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Original Research Article

Comparative Evaluation of the Outcomes Following Chevron Osteotomy with Akin Osteotomy or without It: A Retrospective Clinical Assessment

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Abstract:

Background: One of the most adapted approaches for the corrective surgery of valgus deformity of great toe is the Chevron osteotomy which is usually done with the Akin osteotomy of the proximal phalanx of the hallux. No guidelines exist for their indication technique or postoperative correction loss or adjacent joint arthritis development.

Aim: The present study aimed to comparatively assess the treatment outcomes radiographically following Chevron osteotomy with Akin osteotomy or without Akin osteotomy.

Methods: In 59 subjects assessed, 9 subjects underwent the Chevron osteotomy along with Akin osteotomy combined, whereas 50 subjects were managed with the Chevron osteotomy alone. The radiographs for assessment were taken preoperatively and postoperatively. The outcomes assessed were complications, arthritis of adjacent joints, valgus deformity recurrence, IPA (interphalangeal angle), HVA (hallux valgus angle), and IMA (intermetatarsal angle).

Results: It was seen that lower IPA and HVA angles were maintained with combined Chevron-Akin osteotomy compared to Chevron osteotomy alone. A significant increase in HVA was seen in the Chevron osteotomy group from 18.39 at the first follow-up to 20.83 at the final follow-up visit. However, no significant difference was seen in the two groups concerning the other radiographic variables assessed. No increase in adjacent joint arthritis was seen following hallux valgus surgery.

Conclusion: The present study concludes that no effect on IMA or HVA correction is seen following Chevron-Akin osteotomy in combination, and the combination further decreases the risk of increased IPA or HVA after long-term follow-up. Also, Akin osteotomy has no increased risk of adjacent-joint arthritis and is recommended for correction of hallux valgus deformity.

Keywords: Akin Osteotomy, Chevron Osteotomy, Interphalangeal Angle, Hallux Valgus.

Introduction

Hallux valgus deformity has a high prevalence of nearly 28% in adult subjects globally making it a matter of concern and an issue for Orthopedic surgeons. Hallux valgus deformity affects nearly 20% of subjects in the age range of 18 years to 70 years and nearly 65% of subjects aged >70 years. A high number of hallux valgus surgeries are being done globally every year; these surgeries are considered one of the most common surgeries conducted in the foot region.[1]

Various surgical techniques have been adopted for the hallux valgus correction as mentioned in the literature. The outcomes reported have been satisfactory with the different techniques used. However, no technique has been described as gold-standard for managing the hallux valgus deformity, and the appropriate technique selection is being done by an orthopedic surgeon. Among the various described techniques, the most widely used and described technique is Chevron osteotomy. The complication rates associated with the hallux valgus surgery range from 1% to 75% with the most commonly associated complications being need of fixation removal, arthritis, malunion, overcorrection, nonunion, deformity recurrence, and incomplete correction.[2,3]

Chevron osteotomy has various advantages including a less invasive and simple technique compared to other techniques and ensures minimal shortening

of the metatarsal. Also, a less common incidence has been seen for revision surgery after distal metatarsal osteotomy compared to proximal metatarsal osteotomy. Few authors showed that when Chevron osteotomy has been done properly, positive outcomes are seen in subjects having moderate to severe deformity of the hallux valgus.

Other authors showed that distal first metatarsal osteotomy should only be done in correction of mild to moderate hallux valgus deformity. Mild hallux valgus deformity is considered for an IMA angle of <11°, moderate for 11-16°, severe for IMA angle of >16°, and mild deformity for HVA of < 20°, moderate for HVA angle of 20°-40°, and severe deformity for angle of >40° respectively.[4]

Along with soft-tissue procedures and first metatarsal osteotomy, hallux valgus deformity is usually treated with combined osteotomy of the first proximal phalanx like Akin osteotomy. The Akin osteotomy, which is a medial closing-wedge osteotomy, is done to preserve the lateral cortex of the proximal phalanx while correcting the axis. Hallux valgus surgery is done to correct the radiographic deformity and achieve good functional outcomes including pain alleviation and improvement in the foot biomechanics. Also, hallux valgus deformity in old subjects is linked to a high risk of mortality with an increased risk of falls in affected subjects.[5]

