DOI: https://doi.org/10.30795/jfootankle.2022.v16.1589

Special Article

Metatarsal osteotomies in *Hallux Rigidus*

Martín Ferreyra[1], Antonio Viladot Voegeli[2], Ramón Viladot-Pericé[2] (In Memoriam)

1. Instituto Oulton, Córdoba, Argentina.
2. Orthopaedic Department, Clínica Tres Torres, Barcelona, Spain.

Abstract

This work presents the objectives and indications of the three distal osteotomies of the first metatarsal most frequently used in *Hallux Rigidus* surgery: Weil-Barouk oblique osteotomy, Youngswick (modified Chevron) osteotomy, and Watermann dorsal closed wedge osteotomy. The surgical technique, indications, advantages, and disadvantages of each of them are described.

Level of Evidence V; Therapeutic Studies; Expert Opinion.

Keywords: *Hallux rigidus*; Osteotomy; Metatarsal bones; Forefoot, human.

Introduction

The aim of osteotomies is achieving a more mobile and pain free joint, correcting the etiopathogenic factors that caused the deformity. Osteotomy is intended: 1) To decompress the joint. 2) To shorten the first metatarsal in cases of index-plus metatarsal formula or to decompress the joint. 3) To realign the joint. 4) To lower the first metatarsal head to correct *metatarsus primus elevatus* and *Hallux Flexus,* thus reestablishing the rotation center of metatarsal head. 5) To relax muscles and plantar fascia, which are often retracted. 6) To reduce intermetatarsal angle in cases of *Hallux Valgus-Rigidus.*

Indications

According to Coughlin and Shurnas classification[1], osteotomies are indicated in advanced grade II and in early grade III with joint surface involvement lower than 50%. Both distal oblique osteotomy, as described by Weil for lateral rays and popularized by Barouk[2], and Youngswick osteotomy[3] shorten the metatarsal, decompress the joint, lower the first metatarsal head, and relax muscles and fascia plantar. Therefore, they are indicated for most cases of *Hallux Rigidus* in which the first metatarsal is long or elevated (*metatarsus primus elevatus*), and in the presence of *Hallux Flexus* associated with plantar fascia retraction. In cases of index-plus-minus metatarsal formula, shortening caused by osteotomy in the horizontal plane is compensated with lowering of metatarsal head in the frontal plane. Watermann osteotomy[4] is indicated in cases of *Hallux Rigidus* with no *metatarsus primus elevatus*, *Hallux Flexus*, or plantar fascia retraction. This type of osteotomy realigns articular surface without shortening the metatarsal or lowering its head.

Surgical Techniques

A. Distal oblique osteotomy

This osteotomy is widely used in the treatment of *Hallux Rigidus* (Figure 1).

A medial incision centered on the first metatarsophalangeal joint (MTPJ) was performed. Subsequently, the joint was subluxated in order to allow for surgeons to operate on it. Oblique osteotomy of the metatarsal head was conducted from the dorsal-distal to the plantar-proximal direction, starting on the articular surface with chondral lesion, with an angle from 35° to 45°, based on the extent to which metatarsal head should be lowered. Osteotomy was finished on the plantar surface, proximal to the entry of the vascular bundle that irrigated the metatarsal head, in order to prevent its necrosis. Subsequently, the first metatarsal head was subjected to proximal plantar displacement, depending on the length of the first metatarsal and its degree of dorsiflexion. In our experiment, displacement was +/- 5mm. Osteosynthesis was performed with two double-threaded cannulated screws measuring 3mm in diameter, paying attention to their location so

Study performed at the Instituto Oulton, Córdoba, Argentina.

Correspondence: Martín Ferreyra. **Adress:** Carrer del Dr. Roux, 76, 08017 Barcelona **E-mail:** martinluisferreyra@hotmail.com. **Conflicts of Interest:** none. **Source of funding:** none. **Date received:** October 09, 2021. **Date accepted:** February 09, 2022. **Online:** April 30, 2022.

How to cite this article: Ferreyra M, Viladot Voegeli A, Viladot-Pericé R (In Memoriam). Metatarsal osteotomies in *Hallux Rigidus*. J Foot Ankle. 2022;16(1):2-5.

that it did not surpass the articular surface. Two screws were used in order to prevent varus-valgus displacements of the first metatarsal head. Finally, the excess or dorsal roof and medial exostosis were resected. Sometimes, if fascial tension persists, we recommend performing a proximal percutaneous plantar fasciotomy. In Egyptian feet, which have a very long hallux, we recommend shortening the proximal phalanx, thus reducing axial pressure resulting from contact between shoes and the distal end of the toe.

In cases of *Hallux Valgus-Rigidus*, this technique allows for act on both deformities.

