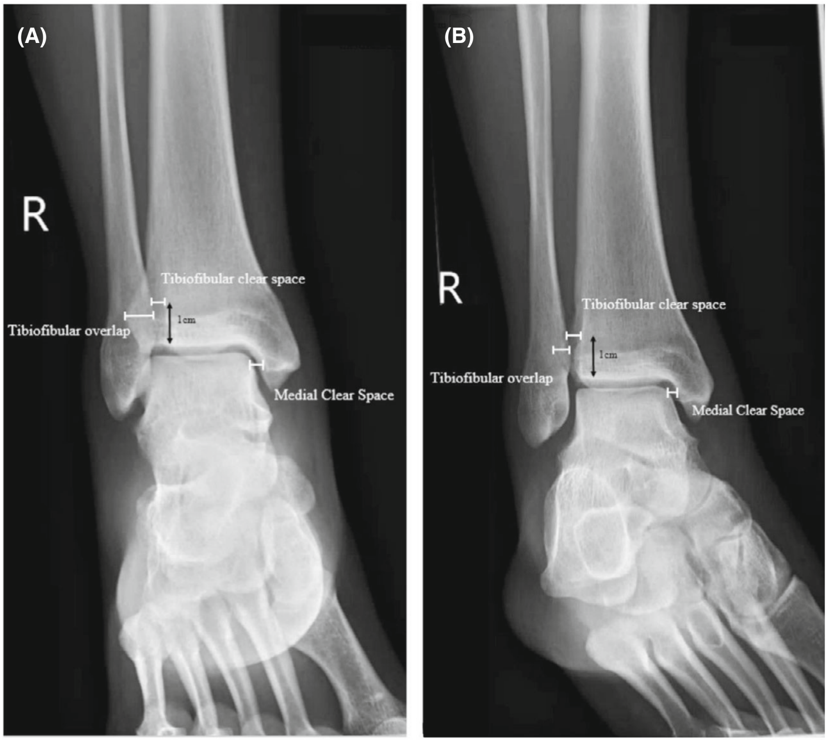

Figure 2. (A) Shows anterior posterior view of right ankle. (B) shows mortise view of right ankle. Both images display tibiofibular clear space measured 1 cm above tibial plafond, tibiofibular overlap and medial clear space.

concluded that the mean TFO on AP view was 4.4 and 4.7 mm in patients with and without diastasis injuries respectively.[23] TFO has a sensitivity of 36% and specificity 78% compared to MRI.[23] The absence of TFO typically indicates a diastasis injury.[24,25] Shah et al. reported the minimum TFO to be −1.9 mm on the mortise views and Sowman et al. found that 1.23% of 324 patients without ankle diastasis injury had an absent TFO.[15,25]

Tibiofibular clear space

Tibiofibular clear space (TCS) is measured between the fibular medial border and lateral border of the tibia perineal incisor. TCS effectively measures the posterior aspect of the syndesmosis.[22] A measurement of less than 6 mm is considered to be normal on both AP and mortise view.[11]

A normal TCS was measured to be 4.6–5.8 mm in the AP view and 3.8–4.5 mm in the mortise view when compared by various X-ray imaging.[15,23,26] The sensitivity and specificity are 82 and 75% respectively when comparing X-ray to MRI.[23]

A summary of MCS, TFO and TCS measurements have been demonstrated in Table 1.

Takao et al. compared the accuracy of standard AP and mortise view with ankle arthroscopy in 52 patients with and without ankle fractures.[13] The study concluded that radiographs have a sensitivity and specificity of 44.1% and 100% for AP views and 58.3% and 100% for mortise views, respectively. Out of these patients, the false negative numbers for standard anterior posterior view was 19 and 15 for mortise view, and false positive for both views were zero.[14] This was further supported by the meta-analysis performed by Chun et al., which demonstrated a sensitivity of 50% and specificity of 100% across 3 separate studies using X-ray to diagnose diastasis injury.[27] However, Chun et al. only included studies that involved diastasis injuries with ankle fractures, these all reported a false positive rate of zero.[27] Due to their high false negative and low false positive rates, radiographs are reliable at diagnosing diastasis injuries in patients with accompanying fractures, however, their ability to rule out isolated diastasis injuries without fracture is limited.[14,27]

