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ANKLE

Bone bruises associated with acute ankle ligament injury: do they need treatment?

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Abstract
Purpose The aim of this systematic review is to analyse the current knowledge, incidence, relevance, and need for treatment of bone bruises associated with acute ankle ligament injury.
Methods A search was made of PubMed, OVID/Medline, Cochrane databases using the keyword "bone bruises" in combination with "ankle", "sprain", "management", "surgery", and "conservative treatment".
Results No randomized controlled trials or prospective cohort studies were found. Only case series were retrieved. A critical appraisal for validity and usefulness of the studies revealed that the best level of evidence on this topic is represented by retrospective comparative studies. Nine studies evaluating the management of bone bruises associated with acute ankle ligament injuries were found.
Conclusion The clinical prognosis of bone bruises is generally good, with a normalization of MRI appearance usually within 6–12 months after trauma. Currently, there is no evidence that these lesions need specific treatment. Thus, the management of the concomitant ligament lesions is sufficient. Further research is necessary to successfully address the management of bone bruises, and more evidence is required to decide if these lesions need to be treated at all.
Level of evidence IV.

Keywords Bone bruises · Ankle · Sprain · Management · Surgery · Arthroscopy

Introduction

Ankle ligament injuries are one of the most common problems occurring in athletes of all ages and activity levels [27, 28]. Ligament lesions are known to be associated with bone bruises in the majority of cases [7, 8, 13]. This is not only the case for knee ligament injuries, but also for ankle ligament lesions [14, 15].

The bone tissue involvement associated with ankle sprains includes bone or osteochondral fractures and "bone bruises". A bone bruise is a subchondral osseous contusion, due to intensive and compressive forces acting on the subcortical bone [6, 18]. A bone bruise is characterized at MRI by increased signal intensity on T2-weighted images and decreased signal intensity on T1-weighted images. T2-weighted images allow to determine the acuity of injury, as reflected by free water (i.e. haemorrhage, oedema, and inflammatory response). T1-weighted images show fat content of the bone marrow. Therefore, a decreased signal intensity on T1-weighted images, in association with T2-weighted images, is useful to determine location and morphology of the injury. Short time to inversion recovery (STIR) images can easily detect fat nullification and bone marrow oedema as an area of high signal intensity.

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The onset of bone bruises may be a macrotrama or repeated microtramatic injuries to the ankle joint. The mechanism of ankle injury determines size and features of the bone bruise. Moreover, it is often accompanied by periosteal oedema and swelling [4, 16, 17, 21, 31]. The MRI allows to evaluate the extent of a bone bruise, other than to study the ligamentous structures about the ankle. Clinically, common symptoms associated with bone bruise include intense pain, stiffness, and swelling [1, 2, 11].

Several approaches have been proposed for the management of bone bruises, including a period of non-weightbearing or protected weightbearing or even surgical procedures, such as drilling. The most common management for bone bruises associated with acute ankle ligament injury is conservative over a 4–6 week period [5, 30, 31].

Although some authors evaluated the treatment of bone bruises associated with acute ankle ligament injury, the clinical relevance and the appropriate management of these lesions remain controversial. Thus, the aim of this systematic review is to analyse the current knowledge, incidence, clinical relevance, and need for treatment of bone bruises associated with acute ankle ligament injury.

Materials and methods

Literature search and data extraction

To find all clinical trials addressing treatment of bone bruises associated with acute ankle ligament injury, a comprehensive search of PubMed, OVID/Medline, Cochrane databases using the keyword "bone bruises" in combination with "ankle", "sprain", "management", "surgery", and "conservative treatment" from the 1 January 1966 to the 31 October 2012 was performed. All articles relevant to the subject were retrieved, and their bibliographies hand searched for further references in this context.

The inclusion criteria were the following: studies reporting a higher prevalence of exposure to traumatic events; MRI used as a diagnostic method; and clinical and/or MRI outcomes. Publications in any languages were considered. Reviewers scanned the bibliographies of all retrieved studies and other relevant publications, including reviews and meta-analyses, for additional relevant articles. All potentially eligible studies had to report on patients with bruised ankle and its treatment. Only articles published in peer-reviewed journals were included in this systematic review. Case reports, letter to editors, and abstracts were excluded.

Disagreements were resolved by discussion.

