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The Unreliability of the Intermetatarsal Angle in Choosing a Hallux Abducto Valgus Surgical Procedure

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A R T I C L E I N F O

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A B S T R A C T

Conventional thinking holds that high intermetatarsal and hallux abductus angles (>15° and >25°, respectively) are associated with a hypermobile first ray and require a Lapidus procedure to achieve satisfactory correction for the treatment of hallux valgus. However, normal first ray motion may be misinterpreted as hypermobility, and it is possible to take advantage of this motion to correct some portion of a large hallux abductovalgus deformity with distal procedures, such as the Austin or first metatarsophalangeal joint fusion. We retrospectively examined radiographs of 61 patients with first intermetatarsal and hallux abductus angles greater than 15° and greater than 25°, respectively, who had undergone hallux abductovalgus correction via Lapidus, Austin, or first metatarsophalangeal joint fusion. Preoperative and postoperative radiographic measurements of the intermetatarsal and hallux abductus angles were made. The results revealed no statistically significant differences in the amount of correction achieved by any of the 3 procedures in comparison with the others. We concluded that, given appropriate patient selection, an Austin or first MTPJ fusion could reliably correct large intermetatarsal and hallux abductus angles that, in the hands of many surgeons, are often treated by means of Lapidus arthrodesis.

The choice of surgical procedure for the correction of hallux abductovalgus (HAV) deformities is usually based on clinical assessment of first metatarsophalangeal joint (MTPJ) and metatarsocuneiform joint (MCJ) mobility, as well as radiographic assessment of the foot deformity. Measures of deformity include the first intermetatarsal angle (IMA), the hallux abductus angle (HAA), sesamoid position, the metatarsus adductus angle (MAA), the presence or absence of arthritis in the MTPJ and sesamoid apparatus, and the degree of sagging or subluxation of the MCJ. Many surgeons consider the first IMA to be the most important factor related to selection of a reconstructive surgical procedure. Generally speaking, patients with first IMAs greater than 15° usually receive a proximal surgical procedure, such as a shaft or base osteotomy or Lapidus arthrodesis, whereas patients with first IMAs of 15° or less are often corrected by means of a distal osteotomy, such as an Austin or Mitchell procedure.

In our experience, popular opinion holds that patients with a first IMA greater than 15° have hypermobility of the first ray; that is, abundant sagittal plane range of motion (ROM) at the first MCJ, and this mandates proximal arthrodesis of the first ray to stabilize the medial column when addressing the hallux valgus deformity (1–8). However, the definition of a hypermobile first ray is largely subjective and difficult to measure (9–12). Roukis and Landsman (13) noted that "an accurate and factual definition of hypermobility of the first ray is elusive at best, and that there is a lack of understanding of the clinical ramifications associated with first ray motion." In addition, it has previously been shown that there is poor correlation between the first IMA and perceived hypermobility (14).

Furthermore, in our experience, the standard procedure for correction of a hallux valgus deformity in the presence of an unstable first ray is a Lapidus procedure. Reduction of the first IMA in hallux valgus surgery is largely dependent on the ability to balance the soft tissue influences around the first MTPJ, in addition to a modest change in the first IMA through a distally placed metatarsal osteotomy. The purpose of this investigation was to compare alterations of IM and HA angles achieved by means of distal reconstructive procedures, namely the distal chevron osteotomy (Austin) and first MTPJ fusion, to those obtained by means of first MC fusion (Lapidus procedure). To this end, we undertook a retrospective comparison of radiographic measurements pertaining to patients with a preoperative first IMA greater than 15°, an HAA greater than 25°, or both, who underwent Lapidus arthrodesis, Austin bunionectomy, or first MTPJ fusion for correction of HAV deformity.

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Table 1
Statistical description of the dataset (n = 61 procedures)*

Procedure	First IMA (°)			HAA (°)			Combined First IMA + HAA (°)		
	Preop	Postop	Δ	Preop	Postop	Δ	Preop	Postop	Δ
Austin (n = 21)	18 (14, 29)	8 (3, 13)	11 (6, 17)	37 (30, 45)	10 (−3, 23)	27 (12, 44)	55 (48, 68)	18 (4, 28)	37 (21, 55)
Lapidus (n = 21)	19 (14, 28)	8 (1, 14)	12 (5, 18)	37 (22, 57)	10 (0, 23)	28 (11, 47)	55 (37, 82)	16 (4, 34)	42 (16, 61)
1st MTPJ fusion (n = 19)	16 (11, 24)	11 (7, 17)	6 (0, 13)	42 (25, 70)	14 (8, 23)	25 (12, 51)	59 (39, 81)	24 (16, 38)	32 (14, 53)
Overall	18 (11, 29)	9 (1, 17)	10 (0, 18)	38 (22, 70)	11 (−3, 23)	27 (11, 51)	55 (37, 82)	19 (4, 38)	37 (14, 61)