To address this issue, anterior–posterior (AP), lateral, and mortise stress have been suggested, highlighted in Figure 3.[22] Lateral and mortise views under stress are performed while an external rotation or abduction force is applied to the ankle mortise to accurately view the anatomical diastasis.[17,18] However, the use of stress X-rays

Table 1. Comparison of the medial clear space, tibiofibular overlap and tibiofibular clear space normal and abnormal values, positive and negative predictive value, sensitivity and specificity.[11,14,16–18,20–29]

Parameter		AP view	Mortise view	How to measure	Normal values	Abnormal values	Positive predictive value	Negative predictive value	Sensitivity	Specificity
Medial clear space	Mean	2.9	-	Measured between medial border of the talus and the lateral border of the medial malleolus on mortise view	<4 mm	>4 mm or >2–3 mm compared to contralateral side	21%	94%	73%	59%
	Range	2.0–5.0	-							
Tibiofibular overlap	Mean	8.3	3.5	Measured between medial border of fibular and lateral border of anterior distal tibial tubercle on anterior posterior/mortise view 1 cm above tibial plafond	>6 mm on AP view or >1 mm on mortise	<6 mm or <24% of fibular width on anterior posterior view or >1 mm on mortise view	20%	89%	36%	78%
	Range	1.8–15.1	-1.9–9.9							
Tibiofibular clear space	Mean	4.6	4.3	Measured between medial surface of talus and lateral surface of medial malleolus on anterior posterior view 1 cm above tibial plafond	<6 mm	>6 mm or >44% of fibular width on anterior posterior view	33%	97%	82%	75%
	Range	0.0–8.0	1.4–7.6							

is controversial, as it can be painful for patients and may require sedation or even anaesthesia.[28] Furthermore, there is a lack of standardisation in the amount of force required to accurately perform a stress examination.[29] Therefore, stress views are often only performed in settings where adequate pain relief is available. In orthopaedic clinics, patients only undergo weight bearing X-ray images to assess if there is widening of the ankle syndesmosis, but stress views are not typically performed if not indicated.

Amin et al. performed a study on 39 males and 40 females to determine the normal parameters of tibiofibular syndesmosis using weight bearing AP radiographs.[30] The parameters include the TCS and TFO which are measured 1 cm above the tibial plafond.[30] In this study, a normal TCS is <4.57 mm or <29% of fibular width in male and <4.28 mm or <30% of fibular width in females. TFO is measured to be >9.29 mm or >57% of fibular width in male and >7.41 mm or >51% of fibular width in females.

In summary, X-ray is the most commonly used imaging modality in diagnosing ankle diastasis injury. The three main parameters used are; MCS, TFO, and TCS. X-ray is more reliable in diagnosing diastasis injury rather excluding the diagnosis. Therefore, X-ray projections performed under stress are suggested to view the anatomical diastasis more accurately. However, the benefit of stress views needs to be weighed against the increased pain and discomfort for the patient.

Computed tomography

Computed Tomography (CT) is another imaging modality that is widely used to diagnose acute ankle diastasis injuries. CT is capable of clearly showing the positional relationship of the distal tibiofibular syndesmosis.[31] This advantage can directly measure the distal tibiofibular syndesmosis gap, allowing a comparison with the contralateral side.[31] Chun et al. performed a meta-analysis on two studies: one to compare CT to arthroscopy and another analysing 123 CT cases.[27] The meta-analysis concluded CT to have a sensitivity and specificity of 73.9% and 62.1% respectively.[27]

It has been found that CT has higher sensitivity compared to X-ray. According to Paredes-Vazquez et al., CT diagnosed 82.3% of diastasis injuries compared to plain radiography, which only detected 64.8% of injuries. This indicates that CT has a higher sensitivity in comparison to X-ray in detecting minor diastasis injury.[31,32] This is also consistent with Ebraheim et al., who on 12 cadaver lower limbs demonstrated that CT scans clearly identifying diastasis injuries as small as 2 mm, whereas X-ray could only detect 50% of 3 mm

Figure 3. 22 M, left Weber B with diastasis injury after twisting injury following a tackle by opponent during football match as delineated on normal and weight bearing X-rays. Non weight bear series: (A) anterior, (B) mortise, (C) lateral. Weight bear series: (D) anterior, (E) mortise, (F) lateral.

