Osteochondral lesions were first described by Konig in 1888. He theorized that spontaneous necrosis was a causative factor for this condition. In 1922, Kappis described osteochondral lesions in the talus. Rendu, in a report published in 1932 describing intraarticular fractures of the talus, was the first to propose that these lesions may have a traumatic etiology. In 1959, Berndt and Harty concluded that these osteochondral lesions of the talus were, in fact, transchondral fractures caused by trauma.

Osteochondral lesions of the talus (OLT) are often painful and frequently cause recurrent synovitis and altered joint mechanics. The incidence of OLT has been reported to range from 0.9% of all talar fractures to 6.5% of ankle sprains. A prospective study looked at 288 ankle fractures that needed open reduction internal fixation and found that 79.2% had cartilage lesions when evaluated arthroscopically.

Etiology

Many different terms have been used to describe these defects of talar articular cartilage including transchondral fracture, osteochondral fracture, osteochondritis dissecans, talar dome fracture, and flaked fracture. The use of various terms may be due to the numerous theories concerning the etiology of this injury. Early investigators suggested fat embolism leading to an ischemic event as a possible cause. Campbell and Ranawat showed that bone infarction could precede pathologic fractures through subchondral bone and suggested that a traumatic event may be responsible for separation of the fragment. Endocrinologic causes also have been proposed, and White reported on three cases of OCL in multiple joints associated with dwarfism. A genetic theory for the etiology of OCL has been suggested, supported by the fact that some families have multiple affected members.

It is currently accepted that OCL of the talus is primarily traumatic in origin. Berndt and Harty proved this in a report in which anteromedial and posterolateral lesions were created using cadavers. They found that anterolateral lesions could be created by dorsiflexing and inverting the ankle, causing the anterolateral aspect of the talar dome to impinge on the fibula. Posteroskeletal lesions were created by inversion and external rotation of the plantar flexed ankle, causing the posteroskeletal aspect of the talar dome to impact the tibial plafond.

Studies have shown that, while trauma is the usual etiology for both anterolateral and posteroskeletal lesions, there is a higher percentage of posteroskeletal lesions without traumatic etiology. Canale and Belding reported on OCL of the talus in which only 64% of the medial lesions were traumatic in origin, thus supporting the theory that medial lesions may have an atraumatic cause. This was supported in a study by Alexander and Lichtman in which all of the anterolateral lesions had a history of trauma, but 18% of the posteroskeletal lesions were atraumatic. A study by Flick and Gould showed that 98% of the lateral lesions were associated with trauma, whereas only 70% of the medial lesions were associated with trauma. One explanation for the higher percentage of atraumatic lesions on the medial side is that there are normally large stresses on the medial talar dome compared to the lateral side that may lead to damage to normal articular cartilage.

Although OCL of the talus can occur anywhere on the talar dome, the two most common sites are anteromedial and posterolateral. The anterolateral lesions tend to be shallow, wafer-shaped lesions and are frequently displaced. The pos-
teromedial lesions are more common and tend to be deeper, cup-shaped lesions. The latter are usually not displaced as often as the lateral lesions.

Classification
There have been many different classification schemes reported in the literature, including radiographic and arthroscopic classifications. Berndt and Harty published the classic classification, which is commonly referred to in the literature. Stage I is a small compression fracture of the talus dome. Stage II is an incomplete avulsion, while stage III is a complete avulsion. Stage IV is a displaced fragment of the articular surface. Ferkel and Sgaglione presented a classification based on CT and ranging from a cystic lesion with an intact dome of the talus to a displaced fragment. Pritsch reported on the correlation between radiological and arthroscopic findings in OCL of the talus. He classified these lesions arthroscopically as grade I, which was intact cartilage; grade II, was intact, soft cartilage; and grade III, in which there is presence of frayed cartilage. A poor correlation was found between arthroscopic and radiographic findings, as some of the patients that were stage IV, radiographically, were only found to be grade I, arthroscopically. Also, some of the lesions that were considered stage II, radiographically, were considered grade III, arthroscopically. Pritsch therefore stressed the importance of visualizing these lesions, arthroscopically, to determine the best treatment option. Other classifications were published, including a more detailed arthroscopic classification by Cheng and colleagues and an MRI staging classification developed by Dipaola and Guhl.

