A Retrospective Analysis of Distal Chevron and Basilar Osteotomies of the First Metatarsal for Correction of Intermetatarsal Angles in the Range of 13 to 16 Degrees

A retrospective study was performed for Austin (Chevron) and basilar type osteotomies of the first metatarsal in patients with preoperative intermetatarsal angles in the range of 13 to 16 degrees. Results indicated better radiographic correction for both groups than in previous studies. When comparing the results for the Chevron and basilar groups, the radiographic results were almost identical, but the Chevron group appeared to have a slightly better subjective result with less complications of metatarsalgia and callus formation and a better range of motion. Comparing intermetatarsal angle correction as a function of the preoperative hallux adductus, no definitive conclusions were made. However, the trend appears to have reduced correction with higher hallux abductus angles.

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Multiple osteotomies have been described for correction of hallux valgus and/or metatarsus primus adductus. In recent years, the distal Chevron (Austin) osteotomy has gained popularity due to its inherent stability, versatility, and relatively short postoperative convalescence period (1). However, the intermetatarsal angle (IM) reduction, afforded by the Chevron osteotomy, is limited by the necessity for bony contact between the osteotomy fragments. In order to obtain greater correction of larger intermetatarsal angles, a closing abductory wedge (basilar) osteotomy is often utilized. The longer lever arm allows for greater lateral transposition of the metatarsal. In contrast to the distal Chevron, the basilar osteotomy has been reported to be technically difficult to perform, requiring a long postoperative recovery period, and associated with complications including excessive shortening and dorsal elevation with transfer metatarsalgia and hallux limitus (2, 3). Thus, it is important to determine the severity of the deformity in which the Chevron osteotomy is no longer adequate for correction, and a more proximal osteotomy is required.

Controversy exists regarding the upper limits of acceptable preoperative IM angles for application of the Chevron osteotomy and lower limits of the preoperative IM angle indicating application of the basilar osteotomy. In analyzing factors of patient dissatisfaction with the Chevron osteotomy, Hattrup and Johnson (4) noted that when preoperative IM angles were in excess of 15 degrees, there was a greater incidence of patient dissatisfaction. In their study, only 52% of patients were completely satisfied when the preoperative hallux abductus angle (HA) ranged from 40 to 48 degrees and only 68.9% were completely satisfied when the preoperative IM angle ranged from 15 to 21 degrees (4). They stressed the importance of a flexible deformity that is not too large, although they did not quantify this. They concluded that the Chevron osteotomy is indicated when the IM angle is less than 12 degrees and contraindicated when the IM angle is greater than 15 degrees (5). Zimmer and Johnson (6) supported this conclusion, stating that the Chevron osteotomy is indicated when the preoperative IM angle is less than 15 degrees and the HA angle is less than 40 degrees. In an earlier study, Grill *et al.* (7) reported the upper limit of the Chevron to be an IM angle of 20 degrees. In reviewing base wedge osteotomies, Jeremin *et al.* (8), stated the criteria to be a preoperative IM angle of 15 degrees in a rectus foot and 12 degrees in the adducted foot. Kempe *et al.* (9), stated the indications for basilar osteotomy to be an IM angle of 13 degrees in a rectus foot and 11 degrees in the adducted foot. Dollinger *et al.*, stated the

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riteria to be a preoperative IM angle of 15 degrees.[3] Vanivenhaus and Feldner-Busztin (10) cited criteria of M angle of 12 degrees. Mann and Coughlin (11) advocate basilar osteotomy when the HA angle exceeds 0 degrees and the IM exceeds 15 degrees. Resch *et al.* 3) stated the possibility for dorsal displacement to be o great that they question whether proximal osteotomy s ever justified. The purpose of this study was to etrospectively compare Chevron and basilar osteotonies to help determine which osteotomy, if any, is nore effective in correcting the hallux abducto valgus leformity with preoperative IM angles in the range of 3 to 16 degrees.

Materials and Methods

Two hundred thirty-eight osteotomies were performed on 198 patients at the Foot Clinics of New York or symptomatic hallux valgus between 1985 and 1988. Of these, 95 osteotomies on 83 patients were for correction of a preoperative intermetatarsal angle in the ange of 13 to 16 degrees. Forty-four were Chevron, 20 asilar and 31 were combination basilar and distal Reverdin (12)-type osteotomies. The procedures were erformed by seven attending surgeons of the Surgery Department. All patients were contacted and asked to eturn for follow-up visit, which included an x-ray valuation, completion of a subjective questionnaire, nd a physical examination of the operative foot, all of which were conducted by the authors.