It was planned to use Review Manager (RevMan. Version 5 forWindows) to calculate the magnitude of treatment effect. However, because only case series were retrieved, no pooling of data was performed.

Results

No randomized controlled trials or prospective cohort studies were found. Only case series were retrieved. A critical appraisal for validity and usefulness of the studies revealed that the best level of evidence on this topic is represented by retrospective comparative studies. Nine studies evaluating the management of bone bruises associated with acute ankle ligament injuries were found [2, 4, 9, 10, 19, 21, 24, 30, 31]. Details of the included studies are summarized in Table 1.

Injury rates

Nine studies investigated the accuracy of MRI to detect the presence of ankle's bone bruises. Comparison of the study results showed a significant incidence of bone bruises associated with ankle sprains, ranging from 7.4 % [30] to 40 % [19]. However, some reports included both acute and chronic injuries. Pinar et al. reported ankle's bone bruises in 10 of 60 patients, which means a prevalence of 17 %. These patients were classified into two groups based on timing of diagnosis: in 4 patients, the assessment was performed within 3 weeks of the initial injury (acute); in 6 patients, the assessment was performed 3–6 weeks after the injury (chronic) [21]. In a retrospective study, a variety of changes was evaluated between 3 and 12 weeks after trauma in 43 of 109 bruised ankles (39 %) [9].

Brown et al. [4] reported MRI findings associated with distal tibiofibular syndesmosis injuries, showing that bone bruises are significantly associated with acute syndesmosis injury ($P < 0.0001$). Indeed, they occur in the 78 % of the ankles with acute syndesmosis injury and only in the 11 % of the ankles with chronic syndesmosis injury or without syndesmosis injury.

The overall rate of bone bruises was 28 %.

Injury characteristics

The most commonly injuries sustained in a sprained ankle are the ATFL and CFL injuries, sequentially [2, 4, 9, 19, 21, 30, 31]. Yammine et al. [30] showed that most athletic injuries involve sprains to tendons, ligaments, and bone bruises. In those cases, lesions usually appear in combination with each other, whereas isolated lesion is less common. The peroneal and flexor hallucis longus (FHL) tendons represented the majority of tendon injuries. They reported a rate of 38.8 % of tendon injuries in 21 patients, of which nine (16.6 %) were isolated. Sijbrandij et al. [24]

Table 1 Details of the included studies

Authors	Evidence level	No. of patients	Age (years)	FU	Incidence of bone bruises	Imaging assessment	Type of lesion	Site of lesion	Management	Relevant message
Nishimura et al. [19]	IV, case series	35	21.8	–	14 (40 %): 14 acute	MRI	Ligament injuries in the 14 patients with bone bruise: ATFL (5), ATFL + CFL (9)	Posterolateral talus (2), posteromedial talus and/or medial malleolus (4), anteromedial talus (6), talus (2)	Repair of the ATFL (8); surgical exploration of the CFL (6)	A bone bruise is an indirect sign to predict associated ligamentous injuries as well as to recognize the mechanism of twisting injury of the ankle on MRI
Pinar et al. [21]	IV, case series	60	25	–	10 (17 %): 4 acute (assessment was done within 3 weeks of the initial injury); 6 chronic (assessment was done 3-6 weeks after the injury)	X-ray; MRI	Ligament injuries in the 10 patients with bone bruise: ATFL (5), ATFL + CFL (5)	Medial talus (5), lateral talus (3), anteromedial calcaneus (1), medial talus and navicula (1)	Diagnostic MRI study	Bone bruise may necessitate a different rehabilitation programme. In those patients with large bony injuries and potential occult cartilage damage, a longer period of protected weightbearing may be indicated.
Zanetti et al. [31]	IV, case series	29	32.9	3 months	6 (20 %): 6 acute	MRI	Ligament injuries: ATFL (29), CFL (24), soft tissue swelling (25), effusions in joint (29)	Medial talus (4), lateral talus (1), medial and lateral talus (1)	Immobilization with ankle brace for 6 weeks	CFL lesion and a bone bruise of the talar dome did not significantly influence clinical outcome. No differences between patients with persistent bone bruise (4/6) and those with no bone bruise (2/6)
Alanen et al. [2]	IV, case series	95	28	3 months	26 (27 %): the rate of patients with their first injury was 80 %	MRI	Ligament injuries in the 26 patients with bone bruise: ATFL (26). Bone injuries: talus (1), tibia (3)	Medial talus (9), lateral talus (4), medial and lateral talus (4), neck (2), dome (4), tibia (7)	Diagnostic MRI study	No influence of bone bruise on clinical outcome. The patients could walk normally and were able to partecipate in sport