Clinical Evaluation
Patients with OCL often have a history of a previous ankle sprain with unresolved ankle pain. The pain may be localized to the area of the lesion and may be accompanied by swelling. Patients may complain of catching and grinding, but locking is a less frequent complaint. Some patients may also complain of a feeling of instability although a finding of instability on physical exam is rare. Posteromedial lesions may be more tender to palpation with the ankle plantar flexed as the posterior part of the talus is brought anteriorly. Conversely, anterolateral lesions may be more tender with the ankle dorsiflexed. The differential diagnosis of this condition should include soft tissue impingement syndrome, reflex sympathetic dystrophy, arthritis, occult fracture, infection, tarsal coalition, lateral ankle instability, subtalar dysfunction, and peroneal subluxation or tendinitis.

Radiological Studies
The initial work-up for OCL of the talus involves plain x-rays of the ankle including anteroposterior, lateral, and mortise views. Posteromedial lesions may be more visible on the plantar flexed mortise, and anterolateral lesions may be more visible on the dorsiflexed mortise. If the patient has signs of instability on clinical exam, stress x-rays may be of use. Plain x-rays, however, may not be the most sensitive in detecting these lesions. A prospective study of patients with six months of ankle pain and x-rays detected only 41% of the lesions that were identified by arthroscopy.

Other studies that may be of value are bone scan, CT, and MRI. CT has been found to provide improved delineation of bone in the axial and coronal planes and is beneficial in delineating an osteochondral fragment. It is also useful in defining subchondral cysts. CT may be limited, however, in its ability to visualize the subtly enlarged grade I lesions. MRI is sensitive for detecting subtle bone changes such as edema or hemorrhage from an osteochondral fracture. It is also useful in visualizing the soft tissues for any other cause of symptoms. Anderson and coworkers performed a study looking at the usefulness of bone scan, CT, and MRI. Two groups of patients were studied: one group had symptoms with normal x-rays and the other group was symptomatic with abnormal x-rays. Of the group of 14 that had normal x-rays, all had abnormal bone scans and MRI. Four CT scans were interpreted as normal despite changes on MRI. Of the second group that had abnormal x-rays, no bone scan was performed. CT and MRI gave equivalent results in nine of ten patients. It therefore seems that MRI is more sensitive than CT in demonstrating the more subtle lesions such as those classified as grade I, but for more pronounced lesions, the two studies are equivalent. DeSmets and associates did a comparison of MRI and arthroscopic findings to determine the sensitivity of MRI. These investigators found that MRI was very accurate in determining the stability of the fragment when compared to the arthroscopic findings.

Natural History
Little is known about the natural history of OCL of the talus. It is not completely understood which lesions will progress to arthritis if left untreated and which will not. The cartilage in the ankle is only 1 to 2 mm thick. It also has a small contact area of about 350 mm (compared with 1120 mm in the knee and 1100 mm in the hip). These factors make the ankle joint less able to adapt to small surface incongruities, leading to increased stress on the joint. A study by McCullough suggested that untreated lesions may not heal but may become asymptomatic. Roden found that 12 of 41 medial lesions went on to develop osteoarthritis. Scharling described osteoarthritis in 6 of 15 patients after excision and drilling, but a medial malleolar osteotomy was performed in this group. It is, therefore, hard to know which lesions will benefit from treatment and which will develop arthritic changes if left untreated.

