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ANKLE

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Abstract
Purpose Injury to the syndesmosis and deltoid ligament is less common than lateral ligament trauma but can lead to significant time away from sport and prolonged rehabilitation. This literature review will discuss both syndesmotic and deltoid ligament injuries without fracture in the professional athlete.
Methods A narrative review was performed using PUBMED, OVID, MEDLINE and EMBASE using the key words syndesmosis, injury, deltoid, ankle ligaments, and athlete. Articles related to the topic were included and reviewed.
Results The incidence of syndesmotic injury ranges from 1 to 18 % of ankle sprains. This may be underreported and is an often missed injury as clinical examination is generally not specific. Both MRI and ultrasonography have high sensitivities and specificities in diagnosing injury. Arthroscopy may confirm the diagnosis, and associated intra-articular pathology can be treated at the same time as surgical stabilization. Significant deltoid ligament injury in isolation is rare, there is usually associated trauma. Major disruption of both deep and superficial parts can lead to ankle dysfunction. Repair of the ligament following ankle fracture is not necessary, but there is little literature to guide the management of deltoid ruptures in isolation or in association with syndesmotic and lateral ligament injuries in the professional athlete.
Conclusion Management of syndesmotic injury is determined by the grade and associated injury around the ankle. Grade I injuries are treated non-surgically in a boot with a period of non-weight bearing. Treatment of Grade II and III injuries is controversial with little literature to guide management. Athletes may return to training and play sooner if the syndesmosis is surgically stabilized. For deltoid ligament injury, grade I and II sprains should be treated non-operatively. Unstable grade III injuries with associated injury to the lateral ligaments or the syndesmosis may benefit from operative repair.
Level of evidence IV.

Keywords Syndesmosis · Deltoid ligament · Ankle · Athlete · Treatment

Introduction

Consensus on the diagnosis and treatment of syndesmotic injuries is difficult as high-level evidence is lacking. This review will look at isolated syndesmotic injuries without fracture, a more common injury in the athletic population.

The ankle is one of the most frequently injured joints in sporting activities [12]. The majority are inversion mechanisms with a sprain or disruption of the lateral ligament complex [19, 77]. Syndesmotic injuries can be associated with prolonged pain, disability and an unpredictable time away from sport; frustrating for the treating physician and the patient [41]. Gerber et al. [29] demonstrated that syndesmosis

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involvement was the most predictive factor of chronic ankle dysfunction at 6 months post-injury, and Wright et al. [82] showed that patients take twice as long to return to sports compared to isolated lateral ligament sprains.

These injuries may occur in isolation or in association with other ligamentous, bony or cartilaginous injuries around the ankle [41]. Missed and chronically unstable injuries may to lead to osteoarthritis [79].

The incidence ranges from 1 to 18 % of ankle sprains [41, 42]. It is likely that this is an underestimate as they may frequently be missed or under treated. Fallat et al. [26] prospectively studied 639 ankle sprains and found an incidence of 5 %, diagnosed by clinical examination alone. In contrast, Boytim et al. [11] found an incidence of 18 % using clinical examination and plain radiographs. Certain high-impact sports such as, skiing, ice hockey and soccer have higher incidences [27, 59, 82]. Nussbaum et al. [56] identified 60 collegiate athletes with syndesmotic injuries over a three-year period in a single institution indicating a higher incidence, and Waterman et al. [78] had an incidence of 6.7 % in their prospective study of an athletic population.

These studies lack consistency in diagnosing the injury. The criteria differ between papers, and few use MRI or other imaging other than plain radiographs. This makes it difficult to interpret the data and identify a true incidence. The increased awareness and importance of early diagnosis of these injuries and the more widespread use of MRI may lead to an increase in the incidence.