Perform accurate hallux valgus correction, it is challenging for most orthopedic surgeons, despite their experience. The combined use of Akin osteotomy with the Chevron osteotomy has been studied extensively in the previous literature. The literature data are scarce for comparison of radiographic features after Chevron osteotomy to combined Chevron-Akin osteotomy. The previous studies comparing the IMA and HVA correction following Chevron osteotomy alone to combine Chevron-Akin osteotomy for hallux valgus deformity correction reported that better correction is seen with combined Chevron-Akin osteotomy compared to Chevron osteotomy alone.[6]

The present study aimed to comparatively assess the treatment outcomes radiographically following chevron osteotomy with Akin osteotomy or without Akin osteotomy.

Materials and Methods

The present retrospective clinical study was performed to assess the treatment outcomes radiographically following chevron osteotomy with Akin osteotomy or without Akin osteotomy. The study data were retrieved from the Department of Orthopaedics, Saraswati Medical College Unnao, Uttar Pradesh.

Following inclusion and exclusion criteria, 59 subjects requiring the hallux valgus deformity [Figure: A, B and C] correction that could be assessed retrospectively were included. The study subjects had 93.22% (n=55) females and 6.77% (n=4) male subjects. Chevron osteotomy [Figure: D and E] was done in 50 subjects and combined chevron-akin osteotomy was done in 9 subjects. [Figure: F, G and H] In cases where adequate correction was not done with chevron osteotomy alone, additional akin osteotomy is done following the literature protocol.[7]

Following inclusion and exclusion criteria, 59 subjects requiring the hallux valgus deformity correction that could be assessed retrospectively were included. The study subjects had 93.22% (n=55) females and 6.77% (n=4) male subjects. Chevron osteotomy was done in 50 subjects and combined Chevron-Akin osteotomy was done in 9 subjects. In cases where adequate correction was not done with Chevron osteotomy alone, additional akin osteotomy is done following the literature protocol.[7]

The mean age of the study subjects was 62.94±3.88 years and 56.53±4.68 years respectively for the Chevron-Akin group combined and the Chevron group alone. The difference was statistically non-significant with p=0.08. All the surgeries were performed by surgeons, experts in the field. For both surgeries, regional ischemia, and intrathecal anesthesia were used. The incisions were over the metatarsophalangeal (MTP) joint and first metatarsal which was then extended distally in cases requiring an additional first proximal phalanx osteotomy. Lateral soft tissues were released by additional dorsal incision. After scraping the periosteum, the bunion was cut from the metatarsal, and with a saw a 60-90o Chevron-shaped incision was made keeping the apex at the first metatarsal head center. After shifting the metatarsal head laterally, correction was evaluated with weight bearing and fixation was done with Kirschner wire/Herbert screw. From the metatarsal head, excess bone was removed along with any existing osteophytes.

Distal extension of initial incision was made in cases requiring additive akin osteotomy of the first proximal phalanx. An accurately sized medial wedge was cut with an oscillating saw perpendicular to the long axis keeping the intact lateral cortical hinge. After correction of the bone axis, stapled shape Kirschner wire was used for fixation.

The protocol for lateral and medial release was similar in all the subjects and the soft tissues were released before the osteotomy. Soft tissues, medially, were released to relax the taut articular capsule with the medial incision already made, and the lateral tissues were released with a dorsal incision for adductor tenotomy and capsule relaxation.

Following surgery, all subjects followed similar physiotherapy procedures. After removing the sutures, subjects were allowed for physiotherapy rehabilitation including manual and physical therapies to avoid scar pain and excessive stiffness of the MTP joint. At the initial 6 weeks of surgery, a forefoot off-

loading orthopedic shoe was given to all the subjects followed by flat-soled footwear. The hospital stay duration was assessed along with first metatarsal head necrosis, non-union, adjacent tissue arthritis, need for fixation removal, fixation loosening, deformity recurrence, overcorrection of hallux varus, achieved correction, IPA (interphalangeal angle), HVA and IMA radiographically.

