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Review

Anatomy, Biomechanics and Treatment of Tibiofibular Syndesmosis Injuries

Abdullah Aborukbah[1], Ameera Alshahrani[2], Ahmed Asiree[3], Ibrahim Alnami[4], Muteb Awaji[5], Nada Alkhaldi[6], Hisham Elbashir[7], Ahmad Alenezi[8], Alhanouf Alhemadi[9], Yara Alabbsi[9], Abdulrahman Bagais[10]

[1] *Department of Orthopedics, Al Thager Hospital, Jeddah, Saudi Arabia*
[2] *Department of Physiotherapy, King Fahad Hospital, Al Baha, Saudi Arabia*
[3] *College of Medicine, Majmaah University, Majmaah, Saudi Arabia*
[4] *College of Medicine, Jazan University, Jazan, Saudi Arabia*
[5] *College of Medicine, Sechenov University, Moscow, Russia*
[6] *Department of Physiotherapy, Mikhwah General Hospital, Al Baha, Saudi Arabia*
[7] *Department of Orthopaedic, Nottingham University Hospitals, Nottingham, England*
[8] *College of Medicine, Jordan University of Science and Technology, Irbid, Jordan*
[9] *Department of Physiotherapy, Al Ansari Specialist Hospital, Yanbu, Saudi Arabia*
[10] *College of Medicine, King Abdulaziz University, Rabigh, Saudi Arabia*

Correspondence should be addressed to **Abdullah Aborukbah**, Department of Orthopedics, Al Thager Hospital, Jeddah, Saudi Arabia. Email: aabo-rukbah@moh.gov.sa

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Abstract

Syndesmosis injuries are quite common globally. Often occurs due to the rotation of the foot or excessive movement in either upward or downward directions at the ankle. These may lead to several injuries, leading to pain, swelling, instability, and a decrease in ankle function. Diagnosing syndesmosis injuries can be challenging since they might not be easily identified through X-rays or clinical examinations. Some other diagnostic approaches, including computed tomography scans or magnetic resonance techniques which can provide information regarding the severity of such injuries. The main treatment approach for syndesmosis injuries depends on how unstable or displaced the joints. Non-surgical treatment options involving immobilization and restrictions on weight-bearing activities can effectively manage minimally displaced injuries. However, surgical intervention with fixation through screws, suture buttons, or other devices is recommended for significantly displaced injuries. The optimal timing for surgery, preferred technique for fixation, and appropriate duration of fixation are still topics of debate requiring research. Generally speaking, though, most patients with syndesmosis injuries tend to have outcomes; however, there is a possibility that some patients may experience pain and stiffness in their ankle joint movements over time while others may develop arthritis or mal-union conditions.

Keyword: *tibiofibular syndesmosis, ankle injury, ligament injury, syndesmotic fixation, syndesmosis injuries*

