The Chevron Osteotomy for Correction of Hallux Valgus

Comparison of Findings After Two and Five Years of Follow-up*

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Abstract

Background: **The chevron osteotomy, an accepted method for the correction of mild and moderate hallux valgus, is generally advocated for patients younger than the age of fifty years. The purposes of this prospective study were to compare the short-term (two-year) and intermediate-term (five-year) results of this operation with respect to patient satisfaction, flexion and extension of the metatarsophalangeal joint, maintenance of correction, and development of arthrosis and to determine whether the effectiveness of the procedure was limited by age.**

Methods: **Between April 1991 and September 1992, the chevron osteotomy was performed for the treatment of mild-to-moderate hallux valgus deformity in sixty-six consecutive feet. Forty-three patients (fifty-seven feet) were available for follow-up at both two and five years postoperatively. The two-year and five-year clinical assessments were based on the American Orthopaedic Foot and Ankle Society's hallux-metatarsophalangeal-interphalangeal scale.**

Results: **Between the two-year and five-year follow-up evaluations, there was only a minimal change in overall patient satisfaction, and the average score on the hallux-metatarsophalangeal-interphalangeal scale was unchanged. The passive range of motion of the first metatarsophalangeal joint decreased between the preoperative assessment and the two-year follow-up evaluation and was unchanged at the five-year follow-up evaluation. Radiographic evaluation showed no changes in the hallux valgus or intermetatarsal angle between the two-year and five-year evaluations, although the number of feet with arthrosis of the metatarsophalangeal joint increased slightly, from eight to eleven. Patients aged fifty years or older did as well as younger patients.**

Conclusions: **At these two follow-up periods, the chevron osteotomy was found to be a reliable procedure for the correction of mild and moderate hallux valgus deformity, and outcome did not differ on the basis of age.**

Painful hallux valgus is a common clinical problem, especially in women[9,23]. The distal chevron osteotomy is a widely accepted method for the correction of mild and moderate hallux valgus[1,2,13,16]. Numerous studies[3,4,6,13,16,18,20,21,26] have analyzed results according to a specific follow-up period (one to five years), but they have lacked information regarding the point between short-term and intermediate-term follow-up at which changes in results may be anticipated. The purposes of the current study were to compare short-term (two-year) and intermediate-term (five-year) results with respect to patient satisfaction, flexion and extension of the metatarsophalangeal joint, maintenance of correction, and development of arthrosis after chevron osteotomy and to determine whether the effectiveness of this procedure was limited by age. In 1996, the short-term results (at an average of 24.3 months) of the chevron procedure for the correction of hallux valgus were presented[26]; in the current study, we compare those results with the results at five years in the same patient population.

Materials and Methods

Between April 1991 and September 1992, fifty-two consecutive patients (sixty-six feet) with mild-to-moderate hallux valgus deformity[14] underwent distal chevron osteotomy of the first metatarsal at the Orthopaedic Hospital Gersthof. Six patients (six feet) could not be included in the five-year follow-up analysis. Two had moved away and could not be located, one had died, and three had undergone revision surgery (one each had the revision because of hallux varus, hallux valgus, and osteonecrosis of the metatarsal head secondary to intraoperative fracture of the metatarsal head). Therefore, forty-six patients (sixty feet) formed the study population for the current investigation. Nonoperative management, including modification of shoewear, nonsteroidal anti-inflammatory medications, orthotic devices, or a combination of these methods, had failed in all patients. All patients had pain (ranging from moderate to severe) related to the hallux valgus deformity.

Although no patient was operated on for cosmetic reasons alone, cosmetic concerns and difficulty with shoewear influenced the pa-

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TABLE I
RADIOGRAPHIC RESULTS

Measurement	Preoperative	At Two Years	At Five Years
Hallux valgus angle* *(degrees)*	29 ± 7	17 ± 11	18 ± 11
Intermetatarsal angle* *(degrees)*	13 ± 3	8 ± 3	9 ± 3

*The values are given as the average and the standard deviation.

tient's decision to undergo surgery. The time from the onset of symptoms to surgery averaged three years (range, 0.5 to twenty years).