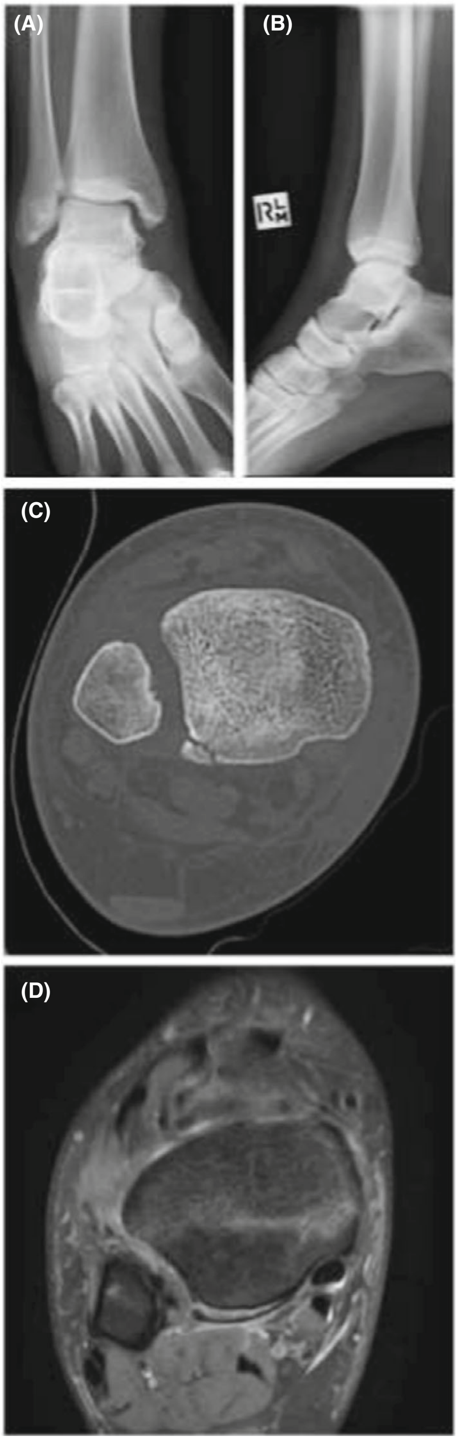

Figure 4. A 17 year old male who fell and internally rotated his right ankle. Mortise and lateral view X-ray do not suggest a syndesmosis injury, but CT scan demonstrated a posterior malleolus avulsion fracture, likely involving the posterior inferior tibiofibular ligament. MRI scan performed showed the avulsion fracture with attached posterior inferior tibiofibular ligament, and a further tear of the interosseous membrane and the anterior inferior tibiofibular ligament. (A) Mortise view. (B) Lateral view. Image (C) Axial CT scan. Image (D) Axial MRI scan.

diastasis injuries and completely missed the 2 mm diastasis injuries.[32] This is presented in Figure 4, where CT demonstrates a posterior malleolus fracture not seen on the plain radiograph. Weight bearing CT (WBCT) also demonstrated diastasis injury better than non-WBCT by measuring the syndesmosis area, though no significant difference is seen in measuring tibiofibular distance (TFD).[33,34]

CT employs the tibiofibular distance (TFD) to determine the presence of a diastasis injury. The TFD is measured between the medial fibula and the nearest point of the lateral tibia border, measured at the anterior, middle, posterior, and maximal portions across the syndesmosis, 10 mm proximal to tibial plafond on axial CT slices.[35] Yeung et al. performed a study on 123 patients over a period of seven years to determine the diagnostic accuracy of CT measurements to predict ankle diastasis instability. Anterior and maximum TFD were found to be the most reliable measurements followed by minimum TFD, while posterior TFD was least reliable.[35] Yeung et al. states the value, sensitivity and specificity for maximum TFD was 5.65 mm, 74.4%, and 78.9%; minimum TFD was 3.95 mm, 74.4%, and 75%; and anterior TFD is 4 mm, 56.5%, and 91.7% respectively comparing CT imaging to intraoperative findings.[35] However, Kotwal et al. determined a wide variation in normal anatomy of the distal tibiofibular syndesmosis, with the anterior TFD ranging from 0.6 to 5.7 mm and posterior TFD ranging from 1.9 to 8.7 mm.[36] Therefore, it is recommended to take multiple measurements and compare the measurements with the contralateral ankle to improve diagnostic accuracy.[35,36] Furthermore, when using the contralateral ankle for comparison, it is vital to ensure that both ankle joint-lines are at the same level, allowing a comparison to be made at the same axial slice.[36]