Table 1 continued

Authors	Evidence level	No. of patients	Age (years)	FU	Incidence of bone bruises	Imaging assessment	Type of lesion	Site of lesion	Management	Relevant message
Labovitz et al. [9]	IV, case series	109	37	–	43 (39 %): the rate of patients within 3 weeks of the initial injury was 44 %; between 4 and 12 weeks was 31 %; after 12 weeks from the injury was 25 %	MRI	Ligament injuries: ATFL (22); ATFL/CFL (27); ATFL/CFL/deltoid (16)	Medial talus (13), lateral talus (9), medial and lateral talus (5), neck (8), malleolar injury (23), calcaneous (4), navicular (2)	Diagnostic MRI study	MRI can be helpful in the evaluation of chronic ankle sprains or ankle pain that is not relieved with regular conservative measures to evaluate for talar dome lesions and other osteochondral or tendon injuries
Sijbrandij et al. [24]	IV, case series	146	30	2 years after the initial injury	Abnormalities of the subchondral bones in 26 (18 %) ankles: fractures (13); contusions (29)	MRI	Bone injuries: talus (23), tibia (19)	In 16 ankles, the subchondral lesions involved the two opposing bones of the talotibial joint (kissing contusions)	Arthroscopy with drilling through the subchondral bone (4); conservative treatment (16); unknown treatment (3)	2 kissing contusions showed persistence of the tibial lesions until 17 months post-injury. X-ray in 15 patients with 12 kissing and 3 solitary lesions showed osteochondral fractures of the talus in 3 patients and no evidence of subchondral injury in the others from 1 month to 2 years after the initial injury
Brown et al. [4]	IV, case series	94	37	Studies were collected from a database over 2 years	26 (28 %): 18 acute; 4 chronic; 4 no injury	MRI	Ligament injuries: ATFL 70 (74 %). Bone injuries: talus 26 (28 %).	Talus (13), medial talus (9), tibia (6). There were 3 fractures in the posterior malleolus	Diagnostic MRI study	Distal syndesmosis injury has a statistically significant association with ATFL injury, bone bruise and fracture

Table 1 continued

Authors	Evidence level	No. of patients	Age (years)	FU	Incidence of bone bruises	Imaging assessment	Type of lesion	Site of lesion	Management	Relevant message
Langner et al. [10]	IV, prospective case series	38	38	6 month	4 (7.8 %): 4 acute	MRI	Ligament injuries in the 4 patients with bone bruise: ATFL (1)	Lateral talus (2), medial malleolus (1), calcaneous (1)	Conservative treatment with an aircast bandage and physical therapy	After 6 months, two patients had not reached full weightbearing. Both had a bone bruise of the talus in the initial MRI. Seven patients did not return to sports activities within 6 months after injury. These patients either had an initial bone bruise ($n = 2$), an OD ($n = 1$), or an injury of two ligaments ($n = 5$, $P < 0.05$).
Yammine et al. [30]	IV, case series	54	33	Studies were collected from a database of 1 year	4 (7.4 %): 4 acute	MRI	Ligament injuries were found in 28 (51.8 %) patients: 10 (18.5 %) were isolated. Bone injuries in 32 (59.2 %) patients: 10 (18.5 %) were isolated. Tendon injuries in 21 (38.8 %) patients: 9 (16.6 %) were isolated	The ATFL was the most injured ligament. The most frequent bone injury location was the talus. The peroneal and FHL tendons represent the majority of tendon injuries	Immobilization with a walking boot for 3–4 weeks	All patients had a good clinical outcome 3 months after the initial orthopaedic consultation. There was 1 case of severe FHL tenosynovitis, partially resolved after 6 months of medical and orthotic treatment

reviewed the images of 146 consecutive patients who underwent MRI of the ankle after acute or recurrent sprain. They showed a relatively high number of subchondral injuries (11 %) involving the subchondral bone of the talus and tibia.