Abbreviations: HAA, hallux abductus angle; IMA, intermetatarsal angle; MTPJ, metatarsophalangeal joint; Postop, postoperative; Preop, preoperative; Δ, change.
* Results displayed as median and range (minimum, maximum).

Patients and Methods

After receiving approval from the institutional review board of Dekalb Medical, Decatur, Georgia, we performed a database query of patients who had undergone HAV correction in the preceding 10 years by surgeons at our institution. Search terms included distal chevron, Austin, first MTPJ fusion, and Lapidus, as well as their respective Common Procedure Terminology codes (28296, 28750, 28297).

Inclusion criteria included patients whose preoperative weight-bearing dorsoplantar (DP) radiographs displayed a first IMA greater than 15° and/or an HAA greater than 25°. We only included patients who underwent primary HAV correction, and all revisional cases were excluded. Patients who had concomitantly undergone other major reconstructive procedures, including metatarsus adductus, panmetatarsal head resections, and major hindfoot and/or ankle reconstruction, were also excluded. We included patients who underwent routine hammertoe correction at the same time as the HAV correction. Only patients who had at least 6-week postoperative weight-bearing DP radiographs with radiographic signs of operative site bone consolidation, regardless of procedure performed, were included.

We obtained postoperative weight-bearing radiographs and measured the corrected IMA and HAAs. The 2 primary authors (C.A.C., R.A.R.) performed the measurement of angles. One author (C.A.C.) used a manual protractor, and the other author (R.A.R.) used a computer-generated protractor (Iconico Inc., New York, NY) to make the measurements. Reliability testing (results not shown) showed that the measurements were consistently within 1° of each other, indicating consistency of the measurement technique. The data were stored in a spreadsheet (Microsoft Excel 2004 for Mac, Version 11.3.7, Microsoft Corporation, Redmond, WA), and then imported into a statistical software program (Stata/SE 9.2 for Macintosh 2007, Stata Corporation, College Station, TX) for correlation analyses. We computed Spearman's rank correlation coefficient (ρ) to measure the strength of the linear dependence between each rater's assessment of 10 different radiographic measurements (inter-rater reliability), and between each rater's assessments of the same 10 radiographic measurements on 2 occasions separated by at least 2 weeks (intra-rater reliability). Using this method to determine correlation, $1 \geq \rho \geq -1$, a value of 1 indicates a perfect positive correlation, and –1 indicates a perfect negative (inverse) correlation, and a value of 0 indicates the absence of association. We chose to use Spearman's rank correlation coefficient (ρ) to determine the correlation between the measurements because we had 2 observers and our outcomes were ordinal. As a general rule, correlation coefficients that range, in terms of absolute value, from 0.60 to 1.00 are considered strong, and those lower than 0.40 are considered weak. It is important, however, when judging the strength of agreement in terms of a correlation coefficient, that the number of measurements (for example, radiographic angular measurements) suits the specific method used to calculate the correlation.

To measure the first IMA, the first metatarsal head and the base of the metatarsal were bisected, and a line was drawn between the 2 sections. The second metatarsal head and base were similarly bisected and a line drawn between the 2 points. The angle formed between these 2 lines served as the first IMA. The HAA was determined by bisecting the head of the proximal phalanx and the base of the proximal phalanx, and drawing a line between these 2 points. The angle formed between this line and the line formed from the bisection points on the first metatarsal served as the HAA.

The exact points were used to measure pre- and postoperative angles. The IMA, HAA, and combined (IMA+HAA) angles were measured on pre- and postoperative radiographs, and the changes in these angles were recorded. Null hypothesis tests comparing the average change in IMA, HAA, and combined IMA+HAA were performed on the following groups: Lapidus with Austin, Lapidus with first MTPJ fusion, and first MTPJ fusion with Austin.

