SAGITTAL PLANE CONSIDERATIONS IN THE KALISH-AUSTIN BUNIONECTOMY: Quantitative and Qualitative Analysis of the Kalish-Austin Bunionectomy

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ABSTRACT

Sagittal plane shift of the first metatarsophalangeal joint by axis guide manipulation of the Austin bunionectomy has been popularized recently in Podiatry Institute literature. The purpose of this paper is to exam sagittal plane changes in those patients who have undergone hallux valgus correction via the Kalish-Austin bunionectomy. It is the authors' opinion that sagittal plane correction of the first ray will be reflected not only in the angular alignment of the first ray, but also in the entire forefoot and rearfoot complex.

Each patient was objectively assessed preoperatively with a test orthotic system utilizing the Electrodynogram for dynamic evaluation and greater understanding of the first ray function. In addition, each patient was assessed postoperatively to determine outcome analysis. Static evaluation was performed by examining the preoperative and postoperative radiographs and documenting the sagittal plane changes.

INTRODUCTION

Preoperative analysis of transverse plane deformity and anticipated correction of hallux abducto valgus is routinely performed by examining preoperative weight-bearing radiographs. In addition, there is usually significant input from the clinical exam. Radiographs are purely two dimensional. Procedure selection and surgical goals are based upon combined clinical and radiographic examination and findings.

At the present, the consideration for concurrent sagittal plane correction is based upon a number of factors that include the presence of hyperkeratotic lesions beneath the second metatarsal head, along the medial aspect of the hallux interphalangeal joint, or the MPJ itself. Biomechanical exam and intra-operative evaluation may also reveal a significant degree of hypermobility of the first ray. In those obvious cases of first metatarsal elevatus, the surgeon may determine that plantarflexion of the capital fragment will be necessary, in addition to reduction of the intermetatarsal angle. This additional plane of correction has often been discussed, but no concrete parameters have yet been described. It is the attempt of the authors to preoperatively determine the specific amount of plantarflexion that will be needed in conjunction with the transverse plane correction.

METHODS AND MATERIALS

The authors selected 17 cases (25 feet) of patients that had undergone hallux valgus correction via the Kalish-Austin bunionectomy between July, 1989 and December, 1992. All procedures were performed by one surgeon. The patients selected underwent the same surgical procedure and preoperative testing via the test orthotic system, and had a minimum of six months of postoperative follow-up at the time of this writing. In addition, the patients were free of postoperative complications such as fixation failure, second surgeries, and infections requiring incision and drainage. The patients also had preoperative and postoperative weightbearing radiographs available for angular assessment and measurements of the first intermetatarsal angle, first metatarsal declination angle, talar declination angle, and the calcaneal inclination angle. These were only angles considered in the initial study, but the includement of other angles and methods of static assessment will be considered in future studies. Angular measurements were performed using standard techniques, by one of the authors. A summary of the results can be found in Table 1.

Table 1

SUMMARY OF RADIOGRAPHIC ANALYSIS (25 FEET)

	PREOPERATIVE				POSTOPERATIVE			
	IM	FMD	TDA	CIA	IM	FDM	TDA	CIA
Mean	14.2	22.6	30.1	22.4	5.6	22.8	30.2	23.8
Standard Deviation	4.6	3.9	4.2	5.6	1.7	4.1	3.5	5.9
Range	7-25	13-30	23-40	13-34	1-8	20-35	24-40	16-40

IM: First Intermetatarsal Angle, FMD: First Metatarsal Declination Angle, TDA: Talar Declination Angle, CIA: Calcaneal Inclination Angle

Preoperative Test Orthotic System

The test orthotic system was designed for this study by one of the authors. Patients were examined preoperatively with a high resolution, bidirectional video tape system. In addition, they would undergo computerized gait evaluation utilizing the Electrodynogram System. In this test system, the sensors were distributed as recommended by the manufacturer: M & L were placed under the tuberosity of the heel, 1 and X were placed over the tibial and fibular sesamoids respectively, the 2, 5 and H sensors were placed proximal to the metatarsal heads and over the interphalangeal joint of the hallux. (Figure 1) The authors' variation from the manufacturers recommendation placed the X and 1 sensors at the level of the first MTPJ. This simple change revealed a number of unusual findings.