Management of the ankle with bone bruise

Commonly, management for acute lateral ankle ligament injury includes three different approaches: early mobilization (functional management), immobilization either in a removable or non-removable cast, and surgical anatomic repair. Five of the included studies reported outcomes of management or long-term sequelae. The decision-making regarding surgical management of a patient with a bone bruise complicating an ankle injury may be aided by the disruption of the ATFL. All patients with either the third or fourth bone bruise pattern showed a complete tear of the ATFL and CF injury on MRI. With these injury patterns, ATFL repair was attempted in 8 patients, with CF exploration in 6 [19]. A more recent study recommended arthroscopic surgery with drilling to manage bone bruises when subchondral bone lesions with intact cartilage occur. Of the 23 patients, arthroscopy with drilling through the subchondral bone was performed within 2 months of the injury in four patients with subchondral fractures of the talus. In 16 patients, conservative treatment was given, and in three patients, the treatment was unknown [24]. However, bone bruises that are asymptomatic or are discovered as incidental findings can be managed non-operatively. The medical management was MRI-finding dependent: long immobilization was proposed in patients with major sprains and osteochondral lesions, whereas short immobilization was performed in the remaining patients. Walking boot immobilization is recommended for 2–4 weeks, followed by range of motion (ROM), strengthening, and proprioceptive rehabilitation exercises [30]. Achieving full ROM in the affected joints will help patients get back to their original state of health as quickly as possible. ROM exercises keep the joints in full motion and inhibit the chance of further scar tissue development. In another series of 29 patients with acute lateral ankle sprain, conservative management was performed for 6 weeks using an ankle brace, permitting dorsal and plantar flexion of the ankle but limiting inversion and eversion [31].

Discussion

The most important findings of the present study are that the clinical prognosis of bone bruises is generally good, with a normalization of MRI appearance usually within 6–12 months after trauma [3, 29], and there is no evidence that these lesions need specific treatment. We found only few studies on incidence of bone bruises after supination trauma. The incidence varies between 7.4 and 40 %. Cartilage damage associated with acute lateral ligament lesions has been reported to occur in 66–90 % of cases [25, 26]. Apparently not all chondral injuries result in microfracture of the underling subchondral bone.

The increasing frequency of bone bruises after twisting injuries of the ankle is probably related to the increased use of MRI in acute ankle injuries and to their heightened understanding. Bone bruises are usually identified by the low signal intensity on T1- and high signal on T2-weighted images of the ankle. Few published studies reported specific results for the management of bone bruises associated with acute ankle ligament injury [19, 24, 30, 31]. This review was designed to discuss the current concepts in the management of bone bruise and to provide a possibly systematic approach to the management of such patients. Pain is thought as a problem, but it has an important role in protecting joint function. Rapid onset of pain following injury is particularly useful, and it is mediated by nerve fibres. Subchondral bone has a rich supply of these fibres, which might produce persistent pain and can take up to a year to heal [2, 20, 31].

Mink and Deutsch [18] first described bone bruising in knee injuries as a distinct entity in 1989, based on the signal intensity on unenhanced T1-weighted MR images. A bone bruise was described as “traumatically involved, geographic, and nonlinear areas of signal loss involving the subcortical bone” detected on T1-weighted MRI. Successively, this classification system was modified to classify true subcortical lesions into three types basing on their characteristic bruising pattern: reticular, geographic, and linear [29].

Nishimura et al. [19] identified four patterns of bone bruises in patients with twisting injuries of the ankle. Roemer and Bohndorf [22] described a classification for bone bruises in which stage I is characterized by bone oedema; stage II is characterized by bony oedema plus spongious impaction, and stage III is associated with microfracture or osteochondral fracture.

Taga et al. [25] investigated intraarticular lesions producing persistent postoperative pain in 31 patients with lateral ligament injury. All of the patients underwent arthroscopic examination immediately before the ligament operation. Chondral lesions were found in 89 % of the freshly injured ankles and 95 % of the ankles with chronic injuries. After follow-up for 1 year postoperatively, persistent pain was noted in 4 patients who had chondral lesions of greater than one-half the thickness of the articular cartilage. Van Dijk et al. [26] studied a consecutive series of 30 patients who had operative repair of acute ruptures of lateral ligaments. During operation, arthroscopy

revealed a fresh injury to the articular cartilage in 20 ankles, in 19 at the tip and/or anterior distal part of the medial malleolus as well as on the opposite medial facet of the talus. They conclude that in patients with a rupture of one or more of the lateral ankle ligaments after an inversion injury, an impingement occurs between the medial malleolus and the medial facet of the talus.

