# OSTEOCHONDRAL LESIONS ASSOCIATED WITH ANKLE FRACTURES: A Literature Review

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## INTRODUCTION

Ankle fractures are among the most commonly encountered types of injuries in the lower extremity. Depending on the type of injury and its mechanism, open reduction with internal fixation may be necessary. Typically, the main concerns with surgically repaired ankle fractures are restoration of fibular length, restoration of joint congruity, and the stabilization of any concomitant syndesmotic injury. By meeting those objectives, the surgeon intends on maintaining long-term function primarily by reducing the possibility of post-traumatic arthritis.

It is well understood that post-traumatic arthritis is a likely possibility given any intra-articular injury. Indeed, the literature supports this notion-post-traumatic arthritis is associated with approximately 12% of all encountered knee, hip, and ankle arthritis (1). Within the ankle joint alone, 70-80% of arthritic joints may be attributed to post-traumatic etiology (2, 3), with post-traumatic arthritis resulting in 14-50% of all fractured ankles (4-7). This may be linked with multiple etiologies including malunion (potentially the most significant), suboptimal reduction/alignment, ligamentous instability, and/or the development of arthrofibrosis (8-19). The treatment protocol for ankle fractures is relatively well agreed upon, with the above-mentioned variables also well agreed upon in considering the prevention of post-traumatic ankle arthritis. Interestingly, one etiology of post-traumatic ankle arthritis that has been somewhat overlooked in foot and ankle literature is the osteochondral lesion (OCL).

A significant amount of effort has been placed on researching OCLs of the ankle, including staging and surgical treatment. However, not as much focus has been placed on the etiology and the appropriate workup of such lesions. Bernt and Hardy's original landmark publication outlined a basic rationale for the correlation between the mechanism of ankle injury and the type of OCL likely to be encountered (20), with anterolateral lesions linked to dorsiflexion-inversion injuries and posteromedial lesions linked to plantarflexion-inversion injuries. This was a somewhat simplified perspective, had a small cohort of only 24 patients (of which 9 of 24 [38%] had lesions), and the diagnosis of OCL was delayed. Typically, the thorough foot and ankle surgeon may initially consider the OCL as potential sequelae of ankle injury. There are a number of potential reasons, however, for this to be overlooked even for the experienced physician. To begin with, the clinical diagnosis of OCL can be difficult, especially when considering the presenting symptomology may not be easily distinguishable from that of the acute ankle fracture. The ordering physician does not usually obtain anything more than standard ankle radiographs in the workup of an ankle fracture, as this is usually enough to devise a treatment plan. Unfortunately, with the exception of larger lesions, standard radiographs are not inherently sensitive modalities for the diagnosis of OCLs and this can easily lead to an initial failure in identification. Furthermore, magnetic resonance imaging and computed tomography, which are both much more sensitive and specific in their identification of OCLs, are not typically ordered in the acute ankle fracture setting.

Given the high incidence of post-traumatic osteoarthritis of the ankle, it is imperative that consideration be given to OCLs as a potential causative factor in poor long-term outcomes. Based on the literature, an ankle that has undergone ORIF may still experience a worse functional outcome in the long-term if a concomitant OCL goes undiagnosed at the time of injury.

## LITERATURE REVIEW

Relatively few articles have been written regarding the incidence of osteochondral defects in ankle fractures. A study by Sorrento et al in 2000 examined the incidence of lateral talar dome lesions in supination-external rotation IV ankle fractures as classified by the Lauge-Hansen scheme (21). The author's rationale for only examining lateral lesions in SER IV fractures was that only lateral lesions were historically associated with trauma, whereas the majority of medial lesions were not (22, 23). A portion of the article was consistent with the earlier mentioned notion that persistent intra-articular complaints within a previously injured ankle joint may be due to the presence of an OCL within the ankle.

This article specifically focused on talar dome lesions, without mention of lesions on either the medial or lateral malleolus or the tibia. They examined 50 ankle fractures treated with open reduction with internal fixation (ORIF) over a two-year period. This was performed through a traditional lateral fibular incision or medial malleolar incision if necessary, and then directly visualizing the talar dome through these incisions by retracting any portion of fractured bone. All talar dome OCLs were treated with excision and subchondral drilling with a .045 inch Kirschner wire (K-wire). The average patient was 44-years-old, with 19 of 50 (38%) reporting a lesion. Of the lesions, 9 of 19 were encountered in bimalleolar fractures, 6 of 19 were in fractures with an associated deltoid ligament tear, and 4 of 19 were in trimalleolar fractures. They concluded that given the 38% incidence, a close inspection of the talar dome should be considered in all ankle fractures (21).