Nault et al. performed a study on 114 normal and injured ankle syndesmoses. This demonstrated four other parameters that could identify diastasis injury on CT,[37] including:

- Rotational parameters
  - Distance between most anterior part of incisura and nearest most anterior point of the fibular (A);
  - Ratio of distance between most anterior part of incisura and nearest most anterior point of fibular to distance between most posterior point of incisura and the nearest most posterior point of fibula (B); and
  - Angle between the talar side of 2 malleoli measured at level of talar dome (C)
- Mediolateral parameter
  - Distance between the tibia and fibula in the middle of incisura (D)

The specific measurements are presented in Table S3.

In clinical practice, CT is often performed to visualise bone fragments and the extent of injuries in fractures. Hence, these were often done after manipulation and reduction of fracture as pre-operative planning. Distal tibiofibular translations are widely used to indicate diastasis injury and mal-reduction. Schon et al. performed a study on 12 cadaveric specimens to determine the accuracy of existing CT methods used for distal tibiofibular syndesmosis measurement in mal-reduced models.[38] The study revealed that a mal-reduction state can be assessed using three components, which include anterior–posterior translation, medial lateral translation, and rotation.[38]

Therefore, CT has a higher specificity and sensitivity, when compared to radiographs for identifying diastasis injuries. However, the radiation dose and cost associated with CT still needs to be considered when deciding on the optimum first line imaging modality. To reduce radiation exposure to patients, Kotwal et al. designed a protocol for targeted CT scanning of the distal tibiofibular syndesmosis which involves five-cut protocol with radiation of only 0.002 mSv[36]. Unfortunately, this protocol is not widely available globally. This is because the study only included 40 participants and the authors concluded more studies were required before the protocol could be utilised.

Rio et al. performed a study on 39 patients comparing WBCT versus non weight bearing CT (NWBCT) in identifying diastasis injuries.[33] The study illustrated unstable ankle with diastasis injuries has a greater syndesmotic area which is better appreciated on WBCT[33]. In Rio's study, WBCT identified 19.9% greater syndesmosis area in the injured ankle when compared to contralateral uninjured ankle. NWBCT only identified 8.8% of syndesmosis area, when a similar comparison is made between the injured ankle and the contralateral uninjured ankle.[33] Figure 5 demonstrates the relationship between weight bearing images of the injured right ankle to normal left ankle and showing a 27% increase in syndesmosis area.

In summary, CT has a higher sensitivity as compared to X-ray and can detect minor diastasis injuries better. The main parameter used is TFD, with anterior and maximum TFD being the most reliable measurements. Due to the wide variation in normal syndesmosis