Thirty-three patients returned and 50 were lost to ollow-up. Of these, 18 had basilar osteotomies repreenting 20 feet of which 13 had an additional Reverdin 12) procedure. Fifteen patients had Chevron osteotonies representing 17 feet. A total of 37 feet were reiewed (Table 1). Chevron osteotomies were performed ccording to the technique described by Austin and eventen (13). Lateral release of the adductor hallucis onjoint tendon and fibular sesamoid are added when reoperative evaluation demonstrates lateral joint tightess where osteotomy alone will not correct the deformty. Care is taken to avoid excessive capsular and lateral issection to minimize the possibility of aseptic necrosis 5). All osteotomies were fixated with either a Kirschner ire or cortical screw to add stability and maintain orrection. Range of motion exercises were initiated at week postoperative to limit fibrosis and stiffening of he metatarsophalangeal joint.

Basilar osteotomies were performed according to the technique of Balacescu (14). When using internal screw fixation, a more oblique Juvara (15) type osteotomy was performed. In all cases, the hinge axis concept described by Smith (16) was utilized to minimize dorsal metatarsal elevation. Adductor and sesamoidal release were performed as with the Chevron. A distal Reverdin (12) osteotomy was added when the articular cartilage of the metatarsal head was deviated laterally. All patients were kept off weightbearing in a below-the-knee cast until radiographic signs of a healed osteotomy were present. Range of motion exercises were initiated after 1 week.

Results

The Chevron group consisted of 14 female patients and one male. The age ranged from 27 to 59 with an average operative age of 44. The follow-up range was 4 to 46 months with an average follow-up of 21 months. Five osteotomies were fixated with cortical screw and 11 with Kirschner wire. The average preoperative IM angle was 13.8 degrees. The follow-up IM angle range was 0 to 10 degrees with an average of 5.2 degrees. The range of IM angle correction was 3 to 14 degrees with an average of 8.6 degrees. The preoperative hallux abductus (HA) angle ranged from 10 to 33 degrees with an average of 22.6. The follow-up HA angle ranged from 0 to 19 degrees with an average of 7.9. The HA angle correction ranged from 0 to 25 degrees with an average of 14.6 degrees.

The basilar group consisted of 15 female patients and 3 males. The age ranged from 19 to 64 with an average operative age of 40. Follow-up examination ranged from 13 to 59 months with an average of 30 months. Fifteen osteotomies were fixated with cortical screws, three with Kirschner wires, one with monofilament wire, and one with a staple. The average preoperative IM angle was 14.6. The follow-up IM angle was 0 to 15 degrees, with an average of 5.3. The range of IM angle correction was 0 to 16 degrees, with an average of 9.3 degrees. The preoperative HA angle was 13 to 40 degrees, with an average 29.1. The follow-up HA angle range was −19 to 21 degrees, with an average of 11.8 degrees. The range of HA angle correction was 5 to 29 degrees with an average of 15.6 degrees (Table 2).

In response to a subjective questionnaire, the most common reason for seeking surgery in both the basilar and Chevron groups was pain followed by deformity. The least frequent reason was for cosmetic appearance. The average return to shoe gear was 2.6 months postoperative in the Chevron group and 3.3 months in the basilar group. However, since the subjective questionnaire did not have a response for earlier than 2 months,

[3] Dollinger, B. M., Hickey, C. H., Gould, J. S. Proximal closing wedge osteotomies for the treatment of hallux valgus. Presented at he American Orthopedic Foot and Ankle Society 19th Annual Meeting, 1989.

TABLE 1. **Patient profile—biographical history and radiographic findings for all patients reviewed**