IMA was defined as the angle between the line coursing through the centers of the base and head of the first metatarsal bone and the corresponding line along the second metatarsal bone. HVA is the angle between the line passing through the centers of the head and base of the first metatarsal bone and the line passing through the centers of the head and base of the first proximal phalanx. IPA is the angle between the lines passing through the centers of the head and base of the first proximal and first distal phalanx.

IMA and HVA were assessed before surgery, 6 weeks following surgery, and at the last follow-up. IPA was assessed before surgery and at follow-up. \

The correction was assessed depending on the difference between IMA and HVA values assessed at the first follow-up and these values before surgery. Correction maintenance was assessed depending on the difference between measured angle values at the first and last follow-up. Arthritis of adjacent joints was assessed in the Chopart joint, Lisfranc joint, metatarsal-cuneiform joint, first interphalangeal joint, first MTP joint, and all joints collectively.

The data gathered were analyzed statistically using SPSS software version 21.0 (IBM Corp., NY, USA) with a student t-test. The significance level was taken at $p<0.05$.

Results

Table 1: Radiographic assessment in two groups of study subjects

Variables	Chevron group (n=50)	Chevron with Akin group (n=9)	p-value
Hospitalization duration (days)	2.85±1.84	2.81±1.63	0.216
Mean age (years)	58.57±13.35	64.57±11.86	0.08
HVA			
Before surgery	29.7±7.52	29.54±7.3	0.743
First follow-up	18.35±6.33	15.15±8.06	0.07
Last follow-up	20.83±7.76	14.9±5.74	0.01
IMA			
Before surgery	11.96±3.14	11.53±3.16	0.126
First follow-up	8.13±2.74	8.39±1.67	0.706
Last follow-up	8.71±5.33	9.03±1.13	0.854
IPA			
Before surgery	5.09±2.36	11.04±4.24	<0.001
Last follow-up	8.8±2.31	6.6±2.18	0.03
Chopart joint arthritis %			
Before surgery	6 (3)	11.1 (1)	0.83
Last follow-up	8 (4)	11.1 (1)	0.73
Lisfranc joint arthritis% (n)			
Before surgery	14 (7)	33.3 (3)	0.04
Last follow-up	14 (7)	33.3 (3)	0.06
Metatarsal cuneiform joint arthritis % (n)			
Before surgery	28 (14)	44.4 (4)	0.22
Last follow-up	30 (15)	55.5 (5)	0.14
Interphalangeal joint arthritis % (n)			
Before surgery	42 (21)	55.5 (5)	0.18
Last follow-up	48 (24)	66.6 (6)	0.15
I metatarsophalangeal joint arthritis % (n)			
Before surgery	90 (45)	100 (9)	0.16
Last follow-up	92 (46)	100 (9)	0.23
Hardware destabilization	8 (4)	11.1 (1)	0.64
Resurgery	12 (6)	0	0.72
Non-union	4 (2)	0	0.47

Table 2: Comparison of arthritis in two groups of study subjects preoperatively and last follow-up visit

Variables	Before surgery % (n=59)	Last follow-up % (n=59)	p-value
Chevron alone group			
Chopart joint	6.77 (4)	8.47 (5)	0.82
Lisfranc joint	13.55 (8)	13.55 (8)	0.86
Metatarsal cuneiform joint	28.81 (17)	30.50 (18)	0.77
Interphalangeal joint	42.37 (25)	47.45 (28)	0.58
I metatarsophalangeal joint	91.52 (54)	91.52 (54)	0.77
Chevron with akin osteotomy group			
Chopart joint	5.08 (3)	5.08 (3)	1
Lisfranc joint	32.20 (19)	32.20 (19)	1
Metatarsal cuneiform joint	44.06 (26)	49.15 (29)	0.75
Interphalangeal joint	1.69 (1)	66.10 (39)	0.74
I metatarsophalangeal joint	100 (59)	100 (59)	1

Table 3: Recurrence and correction achieved in two study groups

Variables	Chevron with akin group (n=9)	Chevron group (n=50)	p-value
Deformities recurrence from IMA in the first and last visit	1.87±2.323	2.55±4.14	0.85
Deformities recurrence from HVA in the first and last visit	4.51±3.53	4.34±4.04	0.957
Correction achieved from IMA before surgery and first follow- up	3.63±1.23	4.13±1.34	0.554
Correction achieved from HVA before surgery and first follow-up	11.83±4.66	15.24±3.94	0.104

