Syndesmotic Ankle Sprain

Sharon G. Childs

Ankle sprain injuries are the most common type of joint sprain. The prevalence of ankle joint sprains accounts for 21% of joint injuries in the body. Although somewhat rare, high-ankle or syndesmotic ankle sprains occur in up to 15% of ankle trauma. This article will present the pathomechanics of the high-ankle or syndesmotic sprain.

Introduction

Ankle sprains are the most common sprain sustained in athletics (Fong, Hong, Chan, Yung, & Chan, 2007) and witnessed as the everyday inversion injury in man (Mack, 1982). A lateral ankle complex sprain (inversion injury) incorporates the stretching and tearing, in varying degrees, of the lateral complex of ligaments. Medial ankle sprain involves the deltoid complex and occurs with less frequency. High ankle sprains or sprains of the tibiofibular syndesmotic structures are not as common as the lateral and medial ankle sprain. The syndesmosis is a joint in which two bony surfaces are cojoined by a ligamentous membrane. The ligamentous fibers are flexible and stretch permitting a limited amount of ankle movement. The incidence of ankle sprain may account for 1 injury in 10,000 people per day (Frey, 2004).

Epidemiology

Foot and ankle injuries are common in athletics. Differentiating gender-specific injury among sport-related injuries came more prominently to the forefront after Title IX to the Education Amendments Act of 1972 (Mitchell, 1995). Studies have compared female anatomical structures to physiologic reaction and pathomechanics related to gender-specific injuries. Ankle injury has been the most identified injury in male and female athletes in the many studies performed since the late 1980s to approximately 1994 (Arendt, 1994; Garrick & Requa, 1988). Syndesmotic sprains account for approximately 11% of ankle injuries in athletic injuries (Molinari, Stolley, & Amendola, 2009; Mulligan, 2011; Williams & Allen, 2010).

According to several research studies, syndesmotic and medial ankle sprain occurs 3 times more frequently in male competitive athletes than in female athletes. This is believed to be secondary to the aggressive nature of male athletes, the sports they play, as well as males' increased body mass index (Harding, 2011; Hermans, Beumer, de Jong, & Kleinrensink, 2010; Lin, Gross, & Weinhold, 2006; Waterman et al., 2011).

Anatomy of the Ankle Joint

Lateral Ankle

The lateral ligamentous complex of the ankle is made up of several separate ligaments: the anterior inferior tibiofibular ligament, the anterior talofibular ligament (ATF), posterior talofibular ligament, and the calcaneofibular ligament. The ATF is the most frequently sprained ligament in the ankle that occurs after an inversion injury. The anterior inferior talofibular ligament (AITF) ligament is flat and tough extending from the longitudinal tubercle of the anterior aspect of the lateral malleolus to the anterolateral tubercle of the tibia. It offers about 30%–35% restraint for ankle stability; it travels inferiorly in a medial to lateral direction.

The posterior talofibular ligament incorporates both deep and superficial fibers. The superficial fibers extend from the posterior tubercle of the tibia to the posterior lateral malleolus. The deep component of the posterior inferior tibiofibular ligament is referred to as the transverse tibiofibular ligament. It is stronger and thicker than the AITF and provides approximately 40% stability and strength to the ankle joint (see Figures 1 and 2).

Medial Ankle

The medial soft tissue complex about the ankle is composed of the thick supportive superficial and deep deltoid ligaments. The deltoid is the strongest of the ligaments. It has a broad triangular shape and is defined by bony insertions onto the navicular, talus, and calcaneus as it fans from the medial malleolus. The deltoid ligaments inhibit abduction of the ankle. Because of the symbiotic mechanics, the relationship between the talus, ankle mortise, the deltoid ligaments, and the medial malleolus, a strong and dominant magnitude of biomechanical reaction forces exists. The soft tissue structures that are culpable for maintaining articular stability between the distal fibula, the tibia, and the ankle joint are the syndesmotic ligaments.

The Syndesmosis

The syndesmosis is a joint in which two bony surfaces are coalesced by a ligament or membrane. The ligamentous

Sharon G. Childs, MS, ANP, Adult Nurse Practitioner; 13 White Spruce Court, Baltimore, MD.

The author has disclosed that he has no financial interests to any commercial company related to this educational activity.