Clinical Assessment

Preoperatively, each patient's age was recorded and all patients underwent an assessment of functional limitation and pain level as well as a physical examination that included measurement of the passive range of motion of the first metatarsophalangeal joint. At both the two-year and the five-year follow-up period, the patients underwent physical examination and assessment with use of the American Orthopaedic Foot and Ankle Society's hallux-metatarsophalangeal-interphalangeal scale[10,27]. This 100-point scale is based on a questionnaire combining subjective and objective data, including the clinical parameters of pain (40 points for none); function (45 points for no restriction), including activity (10 points for no limitations), footwear requirements (10 points for conventional shoes), metatarsophalangeal joint motion (10 points for normal or mild restriction), interphalangeal joint motion (5 points for no restriction), stability (5 points for stable), and callus (5 points for none); and alignment (15 points for good alignment). Additionally, patients were asked to rate their satisfaction with regard to the overall result of the operation and to rate the appearance of the foot as excellent, good, fair, or poor. The range of motion of the hallux was measured by placing one goniometer arm parallel to the hallux and the other goniometer arm parallel to the plantar aspect of the foot and then passively moving the first metatarsophalangeal joint from maximum flexion to maximum extension.

Radiographic Assessment

Anteroposterior and lateral weight-bearing radiographs were made preoperatively as well as at the short-term (two-year) and intermediate-term (five-year) follow-up evaluations. The hallux valgus angle, the first intermetatarsal angle, and the congruency of the first metatarsophalangeal joint were measured with the technique recommended by the American Orthopaedic Foot and Ankle Society[24]. Additionally, the stage of arthrosis of the first metatarsophalangeal joint was determined with a method described by Hattrup and Johnson[5] for evaluation of toes with hallux rigidus. The same investigator performed all preoperative and follow-up radiographic measurements in a blinded fashion.

Statistical Evaluation

The patients were divided into two age-groups: those less than fifty years of age and those fifty years of age or older at the time of surgery. The two groups were then compared, with use of the Student unpaired t test, with regard to patient satisfaction, flexion and extension of the metatarsophalangeal joint, and the score according to the hallux-metatarsophalangeal-interphalangeal scale. Differences among the baseline, two-year, and five-year evaluations were determined with a one-way analysis of variance with a Scheffé comparison. The level of significance was set at $p < 0.05$. We did not perform a statistical analysis of changes in the hallux valgus and intermetatarsal angles because of the reportedly high interobserver and intraobserver variability in radiographic measurement of these angles[22].

Surgical Technique

The surgical technique was described in a previous report[26]. After removing the medial eminence of the first metatarsal head, we performed an intra-articular lateral capsular release by passing a number-11 knife blade horizontally between the sesamoids and the plantar aspect of the metatarsal head. We then created a 60-degree V-osteotomy centered in the first metatarsal head, displaced the capital fragment three to five millimeters laterally, and manually impacted the fragment onto the shaft to obtain a stable reduction. Postoperatively, the patients remained non-weight-bearing for five days, and then most were fitted with a wooden-soled bunion shoe and allowed to bear weight as tolerated.

Results

Of the forty-six patients, three (three feet) were lost to follow-up after the two-year assessment and could not be located for the five-year evaluation. At two years, two of these patients were very satisfied and one patient was satisfied. All of the remaining forty-three patients (fifty-seven feet) were included in the current study. The average score according to the hallux-metatarsophalangeal-interphalangeal scale was the same at both the two-year and the five-year follow-up evaluation (91 ± 12 points [average and standard deviation]; range, 40 to 100 points) for these patients.