Another study by Aktas et al in 2008 was similar to the Sorrento study, agreeing that talar dome lesions should be suspected in ankle fractures (24). Atkas et al also attempted to correlate the incidence of talar dome lesion with the type of ankle fracture. Where they differed, however, was their approach. Rather than direct inspection of the ankle joint, they built their study around arthroscopic visualization. This study also inspected all talar dome lesions rather than solely lateral lesions. They retrospectively reviewed 106 ankle fractures treated surgically over a 3-year period. Of 106 ankle fractures, only those cases with operative records indicating ORIF and mention of a lack or presence of talar dome lesions were included. Arthroscopic examination was performed before and after internal fixation, with treatment of the talar dome lesion being withheld until after stable internal fixation was placed.

Treatment included chondroplasty and debridement or drilling if necessary. AOFAS scores were measured at final follow-up. Ultimately, 86 fractures were included, with the mean age of the patient being 41.4 years and a mean follow-up of 33.9 months, and 24 of 86 having talar dome lesions (27.9%). The distribution of the fractures within the study were 31 bimalleolar, 21 trimalleolar, and 34 distal fibular fractures, with OCLs noted in 4 of 31 bimalleolar fractures (12.9%), 6 of 21 trimalleolar fractures (28.6%) and 14 of 34 distal fibular (41.2%). With a 41.2% rate of occurrence, distal fibular fractures had the highest incidence of all fracture types. The authors agreed this was somewhat counterintuitive considering that bimalleolar and trimalleolar ankle fracture patterns are significantly higher energy injuries than that of distal fibular fractures. They hypothesized that with less bone damage, there may be more energy directly transmitted to the cartilage, resulting in the higher incidence of talar dome lesions in the distal fibular fracture variant rather than the higher energy fracture patterns. They concluded in agreement with the Sorrento et al study in that routine inspection of the ankle joint is justified in the surgical treatment of ankle fractures (24).

To recap, the Sorrento study correlated lateral talar dome lesions with only SER IV type ankle fractures with direct visualization. The Atkas study attempted to correlate any talar dome lesions with general fracture patterns (bimalleolar/trimalleolar/distal fibular/deltoid rupture) after arthroscopic inspection of the ankle joint.

A study by Leontaritis et al in 2009, however, took the thought process a bit further. By arthroscopically inspecting acute ankle fractures, they attempted to correlate the frequency and severity of any type of osteochondral injury (talar, tibial, medial or lateral malleolar) with the specific type of Lauge-Hansen fracture pattern (25). Loren and Ferkel et al performed a study of 48 ankle fractures (including plafond injuries) and arthroscopically found OCLs in 63% of the ankles, but did not attempt to correlate the nature of the encountered OCLs with the ankle fracture classification (26).

Leontaritis' study was comprised of a retrospective chart review to determine if the severity of an acute ankle fracture as classified by the Lauge-Hansen scheme correlated with the severity of arthroscopically detected OCLs. They hypothesized that a more severe fracture pattern would be associated with a higher incidence of intra-articular lesions. Overall, the study included 84 ankles. It classified the location of the lesion, including whether it was on the medial or lateral malleolus, talar dome, tibial plafond, or whether it was simply a loose body. Lauge-Hansen fracture variants were grouped together, with no Lauge-Hansen type III fractures recorded in the inclusion group (25).

OCLs were noted in 61 of 84 patients (73%). Out of those 61 patients, 51 of 84 had talar dome lesions (61%), 5 of 84 (6%) had tibial plafond lesions, and 10 of 84 (12%) had lesions of the articular surface of the lateral or medial malleolus. Out of 84 fractures, 15% were PER I, 1% were PER II, 20% were PER IV, 1% were a SADD variants, 5% were SER I, 11% were SER II, and 46% were SER IV. Severe chondral injuries were defined as two or more OCLs within one injury, while mild-moderate injuries were defined as <2. Statistical analysis by means of Fisher's exact test revealed that type IV injuries (regardless of SER or PER) were 8.1 times more likely to be associated with two or more OCLs than type I injuries, while type IV injuries were 9.7 times more likely than type II injuries to present with two or more OCLs. There was no significant difference between type I and II injuries with regard to the likelihood of sustaining a severe injury. They concluded that the severity of fracture was associated with an increased number of OCLs. Leontaritis et al, however, neither supported nor rejected the notion that treatment of these lesions would be beneficial, and that further studies would need to be performed to reach such conclusions (25).