DOI: 10.1097/NOR.0b013e318257a974

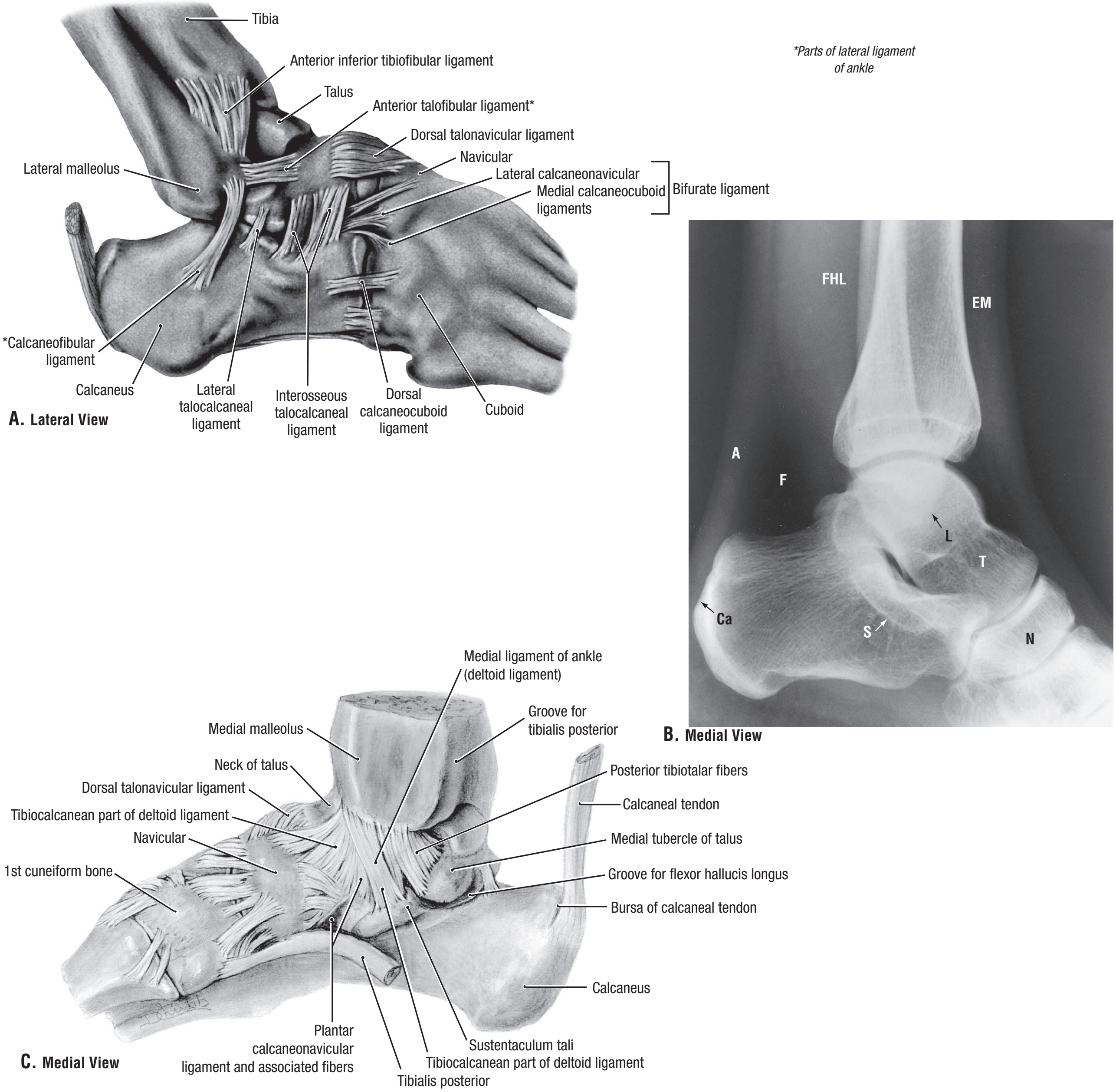
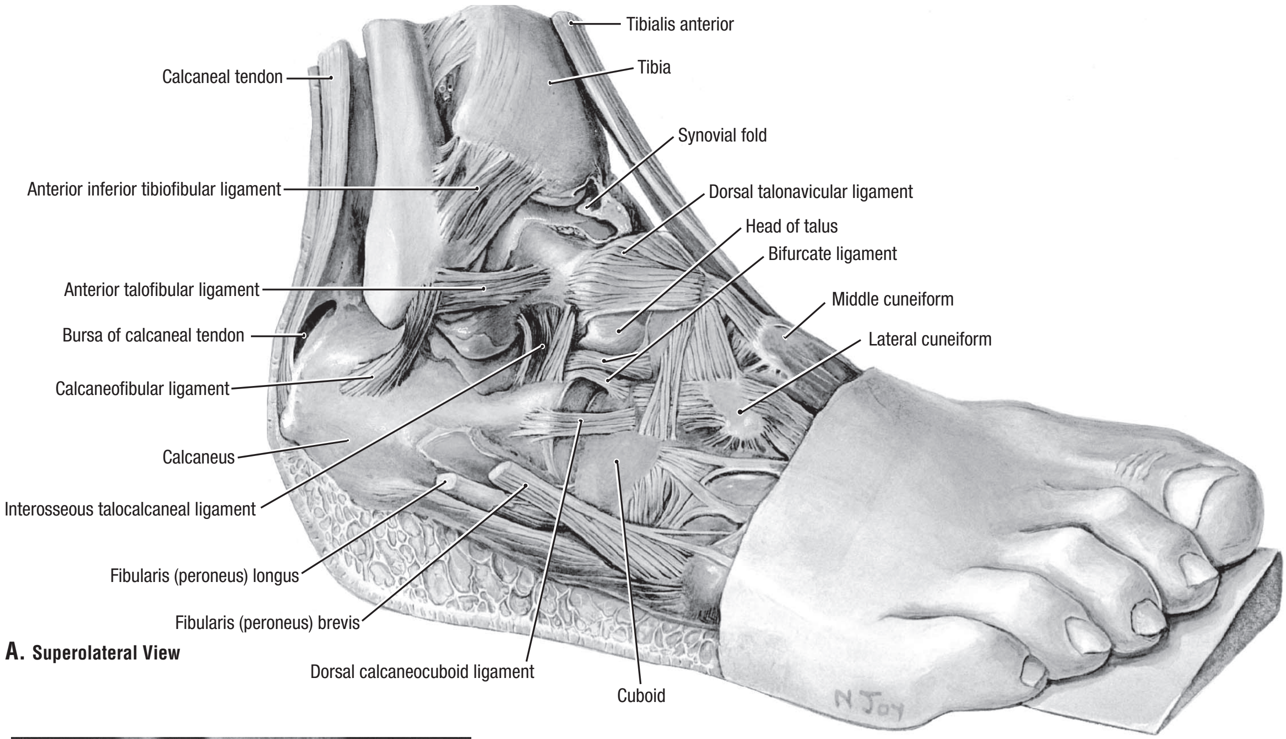