The pain level in the first metatarsophalangeal joint was described preoperatively as minor in twenty (35 percent) of the fifty-seven feet, moderate in thirty-five (61 percent), and severe in two (4 percent). No patient was pain-free preoperatively. At the two-year follow-up evaluation, there was no pain in forty-eight feet (84 percent), minor pain in seven (12 percent), and severe pain in two (4 percent). The two patients who had had severe pain preoperatively were pain-free at the two-year follow-up evaluation. Of the two patients who had severe pain at the two-year follow-up evaluation, one had described the pain level as minor preoperatively and the other had described it as moderate. In one of the two patients, hallux rigidus was the cause of the symptoms; in the other, intraoperative fracture of the metatarsal head had caused arthritic changes of the metatarsal head. At the five-year follow-up evaluation, there was no pain in forty-eight feet (84 percent), minor pain in seven (12 percent), and moderate pain in two (4 percent). Of the two patients who had described the pain as severe at the two-year follow-up evaluation, one had undergone revision surgery because of painful hallux rigidus and the other had refused revision surgery but the pain level had diminished to moderate.

The passive range of motion of the first metatarsophalangeal joint averaged 72 degrees (47 degrees of extension and 25 degrees of flexion) preoperatively, 61 degrees (43 degrees of extension and 18 degrees of flexion) at the two-year follow-up evaluation, and 62 degrees

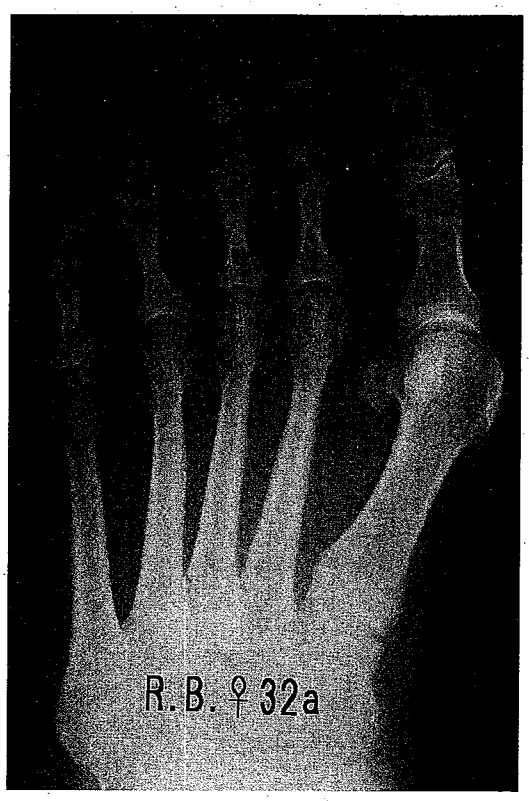

FIG. 1-A

Figs. 1-A, 1-B, and 1-C: Radiographs of a woman with hallux valgus who was treated with a chevron osteotomy when she was thirty-two years old.

Fig. 1-A: Preoperative radiograph showing a hallux valgus angle of 28 degrees and an intermetatarsal angle of 15 degrees.

(42 degrees of extension and 20 degrees of flexion) at the five-year follow-up evaluation.

At the two-year follow-up evaluation, the outcome of the procedure, as rated by the patient, was excellent for thirty-four feet (60 percent), good for fifteen (26 percent), fair for three (5 percent), and poor for five (9 percent). At the five-year follow-up evaluation, the outcome was excellent for thirty-nine feet (68 percent), good for eleven (19 percent), fair for three (5 percent), and poor for four (7 percent).

Of the five patients who were dissatisfied at the two-year follow-up evaluation, three were still dissatisfied at the five-year follow-up evaluation and two rated the five-year outcome as good. One patient who had been satisfied at the two-year follow-up evaluation was dissatisfied at the five-year follow-up evaluation because of increased stiffness in the first metatarsophalangeal joint.

At two years, the cosmetic result of the surgery, as rated by the patient, was excellent for thirty-seven feet (65 percent), good for thirteen (23 percent), fair for five (9 percent), and poor for two (4 percent). At five years, the cosmetic appearance was rated as excellent for thirty-seven feet (65 percent), good for eleven (19 percent), fair for four (7 percent), and poor for five (9 percent).

