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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Video-Based Analysis of High Ankle Sprain

Yüksek Ayak Bileği Burkulmalarının Video Analizi

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ABSTRACT

Objective: To descriptively characterize the injury mechanisms of isolated syndesmotic ankle injuries in professional athletes using systematic video analysis.

Materials and Methods: This observational study analyzed publicly available videos of isolated syndesmotic injuries identified through a systematic YouTube search. Videos of professional athletes with adequate visual quality were included. Injury events were reviewed at reduced playback speed and qualitatively classified according to contact mechanism, sagittal and coronal ankle alignment, foot posture, foot rotation, and knee flexion at the time of injury. Two independent observers evaluated all videos, with interobserver agreement assessed using Cohen's kappa statistics. Injury grade and return-to-play (RTP) duration were recorded descriptively when reported in reliable public sources.

Results: Nineteen professional athletes (median age 22 years) were included. Most injuries occurred in field sports (n = 13), followed by indoor court sports (n = 4) and ice sports (n = 2). The most common injury configuration involved ankle dorsiflexion combined with external rotation and pronation, frequently accompanied by valgus alignment. Contact-related mechanisms predominated, including direct and indirect contact. Median return-to-play was 42 days (interquartile range: 28–56 days).

Conclusion: Real-world video analysis demonstrates consistent mechanical patterns in isolated syndesmotic injuries, supporting experimental models and providing clinically relevant context for future biomechanical and injury prevention research.

Keywords: Mechanism of injury, ankle sprain, syndesmosis, injury prevention

ÖZ

Amaç: Profesyonel sporcularda görülen izole sindesmoz ayak bileği yaralanmalarının yaralanma mekanizmalarını sistematik video analizi kullanarak betimleyici olarak karakterize etmek.

Gereç ve Yöntem: Bu gözlemsel çalışmada, sistematik bir YouTube taraması sonucunda belirlenen izole sindesmoz yaralanmalarına ait kamuya açık videolar analiz edilmiştir. Görüntü kalitesi yeterli olan profesyonel sporculara ait videolar çalışmaya dâhil edilmiştir. Yaralanma anları, video oynatma hızı düşürülerek incelenmiş ve temas mekanizması, ayak bileğinin sagittal ve koronal düzlemdeki dizilimi, ayak postürü, ayak rotasyonu ve yaralanma anındaki diz fleksiyonu açısından niteliksel olarak sınıflandırılmıştır. Tüm videolar iki bağımsız gözlemci tarafından değerlendirilmiş ve gözlemciler arası uyum Cohen kappa istatistiği kullanılarak analiz edilmiştir. Yaralanma derecesi ve spora dönüş (Return to Play - RTP) süresi, güvenilir kamuya açık kaynaklarda bildirildiği durumlarda betimleyici olarak kaydedilmiştir.

Bulgular: Çalışmaya 19 profesyonel sporcu (medyan yaş 22 yıl) dâhil edilmiştir. Yaralanmaların çoğu saha sporlarında (n = 13), bunu takiben salon sporlarında (n = 4) ve buz sporlarında (n = 2) meydana gelmiştir. En sık görülen yaralanma konfigürasyonu, sıklıkla valgus diziliminin eşlik ettiği ayak bileği dorsifleksiyonu ile dış rotasyon ve pronasyon kombinasyonudur. Doğrudan ve dolaylı temas mekanizmalarını içeren temas ilişkili yaralanmalar baskındır. Spora dönüş süresinin medyan değeri 42 gün (çeyrekler arası aralık, 28–56 gün) olarak bulundu.

Sonuç: Gerçek yaşam koşullarında gerçekleştirilen video analizi, izole sindesmoz yaralanmalarında tutarlı mekanik örüntüler bulunduğunu göstermektedir. Bu bulgular, deneysel modelleri desteklemekte ve gelecekteki biyomekanik araştırmalar ile yaralanmaların önlenmesine yönelik çalışmalar için klinik açıdan anlamlı bir bağlam sunmaktadır.

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Anahtar Sözcükler: Yaralanma mekanizması, ayak bileği burkulması, sindesmoz, yaralanmaların önlenmesi

INTRODUCTION

Ankle injuries account for approximately 10-15% of all sports-related injuries. However, the true incidence of syndesmotic injuries remains uncertain [1,2]. This uncertainty is partly attributable to diagnostic challenges and variability in reporting practices. Routine radiographs may be insufficient for detecting syndesmotic injuries, particularly in the absence of associated fractures, both in recreationally active individuals and in athletes [3]. When an injured athlete is unable to clearly describe the mechanism of injury following trauma, diagnosis and treatment may be delayed, consequently prolonging return-to-play (RTP) time.

Syndesmotic injuries have been extensively investigated through cadaveric studies, imaging-based classifications, and rigid body biomechanical models; however, these approaches primarily characterize ligament loading patterns under controlled conditions [4-7]. In contrast, the precise sequence of joint positions, contact characteristics, and limb alignment at the moment of injury during real sporting competitions has not been sufficiently defined. Thus, the existing uncertainty does not stem from a lack of biomechanical understanding of the injury mechanism itself, but rather from the difficulty of accurately capturing and characterizing in vivo injury events.