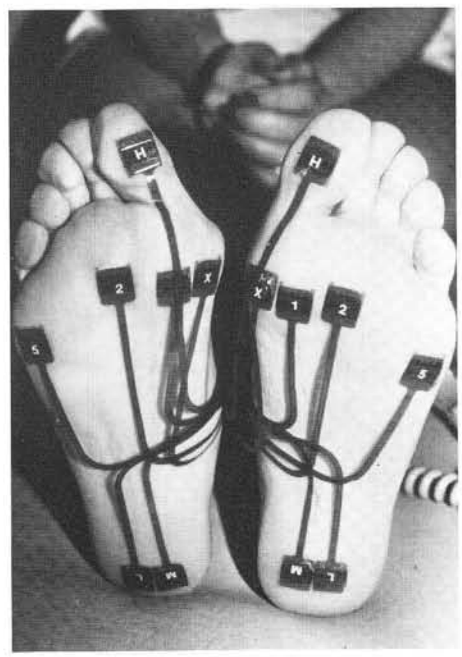
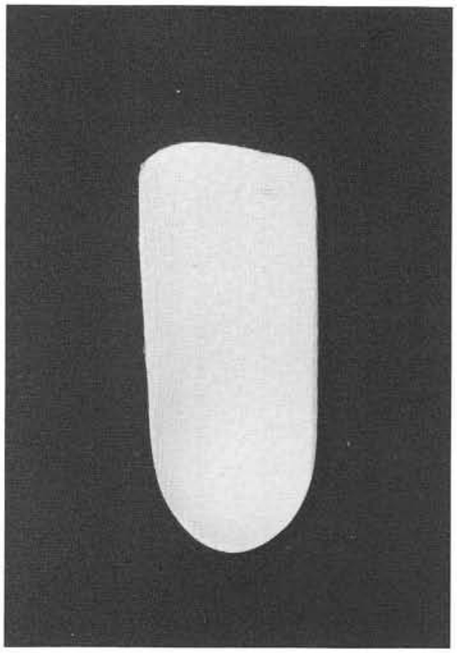


Figure 1. Electrodyne sensor distribution.

The second part of the test system was a test orthotic that was fabricated at the time of preoperative testing. It consisted of a neutral position impression taken semi-weight bearing. The materials used were aliplast and plastizote. The device was shaped into a neutral position orthotic with a forefoot post that was neutral positioned in relation to the rearfoot. It was modified to not influence the forefoot in function with the exception of its thickness.

A series of tests were then performed with variations in a first ray cutout. The cutouts were as follows: standard cutout, bidirectional cutout, metatarsal cuneiform cutout. (Figure 2A-D) Each of these cutouts allowed a certain degree of plantar displacement of the first metatarsal during forefoot loading and subsequent lift phase of gait.

Each patient was tested by the same technician, using the previously described techniques. The overall testing process included a series of tests beginning with a barefoot test followed by a shoe test. This sequence was followed by at least three tests utilizing the test orthotics with variations in the first ray cutout.



Figures 2A-D. Test orthotic system with a series of first ray cutouts (medial margin of device). **A.** Neutral shell without first ray cutout.

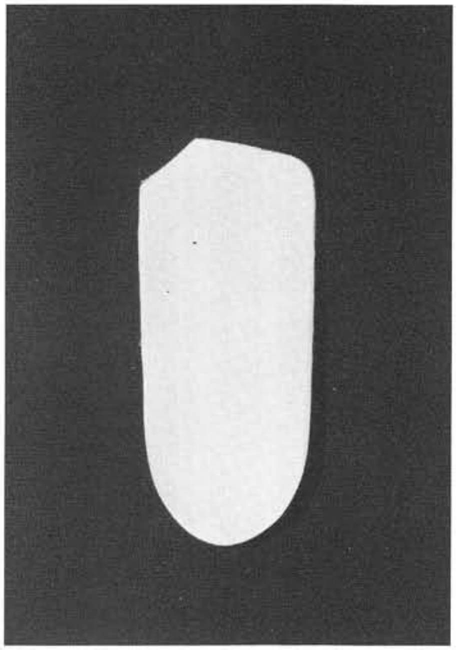


Figure 2B. Standard Cutout.

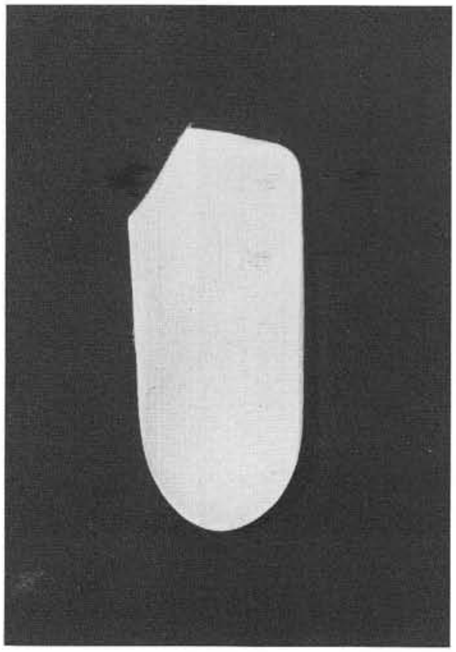


Figure 2C. Bidirectional Cutout.