B. Youngswick (or modified Chevron) osteotomy

This technique was described by Youngswick[3] in 1982 as a modification of the Austin osteotomy. It is also one of the distal metatarsal osteotomies most widely indicated for *Hallux Rigidus* (Figure 2).

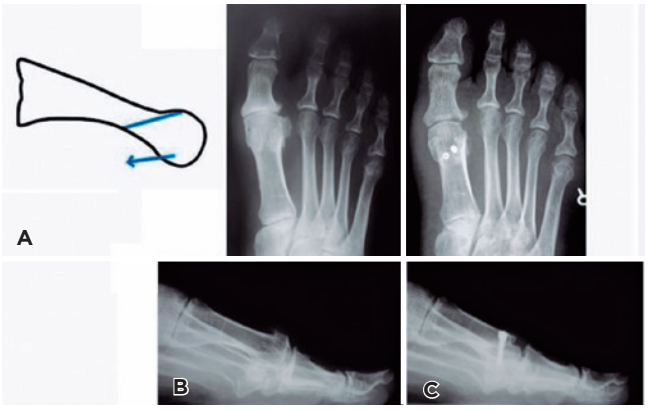

Figure 1. Weil-Barouk oblique osteotomy. A) Intervention scheme. B) Preoperative radiograph. C) Postoperative radiograph.

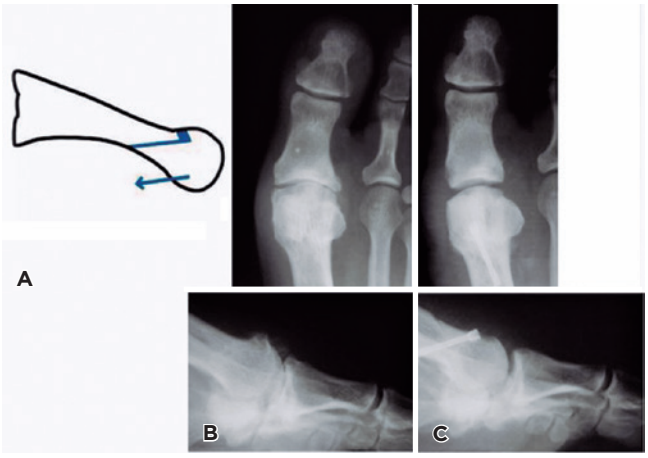

Figure 2. Youngswick osteotomy. A) Intervention scheme. B) Preoperative radiograph. C) Postoperative radiograph

Using the same approach of the previous technique, a V-shape osteotomy was performed with a slightly dorsal vertex on the metatarsal head and the two diagonal lines directed from dorsal-proximal to plantar-proximal towards the vertex, forming an angle of 60°. Subsequently, a second osteotomy was performed parallel to the dorsal branch of the first osteotomy. The width of this second osteotomy determines shortening and lowering of the first metatarsal and articular decompression. This osteotomy is intrinsically more stable than the previous one; thus, only one screw is required for osteosynthesis. This procedure can also be used in cases of *Hallux Valgus-Rigidus.*

C. Watermann dorsal closed wedge osteotomy

Watermann[4] described this procedure in 1927 as a trapezoidal dorsal closed wedge osteotomy on the first metatarsal neck (Figure 3).

Using the same approach as the previous techniques, dorsal wedge osteotomy is performed on the metatarsal head. When osteotomy is closed by dorsiflexion, the metatarsal head rotates so that the plantar articular cartilage, which is usually healthy, is the segment that comes into contact with the base of the phalanx. Furthermore, this procedure reduces the volumetric content of the first MTPJ. This is a relatively unstable osteotomy, due to its perpendicular direction, and has difficult osteosynthesis.

Results

Currently, most authors[5,6] agree that osteotomies are successful in *Hallux Rigidus* grades I and II, whereas results are more unpredictable in the most advanced phases of disease. We share this view.

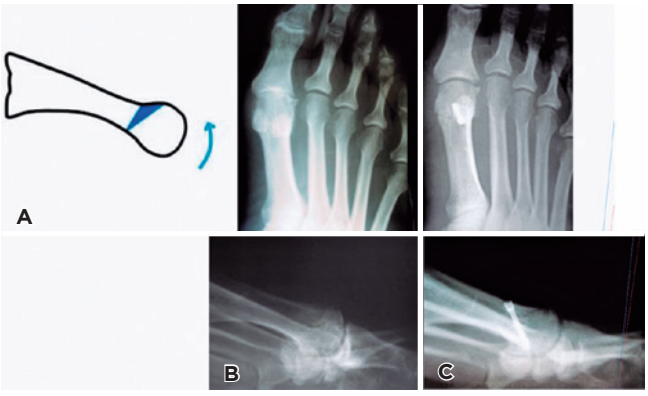

Figure 3. Watermann osteotomy. A) Intervention scheme. B) Preoperative radiograph. C) Postoperative radiograph.

