Hallux valgus treatment: a tridimensional problem

Tratamiento del Hallux valgus: el problema tridimensional

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Keywords:
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ABSTRACT

Objective: To present a new technique called PROMO, and the results on the first patients operated on. **Methods:** Six patients were operated with this technique, with an average metatarsophalangeal (MTTP) angle of 35 degrees, intermetatarsal angle (IMA) of 16 degrees and a mean great toe internal malrotation of 35 degrees. The preoperative AOFAS score was 55 points. Radiological and clinical results were recorded, besides any complication. Our average follow up was 7 months. **Results:** The average postoperative MTTP angle was 5 degrees, the IMA was 4 degrees and the mean great toe internal malrotation was 3 degrees. No metatarsal shortening was observed whatsoever. The postoperative AOFAS score was 85 points with no recurrences. **Conclusions:** We describe a new technique which corrects not only the metatarsus varus, but also the metatarsal internal rotation, present in almost all Hallux Valgus cases. This is performed by rotating the metatarsal through an oblique plane osteotomy with no bone resection. This new procedure corrects the metatarsal malrotation, known factor that increases the Hallux Valgus recurrence. This technique is easy to remember and relatively simple to perform in primary and revision cases. The authors results show that it is as safe and effective as other procedures, with some advantages to be discussed.

Level of evidence: Level V.

Descriptores:
Hallux valgus/cirugía; Osteotomía/métodos; Procedimientos quirúrgicos operativos/métodos; Procedimientos ortopédicos/métodos

RESUMEN

Objetivo: Presentar una nueva técnica llamada PROMO, y los resultados en los primeros pacientes operados: **Métodos:** Seis pacientes fueron operados, con un ángulo metatarsofalángico preoperatorio de 35 grados, intermetatarsiano de 16 grados y una rotación interna promedio del Hallux de 35 grados. El AOFAS preoperatorio fue de 55 grados. Resultados clínicos y radiológicos fueron registrados, así como las complicaciones. Seguimiento promedio fue de 7 meses. **Resultados:** El ángulo metatarsofalángico promedio postoperatorio fue de 5 grados, el intermetatarsiano de 4 grados y la rotación interna promedio del Hallux de 3 grados. No hubo acortamiento metatarsiano. El AOFAS postoperatorio fue de 85 puntos. No se han presentado recurrencias. **Conclusiones:** En este artículo describimos una nueva técnica para Hallux Valgus, que no corrige solo el metatarso varo, sino también la malrotación interna metatarsiana presente en la gran mayoría de los Hallux Valgus. Esto se realiza rotando el metatarsiano a través de un osteotomía oblicua sin resección ósea. Este procedimiento corrige la malrotación metatarsiana, conocido factor de recurrencia en Hallux valgus operados. Esta técnica es fácil de recordar y relativamente sencilla de realizar en casos primarios y de revisión. Los resultados de los autores muestran que es tan seguro y eficaz como otros procedimientos, con algunas ventajas a ser discutidas.

Nivel de evidencia: V.

INTRODUCTION

Osteotomies have been recommended for hallux valgus surgery since the last two decades, with good success rate and reliable over time.[1] The recurrence rate of the deformity depends on the preoperative deformity and on the postoperative sesamoid reduction quality, being higher if the hallux valgus angle is greater than 37-40 degrees, and if postoperatively there is an incomplete reduction of the sesamoids.[2-4] No osteotomy has been proven to be more effective than the others, and different modifications have been made to improve the outcomes of each individual technique.[5] Analyzing each individual technique, not a single one or its modification considers the axial malrotation as the main issue to be addressed. Up to 87% of HV cases present with a metatarsal

