Grip strength measurement for frailty assessment in patients with vascular disease and associations with comorbidity, cardiac risk, and sarcopenia

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ABSTRACT

Objective: Frailty is associated with adverse events, length of stay, and nonhome discharge after vascular surgery. Frailty measures based on walking-based tests may be impractical or invalid for patients with walking impairment from symptoms or sequelae of vascular disease. We hypothesized that grip strength is associated with frailty, comorbidity, and cardiac risk among patients with vascular disease.

Methods: Dominant hand grip strength was measured during ambulatory clinic visits among patients with vascular disease (abdominal aortic aneurysm [AAA], carotid stenosis, and peripheral artery disease [PAD]). Frailty prevalence was defined on the basis of the 20th percentile of community-dwelling population estimates adjusted for age, gender, and body mass index. Associations between grip strength, Charlson Comorbidity Index (CCI), Revised Cardiac Risk Index (RCRI), and sarcopenia (based on total psoas area for patients with cross-sectional abdominal imaging) were evaluated using linear and logistic regression.

Results: Grip strength was measured in 311 participants; all had sufficient data for CCI calculation, 217 (69.8%) had sufficient data for RCRI, and 88 (28.3%) had cross-sectional imaging permitting psoas measurement. Eighty-six participants (27.7%) were categorized as frail on the basis of grip strength. Frailty was associated with CCI (odds ratio, 1.86; 95% confidence interval, 1.34-2.57; $P = .0002$) in the multivariable model. Frail participants also had a higher average number of RCRI components vs nonfrail patients (mean ± standard deviation, 1.8 ± 0.8 for frail vs 1.5 ± 0.7 for nonfrail; $P = .018$); frailty was also associated with RCRI in the adjusted multivariable model (odds ratio, 1.75; 95% confidence interval, 1.16-2.64; $P = .008$). Total psoas area was lower among patients categorized as frail vs nonfrail on the basis of grip strength (21.0 ± 6.6 vs 25.4 ± 7.4; $P = .010$). Each 10 cm^2 increase in psoas area was associated with a 5.7 kg increase in grip strength in a multivariable model adjusting for age and gender ($P < .0001$). Adjusted least squares mean psoas diameter estimates were 25.5 ± 1.1 cm^2 for participants with AAA, 26.7 ± 2.0 cm^2 for participants with carotid stenosis, and 22.7 ± 0.8 cm^2 for participants with PAD ($P = .053$ for PAD vs AAA; $P = .057$ for PAD vs carotid stenosis; and $P = .564$ for AAA vs carotid stenosis).

Conclusions: Grip strength is useful for identifying frailty among patients with vascular disease. Frail status based on grip strength is associated with comorbidity, cardiac risk, and sarcopenia in this population. These findings suggest that grip strength may have utility as a simple and inexpensive risk screening tool that is easily implemented in ambulatory clinics, avoids the need for imaging, and overcomes possible limitations of walking-based measures. Lower mean psoas diameters among patients with PAD vs other diagnoses may warrant consideration of specific approaches to morphomic analysis. (J Vasc Surg 2017;■:1-9.)

Frailty is associated with increased risk of postoperative complications, increased length of hospitalization, and nursing facility discharge after vascular surgery.[1-4] Approximately 10% to 20% of individuals older than 65 years are considered frail,[5,6] with an even higher percentage of individuals, up to 37%, considered prefrail.[7] A 101% increase in vascular surgery patients aged 65 to 84 years is projected by 2040,[8] underscoring the importance of identifying frailty and incorporating this variable into preoperative risk assessment and procedure planning. Despite the relevance of frailty to patients with vascular disease, there is no widely accepted "gold standard" measure, and assessment in this population is often problematic. Because many validated frailty measures use walking-based tests (such as gait speed,[9] timed up-and-go,[10] and metabolic equivalents[11]), they may be impractical or invalid for patients with walking impairment from symptoms or sequelae of vascular disease (such as symptomatic peripheral artery disease [PAD] or previous amputation).

Grip strength has also been used for frailty assessment among the elderly,[12-14] although use within

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disease-specific populations (such as clinical cardiovascular disease) has not been rigorously validated. Grip strength can be obtained easily and inexpensively in clinical environments, making this measure potentially useful as an alternative to walking-based frailty assessment for patients being evaluated for vascular surgery (and other populations in which disease-specific factors may impair walking ability). Population-specific validity of grip strength as a stand-alone surrogate measure of frailty among patients with vascular disease, however, has not been extensively described. We hypothesized that grip strength is associated with measures of frailty, comorbidity, and cardiac risk among patients with vascular disease. To test these hypotheses, we measured grip strength among patients presenting to outpatient vascular surgery and vascular medicine clinics and explored associations with other measures of frailty, comorbidity, and cardiovascular risk.

ARTICLE HIGHLIGHTS

- **Type of Research:** Prospective cross-sectional cohort study
- **Take Home Message:** Dominant hand grip strength identified frailty in 27.7% of 311 patients with vascular disease. There was significant association between frailty, comorbidity, and cardiovascular risk.
- **Recommendation:** The results of this study suggest that frailty is highly prevalent among patients with vascular disease and that grip strength measurement is potentially useful as a screening tool in this population.

METHODS

Study design and participants. Adult patients were recruited from an outpatient vascular clinic (staffed by physicians and nurse practitioners specializing in vascular surgery and vascular medicine) during routine visits at an academic medical center during a 9-month period (August-April 2016). Inclusion criteria were ability to provide informed consent and clinical diagnosis of PAD, abdominal aortic aneurysm (AAA), or carotid artery stenosis. Exclusion criteria included known factors with potential to affect dominant hand strength or function (including history of upper extremity paralysis, stroke, arthritis, or recent ipsilateral upper extremity trauma or surgery). Participant recruitment was based on the research assistant's availability and therefore did not include all consecutive patients who had clinic visits during the study period. This study was approved by the Wake Forest University School of Medicine Institutional Review Board, and informed consent was obtained from participants. This prospective, cross-sectional study was conducted with future plans for follow-up longitudinal analyses of the same cohort evaluating adverse perioperative events, adverse cardiovascular events, and long-term mortality as outcomes.

Grip strength measurement. Participants underwent dominant hand grip strength measurement using a calibrated hydraulic hand dynamometer (Jamar Hand Dynamometer [Performance Health, Warrenville, Ill]; Fig 1) after agreeing to participate. Grip strength measurements were obtained by a trained research assistant during vital sign measurement; measurements were obtained only during this part of the clinic intake process to avoid prolonged wait times or other negative impacts on visits. Grip strength in kilograms was measured using a standardized protocol; participants were seated with the ipsilateral shoulder adducted and neutrally rotated, the elbow flexed to 90 degrees, and the forearm and wrist neutrally positioned. After zeroing the peak-hold needle, a single maximum grip strength measurement was obtained and recorded to the nearest kilogram.

Fig 1. Photograph of calibrated hydraulic hand dynamometer used for grip strength measurement. (Image is reproduced with permission of Performance Health.)

Clinical and demographic data. Additional variables collected from the electronic medical record included age, race, gender, and comorbid conditions (history of myocardial infarction, ischemic heart disease, congestive heart failure, cerebrovascular disease including stroke or transient ischemic attack, chronic obstructive pulmonary