Patient No.	Foot[a]	Sex	Age (years)	Follow-up (months)	Procedure	Fixation	Preoperative		Postoperative[b]	
							IM	HA	IM	HA
1	Rt	F	47	16	Base	Screw	16	31	6	10
2	Rt	F	19	20	Base	Staple	16	20	0	15
3	Rt	F	22	37	Base	Screw	13	28	7	21
4	Lt	F	39	33	Base	Screw	16	31	0	19[c]
5	Rt	M	20	59	Base	K-wire	16	16	0	2
	Lt	M	21	43	Base	Screw	14	13	0	2
6	Rt	F	49	29	Base	Screw	13	30	3	13
7	Rt	F	44	30	Base/Reverdin	Screw	13	30	0	10
8	Lt	F	37	20	Base/Reverdin	Screw	15	35	15	19
9	Rt	M	35	16	Base/Reverdin	Screw	13	25	0	0
10	Rt	F	31	13	Base/Reverdin	Screw	16	37	8	15
11	Rt	F	25	30	Base/Reverdin	Screw	15	32	8	10
12	Lt	F	48	33	Base/Reverdin	Screw	14	30	10	19
13	Lt	F	50	18	Base/Reverdin	K-wire	13	36	7	11
14	Rt	F	57	37	Base/Reverdin	Screw	15	40	6	18
15	Rt	F	64	31	Base/Reverdin	Screw Monofilament	14	30	10	15
16	Rt	F	53	36	Base/Reverdin	Wire	15	40	6	11
17	Rt	F	40	42	Base/Reverdin	Screw	15	20	13	6
	Lt	F	41	32	Base/Reverdin	Screw	14	29	5	14
18	Lt	F	53	24	Base/Reverdin	Screw	15	28	1	26
19	Rt	F	37	14	Chevron	Screw	15	20	4	6
20	Lt	F	58	15	Chevron	K-wire	13	24	3	11
21	Rt	F	31	4	Chevron	K-wire	14	26	6	11
22	Rt	F	44	5	Chevron	Screw	14	14	0	8
	Lt	F	43	18	Chevron	Screw	14	23	0	0
23	Lt	F	27	16	Chevron	Screw	14	27	6	7
24	Rt	F	38	46	Chevron	K-wire	14	33	10	19
25	Lt	F	42	19	Chevron	Screw	13	27	6	12
26	Lt	F	27	39	Chevron	K-wire	13	25	8	4
27	Rt	F	46	20	Chevron	K-wire	13	10	5	10
28	Rt	F	55	35	Chevron	K-wire	14	25	2	8
29	Rt	M	39	19	Chevron	K-wire	15	25	7	0
30	Lt	F	54	26	Chevron	K-wire	14	26	7	5
31	Rt	F	58	27	Chevron	K-wire	11	16	8	4
	Lt	F	59	21	Chevron	K-wire	15	18	10	3
32	Lt	F	52	21	Chevron	K-wire	14	24	4	6
33	Rt	F	32	12	Chevron	K-wire	14	22	5	8

[a] Rt, right; Lt, left.
[b] IM, intermetatarsal; HA, hallux abductus.
[c] Hallux varus.

this data can only be used as a comparison between Chevron and basilar groups and not a true reflection of the time required for return to shoe gear. Of the Chevron group, 64.6% reported to be completely free from surgery-related symptoms within 6 months of surgery compared with 55.6% of the basilar group reporting to be completely symptom free within the same time period. Of the basilar group, 33% acknowledged some surgery-related symptoms still present at the time of follow-up compared with 23.5% in the Chevron group. In rating subjective improvement with the surgical procedure, the Chevron group averaged a 90% improvement rate and the basilar group averaged 84%. In

TABLE 2. **Radiographic summary of IM and HA angles for basilar and Chevron groups**

	Preoperative		Follow-up		Change (Correction)	
	Range	Average	Range	Average	Range	Average
Basilar[a]						
IM	13–16	14.6	0–15	5.3	0–16	9.3
HA	13–40	29.1	(−)19–21	11.8	5–29[b]	15.6[b]
Chevron						
IM	13–15	13.8	0–10	5.2	3–14	8.6
HA	10–33	22.6	0–19	7.9	0–25	14.6

[a] IM, intermetatarsal angle; HA, hallux abductus angle.
[b] Patient No. 4 with hallux varus not included.

ABLE 3. **Results of objective examination for Chevron and basilar groups**

	Chevron	Location	Basilar	Location
Metatarsalgia	2/17 = 11.8%	1 = sub 2 1 = sub 3	5/20 = 25%	2 = sub 1 1 = sub 2 2 = sub 4
Callus	4/17 = 23.5%	2 = sub 2 1 = sub 2, 3 1 = sub 3	12/20 = 60%	7 = sub 2 2 = sub 2, 3 3 = sub 2, 3, 4
Hallux Dorsiflexion	Range 10–75 deg	Average 41.5 deg	Range 0–75 deg	Average 25 deg

elating level of satisfaction, two patients in the Chevron roup stated they were dissatisfied, with one being very lissatisfied. This was due to numbness about the oper- ative area in the dissatisfied patient and subjective eturn of the bunion deformity in the very dissatisfied atient. In the basilar group, only one patient stated lissatisfaction. This was due to return of preoperative ymptoms. These three patients would not have rec- mmended their respective surgical procedures to oth- rs with a similar problem. All other patients in both roups were either satisfied or very satisfied and would ecommend the procedures to others with similar prob- ems.

