The effect of a modified chevron osteotomy for hallux valgus patients: A five-year follow-up study

Shiyong Zhang
The Sixth Affiliated Hospital of Xinjiang Medical
Xue Wang
The Sixth Affiliated Hospital of Xinjiang Medical
Tiannan Chen
The Sixth Affiliated Hospital of Xinjiang Medical
Chengwei Wang
The Third Affiliated Hospital of Xinjiang Medical
Jie Wang (jiew008ang@163.com)
The Sixth Affiliated Hospital of Xinjiang Medical University

Research article

Keywords: Hallux valgus, Chevron osteotomy, Clinical outcome, Follow up, AOFAS score

Posted Date: September 28th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-929642/v1

Abstract

Purpose

This study aimed to detect the effect of a modified chevron osteotomy on hallux valgus (HV) deformity at five-year follow up.

Methods

Twenty patients with symptomatic HV who underwent modified chevron osteotomy between June 2014 and January 2016 were included in the present study. The follow-up duration was more than five years. Each patient was evaluated preoperatively, six weeks postoperatively and five years postoperatively using the visual analog scale (VAS) pain score, the American Orthopaedic Foot & Ankle Society (AOFAS) score and cosmetic and radiological outcomes.

Results

The AOFAS score improved from 54.40 (± 4.58) preoperatively to 94.30 (± 2.15) six weeks postoperatively ($p < 0.001$) and 96.95 (± 1.54) five years postoperatively ($p < 0.001$). The VAS scores decreased from 6.30 (± 1.17)preoperatively to 0.15 (± 0.37) five years postoperatively ($p < 0.001$). The mean intermetatarsal angle improved from 16.00° (± 2.20°) preoperatively to 4.15° (± 1.22°) six weeks postoperatively ($p < 0.001$) and 4.40° (± 1.39°) five years postoperatively ($p < 0.001$). The mean HV angle also improved, from 32.70° (± 5.34°) preoperatively to 4.80° (± 1.40°) six weeks postoperatively ($p < 0.001$) and 5.20° (± 1.32°) five years postoperatively ($p < 0.001$). The cosmetic results were either excellent or good in 19 patients (95%). There was no recurrence in this study during the five postoperative years.

Conclusion

A modified chevron osteotomy can achieve successful correction of moderate-to-severe HV, with excellent outcomes at five-year follow up.

Introduction

Hallux valgus (HV), characterised by a medial prominence of the first metatarsal head and a valgus deviation of the first toe, is a forefoot deformity causing pain and discomfort(1, 2). It has been reported that the prevalence of HV is between 23.0% and 35.7% in shoe-wearing populations(3), with higher prevalence in women than in men since the introduction of high-fashion footwear(4).

More than 100 different surgery strategies have been used for HV correction(3, 5). Distal osteotomies of the first metatarsal bone can successfully correct mild deformities; however, for moderate-to-severe

deformities, proximal osteotomies offer a better treatment choice(6). The advantages of distal chevron osteotomy, including technical simplicity, mechanical stability and minimal shortening, mean that this procedure is widely accepted for HV treatment(7, 8). A meta-analysis by Smith et al. revealed that chevron osteotomy can improve the correction of the intermetatarsal angle (IMA) to 5.3°(9). Ma et al. conducted a meta-analysis including 384 subjects from four studies and found that, although the effects of chevron osteotomy were non-inferior to scarf osteotomy for HV, chevron osteotomy was less technically demanding(10). Chevron osteotomy was also demonstrated to be safe for older patients (aged 60 years or older)(11).

Because the traditional distal chevron osteotomy often causes complications, such as delayed healing or malunion(7), modifications are required to improve the surgical process. To date, few studies have examined the long-term effects of a modified chevron osteotomy in patients with symptomatic HV. We therefore conducted this study to evaluate the effect of a modified chevron osteotomy for HV correction after a long follow-up period (five years).

Materials And Methods

Patients

This study was performed in the Department of Orthopedic Surgery of the Sixth Affiliated Hospital of Xinjiang Medical University. It was approved by the Institutional Review Board of the Sixth Affiliated Hospital of Xinjiang Medical University. All patients enrolled in this study signed informed consent forms.

Twenty patients with symptomatic HV who underwent modified chevron osteotomy between June 2014 and July 2016 were enrolled in this study. The inclusion criteria were as follows: (1) patients were aged 18 years or older and (2) patients had symptomatic HV that did not respond to conservative treatment. Patients with rheumatoid arthritis affecting the foot, diabetic foot problems, arthrolithiasis, neuromuscular disease or foot infections and those who had had previous hallux operations were excluded.

