33 Etiology, Classifications, and Treatment by Arthroscopic Procedures

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33.1 Introduction

Arthroscopy of the first metatarsophalangeal (MTP) joint is still relatively rare, and has been considered to have limited application and to be difficult to accomplish. However, consensus is growing among orthopedic surgeons that a proven surgical technique and the availability of dedicated instruments are making the surgery possible.

Historically the first case dates back to 1985 with Watanabe, Ito, and Fuji [1]. In 1988 Bartlett published the treatment of an osteochondral defect of the head of the first metatarsus of an adolescent boy, entirely by arthroscopy [2]. Ferkel made an important contribution in 1993 when he gave a detailed description of the methodology, specifying the access portals and the intraoperative diagnostic pathway [3].

Initially, arthroscopy of the great toe was used solely as a diagnostic method, but following numerous scientific contributions relating to the technique and its usefulness, it became a treatment method.

Conservative treatment, such as pharmacological therapy and physiotherapy associated with the use of customized orthoses, is the first choice, with surgery being considered only after its failure.

The results obtained in the treatment of major joint pathologies led to the cure of the first MTP joint above all because arthroscopy is less invasive, with minimal bleeding, leaves fewer scars, and is characterized by more rapid functional recovery (especially in athletes), as well as improved esthetics and lower costs as less time is spent in the clinic.

33.2 Indications, Etiology, and Classification

This arthroscopy is no longer 'new-generation surgery,' as it could be called, as it is undergoing continuous development by refining of the technique and the broadening of therapeutic indications.

Up to now, the various pathologies of the great toe have been treated with the classical open methods; arthroscopy is not intended to replace these methods completely, but it is a valid and less aggressive alternative with undoubted advantages.

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The conditions that should prompt the surgeon to consider arthroscopy are persistent pain and swelling that are impervious to physiotherapy and pharmacological treatment, reduced articular function in dorsal and plantarflexion (range of motion), with some episodes of articular blocking.

33.2.1 Major Indications

- Hallux rigidus (Figs. 33.1 and 33.2) (first–second in the Coughlin and Shurnas classification) [4].
- Focal osteochondral lesions (Fig. 33.3).
- Synovitis (Fig. 33.4).
- Soft-tissue impingement.
- Loose bodies (Figs. 33.5 and 33.6).

When treating hallux rigidus, for example, any axial defects of the first ray should be investigated. Dorsal osteophytes, restricting dorsiflexion, must be identified in their position and size, and the degree of the pathology should be established because a serious degenerative arthritic state is one of the counterindications (third–fourth according to the classification of Coughlin and Shurnas) [4].

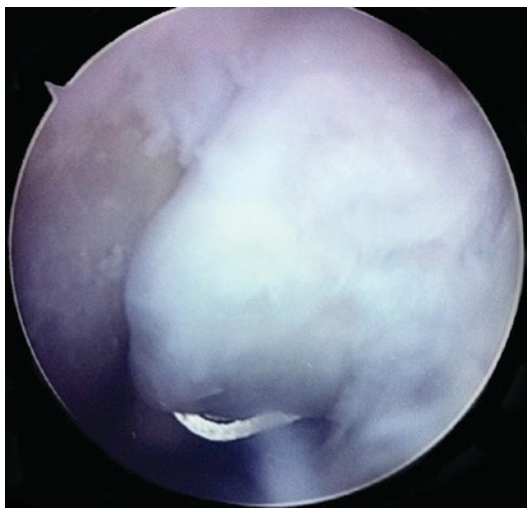

Fig. 33.1 Osteophyte on dorsal edge of head of first metatarsal ray

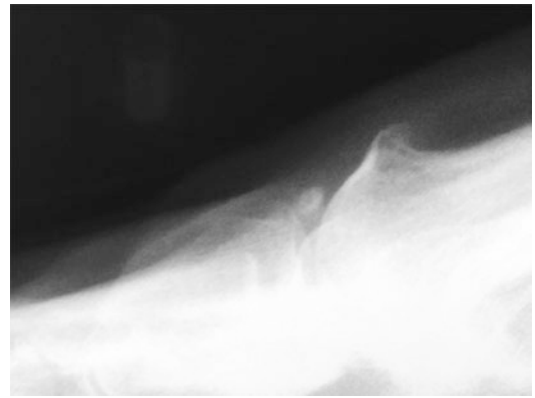

Fig. 33.2 X-ray (lateral view) in a hallux rigidus (first degree) plus intraarticular loose body