Upon physical examination, 2 of 17 patients (11.8%) n the Chevron group complained of metatarsalgia com- ared with 5 of 20 (25%) of patients in the basilar roup. In the Chevron group 4 of 17 patients (23.5%) ad callus present at follow-up compared with 12 of 20 60%) in the basilar group. In both groups, the most ommon location was sub-2nd metatarsal head. There as one case of hallux varus in the basilar group, but his was asymptomatic. None were found in the Chev- on group. The average range of dorsiflexion at the first netatarsophalangeal joint was 41.5 degrees in the Chev- on group and 25 degrees in the basilar group. None of he patients demonstrated pain on range of motion. No ther deformities appeared to be present at the time of ollow-up for both groups. None of the patients ap- eared to have a prominent medial eminence (Table 3).

Discussion

In reviewing results of the present study, the Chevron roup achieved superior correction to previous studies 2, 5–7, 17–19) (Table 4). This, however, may be a eflection of fixation technique. Kinnard and Gordon 18) did not fixate their Chevron osteotomies and chieved only 2.3 degrees of IM angle reduction. They ttributed this to loss of correction in the postoperative eriod. In contrast, Kalish (19) achieved an average of 11 degrees of IM angle correction when fixating the

TABLE 4. **Summary of IM and HA angle correction achieved for Chevron osteotomy from literature review**

Author	Year	IM Change	HA Change
Johnson *et al.* (1)	1978	7.0	12.0
Lewis and Feffer (17)	1981	4.0	13.0
Kinnard and Gordon (18)	1984	2.3	
Meir and Kenzora (5)	1985	0	6.8
Grill *et al.* (7)	1986	7.2	20.5
Zimmer *et al.* (6)	1989	4.8	8.1
Kalish (19)	1989	11.0	14.0
Average		5.2	12.4

TABLE 5. **Summary of IM and HA angle corrections achieved for basilar osteotomy from literature review**

Author	Year	IM Change	HA Change
Curda and Sorto (21)	1981	8.0	21.0
Cedel and Astrom (22)	1982	5.8	20.3
Jeremin *et al.* (8)	1982	13.5	33.5
Dollinger et al.[a]	1989	8.0	19.0
Waivenhaus and Feldner-Busztin (10)	1988	5.9	16.9
Resch *et al.* (3)	1989	4.0	13.0
Average		7.5	20.6

[a] Dollinger, B. M., Hickey, C. H., Gould, J. S. Closing wedge osteotomies for the treatment of hallux valgus. Presented at the American Orthopedic Foot and Ankle Society 19th Annual Meeting, 1989.

Chevron with a cortical screw. Clancy *et al.* (20), demonstrated slightly better IM correction with Chevron osteotomies fixated with a cortical screw as compared with a Kirschner wire. Five of 17 osteotomies (29.4%), in the authors' Chevron group, were fixated with cortical screw. These patients also achieved an average of 11 degrees' reduction in the IM angle, as compared with an average of 7.4 degrees reduction found in those fixated with a Kirschner wire. The latter is consistent with results found by Johnson *et al.* (1), as well as Grill *et al.* (7). Thus, the overall average reduction found in the present study was 8.6 degrees, but superior correc-