Surgical procedure

All the surgical procedures were performed by two experienced surgeons. Patients were anesthetised in the supine position. A tourniquet was used at the proximal thigh. First, adductor hallucis tenotomy and metatarsal-sesamoid capsular release were performed. After this process, the hallux was passively introverted to 5°–10°. Then, a straight incision of approximately 5 cm was made at the first metatarsophalangeal (MTP) joint. The metatarsal head was exposed, and the exostosis was removed. A V-shaped osteotomy was subsequently made, with its apex at 1–1.5 cm proximal to the articular surface of the first metatarsal head. The angle between the upper and the lower arm was approximately 80°–90°. One or two cannulated screws (depending on the length of the osteotomy) were used to stabilise the osteotomy from the dorsum of the distal metatarsal head to the plantar shaft. Then, any medial bone protrusion was removed. Finally, subcutaneous absorbable sutures were used to close the incision.

After surgery, an elastic adhesive bandage was applied. The bandage was adjusted weekly by the surgeons in order to maintain the correction. Six weeks after surgery, walking in a normal shoe was allowed. Twelve weeks after surgery, all restrictions on activity were removed.

Assessments

The follow-up duration was more than five years. Weight-bearing radiographs were made preoperatively, six weeks postoperatively and five years postoperatively. The hallux valgus angle (HVA) and first-to-second IMA were measured, as described in previous studies(12).

American Orthopaedic Foot & Ankle Society (AOFAS) scores and visual analog scale (VAS) pain scores were measured preoperatively, six weeks postoperatively and five years postoperatively. The AOFAS score was used to evaluate the patient's function and pain according to the following scale: 90–100 points = excellent, 80–90 points = good, 70–79 points = fair and < 69 points = poor(13). VAS scoring used a 10-point (10 cm) scaling ruler, where 0 corresponded to no pain and 10 to severe pain.

The cosmesis of the surgically repaired foot was also assessed at the final follow up. Cosmesis was evaluated as excellent, good, fair or poor; it was judged as excellent when the great toe was in a clinically straight position with nopostoperative scar(7).

Statistical analysis

The data in this study were analysed using SPSS 22.0 software. Categorical data were described as numbers and percentages, while quantitative data were described as mean (± standard deviation [SD]). The Wilcoxon signed rank sum test was used to compare the values measured preoperatively and after each follow-up period. To avoid inflated type I error, the Bonferroni correction was used, with $p < 0.0167$ (0.05/3) considered statistically significant.

Results

Twenty patients with symptomatic HV who had undergone modified chevron osteotomy were enrolled in this study. Only 2 (10%) of those patients were men, while 18 (90%) were women. The mean age of the patients at the time of the modified chevron osteotomy was 51.95 (± 12.15) years (range: 19–73 years). The mean follow-up time was 62.55 (± 2.11) months (range: 60–67 months). All patients in this study had pain related to HV deformity before surgery. Preoperatively, the mean VAS score was 6.30 (± 1.17) (range: 5–9) and the mean AOFAS score was 54.40 (± 4.58) (range: 48–67). Seven (35%) of the patients underwent bilateral simultaneous operation; thus, 27 feet in 20 patients were included in the analysis. Before surgery, the mean HVA was 32.70° (± 5.34°) (range: 25°–45°) and the mean IMA was 16.00° (± 2.20°) (range: 12°–16°). The preoperative characteristics of the 20 patients are shown in Table 1.

Table 1
Patient characteristics

Characteristics	Subgroups/results	Number of patients (feet)
Age		
Mean age	51.95 ± 12.15	-
Age group (year)	20–40	1
	40–60	15
	60–80	4
Gender	Female	18
	Male	2
Bilateral vs unilateral	Bilateral	7
	Unilateral	13
Hallux valgus severity (HVA)		
Mean HVA (°)	32.70 ± 5.34	-
	Mild (< 25°)	0
	Moderate (25°-40°)	18 (24)
	Severe (> 40°)	2 (3)
Mean AOFAS score	54.40 ± 4.58	-
Mean VAS	6.30 ± 1.17	-
Note: HVA, Hallux valgus angle; AOFAS, American Orthopedic Foot & Ankle Society; VAS, Visual Analog Scale.		

