



# Third-Generation Minimally Invasive Chevron Akin Osteotomy for Hallux Valgus: Three-Year Outcomes

Azka Yousaf<sup>1</sup> · Jawaad Saleem<sup>1</sup> · Lena Al-Hilfi<sup>1</sup> · Kumar Kunasingam<sup>1</sup>

Received: 16 December 2022 / Accepted: 26 May 2023 / Published online: 5 June 2023  
© Indian Orthopaedics Association 2023

## Abstract

**Introduction** Numerous minimally invasive techniques have been developed for Hallux Valgus in recent years. Third-generation Minimally Invasive Chevron Akin (MICA) osteotomy has shown promising early results, but longer-term follow-up is required to assess whether patient clinical and radiological improvement is sustained. This cohort study presents three-year follow-up outcomes for patients of a single surgeon case series.

**Methods** Thirty-three patients underwent third-generation MICA surgery between 2017 and 2018. Patient clinical-reported outcome measures included American Orthopaedic Foot & Ankle Society (AOFAS), Manchester-Oxford Foot Questionnaire (MOXFQ) scores, and Coughlin satisfaction. Radiographic outcomes were evaluated after a period of three years using hallux valgus angle (HVA) and inter-metatarsal angle (IMA), and compared to pre- and early post-operative outcomes.

**Results** At 36 months, mean AOFAS scores improved from 48.2 to 95.6, mean MOXFQ scores improved from 57.6 to 6.7. Using the Coughlin scale, 81.8% of patients rated their outcome as ‘Excellent’ and 18.2% as ‘Good’. Radiographic outcomes showed HVA and mean IMA decreased from 34.6 degrees to 16.0 degrees and from 13.1 to 6.1, respectively at 36 months.

**Conclusion** Third-generation MICA demonstrates promising patient satisfaction scores post-operatively, and we have shown these improvements are sustained over a minimum three-year follow-up period.

**Level of Evidence** Level IV, case series.

**Keywords** MIS · MICA · Minimally invasive · Hallux valgus · Chevron akin

## Introduction

Patients with symptomatic hallux valgus (HV) that fail conservative management are usually indicated for operative intervention based on a weight-bearing standard radiographic evaluation. The operative management for these deformities has classically been addressed via an open approach. However, in recent years, there has been increasing focus on minimally invasive surgery (MIS).

It is thought that MIS reduces soft tissue trauma, thus promoting quicker recovery and a shorter stay in hospital [1]. Previous studies looking into MIS have identified shorter-term benefits from this type of surgery, but further long-term data are needed to support the idea that MIS is comparable, if not favourable to open surgery [1].

Our team has previously highlighted the excellent patient-reported outcomes at a 12-month period for those having third-generation Minimally Invasive Chevron Akin (MICA) [2]. We now present 36-month follow-up data with the aim of this case series to emphasise the safety and efficacy of MIS for hallux valgus, and to show both clinical and radiographic outcomes are sustained.

✉ Azka Yousaf  
azka.yousaf1@nhs.net

Jawaad Saleem  
jawaad.saleem@nhs.net

Lena Al-Hilfi  
lena.al-hilfi@nhs.net

Kumar Kunasingam  
kumark@doctors.org.uk

<sup>1</sup> Croydon University Hospital, 530 London Rd,  
London CR7 7YE, United Kingdom

