


## CLINICAL ARTICLE

# Modified Chevron Osteotomy with Distal Soft Tissue Release for Treating Moderate to Severe Hallux Valgus Deformity: A Minimal Clinical Important Difference Values Study

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## Abstract

**Objective:** To explore whether modified Chevron osteotomy together with distal soft tissue release would correct moderate to severe HV deformity and what is the minimal clinical important difference (MCID) for objective and subjective evaluating parameters.

**Methods:** From March 2018 to January 2019, 40 hallux valgus patients (including moderate to severe) were enrolled in this retrospective study. The cohort included four males and 36 females. The average age at surgery was 50.95 (range 22–75) years. All patients underwent modified Chevron osteotomy together with distal soft tissue release and completed at least one follow-up at clinic. The American Orthopaedic Foot and Ankle forefoot score (AOFAS, forefoot), Visual Analog Scale (VAS), and Foot Function Index (FFI) were all collected before and after surgery. Besides, the hallux valgus angle (HVA), 1st–2nd intermetatarsal angle (IMA) and distal metatarsal articular angle (DMAA) were measured both before surgery and at last follow-up. All MCID values were calculated by employing distribution-based method.

**Results:** Thirty-seven patients (92.5%) showed satisfied result at a mean 14.3-month follow-up (range 13–22 month). Two patients complained about residual pain at the bunion, and overcorrection (hallux varus) occurred in one patient. Meanwhile, no patient observed nonunion. Being female, age more than 60, residual HVA deformity ( $>15^\circ$ ), and post IMA more than  $9^\circ$  showed no statistical relationship with the post-operation residual pain ( $P > 0.05$ ). However, high VAS score before surgery (more than 7) showed strong correlation with residual pain ( $P < 0.01$ ). The subjective MCID value was 9.50 for AOFAS, 18.92 for FFI, and 1.27 for VAS, respectively.

**Conclusion:** The modified Chevron osteotomy together with distal soft tissue release could achieve a satisfied result for moderate to severe HV deformity at early follow-up. The residual pain was associated with severe pain before surgery (VAS more than 7).

## Introduction

Based on accumulated experience, some surgeons may show over-confidence in their clinical practicing, especially when they have the preoperative conversation with patients concerning the clinical outcome and prognosis.

The judgment from a surgeon, however, is not reliable enough. This is because that the proof is only derived from their learning from predecessors, published research, or former practices, even though those are helpful to provide answers to the questions such as how long it will take for

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patients to be fully recovered and what is the overall success rate of certain operations. It is true that patients may get a precise number, solid data proof, and case studies from surgeons. Nevertheless, most of the follow-up information is collected from patients' self-reported scoring systems and is analyzed by surgeons. Unavoidably, these evaluations are subjective. It made self-reported outcomes less persuasive for every single patient, and the concept of minimal clinically important difference (MCID) of great significance during the last decades.

Minimal clinical important difference is defined as "the smallest change in an outcome measure that results in an important change as identified by the patient or which represents meaningful improvement as judged by clinicians."<sup>1</sup> Currently, this concept would be specifically conducive to evaluating patient-reported outcomes (PROs). In clinical practice, the PROs are utilized when all the clinical information comes from patients while the clinical improvement does not match the evaluation. After decades of endeavor, MCID was finally brought up to bridge the understanding gap between doctors and patients. Till the present, two major methods have been reported for the calculation of MCID values: the anchor-based approach and the distribution-based approach.<sup>2,3</sup> In the anchor-based approach, patients are divided into two groups: the satisfied and the unsatisfied. Then, the difference between the two groups is compared. The distribution-based approach emphasizes the change in every single patient during their recovery, not between two separated groups. Both methods are extremely helpful for understanding the MCID of PROs, whereas no consensus has been achieved for a better selection as for the present.

Hallux valgus (HV) is a common forefoot deformity with a very high incidence and was first introduced by Hueter in 1879.<sup>4</sup> It is characterized by lateral deviation of the great toe and medial deviation of the first metatarsal. Sheree reported a 35.7% incidence of HV deformity in the over-65-years population.<sup>5</sup> This anatomical disorder would gradually lead to painful bunion and shoe-wearing problems in nearly 70% of patients.<sup>6</sup> Over 100 surgical methods were introduced for treating hallux valgus.<sup>7</sup> Among these various procedures, the Chevron osteotomy has achieved successful results for mild to moderate HV deformity with subluxation of the first metatarsophalangeal joint, and it has been demonstrated to be used for almost 40 years.<sup>8</sup> Through decades of modification, this classic procedure has been reported with high satisfaction rate and has been widely accepted by surgeons and patients. However, the MCID regarding American Orthopaedic Foot and Ankle Society (AOFAS), Visual Analog Score (VAS), and Foot Function Index (FFI) after HV patients undergo modified Chevron osteotomy remains uncertain. Over the last decades, most of the follow-up questionnaires were scored by surgeons. During the above-mentioned follow-ups, the discrepancy of satisfaction was occasionally detected between surgeons and HV patients. This inconsistency was derived from the no synesthesia between doctors and patients. The concept of MCID was just

