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Impact of podiatry resident experience level in hallux valgus surgery on postoperative outcomes

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ARTICLE INFO

Article history:

Received 20 November 2013

Received in revised form

17 February 2014

Accepted 3 March 2014

Available online 11 March 2014

Keywords:

Resident experience

Trainee experience

Surgery

Outcome

Podiatry

Podiatric surgery

Foot surgery

ABSTRACT

Background: Despite modern advancements in transosseous fixation and operative technique, hallux valgus (i.e., bunion) surgery is still associated with a higher than usual amount of patient dissatisfaction and is generally recognized as a complex and nuanced procedure requiring precise osseous and capsulotendon balancing. It stands to reason then that familiarity and skill level of trainee surgeons might impact surgical outcomes in this surgery. The aim of this study was to determine whether podiatry resident experience level influences midterm outcomes in hallux valgus surgery (HVS).

Methods: Consecutive adults who underwent isolated HVS via distal metatarsal osteotomy at a single US metropolitan teaching hospital from January 2004 to January 2009 were contacted and asked to complete a validated outcome measure of foot health (Manchester–Oxford Foot Questionnaire) regarding their operated foot. Resident experience level was quantified using the surgical logs for the primary resident of record at the time of each case. Associations were assessed using linear and logistic regression analyses.

Results: A total of 102 adult patients ($n = 102$ feet) agreed to participate with a mean age of 46.8 years (standard deviation 13.1, range 18–71) and average length of follow-up 6.2 y (standard deviation 1.4, range 3.6–8.6). Level of trainee experience was not associated with postoperative outcomes in either the univariate (odds ratio 0.99 [95% confidence interval, 0.98–1.01], $P = 0.827$) or multivariate analyses (odds ratio 1.00 [95% confidence interval, 0.97–1.02], $P = 0.907$).

Conclusions: We conclude that podiatry resident level of experience in HVS does not contribute appreciably to postoperative clinical outcomes.

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1. Introduction

It is estimated that one-third of the world's population will develop hallux valgus (i.e., bunion) deformity at some point in

their lifetime [1,2]. Hallux valgus surgery (HVS) is therefore a commonplace in podiatric and foot and ankle orthopedic circles around the globe. Despite modern advancements in transosseous fixation and operative technique, HVS is still

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<http://dx.doi.org/10.1016/j.jss.2014.03.005>

somewhat tainted with higher than expected rates of suboptimal outcomes [3]. In fact, a recent Cochran review by Ferrari et al. [4] estimated that as many as 25%–33% of patients remain dissatisfied after HVS.

The difficulties surrounding HVS may be related to the inherent challenges of trying to reestablish the complex triplanar and reciprocal motion required at the first metatarsophalangeal joint. Proper intraoperative tensioning and balancing of the intrinsic muscles around the great toe represent additional challenges in maintaining the long-term correction of the deformity [5]. For these reasons, HVS is generally considered a highly nuanced procedure requiring precise osseous and capsulotendon manipulation that is only fully appreciated after years of clinical and operative experience [3].

Resident participation in operative procedures is essential to surgical training [6]. Although the exact proportion of surgeries performed with a resident or trainee surgeon is uncertain, it is likely to be significant. In the Veterans Affairs system, teaching hospitals perform approximately 80% of the surgical workload and identify a resident as the primary surgeon over 90% of the time [7]. Although several studies have previously examined general surgery resident participation and outcomes, each with varying but generally acceptable results [6–11], there are no studies yet that have addressed the interaction between podiatry residents and surgical outcomes. The purpose of this study was to identify whether podiatry resident experience level influences intermediate and long-term postoperative outcomes using a common, yet technically challenging, foot surgery. The study's null hypothesis was that the resident experience level in HVS is not associated with postoperative outcomes.

2. Patients and methods

2.1. Study population and setting

Consecutive adult patients ($n = 295$) who underwent isolated HVS by the podiatry service at Advocate Illinois Masonic Medical Center from January 2004 to January 2009 were contacted by mail and asked to participate. Advocate Illinois Masonic Medical Center is a level 1 trauma center and tertiary care hospital located in metropolitan Chicago, IL. It serves as the primary teaching hospital for an established podiatry residency program, in which residents complete their second and third years of postgraduate surgical training.