## Materials and Methods

### Study Design

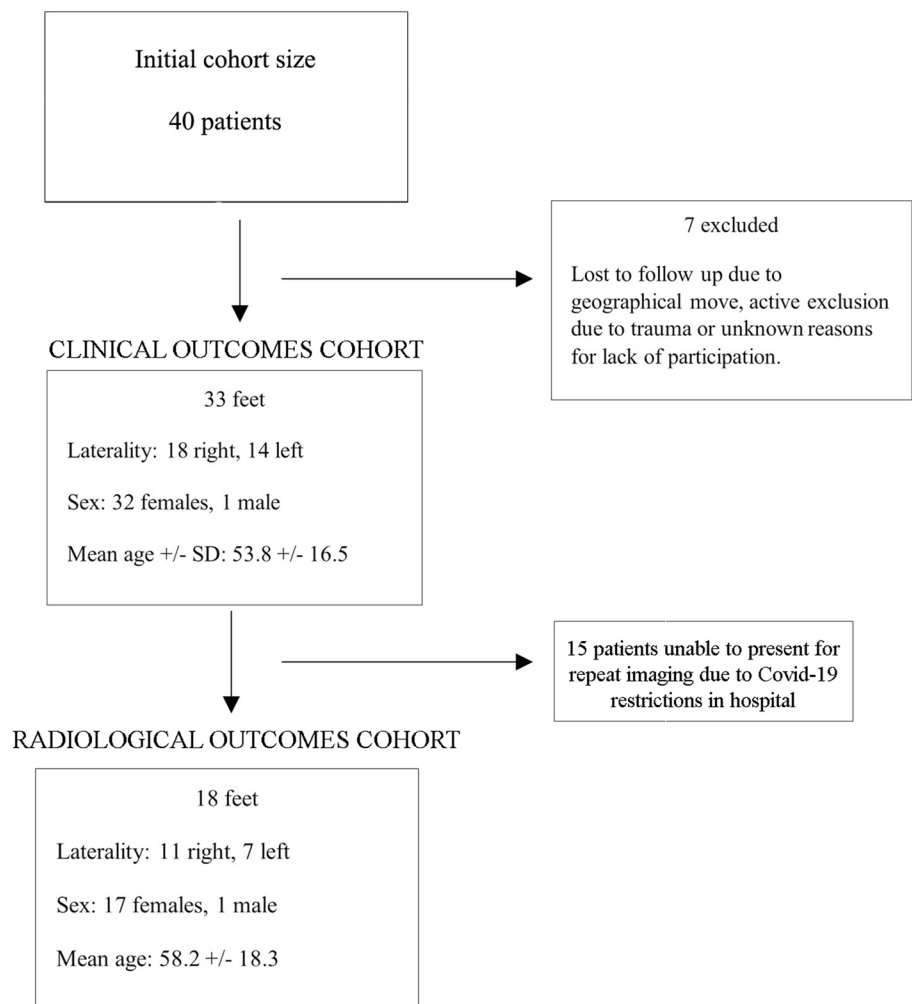
This was a cohort study of patients who underwent third-generation MICA surgery for hallux valgus by a single fellowship-trained consultant surgeon between 2017 and 2018, at a district general hospital in South London, UK. They were consulted at a minimum of 12 months, and 36 months post-operatively to assess clinical and radiological outcomes. Initial sample size was a cohort of 40 patients, however criteria to exclude patients from follow-up included significant trauma or fractures of the foot or ankle in the intervening period. Therefore, overall 33 patients were consulted at a minimum of 36 months. Due to the COVID-19 pandemic limiting patient visitation into the hospital, of the 33 patients contacted and reviewed at a minimum of 36 months, 18 were able to come into hospital for repeat imaging. Patients included in the study are depicted in Fig. 1.

All patients had been counselled in keeping with the National Institute for Health and Care Excellence (NICE) Interventional Procedures Guidance IPG 332 and subsequent literature [3], and informed verbal consent was given for their involvement. The project was registered with the clinical governance department within the healthcare trust in which patients were treated.

### Outcome Measures

Recorded outcomes were in accordance with NICE guidelines for research in minimal access procedures for hallux valgus correction [3]. The primary patient-reported outcome measure (PROM) was defined as an improvement in the postoperative American Orthopaedic Foot and Ankle Society score (AOFAS). AOFAS was used as our primary PROM as it has been widely used in previous MIS literature [4–10]. Secondary clinical outcomes were defined as an improvement in the Manchester-Oxford Foot Questionnaire (MOXFQ) [11] score, which is a validated PROM for hallux valgus. Furthermore, patient satisfaction scores were

**Fig. 1** Flowchart showing patients at each stage of follow-up at 36 months



recorded using the Coughlin scale [12]. All clinical PROMs were directly compared from pre-operative scores to those at 12- and 36-month post-operative time points.

Radiographic evaluation was undertaken on standard foot anteroposterior/lateral weight-bearing radiographs by orthopaedic registrars, an example of which is shown in Fig. 2. The primary radiological outcomes were defined as changes in hallux valgus angle (HVA) and inter-metatarsal angle (IMA) at pre-operative, 12- and 36-month time points. These angles were measured in accordance with the AOFAS ad hoc Committee on Angular Measurements guidelines [12]. Severity of hallux valgus was classified according to the HVA ( $\leq 15$  degrees, normal;  $< 20$  degrees, mild;  $< 40$  degrees, moderate;  $\geq 40$  degrees severe) [13] and the IMA ( $< 9$  degrees, normal; 9–11 degrees, mild; 12–17 degrees, moderate;  $\geq 18$  degrees, severe).