Anatomy

The distal fibula fits in the notch between the anterior and posterior tibial tubercles which provide some bony stability [17]. The syndesmosis complex comprises the anterior inferior tibiofibular ligament (AITFL), the interosseous ligament (IOL), the posterior inferior tibiofibular ligament (PITFL) and the transverse tibiofibular ligament (TTL) which merges with the posterior capsule of the ankle joint [83]. Although it is an extremely stable articulation there is some movement between the two bones during ambulation. Breumer et al. [7] showed, in an intact syndesmosis, that with an external rotation force of 7.5 Nm, the fibula rotates 2°–5° externally and translates 1–3 mm posteriorly. This force simulates the stance phase of gait. The AITFL is the primary restraint to fibular external rotation, and the PITFL restrains posterior translation. The interosseous ligament merges with the interosseous membrane proximally and provides resistance to lateral translation of the fibula [14, 17]. The deep part of the deltoid ligament contributes to mortise stability by limiting external rotation and lateral translation of the talus [83].

Mechanism of injury

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 [27, 83]. As the talus rotates in the mortise, the fibula rotates externally, moves posteriorly and laterally, sequentially tearing the anterior inferior tibiofibular ligament (AITFL), the deep deltoid complex or causing a malleolar fracture, the interosseous ligament (IOL) and finally the posterior inferior tibiofibular ligament (PITFL) [5, 83]. Combined deltoid and syndesmosis injury critically disrupts talar stability [84].

Other mechanisms are possible. Hopkinson et al. [41] in a retrospective review of 15 syndesmotic injuries found 3 hyperdorsiflexion and 3 inversion mechanisms. Another accepted mechanism is a combination of inversion and external rotation [46]. The occurrence of lateral ligament injury with an associated syndesmotic injury suggests this combined mechanism is more common than originally thought. A study by Uys and Rijke [75] using MRI and stress radiography demonstrated an inverted correlation of lateral ligament injury with distal tibiofibular ligament disruption, suggesting different mechanisms for the two injuries. An external rotation mechanism is associated with higher grades of syndesmotic injury. Inversion tends to injure only the AITFL part of the syndesmosis together with the ATFL (lateral ligaments). Another radiological study [52] contradicted this, diagnosing 9 syndesmotic injuries in 20 inversion mechanisms with a high association of lateral ligament disruptions.

History

A history of the event from the patient and the mechanism of injury are important but are noted to be unreliable in some studies [1, 52]. There is no research relating report of injury mechanism to the diagnosis of a syndesmotic injury. The symptoms of inability to weight bear, pain during the push off phase of gait, pain in the anterolateral part of the ankle, swelling and a feeling of giving way may be suggestive of an injury [41] yet none of these symptoms are specific for the syndesmosis and are common after other ankle injuries. The presence of 'high ankle pain', proximally up the anterolateral leg, is suggestive of a more significant injury [56].

Examination

There are a number of special tests for a syndesmotic injury. Nussbaum et al. [56], in a prospective study, showed that local tenderness and the length of tenderness from the ankle were shown to correlate with injury severity and time to return to sports. A positive squeeze test was also predictive of a prolonged return to sports [56]. Local tenderness is not specific in the acute setting. Van Dijk et al. [77] showed that 40 % of supination ankle injuries with anterior talofibular (ATFL) disruption had pain in the area of the AITFL but at arthroscopy had no injury to the ligament. Other tests are the external rotation test [11], the fibular translation test [8], the Cotton test [20] and the cross over leg test [44]. Pain located to the anterolateral region of the ankle on passive dorsiflexion suggests a syndesmotic injury but is not specific. A stabilization [81] test, where the tibia and fibula are tightly bound together with tape, has been described. The patient is asked to stand, toe raise, perform a knee-to-wall test and jump to see whether the pain is reduced after taping indicating that the distal syndesmosis has been stabilized.