Introduction

The ankle joint is prone to injuries. It is considered one of the most commonly affected joints in the human body (1). This joint mainly consists of three bones of the body, which are the tibia, fibula, and talus. It is known that the lower ends of the tibia and fibula together form a mortise that connects with the trochlea of the talus. Maintaining stability and alignment in this connection depends on structures, including the ligaments (medial and lateral), joint capsule, and tibiofibular syndesmosis (2). The primary task done by syndesmosis is to serve as a joint that connects the tibia and fibula enabling a range of motion between them. There are four ligaments in the leg: the tibiofibular ligament, the inferior tibiofibular ligament, the transverse tibiofibular ligament, and the interosseous tibiofibular ligament (3, 4). Additionally, a membrane (IOM) is a thick sheet-like structure extending from the proximal to distal ends of the tibiofibular joint, separating different compartments within the leg (5). Usually, syndesmosis preserves both integrity and alignment of the ankle mortise during weight-bearing activities and motion. It effectively withstands axial, rotational, and translational forces that impact upon this joint. During foot movement towards shin alignment, dorsiflexion causes broader engagement between anterior parts of the talus with mortise leading to slight lateral displacement along, with the posteriorly directed proximal force exerted on the fibula (6). During the movement of the foot (plantar flexion), the back part of the talus bone connects with a specific joint called the mortise. This connection causes the fibula bone to be pulled towards the middle, front, and bottom (7, 8). One important structure responsible for preventing rotation and forward movement of the fibula is known as the Anterior Inferior Tibiofibular Ligament (AITFL). The PITFL is the primary restraint to internal rotation and posterior translation of the fibula (9, 10). The TTFL reinforces the PITFL and prevents excessive widening of syndesmosis. The IOTFL is a thickening of the IOM at its distal end and prevents proximal migration of the fibula. The IOM also contributes to load transfer from the fibula to the tibia. Syndesmosis injuries are relatively common and account for 1-18% of all ankle injuries. They are often associated with ankle or lower leg fractures, especially Weber type C fractures. However, they can also occur in isolation or with other soft tissue injuries. Injuries to syndesmosis are commonly caused by rotation of the foot or excessive movement of the ankle in a downward direction. Through this instability may appear and this weakens the joint area. Syndesmosis injuries can have an impact on patients causing discomfort and limitations. They can affect the function and mechanics of the ankle joint resulting in pain, swelling, instability, restricted a certain range of movement, decreases strength and endurance, and changes in walking patterns. If not properly treated or left untreated altogether, syndesmosis injuries can result in long-term complications such as arthritis, improper healing of bones (malunion), failure of bones to heal (nonunion) infection, or issues with implanted hardware. Generally speaking, outcomes for syndesmosis injuries are favorable; however, some patients may not fully. Experience satisfaction with their recovery. Several factors can influence these outcomes, including severity and duration of injury; presence or absence of associated fractures or soft tissue damage; accuracy and stability achieved during realignment and fixation; occurrence of complications or re-injury; and adherence to care instructions and rehabilitation programs. This paper aims to provide a review based on existing literature concerning anatomy, biomechanics, and treatment options for syndesmosis injuries.

Methodology

On October 1, 2023, we conducted a literature review on the topic of Anatomy, biomechanics and treatment of tibiofibular syndesmosis injuries. Due to this review, we had to search the Medline and PubMed databases, using medical subject headings and various related terms in each database. We used keywords such as tibiofibular syndesmosis, ankle joint, ankle sprain, ankle fracture, ankle stability, etc. We also searched Google Scholar manually. We did try to check the reference also of the retrieved papers for additional sources. To ensure the quality of our review, we applied inclusion criteria, such as

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excluding papers published before 2008 up to 2023 and preferring English language publications. We did not apply any restrictions based on age or publication type.

Discussion

There are several types of ankle joint injury that may occur to an individual but among them syndesmosis injuries are most common. They are more likely to happen in males, rather than females individual with a ratio of 2:1 to 3:1, between males and females (11). Patients who commonly suffer from syndesmosis injuries are usually 30 years old. These types of injuries often occur during sports activities that involve changes, in direction pivoting or jumping. There are several other sports such as soccer, rugby, football etc. are related to these injuries. However, it is important to note that syndesmosis injuries can also happen due to falls, car accidents or workplace hazards.

Biomechanics

When the foot become rotated externa way, severe injury like syndesmosis may occurs to the person. The rotation mostly occurs externally or excessive upward or downward movement of the ankle. These actions can weaken one or more parts of the syndesmosis leading to instability or misalignment of the ankle joint. External foot rotation is typically the cause of syndesmosis injury (12). This happens when the foot is firmly planted on the ground, and the body rotates around it or when external force forcibly rotates the foot outward. This type of mechanism can damage parts of the syndesmosis, starting with AITFL, then IOM, IOTFL, and finally PITFL and TTFL. The extent and severity of injury depend on how much external rotation occurs. Mild external rotation might only cause damage to AITFL, resulting in an incomplete syndesmosis injury. A moderate rotation of the ankle outward can lead to injuries in the AITFL and the IOM, causing a syndesmosis injury with displacement. On the other hand, a severe rotation of the ankle outward can harm all components of the syndesmosis resulting in a syndesmosis injury with significant displacement and widening of the mortise. Syndesmosis injuries can also occur due to excessive downward movement of the foot (13, 14). When raising foot towards the shin is referred to as dorsiflexion while pushing it down away, from the shin is known as flexion. These movements exert forces on the syndesmosis ligaments, which can lead to complete tears. Dorsiflexion can also cause compression forces on the syndesmosis, potentially resulting in fractures involving tibia or fibular spurs. Likewise, plantarflexion can exert distraction forces on syndesmosis, potentially leading to avulsion or fractures involving fibular tubercles.