Radiographic evaluation revealed an average preoperative hallux valgus angle of 29 ± 7 degrees (range, 16 to 50 degrees) and an average preoperative intermetatarsal angle of 13 ± 3 degrees (range, 10 to 20 degrees). At the two-year follow-up evaluation, osseous alignment had been corrected to an average hallux valgus angle of

FIG. 1-B

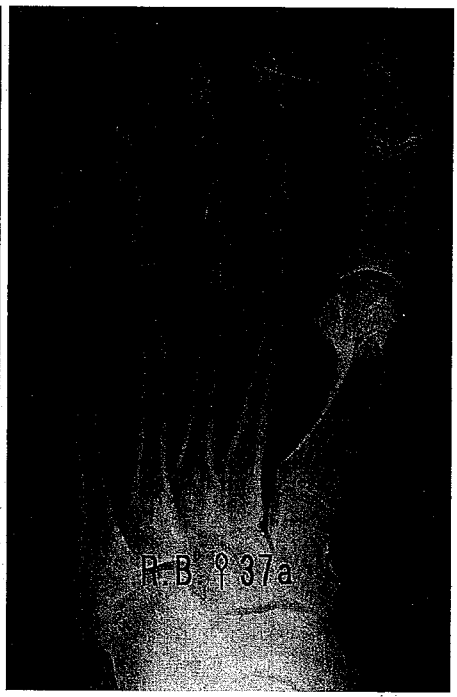

FIG. 1-C

Fig. 1-B: Two-year follow-up radiograph showing successful reduction of the hallux valgus angle to 7 degrees and the intermetatarsal angle to 4 degrees.

Fig. 1-C: Five-year follow-up radiograph showing maintenance of the deformity reduction, with a hallux valgus angle of 10 degrees and an intermetatarsal angle of 5 degrees.

TABLE II

COMPARISON OF CLINICAL AND RADIOGRAPHIC RESULTS IN FEET OF PATIENTS LESS THAN FIFTY YEARS OLD WITH THOSE IN FEET OF PATIENTS FIFTY YEARS OLD OR OLDER

Parameter	Less Than Fifty Years Old* (N = 30)	Fifty Years or Older* (N = 27)	P Value
Preoperative			
Score† *(points)*	63 ± 11 (47-80)	55 ± 13 (24-75)	0.82
Flexion *(degrees)*	24 ± 8 (10-40)	26 ± 8 (10-40)	0.28
Extension *(degrees)*	46 ± 14 (20-75)	48 ± 15 (15-70)	0.36
Hallux valgus angle *(degrees)*	29 ± 8 (17-50)	30 ± 7 (16-48)	
Intermetatarsal angle *(degrees)*	13 ± 3 (10-20)	13 ± 3 (10-20)	
Two-year follow-up			
Patient satisfaction‡ *(points)*	2 ± 1 (1-4)	2 ± 1 (1-4)	0.24
Score† *(points)*	91 ± 15 (40-100)	92 ± 8 (65-100)	0.65
Flexion *(degrees)*	21 ± 14 (–5-45)	15 ± 10 (0-35)	0.10
Extension *(degrees)*	45 ± 17	40 ± 18	0.23
Hallux valgus angle *(degrees)*	14 ± 8 (2-28)	19 ± 9 (0-40)	
Intermetatarsal angle *(degrees)*	8 ± 3 (4-17)	8 ± 3 (0-16)	
Five-year follow-up			
Patient satisfaction‡ *(points)*	2 ± 1 (1-4)	2 ± 1 (1-4)	0.55
Score† *(points)*	91 ± 12 (44-100)	90 ± 12 (52-100)	0.95
Flexion *(degrees)*	23 ± 11 (0-50)	18 ± 12 (0-40)	0.40
Extension *(degrees)*	46 ± 14 (10-80)	39 ± 19 (5-70)	0.05
Hallux valgus angle *(degrees)*	15 ± 6 (6-28)	22 ± 8 (10-40)	
Intermetatarsal angle *(degrees)*	9 ± 4 (5-20)	8 ± 4 (2-16)	

*The values are given as the average and the standard deviation, with the range in parentheses.