Table 2
Statistical comparisons of preoperative and postoperative measurements by procedure (n = 61 procedures)*

Procedure	Measurement	Preoperative	Postoperative	*P* Value†
Austin (n = 21)	First IMA (°)	18 (14, 29)	8 (3, 13)	.0001
	HAA (°)	37 (30, 45)	10 (-3, 23)	.0001
	First IMA + HAA (°)	55 (48, 68)	18 (4, 28)	.0001
Lapidus (n = 21)	First IMA (°)	19 (14, 28)	8 (1, 14)	.0001
	HAA (°)	37 (22, 57)	10 (0, 23)	.0001
	First IMA + HAA (°)	55 (37, 82)	16 (4, 34)	.0001
1st MTPJ fusion (n = 19)	First IMA (°)	16 (11, 24)	11 (7, 17)	.0001
	HAA (°)	42 (25, 70)	14 (8, 23)	.0001
	First IMA + HAA (°)	59 (39, 81)	19 (4, 38)	.0001

Abbreviations: HAA, hallux abductus angle; IMA, intermetatarsal angle; MTPJ, metatarsophalangeal joint; Δ, change.
* Results displayed as median and range (minimum, maximum).
† Wilcoxon signed ranks (Mann Whitney *U*) test.

Results

A total of 61 patients met the inclusion criteria for the study. Of these, 21 (34.43%) patients underwent the Lapidus procedure, 21 (34.43%) underwent the distal chevron (Austin) osteotomy, and 19 (31.25%) underwent first MTPJ fusion. All preoperative and postoperative first IMA, HAA, and IMA+HAA angles, and the changes in these angles, are shown in Table 1. In the distal chevron (Austin) group, the median preoperative first IMA was 18° (range 14°, 29°), the average postoperative first IMA was 8° (range 3°, 13°), and the average change in first IMA was 11° (range 6°, 17°). The average preoperative HAA in the Austin group was 37° (range 30°, 45°), the average postoperative HAA was 10° (range –3°, 23°), and the average change in HAA was 27° (range 12°, 44°). The average combined preoperative IM+HA angle in the Austin group was 55° (range 48°, 68°), the average postoperative combined IM+HA angle was 18° (range 4°, 28°), and the average change in combined IM+HA angle was 37° (range 21°, 55°). With regard to the Lapidus procedure, the median preoperative first IMA was 19° (range 14°, 28°), the average postoperative first IMA was 8° (range 1°, 14°), and the average change in first IMA in this group was 12° (range 5°, 18°). The average preoperative HAA was 37° (range 22°, 57°), the average postoperative HAA was 10° (range 0°, 23°), and the average change in HAA was 28° (range 11°, 47°). The average preoperative combined IM+HA angle in the Lapidus group was 55° (range 37°, 82°), the average postoperative combined angle was 16° (range 4°, 34°), and the average change in the combined angle was 42° (range 16°, 61°). With regard to first MTPJ fusion, the median preoperative first IMA in the first MTPJ fusion group was 16° (range 11°, 24°), the average postoperative first IMA was 11° (range 7°, 17°), and the

Table 3
Statistical comparisons of angular changes by procedure (n = 61 procedures)*

Angular Measurement (°)	Procedures and Angular Change, Median (range)		*P* Value†
IMA (°)	Austin 11 (6, 17)	Lapidus 12 (5, 18)	.2194
	Austin 11 (6, 17)	1st MTPJ fusion 6 (0, 13)	.0003
	Lapidus 12 (5, 18)	1st MTPJ fusion 6 (0, 13)	.0001
HAA (°)	Austin 27 (12, 44)	Lapidus 28 (11, 47)	.5371
	Austin 27 (12, 44)	1st MTPJ fusion 25 (12, 51)	.6941
	Lapidus 28 (11, 47)	1st MTPJ fusion 25 (12, 51)	.4237
IMA + HAA (°)	Austin 37 (21, 55)	Lapidus 42 (16, 61)	.2962
	Austin 37 (21, 55)	1st MTPJ fusion 32 (14, 53)	.1931
	Lapidus 42 (16, 61)	1st MTPJ fusion 32 (14, 53)	.0369

Abbreviations: HAA, hallux abductus angle; IMA, first intermetatarsal angle; MTPJ, metatarsophalangeal joint.
* Change between preoperative and postoperative radiographic angular measurements, results displayed as median and range (minimum, maximum).
† Wilcoxon rank sum test.