A Comparison of Adverse Short-Term Outcomes After Forefoot Amputation Based on Patient Height

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Background: The objective of this investigation was to evaluate adverse short-term outcomes after partial forefoot amputation with a specific comparison performed based on patient height.

Methods: The American College of Surgeons National Surgical Quality Improvement Program database was analyzed to select patients with a 28805 *Current Procedural Terminology* code (amputation, foot; transmetatarsal) who underwent the procedure with "all layers of incision (deep and superficial) fully closed." This resulted in 11 patients with a height of 60 inches or less, 202 with a height greater than 60 inches and less than 72 inches, and 55 with a height of 72 inches or greater.

Results: Results of the primary outcome measures found no significant differences among groups with respect to the development of a superficial surgical site infection (0% versus 6.4% versus 5.5%; $P = .669$), deep incisional infection (9.1% versus 3.5% versus 10.9%; $P = .076$), or wound disruption (0% versus 5.4% versus 5.5%; $P = .730$). In addition, no significant differences were observed among groups with respect to unplanned reoperations (9.1% versus 16.8% versus 12.7%; $P = .630$) or unplanned hospital readmissions (45.5% versus 23.3% versus 20.0%; $P = .190$).

Conclusions: The results of this investigation demonstrate no differences in short-term adverse outcomes after partial forefoot amputation with primary closure based on patient height. Although height has previously been described as a potential risk factor in the development of lower-extremity pathogenesis, this finding was not observed in this study from a large US database. (J Am Podiatr Med Assoc 114(2), 2024; doi:10.7547/21-257)

Although partial foot amputation might result from a variety of potential etiologies, including trauma and peripheral artery disease, the combination of infection with diabetes mellitus is likely the most common contemporary indication. This is a procedure and underlying pathology with substantial economic implications. The cost of treatment of diabetic foot ulcerations and amputations is estimated to be billions of dollars annually and rising.[1-5] Concomitant acute infection has been further demonstrated to be one of the factors driving increased costs,[4] and median hospital stays have been found to be approximately 60% longer for patients with severe compared with moderate foot infections.[6] Patients with both diabetes and foot ulcerations have additionally been noted to have more frequent visits to emergency departments, more frequent hospitalizations, and longer length of hospital stays.[2,7-9]

Partial foot amputations, such as transmetatarsal amputation, are often used to address localized lower-extremity pathologies, including bone and soft-tissue infection, forefoot gangrene, or chronic and nonhealing ulcerations.[10] Although widely considered to be a durable limb preservation option, transmetatarsal amputation might not be as resilient as expected when considering published rates of reoperation (26.9%–40.0%) and progression to major amputation (12.6%–33.2%).[10-19] In the setting of failed partial foot amputation, hospital readmission is often required to address these and other complications.[20] This most frequently directly involves the amputation stump but might also include other

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medical complications, including acute kidney injury, cardiac complications, or gastrointestinal complications.[21] Several investigations have demonstrated unplanned hospital readmission rates as high as 34% after this procedure.[1,21-27]

One patient demographic variable that might affect outcome after partial forefoot amputation is height. Taller patients, with physically longer arteries and nerves, have previously been found to be at increased risk for peripheral neuropathy, peripheral artery disease, venous thromboembolism, and fracture.[28-35] Therefore, the objective of this investigation was to evaluate adverse short-term outcomes after forefoot amputation with a comparison performed based on patient height.

Materials and Methods

The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database was analyzed for the purposes of this investigation. This is a deidentified database not requiring institutional review board approval for use. It includes two *Current Procedural Terminology* codes for partial foot amputation: 28805 (amputation, foot; transmetatarsal) and 28800 (amputation, foot; midtarsal). We chose to include patients with a 28805 *Current Procedural Terminology* code who additionally underwent the procedure with "all layers of incision (deep and superficial) fully closed." This resulted in 11 patients with a height of 60 inches or less, 202 with a height greater than 60 inches and less than 72 inches, and 55 with a height of 72 inches or greater.