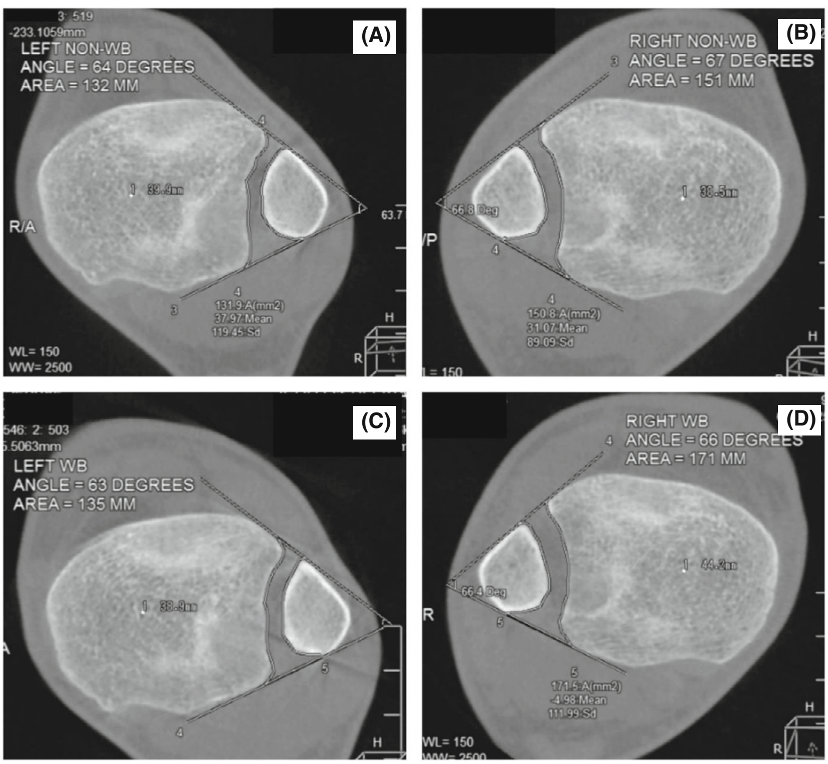

Figure 5. CT scan of difference between the syndesmosis areas on weight bearing versus non weight bearing scans. (A) Left syndesmosis non weight bearing image (top left) ankle 64°, area 132 mm. Image (B) Right syndesmosis non weight bearing image (top right) angle 67°, area 151 mm. (C) Left syndesmosis weight bearing image (bottom left) angle 63°, area 135 mm. (D) Right syndesmosis weight bearing image (bottom right) ankle 66°, area 171 mm.

anatomy, multiple measurements and contralateral ankle comparison measurements should be taken. WBCT is also recommended as it better demonstrates diastasis injuries by evaluating the dynamic change in syndesmosis area.

Magnetic resonance imaging

Magnetic Resonance Imaging (MRI) has the highest sensitivity in detecting minor degrees of diastasis injury.[6] Oae et al. conducted a study with 58 patients to compare the accuracy of MRI with arthroscopy in the diagnosis of tibiofibular diastasis injuries. It was concluded that MRI was able to diagnose AITFL disruption with a sensitivity and specificity of 100 and 93.1% respectively, and PITFL disruption with sensitivity and specificity of 100%.[39] Accuracy of AITFL disruption and PITFL disruption was also noted to be 96.2 and 100% respectively.[14] However, this sensitivity decreased over time. In chronic diastasis injury cases where patients were followed up from 22 to 30 months, MRI sensitivity, specificity, and accuracy decreased to 90.0, 94.8, and 93.4% respectively.[40] As such, ankle diastasis injuries are best diagnosed and treated in the acute setting to reduce the risk of complications stemming from misdiagnosis and mismanagement in a subacute or chronic setting.[40] The high sensitivity of MRI compared to other imaging modalities is shown in Figure 4, where axial MRI could identify which components of ligamentous syndesmosis complex were torn. This could impact clinical decision making as it could lead to future instability. Oae et al. described the MRI criteria for ligament disruption with the following:

- Criterion 1: ligament discontinuity
- Criterion 2: wavy or curved ligament contour or non-visualisation of ligament[39]

While diastasis injury can be diagnosed solely with criterion 1, utilising both criteria 1 and 2 will allow for better sensitivity and specificity as shown in Table 2.

While axial and coronal planes are commonly used to visualise the lateral collateral ligaments on MRI, Herman et al. propose the inclusion of an oblique plane to better detect partial or completely torn ligaments.[41] As AITFL and PITFL running obliquely with respect to the tibial plafond, they are more likely to show partial or complete discontinuity on axial planes.[41] As such, imaging in the axial plane could also lead to false positives as demonstrated in Takao et al.'s study where 2 out of 30 patients had false positive findings.[39] Herman et al. performed a retrospective study on 21 healthy patients with no history of trauma to evaluate the ligament continuity in various MRI planes.[41] The study revealed that AITFL was not continuous in all patients while PITFL was continuous in 16 patients on the axial plane. In comparison, AITFL and PITFL were continuous in 19 and 21 patients respectively on the oblique plane.[41] This demonstrates a better depiction of the AITLF and PITFL on the oblique plane as compared to the axial plane which may reduce false positive results.[41] Therefore, Herman et al. recommended an oblique MR image plane in diagnosing anterior and posterior diastasis injuries.[41]