right for helping doctors better comprehend to what extent patients would feel a change when being treated with essential procedures. Nowadays, little literature concentrates on the MCID of PROs in terms of foot and ankle disorders. In light of the above situation, it is instructive to explore the MCID values for HV patients. The research group in this study tried to explore: (i) the clinical result of Chevron osteotomy combined with distal soft tissue release for moderate to more severe HV patients; (ii) the actual subjective MCID values (derived from PROs) of AOFAS, VAS, and FFI of HV patients who underwent such a procedure; (iii) the objective (detected from measurements) MCID values of hallux valgus angle (HVA), 1st–2nd intermetatarsal angle (IMA) and distal metatarsal articular angle (DMAA).

The retrospective study aims to provide meaningful evidence for surgeons when selecting proper procedure for HA patients.

## Materials and Methods

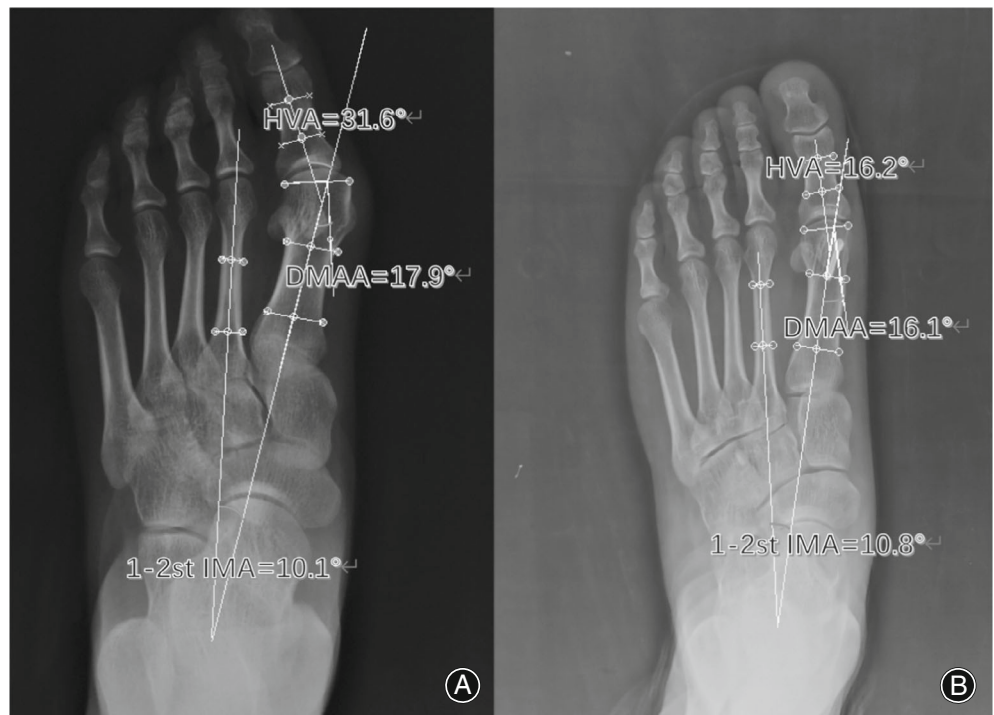
### Inclusion Criteria of Participants

This retrospective study was approved by the local Ethic Committee (Number: JSTEC 202201-14). From March 2018 to January 2019 a total of 83 cases undergoing HV correction surgeries were reviewed. The enrollment criteria are defined as: (i) HV patients with HVA (moderate to severe deformity) more than 20°, and 1st–2nd IMA more than 11° (Figure 1); (ii) age at surgery: between 18 and 80 years; (iii) primary HV correction surgery after failed conservative treatment; (iv) post-operation follow-up time being more than 6 months and at least accomplishing one clinical follow-up; (v) patients who can understand and complete all the self-reported questionnaires; (vi) underwent modified Chevron osteotomy and distal soft tissue release procedure; (vii) data comparison between pre-operation and post-operation, and between satisfied patients and unsatisfied patients; (viii) with all related radiology information.

