The role of metatarsophalangeal joint arthroscopy in hallux rigidus treatment: technique and early results

Ieronim O. Crișan

Abstract: Introduction: The hallux rigidus is a term that signifies a mobility limitation of the metatarsophalangeal joint of the big toe due to osteoarthritic degeneration. Several factors are incriminated in the appearance of this pathology but without being able to establish the cause. The cartilaginous erosion of the metatarsal head and / or the base of the phalange, the dorsal osteophyte of the head of the first metatarsal were found during cadaveric studies. The main reason for consultation is pain and limitation of the dorsiflexion of the big toe during the step. Hypothesis: Arthroscopic debridement of the first metatarsophalangeal joint improves the early postoperative clinical score compared to isolated percutaneous treatment. Material and method: 11 patients divided into 2 groups were assessed clinically at 3 months postoperatively. All patients were hospitalized on an outpatient basis. Results: There was a gain in mobility at 3 months compared to the preoperative assessment in both groups, as well as an improvement in pain without being able to demonstrate the superiority of the additional arthroscopy to the percutaneous debridement. Hypothesis reversed.. Keywords: hallux rigidus, orthopedics, arthroscopy, osteophyte

INTRODUCTION

Pathogenesis

Hallux rigidus is a term invented by Cotterill in 1888, refers to a limitation in mobility of the metatarsophalangeal joint of the hallux. Although he did not call it hallux rigidus, in 1887 Davies-Colley reported for the first time the resection of the base of the first phalanx for this pathology, which he called hallux flexus because of the flexion attitude of the metatarsal-phalangeal joint and the limitation of extension of this joint. Moreover, the understanding of this pathology has advanced thanks to radiological techniques, but the pathogenesis of the hallux rigidus is not yet defined.

The evolution towards the aggravation of the destruction is on the other hand well known. The cartilaginous lesion is supposed to initiate synovitis, which itself supports cartilage destruction, accompanied by osteophyte formation and subchondral bone involvement. [1]

The degenerative process can begin in adolescence when a traumatic event at the metatarsophalangeal
joint damages the articular surface of the head of the first metatarsal. Repetitive strain injuries can also cause cartilage damage. Other causes are mentioned: osteochondritis dissecans of the head of the first metatarsal secondary of an osteochondral fracture at the level of the dorsal convexity of the articular surface, the hyperextension of the first metatarsal, an excessive length of the first metatarsal and a severe pronation of the foot. The hallux rigidus of the adult is most often caused by degenerative arthropathy or osteoarthritis of the metatarsophalangeal joint, while in adolescents the hallux rigidus results from a localized cartilaginous lesion of the head of the first metatarsal most post traumatic time [1,2]

A system for classifying the severity of hallux rigidus takes into account passive mobility, pain, and radiographic assessment to assign a stage from 0 to 4. This classification of Coughlin and Shurnas has been reported to be reliable in predicting the outcome of surgical treatment. [1]

Despite the fact that the metatarsus primus elevatus (dorsal positioning of the first metatarsal on a lateral X-ray in load of the foot) has been incriminated as a primary cause in the pathogenesis of hallux rigidus, this was not proved. No association was identified between hallux rigidus and primus elevatus, hypermobility of the first ray, the first long metatarsal and stiffness of the Achilles tendons, abnormal posture of the foot, symptomatic hallux valgus, shoes or professional occupation. It is more frequently associated with hallux valgus interphalangeal, bilateral involvement in patients with family history, unilateral involvement in patients with traumatic history, female gender. [2]

McMaster reported that the most common finding in seven patients with hallux rigidus was cartilaginous cleavage at the head of the first metatarsal without subchondral bone detachment and that the earliest radiological change was a small depression in the dome of the first metatarsal head. The cleavage is always between the top of the dome and the dorsal edge of the articular surface. McMaster believes that the exquisite pain and dorsal range of motion limitation can be explained by the osteophytic lesion on the dorsal metatarsal head. When hallux is in extension, the arrival of the first phalanx against the metatarsal cleavage site produces pain and reflex flexion of the joint, limiting extension. Then the disease progresses, an osteophyte at the level of the dorsal articular margin of the head of the first metatarsal produces a stop during great toe extension. This is the initial image of the patient: osteoarthritic changes in or around the metatarsophalangeal joint of the hallux. Often the first metatarsal is in the dorsal forcing position, decreasing its angle of plantar inclination on the profile X-rays (primus elevatus). This elevation of the first metatarsal is rather secondary to metatarsophalangeal osteoarthritis than the cause of this one. [1,2,3]

Clinical

The main reason for consultation is the progressive onset of pain and the limitation of the articular amplitudes of the hallux which is either fixed in plantar flexion or limited in dorsiflexion due to osteophytes present around the head of the first metatarsal, especially on the dorsal surface. [1]

This is not the case on the plantar surface where there is a normal mobility in flexion. The severity of the degenerative changes is directly dependent on the duration of the symptomatology. [2]