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internal rotation, shown by an internally malrotated Hallux (on clinical examination), visible metatarsal head condyles on a foot AP x-ray and by laterally subluxated sesamoids as seen on x-rays.[6] Interestingly, even the distal metatarsal articular angle (DMMA), represented by an inclined distal articular metatarsal surface could be just a representation of a malrotated metatarsal bone and not a truly inclined articular surface.[7] These facts highlight the importance of understanding the first metatarsal rotational deformity, as it is more frequently found in hallux valgus deformity than coronal deformities or sesamoid subluxation. It has been shown that this malrotation could play a role in HV recurrence rate and in postop clinical appearance.[8]

The objective of this article is to present a new osteotomy which was called the PROMO: Proximal Rotational Metatarsal Osteotomy. It is performed through a single proximal metatarsal oblique plane osteotomy, achieving any deformity correction through rotation. Any kind of deformity (sagittal or coronal deformity) can be corrected using bone rotation through a single oblique cut. A second cut to remove a wedge is not necessary. Just by rotating the bone through an oblique plane osteotomy any deformity correction can be achieved. The only requirement for this osteotomy to work, is the coexistence of a malrotation, given that only through rotation the coronal or sagittal deformities can be corrected. Of course, the direction of that oblique cut has to be carefully planned to perform it in the right direction. We present the indications, surgical technique and early results of this new osteotomy for hallux valgus correction.

METHODS

We report the results of our first 6 patients we operated on after 7 months follow up. The average preoperative metatarsophalangeal angle was 35 degrees, the intermetatarsal angle was 16 degrees and the mean great toe internal malrotation was 35. The preoperative AOFAS score was 55 points. Radiological and clinical results were recorded, besides any complication. Our average follow up was 7 months. The main contraindication for this osteotomy is a Hallux Valgus mild deformity with no or minimal rotation.

Relative to the preoperative planning, the intermetatarsal (IMTT) angle is measured to evaluate the deformity severity on an AP foot x-ray. The angle to be corrected is also measured, to get a more precise measure of how many degrees are needed to place the metatarsal head over the sesamoid complex.[9] The main downside of any angular measurement, is the limited capacity to evaluate metatarsal malrotation, demonstrated by sesamoid subluxation. Axial sesamoids x-rays can give a rough estimate of first ray malrotation. Another option is to perform a preoperative CT scan, which could assess metatarsal rotation and sesamoid subluxation. The authors assess rotation by clinical examination of the great toe rotation. An easy way to perform this is to measure the great toe nail inclination relative to the floor using a goniometer. Once the intermetatarsal angle and the axial malrotation angle are obtained, the PROMO osteotomy can be planned and calculated. There are different ways for obtaining this ideal osteotomy direction (graphs, equations, etc.),[10-12] but the easiest, fastest and most practical way is utilizing an application available for handheld devices. It is called the "Multiplier" application. It gives the osteotomy direction with mathematical precision using published formulas. A 30 degrees great toe internal rotation will be taken for this example together with a 15 degrees intermetatarsal angle. The objective will be to correct 15 degrees of varus angulation (leave both metatarsals parallel) and 30 degrees of internal rotation. After the metatarsal osteotomy is performed, an optional phalangeal osteotomy (Akin osteotomy) should be performed depending on the remaining interphalangeal deformity.

The technique shown will consider a Hallux Valgus case with 15 degrees of intermetatarsal angle and a metatarsal internal rotation of 30 degrees (Figure 1 and 2). Using the Multiplier application, under the menu