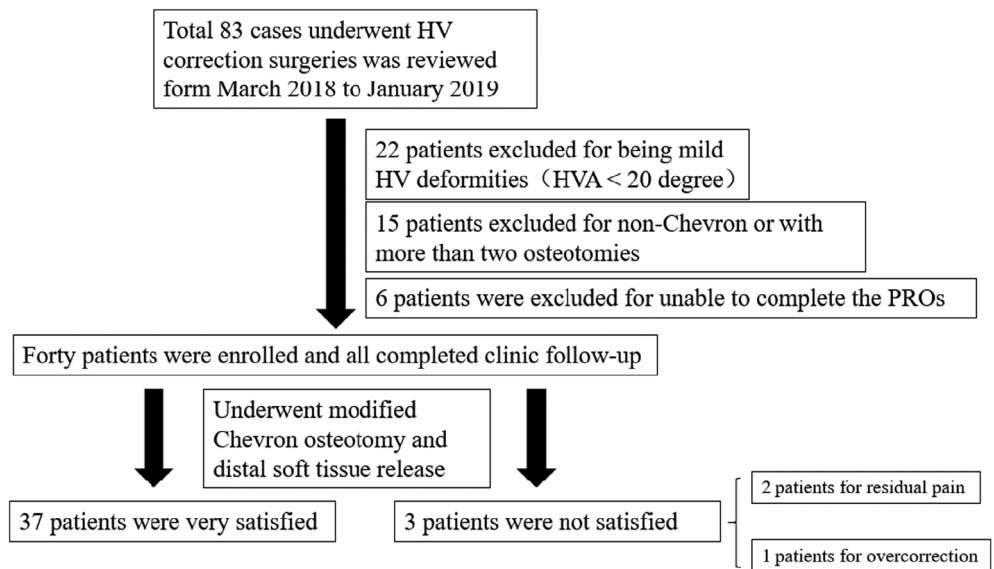
The exclusion criteria included: (i) mild deformity (HVA less than 20°); (ii) during surgery more than two osteotomies (such as Chevron and Akin); (iii) failed to finish questionnaires themselves.

Based on the criteria above, 22 patients were excluded for exclusion criteria, 15 for non-Chevron or combined with more than two osteotomies, and six for being unable to complete the PROs by themselves. Finally, 40 patients were enrolled, and all completed the clinical follow-up (Figure 2). The cohort included four males and 36 females, with the average age at surgery being  $50.95 \pm 15.33$  (range, 22–75) years. All of them completed at least one follow-up at clinic, and answered AOFAS-Forefoot, VAS pain score, and FFI questionnaire.<sup>9–11</sup> Patients were asked about how they appraise their general surgical result based on a five-grade scale (5 characterized as very satisfied, 4 as satisfied, 3 as no change after surgery, 2 as unsatisfied, and 1 as very unsatisfied). Scales 5 and 4 were further classified as the satisfactory group with scales 3, 2, and 1 as dissatisfied group.

**Fig. 1** Preoperative (A) and 16-months postoperative (B) foot anteroposterior X-rays of the same patient who underwent modified Chevron osteotomy and distal soft tissue release. HVA: Hallux Valgus Angle. 1st-2nd IMA: 1st-2nd Intermetatarsal Angle. DMAA: Distal Metatarsal Articular Angle



**Fig. 2** Flow chart of this retrospective study. Forty moderate to severe hallux valgus patients were finally enrolled in this study. Three patients ended up with unsatisfied results



The HVA, 1st-2nd IMA and DMAA were measured both pre-operation and at the 6-month follow-up.