Muscular cramps in the extensor hallucis long tendon without mechanical conflict can be found early in the course of the degenerative process. Gradually the hallux becomes fixed in plantar flexion and the patient is forced to walk on the outer face of the foot. [2]

Unilateral involvement is the most common despite Nilson who postpones bilateral involvement in 60% of his cases. The aesthetic factor (the intolerance of wearing shoes in the heel) gives a preponderance to the female sex. Although Smith reported small series of older patients suffering from hallux rigidus, in the literature the age of the first symptoms were adolescence. [2]

Radiological characteristics

The flattening of the head of the first metatarsal, the joint narrowing, the presence of osteophytes of the dorsal, medial and lateral faces of the metatarsal head and the base of the phalanx, subchondral sclerosis and
the formation of cysts at the level of the head of the first metatarsal are common elements in the elderly population. Sometimes the proximal phalanx is held in plantar flexion due to posterior conflict, and stress images can confirm that the osteophyte block prevents extension of the metatarsophalangeal joint. An osteochondral lesion is occasionally observed in the metatarsal head in adolescents according to Goodfellow and McMaster. [1,2]

Conservative treatment

For most patients, surgical correction is necessary to relieve pain and improve function; however, Yee and Lau, in a review of the hallux rigidus literature, have determined that non-operative measures such as foot orthotics, shoe modifications, and corticosteroid and hyaluronic acid infiltrations prior to surgery should be considered. [2]

Surgical treatment

Despite several recommended surgical procedures for the treatment of hallux rigidus, (including the dorsal subtraction osteotomy of the base of the first phalanx or the distal portion of the first metatarsal, the Keller operation or metatarsophalangeal arthrodesis) no procedure has proved its superiority. The indication for the metatarsophalangeal arthrodesis is the articular narrowing objectivized not only on the frontal and lateral incidences but also on the oblique incidence which shows that the remaining articular space is absent on the frontal and lateral incidences. Modern fixation techniques using compression screws or dorsal plates result in high melting rates (between 94% and 98%) and acceptable clinical outcomes for patients.

Gait studies showed significant improvements in propulsive force, foot load, and walking stability after arthrodesis for hallux rigidus. [2]

The justification for metatarsophalangeal debridement is the pain relief due to mechanical conflict suppression between the dorsal osteophyte of the first metatarsal and the base of the phalanx and the boot. The debridement is performed by resection of the osteophyte and other bone growths on each side of the joint with the aim of a dorsal flexion of the hallux of at least 70°. The success rate varies between 56% and 92%, with better results for stage 1 and 2 and for patients over 60 years of age. The gait analysis showed that there is an overload in the lateral part of the head of the first metatarsal after joint debridement and that these changes can lead to future joint degeneration. [1,2]

The modified Keller procedure (arthroplasty-resection), in which the short extensor hallux tendon and the capsule were used as interposition materials, has been described for the treatment of severe hallux rigidus, but the results vary.[2]

Interposition arthroplasty was also modified by oblique resection of the proximal phalanx. [2]

Silicone-rubber interposition arthroplasty was a short term solution because of silicone synovitis. The hemiarthroplasty of the proximal phalanx with a metallic component was also described, with good results, but there are no long-term studies to evaluate this technique. A study of 23 hemiarthroplasties reported that 91% of patients were satisfied with the results at 5.7 years and that the scores of the American Society of Foot and Ankle were significantly improved. [1,2]

Arthroscopic treatment

The first author to describe the arthroscopy of the hallux was Watanabe in 1972. The procedure gained clinical importance in the 1990s when several authors described the technique. The advantage of arthroscopy at this level is to have a fast recovery and professional reintegration, reduction of postoperative pain, less scar problems and a mobility and strength of the metatarsophalangeal satisfactory. [3,4,5]

The working hypothesis: Arthroscopic treatment improves mobility and decreases pain compared to isolated percutaneous debridement under image intensifier.

MATERIAL AND METHOD

The study is retrospective.

The inclusion criteria was the hallux rigidus stages 1 and 2, without limitation of the walking perimeter.
The exclusion criteria was the diabetic foot and the neurological foot.

Results evaluation was simple based on subjective pain (0-10 where 0 signifies absence of pain and 10 signifies insupportable pain) and local range of motion (hallux extension).

Between November 2015 and March 2016 at Centre Hospitalier Colmar and Guebwiller (France) 11 patients, 6 women and 5 men were undergo surgical treatment of hallux rigidus. Seven patients underwent arthroscopy debridement (group 2) and 4 patients underwent isolated percutaneous debridement (group 1), among them 1 patient had to have a bilateral hallux rigidus surgery at 5 months interval. Patients were evaluated at 3 months postoperatively. The main symptom was the pain of the hallux when walking, and the additional assessment includes standard loading X-ray of the front foot, anteroposterior, lateral-lateral and three quarters (figure 1).