Table 4: Comparison of different variables preoperatively and a first follow-up visit

Variable	Preoperatively	First follow-up	p-value
Chevron Group			
HVA	29.7±5.52	18.35±5.33	<0.001
IMA	11.96±2.14	8.13±2.23	<0.001
Chevron with Akin group			
HVA	29.92±7.52	15.19±8.06	<0.001
IMA	11.53±2.33	8.39±3.23	<0.001

Table 5: Comparison of different variables at the first follow-up visit and last follow-up visit

Variable	First follow-up	Last follow-up	p-value
Chevron Group			
HVA	18.39±5.33	20.83±6.9	0.03
IMA	8.13±2.23	8.75±4.33	1
Chevron with Akin group			
HVA	15.19±8.06	14.9±5.78	1
IMA	8.39±3.23	20.83±6.9	0.197

The present retrospective clinical study was done to comparatively assess the treatment outcomes radiographically following Chevron osteotomy with Akin osteotomy or without Akin osteotomy.

The study included 59 subjects where 50 subjects underwent Chevron osteotomy and 9 subjects underwent additional Akin osteotomy. On comparing different variables, the mean age of the study subjects was comparable with p=0.08 along with the days of hospitalization needed with p=0.216. HVA before surgery and at the first follow-up visit was comparable in two groups with p=0.743 and 0.07 respectively, whereas, at the last follow-up, HVA was significantly higher for the Chevron group with 20.83±7.76 compared to 14.9±5.74 in Chevron and Akin group and p=0.01. IMA was comparable between the two groups preoperatively, at first follow-up, and last follow-up with p=0.126, 0.706, and 0.854 respectively. IPA was significantly higher in an Akin group before surgery (p<0.001) and in the Chevron group at the last follow-up (p=0.03). Chopart joint arthritis had a non-significant difference in the two groups before surgery and at the last follow-up with p=0.83 and 0.73 respectively. Preoperatively, Lisfranc joint arthritis was higher in an Akin group with p=0.04. For arthritis of the metatarsal cuneiform joint, interphalangeal joint, and metatarsophalangeal joint the difference in the two groups was non-significant before surgery and at last follow-up. The rates of hardware destabilization, Re-surgery and non-union was non-significant between the two groups with p=0.64, 0.72, and 0.47 respectively (Table 1).