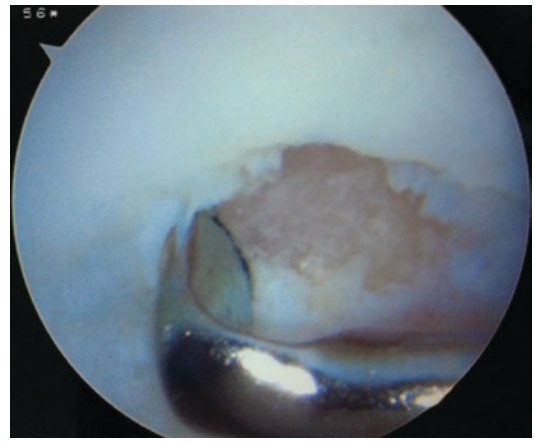

Fig. 33.3 Osteochondral lesion of the first metatarsal head

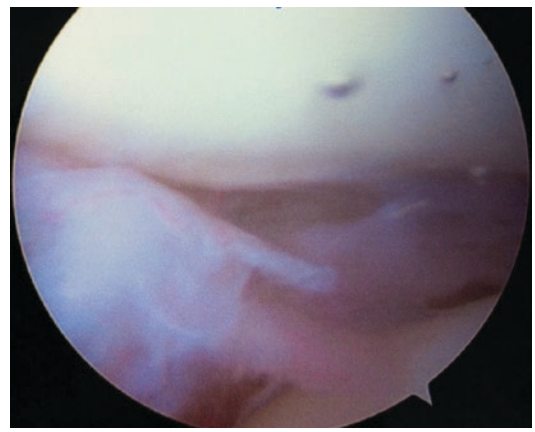

Fig. 33.4 Arthrosynovitis of the first metatarsophalangeal

Fig. 33.5 Loose body

Fig. 33.6 X-ray (frontal view) of first metatarsophalangeal joint with a loose body

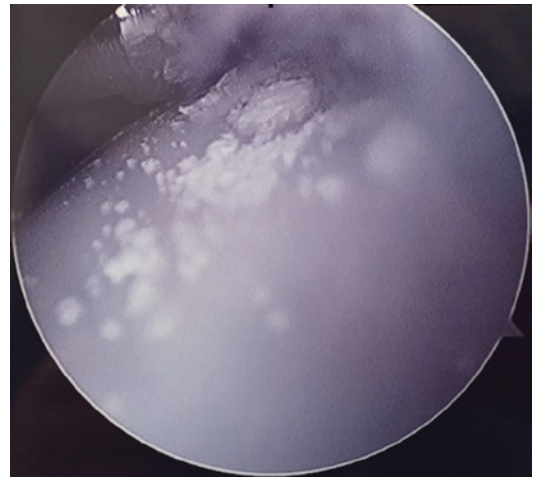

Fig. 33.7 Gout and its intraarticular deposits

This requirement also applies to the chondral and osteochondral lesions that generally affect young sports players. These lesions are derived from osteochondritis dissecans, or may be posttraumatic or microtraumatic osteochondral lesions, sometimes with loose bodies. The size and location of the osteochondral lesions are important and, as stated in the literature, the measurement limit for treatment should be 50 mm^2 or less [5].

33.2.2 Controversial Counterindications

- Endoscopic distal soft-tissue procedure for hallux valgus correction [6].
- Gout and its intraarticular deposits (Fig. 33.7).
- Sesamoiditis and sesamoid fractures.
- Early forms of osteoarthritis.

33.2.3 Absolute Counterindications

- Advanced arthritis stages (end stage; third–fourth in Coughlin and Shurnas classification) [4].
- Severe axial misalignment of the first ray, requiring osteotomies or other corrective procedures.

– Poor vascular status.
– Infection.
– Severe swelling of soft tissues.

33.3 Anatomy

The proper surgical approach requires precise knowledge of the anatomy of the joint. The first MTP joint is essential for walking, bearing twice the load of the other toes; it has been calculated that, at each step, the maximum load on the great toe is between 40% and 60% of the person's weight, and this is much more significant during running and jumping [7].