The reliability of these special tests has been studied. Alonso et al. [1] looked at the external rotation test, the squeeze test and the dorsiflexion test by pairing physical therapists and examining 53 injured ankles. Their research found high agreement among examiners (kappa value of 0.75) with the external rotation test only. In this study, none of the ankle injuries had been investigated prior the study with imaging or arthroscopy, and none was actually known with a proven syndesmotic injury beyond what was obtained from the history and clinical examination. Beumer et al. [4] assessed the ability of 7 examiners to detect syndesmotic injuries using the fibular translation, Cotton, squeeze and the external rotation tests. Three patients with a history and mechanism suggesting a syndesmotic injury together with 9 normal ankles (12 ankles total) of volunteers were examined. The three injured ankles had an arthroscopy the following day, of which two had a confirmed syndesmotic injury. The external rotation test had the lowest inter-observer error and the highest sensitivity. There was a statistically significant correlation of all the tests with confirmed syndesmotic injuries. The injury was missed in 25 % of examinations though. A serious bias to this study is that the examiners were told by the investigators that some ankles had syndesmotic injuries, and this presumably led them to look specifically for this injury. Although an attempt has been made to assess the accuracy of the clinical tests, there are problems with each of these studies.

In a cadaver study, [15] following sectioning of all the ligaments of the syndesmosis, the mean increases in movement of the fibula under stress were 8.8 and 1.5 mm in the sagittal and coronal planes, respectively. This would be detectable clinically, but this is not the usual injury in the athlete. The majority are less severe, with injury to the AITFL and IOL only. Following isolated section of the AITFL, translation of the fibula under stress increased by only 0.5 mm in the coronal and sagittal planes which are clinically undetectable distances. The ability to detect less severe injuries to the syndesmosis clinically may be difficult.

Ceser de Cesar and Muller [16] compared MRI-confirmed syndesmotic injuries with the external rotation and squeeze tests in 56 lateral ankle sprains. The incidence of associated syndesmotic injury was 17.8 %. Sensitivity and specificity of the squeeze test was 30 and 93.5 %, respectively and that of the external rotation test 20 and 84.5 %. This suggests that many tests miss an injury, but if positive, there most likely is an injury. In this study, as with that of Uys and Rijke [75], the severity of lateral ankle sprain did not correlate with syndesmotic injury. These clinical tests are important, and they might raise suspicion of an injury leading to further investigation.

Imaging

Standard weight-bearing AP/Lateral and mortise radiography may reveal a fracture or diastasis. A tibiofibular clear space of greater than 6 mm 1 cm above the plafond is suggestive of an injury [34], and avulsion fractures of the distal tibia may be detected. Medial clear space between the medial malleolus and talus is an important indicator of both syndesmotic and deltoid disruption [16]. The ability to accurately detect less severe injury on plane films is questionable. It is not possible to consistently place every ankle in the exact position for radiography to view the syndesmosis and the relationship of the tibia with the fibula [7]. Neilsen et al. [55] demonstrated the poor correlation of measured tibiofibular clear space, and MRI-confirmed syndesmotic injury. The use of stress views is controversial. They are considered useful with a Telos^{TM} device in latent diastasis but have a high false-negative rate in the acute setting with less severe injuries [61]. Beumer et al. [6], using radiography and radiosteriography found it impossible to detect slight increases in external rotation of the fibula on stress radiographs that occurred following sectioning of the AITFL and IOL, nullifying the use of stress views.

Computerized tomography (CT) scanning is useful for detecting small avulsion fractures and is more accurate than radiographs in showing the relationship of the distal tibia and fibula [24, 28]. Measurement of the contra lateral side is important, and a displacement difference of 2 mm or more is considered pathological. This investigation is non-weight bearing though and will not detect any dynamic instability of the syndesmosis.