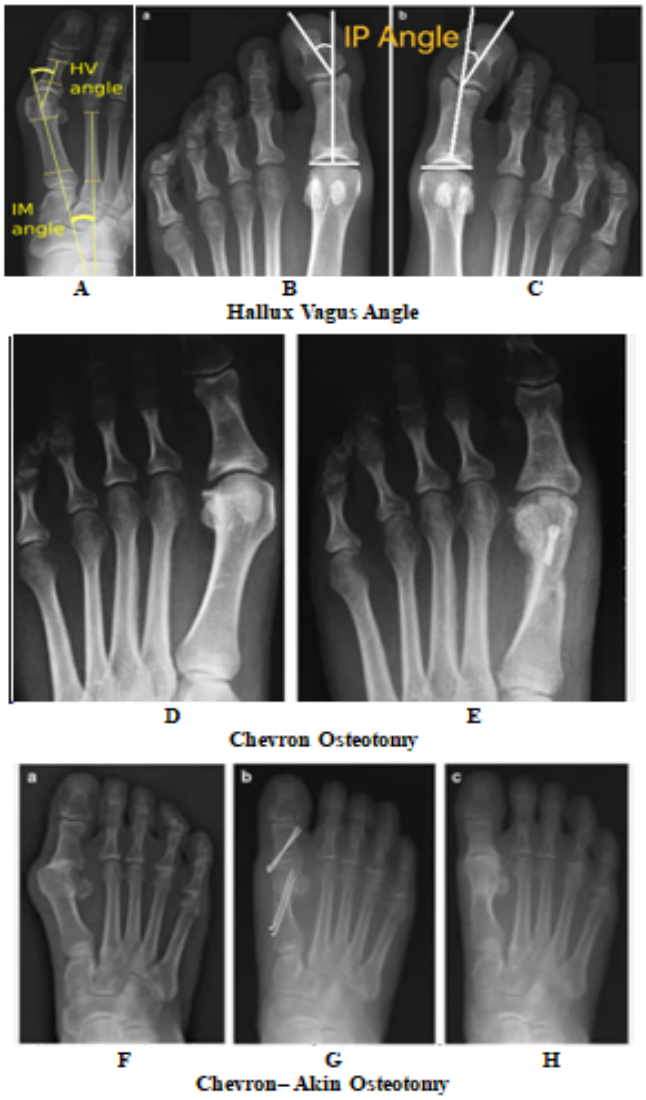

Figure 1:

On assessing arthritis in the two groups, it was seen that in the Chevron group alone, a non-significant difference was seen in arthritis of various joints before surgery and at the last follow-up. A non-significant difference was seen in the Chopart joint, Lisfranc joint, metatarsal cuneiform joint, interphalangeal joint, and I metatarsophalangeal joint in the Chevron group before surgery and at the last follow-up with p=0.82, 0.86, 0.77, 0.58 and 0.77 respectively. In Chevron and Akin osteotomy combined group, a non-significant difference was seen in arthritis of Chopart joint, Lisfranc joint, metatarsal cuneiform joint, interphalangeal joint, and I metatarsophalangeal joint preoperatively and at last follow-up with respective p-values of 1, 1, 0.75, 0.74, and 1 as shown in table 2.

For various variables in the two groups of study subjects, the deformities recurrence in IMA from the first follow-up and last follow-up, the difference was statistically non-significant in the two groups with p=0. 85. Deformities recurrence from HVA in first and last visit, the recurrence was non-significantly higher in the Chevron with Akin group compared to the Chevron alone group with p=0.957. Correction achieved from IMA before surgery and at first follow-up was higher in the Chevron alone group. However, the difference was statistically non-significant with p=0.554. Correction achieved from HVA before surgery and first follow-up was also higher in the Chevron alone group compared to the combined Chevron and Akin group by non-significant difference and p=0.104 as depicted in Table 3.

Concerning the various variables preoperatively and at a first follow-up visit, it was seen that in the Chevron group, HVA was significantly higher preoperatively with 29.7±5.52 compared to 18.35±5.33 at the first follow-up with p<0.001. IMA was significantly higher preoperatively with 11.96±2.14 which decreased significantly to 8.13±2.23 at the first follow-up with p<0.001. In the combined Chevron and Akin group, HVA and IMA were significantly higher

preoperatively compared to the first follow-up with p<0.001 (Table 4).

On assessing different variables at the first and last follow-up, the results seen are summarized in Table 5. In the Chevron group, HVA was significantly higher at the last follow-up with 20.83±6.9 compared to the first follow-up where it was 18.39±5.33 and p=0.03. IMA was non-significantly higher at the last follow-up compared to the first follow-up with p=1. In the combined Chevron and Akin group, HVA was higher at the first follow-up compared to the last follow-up. However, the difference was non-significant with p=1 and IMA was non-significantly higher at the last follow-up compared to the first follow-up with p=0.197 (Table 5).

Discussion

The present study retrospectively assessed 59 subjects where 50 subjects underwent Chevron osteotomy, and 9 subjects underwent additional Akin osteotomy. On comparing different variables, the mean age of the study subjects was comparable with p=0.08 along with the days of hospitalization needed with p=0.216. HVA before surgery and at the first follow-up visit was comparable in two groups with p=0.743 and 0.07 respectively, whereas, at the last follow-up, HVA was significantly higher for the Chevron group with 20.83±7.76 compared to 14.9±5.74 in chevron and Akin group and p=0.01. IMA was comparable between the two groups preoperatively, at first follow-up, and last follow-up with p=0.126, 0.706, and 0.854 respectively. IPA was significantly higher in an Akin group before surgery (p<0.001) and in the Chevron group at the last follow-up (p=0.03). Chopart joint arthritis had a non-significant difference in the two groups before surgery and at the last follow-up with p=0.83 and 0.73 respectively. Preoperatively, Lisfranc joint arthritis was higher in the Akin group with p=0.04. For arthritis of the metatarsal cuneiform joint, interphalangeal joint, and metatarsophalangeal joint the difference in the two groups was non-significant before surgery and at last follow-up. The rates of hardware destabilization, Resurgery, and non-union was non-significant between the two groups with p=0.64, 0.72, and 0.47 respectively. These data were similar to the studies of Wagner E et al [8] in 2016 and Smyth NA et al [9] in 2018 where authors reported subjects with demographic data and postoperative results following valgus hallux surgery as seen in the present study.