### Surgical Procedure

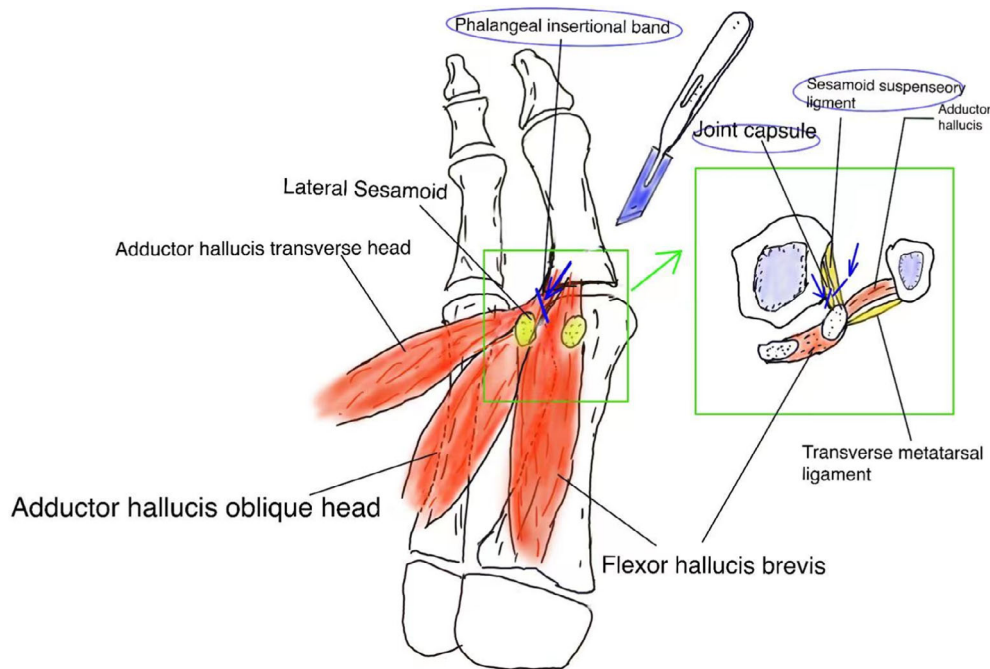
#### Anesthesia and Position

All patients were anesthetized with sciatic nerve and femoral nerve block. After successful anesthesia, patients were

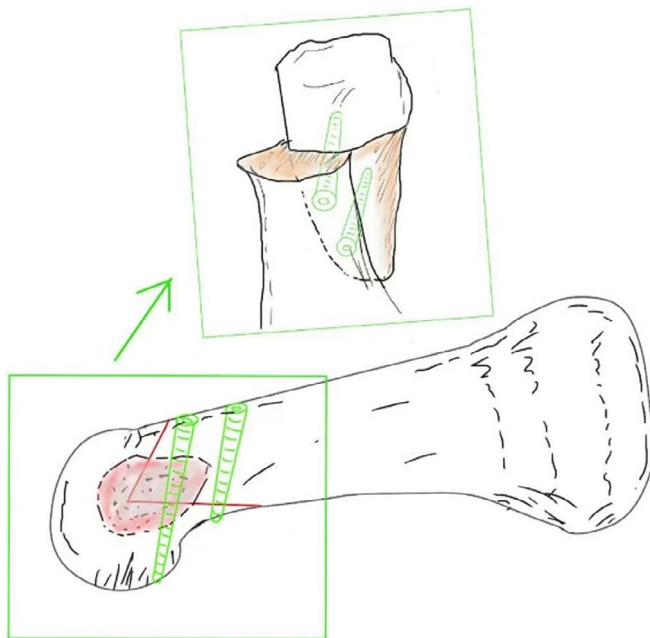
immobilized in supine position. In addition, lower extremity tourniquet was adopted for helping optimize surgical vision.

#### Soft Tissue Release

The distal metatarsal soft tissue release procedure in this institution aims to realign the phalanx under the metatarsal head (Figure 3). At the end of the procedure, the wound was closed with gauze-and-tape compression dressing being applied to maintain the soft tissue tension.



**Fig. 3** The demonstration of soft tissue release. Blue arrows showed the release of anatomical structures



**Fig. 4** The demonstration of Modified Chevron osteotomy

#### Osteotomy

In the modified Chevron osteotomy, a longitudinal incision was made over the medial eminence. After opening the capsule, a long plantar arm and short vertical arm 60° V- or L-shaped Chevron osteotomy (long plantar arm, Figure 4) was achieved with an oscillating saw in the metatarsal region. The first metatarsal was replaced at the aiming position, the

fracture was fixed with a temporary pin, and the extra medial eminence was cut. Then, the lateral capsule and adductor tendon were released, and the osteotomy sites were fixed with a 2.4-mm Herbert screw.

#### Postoperative Rehabilitation and Follow-Ups

Patients were allowed to ambulate with a post-operation heel-weight-bearing shoe. Six to 8 weeks after surgery, patients were required to exercise in soft shoes. Three months after surgery, they were asked to come back to the clinic and take another radiograph. During the post-operation clinical follow-up, all patients would answer the FFI questionnaire<sup>9</sup> and VAS,<sup>10</sup> and surgeons would assist them to complete the AOFAS-Forefoot.<sup>11</sup> The 3-month radiograph would be estimated and measured again. Moreover, patients were requested to come back to the clinic at 3, 6, 12 months and then once a year after surgery.