Figure 1. Model AP view, showing 15 degrees of intermetatarsal angle

Figure 2. Model axial view, showing 30 degrees of internal rotation

"Additional resources" and then "Inclined Osteotomy rotation angle", the coronal plane and axial plane deformity values are entered: 30 degrees of internal rotation and 15 degrees of angulation (intermetatarsal angle). For this case the following values will come up: 1) Rotational orientation of the osteotomy: 15 degrees external (Value 1). 2) Vertical inclination of the Osteotomy: 26 degrees (Value 2). An easy way to follow this angulation is to use a sterile goniometer while performing the osteotomy (author's choice). A longitudinal medial skin incision is made as usual over the metatarsophalangeal joint, carefully handling soft tissues. We perform a transarticular capsulotomy through the medial approach. This approach is our preferred technique, given that it has been shown that an open lateral release in severe hallux valgus cases does not add any correction power nor improve functional outcomes.[13] Once the proximal metatarsal is exposed, a medial metatarsal midaxis line (A) is drawn using the electrocautery/marking pen. Another line (B) is drawn along the bone axis 5mm dorsal to the medial midaxis line already drawn (Figure 3). 5mm equals a 30 degrees arch on a metatarsal with a radius of 0.9cm. This value (5mm) depends on the rotational deformity that has to be corrected (30 degrees in this case). For 20 degrees of great toe internal malrotation, these lines should be 3mm apart. For 45 degrees of malrotation this value should be 7mm.

A K-wire (1) is driven dorsal-distal to plantar-proximal in 26 degrees (Value 2) off the metatarsal perpendicular line (or 74 degrees off the metatarsal axis), starting dorsally 2cm distal to the TMTT (tarsometatarsal) (Figure 3). Another K-wire (2) is driven medial to lateral, starting on the medial metatarsal midaxis line 2cm distal to the TMTT. It should be placed perpendicular to the bone in the frontal plane (Figure 4) and in 15 degrees of elevation from the floor plane (Value 1) (going dorso-medial to plantar-lateral). Next, following the same direction of K-wire (1) and (2), the osteotomy is performed using a microsagittal saw (Figure 5). Be careful not to erase lines (A) and (B). Once the osteotomy is performed, using a field clamp

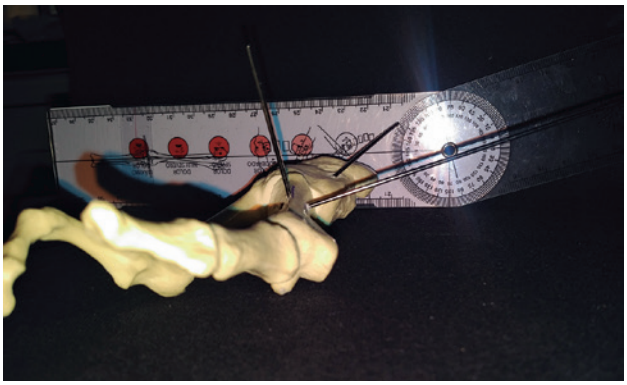

Figure 4. Model axial view showing K wire (2) with 15 degrees of elevation from the ground

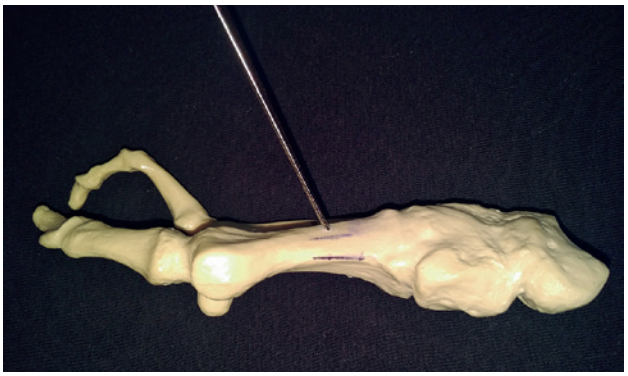

Figure 3. Model medial view, showing lines (A) and (B). Line (A) is midaxis medial line and (B) is 5 mm above (A). The numerical 1 is K wire (1), showing its dorsal entry point