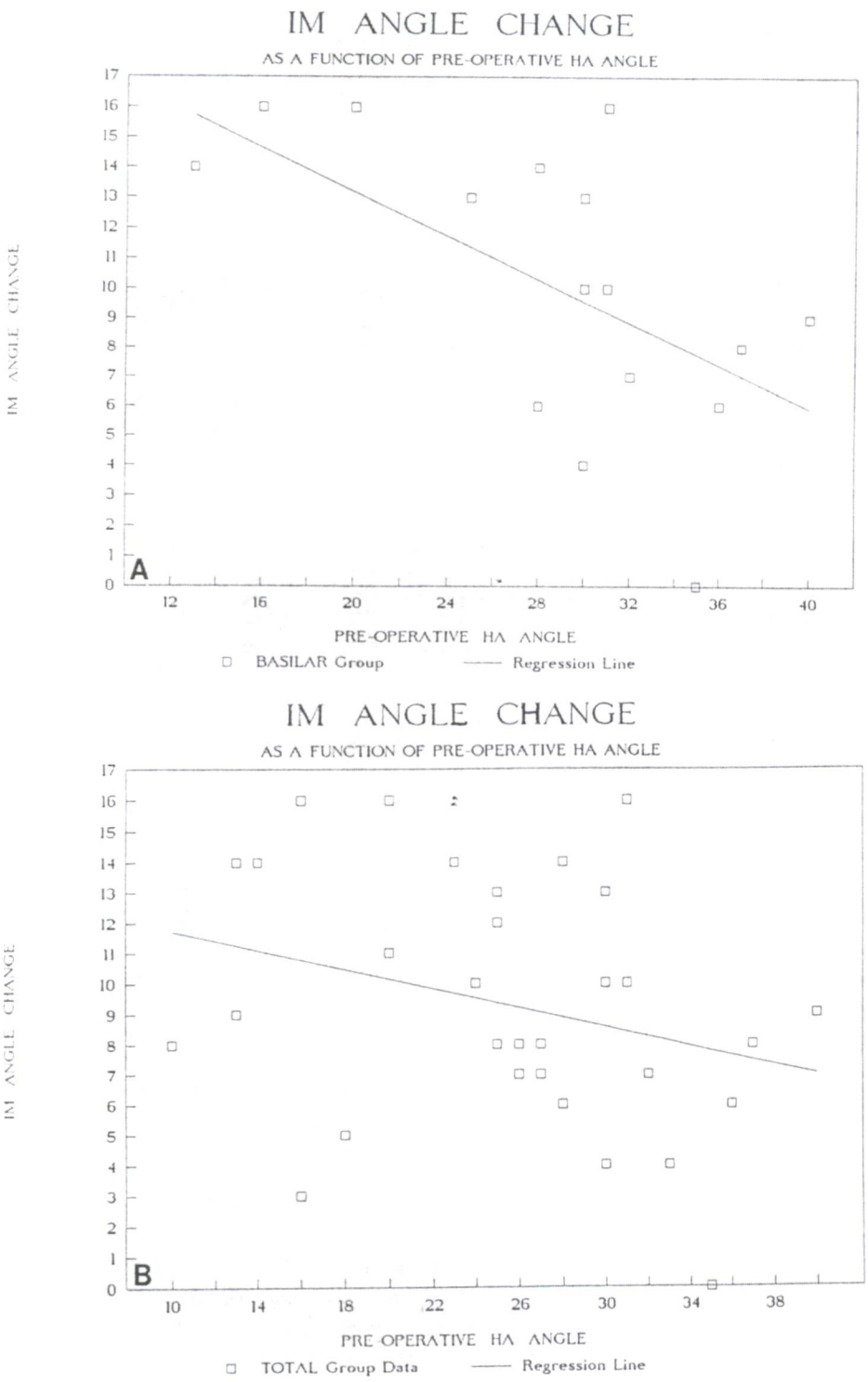
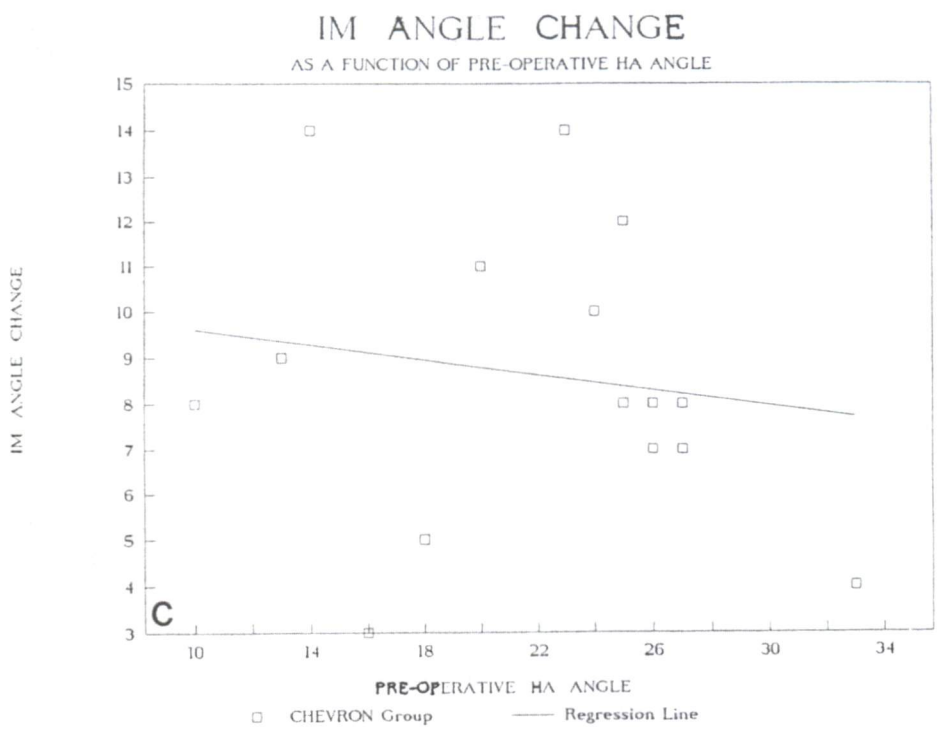