All post-operative complications (defined using the Clavien–Dindo Classification of Surgical Complications as any deviation from the normal postoperative course) and subsequent patient length of stay were recorded.



**Fig. 2** Weight-bearing radiographs at pre- and post-operative stages. Preoperative AP 2 (a). Postoperative at 36 months AP 2 (b) and Lateral 2 (c). Figures obtained from radiographs taken at Croydon University Hospital, London (2021)

## Operative Technique and Postoperative Rehabilitation

The operative technique utilised and postoperative rehabilitation process has been described in detail in our previous paper [2]. All patients were able to fully weight-bear on the same day, and required no overnight hospital stays.

## Comparison and Statistical Analysis

Patient outcomes were compared pre- and post-operatively at 12- and 36-month time points. Statistical analysis was performed using JASP. Descriptive measures used for both clinical and radiological outcomes were mean and standard deviations (SD). Testing for statistical significance was performed using the Student's paired t-test, whilst testing for significance of radiological change over time was done using the Repeated measures ANOVA. The level of significance was set at 0.05.

## Results

33 patients were reviewed with a mean follow-up of 42 months (range, 36–50 months). The mean age of patients in this cohort was 53.8 years (range, 19–88 years), with 32 female and 1 male patient. Due to the COVID-19 pandemic limiting patient visitation into the hospital, of the 33 patients contacted and reviewed at a minimum of 36 months, 18 were able to come into hospital for repeat imaging (Fig. 1).

## Primary Outcome Measures

### Clinical Outcomes

All 33 patients completed AOFAS and MOXFQ scores at preoperative, 12- and 36-month postoperative time points as detailed in Table 1. There was a statistically significant ( $p < 0.001$ ) improvement at both 12 and 36 months when compared to preoperative scores. The mean AOFAS score improved from 48.2 preoperatively  $\pm 14.4$  (range, 24–72), to 93.0 at 12 months  $\pm 9.4$  (range, 60–100), and 95.6  $\pm 6.7$  (range, 78–100) at 36 months postoperatively.

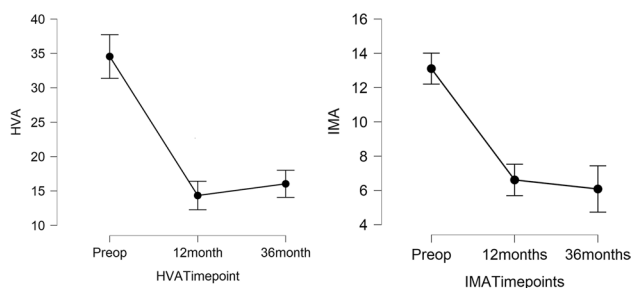
The mean MOXFQ score improved from 57.6  $\pm 16.7$  (range, 26.6–87.5), preoperatively to 10.1  $\pm 17.0$  (range, 0.0–82.8) at 12 months and 6.7  $\pm 11.9$  (range, 0.0–54.7) at 36 months postoperatively. Using the Coughlin scale as reference, 81.8% of patients rated their outcome as Excellent and 18.2% as Good at 36 months.

**Table 1** Clinical outcomes of 33 patients

	Preop (SD)	12-month postop (SD)	<i>p</i> -value <sup>A</sup>	36-month postop (SD)	<i>p</i> -value <sup>A</sup>
AOFAS	48.2 (± 14.4)	93.0 (± 14.4)	< .001	95.6 (± 6.7)	< 0.01
MOXFQ	57.6 (± 16.7)	10.1 (± 17.0)	< .001	6.7 (± 11.9)	< .001

Time point being tested at 12 and 36 months is compared to pre-operative data

<sup>A</sup>Student's paired t-test was used to determine statistical significance



**Fig. 3** Graphs showing mean change in HVA (degrees) and IMA (degrees) at preoperative, 12-month and 36-month time points. Graphs generated from interpretation of radiographs taken at Croydton University Hospital, London (2021)