Eligible patients were ambulatory men and women who underwent HVS via first metatarsal osteotomy for predominantly medial foot “bump” pain and at least 36-mo follow-up. Patients with a chief complaint of joint pain (e.g., hallux rigidus) or those with prior first ray surgery were excluded. Patients requiring osseous surgery other than hammertoe repair (e.g., Weil osteotomy, tailor's bunionectomy, extraosseous talotarsal stabilization) at the time of their bunion surgery, or those with seronegative (e.g., ankylosing spondylitis) or seropositive (e.g., rheumatoid arthritis) inflammatory arthritides were also excluded.

In instances when patients underwent bilateral foot surgery during the same operative setting ($n = 13$), the study foot was determined by a coin flip. For those who underwent

bilateral HVS with first metatarsal osteotomy at different times ($n = 3$), the first operated foot only was used in the analysis. Local ethics committee approval was obtained (Advocate Health Care Institutional Review Board) before the start of the study and all subjects provided written consent.

2.2. Primary outcome measure—the Manchester–Oxford Foot Questionnaire

In response to the recent Cochran review calling for an increased need to evaluate patient-centered outcomes when assessing the success of HVS [4], we selected the Manchester–Oxford Foot Questionnaire (MOXFQ) as the study's primary outcome measure. The MOXFQ is a brief 16-question patient-focused survey designed specifically to assess the pain and function after foot surgery with three domains (foot pain, walking and standing, and social interaction). The total score and each domain are scored on a scale ranging from 0–100, with larger numbers indicating greater levels of disability or pain. The MOXFQ was validated in the context of HVS in 2006 by Dawson et al. [12] demonstrates high correlation with the Short Form 36 and American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal-interphalangeal clinical scale [13] and has greater readability and patient comprehension than the Foot Health Status Questionnaire [14].

Eligible patients, identified through chart review, received a survey via standard mail with instructions to complete and return the form. Participants were then stratified in the following way: Patient's reporting a score >1 standard deviation (SD) above previously published averages [12] for any domain on the MOXFQ and those requiring revision HVS ($n = 4$) were classified as having had a “suboptimal” postoperative outcome. This equated to a walking and standing score >39.4 , pain >30.7 , and social interaction >30.5 . Similarly, patients returning surveys without satisfying either of these two conditions were classified as having had a “favorable” postoperative outcome.

2.3. Primary predictor variable

Resident experience level with HVS served as the primary predictor variable in this study. The following observations were recorded from the surgical logs for the principle resident surgeon on record for each procedure: (1) postgraduate year of training, (2) number of “C level” HVS cases requiring first metatarsal osteotomy, and (3) number of “C level” + “B level” HVS cases requiring first metatarsal osteotomy. During the time frame covered with this study, the Council of Podiatric Medical Education defined a C level case as “the resident participates actively in performing the procedure.” This level of participation could be claimed on surgical logs when the resident performed at least ($>50\%$) most procedures under direct supervision of the attending [15]. B level cases, in contrast, could be claimed by the resident when their participation in the case was $<50\%$ and typically involved greater amounts of observation.

2.4. Other predictor variables (independent variables)

Several potentially important confounders were also examined in the analysis including patient age at the time of

surgery, gender, highest level of education attained, length of follow-up, bunionectomy type (e.g., scarf, modified Austin, and modified Kalish), whether bilateral HVS was performed, board certification status of the attending at the time of surgery, length of surgical residency training of the attending, and whether the case was performed by a “core” attending faculty member of the residency training program. For the purposes of this article, core faculty was defined as any surgeon who receives a stipend from the teaching program. Individual attending surgeons were also considered as independent variables in the analysis if they served as the surgeon on record in five or more cases. Likewise, individual resident physicians were also considered as independent variables if they were involved in five or more included cases. Postoperative complications such as infection, return to the operating room, recurrence, and resultant hallux varus were also recorded from outpatient and hospital records.

2.5. Data analysis

Missing data ($n = 10$ subjects, 11 items total) on the MOXFQ were imputed with the patient’s mean value for completed items on the survey. Patient’s answering “n/a” were given a score of “0” for that item. Relationships between continuous variables and MOXFQ scores were graphically explored using scatter plots. Assessment of a linear correlation was determined using Pearson correlation coefficient (r). Dichotomous variables were tested for their association with surgical outcomes using an independent t-test, Wilcoxon rank-sum test, or simple regression.