Anatomically, this joint comprises the distal portion of the first metatarsal bone (head and neck) and the proximal part of the proximal phalange (ball-and-socket joint). In the plantar region, there are two small sesamoid bones, separated by a central ridge known as the crista: the tibial one is larger and the fibular one is smaller. The two bones are embedded in the flexor hallucis brevis of the great toe and are held together by the intersesamoid ligament. Their function is to change the direction of a muscle pull, to modify pressure and diminish friction.

Arising in the dorsal region, on the median line, the extensor hallucis longus tendon of the great toe is inserted at the base of the distal phalange, and laterally is accompanied by the extensor hallucis brevis that finds its insertion at the base of the proximal phalange.

Articular stability is provided by a capsule–ligament complex and the shape of the articular surfaces [8].

The joint capsule has a strengthening system, the medial and lateral collateral ligaments, added to the metatarso-sesamoid ligaments ending at the plantar plate. Capsule support is also provided by the tendons of the abductor and abductor of the great toe.

Blood supply is by the dorsalis pedis artery with its dorsal and plantar ramifications.

Sensitivity of the great toe is provided by the superficial peroneal nerve, which, in the ankle, obliquely crosses the midfoot and forefoot until it reaches the first MTP joint, located about 4 mm medially from the extensor hallucis longus, innervating the medial and plantar portions. On the other hand, the lateral region is sensitized by the interdigital nerve coming from the medial plantar nerve.

33.4 Physical Examination

The clinical evaluation of the great toe includes looking at the integrity of the cutaneous coating, identifying swollen areas, and any skin discoloration and dorsal subcutaneous osteophytes or peri-articular calluses. Any axial defect of the big toe, typical of the hallux valgus, should be investigated, along with any associated deformities of the lesser toes and the rest of the foot. It is important to palpate the painful points, evaluating the range of motion of the great toe and its stability.

The first MTP joint has a range of movement with active extension of 50–60° and 30–40° active flexion. Passive extension, indispensable in the last phase of the step, reaches or exceeds 90°, compared to 45–50° for passive flexion [9]. Decrease of the normal range of motion of the first MTP joint is one of the features of hallux rigidus.

During the objective examination, the patient should be assessed standing to evaluate the morphotype of the foot and any alterations in walking, including the ability to walk on the toes or heels. Shoes should be checked to assess any deformities of the sole.

Any hypermobility of the first ray should be considered along with any instability on the transverse or sagittal axes.

33.5 Imaging

In the diagnostic exams, the first step is to take an X-ray standing, with anteroposterior radiographs with additional lateral, oblique, and tangential views for the sesamoid bones. This imaging enables detection of osteophytes and assessment of the degree to which the joint line has been reduced, with associated sclerotic areas.

Magnetic resonance imaging (MRI) is very useful; it can be carried out if osteochondral lesions or synovial reactions are suspected. It is useful to assess the type of chondral lesion and to identify loose bodies, sesamoiditis, ligament injuries, plantar plate tear, or osteophytes. Computed tomography (CT) is typically used to identify the location and size of osteophytes and to assess any subchondral cystic areas.

It is important to choose the appropriate imaging examination to make the correct surgical choice, that is, arthroscopic versus open.

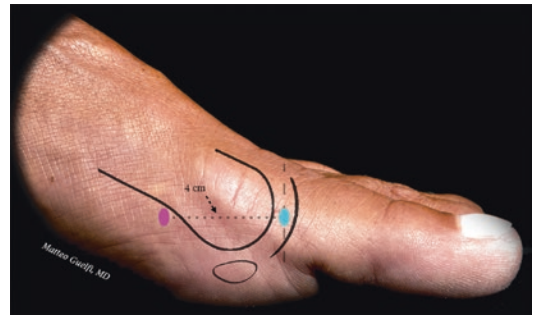

Fig. 33.8 Arthroscopic portals (lateral view) (courtesy of Matteo Guelfi MD)

33.6 Portals

In the literature, six arthroscopic portals to the first MTP joint are described:

1. The dorsal medial, the dorsal lateral, and the medial portals.
2. The medial plantar and the proximal medial portals.
3. The lateral toe web portal.

The portals most commonly used are the dorsomedial and the dorsolateral; others include the medial portal and lateral toe web [10].

When preparing surgical access portals, it is useful to draw the anatomic landmarks (dorsal joint line, the course of the extensor hallucis longus, and the medial dorsal nerve branch) to reduce the risk of causing lesions to the dorsal nerve branch coming from the superficial peroneal nerve (Figs. 33.8 and 33.9).