### Radiological Outcomes

Repeated measures ANOVA revealed a statistically significant effect of surgery on post-operative HVA,  $F(1.40, 23.73) = 91.93$ ,  $p < 0.001$ , decreasing from preoperative mean 34.6 degrees (SD = 11.2), to 12 months postoperative mean 14.3 degrees (SD = 11.0) and 36-month postoperative mean 16.0 degrees (SD = 11.3). Repeated measures ANOVA revealed a statistically significant effect of surgery on postoperative IMA,  $F(1.51, 25.63) = 58.64$ ,  $p < 0.001$ , decreasing from preoperative mean 13.1 degrees (SD = 2.9), to 12 months postoperative mean 6.6 degrees (SD = 3.2) and 36 month postoperative mean 6.1 degrees (SD = 3.5). Therefore, radiological data shows sustained improvement of HVA and IMA from preoperative baseline, with no statistically significant difference when measured at 12 months and 36 months, and these are depicted in Fig. 3.

### Secondary Outcome Measures and Complications

All patients were treated and discharged on the same day, with no overnight stays. The complication rate for the cohort of 40 was 10% at the 12 months postoperatively, with 4 of these patients requiring Akin screw removal after bony union due to soft tissue irritation. At 36 months, additional 2 patients had similar issues and were listed for screw removal. Therefore, there was an overall complication rate of 18.2% at 36 months.

### Discussion

Our case series has shown that MICA surgery is an effective technique to yield positive clinical outcome scores for patients with hallux valgus in the post-operative period. Furthermore, we have shown that there is sustained improvement in these clinical outcome scores after a longer-term postoperative period of 36 months. Analysis of radiological data has shown sustained improvement of HVA and IMA from preoperative baseline, with no statistically significant difference when both are compared at 12 months and 36 months.

Few randomised controlled trials have taken place directly comparing MIS to open surgery, and therefore few meta-analyses are available to conclude on superiority of one approach to the other. A RCT by Kaufmann et al. [4] gives 5-year follow-up data comparing 19 MIS cases to 20 open cases. At 5 years, the MIS group had a median AOFAS score of 95.0, from a baseline of 65.0 preoperatively. Radiologically, the HVA had improved from a preoperative median of 26.4 to 9.8 degrees at 5 years. The IMA had improved from approximately 8.0 to 7 degrees at 5 years (depicted on box-and whisker only). Our MIS results at 36 months show similar in terms of both clinical and radiological outcomes compared to our preoperative scores. When comparing the 12 to 36 months, we identified no statistical significance difference in HVA and IMA with only a minor loss of correction noted in HVA of mean 1.7 degrees. This minor loss in correction in radiological outcomes that we found has also been seen by others investigating long-term data for MIS. Kaufmann et al. [4] found their HVA at 9 months was 7.4, and by 5 years had increased to 9.8 degrees, and this loss of correction was also reflected in the IMA in this period.

The operative technique employed by Kaufmann et al. utilised a Kirschner wire to fix the metatarsal after its repositioning; consequently, they found that 16 patients (84.2%) developed soft tissue irritation requiring its removal. They have since adjusted their operative technique and now utilise a cannulated oblique-headed compression screw (3.5-mm TWIN MIS screw Ø; Marquardt Medizintechnik) for fixation. This is similar to the screw fixation technique we have used in this series.

The RCT by Lee et al. [5] compared 25 MIS versus 25 open cases was compared at 6-month follow-up. Their data demonstrated significantly less pain in the MIS group but

did highlight a complication rate of 24% for these patients which required screw removal. This is greater than our complication rate of 10% and may again be attributed due to the choice of screw design; in our case series, we have used an oblique headless designed chevron screw which theoretically sits more flush with the cortex, minimizing soft tissue irritation.

A case series by Lewis et al. [14] looking at 319 feet has showed an improvement in mean preoperative HVA from 32.9 to 8.7 degrees at 6 weeks, and mean IMA improvement from 15.3 preoperatively to 5.7 degrees postoperatively at 6 weeks. However, their radiological outcome data was only measured at a postoperative period of 6 weeks and so cannot provide information on whether they found sustained radiological improvement in their outcomes.