Hintermann et al also performed a study in 2000 that examined general arthroscopic findings in acute ankle fractures (27). From a cohort of 288 ankle fractures treated over a four-year period, they assessed the ankle ligaments and also examined the ankle for any articular cartilage lesions. Any lesions found were staged based on the severity, with superficial lesions being graded as stage 1, lesions <50%

of the cartilage depth stage 2, lesions >50% thickness stage 3, and erosions down to subchondral bone stage 4. Within the study, they found lesions in 228 ankles (79.2%), with talar lesions found in 200 ankles (69.4%), distal tibia in 132 ankles (45.8%), fibula in 130 ankles (45.8%), and the medial malleolus in 119 ankles (41.3%). They noted that the frequency and severity of the lesions increased from type-B to type-C fractures (as classified by Danis-Weber), with each subgroup of fracture having an increase in the stage of the lesions. No difference, however, was noted between type-A and type-B fractures (27).

Interestingly, Stufkens et al in 2010 then performed a long-term follow-up study utilizing the same patient cohort initially used in the study performed by Hintermann in 2000 (28). The goal of the study was to build on the original idea that cartilage lesions are common in ankle fractures, and from there expound on the potential effects those lesions may or may not have had on the previously studied cohort of patients in the long-term. The hypothesis was that the more extensive the initial cartilage damage, the higher the likelihood that osteoarthritis would later be encountered. To their knowledge, this was the first study examining the correlation between the initial cartilage damage seen under direct arthroscopic visualization and the clinical and radiographic long-term outcomes associated with that fracture and cartilage lesion (28).

Out of Hintermann's original study, a total of 109 patients were available for follow-up, with a mean follow-up length of 12.9 years. They measured two outcome parameters: the AOFAS hindfoot score, and the Kannus arthritis score. Patients were divided into two groups, those with primary cartilage lesions and those without at the time of initial injury. They also used an abbreviated staging system (as compared to the original Hintermann study) for the patient's cartilage lesions, with Category I lesions being up to 50% depth, and Category II lesions being greater than 50% in depth (28).

The results showed 81% of the patients suffered a cartilage lesion in the ankle joint directly as a result of the fracture. There was a varying breakdown of the locations of the lesions, with lesions found on the talus in 65% of the patients, tibia in 50% and fibula in 39%, and no cartilage damage seen in 19% of patients. There was also a varying breakdown of whether the lesions were noted on only the talus, only the tibia, only the fibula, or a combination of the three. Lesions were found only in the talus in 17% of patients, only the tibia in 8%, and only the fibula in 6%. Both the talus and the tibia were involved in 17%, both the talus and fibula in 7%, and both the tibia and fibula in 5%. All three of the joint surfaces were affected in 21% (28).

With respect to predictive values of the two main outcome parameters, signs of osteoarthritis were defined by an AOFAS ≤90 or a modified Kannus score ≤90. Given those parameters, 39% and 43% of patients at long-term follow-up each showed signs of OA, respectively. Cartilage lesions of the tibia (including the medial malleolus) and the talus were all associated with a long-term outcome predictive of osteoarthritis (as defined by AOFAS score of ≤90 points and radiographic score of ≤90 points). Fibular lesions, however, were not found to be associated with the development of posttraumatic osteoarthritis (28).

Finally, this study outlined the lesion depth and location, and how those affected long-term outcomes as well. Lesions exceeding 50% depth in the anterior and lateral talus significantly affected long-term clinical outcomes. Damage exceeding 50% of cartilage depth on the medial malleolus alone was associated with both long-term clinical and radiographic signs of osteoarthritis. Deep lesions on the tibial plafond were found to have little predictive value, with only posterior plafond lesions having an association with a radiographic score of ≤90 points, but no clinical association (28).

This thought process actually fell in line with another study by Lorez and Hintermann in 1999, where they studied ankle fractures 2 years post-injury and ORIF and correlated their overall clinical and radiographic outcomes with their preoperative arthroscopic findings. They found that initial cartilaginous lesions located on the medial malleolus led to poor clinical ratings based on the Kitaoka score and initial cartilaginous lesions on the tibial plafond led to poor radiographic ratings based on the Kannus score at 2 years follow-up (29).