The first portal to be established is the dorsolateral, located on the joint line 2 mm lateral from the extensor hallucis longus. The second portal is dorsomedial, created under arthroscopic control, and is located on the joint line about 2.0 mm distant medially from the extensor hallucis longus and 4.0 mm from the nerve branch.

The remaining two portals, the plantar medial portal and lateral toe web, are used to view the plantar region of the joint and the two sesamoids [11]. The first is located 4.0 mm proximal to the joint line, between the abductor and medial head of the flexor hallucis brevis,

Fig. 33.9 Arthroscopic portals (frontal view) (courtesy of Matteo Guelfi MD)

and the toe web portal is on the dorsal surface of the first web, approximately 4.0 mm proximal and medial [12].

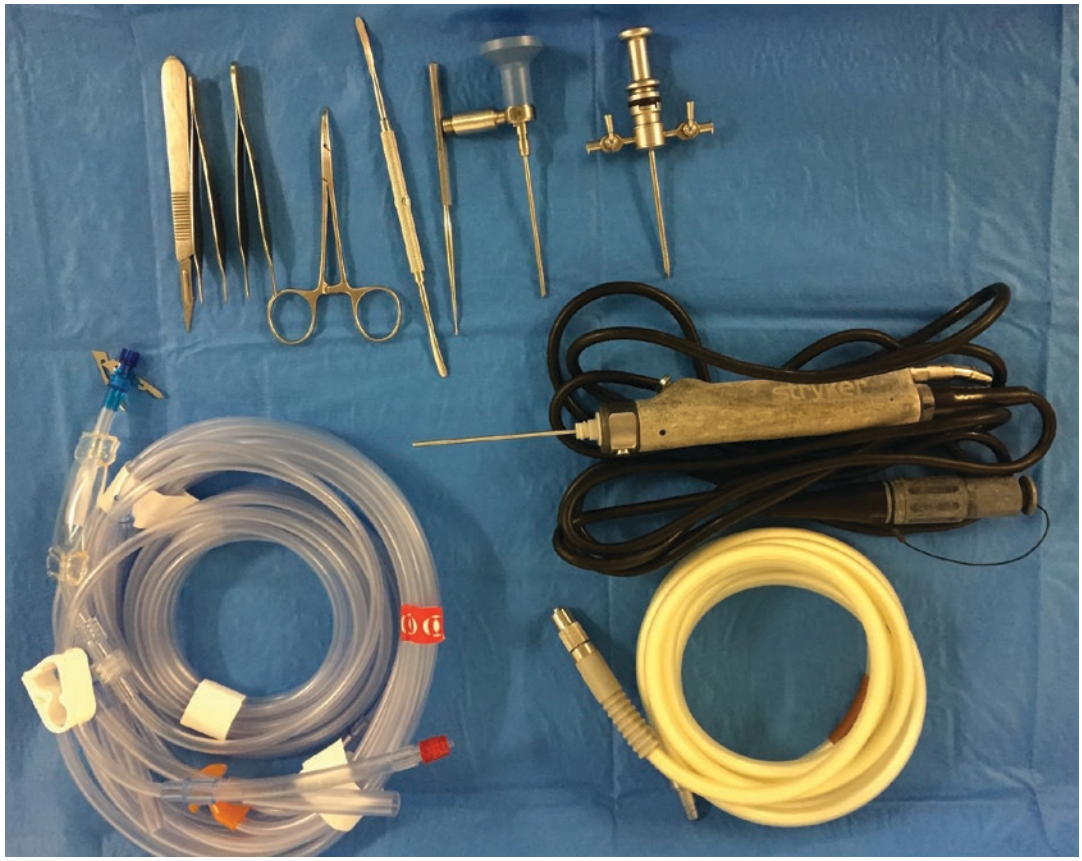

Fig. 33.10 Dedicated arthroscopic instruments

33.7 Equipment

Dedicated instruments include an arthroscope (diameter 1.9, 2.5, or 2.7 mm) with an inclination of 30° or 70° and a set of instruments for small joints with diameter varying from 1.6 to 2.3 mm (freer, basket, grasper, probe) (Fig. 33.10). The authors use an irrigation system (pressure, 45 mmHg).