FIGURE 1. Ligaments of the ankle. (A) Lateral ligaments. The ankle is plantar flexed; thus, part of the body of the talus is exposed, and the foot is inverted. (B) Lateral radiograph. (C) Medial ligaments. The tibialis posterior is displaced from its "bed" of medial malleolus, deltoid ligament, and plantar calcaneonavicular (spring) ligament. The deltoid ligament is attached superiorly to the medial malleolus of the tibia and inferiorly to the talus, navicular, and calcaneus. From *Grant's Anatomy* (11th ed., p. 435) by A. M. Agur and A. F. Dalley, 2005, Philadelphia, PA: Lippincott Williams & Wilkins. Used with permission.

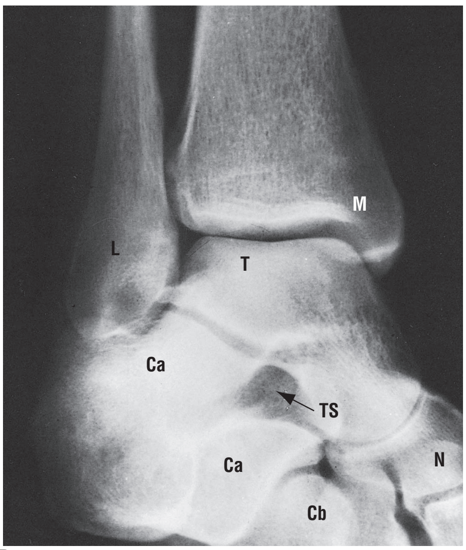
fibers are flexible and stretch permitting a limited amount of movement between structures. Examples of a syndesmosis are the ligamentous membrane in the upper extremity between the radius and ulna, and in the lower extremity (LE) cojoining the fibula and tibia.

In the LE, the syndesmotic ligamentous complex binds the fibula and tibia together and inhibits posterolateral arcuation or bowing of the fibula that may occur with severe axial loading or inaccurate foot planting during an athletic maneuver. A high ankle or syndesmotic sprain is ensconced above the ankle joint.

The syndesmosis plays an important role in stability of the talocural joint (ankle joint). The syndesmotic ligaments consist of the anterior inferior tibiofibular ligament, the distal posterior tibiofibular ligament, the interosseous ligament, and the interosseous membrane (see Figures 3 and 4). The syndesmotic structures inhibit and resist rotational and translational biomechanical forces. The interosseous ligaments and membrane assist with maintaining the conformation of the ankle mortise (Veenema, 2000). These dense ligaments support the anatomical relationship between the distal



A. **Superolateral View**



B. **Lateral View**

FIGURE 2. Ankle and foot. A. Dorsum of foot. The foot has been inverted to demonstrate articular surfaces and tightened ligaments. The exposed articular surfaces include the posterior talar facet of the calcaneus, the anterior surface of the calcaneus, and the head of the talus, all of which are palpable. Because inversion of the foot is commonly associated with plantar flexion of the ankle joint, the superior and lateral articular surfaces of the body of the talus are also commonly exposed. B. Lateral radiograph of ankle. Ca = calcaneus; Cb = cuboid; L = lateral malleolus; M = medial malleolus; N = navicular; T = talus; TS = tarsal sinus. From *Grant's Anatomy* (11th ed., p. 444) by A. M. Agur and A. F. Dalley, 2005, Philadelphia, PA: Lippincott Williams & Wilkins. Used with permission.

fibula and the distal tibia, thus contributing to the stability of the ankle joint. The interosseous ligament is relatively thickened at the distal interosseous membrane. The ligament functions as a spring-like mechanism between the distal lateral and medial malleoli during the action of ankle dorsiflexion. The syndesmosis spreads to accommodate the trapezoidal talus 3- to 4-mm larger anteriorly and then posteriorly during dorsiflexion. The interosseous ligament provides approximately 25% stability for the ankle and LE bones.

Pathomechanics of Syndesmotic Injury

Trauma to the ankle syndesmosis may result from excessive external rotation of the ankle that is adduction