Nonoperative Management
Berndt and Harty found poor results with nonoperative treatment and 84% good results with surgery. Canale and Belding reported on 29 patients with 31 OCLs of the talus. Their study found that with medial stage III lesions, opera-
tive and nonoperative results were equal. The lateral stage III lesions, however, did better with surgical management. Flick and Gould found that symptomatic patients with x-rays showing detached lesions did poorly with nonoperative treatment. Nonoperative treatment usually consists of weight limitation with a period of immobilization in a cast or brace. Once the pain has resolved, attention can be turned toward increasing range of motion and strength. Steroid injections have been found to have no beneficial effect on the healing of these lesions.

**Operative Management**

When contemplating operative management, there are many options including debridement, drilling, internal fixation, bone grafting, mosaicplasty, and autologous chondrocyte transplant. Which procedure is selected depends on factors such as the age of the patient, the size of the lesion, and the status of the remaining articular surface.

Anterolateral lesions are usually easily accessible via an anterolateral arthrotomy. Care must be taken to avoid the branches of the superficial peroneal nerve. Medial lesions are usually more difficult to access due to the fact that they are typically more posterior. Some lesions may be accessible using an anteromedial arthrotomy and plantar flexing the ankle. A posteromedial arthrotomy can also be done in which the neurovascular structures and flexor tendons are retracted and the lesion approached through the posterior tibial tendon sheath. Flick and Gould described creating a groove on the anteromedial surface of the distal tibia with a gouge after exposing the joint through the tendon sheath of the tibialis anterior tendon. This removes approximately 6 to 8 mm of bone. Finally, a medial malleolar osteotomy can be performed to gain exposure, if necessary. This involves making an oblique osteotomy where the medial malleolus joins the tibial plafond. Two holes are pre-drilled for subsequent screw fixation. Medial malleolar osteotomy is not a great option for a number of reasons: including injury to articular cartilage, risk of injury to the neurovascular structures and tendons, and risk of delayed union or nonunion. The development of ankle arthroscopy greatly changed the management of these lesions. Arthroscopy allows for better visualization of the joint with decreased morbidity and easier rehabilitation.

Debridement is a common method of treating OCL of the talus. Detached osteochondral fragments can be removed and the bone bed debrided arthroscopically. The arthroscope is usually placed in the anteromedial portal and the instruments in the anterolateral portal. For lesions that are too posteromedial to be visualized from the anterior portal, a posterolateral portal can be used for visualization with instrumentation in the anteromedial portal. Pritsch and colleagues found good results in 13 of 14 patients treated with debridement alone.

Drilling of the OCL is another surgical option. Drilling of the subchondral bone causes bleeding to the area with an inflow of mesenchymal stem cells. These stem cells then differentiate into fibrocartilage, restoring the articular surface. In general, a 0.062 K-wire is used to penetrate subchondral bone at 3 to 5 mm intervals at a depth of 10 mm. This method tends to work well for small lesions but is not as successful in larger lesions. Anterolateral lesions can easily be reached using the anterolateral portal. Medial lesions are often more difficult due to the posterior position. One technique to overcome this obstacle is to use a transmalleolar technique in which the K-wire is drilled through the medial malleolus. The ankle can then be dorsiflexed and plantar flexed to bring different areas of the lesion to the K-wire. There are also commercially available drill guides to assist in placement of the wire. The lesion can also be drilled retrograde through the sinus tarsi. The talus is entered through the nonarticular portion anterior to the anterior talofibular ligament insertion. This avoids having to drill through normal articular cartilage. Some studies suggest that drilling may yield better outcomes in younger patients. Drilling may also have better results in patients that have a history of trauma. Tol and associates performed a meta-analysis of 16 studies of 165 patients in order to compare excision, curettage, and drilling with excision and curettage alone and excision alone. These investigators found that the best results were with excision, curettage, and drilling followed by excision and curettage, with excision alone having the worst results. Although this is not the most accurate study, as different techniques were used in different reports, there may be some advantage to drilling these lesions as it may stimulate the formation of cartilage. The problem with this technique is that fibrocartilage is formed and it is biomechanically inferior to normal hyaline cartilage and cannot resist stresses across the joint as well. Postoperatively, patients are generally kept non-weightbearing for approximately six weeks. Range of motion exercises are begun early and eventually work is done on strength and proprioception.