MRI effectively displays the structures of the syndesmosis, and a high degree of inter-observer agreement in identifying disruptions has been shown [54]. Takao et al. [68] demonstrated 93 % specificity and 100 % sensitivity for AITFL injuries and 100 % sensitivity and specificity for PITFL tears comparing MRI with ligaments visualized at arthroscopy. In this study, the MRI examiners were blinded both to the patient's clinical status and the arthroscopy result. Of the 52 ankles in their cohort, 33 had malleolar fractures. This indicates a high level of energy transferred through these ankles and may not be directly comparable to the lower grades of syndesmotic injuries seen in many sporting injuries. More subtle injuries may have different sensitivities and specificities.

Ultrasound scanning may be a cheaper and quicker investigation. Mei Dan et al. [48], in a controlled study, demonstrated increases in the tibiofibular clear space during stress ultrasonography of patients with MRI-confirmed AITFL injuries. Sensitivities and specificities were as good as MRI. Ultrasonography unfortunately does not have the ability to detect associated injuries such as osteochondral lesions and bone bruising.

Arthroscopy is a useful diagnostic and therapeutic tool. Instability and the presence of AITFL and PITFL injuries can be identified and confirmed [58]. Brown et al. [14] identified a high incidence of associated injuries including a 28 % incidence of osteochondral lesions in syndesmotic injuries. These lesions can be addressed at the time of surgery and accurate reduction confirmed on visualizing the syndesmosis [48].

Management

A displaced, widened mortise warrants operative fixation across the syndesmosis. There is no controversy with this group, but many sporting injuries have a normal mortise on radiographs and stress views despite significant surrounding soft tissue disruption that may lead to dynamic instability. No level I or II studies are available to aid decision making in the management of this group. The variable time lost from sport indicates the heterogeneous nature of the injury and problems with its current management [42].

Edwards and Delee [25] classified syndesmotic injuries without fractures on radiographs. This probably has little relevance today as other diagnostic tools such as MRI, arthroscopy and ultrasound are used. Gerber et al. [29] provided the West Point Ankle grading system (I-III) based on clinical examination. Grade I is a mild sprain/tear to the AITFL with no instability and Grade III definite instability with complete disruption of all the ligaments. Grade II is vague, with slight instability and tear of the AITFL and partial tear of the IOL. The therapeutic consequences of grade II are not clear, and without an MRI and/or arthroscopy, it may be impossible to discriminate between grade I and II, leaving us with unclear treatment algorithms. According to biomechanical studies [8, 30], a diastasis of 2 mm or more compared to the contralateral side indicates instability of two or more ligaments and is classified as Grade III. As mentioned before, this subtle diastasis may be difficult to detect clinically and radiologically.

Non-operative management of stable injuries has shown good results [29]. Nassbaum et al. [56] treated 60 suspected ‘high ankle sprains’ detected clinically with an aggressive rehabilitation programme entailing a short period of immobilization (1–4 days) in a boot, non-weight bearing followed by an aggressive rehabilitation schedule. The average time of sport was 13.4 weeks. 53 Of the 60 ankles were objectively scored as good or excellent. MRI or arthroscopy was not performed in this study though, meaning that some in the cohort may have had minor lateral ligament sprains which can clinically simulate syndesmotic injuries, which have been shown to recover much faster [82]. The clinical outcomes are poorer if there is associated heterotopic calcification or residual diastasis [2]. Return to play for professional sports people is critical. Kennedy et al. [43] compared Grade 3 syndesmotic injuries treated surgically with conservative treatment in a cast. There was little long-term difference in symptoms and athletic performance, but return to play was on average 3 weeks quicker in the surgical group. Wolf and Amendola [81] advocated a surgical approach for Grade II injuries and proposed the use of arthroscopy. In a retrospective view of his series, associated injuries were found in 9 of 14 syndesmotic injuries, and these were addressed arthroscopically prior to stabilization of the syndesmosis with a percutaneous screw.

When there is no evidence of instability on plain radiographs or stress testing but MRI/Ultrasound examination suggests a higher grade injury with possible dynamic instability, an arthroscopy may assess this and quantify the nature of the injury. Arthroscopy has proven to be more accurate than radiological detection of syndesmotic injury, and any dynamic instability may be addressed at the same time as the diagnostic arthroscopy [57].