Classification

There are many categories of syndesmosis injury available, but they are all categorized by different factors which may include the way they occur, their severity, stability, the extent of displacement, or any associated fractures. However, there isn't an agreed-upon or validated classification system for syndesmosis injuries. Some of the employed classification systems include.

Lauge-Hansen classification: This classification system provides a way by which the category of the ankle fracture can be determined. It consists of four categories: supination adduction (SA), supination rotation (SER), pronation abduction (PA) and pronation external rotation (PER) (15). Each category has four stages that indicate the involvement of parts: the medial malleolus, lateral malleolus, posterior malleolus, and syndesmosis. Syndesmosis injuries typically occur in stage 4 of SER and PER fractures as in stages 2 and 4 of PA fractures.

Weber classification: This classification system for ankle fractures utilizes analysis to categorize them based on the multiple position of the fracture which has connection to the syndesmosis. here are three categories; category A, category B and category C. Injuries related to syndesmosis are commonly associated with category C fractures whereas category B fractures can also result in injuries (16).

AO/OTA classification: This classification system provides a way to categorize fractures based on their location, shape, and the extent of displacement (17). There are three categories; Group A, which includes

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fractures outside of the joint Group B, for fractures within the joint and Group C, for fractures fully located within the joint. Each group is then divided into three subcategories that classify the patterns: Subcategory 1, for fractures Subcategory 2 for wedge shaped fractures and Subcategory 3, for fractures. In each subgroup there are three indicators that show the extent of displacement: Indicator A, for displacement Indicator B for displacement and Indicator C, for displacement. Syndesmosis injury primarily occurs in Group C fractures in C3 fractures. However, it can also occur in some Group B fractures, like B2 and B3.

Clinical manifestation

Disruption or weakening of syndesmosis can result in instability or misalignment of the ankle joint. Instability refers to the joint losing its motion and function because the ligaments are unable to maintain its stability and alignment. Misalignment on the other hand, refers to the position or orientation of the joint caused by bone displacement or angulation relative to each other (18) (19). The degree and direction of instability and misalignment can vary depending on the severity and mechanism of injury. The common forms of instability and misalignment include Diastasis which occurs when there is a separation or gap between the tibia and fibula at their joint, causing displacement of the fibula away from the tibia. Diastasis can be measured by determining the distance between the border of the fibula and the lateral border of the tibia at dome level on anteroposterior radiographs. In adults, a normal value is than 6 mm, while in children it is, then 4 mm (20). Rotation refers to the repositioning of the fibula in relation to the tibia caused by either internal rotation around its long axis. To measure rotation, we look at the angle between the fibula's axis and a line that is perpendicular to the plafond on lateral radiographs. Typically, a normal value falls between 5 to 10 degrees. Translation, on the other hand, relates to alternation of the actual position of the fibula which would correspond to the tibia due to anterior or posterior displacement along its long axis. To measure translation, we determine the distance between the border of the fibula and that of the tibia at the level of the dome on lateral radiographs. A normal value should be 2 mm. Angulation refers to the alteration in the positioning of the fibula in relation to the tibia caused by either downward displacement along its short axis. To measure angulation, one can determine There are mainly presence of angles between the axis of the fibula and a line parallel to the plafond on lateral radiographs. Typically, a normal range for angulation falls within 0-5 degrees. The syndesmosis's instability and misalignment can negatively impact how the ankle functions and moves. It can result in pain, swelling, reduced stability, and limited mobility of the ankle joint. The misalignment can cause unevenness and imbalance in the ankle mortise leading to pressure and stress on the surfaces where the tibia, fibula, and talus meet. This can lead to damage to cartilage lesions in bone and cartilage, arthritis, or improper healing after injury.

Management

This study delves into the management of syndesmosis injuries, a critical consideration for healthcare providers. Successful management relies on conducting an assessment of the patient's health status considering their preferences and expectations. This must be coupled with a judicious review of existing evidence and clinical guidelines. Broadly, the management options for syndesmosis injuries encompass no-operative and operative approaches.