Our data also highlight the importance of clinical outcome scores when considering the success of surgery. Our patients with preoperative HVA graded as “Severe” who underwent MICA surgery had a mean HVA at 36 months of 31.0 degrees and mean IMA of 11.7 degrees. However, these same patients gave clinical outcome scores of a mean AOFAS of 61.3 preoperatively, which increased to 90.3 at 12 months and 96.3 at 36 months postoperatively. These results may show that the vast improvements seen perceived patient satisfaction following MIS may not be well reflected by radiological data. This is an observation that has been acknowledged by others in the past and may highlight the need for both clinical and radiological correlation to determine the success of such a procedure, a need that this paper has looked to address with the use of both clinical and radiological outcomes. [7, 14, 15]

By contrast, Huang et al. [16] focussed solely on radiological outcomes for patients with HV and advised that open surgery is preferable to MIS for patients graded as “Severe”. In their study, 36 patients had a preoperative HVA greater than 30 degrees (mean 34.1 degrees), and postoperatively for 23 of these patients the resultant HVA remained greater than

20 degrees, giving a poor radiological outcome. Their team did not comment on patient-reported clinical outcomes nor their satisfaction, and so in this case, we cannot comment on the true perceived value of these procedures.

When considering MIS, it is important to acknowledge the short-term benefits of such procedures for example with regards to recovery and return to work. A few studies which investigated MIS made reference to length of stay in hospital reported values ranging from 1.33 to 2.6 days. [7, 8, 17] This is longer than our case series where all patients went home on the same day of the procedure. Furthermore, the ability to weight-bear can have an impact on patients with regards to their usual duties and so is important to consider. It can be seen that many studies employing various MIS techniques have allowed their patients to fully weight-bear immediately postoperatively which is the same as the patients in our case series. [4, 7, 8, 18]

Our analysis revealed two outliers. One patient reported a preoperative AOFAS of 37.0 increasing to 90.0 after 12 months postoperatively. However, upon review after 36 months, their AOFAS decreased to 78.0, complaining of screw prominence at the site of surgery when wearing cramped shoes. This was the greatest decrease in clinical outcome between 12 and 36 months.

The second case involved a patient reporting a preoperative AOFAS of 65.0, postoperatively 85.0 and 100.0 at 12 and 36 months respectively, with a satisfaction rating of Excellent. However, they had notable deterioration in their radiological measurements. Preoperatively the HVA was 48.2 degrees, and postoperatively 17.6 and 32.1 degrees at 12 and 36 months respectively. Preoperatively the IMA was 11 degrees, and postoperatively 2.2 and 5.5 degrees at 12 and 36 months respectively. This increase of 14.5 degrees in HVA and 3.3 degrees in IMA after 24 months is the greatest in our dataset at 36 months. An explanation for this may be attributed to the fact that this patient had a coexisting problem with overlapping 3rd and 4th digit (as seen in Fig. 4)

**Fig. 4** AP weight-bearing radiographs of outlier with overlapping 3rd and 4th digits: pre-operative (a), post-operative at 12-month (b), and 36-month (c) time points





on the same foot which may affect the mechanics of how the in situ screws can maintain the position of the hallux. Despite these angular changes, the AOFAS and satisfaction scores reflected a positive clinical outcome, again highlighting that radiological measurements may not be truly reflective of value of surgery to patients with hallux valgus.

## Strengths

Recurrence of HV is usually multifactorial, including factors, such as preoperative anatomic predisposition, other medical comorbidities, postoperative rehabilitation compliance, and the choice of operative technique and the technical competency of the surgeon [19]. Studies looking into factors which may influence reoccurrence after HV operative correction have identified that some patients with postoperative HVA of  $\geq 13.5$  degrees [20], or those that have a postoperative tibial sesamoid position  $> 4$  [21], have a significantly increased risk of hallux valgus recurrence. This emerging data helps highlight the importance that longer-term follow-up for patients undergoing MIS is important to help establish which techniques will not only provide short-term benefit to patients, but ultimately sustain these over a longer period of time. With our case series we have shown there is sustained improvement in clinical outcome scores and patient satisfaction after a longer-term postoperative period of 36 months using the third-generation MICA technique.

## Limitations

This is a case series demonstrating safe and effective use of the technique outside of an originator centre, however it is limited by being single surgeon and single centre. This is a relatively novel method that does require specific training which may limit its generalisability. [9, 22] The results reported here are the first patient cohort preformed unsupervised by surgeon after fellowship training, and therefore include the impact of a learning curve.

