Arthroscopic debridement and bone marrow stimulation for talar osteochondral lesions: current concepts

Gian Luigi Canata, Valentina Casale

ABSTRACT
Symptomatic osteochondral lesions of the talus are a common cause of ankle pain and frequently occur among recreational and professional athletes. These lesions are being increasingly diagnosed and a great variety of treatment approaches exist. Since the talar cartilage has poor reparative capacity, the aim of treatment paradigms is to restore the joint surface with a repair tissue as similar as possible to the original cartilage to provide good long-term results. Multiple surgical approaches have been described over the past years in order to identify the ideal treatment option. Arthroscopic debridement and bone marrow stimulation techniques have increasingly gained consensus. We aimed to review the available evidence on these arthroscopic minimally invasive approaches for osteochondral talar lesions.

INTRODUCTION
Osteochondral defects (OCDs) are lesions involving the articular hyaline cartilage and subchondral bone. These lesions can occur in every joint but most frequently affect the knee and elbow. The ankle joint is involved in 4% of all cases and especially occur in sportsmen. OCDs may result from a single episode of injury or repetitive microtrauma. A traumatic event is generally accepted as the main aetiologic factor of lateral osteochondral lesions, while medial lesions often present after non-traumatic events.

Osteochondral injuries may also occur in the talar dome or, more rarely, in the tibial plafond. Talar dome lesions are predominantly located at the posteromedial or anterolateral side. Lesions located at the anterolateral side of the talar dome are caused by dorsiflexion-inversion stress injury, whereas injuries at the postero-lateral dome are provoked by an inversion, plantar flexion and external rotation of the ankle.

Several surgical techniques have been developed over the years to restore the surface anatomy and joint forces in the presence of osteochondral injuries. The choice of the appropriate treatment specifically depends on the nature and location of the lesion. Bone marrow stimulation (BMS) techniques stimulate the formation of a new fibrocartilaginous tissue over the subchondral bone. Among other arthroscopic treatments, these procedures have provided good outcomes and costs are relatively low.

This current concept article focuses on debridement and BMS techniques, currently considered the treatment of choice for the management of OCDs.

Aetiology
The exact aetiology of talar osteochondral lesions remains unclear. However, most studies report a history of trauma as the main cause for developing an OCD. These injuries are especially common after acute and chronic ankle sprains. The impact of multiple forces leads to a cartilage contusion, which may be transmitted to the subchondral bone, causing subchondral microfractures progressing to an OCD or subchondral cyst. Metabolic diseases, genetic predisposition, vascular or synovial alterations or chronic microtraumas are also cited among the causes of OCDs development.

Clinical presentation
In the case of osteochondral lesions of the talus, symptoms may be aspecific. Patients may experience a painful ankle and report instability or blocking. Swelling may be absent and range of motion normal or only moderately limited. After a few weeks, when symptoms of an ankle sprain or ‘simple’ trauma should have reduced, the patient experiences persistent or intermittent deep ankle pain during or after physical activity. It should be also noted that the affected joint could present normal motility, and no evident tenderness on palpation; this often leads to a diagnosis delay in case of an OCD. If symptoms persist after 4–6 weeks, a talar osteochondral lesion should always be suspected.

Diagnosis and classification
History taking and clinical assessment are fundamental for a correct diagnosis. Diagnostic examinations include tests to assess instability and range of motion, and to exclude neurological and vascular conditions. The affected side should always be compared with the contralateral side.

Plain radiographs are the test of choice, although they do not always identify OCDs, unless there is a displaced fragment. In case of posteriorly located lesions, Thompson and Loomer developed the heel-rise view in order to overcome the low sensitivity of standard radiological examination. Using this view doubles the diagnostic OR for OCDs.

For a correct radiological evaluation, plain radiographs should be the first examination to be performed. However, conventional radiography does not detect cartilage defects or non-displaced fragments. In case an osteochondral lesion is still suspected, a CT scan is often preferred to get further details. It is highly sensitive and specific for detecting OCDs, but it cannot visualise the articular cartilage, as well as radiographs.

CrossMark
Finally, MRI is justified in cases of persistent ankle pain. It can be used to assess both lesions of the articular cartilage and subchondral bone, as well as to evaluate the surrounding soft tissue for abnormalities, even if it can be relatively expensive in some countries and cannot be immediately available in all areas.

Berndt and Harty first developed the most widely recognised scale based on both radiographic images and intraoperative findings (table 1). This staging system is greatly important to define the appropriate surgical treatment.

The Berndt and Harty scale was challenged because many radiographic images could not be classified and there were no references to cystic lesions. For this reason, in 1993 a fifth stage was added to the mentioned scale to include cystic lesions within the talon dome. The adoption of arthroscopy in the management of OCDs and improvements in radiological evaluations led to further classifications to improve diagnostic, therapeutic and prognostic aspects.