For arthritis in the two groups, it was seen that in the Chevron group alone, a non-significant difference was seen in arthritis of various joints before surgery and at the last follow-up. A non-significant difference was seen in the Chopart joint, Lisfranc joint, metatarsal cuneiform joint, interphalangeal joint, and I metatarsophalangeal joint in the Chevron group before surgery and at the last follow-up with p=0.82, 0.86, 0.77, 0.58 and 0.77 respectively. In the Chevron and Akin osteotomy combined group, a non-significant difference was seen in arthritis of Chopart joint, Lisfranc joint, metatarsal cuneiform joint, interphalangeal joint, and I metatarsophalangeal joint preoperatively and at last follow-up with respective p-values of 1, 1, 0.75, 0.74, and 1. These results were consistent with the previous studies of Mitchell LA et al[10] in 1991 and Strydom A et al[11] in 2016 where authors suggested similar arthritis following hallux valgus surgery and Akin protocol as seen in the present study.

The study results showed that for various variables in the two groups of study subjects, the deformities recurrence in IMA from the first follow-up and last follow-up, the difference was statistically non-significant in the two groups with p=0. 85. Deformities recurrence from HVA in first and last visit, the recurrence was non-significantly higher in the Chevron with Akin group compared to the Chevron alone group with p=0.957. Correction achieved from IMA before surgery and at first follow-up was higher in the Chevron alone group. However, the difference was statistically non-significant with p=0.554. Correction achieved from HVA before surgery and first follow-up was also higher in the chevron alone group compared to the combined Chevron and Akin group by non-significant difference and p=0.104. These results were in agreement with the findings of Schilde S et al [12] in 2021 and Kaufmann G et al [13] in 2019 where authors reported similar differences in various variables following hallux valgus surgery and Akin osteotomy as seen in the present study.

It was seen also that in the Chevron group, HVA was significantly higher preoperatively with 29.7±5.52 compared to 18.35±5.33 at first follow-up with p<0.001. IMA was significantly higher preoperatively with 11.96±2.14 which decreased significantly to 8.13±2.23 at the first follow-up with p<0.001. In the combined Chevron and Akin group, HVA and IMA were significantly higher preoperatively compared to the first follow-up with p<0.001. These findings were in line with the previous findings of Zhang FQ et al [14] in 2010 and Kaufmann G et al [15] in 2019 where authors reported a decrease in HVA and IMA following the hallux valgus surgery compared to it being preoperatively.

The study results showed that in the Chevron group, HVA was significantly higher at the last follow-up with 20.83±6.9 compared to the first follow-up where it was 18.39±5.33 and p=0.03. IMA was non-significantly higher at the last follow-up compared to the first follow-up with p=1. In the combined Chevron and Akin group, HVA was higher at the first follow-up compared to the last follow-up. However, the difference was non-significant with p=1 and IMA was non significantly higher at the last follow-up compared to the first follow-up with p=0.197. These

findings were also confirmed by Park Jy et al [16] in 2011 and Thordarson DB et al [17] in 2001 where similar changes were seen in IMA and HVA following hallux valgus osteotomy as seen in the present study.

Conclusion

Within its limitations, the present study concludes that no effect on IMA or HVA correction is seen following Chevron-Akin osteotomy in combination, and the combination further decreases the risk of increased IPA or HVA after long-term follow-up. Also, Akin osteotomy has no increased risk of adjacent-joint arthritis and is recommended for correction of hallux valgus deformity.

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