Due to the Covid-19 pandemic, there were restrictions on which patients could come back into hospital for repeat imaging and consequently there was increased missing data. This may provide selection bias to our radiological results as the patients who were not able to come in for imaging may be those who were shielding/too frail/elderly. Research has shown that some medical conditions, some which commonly present at older ages, may result in a loss of synovial capsular support. This may be a result of inflammatory arthritis or invasive crystalline deposition as in rheumatoid arthritis, seronegative arthropathies, or gout. All of these aforementioned conditions have been implicated in HV recurrence [23]. Therefore, the limitation of frailer/older patients may have an impact on our case series as some may

have radiological change explained by similar pathological effects in the interim period.

## Conclusion

Our case series has shown that third-generation MICA provides a good outcome for patients with hallux valgus, and that this benefit is sustained over 36-month period. However, more comparative trials are needed to be able to determine the benefits of MIS over open surgery, with specific emphasis on the short-term advantages gleaned such as recovery time.

## Declarations

**Conflict of Interest** Miss Yousaf has no conflicts of interest. Mr Saleem has no conflicts of interest. Dr Al-Hilfi has no conflicts of interest. Mr Kunasingam has no conflicts of interest.

**Ethical Approval** All patients had been counselled in keeping with the National Institute for Health and Care Excellence (NICE) Interventional Procedures Guidance IPG 332 and subsequent literature [3].

**Informed consent** Informed verbal consent was obtained from patients for their involvement, and institutional ethical consent was obtained before commencing the study.

## References

1. Roukis, T. S. (2009). Percutaneous and minimum incision metatarsal osteotomies: a systematic review. *Journal of Foot & Ankle Surgery.*, 48(3), 380–387. <https://doi.org/10.1053/j.jfas.2009.01.007>
2. Holme, T. J., Sivaloganathan, S. S., Patel, B., & Kunasingam, K. (2020). Third-generation minimally invasive chevron akin osteotomy for hallux valgus. *Foot & Ankle International.*, 41(1), 50–56. <https://doi.org/10.1177/1071100719874360>
3. Excellence NifHaC. Surgical correction of hallux valgus using minimal access techniques. Accessed 16 January, 2021. <https://www.nice.org.uk/guidance/ipg332/chapter/1-Guidance>
4. Kaufmann, G., Mortlbauer, L., Hofer-Picout, P., Dammerer, D., Ban, M. C., & Liebensteiner, M. (2020). Five-year follow-up of minimally invasive distal metatarsal chevron osteotomy in comparison with the open technique a randomized controlled trial. *Journal of Bone and Joint Surgery-American Volume.*, 102(10), 873–879. <https://doi.org/10.2106/jbjs.19.00981>
5. Lee, M., Walsh, J., Smith, M. M., Ling, J., Wines, A., & Lam, P. (2017). Hallux valgus correction comparing percutaneous chevron/akin (PECA) and open scarf/akin osteotomies. *Foot & Ankle International.*, 38(8), 838–846. <https://doi.org/10.1177/1071100717704941>
6. Brogan, K., Lindisfarne, E., Akehurst, H., Farook, U., Shrier, W., & Palmer, S. (2016). Minimally Invasive and open distal chevron osteotomy for mild to moderate hallux valgus. *Foot & Ankle International.*, 37(11), 1197–1204. <https://doi.org/10.1177/1071100716656440>
7. Chan, C. X., Gan, J. Z. W., Chong, H. C., Singh, I. R., Ng, S. Y. C., & Koo, K. (2019). Two year outcomes of minimally invasive

