Chronic giving way and ankle dysfunction are common after ankle sprains (Table 1). In a study involving young athletes in 1986, Smith and Reischl reported in basketball players that 50% of the athletes have a dysfunction after sprain and 15% were affected in playing performance. In 1975, Staples described 27% functional instability and 12% sport disability. According to the literature review of more than 100 articles on treatment of ankle sprains, there is a variable (0%–78%) incidence of dysfunction regardless of treatment type: cast, surgery, or functional. In our approach to chronic ankle pain and giving way, one must consider the differential diagnosis before treatment can be directed appropriately.

One of the common diagnoses associated with ankle injury is osteochondral lesions of the talus (OLT). Lippert and colleagues described a 7% incidence of osteochondral lesion after chronic ankle sprains in 962 patients. In 1955, Bosien and colleagues reported on a series of 133 patients; the incidence of osteochondral lesion was 6.7%. The results of acute ankle arthroscopy in a series of acute ankle sprains revealed a medial talar chondral lesion in 66% of cases (30 patients). The advent of MRI also has allowed us to make the diagnosis of occult lesions more readily. In
a retrospective study on 108 ankle sprains, Labovitz and Schweitzer\textsuperscript{7} looked at the incidence, location, pattern, and age of occult osseous injuries after ankle sprains. The MRI findings showed bone bruises in 39%. This article discusses OLT, treatment options, and resurfacing techniques.

**DIAGNOSIS, INVESTIGATION, AND CLASSIFICATION**

Stauffer and colleagues\textsuperscript{8} theorized on the correlation between inversion sprains and the increasing of forces applied on the talar dome. With anterior subluxation and inversion of the talus within the mortise, one can speculate how either anterolateral or posteromedial lesions could occur. The diagnosis of OLT is commonly missed on initial examination or radiographs. One must consider chronic pain, swelling, mechanical catching, and giving way possibly coming from an underlying chondral defect. Usually OLT is secondary to trauma, either after a single or repetitive event. The investigation for an OLT may include radiographs, CT scan, bone scan, and MRI to define the location, size, cartilage surface, and joint condition. Posteromedial or anterolateral locations are most common. The sensitivity of routine radiography is 50\% to 75\%, whereas pickup on bone scan is 99\% sensitive. CT scan may be useful for bony anatomy and location of the lesion. MRI is indicated if radiographic results are normal; it may give information regarding vascularity, healing, and cartilage integrity.

In 1959, Bernt and Hardy\textsuperscript{9} classified OLT into four types according to radiographic findings. Canale and Belding\textsuperscript{10} classified the lesion into four different types according to the cartilage damage:

- **Type I:** cartilage intact
- **Type II:** partially detached
- **Type III:** complete separation in crater
- **Type IV:** completely displaced in joint

Anderson and colleagues\textsuperscript{11} modified the Bernt and Hardy classification according to CT scan findings:

- **Stage 1:** subchondral compression
- **Stage 2:** incomplete separation
- **Stage 2a:** subchondral cyst

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<td>Results of arthroscopic debridement based on diagnosis</td>
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<td>Diagnosis</td>
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<tr>
<td>OLT</td>
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<tr>
<td>Soft tissue impingement</td>
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<tr>
<td>Anterior bony impingement</td>
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<td>Lateral plica</td>
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<td>Postfracture scar</td>
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<td>OA/chondromalacia</td>
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**Abbreviation:** OLT, osteochondral lesions of the talus.

Stage 3: detached, undisplaced fragment
Stage 4: displaced fragment

Loomer and colleagues\textsuperscript{12} improved CT scan classification by including the type 5 cystic lesions (\textbf{Fig. 1}):  
Stage 1: subchondral compression (edema)  
Stage 2: incomplete fracture, undisplaced  
Stage 3: complete fracture, undisplaced  
Stage 4: displaced fragment  
Stage 5: radiolucent (fibrous) defect, roof intact

Pritsch and colleagues\textsuperscript{13} introduced arthroscopic grading:  
Stage 1: intact, shiny cartilage  
Stage 2: intact but soft  
Stage 3: frayed cartilage

The purpose of assessing these lesions is to be able to estimate the size, location, and integrity of the articular cartilage surface to recommend optimal treatment.

\textbf{Treatment}

In the operative treatment of OLT, we need to differentiate between acute and chronic lesions. Acute lesions are usually treated by excision particularly if the fragment is small, displaced, or comminuted (\textbf{Fig. 2A, B}). Indications for repair are controversial, but if the fragment is large, repair may be attempted, particularly with an anterolateral location. In our experience, if the lesion is larger than one third of the talar dome width, fixation should be considered. The overall indications for repair can be restricted to the cases of a large lesion (> 35% talar dome surface area) with a cartilage surface intact (\textbf{Fig. 3A, B}).