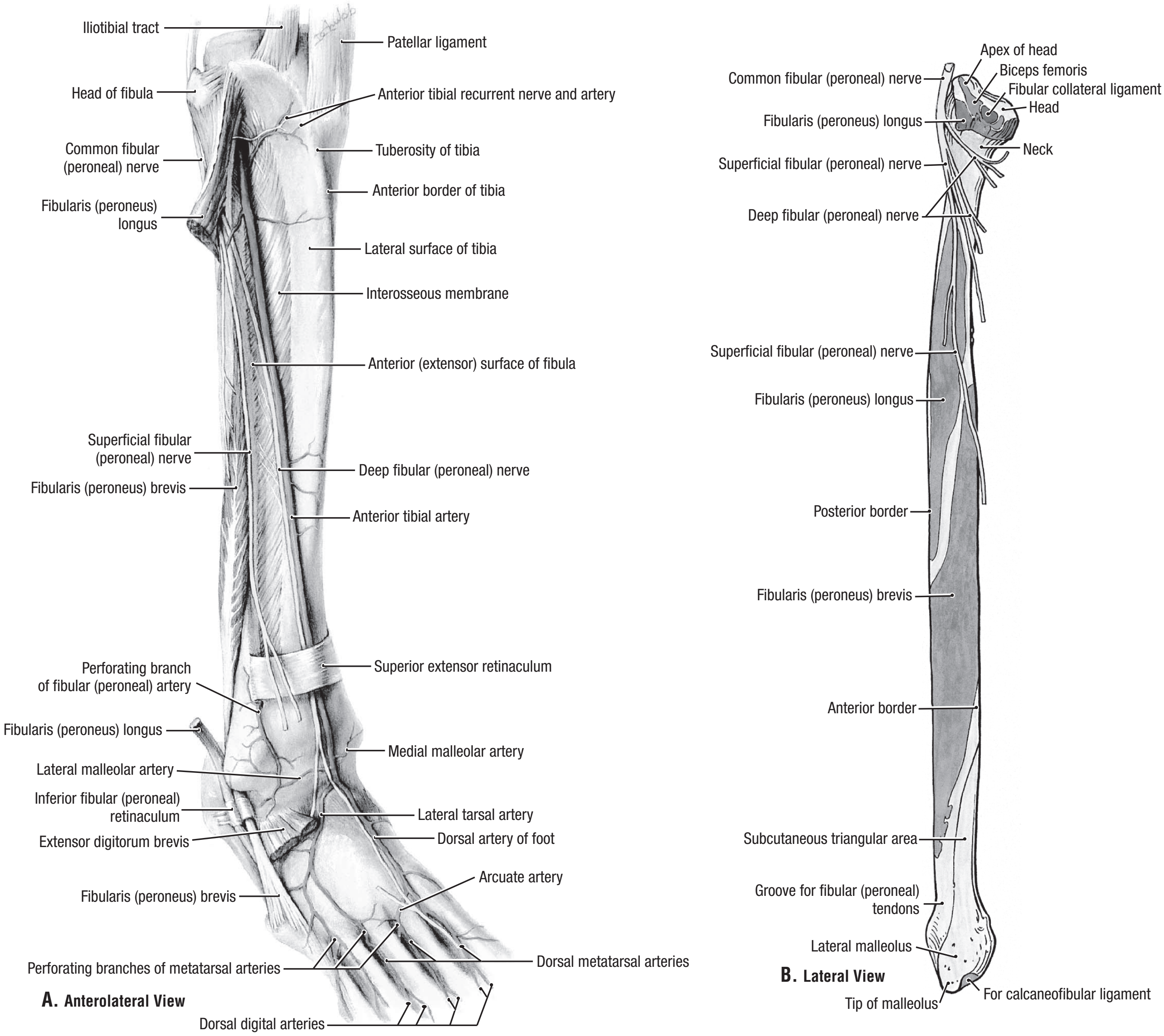


FIGURE 3. Arteries and nerves of anterior and lateral aspects of leg and dorsum of foot. (A) Dissection, anterolateral view. The anterior crural muscles (muscles of the anterior compartment) were removed, and the fibularis (peroneus) longus muscle was excised. The common fibular (peroneal) nerve is exposed. It lies in contact with the posterior aspect of the head of the fibula, and its branches are applied directly to the neck and body of the fibula deep to the fibularis (peroneus) longus muscle. The anterior tibial artery enters the anterior compartment in contact with the medial side of the neck of the fibula. The superficial fibular (peroneal) nerve follows the anterior border of the fibularis brevis muscle, which guides it to the surface to become cutaneous. (B) Muscle attachments on the lateral aspect of the fibula. The relations of the common fibular nerve and branches are illustrated. The lateral surface of the fibula spirals slightly; thus, the proximal end is directed more laterally. The distal end is grooved and faces posteriorly, allowing the lateral malleolus to act as a pulley for the long and short fibularis (peroneal) tendons. Part A also demonstrates the interroseous membrane that extends from proximal to the distal lower extremity. From *Grant's Anatomy* (11th ed., p. 407) by A. M. Agur and A. F. Dalley, 2005, Philadelphia, PA: Lippincott Williams & Wilkins. Used with permission.

or abduction of the foot, end-range extremes of dorsiflexion, or admixtures of dorsiflexion in association with adduction or abduction of the foot and ankle.

The two most common pathomechanics of syndesmotic ankle sprain are external foot rotation and hyperdorsiflexion of the ankle joint. These maneuvers create widening of the ankle mortise causing disruption of the syndesmosis with secondary talar instability (Norkus & Floyd, 2001). During the act of dynamic powerful forces to the forefoot, the talus rotates laterally (tearing the ATFL) and propels the fibula externally away from the tibia. Shearing and twisting torque mechanisms may be transferred axially up the extremity, causing tearing of the entire interosseous membrane (Bennett, 2011).