Figure 1. *A*, Regression line for basilar group. Note steep slope with IM angle change decreasing as preoperative HA angle increases. *B*, Regression line for total group (basilar and Chevron). Note moderate slope.

tion was achieved in patients fixated by cortical screw. The reduction of HA angle in the Chevron group was consistent with the overall average reduction found in past studies (2, 5–7, 17–19).

The basilar group also achieved better reduction of the IM angle than has been reported by past studies (3, 8, 10, 11, 21, 22) (Table 5). Although Jeremin *et al.* (8) obtained an average IM angle correction of 13.5 degrees from an initial preoperative average value of 15.6 degrees, 5 of 24 (21%) patients had a negative IM demonstrating overcorrection. The correction of the HA angle found in the present study was less than the overall average found in previous studies of basilar osteotomies (3, 8, 10, 11, 21, 22). This may be attrib-



ure 1. *C*, Regression line for evron group. Note shallow pe, but IM angle change still creases as preoperative HA an- increases.

d to a significantly higher preoperative HA angle ınd in previous studies.

The preoperative HA angle of the authors' basilar ıup averaged 29.1 degrees, compared with the overall erage from previous studies of 36.6 degrees. Similarly, evious studies have also demonstrated a greater proısity for hallux varus. Curda and Sorto (21) reported 5.1% rate of hallux varus following basilar osteotıy. Jeremin *et al.* (8) did not site the specific occurıce of hallux varus; however, they did demonstrate a % rate of overcorrection of the IM angle. Thus, the ıl of basilar osteotomy is maximal reduction of the and HA angles, without overcorrection, making this eotomy technically difficult to perform.

n evaluating the results of the present study, the ilar group achieved an average of 1.3 degrees of rrection in IM angle more than the Chevron group, d only 1 degree of correction more in the HA angle. us, the radiographic results were almost identical. bjectively, both groups had a high degree of patient isfaction, with the Chevron group experiencing a ter return to function and overall greater satisfaction. ıon objective clinical examination, the Chevron ıup obtained a better result. There was less metatargia, callus formation, and better range of motion. ese results are consistent with previous studies.

The other question investigated was whether there is elationship between the preoperative HA angle and amount of IM angle correction achieved. This may y an important role in determining which procedure to utilize in correction of the deformity. If within the same IM angle range (13 to 16 degrees) there is less correction achieved with higher preoperative HA angles, a more aggressive (basilar) osteotomy may be required. The authors evaluated the IM angle change as a function of the preoperative HA angle.

Three groups were studied, the basilar, the Chevron, and the total or combined group. For each group, individual patients were plotted on a graph, with IM angle change as a function of preoperative HA and the slope determined (Fig. 1). In all three groups it was found that a negative slope existed, *i.e.*, as the preoperative HA angle increases, the IM angle correction decreases. However, using the Pearson correlation,[4] only the basilar group was found to be statistically significant ($z = -2.50$). The total group had a moderately strong correlation ($z = -1.75$) and a weak correlation ($z = -0.58$) was found in the Chevron group, though both groups were not statistically significant. Thus, definitive conclusions cannot be drawn. However, because the total sample population was small, statistical correlation was difficult to obtain. Furthermore, the weak slope found in the Chevron group may be a reflection of a small spread of initial HA. Therefore, further investigation is required to evaluate the above relationship, since the trend appears to have reduced correction with higher HA angles.