Non-operative Treatment

Non-surgical treatment is mainly used for stable or slightly displaced syndesmosis injuries that don't affect the function or mechanics of the ankle joint. This approach involves two parts; immobilization and limiting weight bearing, followed by rehabilitation (21, 22). Immobilization helps protect the injured structures and promote healing. There are methods, like casting using a boot or wearing a brace, to restrict motion in the ankle joint. At the time, limiting weight bearing with crutches, walkers, or canes aims to reduce strain on the affected limb. The duration and level of immobilization and weight-bearing restriction depend on factors like how severe and long-lasting

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the injury's well as patient-reported pain, swelling, and stability. Typically, immobilization lasts around 4 6 weeks while maintaining restrictions on weight bearing for 6-12 weeks. After that, progressive rehabilitation focuses on restoring ankle function and mechanics by prospering the limb's range of movement, strength, endurance, balance, and coordination. Rehabilitation includes exercises, manual therapy techniques, and various therapeutic devices tailored to each individual's needs under the supervision of therapists or orthopedists. It usually begins after removing immobilization and gradually reduces weight-bearing restrictions. This phase may last from 3-6 months until the patient fully recovers or reaches their desired level of satisfaction. Non-surgical treatment can lead to results, although patient experiences may vary. The success depends on factors such as diagnosis, consistent care, patient cooperation with prescribed protocols, and the possibility of complications, like stiffness, muscle wasting, limited mobility, infection, blood clotting issues or reflex sympathetic dystrophy. Therefore, it is crucial to select and monitor patients during surgical management of syndesmosis injuries.

Operative Treatment

Surgical treatment is only recommended for syndesmosis injuries that are unstable or cause disruption to ankle joint function and biomechanics. In some cases, the main focus is fixing the syndesmosis using screws, suture buttons, or other devices, followed by rehabilitation. The objective of fixation is to restore the alignment and stability of the tibiofibular joint. The choice of fixation device depends on factors like surgeon preference, the type and severity of the injury presence of fractures or soft tissue injuries well, as evidence-based guidelines. Common fixation options include screws that create a connection between the fibula and tibia, suture buttons that provide fixation, and various other devices like plates, staples, rods, nails, or anchors with different designs and mechanisms. The surgical procedure for fixation involves anesthesia administration, patient positioning for surgery incision making, reduction of the joint to its position, and placement of the chosen device in position within the wound area, followed by closure. This approach requires expertise in surgery from surgeons. After surgery, immobilization is necessary based on factors to management but also taking into consideration the choice and stability of the chosen fixation device. Typically, immobilization lasts for 4 to 6 weeks, while weight-bearing restrictions may persist for 6 to 12 weeks. Progressive rehabilitation, similar to its counterpart, aims to restore ankle function and biomechanics through a personalized program overseen by physical therapists or orthopedists. This phase occurs after the removal of immobilization and the gradual reduction of weight-bearing restrictions, typically lasting between 3 and 6 months. The ultimate goal is to achieve recovery or patient satisfaction. Surgical intervention has shown outcomes in treating syndesmosis injuries. Fixation devices have their own benefits and drawbacks. While screws provide stability, they can lead to stress concentration and hardware irritation. It may require removal. On the other hand, suture buttons offer fixation, with fewer hardware complications and the potential to avoid removal. However, there might be some difficulties in obtaining them and inserting them properly.

Conclusion

The treatment of syndesmosis injuries requires an assessment of patient factors and following evidence-based guidelines. Both non-surgical and surgical methods have their advantages and also would be chosen based on the conditions of the injury and the patient's requirements. Regardless of the chosen method, it is vital to monitor and provide rehabilitation to ensure the possible outcomes for patients with syndesmosis injuries.

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Conflict of interest

There is no conflict of interest.

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Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

References

1. Medina McKeon JM, Hoch MC. The Ankle-Joint Complex: A Kinesiologic Approach to Lateral Ankle Sprains. J Athl Train. 2019;54(6):589-602.

2. Hermans JJ, Beumer A, de Jong TA, Kleinrensink GJ. Anatomy of the distal tibiofibular syndesmosis in adults: a pictorial essay with a multimodality approach. J Anat. 2010;217(6):633-45.