Multivariable logistic regression was used to predict suboptimal outcomes after HVS based on the patient and provider predictor variables in the study. Significant predictor variables were determined by first conducting a univariate analysis for each predictor. Potentially important independent variables (with $P < 0.25$) in the univariate analysis were then entered into a multivariable, logistic regression model. Statistical interaction (P values < 0.05) was tested by looking at all pairwise interactions among the predictors using forward selection. Potential confounders were identified using stepwise backward elimination working back from a full model (without the interaction terms). The final regression model consisted of the clinically important predictors, significant confounders, and significant interaction terms. The Hosmer–Lemeshow goodness-of-fit test was used to assess how effectively the final model described the outcome of interest. Data were analyzed using SAS software (version 9.2 of the SAS System for Windows; SAS Institute, Cary, NC). All tests were two-tailed with P values < 0.05 considered statistically significant.

3. Results

A total of 102 adult patients (45 modified Austin bunionectomies, 10 Kalish-type procedures, and 47 scarf bunionectomies) returned usable surveys (102/295, 35% response rate). The mean age of the cohort was 46.8 y (SD 13.1, range 18–71) and most participants were women (91/102, 89%). The average length of follow-up was 6.2 y (SD 1.4, range 3.6–8.6).

Table 1 – Patient and provider characteristics stratified by postoperative HVS outcome.

	Favorable outcome ($n = 64$)	Suboptimal outcome ($n = 38$)	P value
Patient characteristics			
Age	45.6 (13.4)	48.9 (12.3)	0.205
Female gender	59/64 (0.92)	32/38 (0.84)	0.212
Follow-up (y)	5.9 (1.4)	6.7 (1.4)	0.006*
Bilateral foot surgery	9/64 (0.14)	4/38 (0.11)	0.606
Study foot = right	33/64 (0.52)	22/38 (0.58)	0.537
Education (highest level)			
High school	15/64 (0.23)	8/38 (0.21)	0.782
Some college	22/64 (0.34)	12/38 (0.32)	0.773
College graduate	14/64 (0.22)	11/38 (0.29)	0.424
Masters or higher	13/64 (0.20)	7/38 (0.18)	0.817
Surgical procedure			
Modified Austin	26/64 (0.41)	19/38 (0.50)	0.359
Modified Kalish	6/64 (0.09)	4/38 (0.11)	0.851
Scarf bunionectomy	32/64 (0.50)	15/38 (0.39)	0.305
Provider characteristics			
Board certified attending	51/64 (0.80)	27/38 (0.71)	0.323
Attending years of surgical training	2.03 (0.77)	1.73 (0.95)	0.126
Core attending in training program	47/64 (0.73)	23/38 (0.60)	0.176
Resident postgraduate year	2.47 (0.50)	2.45 (0.50)	0.838
Resident number of HVS cases [†]	41.4 (25.6)	40.4 (20.6)	0.830

All values are displayed as frequency (percentage of column total) or as mean (SD). t-test or Wilcoxon rank-sum test was used for comparisons of continuous variables.

χ^2 or Fisher exact test was used for comparisons of categorical variables.

* Statistically significant test result.

[†] Refers to the total number of “C level” HVS cases performed before surgery.

There were 18 attending surgeons and 18 different resident physicians involved in patient care. Three attending surgeons performed over half of the surgeries (59/102, 58%), and most of the trainees (10/18, 55%) claimed to be the principle resident surgeon on at least five of the included cases. The mean postoperative MOXFQ score for our cohort was 20.4 (SD 25.1, range 0–95.3). The mean postoperative MOXFQ scores in each of the domains were walking and standing 19.6 (SD 27.1), pain 23.5 (SD 26.8), and social interaction 17.7 (SD 25.1).

There were three minor complications each attributed to screw removal for painful hardware (3/102, 3%). Four patients required surgical revision (two for hallux varus and two for joint stiffness) at an average of 2.3 y. No patient was readmitted for postoperative infection, deep vein thrombosis, or other major complication.

Patient and provider characteristics stratified by postoperative outcome are provided in Table 1. There were 64 favorable postoperative outcomes and 38 suboptimal outcomes in our cohort. The only variable in the univariate analysis found to be associated with suboptimal HVS outcomes was length of follow-up ($P = 0.006$), with longer lengths of follow-up found in the suboptimal group (mean 5.9 [1.4 y] versus 6.7 [1.4 y]). Level of resident experience with HVS showed no association with postoperative outcome when using both resident C level cases only (mean 41.4 [26] versus 40.4 [21], $P = 0.838$) and resident C + B level cases (mean 54.4 [32] versus 52.8 [24], $P = 0.7903$). This is clearly demonstrated in the scatter plot looking at resident number of prior HVS cases (C level) and postoperative MOXFQ total scores for the cohort (Fig. 1, $r = 0.002$, $P = 0.978$).

