

# High-Speed Video Analysis of Syndesmosis Injuries in Soccer—Can It Predict Injury Mechanism and Return to Play? A Pilot Study

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## Abstract

**Background:** Ankle syndesmosis injuries in professional soccer may lead to an unpredictable and prolonged recovery. This injury has been investigated in anatomical and radiologic studies but the precise mechanism leading to syndesmosis injury is not well understood and remains debated. The 2 goals of this study were to (1) evaluate the relationship between the mechanism of syndesmosis injury as determined by high-speed video analysis and the injured structures identified by clinical and radiologic examination and to (2) investigate the relationship between mechanism of injury and time of return to play.

**Methods:** This pilot study prospectively reviewed high-speed video analysis of 12 professional soccer players who sustained syndesmosis injuries. The mechanism of injury was compared with the clinical and MRI evaluation and the time taken to return to play.

**Results:** Higher-grade syndesmosis injuries occurred during ankle external rotation with dorsiflexion. Supination-inversion injuries with a standard lateral ankle sprain (rupture of the anterior talofibular ligament) may extend proximally, causing a lower-grade syndesmosis injury. These may present with signs of a high ankle sprain but have a quicker return to sport than those following a dorsiflexion-external rotation injury (mean 26 days vs 91 days).

**Conclusions:** Video analysis confirmed that at least 2 mechanisms may result in injury to the ankle syndesmosis. Those “simple” ankle sprains with signs of syndesmosis injury had a quicker return to play. This new finding may be used by club medical teams during their initial assessment and help predict the expected time away from soccer in players with suspected high ankle sprains.

**Level of Evidence:** Level IV, retrospective cohort study.

**Keywords:** Ankle injury, biomechanics, syndesmosis injury, soccer injuries, video analysis

## Introduction

Ankle injuries account for 10% to 15% of all sporting injuries and the ankle syndesmosis may be injured in up to 18% of all ankle sprains.<sup>7,8,14-16</sup> Syndesmosis injuries are also associated with a less predictable outcome and prolonged recovery.<sup>9,19,23</sup> Identification of a syndesmosis injury requires a high level of suspicion, and differentiation from a simple ankle sprain may be difficult leading to a delay in accurate diagnosis and subsequent treatment.<sup>21</sup> A severe ankle supination-inversion injury with rupture of the anterior talofibular ligament (ATFL) may lead to proximal extension of the injury with signs of a “high ankle sprain” but this may have a quicker return to sport than an isolated syndesmotomic injury.<sup>4</sup>

The distal fibula is firmly attached at the fibular notch of the tibia by several syndesmotomic ligaments and stability of this articulation is necessary to allow proper ankle function.<sup>1,3,10,12,24</sup> The ligaments that stabilize this joint are the anterior inferior tibiofibular ligament (AITFL), the posterior

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**Table 1.** Modified West Point Grading.

Criteria	Grade I	Grade II	Grade III
Evidence of instability	None	None or slight	Definite
Localization of syndesmosis tenderness	Mild tenderness AITFL only	Tender AITFL, $\pm$ PITFL and proximally <6 cm	Tender AITFL, PITFL and proximally >6 cm
Deltoid ligament involvement	No	Yes/No	Yes
Weight-bearing ability <5 days from injury	Full or partial without significant pain	Difficult or impossible without supportive device (ie, brace, tape, or cane)	Impossible
Specialist tests	Positive external rotation test results Positive/negative squeeze test results	Positive external rotation test results Positive squeeze test results	Positive external rotation test results Positive squeeze test results
Plain radiographs	No mortice widening	No mortice widening	Mortice widening
MRI findings	Isolated sprain to AITFL	Rupture AITFL and IOL Deltoid injury $\pm$ PITLF	Rupture AITFL, IOL and PITFL Deltoid injury

Abbreviations: AITFL, anterior-inferior tibiofibular ligament; IOL, interosseous ligament; PITFL, posterior-inferior tibiofibular ligament; MRI, magnetic resonance imaging.