### MANAGEMENT OF OSTEOCHONDRAL TALAR LESIONS

Several authors have reported good to excellent outcomes in a high percentage of patients submitted to arthroscopic debridement, microdrilling (MD) and microfracturing (MF). Therapeutic modalities depend on symptoms, the grade of the lesion and the size of the lesion (<1.5 cm).

In the presence of lesions unstable with mechanical symptoms or recalcitrant to conservative measures, operative treatment is strongly recommended.

Over the years, several authors have analysed different arthroscopic techniques which may help to restore the original anatomy.

These procedures are debridement and BMS, including drilling, MF and abrasion arthroplasty; fastening a lesion through fragment fixation, bone grafting or retrograde drilling; hyaline cartilage regeneration or replacement using osteochondral autograft transplantation, autologous chondrocyte implantation or allografts.

Many authors suggest retrograde drilling in osteochondral lesions with an intact cartilage surface or in case of large and floating fragments which need to be secured to the talon dome with screws, pins, bone pegs or Kirschner wires.

Retrograde drilling was also proposed by Taranow et al in patients with subchondral cysts or as an alternative to the traditional anteromedial and anterolateral approaches when lesions are difficult to access.

Kono et al have pointed out that the posterolateral portal seems more reliable than the anterolateral one in performing retrograde drilling, to prevent the possibility of injuring the talon attachment of the anterior talofibular ligament or mechanoreceptors around the sinus tarsi.

No substantial difference emerges between the functional results of transmalleolar and retrograde drilling. Additionally, retrograde drilling provides the opportunity to drill close to the subchondral bone without damaging the articular structures.

### Table 1 Radiographic classification of osteochondritis dissecans (Berndt and Harty)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>Small, subchondral compression of the bone (no visible fragment)</td>
</tr>
<tr>
<td>II</td>
<td>Incomplete bony fracture</td>
</tr>
<tr>
<td>III</td>
<td>Complete fragment avulsion with no displacement</td>
</tr>
<tr>
<td>IV</td>
<td>Total detachment of fragment with displacement</td>
</tr>
</tbody>
</table>

### Debridement and BMS

Arthroscopic debridement and BMS currently stand out as the gold standard treatment for talar osteochondral lesions, especially when a complete detachment of the lesion is present, and internal fixation is not amenable. Arthroscopic excision, curettage and BMS are the most reliable treatments for primary OCDs in terms of low morbidity, relatively quick recovery and high success rate. Furthermore, the popularity of BMS procedures can be also attributed to its cost-effectiveness.

Multiple risk factors have proven to negatively influence the clinical results after BMS, such as high body mass index (BMI) and the presence of degenerative cartilage lesions. A history of ankle trauma and lesion extent bigger than 1.5 cm² are predictors of BMS procedures.

The main principle behind BMS is the tight connection between biomechanical characteristics of the subchondral bone and articular cartilage conditions, as well as the homoeostatic balance of the whole joint. Basically, BMS techniques stimulate filling of a cartilage defect with reparative tissue.

The release of blood and mesenchymal cells induced by perforation of the subchondral bone promote the formation of a clot in the defect that slowly differentiates into a fibrocartilaginous repair tissue.

Therefore, BMS may be considered the first-line approach in cases of full-thickness cartilage lesions, although the durability of such repair tissue is still a topic of discussion, especially in defects larger than 2–4 cm² and located in other areas than the knee joint.

In the presence of a subchondral cyst, several approaches are possible, especially if the lesion is smaller than 2.0 cm². If a bigger lesion is present, a graft is usually recommended because minimally invasive techniques alone could not provide satisfying results.
results. Few studies have recently shown good to excellent results following BMS alone, even in the presence of small cystic lesions. Lee et al. have compared the outcomes of patients treated with microfracture for small to mid-sized osteochondral lesions of the talus with and without subchondral cysts. The results showed that the presence of a subchondral cyst does not negatively affect clinical results (figures 1 and 2).

Arthroscopic drilling is one of the most frequently used methods, due to the advantages of being less invasive than other surgical methods and requiring a short hospitalisation period. Becher Thermann discussed the avoidance of thermal injury and the easier accessibility to all defects as the main advantages of MF and MD, in comparison with other more invasive procedures which require transstitial drilling or osteotomy of the medial malleolus.

However, Chen et al. observed in a rabbit model that the development of a compact bone around the new holes after MF inhibits the release of marrow cells and, consequently, limits the repairing process.

In contrast to this, MD did not cause heat necrosis around the drill holes, and therefore the use of a thin drill bit under cooled irrigation was adopted. MD is considered a reliable and effective surgical procedure among other BMS techniques (figures 3–7).

Additionally, the fibrous tissue resulting from MF is more likely to develop osteoarthritis. In case of intact cartilage, retrograde drilling of the subchondral bone can be an effective option, although long-term follow-up results are still needed.