#### Statistical Method

The quantitative parameters such as AOFAS, FFI, VAS, HVA, IMA, and DMAA were described with average deviation and standard deviation (SD). In terms of the normally distributed data, the differences between groups were compared with a student's *t* test. The non-normally distributed data were compared with the chi-square test. Besides, the differences between preoperative and postoperative parameters were compared with a paired *t* test. The SD approach was adopted for calculating the MCID values. By employing the SD method, MCID value was defined as the value of one-half of an SD for calculating mean change from pre-operation to



**TABLE 1** A paired *t* test showed the significant improvement (\*) of hallux valgus patients who underwent modified Chevron with distal soft tissue release and the calculated minimal clinical important difference values

N = 40	Pre-OP	Post-OP	MICD (1/2 of SD)	<i>t</i>	Sig.
Pre-HVA vs Post-HVA (°)	38.10 ± 9.81	9.93 ± 6.21	5.64	15.80	0.001*
Pre-IMA vs Post-HVA (°)	12.79 ± 3.94	6.90 ± 2.58	1.85	10.08	0.001*
Pre-DMAA vs Post-DMAA (°)	19.20 ± 9.17	7.48 ± 5.25	4.26	8.71	0.001*
Pre-AOFAS vs Post-AOFAS	61.63 ± 19.96	96.18 ± 5.58	9.50	-11.50	0.001*
Pre-FFI vs Post-FFI	52.75 ± 38.56	2.85 ± 4.74	18.92	8.34	0.001*
Pre-VAS vs Post-VAS	3.78 ± 2.51	0.75 ± 1.13	1.27	7.54	0.001*

post-operation. Two types of MCID value were introduced in the present study. The objective MCID values included HVA, IMA, and DMAA, while the FFI, VAS, and AOFAS scores were listed as subjective values. After all, the MCID values were calculated, and a receiver operating characteristic (ROC) curve was drawn. Then, the sensitivity, specificity, and area under the curve (AUC) was analyzed to confirm the validity of each MCID value. A Pearson's chi-square test was utilized to explore the possible correlated factors with postoperative residual pain. All data were explored by SPSS software Version 20 (Chicago, IL, USA) with *P* value <0.05 as statistical difference.

## Results

### General Results

A total of 40 patients were reviewed in this retrospective study. The mean follow-up time was 14.3 (range, 12–22) months. The HVA decreased from mean 38.1° preoperatively to mean 9.93° postoperatively, the IMA from mean 12.79° to 6.9°, the DMAA from 19.2° to 7.84°. All these objective parameters presented significant improvement (Table 1, *P* < 0.05) with a paired sample *t* test. Additionally, the modified Chevron osteotomy also showed excellent results regarding PROs. The AOFAS, FFI, and VAS score all presented significant improvement (Table 1, *P* < 0.05).

### Satisfaction Rate and Complications

Thirty-seven patients reported satisfied results. Three patients came back to the clinic with unsatisfied feedback. The satisfaction rate was 92.5%. Two of them complained about residual pain, while one complained about secondary hallux varus deformity after surgery. One patient suffered from incision infection 3 weeks after the operation and took oral antibiotics for 2 weeks. The infection was successfully eliminated eventually. No bone nonunion in patients was observed during the follow-ups. Besides, no revision was performed.

### Objective and Subjective Minimal Clinical Important Difference (MCID) Results

The objective observed parameters, including HVA, IMA, and DMAA, were detected through radiographic measurements (Figure 1). The calculated MCID values based on SD

**TABLE 2** The proportion of patients that exceeded each minimal clinical important difference value

	Exceeded (%)	Non-exceeded (%)
AOFAS-MICD	92.5	7.5
FFI-MICD	80	20
VAS-MICD	70	30
IMA-MICD	85	15
HVA-MICD	97.5	2.5
DMAA-MICD	72.5	27.5

approach included 5.64° for HVA, 1.85° for IMA, and 4.26° for DMAA, respectively. The subjective MCID values (derived from PROs) were 9.50 for AOFAS, 18.92 for FFI, and 1.27 for VAS, respectively. Based on each MCID value, 92.5% of the patients surpassed the minimal AOFAS change, while 80% exceeded the minimal FFI change, and 70% patients exceeded minimal VAS change. Regarding the objective MCID values, 85% patients exceeded the minimal IMA change, and 97.5% patients exceeded the minimal HVA change (Table 2).