Surgical technique

Operative stabilization of acute injuries includes screw fixation, dynamic fixation with a suture button or direct repair of the AITFL with or without suture anchors. Numerous biomechanical and clinical studies with varying levels of evidence have looked at the optimal size and number of screws for fixation [3, 33, 40]. There appears to be no difference in using quadricortical or tricortical screws clinically, but biomechanically, two tricortical 3.5-mm screws are more stable than one screw and are recommended in heavier individuals or with highly unstable injuries. The position of the ankle during tightening of the screw was traditionally taught to be in dorsiflexion, but Tornetta et al. [73] found no difference in range of ankle motion following screw tightening in plantarflexion or dorsiflexion in a cadaver model. No clinical studies have confirmed this but the current recommendation is to tighten the screw with the ankle in neutral dorsiflexion. Avoiding the lag effect of the screw is important to not overtighten the syndesmosis. The evidence for syndesmotic screw fixation is difficult to draw conclusions from due to inconsistencies and predominantly cadaver-based biomechanical studies, not level 1 or 2 clinical studies. Van den Bekerom et al. [76] summarized the available literature regarding syndesmotic screw placement and recommended: during tightening, the ankle should be in the neutral position. 3.5-mm screws are adequate but 4.5-mm screws may be used in larger fibulas or larger patients. Two tricortical screws provide secure fixation but are less secure than quadracortical screws. Quadracortical screws are more likely to break due to the rigid fixation and should definitely be removed prior to weight bearing. The optimal time for removal is not known, but 6–8 weeks allows time for the ligaments to heal in the correct position.

Studies looking at accuracy of reduction are concerning. Gardener [28] found an incidence of 54 % malreduction and remaining diastasis in 24 % of ankle fractures with associated syndesmotic injuries. This may not be the case in syndesmotic injuries without fracture, but this is not known and requires further investigation. Accuracy of reduction has been shown to correlate with poorer outcome and the development of post-traumatic arthritis [14].

Concerning hardware, in a prospective controlled clinical trial, bioabsorbable screws had clinical results and complication rates equal to metal screws with the advantage of not having to be removed [71]. Foreign body reaction and granuloma formation is a concern and reported in the literature [10]. Screw removal is controversial. Schepers [63] reviewed the literature, finding 7 studies comparing screw removal with screw retention. There was one randomized control trial (RCT) and one quasi RCT. The rest were retrospective cohorts. Little evidence to support screw removal was found. Hamid et al. [32] showed that screws that had broken or showed surrounding lysis had better ankle scores suggesting that regaining micro-movement at the syndesmosis is advantageous. Most surgeons today still elect to remove the screw/s, but the timing of screw removal is variable [69].

Dynamic stabilization with the suture button technique (TightRope, Arthrex Inc, Naples, FL, USA) has the advantage of not requiring removal and allowing near normal micro-motion at the distal tibiofibular joint. First implanted by Seitz et al. [65], it has become useful and effective in stabilizing the syndesmosis. Biomechanical studies [66, 72] have shown that the technique has slightly inferior stability compared to screw fixation but allows some advantageous motion. Teramato et al. [70] showed that two suture buttons were significantly more stable than one but was still less stable than screw fixation. The most stable suture button construct was the anatomical fixation in isolated AITFL injuries [72]. Biomechanical cadaver studies apply various forces to the fixed syndesmosis, but it is not known whether they approximate the forces transmitted during ambulation or the forces that might occur clinically during sporting activities. Ultimately, clinical trials are necessary to determine such outcomes.

