Ambulation and functional outcome after major lower extremity amputation

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ABSTRACT

Objective: Major lower extremity amputations (MLEAs) remain a significant source of disability. It is unknown whether postamputation functional outcomes and outcome predictability have changed with a population of increasingly aging and obese patients. Accordingly, we sought to evaluate contemporary trends.

Methods: A retrospective chart review was performed to identify patients undergoing MLEA using *Current Procedural Terminology* codes in a university hospital. Demographics, comorbidities, perioperative variables, and outcomes were obtained. Descriptive statistics, *t*-tests, and χ^2 and multivariate logistic regression modeling were used where appropriate. Survival analyses were performed with the Kaplan-Meier method.

Results: From October 2005 to November 2016, 206 patients (147 male; mean age, 63 ± 13.5 years) underwent 256 MLEAs (90.9% below-knee amputations, 1.3% through-knee amputations, and 7.8% above-knee amputations [AKAs]) related to acute and critical limb ischemia, infection, or other causes. Mean follow-up was 178.7 ± 266.9 days. Conversion from below-knee amputation to AKA was 3.5%. Estimated 1-year survival was 83%, and it was 15% lower in nonambulatory patients (75% vs 90%; $P = .04$). Overall 1-year postamputation ambulatory rate was 46.1%. Nonambulatory patients had a higher body mass index (30.9 ± 8.0 vs 25.6 ± 5.4; $P < .001$), lower preoperative hematocrit (31.0% ± 7.4% vs 33.3% ± 8.1%; $P < .05$), higher modified frailty index (mFI; 8.4 ± 1.0 vs 5.4 ± 1.2; $P < .0001$), higher chronic alcohol use (9% vs 1%; $P = .01$), dependent preoperative functional status (29% vs 2.1%; $P < .01$), and lack of family support (66.3% vs 17.9%; $P < .01$); they were less likely to be married (83.2% vs 35.8%; $P < .01$) and more likely to have an AKA (20% vs 52.6%; $P = .004$). There were no patients with dementia, on dialysis, or with bilateral MLEAs who were ambulatory after amputation. Factors predictive of nonambulatory status after MLEA with multivariate logistic regression analysis included increased body mass index (odds ratio [OR], 0.88; 95% confidence interval [CI], 0.81-0.98; $P = .017$) and an increased mFI (OR, 0.23; 95% CI, 0.16-0.34; $P < .0001$); a higher hemoglobin level was protective (OR, 1.3; 95% CI, 1.03-1.62; $P = .019$).

Conclusions: Patients should be counseled that <50% of patients receiving MLEAs are ambulatory after amputation. Educating patients about the deleterious effects of obesity on ambulatory status after MLEA may motivate patients to improve their level of fitness to achieve successful ambulation. Patients with an elevated mFI, patients with dementia, and those on dialysis should be considered for AKAs. (J Vasc Surg 2018;67:1521-9.)

In the United States, nearly 1.5 million people are living with lower extremity limb loss,[1] with 82% related to compromised vasculature, particularly from diabetes.[2] The rate of amputations related to compromised vasculature remains high despite increased attention to prevention by optimizing vascular medicine.[2] In addition, demographics and characteristics of the current population of patients are changing. There has been a rise in the incidence of obesity in the United States from 22.3% in 1988 to 36.5% in 2014, and there is an anticipated rise in the percentage of patients older than 65 years from 14.9% in 2015 to 20.6% by 2030.[3]

Preservation of ambulatory status by means of limb salvage or healed amputation with prosthesis use is critical for the maintenance of independence.[4,5] When possible, limb salvage is preferred, with a goal to minimize the extent of amputation and to preserve limb length for functional use, which may require revascularization. However, revascularization may not be practical or effective for all, and some may benefit most from a well-healed amputation with early ambulation with a prosthesis. This affords early return to function and limits the risk of failed revascularization with a potentially higher amputation level or significant time spent on serial débridement and wound care.[6] Because a higher level of major lower extremity amputation (MLEA) results in increased energy expenditure, greater difficulty with

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transfers, and subsequent lower ambulatory rates, it is essential to optimize opportunities for a successful MLEA with preservation of function.[7]