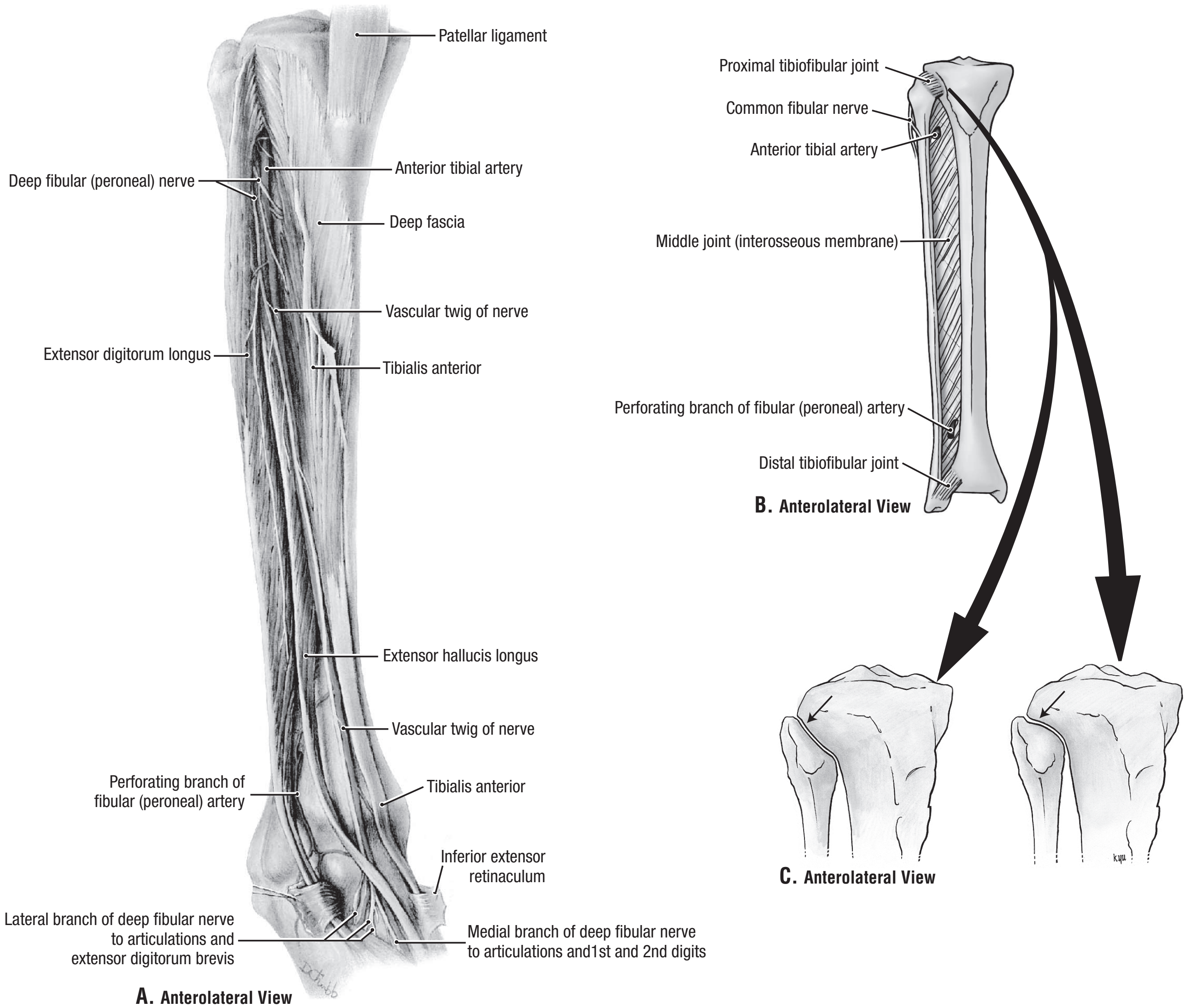


FIGURE 4. Anterior leg—deep and tibiofibular joints. (A) Deep dissection of the anterior compartment of the leg. The muscles are separated to display the anterior tibial artery and deep fibular nerve. (B) Superior and inferior tibiofibular joints and interosseous membrane. (C) Superior tibiofibular joint. Oblique form of joint surfaces is depicted on the left and the horizontal form on the right. The proximal tibiofibular joint (arrows) has important functions in the dissipation of torsional stress applied at the ankle and in the dissipation of lateral bending movement of the tibia. Generally, the greater the angle of inclination, the smaller the surface area of the joint. Rotation at this joint occurs during dorsiflexion of the ankle. From *Grant's Anatomy* (11th ed., p. 406) by A. M. Agur and A. F. Dalley, 2005, Philadelphia, PA: Lippincott Williams & Wilkins. Used with permission.

Severe hyperdorsiflexion that occurs when the foot is planted and the body falls or is pushed forward drives excessive forces that sprain or rupture the anterior and posterior tibiofibular ligaments (Silvestri, Uhl, Madaleno, Johnson, & Blackport, 2002). In association with syndesmotic sprain, the degree of ankle ligamentous sprain can result in the distal tibia and fibula spreading excessively apart. This is referred to as diastasis. The tibiofibular clear space is approximately 5 mm (Wolfe, Uhl, Mattacola, & McCluskey, 2001). Widening of the ankle mortise by 1 mm decreases the contact area of the tibiotalar joint by 42% causing significant ankle instability (Hermans et al., 2010). See Box 1 for factors influencing the development of syndesmotic injury. Grades 1 and 2 syndesmotic sprain may be self-limiting or occur in conjunction with fracture and destabilization of the mortise (Veenema, 2000) (see Figure 5). In Types 1 and 2 injuries, the patient is symptomatic for ankle sprain, yet findings from plain x-ray films may be read as negative. In Type 2, diastasis of the syndesmosis is seen on plain films (Evans & Schucany, 2006). Type 3 ankle traumas show significant diastasis on plain x-ray film; the patient generally presents with concomitant fibular fracture and an unstable ankle (Kirchner, Musgrave, & Musgrave, 2005). Significantly severe syndesmotic diastasis occurs in conjunction with proximal and distal fibular fracture (Kirchner et al., 2005; see Figure 6).