Coetzee and Eberling [18] published their preliminary results of a prospective randomized trial comparing screw fixation to suture button, showing encouraging medium term results for suture button fixation. Ankle scores were higher in the suture button technique, although this did not reach statistical significance, and there was greater early range of ankle motion. Other case series' and retrospective reviews have shown good results and maintenance of reduction [22]. Although the technique is supposed to eliminate the need for removal, there are several reports of infection, skin irritation and granuloma formation warranting removal [80]. In a recent study of 19 injuries requiring TightRope (Arthrex Inc, Naples, FL, USA) fixation, 22 % required removal for wound problems or knot prominence [74]. Despite the higher than anticipated complication rate requiring removal of the suture button, it is done so through a small wound with few complications. Although reported, [39] post-removal fracture is rare and possibly less likely than following screw removal. Return to play following TightRope (Arthrex Inc, Naples, FL, USA) removal may commence shortly after the wound has healed where as with screws, contact and extreme force should be avoided for some time after screw removal to avoid fracture.

Further prospective studies are needed to confirm the long-term clinical outcomes of suture button fixation.

Recommendations

A thorough history and physical examination is mandatory. Television footage in professional athletes may show the mechanism and raise suspicion of a syndesmotic injury. Preferred imaging includes standard 3 view radiographs—weight bearing if tolerated and MRI if clinically indicated. CT scanning is helpful if avulsion fractures are suspected or seen on radiographs or MRI.

For grade I sprains with no instability and partial disruption of the AITFL, management entails immediate rest, ice and immobilization in a cast or non-weight-bearing boot for 5–7 days to allow the acute inflammation and swelling to subside. Partial weight-bearing commences at 7–14 days post-injury as tolerated and active assisted physiotherapy concentrating on range of motion and light proprioception exercises are instituted. From day 14–21: full weight bearing as tolerated, strength training and proprioception is emphasized. Functional exercises—toe standing, light running, is commenced initially, increasing to toe—toe running and single leg hopping. A sign of a healing syndesmosis is the ability to repeatedly single leg hop. Return to sporting activity is permitted when able to single leg hop for 30 s without significant pain. This is usually at 6–8 weeks post-injury but is variable.

Grade II injuries are varied, and decision making can be difficult. The recreational sportsperson without diastasis can be treated non-operatively as discussed above with good results. Prolonged time to return to sports is expected, and patients must be told this. For the professional athlete with a grade II injury and clinical suspicion of dynamic instability, we recommend an examination under anaesthesia (E.U.A) and arthroscopy with assessment of the syndesmosis. Dynamic diastasis of 2 mm or more warrants fixation. Post-operative CT scanning is indicated in some cases where an accurate reduction is a concern.

Grade III injuries are uncommon in the athlete and often associated with other injuries around the ankle. An arthroscopy prior to fixation can identify intra-articular pathology and address these if present. If the syndesmosis is grossly unstable, two screw fixation or two TightRopes (Arthrex Inc, Naples, FL, USA) will stabilize the ankle. Injures of the deltoid and/or lateral ligaments may have to be repaired if unstable.

Post-operatively, the ankle is treated in a non-weight-bearing splint for 10 days to 2 weeks allowing wound healing and resolution of inflammation. Range of motion is regained first with early proprioception training and partial weight bearing at 3–4 weeks post-op. Full weight bearing is commenced at 4 weeks as tolerated and strength training continued. Return to running and high-impact activity is commenced after 8 weeks as dictated by rehabilitation progress and resolution of pain.

Conclusion

Syndesmosis injuries are complex and may lead to significant time lost from sport and disability. Accurate diagnosis and appropriate treatment is essential as repeated stress to the injured syndesmosis and late diagnosis delays recovery and adversely affects outcome [57]. Obvious diastasis needs reduction and operative fixation, but treatment of less severe injuries is controversial with little evidence to guide our management protocols. Non-operative treatment may have good results, but it entails a lengthy rehabilitation period. In the professional athlete, more aggressive surgical treatment is warranted. Arthroscopy may aid accurate diagnosis, and if there is dynamic instability, then early operative stabilization may improve the time to return to sport. Further study is needed to determine optimal diagnostic and therapeutic guidelines.