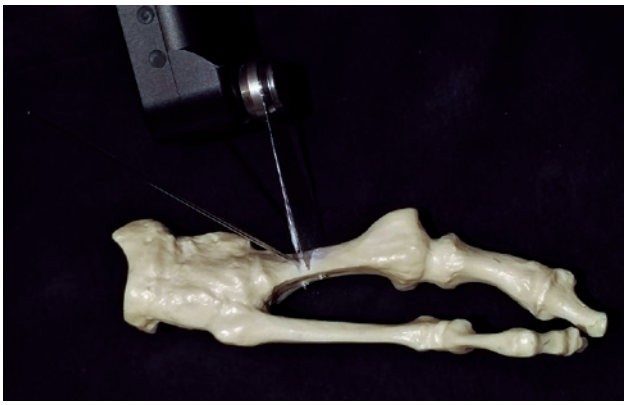

Figure 5. Model AP view showing the saw cut following both K wires orientation

or Backhaus, the distal loose end of the metatarsal is rotated externally to match lines (A) and (B). Temporal fixation can be achieved with k wires. Check under image intensifier a satisfactory deformity correction. First and second metatarsals should be parallel (Figure 6). A 2.7 lag screw using cannulated instruments is placed through K-wire (3). A medially located locking plate is placed using 2 screws proximal and 2 screws distal to the osteotomy (Figure 7). An Akin osteotomy is added as needed depending on the interphalangeal angle and metatarsophalangeal soft tissue balance. A bunionectomy is performed at the end of the procedure as needed. The final toe rotation is checked by clinical examination.

Figure 6. AP foot fluoroscopy, showing metatarsal deformity correction with both metatarsals shafts parallel

Figure 7. AP foot fluoroscopy, showing metatarsal deformity correction with both metatarsals shafts parallel

RESULTS

The average postoperative metatarsophalangeal angle was 5 degrees, the intermetatarsal angle was 4 degrees and the mean great toe internal malrotation was 3 degrees. No metatarsal shortening was observed whatsoever. The postoperative AOFAS score was 85 points after 7 months follow up. All 6 patients were satisfied with the surgery. Weight bearing is allowed as tolerated immediately postoperatively using a hard sole postoperative shoe. Great toe range of motion exercises are encouraged once wounds are completely healed, fact that happened at 2 weeks on average. Transition to a conventional shoe happens at 1 month postoperative. No complications have been reported during this study follow up, such as deformity relapse, infections or deep vein thrombosis, between others.

DISCUSSION

Any osteotomy performed should be powerful enough to align the metatarsophalangeal joint and to locate the first metatarsal as parallel as possible to the second metatarsal (correcting coronal plane deformity), but also to locate the first metatarsal on top of the sesamoids (correcting the axial plane deformity, i.e. malrotation). Even when the metatarsal is placed perfectly parallel to the second metatarsal after a classic HV osteotomy, the sesamoids frequently remain laterally subluxated because no malrotation is addressed. The rotational osteotomy we present here was initially described by Rab in 1988 for tibial Blount's disease,[14,15] where there is a tibial varus and internal rotation deformity, therefore needing a two- plane correction. It consists of a single oblique cut, through which rotation is corrected. Because of the oblique nature of this osteotomy, while rotating the bone through this oblique plane the coronal deformity is corrected. Mathematical models,[10] graphical analysis[11,12] and 3-D planning[12] have been used to prove its utility in correcting long bone multiple plane deformities.

The technique presented here allows preoperative planning, and allows a complete correction of the deformity, as shown in this short and preliminary series of patients. The possibility of achieving correction of both the coronal and axial malrotation through a single cut not losing bone length makes this osteotomy very attractive. Classic metatarsal osteotomies like the chevron or scarf osteotomies will only correct the coronal component of the deformity, and as such, will maintain the axial malrotation, and we have seen this happen in our clinical practice.

Some issues remain over this osteotomy, as the mathematical precision needs to be accompanied by an easy set of guides to perform more easily the cuts, and this is under development. The fixation of the osteotomy should be performed with an interfragmentary screw and a medial or plantar plate, and development also still should be pursued in this respect.