Mechanism-focused descriptive studies using video analysis provide a complementary perspective by documenting how injuries occur under uncontrolled, sport-specific conditions [8]. Rather than quantitatively measuring joint angles, this approach emphasizes pattern recognition of recurring mechanical scenarios, including limb position, type of contact, and alignment at the time of injury. Such descriptive analyses are particularly valuable for contextualizing experimental findings and for generating hypotheses for future biomechanical or preventive studies [8,9].

The present study addressed the following question: How do isolated syndesmotic injuries occur under real competition conditions, particularly with respect to lower extremity alignment and contact mechanisms at the moment of injury, and what are their potential descriptive associations with return-to-play (RTP) duration? Accordingly, the primary aim of this study was to descriptively characterize the mechanisms of isolated syndesmotic injuries in professional athletes using systematic video analysis. Particular emphasis was placed on sagittal and coronal ankle alignment, foot rotation, contact mechanism, and overall limb configuration at the time of injury. In addition, we sought to descriptively explore the relationship between injury patterns and RTP.

MATERIAL AND METHODS

This study was designed as an observational video analysis. On April 7, 2023, a systematic search was conducted on YouTube using the terms "high ankle sprain" and "syndesmosis injury." Browser cookies were cleared prior to the search to minimize algorithmic bias. All videos were independently reviewed by two authors. Athlete injury information was cross-verified using official club announcements and publicly accessible, reliable sports injury databases [10,11] (e.g., DraftSharks, SportRadar). These sources were used solely to confirm the reported syndesmotic injury event and RTP duration; no independent clinical diagnoses were made by the authors.

Inclusion criteria consisted of identifiable professional athlete status, availability of video footage capturing the reported injury event, clear visualization of the foot, ankle, and knee at the time of injury, and sufficient video quality (minimum resolution of 640 × 360 pixels and frame rate ≥25 Hz). Videos were excluded if the injury mechanism was unclear, visual quality was inadequate, footage was duplicated, or if concomitant injuries such as fractures or deltoid ligament ruptures were reported. Following screening, 32 videos were identified; 13 were

excluded (unknown athlete identity, insufficient visualization, suspected alternative diagnosis, low quality, or duplication), resulting in 19 videos included in the final analysis. Of these, two involved ice hockey athletes; these cases were evaluated separately because of the rigid skate boot and sport-specific movement constraints.

Videos were reviewed at 0.25× playback speed without the use of quantitative motion analysis software; therefore, no angular measurements were recorded. Analysis focused on qualitative classification of injury characteristics, including presence of contact (direct, indirect, or no contact), sagittal ankle position (neutral, dorsiflexion, plantarflexion), coronal ankle alignment (neutral, varus, valgus), foot posture (neutral, pronation, supination), foot rotation (internal, external, neutral), and knee flexion category.

Two observers independently evaluated all videos. In cases of disagreement, videos were re-reviewed jointly until consensus was reached. This qualitative video analysis methodology has been previously applied in published studies investigating sports injury mechanisms [12,13]. Injury severity grading (grade 1-3) and treatment modality were recorded only when explicitly reported in reliable public sources. These classifications were not independently verified by imaging or medical records and were treated as descriptive variables. RTP was defined as the time from injury to return to competitive play.

Statistical analysis

Interobserver reliability was assessed using Cohen's kappa statistics, with weighted kappa applied for ordinal variables. Agreement strength was interpreted according to standard criteria. Continuous variables were summarized using median and interquartile range (IQR) due to non-normal distribution and small sample size. Statistical analyses were performed using SPSS version 23.

RESULTS

A total of 19 athletes were included in the analysis, of whom 18 were male and 1 was female. Based on the playing environment and footwear characteristics, sports were grouped as field sports, indoor court sports, and ice sports. Field sports included American football and rugby (n = 13), indoor court sports included basketball (n = 4), and ice sports included ice hockey (n = 2). Ice hockey cases were evaluated separately due to the rigid skate boot and sport-specific movement constraints. Injury mechanisms were categorized as direct contact (n = 8), indirect contact (n = 6), and fall-related mechanisms (n = 5). The median age at injury was 22 years (IQR, 21–27 years). Based on information reported on publicly accessible injury databases, 4 injuries were classified as grade 1, 7 as grade 2, and 8 as grade 3 syndesmotic injuries. Among athletes with reported grade 3 injuries, 6 underwent surgical treatment. Return-to-play time was reported descriptively using the median and interquartile range. The median duration was 42 days (IQR, 28–56 days; range, 7–56 days), without implying a causal association with injury mechanism or injury grade. Interobserver agreement was high (Cohen's κ = 0.920 for the nominal variable; the lowest weighted Cohen's κ among ordinal variables was 0.870 [95% CI, 0.795–0.945]); intraobserver agreement was also high (weighted κ = 0.932 [95% CI, 0.881–0.983]). Information on the joint positions of the foot, ankle and knee is summarized in Table 1. Return-to-play duration varied descriptively across injury-mechanism and injury-grade groups (Table 2). Given the small subgroup sizes, these summaries should not be interpreted as inferential evidence of an association. One of the injuries in ice hockey occurred as a result of a fall, while the other occurred due to an indirect impact. In both injuries, the foot was in pronation and external rotation, and the knee was in flexion. Due to the motion-restricting equipment worn, the hindfoot and the ankle were maintained in a neutral position.