Deltoid ligament injuries

The majority of the literature on deltoid ligament injury is associated with lateral malleolar and fibular fractures. There is little evidence available to guide the management of deltoid injuries without fracture.

Strömsöe et al. [67], in a randomized, controlled prospective study, showed no difference in outcome of sutured deltoid ligaments compared to non-sutured ligaments in displaced ankle fractures provided the talus is reducible in the mortise. Other studies support non-surgical treatment [23, 47] with low incidences of medial instability and good return to function. The presence of a fracture delays return to weight bearing and rehabilitation. This may allow the deltoid to heal in the correct position. For the athlete with a pure soft tissue injury, return to participation is important, and early stress through a completely disrupted ligament may lead to healing in stretched position, contribute to instability of associated injuries, delay rehabilitation and possibly result in long-term medial instability [38].

Isolated injury to the deltoid ligament is uncommon. Broström [13] noted an incidence of medial ankle pain suspecting deltoid injury in just 3 of 281 ankle sprains. The majority involve associated injury to the syndesmosis, lateral ligament complex, fracture of the medial or lateral malleoli and high fibula [35]. In this section, we will discuss deltoid injury without a fracture.

Anatomy and biomechanics

The deltoid ligament has a superficial and a deep layer. The superficial layer is more vertical and fan shaped, consisting of the tibiospring, tibionavicular, tibiocalcaneal and the superficial posterior tibiotalar ligaments [51]. This layer is not consistent, and anatomical variations are common. The deep layer is more horizontal consisting of the deep posterior tibiotalar, intermediate tibiotalar and the deep anterior tibiotalar ligaments. Essentially, the superficial ligaments cross two joints and the deep layer just the ankle joint [35]. Biomechanically, the deltoid limits talar abduction, pronation and external rotation [17]. Grath [31] in a cadaver model showed that with the lateral structures removed, talar shift was limited to less than 2 mm but increased to 4 mm with section of the deep deltoid, indicating the important stabilizing effect of the ligament.

The cadaver study by Rasmussen et al. [62] revealed that the many parts of the deltoid aid stability throughout ankle range of motion. Abduction is limited by the superficial tibiocalcaneal ligament; plantarflexion is limited by the anterior deep tibiotalar ligament; external rotation by the anterior and intermediate deep tibiotalar ligaments and dorsiflexion by the deep posterior tibiotalar ligament. When the entire deep deltoid and the lateral anterior talofibular ligaments (ATFL) are sectioned, both internal and external rotations are increased, and if the syndesmosis is sectioned too, the talus dislocates freely on external rotation [62].

Mechanism and clinical presentation

Pronation and eversion, external rotation, supination and external rotation or abduction may lead to medial injury or fracture [46]. Isolated deltoid injury usually involves the superficial part, is rotationally stable, and has a good prognosis. Complete disruption of both the deep and superficial parts is almost always associated with other injuries to the ankle or fibula [50]. Pain, swelling and haematoma formation over the medial malleolus may be present immediately, but instability is difficult to assess in the acute setting. Delayed examination using the lateral talar tilt test, anterior drawer test in external rotation and the gravity stress test can be helpful, but the specificities of these tests are not known [49]. Stress radiographs and MUA are not routine but can be useful if there is another indication for surgery.

Examination of the syndesmosis, the lateral malleolus, anterolateral ankle and entire fibula is important to exclude a lateral injury and/or high fibula fracture. Tibialis posterior, flexor hallucis longus and the saphenous nerve can be injured and must be examined. Hinterman et al. [37] identified an incidence of associated lateral ligament instability in 40 % of patients treated surgically for chronic medial instability, and Crim et al. [21] had a 72 % incidence of deltoid ligament injury identified on MRI in their series of surgically treated chronic lateral ligament injuries. Although these studies only include chronic injuries and the real incidence in the acute setting may be lower, it still highlights the importance of assessing the lateral and medial ligaments together as this may be a more common association than originally thought.