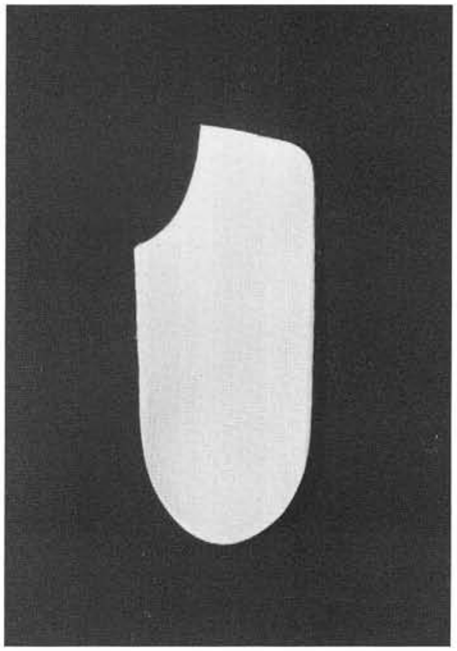
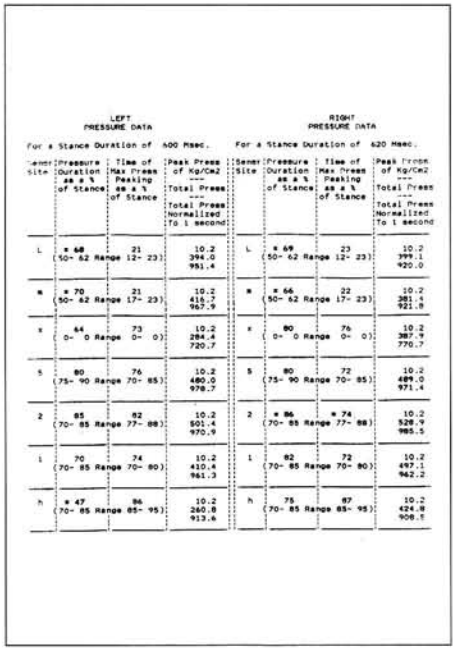


Figure 2D. Metatarsal Cuneiform Cutout.

The important data that was examined from the Electrodynogram printout consisted of the ratio of the total pressure of the X and 1 sensors. (Figure 3) It is postulated that as the ratio of the total pressure reflected by the X and 1 sensors approached one (1) during the gait cycle and that it represented uniform loading of the metatarsophalangeal joint. (Figures 4A-4D)



LEFT
PRESSURE DATA

For a Stance Duration of 600 Msec.

Sensr Site	Pressure Duration as a % of Stance	Time of Max Press Peaking as a % of Stance	Peak Press of Kg/Cm2 --- Total Press --- Total Press Normalized To 1 second
L	* 68 (50- 62 Range	21 12- 23)	10.2 394.0 951.4
M	* 70 (50- 62 Range	21 17- 23)	10.2 416.7 967.9
X	64 (0- 0 Range	73 0- 0)	10.2 284.4 720.7
5	80 (75- 90 Range	76 70- 85)	10.2 480.0 978.7
2	85 (70- 85 Range	82 77- 88)	10.2 501.4 970.9
1	70 (70- 85 Range	74 70- 80)	10.2 410.4 961.3
h	* 47 (70- 85 Range	86 85- 95)	10.2 260.8 913.6

RIGHT
PRESSURE DATA

For a Stance Duration of 620 Msec.

Sensr Site	Pressure Duration as a % of Stance	Time of Max Press Peaking as a % of Stance	Peak Press of Kg/Cm2 --- Total Press --- Total Press Normalized To 1 second
L	* 69 (50- 62 Range	23 12- 23)	10.2 399.1 920.0
M	* 66 (50- 62 Range	22 17- 23)	10.2 381.4 921.8
X	80 (0- 0 Range	76 0- 0)	10.2 387.9 770.7
5	80 (75- 90 Range	72 70- 85)	10.2 489.0 971.4
2	* 86 (70- 85 Range	* 74 77- 88)	10.2 528.9 985.5
1	82 (70- 85 Range	72 70- 80)	10.2 497.1 962.2
h	75 (70- 85 Range	87 85- 95)	10.2 424.8 908.5

Figure 3. Typical EDG printout of pressures.