Potential important predictors in the univariate analysis ($P < 0.25$) that were entered into the multivariable analysis along with level of resident experience (C level cases) were length of follow-up (in years), age, gender, attending years of surgical training, and whether the attending was “core” faculty. In addition, one attending (“attending X,” univariate $P = 0.075$) and one resident (“resident Y,” univariate $P = 0.095$) were eligible for entry into the final multivariable analysis.

Table 2 shows the final multivariate model for predicting suboptimal outcomes after HVS. There were no statistically significant interaction terms added to the model. As expected, age and follow-up were retained in the final model, but interestingly “attending X” and “resident Y” were also identified as significant independent predictors of suboptimal outcomes. The Hosmer–Lemeshow goodness-of-fit test was not significant (0.768, $P = 0.479$), indicating that the model is well fit throughout the spectrum of predicted risk. Finally, the final model was able to discriminate between suboptimal and favorable HVS outcomes more than three quarters of the time (area under the receiver operating characteristic curve = 0.768).

4. Discussion

Although previous work has examined how general surgery residents’ impact surgical outcomes [6–11], this is the first study to critically evaluate podiatry residents and postoperative outcomes. We found that podiatry resident level of experience in HVS was not associated with postoperative outcomes using a relatively common, yet technically challenging, foot surgery. In addition, operating with podiatry residents appears to be safe, as our minor (3/102, 3%) and major (0/102, 0%) complication rates, and rate of revision (4/102, 4%) did not differ notably from previously published rates [4].

That being said, the mean MOXFQ scores in our series were slightly higher (i.e., worse) than those previously reported in the literature. Dawson et al. [12], for example, reported postoperative means of 16, 20, and 12 for the walking and standing, pain, and social interaction domains, respectively. Similarly, Maher and Kilmartin [16] reported mean scores of 12, 15, and 19.1 for the same MOXFQ domains using a cohort of 71 postoperative HVS patients. It is possible that the slightly higher MOXFQ scores encountered in our series may be, at least, partly attributed to resident participation. However, we believe this discrepancy is more likely due to the larger number of attending surgeons, which we included in our

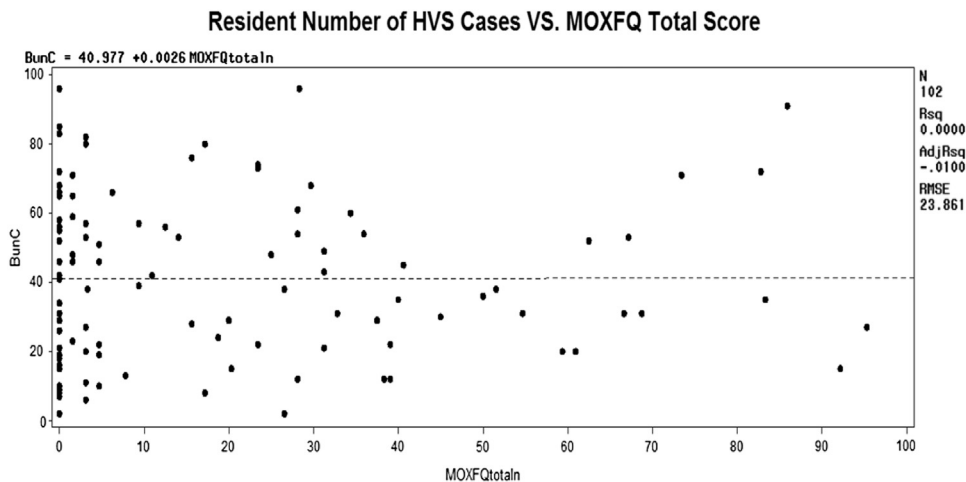


Fig. 1 – Resident number of “C Level” HVS cases with first metatarsal distal osteotomy versus MOXFQ Total scores at mid-term follow-up (avg. 6.2 years).

Table 2 – Final multivariable model for predicting suboptimal outcomes following HVS.

Risk factor	Regression coefficient	Odds ratio	95% CI	P value
Intercept	–6.675	—	—	—
Resident number of HVS cases	–0.002	1.00	0.97–1.02	0.907
Age	0.049	1.05	1.01–1.10	0.016
Follow-up (y)	0.536	1.71	1.19–2.45	0.004
Attending X	2.140	8.50	1.67–43.30	0.010
Resident Y	1.742	5.71	1.28–25.51	0.023

The area under the receiver operating characteristic curve = 0.768.
 Hosmer–Lemeshow goodness-of-fit test = 7.546, P = 0.479.
 CI = confidence interval.

study and their varying levels of operative training and expertise. When considering only the core attendings involved in the training program—those who also typically attained higher levels of board certification and completed longer programs of postgraduate residency training—the MOXFQ scores, although not statistically significant, more closely resembled those from prior studies (Fig. 2). This observation may also suggest that regular and repetitive interaction between trainees and mentors might facilitate improved outcomes in HVS. Unfortunately, our study was underpowered to confirm this type of interaction effect with statistical significance.