Finally, a study by Lantz et al in 1991 was also consistent with this, with 31 of 63 ankle fracture patients initially treated with ORIF having talar dome injuries. Within that study, the overall results were worse in patients with such lesions at 2-year follow-up. Twenty-five patients followed-up, and 13 still had pain, out of which 8 of 13 of those had talar dome injuries. The study concluded that the functional status and ankle range of motion were significantly poorer in patients with talar dome chondral injuries (30). The overall study results found in the studies are outlined in Table 1.

## DISCUSSION

The literature surrounding ankle fractures and the incidence of OCLs associated with those injuries is relatively sparse, especially when considering how much overall literature there is concerning ankle fractures and OCLs separately. Overall, there appears to be a consistent view among the majority of the literature. Among the above mentioned studies, the general consensus excluding the Ono et al study is that there is a high incidence of OCLs in ankle fractures, with different results reported depending on where the examiners looked for the lesions. All authors except Ono et al proposed that arthroscopic or direct examination of the

**Table 1. Overall study results indicating percentage of osteochondral lesions encountered in ankle fractures based on location within the ankle**

| STUDY | TALUS | MEDIAL MALLEOLUS | FIBULA | TIBIAL PLAFOND | TOTAL |
|---|---|---|---|---|---|
| Aktas | 24/88 (27.9%) | DNE | DNE | DNE | 24/86 (28%) |
| Ferkel | 19/48 (40%) | DNS | DNS | 11/48 (23%) | 30/48 (63%) |
| Lantz | 31/63 (48%) | DNS | DNS | DNS | 31/63 (48%) |
| Leontaritis | 51/84 (61%) | 10/84* (12%) | 10/84* (12%) | 5/84 (6%) | 61/84 (73%) |
| Hintermann | 200/288 (69%) | 119/288 (41.3%) | 130/288 (45%) | 132/288 (46%) | 228/288 (79%) |
| Ono | DNS | DNS | DNS | DNS | 21/105 (20%) |
| Sorrento | 19/50**(38%) | DNE | DNE | DNE | 19/50 (38%) |

DNE = did not examine; DNS = did not specify.
* Leontaritis et al did not specify between whether the 10/84 lesions were located on the medial malleolus or the fibula.
** Sorrento et al specifically only examined lateral talar dome lesions.

ankle joint should be considered in the acute ankle fracture setting in order to rule out the presence of OCLs (31).

The majority of studies agreed that examination of the ankle joint should be performed, and given the diversity of lesions encountered in several of the studies, arthroscopic examination of the ankle would seem to be the most thorough modality of inspection. The combination of the studies by Hintermann et al in 2000 and the Stufkens et al long-term follow-up in 2010 were able to best establish a correlation between initial OCLs incurred during an ankle fracture and poor long-term outcomes. Along with Lorez and Hintermann's study in 1999, and the study by Lantz et al in 1991, these were the only studies that made such a correlation. The only question that remains is whether or not to address these injuries in the acute setting. It would stand to reason that initially addressing OCLs during the time of ankle ORIF may help improve long-term function. This is evidenced by the Stufkens et al 2010 study and the Lorez et al 1999 studies, given that patients had significantly worse long-term clinical or radiographic outcomes depending on the type of OCLs incurred at the time of injury.

Multiple other studies have hypothesized that long-term outcomes may be affected by OCLs incurred during ankle fractures. Lindsjo et al performed a study that showed patients with displaced ankle fractures had 81% good long-term results, while only 38% of non-displaced impacted fractures resulted in good long-term outcomes (32). Lindsjo suggested that this might have had something to do with articular cartilage damage at the time of injury. The findings in the Lindsjo study fall in line with the findings in a study by Atkas et al, which had a higher incidence of talar dome lesions within distal fibular fractures than in bimalleolar or trimalleolar fracture variants. Both of these findings are consistent with the notion that with less bone and soft tissue damage, articular cartilage injury may be more likely in nondisplaced injury patterns.

To summarize, there are multiple studies citing the relatively high incidence of OCLs with ankle fractures. Moreover, the remaining studies relate a poor long-term clinical outcome with patients who initially incur OCLs after acute ankle fractures. Given these important facts, the literature seems to suggest that the foot and ankle surgeon should routinely consider inspecting the ankle joint in the setting of acute ankle fractures and possibly address these lesions at the time of ORIF.

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