Figure 4A-D. Preoperative dorsal plantar, and lateral views of one patient in the study. Her preoperative angular relationships were as follows: IM 10, FMD 24, TDA 33, CIA 33. Postoperative angular relationships: IM 1, FMD 27, TDA 25, CIA 40. The EDG X:1 ratios were as follows: preoperative 0.64, postoperative 0.45.

RESULTS

A summary of the results are found in Tables 1 and 2. A full report of each angular measurement of the patients used is beyond the scope of this current paper and will be reserved for future publication. The radiographic results report on all cases initially examined. However, in reviewing the data, there were 9 feet involving 6 cases that had incomplete EDG data. They were subsequently discarded from the second half of the analysis.

There were a number of variables that were encountered. The first has already been noted and includes a number of the cases reviewed for this initial retrospective study that had incomplete Electrodynogram data, either preoperatively as a result of technical error (one case) or as a result of not undergoing testing (two cases) or data not obtained postoperatively at the time of this writing (6 cases). As a result, the overall sampling size may not be large enough for adequate statistical analysis. The authors will attempt to eliminate all of these variables in the future for a more definitive report.

Figure 4B.

Figure 4C.

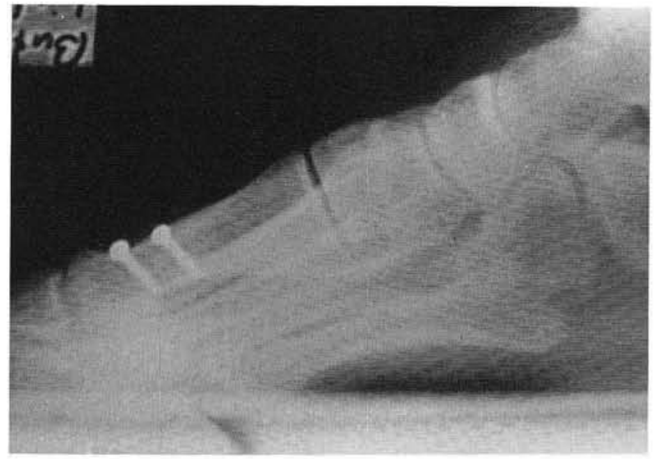


Figure 4D.

Table 2

SUMMARY OF EDG X SENSOR TO 1 SENSOR RATIO (16 FEET, 11 CASES)

	PREOPERATIVE	POSTOPERATIVE
Mean	0.65	0.71
Standard Deviation	0.29	0.27
Range	0.24-1.2	0.20-1.23

DISCUSSION

The purpose of this paper was to examine the sagittal plane changes that occur with the use of the Kalish-Austin bunionectomy by utilizing a preoperative dynamic testing model. It was the authors' assumption that sagittal plane correction needs to be obtained in conjunction with transverse plane correction and that it can be predicted based upon dynamic function utilizing a test model. The best ratio of total pressure between the X and 1 sensor utilizing the preoperative test orthotic system was selected. The cutouts correspond to certain degrees of plantar flexion of the apical axis guide during the surgical procedure: standard/(0-5°), bidirectional/(5-10°), and metatarsal cuneiform/(15-20°). These values were initially obtained through trial and error and then became rather predictable as the number of cases increased over a three-year period. However, the statement that a bidirectional cutout can produce a similar overall angular change in the sagittal plane can not be made at this time. In reviewing the summary data, it can be noted that there was an overall increase in the total pressure ratio of the X:1 in the postoperative test, 0.65 to 0.71. A thorough statistical analysis has not been performed, yet the authors believe that this does show a trend.

The overall angular changes reveal that the Kalish-Austin bunionectomy can achieve a wide range of correction in both the transverse plane as well as the sagittal plane. The average change in the transverse plane (first intermetatarsal angle) was 8.6° degrees. If the authors' overall concept holds true, there should be corresponding sagittal plane changes as well. These changes should be reflected as an increased first metatarsal declination angle, a decrease in the talar declination angle and an increase in the calcaneal inclination angle. In examining the data summary, it does reflect a significant change in the first metatarsal declination angle, 5.6°, however the changes in the talar declination angle (0.1°) and the calcaneal inclination angle (1.4°) were not nearly as significant.

It has been the authors' attempt to quantify and qualify the sagittal plane changes in the Kalish-Austin bunionectomy through a retrospective study. It cannot be stated at this time that the current model in use can predict and determine both the needed amount of sagittal plane correction via the apical axis guide as well as the resultant sagittal plane change seen postoperatively. Testing will continue and a more in depth paper will be published.

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