

Average Correction of the Weil Metatarsal Osteotomy: An Extensive Radiographic Analysis

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Statement of Purpose

Pain associated to the forefoot has garnered various terminology and is commonly referred to as metatarsalgia. These conditions may have many origins and contributing factors such as an abnormal metatarsal parabola, underlying biomechanical etiology and trauma. (1). The lengths of the 5 metatarsals are distributed in a specific pattern to provide an equal sharing of pressure across the forefoot from mid-distance to toe-off. Most frequently, the length of the metatarsals according to Villadot is 1 < 2 > 3 > 4 > 5 (2). Alteration of this typical metatarsal parabola is associated with biomechanical consequences and specific pain at the second MTPJ, hyperkeratotic lesions, plantar plate disruption and subsequent digital dislocation at the MTPJ (3).

In 1985, Weil described a distal metatarsal osteotomy to allow for shortening of the capital fragment and subsequent correction of the metatarsal length (4). This is typically performed at the metatarsal head with an osteotomy parallel to the weight bearing surface. The expected displacement from the Weil metatarsal osteotomy has been poorly defined. There remains paucity in the literature in terms of quantification of mean shortening achieved through use of the Weil metatarsal osteotomy.

Our objective was to determine a value for the average amount of shortening achieved with the Weil metatarsal osteotomy at both the second and third metatarsal. To our knowledge, this is the largest radiographic review that has been performed on the subject.

Methodology & Procedures

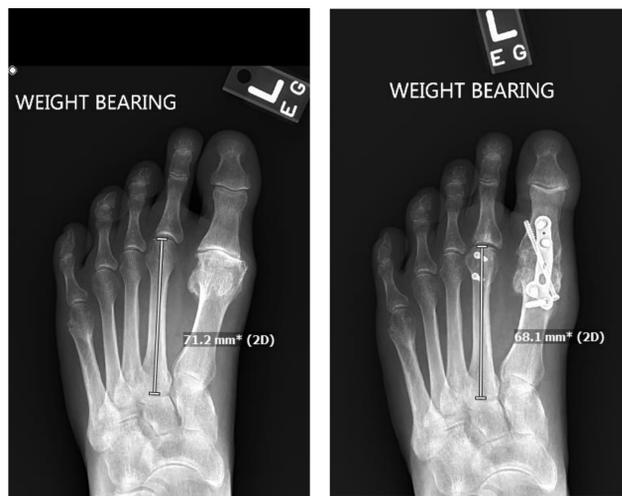


Figure 1: Absolute length of the second metatarsal in millimeters derived from measuring the line bisecting the second metatarsal that connects the most proximal aspect of the base and the most distal aspect of the metatarsal head (5).

Results

A total of 135 patients were identified, with a total of 71 patients meeting the inclusion criteria with sufficient follow-up and imaging. 97 weil metatarsal osteotomies were then further analyzed, 70 at the second met and 27 at the third metatarsal. The average patient age at time of surgery was 56 years old (range 20-78). There were 67 females, 4 males, 48 right feet, and 49 left feet. The data is presented below. (Table 1 & Figure 2)

| Average Shortening of the Weil Osteotomy | | | | | | |
|--|-------|-----------|---------|------------|-----------|--------|
| | Total | Mean (mm) | SD (mm) | Range (mm) | IQR | Median |
| Metatarsal 2 | 70 | 4.0 | 1.6 | (0.5,8.8) | (3.0,4.8) | 3.8 |
| Metatarsal 3 | 27 | 3.8 | 1.7 | (0.5,8.5) | (2.8,4.8) | 3.7 |

Table 1: Depiction of the results obtained at the respective metatarsal. SD = Standard Deviation. IQR = Interquartile Range (25th percentile, 75th percentile). Range = (minimum, maximum)