Extracted information included the following variables: age, sex, new race, ethnicity Hispanic, height, weight, functional health status before surgery, American Society of Anesthesiologists classification, estimated probability of mortality, estimated probability of morbidity, wound classification, total operation time, length of total hospital stay, diabetes mellitus with oral agents or insulin, current smoker within 1 year, dyspnea, congestive heart failure within 30 days of surgery, hypertension requiring medication, currently receiving dialysis (preoperative), open wound/wound infection, occurrences of superficial incisional surgical site infection, occurrences of deep incisional surgical site infection, occurrences of wound disruption, occurrences of sepsis, unplanned reoperation, and unplanned readmission as defined by the American College of Surgeons National Surgical Quality Improvement Program User Guide.[35] The primary outcome measures were considered as a frequency count of superficial surgical site infection, deep incisional infection, wound disruption, sepsis, unplanned readmission, and unplanned reoperation within 30 days of the index procedure.

Data were stored in a password-protected personal computer for subsequent statistical analysis. All of the statistical analyses were performed by one of us (A.J.M.) using SAS software, Version 9.2 (SAS Institute Inc, Cary, North Carolina). Categorical data are reported as frequency count (percentage) and are compared by means of the Kruskal-Wallis test. Continuous data are reported as mean ± SD (range) and are compared by means of the analysis of variance test.

Results

A comparison of demographic information among groups (height ≤60 inches versus height >60 inches and <72 inches versus height ≥72 inches) is provided in Table 1. Significant differences were observed with respect to patient age (69.36 years versus 62.50 years versus 55.62 years; $P < .001$), frequency of male sex (90.9% versus 70.3% versus 98.2%; $P < .001$), frequency of Hispanic ethnicity (36.4% versus 10.9% versus 0%; $P = .020$), patient height (58.55 inches versus 67.31 inches versus 73.40 inches; $P < .001$), patient weight (149.30 lb versus 192.04 lb versus 233.76 lb; $P < .001$), frequency of hypertension (90.9% versus 82.2% versus 67.3%; $P = .034$), estimated probability of morbidity (0.161 versus 0.132 versus 0.115; $P = .033$), and estimated probability of mortality (0.052 versus 0.027 versus 0.014; $P = .003$).

Results of the primary outcome measures are displayed in Table 2. No differences were observed between groups with respect to the development of a superficial surgical site infection (0% versus 6.4% versus 5.5%; $P = .669$), deep incisional infection (9.1% versus 3.5% versus 10.9%; $P = .076$), wound disruption (0% versus 5.4% versus 5.5%; $P = .730$), sepsis (0% versus 6.9% versus 5.5%; $P = .628$), unplanned reoperations (9.1% versus 16.8% versus 12.7%; $P = .630$), or unplanned hospital readmissions (45.5% versus 23.3% versus 20.0%; $P = .190$).

Discussion

As with any scientific investigation, critical readers are encouraged to review the study design and specific results to reach their own independent conclusions; the following represents our conclusions based on the preceding results. We also never consider data to be definitive but do think that these