Sometimes, the osteochondral fragment can be fixed to the body of the talus. This is generally an option for the young patient with a large lesion. Internal fixation is beneficial when the injury is acute and the fracture is larger than one-third of the talar dome. Results of fixation also tend to be better in younger patients. Chronic osteochondral lesions heal poorly with internal fixation due to fibrous tissue and sclerosis in the defect. There are various ways to fix this lesion. A cancellous or Herbert screw can be used, but this requires a medial malleolar osteotomy or a transmalleolar hole if the lesion is on the medial side. K-wires can also be used to fix the osteochondral lesion, but with this technique it is difficult to compress the fragment. The lesion can also be fixed retrograde with a K-wire through the sinus tarsi to prevent damage to articular cartilage. Recent studies have found that fibrin glue can be used to successfully fix these lesions and eliminate the problems of added exposure or articular damage.

Bone grafting often becomes necessary with larger os-
teochondral lesions. Subchondral cysts can be packed with bone graft to support overlying healthy articular cartilage. With large articular defects, allograft or autograft can be used to reconstitute the joint surface. Allograft is generally used when the defect is at least 1 cm and the fragment is irreparable. Factors that contribute to good results are the use of fresh allograft, having a firm press fit, no instability of the joint, and keeping the patient non-weightbearing until there is evidence of osteointegration. Factors that may lead to a poor result are patient age (older than fifty-five), obesity, osteoarthritis, and frozen allografts. Gross and coworkers reported good results in six of nine patients undergoing allograft. Three failures were noted secondary to fragmentation and resorption of the graft. Autograft can also be taken from the distal femur or the anterior dome of the talus to fill in large defects. The use of this technique depends on the size of the lesion and the amount of autograft available.

Mosaicplasty has had success in osteochondral defects in the knee and has shown promise in talar osteochondral lesions as well. This technique allows for the restoration of normal articular cartilage. The lesion should usually be at least 10 mm in diameter. The ankle joint is first visualized with arthroscopy. An open arthrotomy is then performed to allow for better access. An autogenous graft is taken usually from the ipsilateral knee. The recipient site is drilled and dilated. The grafts are then inserted into the defect and the ankle placed through a range of motion to ensure congruency. The patient is kept non-weightbearing for approximately two to four weeks, but range of motion exercises are encouraged. Studies have shown that patients who have had this procedure have experienced good pain relief. Second-look arthroscopies have shown a normal, congruous joint and biopsies have shown normal type II cartilage. MRI done postoperatively in a study by Assenmacher and coworkers showed complete integration of the osteochondral plugs. Mosaicplasty has the benefit of filling in the articular defect with normal cartilage rather than fibrocartilage and has been shown to be successful with larger lesions.

Autologous chondrocyte transplantation has also had success with osteochondral lesions in the knee and is beginning to be used for OCL of the talus. Chondrocytes are harvested, cultured, and then used to fill in the defect with a periosteal graft. Peterson has used this in 14 patients with OCL of the talus and had 85% good and excellent results at an average follow-up of 34.5 months. While there are no randomized, prospective studies on autologous chondrocyte transplantation to date, this may become more popular in the near future.

Conclusion

Osteochondral lesion should be suspected in a patient with a history of ankle sprain with continued ankle pain. Obtaining the proper radiographic studies will help identify this lesion. Stage I and II lesions should probably be treated with an initial attempt at nonoperative management. Arthroscopic debridement and drilling is a good option to allow cartilage to fill into smaller defects. Larger lesions that are acute should be fixed if possible. If fixation is not an option, alternatives include bone grafting or mosaicplasty. Autologous chondrocyte transplantation may become a proven treatment option in the future.

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