The published literature[7-10] on distal oblique osteotomy is heterogeneous: authors use different classification methods, indicate surgery in different grades of *Hallux Rigidus* (from grade I to III), although it has never been indicated for grade IV, and follow-up time after intervention varies widely: from 12 months up to 11.1 years. However, all authors do agree on the goodness of the technique, with rates of excellent and good outcomes higher than 80%.

Our experiment[11] with distal oblique osteotomy is based on 32 feet, all presenting with grade II of the disease, with a mid-term follow-up of 39.4 months. Results were consistent with those of the reviewed literature: outcomes were excellent in 75% of the cases, and good in 25%, which is explained by the fact that our series did not include patients in advanced disease phases.

Kilmartin[12] compared oblique osteotomy with Reverdin-Green osteotomy and shortening Scarf osteotomy and did not find differences in results as well.

A literature review on Youngswick osteotomy showed similar findings: series were little homogeneous. Dickerson et al.[13] observed 94% of satisfactory outcomes with 32 patients, with a mid-term follow-up of 4 years. Slullitel et al.[14] also found satisfactory long-term outcomes in 61 operated patients with *Hallux Rigidus* of grades II and III. Olof and Jhala-Patel[15] indicate osteotomy in grades III and IV of the disease and obtained a satisfaction level of 85% among their patients.

Since distal oblique osteotomy and Youngswick osteotomy have the same objectives and indications, several comparative studies have been conducted to assess whether one technique is better than the other.

We[16] published a prospective study of both osteotomies in the mid-term, with a minimum postoperative time of 24 months. Twenty-five feet operated with each technique were evaluated, all presenting with grade II of the disease, and there were no significant differences in outcomes. Xu et al.[17] also compared the results of the two osteotomies in 33 feet. In their case, intervention was indicated in grades III and IV of the disease. They did not find differences between the two techniques as well. Interestingly, a study by LaMar et al.[18] performed a mechanical comparison with bone models in a laboratory, in order to assess the stability of the two osteotomies. There was likewise no difference between them.

With regard to distal Watermann dorsiflexion osteotomy, Cho et al.[19] reviewed 42 feet with a mid- to long-term follow-up of at least 3 years, in patients with *Hallux Rigidus* of grades III and IV. Based on the results, the authors conclude that this osteotomy is effective in grade III with viable cartilage on at least 50% of the articular surface, but should not be indicated in grade IV, due to the high rate of reoperations. Laakmann et al.[20] have modified osteotomy by adding a double section in the dorsal line in order to realign the metatarsal head in dorsiflexion and lower it in the frontal plane. This makes it possible to correct *metatarsus primus elevatus-Hallux Flexus* and to relax the plantar fascia, achieving good results.

Lee et al.[21] compared the outcomes of distal oblique osteotomy with those of cheilectomy and concluded that, although the latter technique has a recurrence rate of 30%, which is explained by the fact that it does not resolve the etiopathogenic factors causing *Hallux Rigidus*, the two techniques gave satisfactory outcomes for the patient.

Complications

The complications described with these techniques are the following:

1. Delayed union, malunion, or non-union
2. Avascular necrosis of the metatarsal head
3. Osteotomy fracture
4. Hardware loosening
5. Transfer metatarsalgia
6. Loss of postoperative mobility and persistence of pain.
7. Disease recurrence.

Conclusions

According to the published literature and to our own experiment, we consider that osteotomies are indicated in the treatment of grade II and early grade III *Hallux Rigidus*. Their purpose is to preserve articular surface, decompress the joint, and correct changes in the center of rotation.

Although disease origin is multifactorial, we believe that excessive plantar fascia tension is a determining factor for *metatarsus primus elevatus* and *Hallux Flexus.* In selected cases, plantar fasciotomy on the heel allows for additional joint decompression.