As shown in Table 2, the mean AOFAS score improved from 54.40 (± 4.58) (range: 48–67) preoperatively to 94.30 (± 2.15) (range: 90–98) six weeks postoperatively ($Z = -3.926$, $p < 0.001$); it further improved to 96.95 (± 1.54) five years postoperatively ($Z = -3.766$, $p < 0.001$). The VAS scores were 1.30 (± 0.57) (range: 1–3) six weeks postoperatively and 0.15 (± 0.37) (range: 0–1) five years postoperatively. Only 3 patients reported minor pain after excessive exercise five years postoperatively. The mean IMA improved from 16.00° (± 2.20°) (range: 12°–16°) preoperatively to 4.15° (± 1.22°) (range: 2°–6°) six weeks postoperatively ($Z = -3.932$, $p < 0.001$) and 4.40° (± 1.39°) (range: 2°–7°) five years postoperatively ($Z = -3.933$, $p < 0.001$). The mean HVA improved from 32.70° (± 5.34°) (range: 24°–45°) preoperatively to 4.80° (± 1.40°) (range: 3°–8°) six weeks postoperatively ($Z = -3.923$, $p < 0.001$) and 5.20° (± 1.32°) (range: 3°–7°) five years postoperatively ($Z = -3.924$, $p < 0.001$).

Table 2
The results of assessments

	Preoperatively	6 weeks postoperatively	5 years postoperatively
AOFAS score	54.40 ± 4.58	94.30 ± 2.15*	96.95 ± 1.54*,&
VAS score	6.30 ± 1.17	1.30 ± 0.57*	0.15 ± 0.37*,&
HVA (°)	32.70 ± 5.34	4.80 ± 1.40*	5.20 ± 1.32*
IMA (°)	16.00 ± 2.20	4.15 ± 1.22*	4.40 ± 1.39*

Note: Data are presented as mean ± standard deviation. *Difference of each measures between preoperative and each follow-up period was significant ($p < 0.001$). & Difference of values measured 6 weeks postoperatively and 5 years postoperatively was significant ($p < 0.001$). HVA, Hallux valgus angle; IMA, intermetatarsal angle; AOFAS, American Orthopedic Foot & Ankle Society; VAS, Visual Analog Scale.

After surgery, all incisions healed primarily. The osteotomy healing time was approximately three to four months. The cosmetic results five years postoperatively were excellent in 12 patients (60%), good in 7 (35%), fair in 1 (5%) and poor in 0 (0%). There was no HV recurrence during the five postoperative years; neither did any complications, such as transfer metatarsalgia, stiffness of the first MTP joint or necrosis of part or all of the metatarsal head, occur.

Discussion

The present study indicates that a modified chevron osteotomy can improve all outcome assessments (e.g. VAS score, AOFAS score, HVA and IMA) in patients with HV and that these improvements can persist for at least five years postoperatively.

Risk factors for HV include gender, connective tissue disorders, pes planus and hypermobility of the first ray(14). A higher prevalence of HV is seen in women, which may indicate that the habit of wearing constricting shoes is an additional risk factor(7). Of the 20 patients with symptomatic HV enrolled in this study, only 2 were men, i.e. the gender ratio was 9:1; this is consistent with previous studies(15). Dysfunction of the first MTP joint, pain and transfer metatarsalgia are the main symptoms of HV. Irritation of the dorsal cutaneous nerve and inflammation of the bursa over the medial eminence contribute to the development of pain(16).

Chevron osteotomy is usually used in patients with mild or moderate HV. However, the traditional chevron osteotomy was associated with complications such as malunion, delayed healing, necrosis of the metatarsal head and shortening of the first metatarsal(7); modifications have therefore been made to the technical part of this surgical procedure to allow early rehabilitation and weight bearing (17). In this study, 27 feet in 20 patients with HV were corrected by modified chevron osteotomy. This surgery achieved good stability. There was no recurrence of HV in the present study during the five postoperative years and no complications, such as transfer metatarsalgia, stiffness of first MTP joint or necrosis of part or all of the

metatarsal head; this demonstrates that this technique is safe. In a previous study, Deenik et al. reported a recurrence rate for HV of 7% after distal chevron osteotomy(18). Additionally, the results of Seo's study indicate a 9% recurrence rate after distal chevron osteotomy in patients with HV aged 60 years or older(11). Comparison between our study and these two previous studies may suggest the conclusion that the modified chevron osteotomy we employed had improved stability over the traditional chevron osteotomy; this conclusion is supported by other studies(7, 19). Verdu-Roman et al. found that a modified chevron osteotomy mitigated the shortcomings of the traditional chevron osteotomy(19). The modified procedure was able to alter foot biomechanics to reduce pain and improve foot activity(19).