The authors have included in their management algorithm[5] this new osteotomy, specifically when there is a young patient with an increased metatarsal axial malrotation. For moderate and severe deformities for patients younger than 50 years old, the authors think that a PROMO osteotomy could be the treatment of choice. In case of elderly patients or a grossly unstable tarsometatarsal joint, a Lapidus procedure should be the procedure of choice. The PROMO technique should never be used if there is no malrotation. This is seen only in mild Hallux Valgus, where a pure translating osteotomy (Chevron) is enough to achieve a satisfactory correction.

CONCLUSION

Although this is a very small series of patients, the authors have seen a reliable and rapid bone consolidation. This could be thanks to a larger bone apposition area than in a classic transverse osteotomy and thanks to the lag screw, which gives better stability and compression. The authors think that this new osteotomy is reliable, versatile and easy to perform, and it combines coronal and rotational deformity correction without any bone resection. Hopefully addressing the hallux valgus deformity as a tridimensional deformity will allow us to decrease the recurrence risk.

REFERENCES

1. Trnka, Hans-Jorg. Osteotomies for Hallux valgus correction. Foot Ankle Clin. 2005;10(1):15-33.
2. Deenik AR, de Visser E, Louwerens JW, de Waal Malefijt M, Draijer FF, de Bie RA. Hallux valgus angle as a main predictor for correction of hallux valgus. BMC Musculoskelet Disord. 2008 May 15;9:70.
3. Okuda R, Kinoshita M, Yasuda T, Jotoku T, Shima H, Takamura M. Hallux valgus angle as a predictor of recurrence following proximal metatarsal osteotomy. J Orthop Sci. 2011;16(6):760-4.
4. Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. Postoperative incomplete reduction of the sesamoids as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2009;91(7):1637-45.
5. Wagner E, Ortiz C. Osteotomy considerations in hallux valgus treatment. improving the correction power. Foot Ankle Clin. 2012; 17(3):481-98.
6. Kim Y, Kim JS, Young KW, Naraghi R, Cho HK, Lee SY. A new measure of tibial sesamoid position in hallux valgus in relation to the coronal rotation of the first metatarsal in CT scans. Foot Ankle Int. 2015;36(8):944-52.
7. Yamaguchi, S, Sasho T, Endo J, Yamamoto Y, Akagi R, Sato Y, Takahashi K. Shape of the lateral edge of the first metatarsal head changes depending on the rotation and inclination of the first metatarsal: a study using digitally reconstructed radiographs. J Orthop Sci. 2015, 20(5):868-74.
8. Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. The shape of the lateral edge of the first metatarsal head as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2007;89(10):2163-72.
9. Ortiz C, Wagner P, Vela O, Fischman D, Cavada G, Wagner E. "Angle to be corrected" in preoperative evaluation for hallux valgus surgery: analysis of a new angular measurement. Foot Ankle Int. 2016;37(2):172-7.
10. Sangeorzan BJ, Sangeorzan BP, Hansen ST Jr, Judd RP. Mathematically directed single-cut osteotomy for correction of tibial malunion. J Orthop Trauma. 1989;3(4):267-75.
11. Paley D.Principles of deformity correction. Berlin: Springer-Verlag; 2002. p. 256-68.
12. Dobbe JG, Pré KJ, Kloen P, Blankevoort L, Streekstra GJ. Computer-assisted and patient-specific 3-D planning and evaluation of a single-cut rotational osteotomy for complex long-bone deformities. Med Biol Eng Comput. 2011;49(12):1363-70.
13. Wagner E, Ortiz C, Figueroa F, Vela O, Wagner P, Gould JS. Role of a limited transarticular release in severe hallux valgus correction. Foot Ankle Int. 2015;36(11):1322-9.
14. Rab GT. Oblique tibial osteotomy for Blount's disease (tibia vara). J Pediatr Orthop. 1988; 8(6):715–720
15. Rab GT. Oblique tibial osteotomy revisited. J Child Orthop. 2010; 4(2):169-72.