Title

Lapidus arthrodesis: Original or modified. When to perform it.

Keywords: TMTJ Arthrodesis/ Hallux Valgus/ Arthrodesis/ Cuneometatarsal Instability/Lapidus

Summary.

Arthrodesis of the first cuneometatarsal joint or Lapidus procedure is an effective alternative for the treatment of severe hallux valgus especially when associated with hypermobility at the level of this joint. Cuneometatarsal hypermobility or instability is difficult to evaluate and is not a recent concept, initially it was evaluated mainly in the sagittal plane, but during the last few years new and better ways to objectify it have been reported, including the coronal and transverse planes. Originally Lapidus described his arthrodesis as including cuneometatarsal fusion and the bases of the first and second metatarsals (Original Lapidus), over the years modifications have been made including the addition of a plate to the cuneometatarsal fusion without arthrodesing the metatarsals, known as modified Lapidus. The decision to perform one or the other procedure is closely related to the correct evaluation of stability pre- and intraoperatively. We present a clinical case of hallux valgus with instability of the TMTJ1 in which it was decided to perform original Lapidus with the aid of a medial plate that allows intraplate passage of the screw used for fusion of the bases of both metatarsals.

Introduction:

The incidence of hallux valgus reaches 20%-35% of the adult population. The importance of an adequate treatment becomes vital due to the possibility of recurrence that this pathology can have if the surgery performed is not correctly indicated.

In the early 20th century, fusion of the cuneometatarsal joint was described as an effective treatment alternative for this deformity. In the 1950's Lapidus popularized his technique for the treatment of Hallux Valgus associated with hypermobility of the TMTJ 1, but he only focused on evaluating it in the sagittal plane. He described his technique using three screws with which he performed a fusion of the TMTJ1 and between the first and second metatarsals.

Since its publication to date, several modifications have been made to the classically described technique, being the "modified Lapidus" the most used nowadays, which consists of fusing TMTJ1 with an interfragmentary screw, adding a plate that provides greater stability and can be positioned dorsally, dorsomedially, medially or plantar without fusing the first and second MTT. These modifications seek to improve the technique and reduce complication rates, mainly by improving union rates and reducing recurrences. On the other hand, the current "Original Lapidus" includes the same as the modified Lapidus, but adding the arthrodesis between the bases of the first and second

metatarsal described in the Classic Lapidus. For its selection as a surgical option, it is essential to perform an evaluation in 3 planes: transverse, coronal and axial of the stability of the cuneometatarsal joint and thus decide which of the two techniques to perform. The importance of this case study is relevant due to the difficulty in clinically determining cuneometatarsal instability and to the fact that an incomplete evaluation and clinical radiological analysis of hallux valgus associated with hypermobility in the pre- and intraoperative period are fundamental in deciding which surgical technique to perform and which implants to use, which ultimately influences the surgical outcome expected by the patient and the surgeon.

The objective of this case study is to analyze the best way to evaluate preoperatively and intraoperatively the stability of the cuneometarasal joint in order to, according to this, discuss when to consider doing modified Lapidus or Original Lapidus. To address how to perform the Original Lapidus technique when required and to define the best fixation method for it.

Clinical Case

Female patient, with initials C.J., 50 years old, with a history of pain for several years related to right hallux valgus that presented on walking and wearing shoes. With a long history of flat feet.

Clinically full range of motion of MTTF joint, with prominent, painful bunion and erythematous skin that bothers him with the use of footwear, with pain on palpation of the head of the 2nd and 3rd metatarsal and hyperkeratosis per plantar, without pathology in minor orthotics. Asymptomatic flexible flat feet.

An AP and lateral radiograph of the loaded foot was taken (Figure 1) and moderate to severe hallux valgus was observed.



Figure 1.

Clinically, the stability of TMTJ1 is evaluated, showing hypermobility in the sagittal and transverse planes, in AP and lateral radiographs of the loaded foot showing a varus and pronated first metatarsal with lateralized sesamoids.

Management and results.