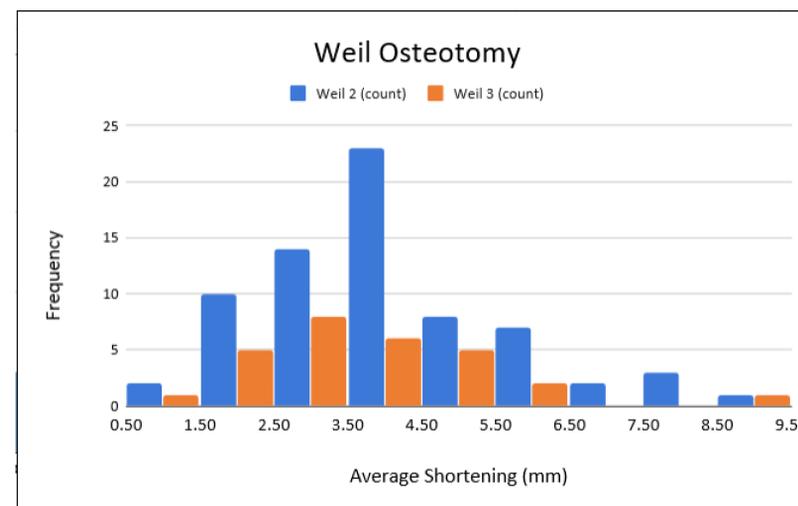


Figure 2: Histogram depicting the shortening of the metatarsals from the Weil Osteotomy. Data organized into 9 bins of size 1.0 starting from [0.5, 1.5)

Analysis & Discussion

A total of 70 Weil osteotomies at the second metatarsal and 27 at the third metatarsal met the criteria for evaluation for a total of 97 Weil metatarsal osteotomies. To our knowledge, this is the largest retrospective radiographic study to quantitatively evaluate the amount of shortening obtained that has been performed to date.

Our results are consistent with what is reported in the current literature with an average of 4.0 mm of shortening at the second metatarsal and 3.8 mm of shortening at the third. Previous studies have found an average variation of 3.5 to 5.6 mm on a range of 28-66 metatarsals (6-9). Our results not only validate the amount of shortening that is to be expected when performing this surgical procedure but also add to the current body of knowledge to give a more accurate representation by looking at a larger data pool. Based on anatomical variation among the population and among sex in regard to foot size, the shortening obtained by this procedure will remain variable, however these results may be utilized as a reference point.

A limitation of our study was the variability in surgeons performing the specific operations. However, all procedures were performed by physicians in the podiatry division of the orthopedic department at UF Health Jacksonville over the previously described timeline.

Future prospective studies of even larger patient population warrant consideration to add to these results.



Figure 3: Previously reported measurement for the relative metatarsal length as obtained on weight bearing AP radiograph (5).

Methodology & Procedures

The appropriate IRB approval was obtained prior to an investigation into patient's protected health information. A medical record search was performed to obtain the population cohort based on CPT 28308 for metatarsal osteotomy over dates 01/2013 – 08/2019 at UF Health Jacksonville. Patients over the age of 18 having undergone the above named procedure within the date range with a minimum of 1-year postoperative follow-up and the appropriate weight bearing imaging at each interval visit met the inclusion criteria for the study. Those under the age of 18, inadequate follow-up or imaging, or with metatarsal osteotomy performed at a location away from the metatarsal head were excluded from the analysis.

The absolute second metatarsal length (Figure 1), utilized previously by Fleischer et al, was evaluated from the pre-operative WB AP foot radiograph and again at the 3-month and 1-year AP weight-bearing radiographs to determine the amount of shortening. For the third metatarsal length, a WB oblique radiograph was chosen due to a clear visibility of the metatarsal head and base without superimposition of the neighboring metatarsals.

Mean, median, range, interquartile range and standard deviations were calculated for both the second and third metatarsals.

Literature review

The amount of shortening that is reported in current literature is highly variable and based on a limited amount of procedures. Some authors advocate for plantar fragment translation proximally by the pre-determined amount as measured on the pre-operative AP radiograph (3). Others report that the metatarsal head will naturally displace proximally, recommending 5-10 mm of shortening (5).

To date, the largest of these studies specifically addressing the amount of shortening was performed in 2009 investigating 66 distal metatarsal osteotomies. The investigators found 4.5 mm shortening of the second metatarsal with 3.5mm shortening of the third metatarsal by their technique (6). Vandeputte in 2001 evaluated 32 patients or a total of 59 metatarsals and found an average shortening of 5.9mm (7). Podskubka et al in 2002 performed an evaluation of 12 patients for a total of 28 metatarsals and found average shortening of 5.6mm (8). Finally, a study by Hofstaetter in 2005 analyzed 7-year follow-up in 25 feet with a mean metatarsal shortening of 4.3mm (9). This gives us a variation in the current literature with reports of 3.5 - 5.6mm of average shortening on a relatively small number of metatarsals (28 – 66 metatarsals) (6-9).

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