Authors' contributions: Each author contributed individually and significantly to the development of this article: MF *(https://orcid.org/0000-0001-7149-7358) Wrote the article, participated in the review process, bibliographic review, formatting of the article, interpreted the results of the study; AVV *(https://orcid.org/0000-0002-4192-6163) Wrote the article, participated in the review process, bibliographic review, formatting of the article, interpreted the results of the study; RVP (In Memoriam) *(https://orcid.org/0000-0002-8254-2916) Wrote the article, participated in the review process, bibliographic review, formatting of the article, interpreted the results of the study . All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

References

1. Coughlin MJ, Shurnas PS. Hallux rigidus. Grading and long-term results of operative treatment. J Bone Joint Surg Am. 2003;85(11): 2072-88.
2. Barouk LS. L´ostéotomie cervico-céphalique de Weil dans les métarsalgies medians. Méd Chir Pied. 1994;10:23-33.
3. Youngswick FD. Modifications of the Austin bunionectomy for treatment of metatarsus primus elevatus associated with hallux limitus. J Foot Surg. 1982 Summer;21(2):114-6.
4. Watermann H. Die afthritis deforman des Gross zenhengrundege lenkes als Selbstandiges Krankheitsbild. Z Chir Orthop Chir 1927; 48:346.
5. Shereff MJ, Baumhauer JF. Hallux rigidus and osteoarthrosis of the first metatarsophalangeal joint. J Bone Joint Surg Am. 1998; 80(6):898-908.
6. Haddad SL. The use of osteotomies in the treatment of hallux limitus and hallux rigidus. Foot Ankle Clin. 2000;5(3):629-61.
7. Ronconi P, Monachino P, Baleanu PM, Favilli G. Distal oblique osteotomy of the first metatarsal for the correction of hallux limitus and rigidus deformity. J Foot Ankle Surg. 2000;39(3):154-60.
8. Malerba F, Milani R, Sartorelli E, Haddo O. Distal oblique first metatarsal osteotomy in grade 3 hallux rigidus: a long-term follow up. Foot Ankle Int. 2008;29(7):677-82.
9. Gonzalez JV, Garrett PP, Jordan MJ, Reilly CH. The modified Hohmann osteotomy: an alternative joint salvage procedure for hallux rigidus. J Foot Ankle Surg. 2004;43(6):380-8.
10. Giannini S, Ceccarelli F, Faldini C, Bevoni R, Grandi G, Vannini F. What's new in surgical options for hallux rigidus? J Bone Joint Surg Am. 2004;86-A Suppl 2:72-83.
11. Voegeli AV, Marcellini L, Sodano L, Perice RV. Clinical and radiological outcomes after distal oblique osteotomy for the treatment of stage II hallux rigidus: Mid-term results. Foot Ankle Surg. 2017;23(1):21-6.
12. Kilmartin TE. Phalangeal osteotomy versus first metatarsal decompression osteotomy for the surgical treatment of hallux rigidus: a prospective study of age-matched and condition-matched patients. J Foot Ankle Surg. 2005;44(1):2-12.
13. Dickerson JB, Green R, Green DR. Long-term follow-up of the Green-Watermann osteotomy for hallux limitus. J Am Podiatr Med Assoc. 2002;92(10):543-54.
14. Slullitel G, López V, Calvi JP, D'Ambrosi R, Usuelli FG. Youngswick osteotomy for treatment of moderate hallux rigidus: Thirteen years without arthrodesis. Foot Ankle Surg. 2020;26(8):890-4.
15. Oloff LM, Jhala-Patel G. A retrospective analysis of joint salvage procedures for grades III and IV hallux rigidus. J Foot Ankle Surg. 2008;47(3):230-6.
16. Viladot A, Sodano L, Marcellini L, Zamperetti M, Hernandez ES, Perice RV. Youngswick-Austin versus distal oblique osteotomy for the treatment of Hallux Rigidus. Foot (Edinb). 2017;32:53-8.
17. Xu WB, Zhang F, He PP, Zhu YZ, Yao LF, Shen CC, et al. [Clinical study of Youngswick versus distal oblique osteotomy in the treatment of grade and hallux rigidus]. Zhonghua Yi Xue Za Zhi. 2020;100(27):2144-9.
18. LaMar L, Deroy AR, Sinnot MT, Haut R, Squire M, Wertheimer S. Mechanical comparison of the Youngswick, sagittal V, and modified Weil osteotomies for hallux rigidus in a sawbone model. J Foot Ankle Surg. 2006;45(2):70-5.
19. Cho BK, Park KJ, Park JK, SooHoo NF. Outcomes of the Distal Metatarsal Dorsiflexion Osteotomy for Advanced Hallux Rigidus. Foot Ankle Int. 2017;38(5):541-50.
20. Laakmann G, Green R, Green D. The Modified Watermann Procedure. A Preliminary Retrospective Study. In: Camasta, CA, Vickers NS, Ruch JA, editors. Reconstructive Surgery of the Foot and Leg, Update 96. Tucker GA: The Podiatry Institute; 1996. p. 128-35.
21. Lee JY, Tay KS, Rikhraj IS. Distal oblique osteotomy versus cheilectomy for moderate-advanced hallux rigidus: A 2-year propensity-score-matched study. Foot Ankle Surg. 2021;27(4): 443-9.