Due to these findings on physical examination and radiology, cuneometatarsal arthrodesis with Medartis medial plate, Weill 2-3 and Akin Osteotomy is planned. During surgery, a classic medial approach is performed between the MTTF1 and TMTJ1 joint, buniectomy and then cuneometatarsal arthrodesis is performed, resecting the articular cartilage of the base of the first metatarsal and the medial cuneiform respectively, making a small wedge of lateral base, the articular faces of the fusion are prepared with A.K. 2.0, the metatarsal is disrotated and fixed transitorily. Adequate clinical reduction is observed and it is fixed and compressed definitively with a 3.5 screw. Subsequently, a medial plate is added and fixed with wedge-locked screws, further compression is performed through the eccentric hole of the plate and it is fixed with locked screws at the base of the metatarsal. Once the cuneometatarsal arthrodesis is completed using the Modified Lapidus technique, correct stability in the sagittal plane and adequate position of the sesamoids is tested. A stress maneuver is performed, testing stability in the transverse plane of the first ray, with clinical and radiological persistence of instability in this plane, as shown in Figure 2.



Figure 2: Increased intermetatarsal space when performing stress maneuver to test transverse stability.

Due to these intraoperative findings, it was decided to perform the original Lapidus Technique, the base of the first and second metatarsals was prepared respectively, the cuneometatarsal compression screw was removed and a 3.5 screw was placed through the medial plate, this screw fixed both metatarsals in the correct position. The stress maneuver is performed again, showing total stability of the cuneometatarsal fusion this time in all planes. (figure 3)



Figure 3. When applying the stress maneuver, correct stabilization is observed once the arthrodesis between both metatarsals has been performed.

Subsequently, Weill osteotomy was performed on the 2nd and 3rd metatarsals and Akin osteotomy. With the bony remnants of these wedges, graft was added to the arthrodesis between the bases of the 1st and 2nd metatarsal to ensure fusion (Figure 4).



Figure 4.

Discussion.

When we are faced with patients with moderate to severe hallux valgus, it is of vital importance to evaluate the stability of the cuneometatarsal joint, which is a topic currently under discussion and is not easy to determine. In the beginning it was debated which comes first, if the instability led to Hallux Valgus or was a consequence of it and mainly this evaluation was focused mostly on the sagittal plane. In recent years it has gained more interest among researchers the perception that TMT instability occurs more in the transverse plane than in the sagittal, this added to the role that would also play the changes found in the coronal plane that are related to the pronation of the first metatarsal which has led to a better understanding of the problem and there is much literature that tries to address more fully the etiology and the best resolution of this pathology.

Currently it is recommended to evaluate stability in the three planes and according to the following order of importance: transverse, coronal and sagittal. In the first one it is recommended to apply force with the thumb and index finger of the hand in the first intermetatarsal space having reduced and aligned both metatarsals, the instability would be positive if the medial displacement of the first ray is perceived together with the greater sensation of touching both fingers and the sensation of hypermobility with the index finger in the cuneometatarsal joint (figure 5).



Figure 5: Stability evaluation maneuver in the transverse plane.

In the coronal plane the rotation of the first metatarsal can be assessed by looking at the pronation of the ray when the patient is asked to bear his own weight on his foot. (Figure 6)



Figure 6: A) Unloaded foot. B) Foot under load showing pronation of the first metatarsal.

Finally, in the sagittal plane, it is recommended to fix the medial wedge with one hand and perform dorsal-plantar translation of the base of the first metatarsal with the other hand. This is described as positive if a translation of 8 to 10 mm is verified.

From the radiological point of view to evaluate the transverse plane it is described to perform a loaded AP foot X-ray without and with tape that keeps both metatarsals aligned, in the loaded AP foot X-ray with tape the reduction and alignment of the two metatarsals can be observed, while the same X-ray without the tape will show the separation of the two metatarsals. For the coronal plane it is important to evaluate the

position of the sesamoids with respect to the axis of the first metatarsal and the shape of the head of the first ray in the loaded AP radiographs, which would give an estimation of the degrees of pronation of the metatarsal. Finally, in order to evaluate sagittal stability, the loaded lateral foot X-ray could show a plantar opening at the level of the cuneometatarsal joint and the extended position of the first ray, which would indicate instability in this plane.

Regarding intraoperative stability, it is a rule to perform the clinical maneuver described above to evaluate the stability in the transverse plane once the modified Lapidus arthrodesis has been performed; if at this moment the maneuver is positive, it is recommended to perform the original Lapidus. At this point it is important to keep in mind that what should be performed here is an arthrodesis between the bases of both metatarsals, since due to the mobility present at this level it is very likely that only by fixing both metatarsals with a screw it ends up loosening, showing peritoneal osteolysis or finally breaking, both complications can cause pain and recurrence of hallux valgus by not being able to stabilize or align both metatarsals.