†The scores are given according to the American Orthopaedic Foot and Ankle Society's hallux-metatarsophalangeal-interphalangeal scale[10,27].

‡Patient satisfaction was graded on a scale[26] of 1 to 4 points.

17 ± 11 degrees (range, 0 to 40 degrees) and an average intermetatarsal angle of 8 ± 3 degrees (range, 0 to 17 degrees). At the five-year follow-up evaluation, the average hallux valgus angle was 18 ± 11 degrees (range, 6 to 40 degrees) and the average intermetatarsal angle was 9 ± 3 degrees (range, 2 to 20 degrees) (Table I and Figs. 1-A, 1-B, and 1-C). We noted a laterally deviated metatarsal head in two patients and a dorsal malunion in another patient. No osteonecrosis of the metatarsal head was noted at the two-year or five-year follow-up evaluation. Arthritis of the metatarsophalangeal joint was noted in eight feet at the two-year follow-up evaluation and in eleven feet at the five-year follow-up evaluation. Of these patients, one underwent revision surgery for progressive hallux rigidus, one had moderate symptoms, two had minimal symptoms, and the others were asymptomatic.

We compared the thirty feet in patients who were less than fifty years of age with the twenty-seven feet in patients who were fifty years of age or older (Table II). Preoperatively, we found no significant differences between these two groups with regard to the score according to the hallux-metatarsophalangeal-interphalangeal scale ($p = 0.82$), flexion of the metatarsophalangeal joint ($p = 0.28$), or extension of the metatarsophalangeal joint ($p = 0.36$). At the two-year follow-up evaluation, the older group had more limited flexion (15 degrees) than the younger group (21 degrees) and had lost more flexion (average, 11 degrees; range, 0 to 30 degrees) than the younger group (average, 3 degrees; range, 0 to 20 degrees), but these differences were not significant ($p = 0.08$). We found no significant differences between the two age-groups with regard to the score according to the hallux-metatarsophalangeal-interphalangeal scale ($p = 0.65$), extension of the metatarsophalangeal joint ($p = 0.23$), or patient satisfaction ($p = 0.24$) at two years. Similarly, at the five-year follow-up evaluation, we found no significant differences between the two age-groups with regard to flexion of the metatarsophalangeal joint ($p = 0.40$), extension of the metatarsophalangeal joint ($p = 0.05$), the score on the hallux-metatarsophalangeal-interphalangeal scale ($p = 0.95$), or patient satisfaction ($p = 0.55$). We found no differences between the age-groups with regard to the radiographic results.

Complications included hypoesthesia of the great toe (two), sesamoiditis (one), malunion (three), deep infection (one), and complex regional pain syndrome (one). One of the patients with hypoesthesia of the great toe found it tolerable, whereas the other patient was dissatisfied with the result. The patient with sesamoiditis underwent tibial sesamoidectomy and was subsequently symptom-free. The dorsal malunion was managed effectively with an orthotic device. The complex regional pain syndrome resolved with desensitization modalities. Although the patient who sustained the deep infection was dissatisfied with the result because of persistent pain and a decreased range of motion, additional surgery was refused. Of the two patients with lateral malunion of the metatarsal head, one rated the outcome at the five-year

follow-up evaluation as excellent and the other rated it as good.

Discussion

To the best of our knowledge, this is the first prospective study comparing the results of the chevron osteotomy at two follow-up periods in the same patient population. We also believe that this study, in which the patients were followed for a minimum of sixty months, has the longest average duration of follow-up after a chevron osteotomy.

The results of the current study demonstrate that the chevron procedure is a reliable method with which to treat mild or moderate hallux valgus deformity, but the patient must be informed that a loss of motion of the first metatarsophalangeal joint is to be expected. We found no differences in outcome based on age.

