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Original Research

Factors Associated With Early Loss of Hallux Valgus Correction

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A B S T R A C T

Recurrence is common after hallux valgus corrective surgery. Although many investigators have studied the risk factors associated with a suboptimal hallux position at the end of long-term follow-up, few have evaluated the factors associated with actual early loss of correction. We conducted a retrospective cohort study to identify the predictors of lateral deviation of the hallux during the postoperative period. We evaluated the demographic data, preoperative severity of the hallux valgus, other angular measurements characterizing underlying deformities, amount of hallux valgus correction, and postoperative alignment of the corrected hallux valgus for associations with recurrence. After adjusting for the covariates, the only factor associated with recurrence was the postoperative tibial sesamoid position. The recurrence rate was ~50% and ~60% when the postoperative tibial sesamoid position was >4 and >5 on the 7-point scale, respectively.

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Recurrence after hallux valgus (HV) corrective surgery is common (1,2). Many factors have previously been identified as risk factors for recurrence (1,3–8). To identify these risk factors, many investigators evaluated the demographic, physical, and radiographic factors in their search for an association with recurrence using bivariate analyses (5,7–10). Very few, however, have accounted for the relationships between these variables (4,6,11).

Many of the variables evaluated in HV outcomes-based studies are known to have relationships with each other (12,13). Therefore, independent factors affecting the outcome are often masked among the potential confounders unless multivariate adjustments are used. For example, the severity of the bunion deformity can be correlated with amount of correction achieved or type of procedure chosen by the surgeon. Therefore, it is difficult for a surgeon to understand which factors are important in preventing recurrence after HV surgery.

Additionally, in many studies, recurrence of HV has been defined in terms of the final hallux position relative to the first metatarsal. Although this definition is more representative of the final appearance of the foot, it does not account for the actual loss of HV correction.

We conducted a multivariate risk factor analysis of HV recurrence, measured as the early loss of the HV angle (HVA), adjusting for covariates of clinical interest. The goal of the present study was to identify the independent factors associated with early loss of HV correction after bunion surgery.

Patients and Methods

We evaluated patients who had undergone surgical correction of HV deformity. Patients were enrolled from the Scott & White Health Care System (Temple, TX) who had undergone surgery from January 1, 2004 to December 31, 2006. Our institution's institutional review board approved the protocol. Patients with osseous HV corrective procedures were identified using Common Procedural Terminology codes (28296, metatarsal head osteotomy; 28297, Lapidus-type procedure; 28299, double osteotomy; 28306, osteotomy with or without lengthening, shortening, or angular correction; 28740, single first tarsometatarsal joint arthrodesis; and 28750, first metatarsophalangeal joint [MTPJ] arthrodesis). The radiographic review process confirmed the accuracy of the coding.

These patients were then evaluated for the following inclusion and exclusion criteria. The inclusion criteria were patient age 18 to 80 years and the availability of weightbearing radiographs within 1 year preoperatively and ≥6 months postoperatively. Patients who underwent revision HV surgery were excluded. Also, patients who had undergone first MTPJ arthrodesis or first MTPJ resection arthroplasty, such as the Keller procedure, were excluded.

After enrollment, the demographic, physical, radiographic, and surgical data were collected from each subject's medical records. These included patient age at surgery,

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gender, body mass index (BMI), smoking history, side of the procedure, type of HV procedure, concurrent hammer toe or Akin proximal phalangeal osteotomy procedure, fixation type, preoperative HVA, first and second intermetatarsal angle (IMA), tibial sesamoid position, Engel's angle, talar declination angle, calcaneal inclination angle, cuboid abduction angle, lateral IMA, first metatarsal declination angle, amount of HV correction in degrees, amount of HV correction as a percentage, interval from surgery to the last radiographic examination, amount of sesamoid reduction, and postoperative HVA, IMA, and tibial sesamoid position. All the angles were measured on plain weightbearing radiographs taken preoperatively, within 3 months after surgery, and ≥6 months after surgery. If multiple radiographs were available >6 months after surgery, measurements were taken using the latest radiographs.

The BMI was calculated from the weight and height measurements recorded during the preoperative evaluation (BMI = weight in kilograms divided by height in square meters). Smoking history was recorded as current versus nonsmoker. Nonsmoker consisted of never-smoker and quit-smoker. The HV corrective procedures were dichotomized into "distal" and "proximal" procedures. All distal procedures were metatarsal head (mostly chevron) osteotomies. The proximal procedures consisted of first tarsometatarsal joint arthrodesis (modified Lapidus procedure), closing base wedge, crescentic, and mid-shaft osteotomies. Adjunctive procedures such as hammer toe correction or hallux proximal phalangeal osteotomy were coded as yes or no. Fixation type was categorized as standard versus enhanced. Standard fixation consisted of Kirschner wire or screw fixations, regardless of the number of such fixations. Fixation was considered enhanced if ≥1 plate had been used.

For radiographic examination, the HVA was defined as the angle created by the long axis of the proximal phalanx of the hallux and the long axis of the first metatarsal bone. The IMA was defined as the angle created by the long axis of the first and second metatarsal bones. Engel's angle, which was used to measure the amount of metatarsus adductus, was defined as the angle created by the long axis of the intermediate cuneiform and the second metatarsal bone on the dorsoplantar view on weightbearing plain radiographs. In the case of metatarsal osteotomy, the long axis was considered as the line connecting 2 points that bisect the distal and proximal ends of the corrected long bone (14,15). For the tibial sesamoid position, the 7-level grading system described by Hardy and Clapham (16) on the dorsoplantar view of a plain radiograph was used. The lateral IMA was defined by the angle created from the dorsal cortices of the first and second metatarsals on the weightbearing lateral view. The metatarsal declination angle was created from the dorsal cortex of the first metatarsal and the ground surface on the lateral radiograph. The talar declination angle was created from the bisection of the talus and the ground surface on the lateral projection.