- hallux valgus surgery. *Foot and Ankle Surgery.*, 25(2), 119–126. <https://doi.org/10.1016/j.fas.2017.09.007>
8. Karry, L. K. L., Siu-Wah, K., & Yuen-Hon, C. (2015). Percutaneous chevron osteotomy in treating hallux valgus: hong kong experience and mid-term results. *Journal of Orthopaedics Trauma and Rehabilitation.*, 19(1), 25–30. <https://doi.org/10.1016/j.jotr.2014.02.001>
  9. Jowett, C. R. J., & Bedi, H. S. (2017). Preliminary results and learning curve of the minimally invasive chevron akin operation for hallux valgus. *Journal of Foot & Ankle Surgery.*, 56(3), 445–452. <https://doi.org/10.1053/j.jfas.2017.01.002>
  10. Trnka, H. J., Krenn, S., & Schuh, R. (2013). Minimally invasive hallux valgus surgery: A critical review of the evidence. *International Orthopaedics.*, 37(9), 1731–1735. <https://doi.org/10.1007/s00264-013-2077-0>
  11. Morley, D., Jenkinson, C., Doll, H., et al. (2013). The manchester-oxford foot questionnaire (MOXFQ) development and validation of a summary index scORE. *Bone & Joint Research.*, 2(4), 66–69. <https://doi.org/10.1302/2046-3758.24.2000147>
  12. Coughlin, M. J., Saltzman, C. L., & Nunley, J. A. (2002). Angular measurements in the evaluation of hallux valgus deformities: a report of the ad hoc committee of the American Orthopaedic foot & ankle society on angular measurements. *Foot & Ankle International.*, 23(1), 68–74. <https://doi.org/10.1177/107110070202300114>
  13. Coughlin, M. J., & Jones, C. P. (2007). Hallux valgus: demographics, etiology, and radiographic assessment. *Foot & Ankle International.*, 28(7), 759–777. <https://doi.org/10.3113/fai.2007.0759>
  14. Lewis, T. L., Ray, R., Miller, G., & Gordon, D. J. (2021). Third-generation minimally invasive chevron and akin osteotomies (MICA) in hallux valgus surgery: two-year follow-up of 292 cases. *Journal of Bone and Joint Surgery.* <https://doi.org/10.2106/JBJS.20.01178>
  15. Thordarson, D., Ebrahimzadeh, E., Moorthy, M., Lee, J., & Rudicel, S. (2005). Correlation of hallux valgus surgical outcome with AOFAS forefoot score and radiological parameters. *Foot & Ankle Int.*, 26(2), 122–127. <https://doi.org/10.1177/107110070502600202>
  16. Huang, P. J., Lin, Y. C., Fu, Y. C., Yang, Y. H., & Cheng, Y. M. (2011). Radiographic evaluation of minimally invasive distal metatarsal osteotomy for hallux valgus. *Foot & Ankle International.*, 32(5), 503–507. <https://doi.org/10.3113/fai.2011.0503>
  17. Maffulli, N., Longo, U. G., Oliva, F., Denaro, V., & Coppola, C. (2009). Bosch osteotomy and scarf osteotomy for hallux valgus correction. *Orthopedic Clinics of North America.*, 40(4), 515. <https://doi.org/10.1016/j.ocl.2009.06.003>
  18. Lucattelli, G., Catani, O., Sergio, F., Cipollaro, L., & Maffulli, N. (2020). Preliminary experience with a minimally invasive technique for hallux valgus correction with no fixation. *Foot & Ankle International.*, 41(1), 37–43. <https://doi.org/10.1177/1071100719868725>
  19. Raikin, S. M., Miller, A. G., & Daniel, J. (2014). Recurrence of hallux valgus a review. *Foot and Ankle Clinics.*, 19(2), 259. <https://doi.org/10.1016/j.fcl.2014.02.008>
  20. Hagio, T., Yoshimura, I., Kanazawa, K., et al. (2021). Risk factors for recurrence of hallux valgus deformity after minimally invasive distal linear metatarsal osteotomy. *Journal of Orthopaedic Science.* <https://doi.org/10.1016/j.jos.2020.12.013>
  21. Shibuya, N., Kyprios, E. M., Panchani, P. N., Martin, L. R., Thorud, J. C., & Jupiter, D. C. (2018). Factors associated with early loss of hallux valgus correction. *Journal of Foot & Ankle Surgery.*, 57(2), 236–240. <https://doi.org/10.1053/j.jfas.2017.08.018>
  22. Palmanovich, E., Ohana, N., Atzmon, R., et al. (2020). MICA: a learning curve. *Journal of Foot & Ankle Surgery.*, 59(4), 781–783. <https://doi.org/10.1053/j.jfas.2019.07.027>
  23. Sammarco, G. J., & Idusuyi, O. B. (2001). Complications after surgery of the hallux. *Clinical Orthopaedics and Related Research.*, 391, 59–71.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.