To remove soft tissues, typical in arthrosynovitis, a 2.5-mm shaver is used. In the treatment of hallux rigidus and for osteochondral lesions, a 2.5-mm bone resector is used to debride the osteophytes and the damaged cartilage; a 2.0-mm curette and a microfracture set or 1.0 mm Kirschner wire is used to stimulate the subchondral bone for bone marrow stimulation (BMS).

For the treatment of osteophytes in hallux rigidus, it is advisable to have a brightness amplifier on hand to check the proper removal of bone spurs.

33.8 Preoperative Preparation and Operative Technique

The patient is placed in supine position on the operating table with the heel on the edge of the table and the foot straight. Anesthesia may be local/regional (epidural anesthesia) or general. The authors prefer to use a tourniquet on the thigh. It is advisable to apply it above the ankle and calf to prevent blockage of the extensor hallucis longus (EHL) or flexor hallucis longus (FHL) tendon.

Arthroscopic treatment of small joints is often difficult because of the reduced working space and the skeletal joint architecture, so the surgeon may use an invasive or noninvasive distractor. The first option is to use an external fixator; the noninvasive systems include manual traction, which usually provides a good view, or

Fig. 33.11 Manual distraction systems with a finger trap

the use of a sterile finger trap applied to the great toe and hooked up to a shoulder holder system (Fig. 33.11).

The position of the surgeon relative to the patient may vary according to preference: he can sit at the foot of the table or by the side of the patient, working with the foot in a frontal position. The viewing monitor should be placed accordingly. After drawing the anatomic landmarks (joint line, extensor hallucis longus, cutaneous nerve branch), mark the arthroscopic portals (Fig. 33.8 and 33.9).

The dorsolateral portal is carried out first. The first step is to introduce into the joint 5.0 ml saline solution using a syringe with #22 needle, to create the working space (Fig. 33.12). Using an 11-blade scalpel, vertically cut only the skin (3 mm), make a subcutaneous blunt dissection, and open the capsule with a hemostat or mosquito clamp, taking care not to damage the cartilage (Figs. 33.13 and 33.14).

Fig. 33.12 Creation of dorsolateral portal using a #22 needle without finger trap

Fig. 33.13 Introduction of shaft of the arthroscope into the joint

Fig. 33.14 Introduction of the arthroscope into the joint

The dorsal medial portal is created using the same 22 G needle, under arthroscopic control and via trans-illumination, a useful system that enables the surgeon to avoid lesions to the vascular structures and articular cartilage [12].

Before diagnostic examination, a shaver may be used to remove the intraarticular synovial tissue because it often blinds the vision. The shaver should be switched in the two portals, controlling the tip to not damage the surrounding tissues. The joint should be assessed in line with Ferkel guidelines by identifying the 13 points via the two classic dorsal portals [13]:

1. Lateral gutter.
2. Lateral corner of the metatarsal head.
3. Central portion of the metatarsal.
4. Medial corner of the metatarsal head.
5. Medial gutter.
6. Medial capsular reflection.
7. Central bare area.
8. Lateral capsular reflection.
9. Medial portion of the proximal phalanx.
10. Central portion of the proximal phalanx.
11. Lateral portion of the proximal phalanx.
12. Medial sesamoid.
13. Lateral sesamoid.

33.8.1 Osteochondral Lesions

During the diagnostic examination, feel the condition of the cartilage coating, looking for chondromalacic areas and their staging. As described by Kim, osteochondral lesions of less than 50 mm^2 can be treated with BMS after careful debridement of the diseased cartilage tissue and with stimulation of the subchondral bone with small-diameter micropicks for microfracture, penetrating into the subchondral bone no more than 3 mm [5]. After carrying out the microfractures, the tourniquet is released and the water inflow closed off, to ensure the bone tissue bleeds properly, allowing clotting rich in mesenchymal cells.

33.8.2 Hallux Rigidus

In treating hallux rigidus, the authors recommend a variant of the position of the patient on the operating table. The knee, supported by a leg holder, is bent, providing a stable support for the foot on the operating table, and traction is manual (Fig. 33.15).

Fig. 33.15 Position preferred by the authors in the treatment of hallux rigidus

After creating two classic dorsal portals, carry out the needed synoviectomy to locate and estimate the size of the osteophytes. Importantly, use a Freer to clear the portion of the articular capsule adhering to the osteophytes. After creating a working space, remove excess bone on both sides. The portals should be inverted to provide an unobstructed view. After cheilectomy, assessed with a brightness amplifier, check the recovery of the range of motion, above all the dorsal flexion, excluding elements of impingement (Fig. 33.16).