Box 1. Risk Factors for Developing Sports-Related Syndesmotic Ankle Sprain

- Sex—increased incidence in male athletes (3× more than in females)
- Intercollegiate and professional athletes (competitiveness, aggressiveness)
- Body mass index
- Collision sports—football, ice hockey, soccer, rugby
- The deconditioned "weekend athlete"
- Improper muscle conditioning, stretching, strength training
- Poor proprioception for sport and in the older athlete
- Aggressive sports, for example, football, ice hockey; sports that require frequent jumping and axial loading—basketball, gymnastics
- Wearing inappropriate or improper footwear for sport
- Biomechanical forces that create higher tensile strength in tissues about the ankle

Ankle Fracture and Syndesmotic Disruption

High-impact sports creating significant pathomechanical forces may cause fracture at the site of injury as well as extending proximally fracturing the fibular head (see Figure 6). This is referred to as a Maisonneuve fracture. Maisonneuve fractures, fractures of the proximal one-third of the fibula, present with extensive rupture of the interosseous membrane (Wilson, 1984). The more proximal the fracture is in the fibula, one can expect significantly severe trauma to the tibiofibular ligaments. This type of fracture usually occurs in three fracture patterns: (1) distal one-third of the fibula, (2) long oblique, and (3) short oblique and transverse oblique (Wilson, 1984). Distal fibular fracture (avulsion fracture) occurs in 50% of inversion sprains (Bennett, 2011). Syndesmotic rupture is seen in 50% of Weber type B and C fractures (Hermans et al., 2010). The most common fracture in syndesmotic injury is seen in the distal third of the fibula (see Figure 7), yet the fracture level is dependent upon the gradation of disruption of the syndesmosis. This usually involves rupture of the interior inferior tibiofibular ligament and a rupture of the interosseous membrane. Osteochondral fracture of the talus, distal fibula, and proximal fibula is another fracture pattern seen in severe torquing sports mechanisms (football, ice hockey, slalom skiing; Linz, Conti, & Stone, 2001). The lateral-view x-ray film provides the most discerning judgment for demonstrating the level of syndesmotic disruption (Wilson, 1984). These types of fractures are unstable and usually require open reduction internal fixation stabilization of the ankle (Lin et al., 2006).

Athletics and Syndesmotic Sprain

Sports played on uneven or artificial turf with cleated sports shoes can create or increase the likelihood of dorsiflexion and adduction of the foot and ankle (Brosky, Nyland, Nitz, & Caborn, 1995). High-impact and high-collision sports and sports that have jump landing maneuvers such as football, soccer, basketball, and rugby are known to cause outward twisting and torque, thereby increasing the incidence of syndesmotic ankle sprain. Table 1 shows particular sports trauma associated with mechanism of injury. Although there is a plethora of sports medicine–related research, there still exists a low level of evidence of literature regarding the assessment, diagnosis, and treatment of syndesmotic ankle sprain (Amendola, Williams, & Foster, 2006; Williams, Jones, & Amendola, 2007).