Regarding the surgical technique of this fusion between the bases of both metatarsals, it is important to previously prepare the bases by resecting the cortex of both, reduce them and fix them with a cortical screw, ideally intraplate, which gives greater stability to the screw and add bone graft in order to achieve the formation of a firm bone bridge that will provide the necessary fixation to our arthrodesis. In this sense, the correct selection of the plate to be used and its position becomes relevant.

Multiple studies have already confirmed the advantages in terms of stability and union rates of medial and plantar plates versus dorsal or dorsomedial plates, which are not currently recommended. Between the plantar and medial plates there are studies that, although they conclude that there are no differences in terms of union rates between the two, the plantar position plate would provide biomechanical advantages by acting as a tension band allowing protected walking in the immediate postoperative period. With respect to medial plates, there are at least three known comparative advantages versus plantar plates:

1- To provide us with a force that opposes the medial deviation of the first ray in cases of hallux valgus plus cuneometatarsal instability.

2- Avoid manipulating the posterior tibial tendon insertion that some plantar or midplantar plates contact.

3- To have the possibility of using a hole that allows the passage of a 3.5 screw through the plate to fix both metatarsals. In the plantar plates it would have to be made extraplate.

In this sense, the Medartis medial plate, which has a low profile, does not contact tendon insertions, provides extra intraplate compression and has a hole for the passage of a 3.5 screw, is an option to consider.

In summary, it is important to know how to evaluate stability in all planes, to perform the intraoperative test and once the persistence of instability in the transverse plane has been determined after having performed the modified lapidus, to make the decision to perform the original lapidus and for this it is important to correctly select a plate that allows medial support and to pass through it the screw that stabilizes both metatarsals.

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References.

- 1. Mansur NSB, de Souza Nery CA. Hypermobility in Hallux Valgus. Foot Ankle Clin. 2020 Mar;25(1):1-17.
- Santrock RD, Smith B. Hallux Valgus Deformity and Treatment: A Three-Dimensional Approach: Modified Technique for Lapidus Procedure. Foot Ankle Clin. 2018 Jun;23(2):281-295.
- Nishikawa DRC, Saito GH, Mendes AAM, Prado MP. Management of the Tarsometatarsal Joint in the Rotational Correction of Hallux Valgus by the Modified Lapidus Procedure: Intraoperative Technical Tips to Prevent Complications. Foot Ankle Spec. 2021 Dec;14(6):528-533.
- 4. Cottom JM, Baker JS. Comparison of Locking Plate with Interfragmentary Screw Versus Plantarly Applied Anatomic Locking Plate for Lapidus Arthrodesis: A Biomechanical Cadaveric Study. Foot Ankle Spec. 2017 Jun;10(3):227-231.
- 5. Li S, Myerson MS. Evolution of Thinking of the Lapidus Procedure and Fixation. Foot Ankle Clin. 2020 Mar;25(1):109-126.
- Klos K, Wilde CH, Lange A, Wagner A, Gras F, Skulev HK, Mückley T, Simons P. Modified Lapidus arthrodesis with plantar plate and compression screw for treatment of hallux valgus with hypermobility of the first ray: a preliminary report. Foot Ankle Surg. 2013 Dec;19(4):239-44.
- 7. McCabe FJ, McQuail PM, Turley L, Hurley R, Flavin RA. Anatomical reconstruction of first ray instability hallux valgus with a medial anatomical TMTJ1 plate. Foot Ankle Surg. 2021 Dec;27(8):869-873.
- Schilde S, Ketelhut L, Kielstein H, Delank KS, Gutteck N. Anatomical study of Lapidus arthrodesis using two different plantar plate systems. Foot Ankle Surg. 2020 Jul;26(5):585-590.
- 9. Wagner P, Wagner E. Role of Coronal Plane Malalignment in Hallux Valgus Correction. Foot Ankle Clin. 2020 Mar;25(1):69-77.
- 10. Willegger M, Holinka J, Ristl R, Wanivenhaus AH, Windhager R, Schuh R. Correction power and complications of first tarsometatarsal joint arthrodesis for hallux valgus deformity. Int Orthop. 2015 Mar;39(3):467-76.