Although resident experience did not correlate with postoperative results in this study, certain individuals themselves (e.g., attending X and resident Y) were associated with poorer HVS outcomes. Until now, quality assurance exercises at our

hospital have been limited to *ad hoc* review of postoperative X-rays for surgeries performed by members of the foot and ankle service. Our study however raises the possibility of also using patient-reported outcomes to identify resident and/or attending surgeons in need of independent review of their techniques to improve their patient outcomes within expected levels.

Like many retrospective cohort studies, our results may suffer from residual confounding, inability to account for the baseline severity of the hallux valgus deformity, and selection or respondent bias. Also, since all procedures in this study involved a postgraduate trainee, we were unable to assess the impact, which resident involvement (*versus* no resident involvement) had on postoperative outcomes. Further large-scale studies examining both operating conditions would be needed to better address this. Finally, our study was conducted within a large, tertiary care teaching hospital with several dedicated, core faculty members responsible for residency education, so is not clear just how generalizable our findings will be to smaller podiatry residency training programs or larger programs that may have less oversight and/or individual instruction.

5. Conclusions

In summary, we found that neither podiatry resident seniority nor surgical experience level influenced mid- and long-term postoperative outcomes in HVS. These findings may provide guidance for attending and resident physicians during office consultations and better equip patients with appropriate postoperative expectations when contemplating HVS in teaching environments.

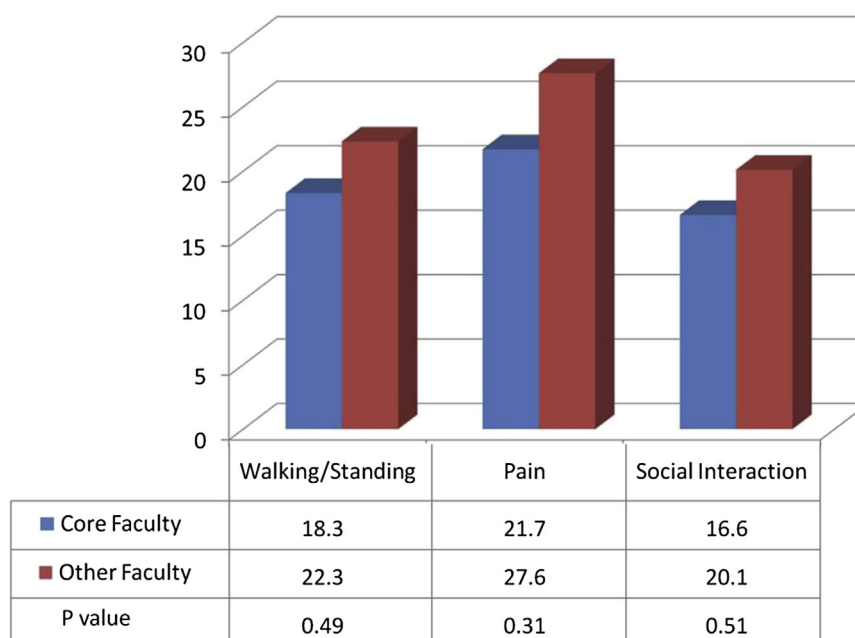


Fig. 2 – Mean MOXFQ scores across the three domains for “core” (n = 70 procedures) and other (n = 32 procedures) faculty in the residency training program. (Color version of figure is available online.)

Acknowledgment

This project was funded, in part, by the National Institutes of Health (1T35DK074390-01) and Advocate's President's Fund.

Authors' contributions: A.E.F., M.C.Y., R.M.J., and C.H.R. contributed to conception and design. A.E.F., A.B., T.N., B.J.M., and R.C.O.R. collected the data. A.E.F. and R.M.J. analyzed and interpreted the data. A.E.F., M.C.Y., R.M.J., A.B., T.N., B.J.M., R.C.O.R., and C.H.R. wrote the article. A.E.F., M.C.Y., R.M.J., A.B., T.N., B.J.M., R.C.O.R., and C.H.R. made the critical revision of the article. A.E.F. and M.C.Y. were in charge of obtaining funding.

Disclosure

The authors reported no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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