Prior studies have effectively evaluated functional outcomes and predictors of ambulation after MLEA,[8,9] but this has not been revisited with an increasingly aging and more obese population. We hypothesized that the rate of prosthesis use, ambulation, and functional outcomes may have changed. Accordingly, both patients and physicians must be accurately informed on expected contemporary functional outcomes and prosthetic use after MLEA. This may allow the identification of predictors of ambulation after MLEA and development of targeted strategies to maximize the opportunity to preserve ambulatory status. In this context, we sought to evaluate predictors of ambulation and functional status after MLEA in a present-day population.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective cohort study
- **Take Home Message:** One year after 256 major lower extremity amputations (MLEAs), 46.1% of the patients ambulated; obesity and high modified frailty index predicted nonambulatory status; and no patients with dementia, with bilateral MLEAs, or on dialysis were ambulatory.
- **Recommendation:** The authors suggest educating patients about the deleterious effects of obesity on ambulatory status after MLEA and that for dialysis patients and for those with elevated modified frailty index and dementia, an above-knee amputation should be considered.

METHODS

This study was approved by the Institutional Review Board of Oregon Health & Science University (OHSU). Because of the retrospective nature of the study and impossibility of contacting all of the subjects, consent of individual patients was waived. We performed a single-center retrospective review of consecutive MLEAs performed at OHSU between October 2005 and November 2016.

Inclusion and exclusion criteria and demographics.

We included all below-knee amputations (BKAs), through-knee amputations (TKAs), and above-knee amputations (AKAs) performed at OHSU. Amputation revisions were not regarded as separate MLEAs and therefore were not included separately for statistical analysis. Patients were identified through an electronic medical record (EMR) search using *Current Procedural Terminology* codes 27594, 27596, 27598, and 27880 to 27888 by a separate administrative data abstractor, irrespective of the service performing the procedure. Loss to follow-up was documented if the patient missed three consecutive appointments to the vascular surgery clinic after discharge from initial hospitalization, if the patient was referred back to a community provider and no further follow-up was obtained, or documentation of postoperative outcomes was not available. When patients returned to their communities and our institutional follow-up was not available, the EMR health information exchange program, Care Everywhere, was used; this program provides records from a robust network of community facilities. Vital status was derived from medical records and review of the Social Security Death Index.

Data obtained from EMR review included demographics (age, gender, race, tobacco use, chronic alcoholism [defined as >6 units of alcohol per day], active illicit drug use, medical comorbidities, presence of dementia, social support, marital status, body mass index [BMI]), preoperative variables (ankle-brachial index, indication for amputation, prior revascularizations, time from revascularization to amputation, white blood cell count on admission and before formal amputation revision, hemoglobin, hematocrit, hemoglobin A_{1c}, risk score [Wound, Ischemia, and foot Infection score], functional status, contralateral limb status), operative details (level of amputation, service performing the amputation), and postoperative variables (length of stay, length of follow-up, orthotic consultation, prosthetic fitting, prosthetic use, ambulatory status, wound infection, need for subsequent débridement, number of amputations or revisions required, myocardial infarction, and mortality). Preoperative functional status was defined by the American College of Surgeons National Surgical Quality Improvement Program as "independent" if the patient did not require assistance from another person for any activities of daily living, "partially dependent" if the patient required some assistance from another person for activities of daily living (including patients who use prosthetics, equipment, or devices but still require some assistance from another person), or "totally dependent" if the patient required total assistance for all activities of daily living.[10] Functional ambulatory status was defined as "the ability to walk, with or without the aid of appropriate assistive devices (such as prostheses, orthoses, canes or walkers), safely and sufficiently to carry out mobility-related activities of daily living"[11] and was assessed by physical therapists and physical medicine and rehabilitation physicians. In addition, we included evaluation of the modified frailty index (mFI)[12] in our patients. This is an index created from the American College of Surgeons National Surgical Quality Improvement Program that uses 11 data points based on cardiac risk factors, pulmonary disease, and functional status. It has been validated in multiple disciplines and has been demonstrated to be a better discriminator of mortality than other risk indices.[13-15]