\begin{figure}[h]
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\end{figure}
In chronic types I and type II lesions (undisplaced), multiple drilling versus excision should be considered. Particularly in adolescents, it seems prudent to be cautious with excision and expect a higher rate of healing. In type III and type IV lesions, typically excision or curettage are preferred with predictable outcomes. In Loomer type V, the cystic lesion usually needs to be addressed. Multiple drilling may be helpful, but generally a large cystic lesion may need antegrade or retrograde bone grafting or mosaicplasty. If the articular surface is intact, retrograde techniques are preferred. Usually they are approached though the sinus tarsi under fluoroscopic control (Fig. 4A–E). If the articular surface is disrupted, antegrade techniques (ie, mosaicplasty) are recommended (Fig. 5A–D). Results of surgical treatment (debridement) are good. Stetson and Ferkel\textsuperscript{14} treated 66% medial OLT, 27% lateral, and 7% central. In their series, they achieved 83% good to excellent overall results with debridement. According to various authors and literature review,\textsuperscript{15} the procedure has 0 to 90% of good and excellent results.

Amendola and colleagues\textsuperscript{16} showed that patients’ perceptions of the overall benefit they received from the arthroscopic treatment was best for localized lesions of the

![Fig. 2. (A) Acute lateral octochondral fracture after sprain. (B) Arthroscopic view before excision.](image)

![Fig. 3. (A) Radiographs in a 16-year-old girl with large (50% talar dome) OLT. (B) After fixation and healing, MRI at 6 months.](image)
ankle. Outcomes were best for OLT, soft tissue and bony impingement, and lateral plica (outcome based on visual analog scale). More recently, a systematic review of the literature by Tol and colleagues\textsuperscript{17} noted that excision with debridement of the bed of the lesion was successful. They showed that nonoperative treatment had 45% success, excision alone had 38% success, and excision and curettage had similar results to excision, curettage, and drilling, with 78% and 85% success, respectively.

Fig. 4. (A) Radiographic Loomer type V. Lesion medial talar dome. (B) CT scan shows a large cystic lesion. (C) K-wire fluoroscopic positioning. (D) Five-millimeter reamer to enter lesion followed by bone graft. (E) Curettage of the large cystic lesion.
Posterior Ankle Arthroscopy Technique

In the treatment of OLT, posterior prone arthroscopy\textsuperscript{18–20} allows access to posterior lesions (Fig. 6A–C). The arthroscopic approach allows for debridement or curettage of the lesion. The exposure to posterior lesions in which resurfacing may be necessary is currently achieved through a posteromedial open approach or a medial malleolar osteotomy (Fig. 7). If perpendicular access is required for resurfacing, however (ie, mosaicplasty), then additional exposure can be obtained by arthrotomy with or without a malleolar osteotomy. In a cadaveric study on 11 specimens, Muir and colleagues\textsuperscript{21} concluded that 75% of talar dome can be accessed by arthrotomy without osteotomy, that medial and lateral malleolar osteotomies allow 100% sagittal exposure, that anterolateral (chaput) osteotomy\textsuperscript{22} provides additional 22% sagittal lateral exposure, and that with all exposures, 15% of residual area is still inaccessible in the posterior central talar dome.

CONTROVERSIES

An asymptomatic finding on radiography/CT/MRI or bone scan remains controversial but at this point is generally left untreated. Posterior lesions—whether posteromedial or lateral—that are difficult to access arthroscopically from a supine and anterior approach need a posterior approach or malleolar osteotomy (Fig. 7) or prone posterior arthroscopy (see Fig. 6A). Combined mechanical instability and OLT occur often. In general if the symptoms are predominantly pain from the lesion, treatment of the lesion alone is satisfactory; however, if instability is symptomatic, treatment of OLT and instability is necessary. If debridement fails and chronic pain continues after excision, it is necessary to rule out and treat other contributing causes (associated lesions, impingement), treat instability, assess the joint overload at area of lesion, and if
Fig. 6. (A) Posterior portals in the prone position. (B) Lesion on the posterior downslope better accessed posteriorly. (C) Arthroscopic view from posterolateral portal, instrument in posteromedial portal.

Fig. 7. Operative radiographic step cut medial osteotomy.
present, correct the alignment. If all of the possible contributing lesions have been ruled out, then resurfacing the lesion that already has been treated by debridement may be an option.

Achieving correct limb alignment is most important in any resurfacing or reconstructive procedure. Generally a calcaneal osteotomy—either lateral closing wedge for varus or medial displacement osteotomy for valgus—is the preferred osteotomy. If there is tibial deformity, a supramalleolar osteotomy may be of value. Hindfoot alignment views are essential in assessing overload (Fig. 8A–C). If all contributing problems are not present or have been addressed, mosaicplasty or other methods of resurfacing may be indicated. In our experience, the indications for resurfacing are the large lesions (> 1.5 cm) after a failed excision.