The postoperative radiographic angles were measured from weightbearing radiographs taken not later than 3 months postoperatively. The amount of HV correction was defined as the degree of correction in the HVA (preoperative HVA minus postoperative HVA within 3 months). The percentage of correction was calculated as the HVA correction in degrees divided by the preoperative HVA and multiplied by 100%.

The outcome variable, recurrence, was defined by a loss of the HVA of ≥3° after ≥6 months postoperatively. This amount was selected for a more conservative definition of recurrence, because a few degrees of difference in radiographic measurements can be within the range of error. Schneider et al (17) showed the intraobserver coefficient of repeatability to be 2.1° to 3.3° in the HVA, depending on the method used to measure it.

Statistical Analysis

Age, BMI, and preoperative radiographic angles were dichotomized into upper and lower 50th percentiles, divided at the median. The tibial sesamoid position was treated as an ordinal variable, because it has not yet been validated for use as a continuous variable, although, intuitively, a greater number indicates more dislocation. The postoperative radiographic angles were dichotomized into normal and abnormal results, using well-accepted cutoffs. The HVA was divided into ≥15° versus <15°, and the IMA was divided into ≥9° and <9° (16,18–21).

To evaluate the effect of these variables on HV recurrence, we first used bivariate analyses to identify the factors that were potentially associated with the final outcomes. The χ^2 test of independence or Fisher's exact test was used for this task. A p value of < .1 on the bivariate analyses was used to identify variables to be included in the final regression model.

All statistical analyses were performed using the R statistical package (R, Developmental, Core, Team. R: A Language and Environment for Statistical Computing 2012; available at: http://www.R-project.org) by the primary author (N.S.). The association is presented in terms of the odds ratio (OR) and was considered significant when the 95% confidence interval (CI) did not include 1 after adjusting for potential covariates.

Results

Of the 213 patients who had undergone HV corrective procedures during the study period, 151 satisfied the inclusion and exclusion criteria. Most of the exclusions were because of the lack of weightbearing radiographs ≥6 months after the day of surgery. Of the remaining patients, 140 were female and 11 were male. The mean age of this cohort was 57 (range 18 to 80) years. Of the 15 surgeons who performed ≥1 surgery, 5 performed 72% of the cases. Most (100 of 151; 66%) of the patients had undergone distal metatarsal osteotomy as the primary procedure. In addition, 23 had undergone first tarsometatarsal fusion (modified Lapidus procedure) and 30, proximal/midshaft/double metatarsal osteotomies.

The mean and median preoperative HVAs were 27.5° and 27.4°, respectively. The mean and median preoperative IMAs were 14.0° and 13.9°, respectively. The mean postoperative (within 3 months after surgery) HVA and IMA were 14.2° and 8.7°, respectively. The mean final (≥6 months after surgery) HVA was 15.4°. Of the 151 patients, 47 (32%) developed recurrence. The mean final HVA among those in the recurrence group was 24.0° ± 9.19°, and the mean in the nonrecurrence group was 11.3° ± 8.94°. This difference was statistically significant (t test, p = .001).

After the bivariate analyses, we determined that the preoperative HVA, preoperative IMA, amount of HVA correction, and postoperative tibial sesamoid position should be included in the final logistic model. After adjusting for these covariates, only the postoperative tibial sesamoid position remained statistically significant (OR 1.4, 95% CI 1.10 to 1.85). The results of the bivariate analyses and the factors included in the final logistic models are presented in Table 1. The results of the regression analysis are presented in Table 2.

Because the postoperative tibial sesamoid position was the only significant factor, the relationship between the sesamoid position and HV recurrence was further evaluated in a post hoc analysis to explore and identify additional clinically useful information. The sesamoid position was dichotomized as large and small at different cutoff points, and the association of the dichotomized sesamoid positions with HV recurrence was assessed in terms of the OR and CI after adjusting for the same covariates identified above.

The post hoc analysis showed that a postoperative tibial sesamoid position >4 was statistically significantly associated with HV recurrence (OR 3.4, 95% CI 1.54 to 7.66; Table 3). When the position was >5, the association was stronger (OR 4.4, 95% CI 1.59 to 12.69). The recurrence rate when the postoperative sesamoid position was >4 and >5 was 51% and 60%, respectively.

No association was found between the postoperative tibial sesamoid position and HVA correction (χ^2, p = .683). Additionally, when the HVA correction was removed from the final model, the postoperative tibial sesamoid position remained significantly associated with HV recurrence (OR 1.4, 95% CI 1.07 to 1.78).

To determine whether a different definition of recurrence would change the results, we repeated the analysis with recurrence defined as loss of HVA correction of >2°. The results did not change and the postoperative tibial sesamoid position remained the only factor associated with recurrence (OR 1.4, 95% CI 1.10 to 1.79).

Discussion

It has been shown that the postoperative sesamoid position is associated with HV recurrence in patients treated with proximal osteotomies (22–25). In contrast, Shi et al (10) suggested no association was present between the postoperative sesamoid position and HV recurrence when patients were treated with a distal metatarsal osteotomy. This was based on their result that only 1 of 4 patients who lost the sesamoid correction developed HV recurrence. In our study, in which most procedures were distal osteotomies, the sesamoid position was, and the use of distal versus proximal osteotomy was not, associated with HV recurrence. This insignificance might have resulted from surgeons selecting more aggressive procedures for large HV deformities. However, a large HV deformity was not associated with recurrence after adjusting for other covariates.