**Table 2.** Player Demographics, Injuries, Treatments, and Return to Play.

Player	Age	Injury	Mechanism	AITFL	ATFL	PITFL	Management	RTP
1	23	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Nonoperative	86
2	27	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Nonoperative	61
3	18	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Nonoperative	40
4	21	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Operative	96
5	20	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Operative	100
6	26	Contact	DF-Ext Rot	Ruptured	Intact	Intact	Nonoperative	60
7	29	Contact	DF-Ext Rot	Ruptured	Intact	Ruptured	Nonoperative	165
8	25	Contact	DF-Ext Rot	Ruptured	Intact	Ruptured	Operative	140
9	27	Contact	Sup-Inv	Partial rupture	Ruptured	Intact	Nonoperative	21
10	22	Contact	Sup-Inv	Partial rupture	Ruptured	Intact	Nonoperative	35
11	21	Contact	Sup-Inv	Partial rupture	Ruptured	Intact	Nonoperative	22
12	20	Non-contact	DF-Ext Rot	Ruptured	Intact	Intact	Operative	72

Abbreviations: AITFL, anterior-inferior tibiofibular ligament; ATFL, anterior talofibular ligament; DF-Ext Rot, dorsiflexion-external rotation; PITFL, posterior-inferior tibiofibular ligament; RTP, return to play in days; Sup-Inv, supination-inversion.

inferior tibiofibular ligament (PITFL), and the interosseous ligament (IOL). The most distal and inferior aspect of the interosseous membrane also helps to stabilize this joint. The exact mechanism of injury required to damage these structures is debated in the literature, despite clinical, radiographic, and biomechanical-cadaveric studies.<sup>11,22</sup>

The most accepted mechanism of injury is an external rotation moment through the foot and ankle with the ankle in dorsiflexion and the foot pronated,<sup>5,6,8,24</sup> but others have suggested inversion with external rotation,<sup>17,20</sup> hyper-dorsiflexion,<sup>13</sup> or even pure inversion.<sup>13,18</sup> Previous studies suggest that the more common lateral ligament injury sustained during supination-internal rotation may also lead to a mild syndesmosis injury.<sup>4</sup> It is possible that different mechanisms of injury may lead to different severities of syndesmosis disruption and that this may therefore also affect the time of return to sport.

Professional soccer is a sport in which syndesmosis injuries are commonly encountered and early magnetic resonance (MR) imaging is often sought.<sup>4,11,17,22</sup> It also

attracts significant media exposure with routine slow-motion video recording from various angles and subsequent analysis of injury mechanisms. Soccer therefore lends itself to being an ideal sport in which MRI and video findings of this injury may be compared.

It is not known whether the severity of a syndesmosis injury and time of return to play depends on the mechanism of injury. The purpose of this pilot study was to analyze the video footage of professional soccer players sustaining syndesmosis injuries during a match and compare the injury mechanism with the clinical assessment and the structures damaged on subsequent MRI scan. The hypotheses of this study were 2-fold:

1. Clinical and radiologic assessment of injured structures correlates with mechanisms of injury identified by high-definition slow-motion video analysis.
2. Determining the mechanism by video analysis aids prediction of injury severity.

## Methods

A total of 12 syndesmosis injuries were identified from 2 English professional soccer clubs during 5 seasons. Local institutional board review was granted for this study with consent from players to hold anonymized information on a database. Players had their injury recorded in the form of high-definition slow-motion video footage. The club senior physiotherapist and 2 of the authors independently performed frame-by-frame analysis of each injury. This determined the positions of the foot, ankle, and knee during the injury event recording the mechanism of injury as hindfoot inversion or eversion, ankle internal or external rotation, and foot supination or pronation.