The AOFAS score is widely used to evaluate pain, function and alignment (20). In the present study, the AOFAS score improved from 54.40 (± 4.58) preoperatively to 94.30 (± 2.15) six weeks postoperatively and 96.95 (± 1.54) five years postoperatively; i.e. the AOFAS score was significantly improved postoperatively. These improvements indicate that modified chevron osteotomy for HV increased patients' quality of life (QoL)(21). A recently published study including 591 cases showed that HV corrective surgery significantly improved the QoL of patients after a follow up of two years(22). Our study confirms this result. More importantly, our study employed a much longer follow-up period, indicating that patients' long-term QoL may be improved by HV surgery. The evaluation of VAS scores in this study further confirms this conclusion.

Radiological evaluation was also performed in this study. As expected, the HVA and IMA were significantly improved after surgery. These improvements persisted at the five-year follow up. A study conducted by Giotis et al. enrolled female athletes who had undergone modified chevron osteotomy(7). At two-year postoperative follow up, the mean HVA and IMA were significantly decreased(7). Vasso et al. conducted a study in which 184 consecutive patients with symptomatic HV who had undergone modified chevron osteotomy were enrolled(23). At 24–56-month follow up, the mean HVA had significantly decreased, from 34.1° preoperatively to 6.2° postoperatively, and the mean IMA had improved from 18.5° preoperatively to 4.1° postoperatively(23). In the present study, the mean HVA and IMA decreased from 32.7° and 16.0° preoperatively to 5.2° and 4.4° five years postoperatively, indicating an excellent clinical outcome for the modified chevron osteotomy.

The present study has several limitations. First, it is a retrospective study with a very small sample size, and all patients were from a single centre. This could cause selection bias. Second, this study did not involve a control group. Third, limited assessments were used to evaluate clinical efficacy (VAS score, AOFAS score, HVA and IMA). Other indicators, such as first metatarsal bone shortening value and sesamoid grade(11) should also be used. Furthermore, the computed tomography of the patients with HV was not routinely examined. Finally, it is not clear from this study whether a modified chevron osteotomy could mitigate the complications caused by the traditional chevron osteotomy. A further study with a larger sample size on this topic should therefore be conducted.

Conclusion

Modified chevron osteotomy achieved successful correction of moderate-to-severe HV, with excellent outcomes at five-year follow up.

Declarations

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article

Competing interests

All of the authors had no any personal, financial, commercial, or academic conflicts of interest separately.

Funding

Not applicable

Authors' contributions

Shiyong Zhang conceived of the study, and Xue Wang and Tiannan Chen participated in its design and coordination and Chengwei Wang and Jie Wang helped to draft the manuscript. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Korwin-Kochanowska K, Potié A, El-Boghdadly K, Rawal N, Joshi G, Albrecht E. PROSPECT guideline for hallux valgus repair surgery: a systematic review and procedure-specific postoperative pain management recommendations. Regional anesthesia pain medicine. 2020;45:702–8.
2. Guo J, Qin S, Zhang F, Dong W, Hou Z, Zhang Y. The plantarward oblique Chevron osteotomy: an optional method to treat hallux valgus with painful plantar callosities. Scientific reports. 2019;9:17364.
3. Smyth NA, Aiyer AA. Introduction: Why Are There so Many Different Surgeries for Hallux Valgus? Foot and ankle clinics 23: 171–182, 2018.