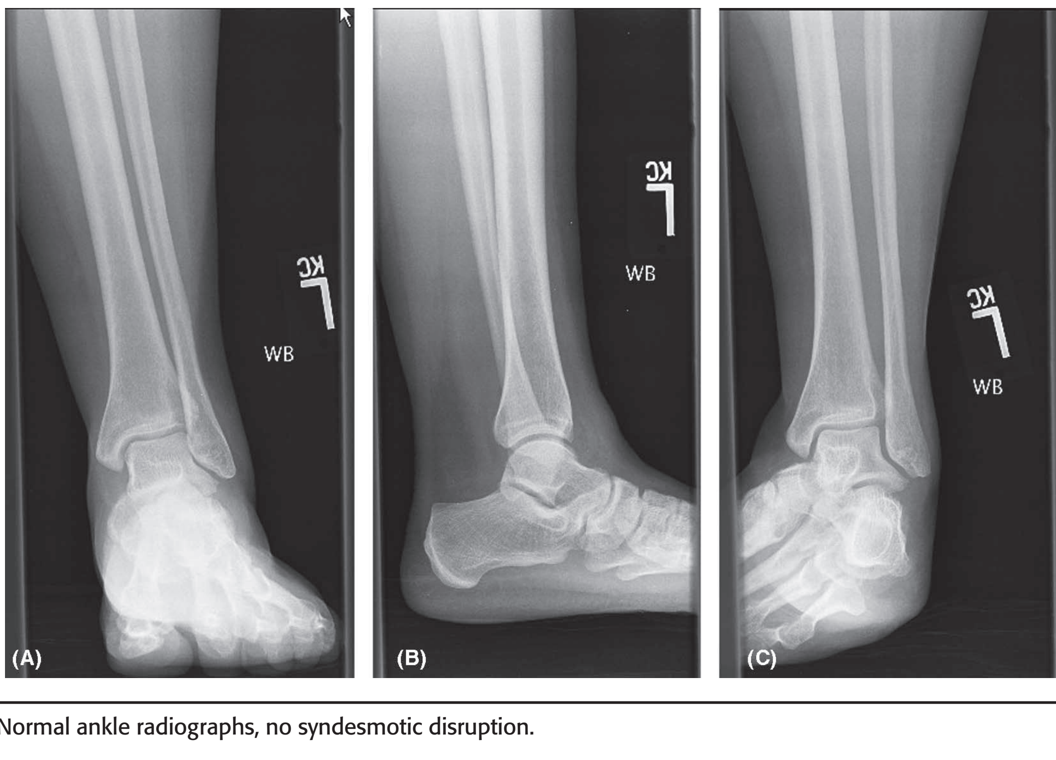


Figure 5. Normal ankle radiographs, no syndesmotic disruption.

FIGURE 6. Syndesmotic diastasis associated with proximal and distal fibular fracture. Views A, B, and C of the X-rays demonstrate syndesmotic disruption, fibular fracture, severe ankle dislocation, and rupture of the Deltoid ligament complex. View D shows post-operative ORIF (open reduction internal fixation) X-ray of the ankle following stabilization for severe ankle fracture dislocation.

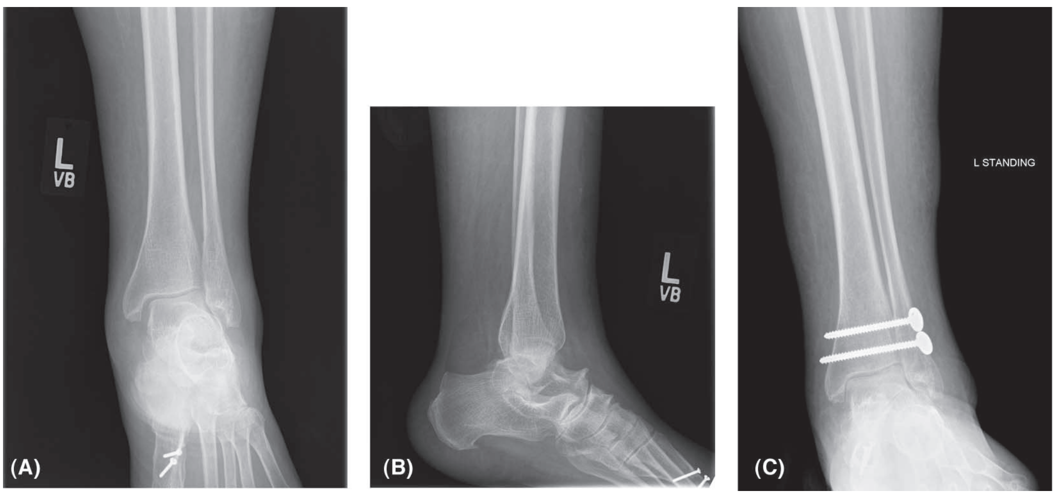


FIGURE 7. Preoperative X-rays (views A, B) of AP/Lateral of the ankle depicting Maisonneuve fracture. Note diastasis of the tibio-fibular clear space to be >5mm. View C shows a postoperative X-ray of ORIF after stabilization of syndesmotic disruption and Maisonneuve fracture. Also note previous ORIF of great toe. X-rays courtesy of Johnny Lin, MD, Midwest Orthopaedics at Rush Chicago, IL. Used with permission.

TABLE 1. SPORTS INJURIES AND ASSOCIATED MECHANISMS OF INJURY

Sport	Mechanism of Injury	End Result
High-contact sports, for example, football, slalom skiing, rugby, ice hockey, soccer, men's team handball, basketball, gymnastics	Collision sports, axial loading—jump landing onto foot/ankle External rotation of the foot, hyperdorsiflexion of foot/ankle; foot planted—external forces being driven to lateral aspect of femur or lower extremity High body mass index, plantar flexion, inversion injury; external rotation pronation of foot yielding deltoid complex and lateral complex trauma	Pain, mortise widening, ankle instability; diastasis, concomitant fracture of proximal and distal fibula; avulsion fracture; combined injury to lower extremity

Summary

Syndesmotic ankle sprain runs the gamut from mild to severe ankle instability, limitation in normal biomechanical movements, gait/ambulation, and pain. Delay in diagnosis and management of syndesmotic sprain will cause a protracted and difficult course of healing and increase the morbidity for the athlete.

References

Agur, A. M., & Dalley, A. F. (2005). *Grant's anatomy* (11th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Amendola, A., Williams, G. N., & Foster, D. (2006). Evidence-based approach to treatment of acute traumatic syndesmosis (high ankle) sprains. *Sports Medicine and Arthroscopy*, *14*(4), 232–236.

Arendt, E. A. (1994). Orthopedic issues for active and athletic women. *Clinics in Sports Medicine*, *13*, 483–503.