Bauer et al. performed a study on 3 patients and 3 cadavers to compare the auto calibrating parallel imaging technique at 3 Tesla (T) with standard acquisitions at 3 T and 1.5 T for small-field-of-view imaging of the ankle.[42] The study concluded that using higher field strength (3 T) with generalised auto calibrating partially parallel acquisition (GRAPPA) allows better imaging quality and a reduction in scan time by 44%.[42] This finding is also supported by the study performed by Clanton et al. on 21 patients, who had preoperative 3 T ankle MRI and arthroscopic assisted surgery for suspected syndesmotic injury, the ankle pathology which demonstrated better visualisation of individual syndesmotic structures in both normal and injured patients.[43]

Brown et al. carried out a study on 90 patients using 1.5 T MRIs to investigate findings associated with acute and chronic diastasis injuries.[44] In their study, bone bruising and talar dome osteochondral lesions were more common in acute injuries, with an occurrence rate of 78 and 48% respectively. On the other hand, incongruent tibiofibular joint and osteoarthritis are more commonly associated with chronic injuries with an occurrence rate of 58 and 19% respectively.

MRI is proven to have the best specificity and sensitivity among imaging modalities and uses no radiation. However, there is a significant delay in obtaining MRI scans in an acute setting due to limited availability of MRI machines and longer processing time when compared to other modalities.[45] This may delay management and could lead to chronic complications. Furthermore, unlike radiographs or CT imaging, MRI imaging is a prolonged process in an enclosed space, which may heighten the effects of claustrophobia or

Table 2. Sensitivity, specificity and accuracy of criteria 1 and 2 for AITFL[1] and PITFL[2] injuries.[41]

Diastasis injury	Criteria	Sensitivity (%)	Specificity (%)	Accuracy (%)
AITFL[1]	1	100	70	84
	1 and 2	100	93	97
PITFL[2]	1	100	84	95
	1 and 2	100	100	100

[1]AITFL-anterior inferior tibiofibular ligament.
[2]PITFL-posterior inferior tibiofibular ligament.

anxiety. It is also contraindicated in patients with certain internal devices such as metallic implants or prosthetic heart valves which are MR-incompatible.

We acknowledge the limitations of this literature review. A systematic review process according to PRISMA guidelines was not followed for the articles reviewed and screened, but this review rather takes on a narrative style. Additionally, study heterogeneity made it difficult to directly compare studies.

Our review highlighted the use of existing modalities in investigating an injury that is common but difficult to adequately diagnose. The role of dynamic imaging and establishing validated diagnostic criteria would be the next step for research in this field.

Conclusion

Diastasis ankle injury is an important pathology that needs to be diagnosed promptly. A missed diagnosis can have detrimental long-term consequences for the patient. Whilst ankle arthroscopy is the most ideal method for diagnosis, it is not always possible to conduct. As such, X-ray should continue to be the first line imaging modality in all cases due to its wide availability, quick processing time and reduced cost. CT imaging is useful to identify fractures and widening of the syndesmosis that suggest a diastasis injury, and newer modalities such as WBCT will provide improved diagnostic capabilities. It is favoured over X-ray, due to its increased sensitivity and specificity, ability to show the positional relationship of the distal tibiofibular syndesmosis, and reliability in detecting minor diastasis injuries. MRI has a high sensitivity and specificity for identifying acute diastasis injuries, does not expose patients to radiation, and can highlight ligamentous disruption. However, MRI does have drawbacks, such as increased wait time and contraindications to some patient cohorts such as patients with metallic implants and claustrophobic patients. In summary, various imaging modalities can be used for diagnosis of ankle diastasis injury, each with their own benefits and drawbacks. The literature review clearly outlines the most appropriate circumstances in which each is used and the parameters used for diagnosis.

Conflict of Interest

The authors have no conflicts of interest to disclose.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1 Normal radiographic values of distal tibiofibular syndesmosis.

Table S2 Sensitivity and specificity of different MCS cutoff value in diagnosing diastasis injury.

Table S3 Measurements of four parameters to assist in identifying diastasis injury on CT.