All injuries were assessed clinically within 24 hours of injury by the head of medical services at the football clubs and subsequently underwent MR imaging, which were reported on by a musculoskeletal radiologist. The injuries were then graded I to III using the modified West Point Ankle Grading system (Table 1).<sup>9</sup> Potentially unstable injuries underwent arthroscopic assessment and stabilization of the syndesmosis with a suture-button technique if required. The return to play time as an indication of severity of injury was defined as the time from the date of injury to the date that the player became available for first team selection again.

## Results

### Video Analysis of Mechanism of Injury

Eleven of the 12 injuries were sustained with contact during a tackle, and the remaining injury was sustained when the player was attempting a sudden change in direction. The types of injuries sustained by the 12 players is summarized in Table 2. The video analysis identified that 9 to 12 (75%) of the injuries occurred with forced external rotation of the ankle during dorsiflexion. This injury involved the player's foot being planted on the ground and held fixed in position by the studs of the football boot. The ankle was then forced into dorsiflexion as the injured player's center of gravity progressed forward over and beyond the ankle joint, forcing the planted foot to act as a moment arm, externally rotating the ankle. An illustrative example is given in a series of video stills in Figure 1. The mean return to play time for this dorsiflexion-external rotation injury was 91 days (range 40-165).

Video analysis confirmed that the remaining 3 syndesmosis injuries (25%) occurred during a supination-inversion type of mechanism with the ankle mortise internally rotating during plantar flexion. An example of this injury mechanism is shown in Figure 2. The mean return to play time for players with this supination-inversion injury was 26 days (range 21-35).

None of the players with a supination-inversion injury mechanism required surgery, but 4 players with dorsiflexion external-rotation mechanisms had clinical signs of instability

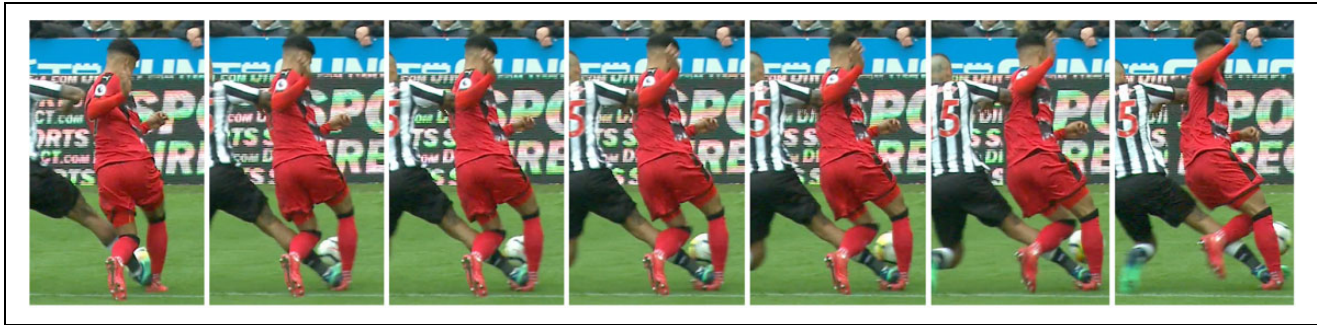


**Figure 1.** Series of video stills demonstrating right ankle syndesmosis injury with the ankle being forced into dorsiflexion-external rotation.

and underwent surgical stabilization with a suture-button following confirmation of instability at arthroscopy.

### Clinical Evaluation

All players were recorded as having a swelling over the anterolateral aspect of the ankle with tenderness specifically over the AITFL. Each demonstrated a positive "Squeeze Test" and "External Rotation Test" consistent with an ankle syndesmosis injury.<sup>2,13</sup> There was no correlation between the immediate clinical findings and either the mechanism of injury or return to play time.



**Figure 2.** Series of video stills demonstrating right ankle supination-inversion injury.

### Imaging

AITFL injuries were demonstrated on MRI scans for all 12 players. In the nine patients with dorsiflexion-external rotation mechanism of injury, there was complete rupture of the AITFL, the anterior talofibular ligament (ATFL) was normal in all and the PITFL was injured in 2 cases (with concurrent injury to the IOL). In the 3 players with supination-inversion injuries, there was complete rupture of the ATFL but only a partial tear to the AITFL and no other syndesmosis ligament was injured.