Bennett, J. M. (2011). *High ankle sprain (syndesmotic sprain)*. Retrieved March 27, 2011, from http://www.sportsmed.com/articles/id/40.aspx

Brosky, T., Nyland, J., Nitz, A., & Caborn, D. N. (1995). The ankle ligaments: Consideration of syndesmotic injury and implications for rehabilitation. *Journal of Orthopaedics and Sports Physical Therapy*, *21*(4), 197–205.

Evans, J. M., & Schucany, W. G. (2006). Radiological evaluation of a high ankle sprain. *Proceedings of Baylor University Medical Center*, *19*, 402–405.

Frey, C. (2004). Persistent pain and instability following ankle sprain: Honing in on the diagnosis. *Journal of Musculoskeletal Medicine*, *2*(8), 435–443.

Fong, D. T., Hong, Y., Chan, L. K., Yung, P. S., & Chan, K. M. (2007). A systematic review of ankle injury and ankle sprain in sports. *Sports Medicine*, *37*(1), 73–94.

Garrick, J. G., & Requa, R. K. (1988). The epidemiology of foot and ankle injuries in sports. *Clinics in Sports Medicine*, *7*, 29–36.

Harding, A. (2011). *Ankle sprains hit male athletes hardest*. Retrieved March 27, 2011, from, http://www.nlm.nih.gov/medlineplus/news/fullstory_108827.html

Hermans, J. J., Beumer, A., de Jong, T. A., & Kleinrensink, G. T. (2010). Anatomy of the distal tibiofibular syndesmosis in adults: A pictorial essay with a multimodality approach. *Journal of Anatomy*, *217*(6), 633–645.

Kirchner, J. S., Musgrave, A. L., & Musgrave, D. S. (2005). Managing chronic pain after ankle sprain. *Journal of Musculoskeletal Medicine*, *22*(8), 407–416.

Leland, R. H., & Mast, J. W. (2001). Ankle fractures and dislocations including pylon fractures. In M. Chapman (Ed.), *Chapman's orthopaedic surgery* (3rd ed., Vol. 3, pp. 811–845). Philadelphia, PA: Lippincott Williams & Wilkins.

Lin, C. F., Gross, M. L., & Weinhold, P. (2006). Ankle syndesmosis injuries: Anatomy, biomechanics, mechanisms of injury, and clinical guidelines for diagnosis and intervention. *Journal of Orthopaedics and Sports Physical Therapy*, *36*(6), 372–384.

Linz, J. C., Conti, S. F., & Stone, D. A. (2001). Foot and ankle injuries. In F. Fu & D. Stone (Eds.), *Sports injuries: Mechanisms, prevention, and treatment* (2nd ed., pp. 1135–1163). Philadelphia, PA: Lippincott Williams & Wilkins.

Mack, R. P. (1982). Ankle injuries in athletes. *Clinical Sports Medicine*, *1*, 71–84.

Marder, R. A. (2001). Ankle ligament injuries. In M. Chapman (Ed.), *Chapman's orthopaedic surgery* (3rd ed., Vol. 3, pp. 2473–2483). Philadelphia, PA: Lippincott Williams & Wilkins.

Mitchell, L. A. (1995). Foot and ankle injuries in the female athlete. In P. E. Baxter (Ed.), *The foot and ankle in sports* (pp. 337–345). St. Louis, MO: Mosby Yearbook.

Molinari, A., Stolley, M., & Amendola, A. (2009). High ankle sprains (syndesmotic) in athletes: Diagnostic challenges and review of the literature. *Iowa Orthopaedics Journal*, *29*, 130–138.

Mulligan, E. P. (2011). Evaluation and management of ankle syndesmotic injuries. *Physical Therapy in Sports*, *12*, 57–69.

Norkus, S. A., & Floyd, R. T. (2001). The anatomy and mechanisms of syndesmotic ankle sprains. *Journal of Athletic Training*, *36*(1), 68–73.

Silvestri, P. G., Uhl, T. L., Madaleno, J. A., Johnson, D. L., & Blackport, R. M. (2002). Management of syndesmotic ankle sprains. *Athletic Therapy Today*, *7*(5), 2–3.

Veenema, K. R. (2000). Ankle sprain: Primary care evaluation and rehabilitation. *Journal of Musculoskeletal Medicine*, *17*(9), 563–576.

Waterman, B. R., Belmont, P. J., Cameron, K. L., Svoboda, S. J., Alitz, C. J., & Owens, B. D. (2011). Risk factors for syndesmotic and medial ankle sprain: Role of sex, sport, and level of competition. *American Journal of Sports Medicine*. Retrieved July 13, 2011, from http://ajs.sagepub.com/content/39/5/992.abstract

Williams, G. N., & Allen, E. J. (2010). Rehabilitation of syndesmotic (High) ankle sprains. *Sports Health: A Multidisciplinary Approach*, *2*, 460.

Williams, G. N., Jones, M. H., & Amendola, A. (2007). Syndesmotic ankle sprains in athletes. *American Journal of Sports Medicine*, *35*(7), 1197–1207.

Wilson, F. C. (1984). Fractures and dislocations of the ankle. In C. Rockwood & D. Green (Eds.), *Fractures in adults* (2nd ed., Vol. 2, pp. 1665–1701). Philadelphia, PA: Lippincott.

Wolfe, M. W., Uhl, T. L., Mattacola, C. G., & McCluskey, L. C. (2001). *Management of ankle sprains*. Retrieved July 13, 2011, from http://www.aafp.org/afp/2001/0101/p93.html