33.8.3 Synovitis, Loose Bodies, and Sesamoiditis

Synovitis is one of the most common causes of joint pain, so is necessary to remove the synovial soft tissue carefully, using a shaver, and always paying attention to the presence of loose bodies in the joint: these must be removed.

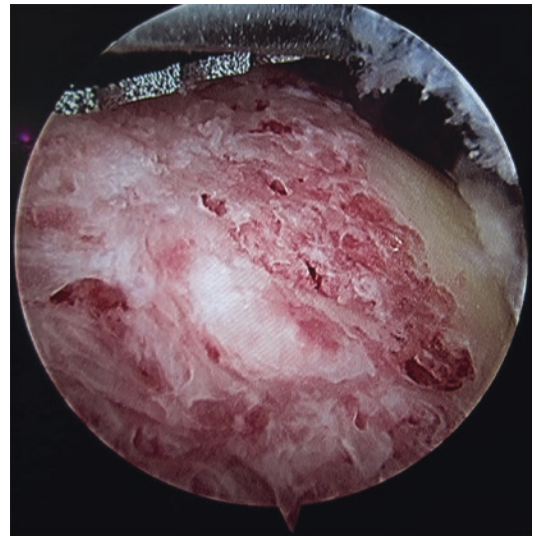

Fig. 33.16 First metatarsal head after cheilectomy

Inspection of the sesamoids and plantar plate is carried out via medial plantar access, as already described. The portals are sutured with nonabsorbable 3.0 nylon thread. The dressing is completed with sterile gauze near the surgical access points.

33.9 Postoperative Management

The patient is treated by outpatient procedures. During the first week, a short Walker or orthopedic footwear with a rigid sole should be used. Walking should be allowed if pain free. Antiinflammatory medications are recommended to control pain. Dressing of surgical injuries should be repeated every 2 days, and the stitches removed after 10 days.

For rehabilitation, start early with mobilization (active and passive) of the toe, carrying out gentle movements of circumduction and flexion/extension. Normal footwear can be used after a few weeks, when the patient is able to walk without pain.

The patient may return to noncontact sports (swimming, spinning) immediately after healing of the wounds. Contact sports should be avoided for at least 2 months.

33.10 Complications

Numerous complication from the surgery are described in the literature, such as nerve injuries and iatrogenic cartilage injuries. Van Dijk reported that neuropraxia of the dorsal medial cutaneous nerve is the most frequent [14]. In 2006 Debnath et al. recorded two temporary nerve lesions among 20 patients undergoing arthroscopy of the first metatarsophalangeal joint [15].

Portals should be carried out precisely, ensuring the proper size of the instruments and their proper intraarticular handling to avoid iatrogenic damage to the cartilaginous surfaces. One complication is the risk of surface and deep infections [16].

When treating hallux rigidus, a brightness amplifier or use of surgical devices such as a Kirschner wire is absolutely necessary, enabling the surgeon to properly remove the osteophytes shaping the articular profiles. These devices should be used during the learning curve, where there is a risk of carrying out excessive or insufficient resections, aggravating the articular damage.

33.11 Pitfalls and Tricks

- Carry out a precise clinical assessment of the patient and the pathology to be treated, informing him/her of all the risks and benefits of the surgery. Arthroscopy of the metatarsophalangeal joint cannot be carried out in all cases.
- The major indications for arthroscopic treatment of the first MTP joint are hallux rigidus (first–second in the Coughlin and Shurnas classification), focal osteochondral lesions, synovitis, soft tissue impingement, and loose bodies.
- Position the patient correctly on the operating table.
- Highlight the arthroscopic portals and mark the position of the anatomic structures involved (joint line of first metatarsophalangeal joint, extensor hallucis longus, medial dorsal cutaneous nerve branch).
- The joint should be assessed in line with Ferkel's guidelines.
- Careful use of the instruments is necessary to avoid iatrogenic damage to the joint tissues. If the portals are inadequate, it is advisable to use accessory portals, above all for the plantar sesamoid region.
- For osteochondral lesions, carefully debride the diseased cartilage tissue and stimulate the subchondral bone with small-diameter micropicks for microfractures.
- In the treatment of hallux rigidus, a brightness amplifier is absolutely necessary, enabling the surgeon to properly remove the osteophytes.

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