4. Gribbin CK, Ellis SJ, Nguyen J, Williamson E, Cody EA. Relationship of Radiographic and Clinical Parameters With Hallux Valgus and Second Ray Pathology. Foot Ankle Int. 2017;38:14–9.
5. van Groningen B, van der Steen MC, Reijman M, Bos J, Hendriks JG. Outcomes in chevron osteotomy for Hallux Valgus in a large cohort. Foot. 2016;29:18–24.
6. Easley ME, Trnka HJ. Current concepts review: hallux valgus part II: operative treatment. Foot Ankle Int. 2007;28:748–58.
7. Trnka HJ, Krenn S, Schuh R. Minimally invasive hallux valgus surgery: a critical review of the evidence. International orthopaedics. 2013;37:1731–5.
8. Giotis D, Paschos NK, Zampeli F, Giannoulis D, Gantsos A, Mantellos G. Modified Chevron osteotomy for hallux valgus deformity in female athletes. A 2-year follow-up study. Foot ankle surgery: official journal of the European Society of Foot Ankle Surgeons. 2016;22:181–5.
9. Matsumoto T, Gross CE, Parekh SG. Short-Term Radiographic Outcome After Distal Chevron Osteotomy for Hallux Valgus Using Intramedullary Plates With an Amended Algorithm for the Surgical Management of Hallux Valgus. Foot ankle specialist. 2019;12:25–33.
10. Smith SE, Landorf KB, Butterworth PA, Menz HB. Scarf versus chevron osteotomy for the correction of 1–2 intermetatarsal angle in hallux valgus: a systematic review and meta-analysis. The Journal of foot ankle surgery: official publication of the American College of Foot Ankle Surgeons. 2012;51:437–44.
11. Ma Q, Liang X, Lu J. Chevron osteotomy versus scarf osteotomy for hallux valgus correction: A meta-analysis. Foot ankle surgery: official journal of the European Society of Foot Ankle Surgeons. 2019;25:755–60.
12. Seo JH, Lee HS, Choi YR, Park SH. Distal chevron osteotomy with lateral release for moderate to severe hallux valgus patients aged sixty years and over. International orthopaedics. 2020;44:1099–105.
13. Tan H, Li A, Qiu X, Cui Y, Tang W, Wang G, Ding W, Xu Y. Operative treatments for osteochondral lesions of the talus in adults: A systematic review and meta-analysis. Medicine. 2021;100:e26330.
14. Palmanovich E, Ohana N, David S, Small I, Hetsroni I, Amar E, Sharfman ZT, Segal D, Atzmon R. Distal Chevron Osteotomy vs The Simple, Effective, Rapid, Inexpensive Technique (SERI) for Mild to Moderate Isolated Hallux Valgus: A Randomized Controlled Study. Indian journal of orthopaedics. 2021;55:110–8.
15. Nery C, Coughlin MJ, Baumfeld D, Ballerini FJ, Kobata S. Hallux valgus in males–part 1: demographics, etiology, and comparative radiology. Foot Ankle Int. 2013;34:629–35.
16. Bösch P, Wanke S, Legenstein R. Hallux valgus correction by the method of Bösch: a new technique with a seven-to-ten-year follow-up. Foot Ankle Clin. 2000;5:485–98. v-vi.
17. Acar B, Kose O, Turan A, Unal M, Kati YA, Guler F: Comparison of Bioabsorbable Magnesium versus Titanium Screw Fixation for Modified Distal Chevron Osteotomy in Hallux Valgus. BioMed research international 2018: 5242806, 2018.

18. Deenik A, van Mameren H, de Visser E, de Waal Malefijt M, Draijer F, de Bie R. Equivalent correction in scarf and chevron osteotomy in moderate and severe hallux valgus: a randomized controlled trial. Foot Ankle Int. 2008;29:1209–15.
19. Verdu-Roman C, Sanz-Reig J, Martinez-Gimenez E, Carratala-Munuera C, Lopez-Pineda A, Quesada JA, Gil-Guillen VF, Orozco-Beltran D. Plantar pressure improvement in moderate hallux valgus with modified chevron osteotomy: Clinical and radiographic outcomes. Foot ankle surgery: official journal of the European Society of Foot Ankle Surgeons. 2020;26:205–8.
20. Grün W, Molund M, Nilsen F, Stødle AH. Results After Percutaneous and Arthroscopically Assisted Osteosynthesis of Calcaneal Fractures. Foot Ankle Int. 2020;41:689–97.
21. Hernández-Castillejo LE, Álvarez-Bueno C, Garrido-Miguel M, Torres-Costoso A, Reina-Gutiérrez S, Martínez-Vizcaíno V. The effect of hallux valgus open and percutaneous surgery on AOFAS scale: a systematic review and meta-analysis. Quality of life research: an international journal of quality of life aspects of treatment care rehabilitation. 2021;30:957–66.
22. Zhu M, Chen JY, Yeo NEM, Koo K, Rikhraj IS. Health-related quality-of-life improvement after hallux valgus corrective surgery. Foot ankle surgery: official journal of the European Society of Foot Ankle Surgeons. 2021;27:539–42.
23. Vasso M, Del Regno C, D'Amelio A, Schiavone Panni A. A modified Austin/chevron osteotomy for treatment of hallux valgus and hallux rigidus. Journal of orthopaedics traumatology: official journal of the Italian Society of Orthopaedics Traumatology. 2016;17:89–93.