Schuman et al. recommended a combination of debridement and drilling in the treatment of OCDs. An adequate debridement of the lesion before drilling prevents recurrent symptoms.
and revision surgery. The combination of these techniques showed good to excellent results in a high percentage of cases.\textsuperscript{44}

In a retrospective study of 34 patients, Robinson \textit{et al}\textsuperscript{45} found that excision and curettage provide better outcomes than excision, curettage and drilling. The drilling procedure is targeted at a limited number of cases, since it violates the normal structure of the medial malleolus.

In regard to MF, the correct dimension and placement of the holes is primarily important.

Kok \textit{et al}\textsuperscript{46} have remarked on the difference between microfracture awls and the Kirschner wire. However, the use of microfracture awls is not an easy task in the presence of defects located posteriorly.

After surgery, active plantar flexion and dorsiflexion are recommended. Full weight-bearing should be progressively reached within 2–4 weeks in patients with central or posterior lesions up to 1 cm. In case of larger or anterior defects, rehabilitation takes 2 weeks more for a full weight-bearing recovery. Running is generally permitted after 12 weeks.\textsuperscript{8, 47}

Van Eekeren \textit{et al}\textsuperscript{29, 48} have recently discussed the potential factors favouring optimal rehabilitation. Some examples are young age, low BMI, small osteochondral lesion size, use of growth factors or hyaluronic acid. However, despite the high incidence of patients returning to sports at long-term follow-up, the activity level decreased and never reached the preinjury level.\textsuperscript{29}

An increasing number of authors are currently performing hyaluronic injections at the end of surgery, particularly following arthroscopic MF surgery.\textsuperscript{49} After microfracture procedure, a fibrocartilaginous repair tissue develops presenting the type I collagen properties. Since this tissue differs from hyaline cartilage in biological and mechanical properties,\textsuperscript{50} it may degenerate over time; thus, several authors have suggested the addition of hyaluronic acid administration, sometimes associated with platelet-rich plasma injections, which have reported fairly good outcomes.\textsuperscript{49, 51} (box 1).

**FUTURE PERSPECTIVES**

At the present time, the long-term efficacy of cutting-edge techniques is largely unknown. The long-term viability of cartilage is currently being studied, focusing on its possible fissuring and fibrillation.

Improvement in imaging sensitivity has helped current research to achieve promising results; in particular, the progress in morphological MRI will guarantee a better diagnosis and monitoring of osteochondral lesions.

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**Box 1 Current concepts for arthroscopic debridement and bone marrow stimulation for osteochondral defects**

- Arthroscopic debridement and bone marrow stimulation currently are the first-line treatment for talar osteochondral lesions.\textsuperscript{19, 30}
- Multiple risk factors have proven to negatively influence the clinical results after bone marrow stimulation (BMS), such as high body mass index (BMI) and the presence of degenerative cartilage lesions. A history of ankle trauma and lesion extent bigger than 1.5 cm\textsuperscript{2} are the hallmarks for BMS procedures.\textsuperscript{6, 32}
- Van Eekeren \textit{et al}\textsuperscript{29} state that if a complete detachment of the lesion has occurred and internal fixation is not feasible, arthroscopic debridement and BMS are the treatment of choice for talar osteochondral lesions.
- In regard to microfracturing, the correct dimensions and placements of the holes are primarily important. Kok \textit{et al}\textsuperscript{46} have remarked on the difference between microfracture awls and the Kirschner wire. However, the use of microfracture awls is not an easy task in the presence of defects located posteriorly.
- After surgery, active plantar flexion and dorsiflexion are recommended. Full weight-bearing should be progressively reached within 2–4 weeks in patients with central or posterior lesions up to 1 cm, centrally or posteriorly positioned. Larger or anterior defects require partial weight bearing up to 6 weeks. Patients can start running at 12 weeks.\textsuperscript{8, 47}
Ongoing research aims to provide the proper indications for conservative treatment and optimise surgical procedures. BMS techniques continue to evolve towards a reduction of both operative invasiveness and morbidity, recovery timing, as well as surgical costs. The latest advances in BMS supported by biological research, now working on the use of mesenchymal stem cells, growth factors and biological scaffolds, will allow clinicians to achieve the best possible results in the healing processes (box 2).

CONCLUSIONS
In case of small-sized to medium-sized lesions (<1.5 cm²), arthroscopic treatment using debridement and mini-invasive drilling may be considered the gold standard for arthroscopic therapy of talar osteochondral lesions.

Acknowledgements The authors wish to acknowledge the assistance of Dr Gwendolyn Vuurberg in writing the present article and Catena Cottone for technical editing.

Competing interests None declared.

Provenance and peer review Commissioned; externally peer reviewed.

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Canata GL, Casale V. *JISAKOS* 2017;2:2–7. doi:10.1136/jisakos-2016-000099


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J ISAKOS 2017 2: 2-7 originally published online October 27, 2016
doi: 10.1136/jisakos-2016-000099

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