Figure 1: Hallux rigidus, stage 2, presence of the dorsal osteophyte on the lateral and three quarters X-Ray

Percutaneous articular debridement was accomplished using a specific Shannon TM drill 2.0x8 millimeters under image intensifier within regional anesthesia, no tourniquet needed.

Metatarsal-phalangeal hallux arthroscopy was performed under regional anesthesia (popliteal block) with a calf tourniquet in all patients.

The patient is placed supine, heel in the vacuum, with a pad under the ipsilateral buttock to ensure a strictly vertical position of the foot. The surgeon is positioned at the end of the table, scrub nurse left of the surgeon (left-handed surgeon), arthroscopy column next to the patient’s head (figure 2).

Hallux flexion-extension movements helps identifying metatarsophalangeal space. A needle is placed in the joint, laterally or medially to the long extensor tendon of the great toe, image intensifier serves in checking the correct intraarticular positioning. To avoid dorsal sensory branches damage the incision is placed slightly plantar affecting the skin only, while a Kelly or Halsted forceps is used for deep dissection. To prevent cartilage damage a small cannula is introduced. A 2.4 mm scope is used and placed preferably posteromedial while the instruments are placed posterolateral. In doubt X-Ray checking is desirable to confirm the correct intra-articular instruments positioning.

Articular distraction gap is performed by a “Japanese fingerstall [3]” or by pulling out the hallux with a Velpeau band (figure 3). By pulling the toe with the hand and placing the probe within the joint, the anatomical structures can be explored during flexion-
extension movements (sesamoid and head of the first metatarsal) (figure 4).

**Figure 2:** Patient positioning, the hardware and the operating room display. Artisanal traction by Velpeau band.

Often the posterior synovium and the lateral and medial gutters must be cleaned along using a Shaver TM to obtain a good visualization of the joint, paying attention to the extensor tendon of the hallux (figure 5). [3] [4] [5]

**Figure 3:** Hallux arthroscopic approach

In first and second stages, a cartilage lesion is usually found centrally or dorsally on the first phalanx or on the dorsal metatarsal head, while the subchondral bone remains intact (Figure 6).

**Figure 4:** The medial sesamoid
Cartilaginous valves are regularized with a curette and the debridement and osteophytes resection continues with the shaver or radiofrequency probe. If the subchondral bone is exposed, micro fractures by a 15 millimeters diameter Kirschner wire are produced to stimulate neo cartilage induction.

Figure 5: Hallux extensor tendon

The pre- and postoperative dorsiflexion are measured by laterally X-Ray checks, allowing us to note in the operative report the mobility gain (figure 7).

Figure 7: Left image: 45° of dorsal flexion on preoperative X-Ray; right image: 80° dorsal flexion of the great toe on postoperative x-ray

At the end of the procedure, the release of the tourniquet enables bleeding control, the skin is stitched with resorbable sutures, and a compressive dressing is realized.

Postoperatively walking without crutches is allowed the next day and the wearing of a medical soft padded shoe is recommended for the next two weeks.

In all cases, patients needed one day hospital stay.

RESULTS AND DISCUSSION

The average age for group 1 was 53.2 years and 56.8 years for group 2.

The preoperative mobility for group 1 was 26° of extension and 17.5° of flexion on average; for group 2 the hallux extension was at 47° for 15° flexion. At the end of the procedure, the dorsiflexion obtained was at least 80°. The average duration of the percutaneous
and arthroscopic procedure was 64 minutes, no adverse events were reported.

Operative follow-up was simple with minimal residual pain (VAS = 1) for both groups and one return to work at 3 months with one exception, 1 patient who had 4 months off work due to persistent pain (VAS = 4).

At 3 months of the operation the group 1 had 77° extension of the hallux for 8° of flexion while for the group 2 one notes 85° of extension for 15° of flexion. In terms of increased mobility at 3 months, arthroscopy has not yet shown superiority over isolated percutaneous articular pruning, but in terms of subjective satisfaction, group 2 reported better results in terms of pain. Only one patient underwent a bilateral pruning, and he declared himself more satisfied on the side operated by arthroscopy plus percutaneous pruning than by the side operated by isolated percutaneous pruning.

Our working hypothesis was therefore invalidated.

Weaknesses of the study: retrospective study with a small series of patients, no long-term results.

The literature is poor in this field, no comparison was made.

CONCLUSION

The arthroscopy of the hallux makes it possible to achieve an accurate joint assessment and a suitable treatment. In our very short experience and to confirm the arthroscopic debridement and the synovectomy complementary to the percutaneous pruning improves the subjective score of the treatment of the early hallux rigidus, but it remains to define the result and in particular the gain of mobility at a distance and at to quantify the progression towards osteophalangeal osteoarthritic degeneration.

Abreviations
VAS: Visual Analog Scale

Acknowledgements
There are no conflict of interest.

References:

1. Campbell’s Operative Orthopaedics, twelfth edition, S. Terry Canale, James H. Beaty- First metatarsophalangeal joint arthroscopy, p 2389