Table 1. The status of joint positions at the time of injury

			Number (n)	Ratio(%)
ANKLE	Ankle Position (Sagittal)	*Neutral*	7	41.2
		Plantarflexion	0	0
		Dorsiflexion	10	58.8
	Ankle Position (Coronal)	*Neutral*	1	5.9
		Varus	2	11.8
		Valgus	14	82.3
FOOT	Foot Position	*Neutral*	2	11.8
		Supination	0	0
		Pronation	15	88.2
	Foot Rotation	*Neutral*	2	11.8
		External	15	88.2
		Internal	0	0
KNEE	Flexion angle	*0-30*	4	23.5
		30-90	8	47.1
		90-150	5	29.4

Ice hockey cases (n = 2) were excluded from this table because of the rigid skate boot and sport-specific movement constraints; percentages are based on 17 athletes.

Table 2. Return-to-play duration by injury characteristics

	N	Median RTP (days)	IQR (days)*
Injury mechanism			
Fall-related	5	21	45.5
Direct contact	8	35	24.5
Indirect contact	6	56	28
Injury grade			
Grade 1	4	21	40.25
Grade 2	7	28	14
Grade 3	8	56	10.5
Surgery			
Yes	6	56	0
No	13	28	17.5

**IQR was calculated as Q3 minus Q1.*

DISCUSSION

This mechanism-focused descriptive video analysis identified consistent patterns in limb position and contact characteristics at the time of isolated syndesmotic injury. The most frequently observed configuration involved ankle dorsiflexion combined with external foot rotation and pronation, often accompanied by valgus alignment at the foot and ankle. These patterns provide real-world contextual support for experimental concepts identifying external rotation forces as a primary contributor to syndesmotic ligament injury.

Cadaveric and simulation-based studies have demonstrated that increasing external rotation and dorsiflexion progressively load the anterior-inferior tibiofibular ligament (AITFL) and interosseous ligament (IOL) [2,5,6,14]. Wei et al. further reported increased syndesmotic ligament strain when dorsiflexion, external rotation, and eversion occur simultaneously [5]. However, external rotation forces alone appear insufficient to fully explain this injury pattern [14]. The descriptive findings of the present study, demonstrating valgus-oriented injury configurations in real sporting scenarios, align with and extend these biomechanical observations.

One notable finding was the predominance of contact-related mechanisms, including both direct contact at the foot-ankle level and indirect contact transmitted through the same limb. This observation underscores the importance of external factors in the development of syndesmotic injuries and highlights the limitations of purely non-contact models in explaining high ankle sprains in competitive sports, as suggested in prior studies [15].

Return to play (RTP) duration demonstrated substantial variability and did not show a consistent descriptive association with observed injury patterns or reported injury grade. This finding aligns with previous literature suggesting that RTP following syndesmotic injury is influenced by multiple factors, including rehabilitation strategies, sport-specific demands, and unmeasured concomitant soft tissue injuries [14,15]. Given the descriptive nature of the present study and the lack of imaging confirmation, no inferential conclusions regarding injury severity or prognosis can be drawn.

Several limitations should be considered when interpreting these findings. The absence of quantitative video analysis software precluded precise kinematic measurements, and injury classification relied on publicly available reports rather than direct access to medical imaging or official team medical records. Additionally, the small sample size and inclusion of multiple sports limit generalizability. To reduce biomechanical heterogeneity, ice hockey cases were analyzed separately due to the rigid skate boot, which may alter ankle mechanics. Despite these limitations, high interobserver agreement supports the internal consistency of the descriptive assessments.

CONCLUSION

This mechanism-focused descriptive study provides real-world insights into syndesmotic injury configurations that complement existing experimental models. By documenting recurring mechanical patterns rather than quantifying joint kinematics, it offers contextual contributions to future hypothesis-driven biomechanical research and sport-specific injury prevention strategies.

Ethics Committee Approval / Etik Komite Onayı
Ethics approval was not required for this non-interventional study.

Conflict of Interest / Çıkar Çatışması
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Author Contributions / Yazar Katkıları
Concept: NE, AY; design: NE, AY; supervision: MY, HG; materials: NE, MY; data collection: AY, TOB; analysis and interpretation: MY, TOB; literature review: NE, AY; writing manuscript: NE, HG; critical reviews: AY. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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