### The Effectivity of Minimal Clinical Important Difference (MCID) Values

The ROC curves were drawn according to each different MCID value (cut-off value). The AUCs of AOFAS MCID, FFI MCID, and VAS MCID was 0.65, 0.57, and 0.56, respectively (Figure 5). The AUCs of all the objective MCID values were over 0.5. For the subjective MCID values, the AUCs were 0.42, 0.49, and 0.53 for IMA, HVA, and DMAA MCID values. Only the DMAA MCID value presented possible effectivity (AUC = 0.53, *P* = 0.857) for estimating patients' clinical outcomes (Table 3).

### Residual Pain and Correlated Factors

Two patients were dissatisfied and complained about residual painful bunion after surgery. In accordance with former experience, it was assumed that factors such as being female, aged over 60 years, with pre-operation VAS more than 7, residual HVA deformity (HVA more than 15°), and post-surgical unnormal IMA (IMA more than 9°) might influence the outcome. Hence, a Pearson's chi-square test was utilized for exploring the correlation between postoperative residual pain and the above factors.

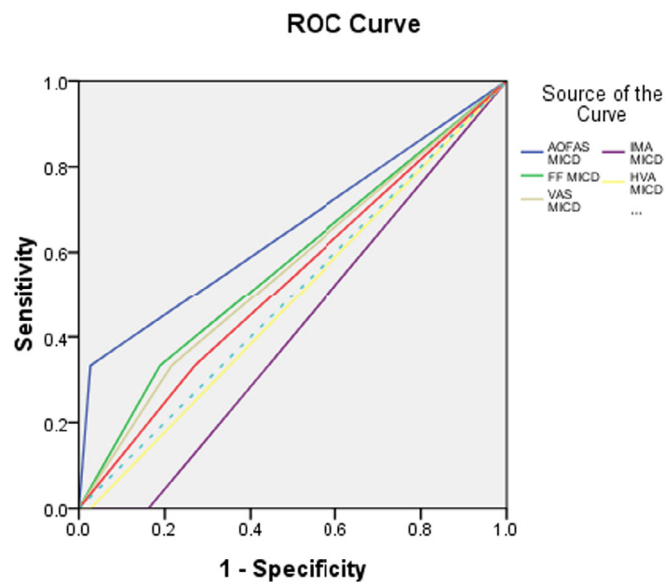
Being female, aged more than 60 years, having residual HVA deformity ( $>15^\circ$ ), and post IMA more than  $9^\circ$  showed no statistical relationship with the post-operation residual pain (Table 4,  $P > 0.05$ ). Nevertheless, high VAS score before surgery (more than 7) showed strong correlation with residual pain (Table 4,  $P < 0.001$ ).

## Discussion

### The Chevron Osteotomy Could Correct Moderate to Severe Deformity

Hallux valgus deformity gets in the way of people's normal life in upright walking. Numerous surgical methods have

been introduced for this long-standing disease. However, due to the insufficient balancing of the medial site, the correction of the hallux valgus becomes challenging. The most common osteotomies include Chevron, Akin, Scarf, and Lapidus procedure. Some of them belong to the proximal, while some concentrate on the distal metatarsal. As for the classic distal osteotomy, Chevron is initially indicated for mild to moderate HV deformity, and it was reported with limited efficiency of correction in the treatment of severe deformities ( $HVA > 30^\circ$  or  $IM > 13^\circ$ ). Nevertheless, recent literature has reported that Chevron together with adequate distal soft tissue release could achieve satisfied outcomes for moderate to severe HV deformity.<sup>5,12</sup> The above-mentioned studies all emphasize the importance of balancing the soft tissue after correcting the bony deformity. For most HV cases, the contracted lateral capsule, lateral suspensory ligament, and adductor hallucis (phalangeal insertional band; Figure 3) is enough to realign the proximal phalanx right under the metatarsal head.<sup>13</sup> For some severe deformities, the transverse metatarsal ligament and even part of the flexor hallucis brevis (lateral proximal part connected to lateral sesamoid) could be released for adequate realignment. Judged from previous experience, after adequate soft tissue release, the balance could be achieved. While, for a bigger 1–2 IMA, the stable position would be broken as time goes on. The fixed 1–2 IMA more than  $10^\circ$  suggested a high recurrence of deformity. In the current research, the mean IMA before and after surgery was 12.79 and 6.90, respectively, indicating a low risk of HV recurrence after surgery. However, the result



Diagonal segments are produced by ties.

**Fig. 5** Receiver operating curves of each minimal clinical important difference value (cut-off value). The MICD value of American Orthopaedic Foot and Ankle forefoot score (AOFAS) showed good identification efficacy.