### Discussion

Differentiation of the more common lateral ligament injury from the more severe syndesmosis injury may be difficult in the acute setting but may have a significant impact on the player's predicted return to play and subsequently on team selection. Therefore, early diagnosis of a syndesmosis injury may help the medical team both in terms of advice to team management and in instigating optimal treatment. English Premiership soccer matches have high-definition slow-motion cameras recording at multiple angles and are potentially a method by which the mechanism of injury may be reviewed quickly and then used as part of the overall assessment of a player.

The exact mechanism leading to syndesmosis injuries has been debated in the literature—players may be unsure of their foot position during a sudden injury and biomechanical studies of cadavers have reproduced disruption to the syndesmosis with various mechanisms. In a retrospective study of 15 cases, there were 3 hyperdorsiflexion and 3 inversion injuries while a prospective study of 25 patients suggested the mechanism a combination of inversion and external rotation.<sup>13,20</sup> This was supported in a radiologic study of the ATFL by Milzl in which a syndesmosis injury was present in 9/20 ankle inversion injuries.<sup>18</sup> The video analysis study presented here would support inversion-supination as a possible mechanism of injury. It also concurs with MRI and stress radiography that suggests although this mechanism may injure both ATFL and AITFL there is incomplete disruption of the syndesmosis and consequently a less severe (grade I) syndesmosis injury.<sup>20</sup> The earlier return to sport

observed in this small group of patients supports clinical studies, suggesting that injury to the ATFL with involvement of the syndesmosis results in a quicker recovery than for those in which the ATFL is normal, presumably because of a different mechanism of injury.<sup>4</sup>

The most accepted mechanism of injury in the literature is external rotation with the ankle in dorsiflexion and the foot pronated.<sup>6,24</sup> This leads to external rotation of the fibula relative to the tibia, forcing the syndesmosis to open anteriorly hinging on the PITFL posteriorly. This mechanism leads to the AITFL becoming the first ligament injured. If the external rotation force is then removed, an isolated AITFL rupture is sustained. Further force and external rotation will lead to damage to the IOL and PITFL and a higher-grade injury as has been observed in the current study.

We acknowledge that video analysis during live soccer matches has flaws and is not comparable with laboratory-based gait analysis or the accuracy of reproducing injuries in cadavers. The slow-motion images are open to individual interpretation, but we believe that they are reproducible and may accurately identify the foot and ankle position during injury. No assessment was made of the inter- or intraobserver variability in this study. This is a small series of patients, but it is the first study to attempt a scientific *in vivo* assessment of the precise mechanism of injuries sustained rather than theorizing the mechanism—although this has been suggested in biomechanical studies, this has not previously been demonstrated in clinically and radiologically proven syndesmosis injuries. The video analysis presented here demonstrates that the mechanism of ankle dorsiflexion and external rotation may lead to the more severe (grade II) syndesmosis injury and this may help to explain why it is associated with a longer time of return to sport. It was also able to identify those injuries where the syndesmosis was involved in a lateral ligament injury which had an earlier return to sport. We also acknowledge that surgery may have altered the time of return to play, but we believe that this reflects the more serious nature of the injury with the dorsiflexion external-rotation mechanism rather than the surgical procedure itself. None of those with a supination-inversion injury and presumed lower degree of injury required

surgery. Because of the small numbers in this pilot study, it was not valid to perform a subgroup analysis comparing surgery with nonsurgery.

## Conclusions

Although this is a pilot study with only 12 players and limited conclusions can be drawn from it, we believe that video analysis of ankle injuries during professional soccer may be a useful accessory assessment tool. We have found 2 distinct injury mechanisms that may have different injury severities and RTP times and that further study of this is needed.

## Declaration of Conflicting Interests

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