[4] *Fundamentals of Behavioral Statistics*, 2nd ed., pp. 187–189, edited by Runyon-Haber, Addison-Wesley, Reading, MA, 1971.

Conclusion

In the moderate bunion deformity with IM angles in the range of 13 to 16 degrees and HA angle less than 20 degrees, the Chevron osteotomy is preferred over the basilar osteotomy. This is especially true when internal screw fixation is utilized. With a more severe preoperative HA angle, the basilar osteotomy may be required even within this IM angle range.

References

1. Johnson, K. A., Cofield, R. H., Morrey, B. F. Chevron osteotomy for hallux valgus. Clin. Orthop. 142:44, 1979.
2. Schuberth, J. M., Reilly, C. H., Gudas, C. J. The closing wedge osteotomy. A critical analysis of first metatarsal elevation. J. A. P. A. 74:13, 1984.
3. Resch, S., Stenstrom, A., Neils, E. Proximal closing wedge osteotomy and adductor tenotomy for treatment of hallux valgus. Foot Ankle 9:272, 1989.
4. Hattrup, S. J., Johnson, K. S. Chevron osteotomy: analysis of factors in patients' dissatisfaction. Foot Ankle 6:7, 1985.
5. Meier, P. J., Kenzora, J. E. The risks and benefits of distal first metatarsal osteotomies. Foot Ankle 6:7, 1985.
6. Zimmer, T. J., Johnson, K. A., Klassen, R. A. Treatment of hallux valgus in adolescents by the Chevron Osteotomy. Foot Ankle 9:190, 1989.
7. Grill, F., Hetherington, V., Steinbok, G., Altenhuber, J. Experiences with the Chevron osteotomy on adolescent hallux valgus. Arch. Orthop. Trauma Surg. 106:47, 1986.
8. Jeremin, P. J., DeVincentis, A., Goller, W. Closing base wedge osteotomy: an evaluation of twenty-four cases. J. Foot Surg. 21:316, 1982.
9. Kempe, S. A., Grapel, D., Hovanec, P. A mathematical approach to closing base wedge osteotomy. J. A. P. A. 74:60, 1984.
10. Wanivenhaus, A. H., Feldner-Busztin, H. Basal osteotomy of the first metatarsal for the correction of metatarsus primus varus associated with hallux valgus. Foot Ankle 8:337, 1988.
11. Mann, R. A., Coughlin, M. J. Hallux valgus—etiology, anatomy, treatment and surgical considerations. Clin. Orthop. 157:3, 1981.
12. Reverdin, J. Anatomic et operation de l'hallux valgus. Int. Med. Cong. 2:408, 1881.
13. Austin, D. W., Leventen, E. O. A new osteotomy for hallux valgus. Clin. Orthop. 157:25, 1981.
14. Balacescu, J. Un caf de hallux valgus simetric. Rev. Chir. Orthop. 7:128, 1903.
15. Juvara, E. Nouveau procede pour la cure radicale du "hallux valgus." Presse Med. 40:395, 1919.
16. Smith, T. F. The hinge concept in base wedge. Osteotomies. In *Doctor's Hospital Podiatry Institute Seminar Manual*, pp 66–68, edited by B. Schlefman, 1983.
17. Lewis, R. J., Feffer, H. L. Modified Chevron osteotomy of the first metatarsal. Clin. Orthop. 157:105, 1981.
18. Kinnard, P., Gordon, D. A comparison between Chevron and Mitchell osteotomies for hallux valgus. Foot Ankle 4:241, 1984.
19. Kalish, S. K. Modification of the Austin hallux valgus repair. In *Podiatric Education and Research Institute—Reconstructive Surgery of the Foot and Leg Update '89*, pp. 14–19, edited by E. D. McGlamry, 1989.
20. Clancy, J. T., Berlin, S. J., Giordano, M. L., Sherman, S. A. Modified Austin bunionectomy with single screw fixation: a comparison study. J. Foot Surg. 28:285, 1989.
21. Curda, G. A., Sorto, L. A. The McBride bunionectomy with closing abductory wedge osteotomy. J. A. P. A. 71:349, 1981.
22. Cedell, C. A., Astrom, M. Proximal metatarsal osteotomy in hallux valgus. Acta Orthop. Scand. 53:1013, 1982.