**TABLE 4** Pearson's chi-squared test for analyzing the correlations with postoperative residual pain (\*  $P < 0.05$ )

	N	Pearson Correlation	Sig.(2-tailed)
Being Female	40	0.096	0.554
Age > 60	40	0.281	0.079
Pre VAS > 7	40	0.806	0.000*
Post IMA > $9^\circ$	40	-0.115	0.481
Post HVA > $15^\circ$	40	-0.106	0.516

**TABLE 3** Area under the curve basing on different minimal clinical important difference values

Test result variable(s)	Area	Std. error <sup>a</sup>	Asymptotic Sig. <sup>b</sup>	Asymptotic 95% confidence interval	
				Lower bound	Upper bound
AOFAS MICD	0.653	0.195	0.383	0.272	1.035
FFI MICD	0.572	0.183	0.681	0.213	0.932
VAS MICD	0.559	0.182	0.739	0.202	0.915
IMA MICD	0.419	0.152	0.644	0.121	0.716
HVA MICD	0.486	0.172	0.939	0.150	0.823
DMAA MICD	0.532	0.179	0.857	0.181	0.882

<sup>a</sup> Under the nonparametric assumption.; <sup>b</sup> Null hypothesis: true area = 0.5.

still needs further verification with more samples and long time follow-up.

In this study, modified Chevron osteotomy and adequate distal metatarsal soft tissue release could correct HV deformity patients with high satisfaction rate. The total satisfaction rate was 92.5% in mean 14.3 (range 12–22)-month follow-up. The subjective parameters including AOFAS, FFI, and VAS showed significant improvement with good efficacy ( $P < 0.05$ ). These MCID values indicate the least change that patients could feel regarding these parameters. By employing SD method, the calculated AOFAS MCID value was 9.5, and 92.5% patients exceeded this point. The calculated FFI MCID value was 18.92 with 80% achieving this threshold. The calculated VAS pain MCID value was 1.27 with 70% reaching this threshold. In another word, patients could perceive a minimal 9.5 score improvements in AOFAS and 18.92 score improvements in FFI. So far, there existed no former literature focusing on FFI and AOFAS score MCID calculating. The obtained results could provide reliable reference for future studies. The VAS pain MCID has been reported as 1.8, 5.2, and 4.3 points with SD approach, average change approach, and change difference approach,<sup>15</sup> which was similar in the current work (VAS pain MCID = 1.27 for SD approach). In the meantime, this calculated VAS pain MCID value (1.27 points) also testified the good efficacy of VAS in the evaluation of HVA patients, which means a minimal 1.27 score improvement in VAS could be detected by patients.

Three patients were not satisfied after surgery. One patient showed hallux varus after surgery, but there was no pain and she had no problem when wearing shoes, and she was satisfied with the surgery (Figure 6). All patients achieve

bone union, which proved modified Chevron osteotomy with one screw was a stable procedure. Two of them still complained about the residual pain in the original bunion. The Pearson's chi-square test revealed that the residual pain was in high association with the higher preoperative VAS ( $>7$ ). Normally, the VAS was not so high for a HV patient. The mean VAS before surgery was 3.78 and 82.5% (33/40) patients were below 7. During the clinic visit, seven patients presented a slightly anxious mental state. While the residual deformity (HVA more than  $15^\circ$ , IMA more than  $9^\circ$ ) showed no statistical relation with the residual pain. Therefore, it can be assumed that the metal state could possibly aggravate the pain.

The total satisfaction rate was 92.5% in the average 14.3-month follow-up after the modified Chevron and distal soft tissue release procedure, which is a quite promising result for moderate and severe HV patients. Most patients showed very satisfied result at last follow-up (For example see Figure 7). It is reported that the modified Chevron osteotomy with appropriate soft tissue balancing could achieve relative high satisfaction rate (87%–94%)<sup>16,17</sup> in the moderate HV deformity patients, and the average HV correction was  $12^\circ$ – $15^\circ$ , with the IMA correction being  $4^\circ$  to  $5^\circ$ . In this study showed an average HV correction of  $28.18^\circ$  for modified Chevron osteotomy, which is almost twofold of the former result. The discrepancy indicated that modified Chevron combined with appropriate soft tissue release procedure could achieve a powerful correction result with a relatively high satisfaction rate. Trnka *et al.* reported an  $18^\circ$  HV correction for Chevron together with soft tissue release.<sup>18</sup> However, the improvement of IMA was not so good for Chevron ( $5.8^\circ$  in this study), which was basically conformed to the