In high ankle sprains associated with bone bruises, an injury of the distal tibiofibural syndesmosis can occur. When it happens, two different stages of the syndesmosis' involvement can be distinguished: acute syndesmosis injury with oedema of the syndesmosis and chronic syndesmosis injury with disruption or thickening of the syndesmosis without oedema [4].

The literature supports conservative management as first-line choice for grades I and II ankle sprains in all patients. Injuries are mostly caused by an inversion stress during sport activities, falls, or traffic accidents [7, 8, 13]. Moreover, eversion and abduction of the foot are often associated with other ligament or tendon injury and bone bruises have been described as an indirect sign of a ligament injury [12, 19]. This management is associated with good results; however, if it is not appropriately performed, long-term sequelae can occur [23].

In four studies, MRI scans of the injured ankles described the presence of bone bruises and found that reinjury may play an important role in their occurrence [2, 4, 9, 21]. The first study showed the presence of bone bruises in the talus and/or malleoli in 14 of 35 patients who had a twisting injury of the ankle with subsequent lesion of the ATFL alone or in association with CFL lesion. Patients were studied with MRI performed from 1 up to 37 days after [19]. While standard radiographic examination is not able to detect talar dome osteochondral fractures, MRI allows to perform an early diagnosis which plays a critical role to provide an optimal treatment and time for recovery. The question remains if these subchondral and intraosseous fractures can be a primary cause of post-traumatic osteoarthritis and represent a cause of post-traumatic chronic ankle pain. Zanetti et al. [31] showed a complete resolution of talar dome bone bruises in two patients after conservative treatment, using an ankle brace that permitted dorsal and plantar flexion at the ankle but limited inversion and eversion for 6 weeks. A comparison between lesions detected at follow-up MRI and results of clinical follow-up showed no differences between patients with persistent bone bruise (4/6) and those with no bone bruise (2/6). In another study, investigators described no influence of bone bruise on clinical outcome for ankle sprains after 3 months [2]. Three months of follow-up suggested that these patients could walk normally and were able to participate in sport. Basing on results from a small cohort of patients managed with simple drilling through the subchondral bone or conservative approach, Sijbrandij et al. [24] suggested that "kissing contusions" of the talotibial joint were persistent up to 17 months post-injury. Drilling of these lesions has not been demonstrated to be beneficial. We believe that drilling trough intact cartilage produces an unnecessary damage to the articular cartilage and does not add to the healing. There is no evidence to believe that the initial subchondral microfracture will not heal without additional healing. Fifteen patients with 12 kissing lesions and 3 solitary lesions were assessed with standard radiographic examination, reporting osteochondral fractures of the talus in three patients and no evidence of subchondral injury in the others from 1 month to 2 years after the initial injury. Most recently, Yammine and Fathi [30] have reported the results of conservative management using a walking boot for 3–4 weeks. Good clinical results were reported in all patients after 3 months. Only one patient developed a severe FHL tenosynovitis, partially resolved after 6 months of conservative management, including drugs and brace.

Limitations of the present systematic review are mainly related to the scanty quality of the studies available in the literature. No pooling of data analysis could be performed because only case series were retrieved. Given the limitations of the case series, especially the study design and the extensive clinical heterogeneity, it is not possible to determine clear recommendations regarding the management of patients with bone bruises associated to acute ankle ligament injuries. Large and powered randomised trials should be conducted to help answer these questions by using validated functional and clinical outcomes.

Although several authors suggest that bone bruises should be treated with a period of non-weightbearing or protected weightbearing or even surgical procedures, such as drilling, the present systematic review highlighted that there is no current evidence that any kind of treatment gives a better result when compared to no treatment. Thus, we believe that only the ligament injuries should be treated after a trauma of the ankle, whereas any management addressing associated bone bruises should be considered an overtreatment.

Conclusion

The clinical prognosis of bone bruises is generally good, with a normalization of MRI appearance usually within 6–12 months after trauma [3, 29]. Currently, there is no evidence that these lesions need specific treatment. Thus, the management of the concomitant ligament lesions is sufficient. Further research is necessary to successfully address the management of bone bruises, and more evidence is required to decide if these lesions need to be treated at all.

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