Analysis of the hallux valgus and intermetatarsal angles showed only minimal changes between the two follow-up periods. This finding contrasts with those of Klosok et al.[11], who reviewed the results in twenty-two patients (thirty-six feet) at an average of twenty-two and thirty-eight months after chevron osteotomy without a lateral capsular release. The hallux valgus angle was corrected from an average of 30 degrees preoperatively to an average of 21 degrees at the short-term follow-up evaluation, but correction was lost. At the thirty-eight-month follow-up evaluation, the average hallux valgus angle was 26 degrees. The fact that we routinely performed a lateral capsular release may have helped to maintain the correction in our study.

Preoperatively, two patients in our study had an intermetatarsal angle of 20 degrees, which was not within our standard indications for use of a chevron procedure to correct a hallux valgus deformity. Usually, we use a chevron procedure to correct intermetatarsal angles of less than 16 degrees and a proximal metatarsal osteotomy to correct intermetatarsal angles of 16 degrees or more. In one of these two patients, the correction was successful, with a reduction of the intermetatarsal angle to 10 degrees. However, in the other patient, we failed to correct the deformity; the intermetatarsal angle was corrected to only 16 degrees.

There is ongoing discussion about whether a lateral release should be added to a chevron procedure and whether doing so increases the risk of osteonecrosis of the metatarsal head. The study by Meier and Kenzora[15] is commonly quoted because of its 40 percent prevalence of osteonecrosis of the metatarsal head after a chevron procedure with a lateral (adductor) release. Those authors reviewed the results of sixty chevron procedures performed by several orthopaedic surgeons or residents, but an adductor release was performed in only ten patients. Osteonecrosis developed in four of the ten, but symptoms and follow-up times for those patients were not reported.

Resch et al.[19] examined the results of early bone scintigraphy after randomized chevron osteotomies with or without an adductor tenotomy in thirty-eight patients. Bone scintigraphy delineated three central defects (decreased activity) in those treated with a chevron osteotomy alone and one defect in a patient treated with a chevron osteotomy and an adductor tenotomy. Jones et al.[8] demonstrated, in cadaver specimens, that technical errors alone can result in damage to the vessels that supply the metatarsal head. In the series of Pochatko et al.[18], Peterson et al.[17], and Trnka et al.[27], a total of 224 chevron osteotomies were performed in combination with a lateral soft-tissue release. Of those 224 procedures, 178 had documented follow-up; only four cases of osteonecrosis (three asymptomatic and one symptomatic) were identified. In three of those cases, the osteonecrosis could be linked to overzealous soft-tissue stripping[27]. We believe that there is a place for a lateral soft-tissue release in combination with the chevron procedure, but care must be taken to avoid damage to the vessels that supply the metatarsal head. We believe that this goal can be achieved with use of the intra-articular approach described above.

A major issue in recent years was raised by the study by Johnson et al.[7], which established an age of more than fifty years as a contraindication to use of the chevron osteotomy. In the current study, we found no significant difference in the range of motion or the clinical results between the two age-groups. Therefore, we disagree that age is a contraindication to chevron osteotomy, although one must bear in mind that there is a likelihood of loss of correction in older patients, as reported by Tollison and Baxter[25] and by Kwiatkowski et al.[12].

Fixation is an important consideration with the chevron procedure. In the current series, we generally used no fixation, and patients were allowed to bear weight as tolerated after the fifth postoperative day. At the time of follow-up, we noted a laterally displaced metatarsal head in two patients, but one had an excellent result and one had a good result. Four patients had intraoperative instability of the osteotomy site; one was managed with temporary pin fixation, and three were managed with cast immobilization. Although most of our patients did well, we have been influenced by others[17,18] and have now changed our technique to include temporary pin fixation.

With two and five years of follow-up of the same patient population, we have been able to show that the chevron osteotomy is a reliable and durable procedure for the treatment of mild and moderate hallux valgus deformity in adults of all ages.

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