**Fig. 6** One unsatisfied patient was observed with hallux varus after surgery. (A) pre-Operation; (B) 6 weeks after surgery; (C) 1 year after surgery showed hallux varus deformity



**Fig. 7** Patient underwent Chevron and 2nd Metatarsal Weil Osteotomy with a very satisfied result. (A) Pre-operation anterior–posterior X-ray of left foot. (B) One year after operation anterior–posterior X-ray of left foot.

former literature.<sup>16</sup> Due to this procedure only being located on the distal metatarsal, it was already an acceptable result for the IMA correction. Chou *et al.* reported 7° improvement of DMAA in 14 patients.<sup>19</sup> The result measuring 40 patients' post-operation X-rays showed an average 11° change in DMAA after surgery. The better improvement of DMAA was most likely caused by the adequate soft tissue release and proper recovery plan. The ROC verified that the DMAA MCID value was a solid indicator that can actually be perceived by patients, also proving the powerful correction ability of Chevron Osteotomy for DMAA.

### **The Significance of Minimal Clinical Important Difference (MCID) Value**

Both surgeons and patients wonder about the improvement for patients after a standard surgery. What is the smallest improvement and how is that change demonstrated in their function scores or radiologic measurements? This is exactly what MCID desperately attempt to answer. Hallux valgus deformity correction shows definite advantages for MCID calculation. The current research aims to provide reliable subjective (from PROs) and objective (through measurements) MCID values of patients undergoing the Chevron osteotomy. Furthermore, it can further verify the clinical efficacy of Chevron combined with soft tissue release for moderate to severe hallux valgus deformity.

The concept of MCID is brought up for overcoming the disadvantages of “statistical difference.” From the perspective of surgeons, the clinical change might have significant improvement in the treatment of certain disease.

However, the PROs sometimes showed discrepancy with the statistical result. For most cases, surgeons may not obtain the same feedback of the operation with that of patients because they are not the ones who suffer from the disease and receive the treatment. Under the above-mentioned circumstances, the MCID value calculation would present the minimal change that can be perceived from the perspective of patients. This value matters because it does not only provide surgeons reliable reference for understanding the clinical recovery through PROs, but also lowers the understanding gap between patients and surgeons.

### **Why Choose Distribution-Based Methods for Calculating Minimal Clinical Important Difference (MCID)?**

There are different calculating methods for MCID values. However, no consensus has been made so far. Generally, these methods are divided into distribution-based methods and anchor-based methods. The former ones do not calculate based on patients' satisfaction.<sup>3</sup> In comparison, in the anchor-based method, data are investigated between the satisfied and dissatisfied groups. These methods all have advantages and disadvantages. In the present study, only three patients reported unpleasant feedback, which made the anchor-based method not applicable for the calculation. The SD method is one kind of the distribution-based approaches, which depends more on patients' characteristics instead of the satisfaction degree. Former studies elaborated that SD represents the variation among a group of scores, and 0.5 SD stands for the limitation of the human mental discriminative capacity. This limit was found in a vast majority of PRO studies and could be utilized as MCID value.<sup>3,20</sup> Regarding a cohort with a small number of unsatisfied participants, this method could provide reliable results for the current work.

With numerous doctors putting increasing efforts into the real PROs, the PROMIS (Patients-Reported Outcome Measurement Information System) was designed. It is becoming increasingly popular in America. This adjusted questionnaire was designed to be highly patient-friendly. Through answering several questions, the items in the questionnaire can be easily understood by patients, and PROMIS could present rather reliable clinical outcomes after surgery. Besides, it was reported that PROMIS is a valid and reliable tool for estimating clinical outcomes for foot and ankle patients.<sup>14</sup> Moreover, it is believed that PROMIS together with MCID would be a priority option for the PRO-related studies in the very near future.

### **Limitations**

Several deficiencies still exist in this retrospective study. Initially, there are not enough dissatisfied patients (only three), making tracing risk factors statistically difficult. Second, the average follow-up is not long enough (mean 14 months). Meanwhile, further long-term clinic visits are needed. Third, with few cases with dissatisfaction, it is impossible to compare the MCID values between anchor-based and



distribution-based methods. Larger sample size, longer-term follow-up, and a well-designed prospective approach are necessary in future studies.

### Conclusion

To conclude, the modified Chevron osteotomy together with distal soft tissue release could achieve a satisfied result for

moderate to severe HV deformity at early follow-up. The residual pain was associated with severe pain before surgery (VAS more than 7).

### Conflict of Interest

All authors declare no conflict of interest.

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