Fig. 8. (A) Anteroposterior and lateral radiographs of patient with continuing pain after medial osteoarticular transfer system procedure. Ankle is in pre-existing varus. (B) Hindfoot alignment view. (C) Postoperative supramalleolar corrective opening wedge osteotomy.
Articular Resurfacing

In general, indication for surgical treatment of these lesions is failure of nonoperative management, in which the patient continues to have symptoms from the lesion despite activity modification, rehabilitation, and bracing. In athletes with acute ankle sprains and displaced osteochondral lesions, one may elect early arthroscopic excision to allow earlier return to play. Indication for articular resurfacing is failure of excision with curettage or drilling. In circumstances in which there is a large bony defect or lesions larger than 15 mm, one may elect a primary resurfacing technique versus excision and debridement.

MOSAICPLASTY

Hangody and colleagues\(^2\)\(^3\) popularized this technique by taking osteochondral plugs from the ipsilateral knee to the ankle. They reviewed 36 consecutive patients with 2 to 7 years of follow-up who were treated for detached lesions larger than 10 mm. Osteochondral grafts were taken from the ipsilateral knee. Malleolar osteotomy was performed in some cases. Postoperatively, patients were managed with 2 weeks of casting (4 weeks with osteotomy). The results were 28 excellent, 6 good, 2 fair. 100% full range of motion was reached by 8 weeks in all cases, and no knee complaints were reported. Others since have reported similar outcomes with few complications.\(^2\)\(^4\)–\(^2\)\(^6\) The technique has been well described by these authors. Generally they are most commonly indicated for medial lesions.

Athletes who have failed conservative treatment or excision and curettage need further treatment. A medial malleolar osteotomy or lateral chaput osteotomy (the lateral lesions are more anterior) is required. Once the lesions size is determined and the number of plugs determined, either arthroscopic or open procurement of the grafts from the ipsilateral knee is required. My preference is not to take plugs larger than 6 mm from the lateral anterior femoral condyle trochlear ridge (Fig. 9A–D). Infrequent donor site morbidity has been reported. Postoperative ankle radiographs show a step off in the subchondral bone plate because the cartilage from the knee is thicker than the ankle.

AUTOLOGOUS CHONDROCYTE IMPLANTATION

The technique of autologous chondrocyte implantation has not had a large experience in ankles of athletes. Often it involves bone grafting (“sandwich”), and malleolar osteotomy is necessary as in the mosaicplasty technique. Nam and colleagues\(^2\)\(^1\) reported 11 cases with 2 to 5 years of follow-up: 9 medial OLT, 2 lateral, 5 autologous chondrocyte implantation alone, 6 autologous chondrocyte implantation and bone grafting. In 10 patients, a second look and screw removal was performed. The results increased from 10 poor and 1 fair (preoperative) to 3 excellent, 6 good, and 2 fair (postoperative). American Orthopaedic Foot and Ankle Society score improved from 47.4 ± 17.4 to 84.3 ± 8.1. MRI and arthroscopy confirmed good fill and improvement from 6 to 24 months. Similar results have been achieved by others.\(^2\)\(^7\)–\(^2\)\(^9\) Malleolar osteotomy was required in most of these cases using autologous chondrocyte implantation. Giannini and colleagues\(^2\)\(^8\) also used the osteochondral fragment as the source of cells with excellent results.

OSTEOCHONDRAL ALLOGRAFT

Osteochondral allograft transplantation provides mature hyaline cartilage with living chondrocytes with structural support to the osteochondral defect. In contrast to
autogenous graft from the knee, donor site morbidity is eliminated and this technique allows for restoration of the articular surface by taking the appropriate grafts from the matching donor site. The author’s preference is to obtain matched tali, freshly preserved, which gives one the ability to resurface any part of the talar body anatomically, particularly the shoulders (Fig. 10A-C). Gross and colleagues\(^{30}\) initially described fresh allograft transplantation using single talus allografts fashioned to fit into the osteochondral defects in nine patients. Six patients were satisfied with their results and had a mean survival of 11 years. Three patients required ankle fusions. “Fresh” preserved osteochondral allograft was recently described by Tontz and colleagues.\(^{31}\) Twelve patients affected mostly by bipolar lesions (tibial and talar aspects) with an average age of 43 years were controlled at more than 21 months’ follow-up. All grafts healed at the host/donor interface. Complications included intraoperative fracture in one patient and graft collapse that required revision allografting in another. Most patients were relieved of preoperative pain and were satisfied with the procedure; however, there were several reoperations. With newer techniques and improved viability, it is a useful procedure for large focal defects of the talus or tibia. Unipolar lesions expectedly would be more predictable than bipolar. Fresh tibiotalar allografting is an exciting and promising technique in the treatment of articular cartilage defects in young, athletic patients. The major concerns in this procedure continue to be the viability of the cartilage, host-versus-graft disease, and the possible transmission of infective disease.
OLT are a common cause of disability after an ankle sprain. Strategies in management are evolving. Excision and debridement (curettage or drilling) continue to be the mainstay of initial surgical treatment. Articular resurfacing options continue to be popular and continue to improve. The role of autologous or allograft osteochondral resurfacing needs further investigation. For athletes with these difficult lesions, careful evaluation and appropriate operative or nonoperative treatment can allow return to play after 3 to 6 months.

REFERENCES