3. Hunt KJ. Syndesmosis injuries. Curr Rev Musculoskelet Med. 2013;6(4):304-12.

4. McKeon KE, Wright RW, Johnson JE, McCormick JJ, Klein SE. Vascular anatomy of the tibiofibular syndesmosis. J Bone Joint Surg Am. 2012;94(10):931-8.

5. See A, Bear RR, Owens BD. Anatomic mapping for surgical reconstruction of the proximal tibiofibular ligaments. Orthopedics. 2013;36(1):e58-63.

6. Yuen CP, Lui TH. Distal Tibiofibular Syndesmosis: Anatomy, Biomechanics, Injury and Management. Open Orthop J. 2017;11:670-7.

7. Brockett CL, Chapman GJ. Biomechanics of the ankle. Orthop Trauma. 2016;30(3):232-8.

8. Michael JM, Golshani A, Gargac S, Goswami T. Biomechanics of the ankle joint and clinical outcomes of total ankle replacement. J Mech Behav Biomed Mater. 2008;1(4):276-94.

9. Del Buono A, Florio A, Boccanera MS, Maffulli N. Syndesmosis injuries of the ankle. Curr Rev Musculoskelet Med. 2013;6(4):313-9.

10. Khambete P, Harlow E, Ina J, Miskovsky S. Biomechanics of the Distal Tibiofibular Syndesmosis: A Systematic Review of Cadaveric Studies. Foot Ankle Orthop. 2021;6(2):24730114211012701.

11. Mei-Dan O, Carmont M, Laver L, Nyska M, Kammar H, Mann G, et al. Standardization of the functional syndesmosis widening by dynamic U.S examination. BMC Sports Sci Med Rehabil. 2013;5:9.

12. Mait AR, Forman JL, Nie B, Donlon JP, Mane A, Forghani AR, et al. Propagation of Syndesmotic Injuries During Forced External Rotation in Flexed Cadaveric Ankles. Orthop J Sports Med. 2018;6(6):2325967118781333.

13. Dubin JC, Comeau D, McClelland RI, Dubin RA, Ferrel E. Lateral and syndesmotic ankle sprain injuries: a narrative literature review. J Chiropr Med. 2011;10(3):204-19.

14. DiStefano LJ, Padua DA, Brown CN, Guskiewicz KM. Lower extremity kinematics and ground reaction forces after prophylactic lace-up ankle bracing. J Athl Train. 2008;43(3):234-41.

15. Tartaglione JP, Rosenbaum AJ, Abousayed M, DiPreta JA. Classifications in Brief: Lauge-Hansen Classification of Ankle Fractures. Clin Orthop Relat Res. 2015;473(10):3323-8.

16. Han SM, Wu TH, Wen JX, Wang Y, Cao L, Wu WJ, et al. Radiographic analysis of adult ankle fractures using combined Danis-Weber and Lauge-Hansen classification systems. Sci Rep. 2020;10(1):7655.

17. Cornelius CP, Audigé L, Kunz C, Rudderman R, Buitrago-Téllez CH, Frodel J, et al. The Comprehensive AOCMF Classification System: Mandible Fractures- Level 2 Tutorial. Craniomaxillofac Trauma Reconstr. 2014;7(Suppl 1):S015-30.

18. Porter DA, Jaggers RR, Barnes AF, Rund AM. Optimal management of ankle syndesmosis injuries. Open Access J Sports Med. 2014;5:173-82.

19. Corte-Real N, Caetano J. Ankle and syndesmosis instability: consensus and controversies. EFORT Open Rev. 2021;6(6):420-31.

http://dx.doi.org/10.52533/JOHS.2023.31102

20. Corvino A, Rosa D, Sbordone C, Nunziata A, Corvino F, Varelli C, et al. Diastasis of rectus abdominis muscles: patterns of anatomical variation as demonstrated by ultrasound. Pol J Radiol. 2019;84:e542-e8.

21. Williams GN, Allen EJ. Rehabilitation of syndesmotic (high) ankle sprains. Sports Health. 2010;2(6):460-70.

22. Schnetzke M, Vetter SY, Beisemann N, Swartman B, Grützner PA, Franke J. Management of syndesmotic injuries: What is the evidence? World J Orthop. 2016;7(11):718-25.

http://dx.doi.org/10.52533/JOHS.2023.31102