Imaging

Radiographic series should include AP, mortise and lateral views, the sensitivity and specificity of which are 57 and 60 %, respectively [36]. Ultrasound has greater diagnostic ability with a 100 % sensitivity and specificity in this study [36]. Other views should be guided by the clinical examination, such as high fibular pain. According to biomechanical and cadaver studies, widening of the medial joint space and talar shift greater than 2 mm indicates both a deltoid injury and injury to either the lateral ligaments, syndesmosis or fibula [62]. Isolated injuries may appear normal on radiographs, stressing the importance of the clinical examination. MRI has a high sensitivity and specificity for confirmation of injury to both the superficial and deep deltoid [45, 53] and is useful for the acutely injured ligament. The syndesmosis and osteochondral surface may also be visualized. CT scan is indicated in cases with an associated fracture or avulsion and when bony anatomy is unclear on radiographs or MRI.

Management

There is agreement that isolated superficial deltoid injury with no instability may be treated non-operatively with a short period of immobilization and a rehabilitation programme similar to that used for lateral ligament injures.

There is controversy regarding the management of complete injuries of both the deep and superficial deltoid. These are almost always associated with other injuries that may require surgical intervention. Proponents of non-surgical treatment base their decision on studies of deltoid ligament injuries associated with lateral malleolar ankle fractures which have shown good results and lower complication rates with fibular stabilization and non-operative treatment of the medial side [9, 47].

Little literature is available for the athlete regarding return to sport and training following deltoid repair or lack thereof, without a fracture. Lateral ligament, syndesmosis or osteochondral lesions are the most commonly associated injuries and may need surgery themselves. In-folding of the ruptured deltoid is a common cause of persistent increased medial clear space and malreduction [60]. If identified, the deltoid must be explored, and the talus accurately reduced and the ligament repaired [64]. Gardener [28] had a malreduction incidence of 52 % in his series and failure to address the infolded deltoid may have contributed to this high incidence. Exploration of the deltoid was not mentioned in this study. The anterior and intermediate deep deltoid ligaments primarily limit external rotation and are consistently injured in high-grade syndesmotic injuries due to the mechanism. Failure to correct the externally rotated talus prior to syndesmotic fixation may lead to malreduction.

Recommendations

A careful examination of the ankle, foot and lower limb to identify associated injuries should be performed. MRI scanning is useful and helps detect soft tissue and chondral pathology not found at examination. Isolated superficial or partial injuries may be treated in a boot, non-weight bearing for 5–7 days with rehabilitation commenced as tolerated. Return to full weight bearing and light training after 6–8 weeks is expected [27]. If there is an associated injury requiring surgery, we perform EUA and obtain intraoperative stress views. If unstable, the deltoid should be repaired at the time of surgery.

For complete deep and superficial deltoid ligament injury, we advocate arthroscopy to identify and treat osteochondral pathology, if present. The syndesmosis and lateral ligaments can be evaluated at the same time although the diagnosis of injury to them should be known prior to surgery. Deltoid exploration and repair should be performed prior to the syndesmosis or lateral ligament stabilization. In this way, in-folding is identified, and the medial clear space can be reduced under vision. This enables accurate reduction of the fibula and/or repair of the lateral ligaments.

Conclusion

Deltoid injuries are most often associated with other bony and soft tissue trauma around the ankle. Although the ligament has been shown to heal well if treated non-surgically when associated with lateral ankle fractures, surgical stabilization in complete disruptions without fracture but with associated lateral soft tissue injury may benefit the athlete. There is no high-level evidence to support or refute surgical intervention, but we feel that early stability and repair aids anatomical reduction of the talus and assists early rehabilitation. This should be the focus of future research.

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