Table 1. Demographic Comparison of Height Cohorts

Variable	Height ≤60 inches (n = 11)	Height >60 to <72 inches (n = 202)	Height ≥72 inches (n = 55)	*P* Value
Age (mean ± SD [range] [years])	69.36 ± 13.46 (43–88)	62.50 ± 11.64 (35–89)	55.62 ± 11.29 (33–77)	<.001[a]
Male sex (No. [%])	10 (90.9)	142 (70.3)	54 (98.2)	<.001[a]
Race (No. [%])				.743
White	6 (54.5)	124 (61.4)	35 (63.6)	
Black or African American	2 (18.2)	46 (22.8)	12 (21.8)	
Unknown or not reported	2 (18.2)	26 (12.9)	6 (10.9)	
Asian	1 (9.1)	4 (2.0)	0	
American Indian or Alaska Native	0	0	2 (3.6)	
Native Hawaiian or Pacific Islander	0	2 (1.0)	0	
Ethnicity (No. [%])				
Hispanic	4 (36.4)	22 (10.9)	0	.020[a]
Non-Hispanic	6 (54.5)	149 (73.8)	45 (81.8)	
Unknown	1 (9.1)	31 (15.3)	10 (18.2)	
Height (mean ± SD [range] [inches])	58.55 ± 1.97 (55–60)	67.31 ± 2.94 (61–71)	73.40 ± 1.37 (71–76)	<.001[a]
Weight (mean ± SD [range] [lb])	149.30 ± 31.46 (95–177)	192.04 ± 45.64 (84–400)	233.76 ± 50.67 (141–357)	<.001[a]
Preoperative functional health status (No. [%])				
Independent	8 (72.7)	173 (85.6)	49 (89.1)	.260
Partially/totally dependent	3 (27.3)	25 (12.4)	5 (9.1)	
Unknown functional status or not reported	0	4 (2.0)	1 (1.8)	
Diabetes mellitus (No. [%])	11 (100.0)	202 (100.0)	55 (100.0)	>.99
Current smoker (No. [%])	1 (9.1)	47 (23.3)	17 (30.9)	.247
Hypertension (No. [%])	10 (90.9)	166 (82.2)	37 (67.3)	.034[a]
Congestive heart failure (No. [%])	1 (9.1)	10 (5.0)	1 (1.8)	.459
Dialysis (No. [%])	4 (36.4)	40 (19.8)	5 (9.1)	.055
Open wound/wound infection (No. [%])	8 (72.7)	139 (68.8)	38 (69.1)	.963
Wound classification (No. [%])				
Class 1	1 (9.1)	0	8 (14.8)	.280
Class 2	1 (9.1)	17 (8.4)	6 (10.9)	
Class 3	2 (18.2)	45 (22.3)	12 (21.8)	
Class 4	7 (63.6)	93 (46.0)	29 (52.7)	
American Society of Anesthesiologists classification				
Class I	0	0	1 (1.8)	.131
Class II	0	6 (3.0)	2 (3.6)	
Class III	7 (63.6)	140 (69.3)	43 (78.2)	
Class IV	4 (36.4)	54 (26.7)	9 (16.4)	
Class V	0	0	0	
Unknown	0	2 (1.0)	0	
Estimated probability of morbidity (mean ± SD [range])	0.161 ± 0.087 (0.06–0.35)	0.132 ± 0.060 (0.03–0.36)	0.115 ± 0.047 (0.05–0.25)	.033[a]
Estimated probability of mortality (mean ± SD [range])	0.052 ± 0.064 (0.0–0.21)	0.027 ± 0.038 (0.00–0.26)	0.014 ± 0.018 (0.0–0.10)	.003[a]
Total operation time (mean ± SD [range] [min])	51.18 ± 26.39 (25–111)	58.83 ± 58.57 (15–743)	57.58 ± 35.13 (9–198)	.895
Total length of hospital stay (mean ± SD [range] [d])	10.45 ± 8.55 (1–25)	7.84 ± 11.0 (0–43)	6.15 ± 6.18 (0–29)	.347

Note: Categorical data are compared by means of the Kruskal-Wallis test. Continuous data are compared by means of the analysis of variance test.

[a]Level of significance is defined as $P < .05$.

Table 2. Comparison of Short-Term Adverse Outcomes Among Height Cohorts

Outcome	Patients (No. [%])			*P* Value
	Height ≤60 inches (n = 11)	Height >60 inches or <72 inches (n = 202)	Height ≥72 inches (n = 55)	
Superficial surgical site infection	0	13 (6.4)	3 (5.5)	.669
Deep incisional infection	1 (9.1)	7 (3.5)	6 (10.9)	.076
Wound disruption	0	11 (5.4)	3 (5.5)	.730
Sepsis	0	14 (6.9)	3 (5.5)	.628
Unplanned reoperation	1 (9.1)	34 (16.8)	7 (12.7)	.630
Unplanned hospital readmission	5 (45.5)	47 (23.3)	11 (20.0)	.190

Note: Categorical data are compared by means of the Kruskal-Wallis test. Level of significance is defined as $P < .05$.

results might be worthy of attention and future investigation.

Using information collected and analyzed from a large US database, we observed no differences in adverse short-term outcomes after primarily closed partial forefoot amputations with a comparison performed based on patient height. Although height has previously been described as a potential risk factor in the development of lower-extremity neuropathy and arterial disease,[28-33] no adverse short-term postsurgical outcome differences were observed with respect to superficial infection, deep infection, wound disruption, sepsis, and unplanned reoperations/readmissions.

All scientific investigations have limitations, and this one has several important limitations to consider. First, because data were collected from an existing database, we are restricted to only the available information and the original extraction from the medical records. In other words, we cannot personally speak to the accuracy of the data and were unable to collect any data points not found in the database. Second, the database contains only information on short-term (30-day) adverse outcomes and, therefore, we cannot speak to anything occurring with these patients after 30 days. And finally, all retrospective comparison investigations are at risk for an inherent and confounding selection bias, and this investigation is no different.

In conclusion, the results of this investigation demonstrate that despite some differences in patient demographic characteristics, no significant differences in short-term adverse outcomes after the performance of partial forefoot amputation based on patient height are expected.

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