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Clinical relevance of the modified physical performance test versus the short physical performance battery for detecting mobility impairments in older men with peripheral arterial disease

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Abstract

Purpose—The study is to compare the Modified Physical Performance Test (MPPT) and Short Physical Performance Battery (SPPB) as metrics of mobility and function in older men with peripheral arterial disease (PAD).

Materials and methods—A total of 51 men (55–87 years) with PAD underwent functional testing including the SPPB, MPPT, Walking Impairment Questionnaire (WIQ), stair ascent, and 6-min walk distance. Individuals were grouped according to SPPB and MPPT scores as not limited on either, limited only on the MPPT, or limited on both.

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Disclosure statement

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Results—The MPPT identified a higher proportion of patients as being functionally limited than the SPPB (p <0.001). Men identified as limited only by the MPPT, and not the SPPB, were subsequently confirmed to have lower function on all measures compared to those not identified as limited by either the SPPB or the MPPT (p <0.02).

Conclusions—These findings suggest the MPPT is an appropriate measure to identify early declines in men with PAD and may identify global disability better than SPPB.

Keywords

Mobility function; peripheral arterial disease; short physical performance battery; walking impairment; modified physical performance test

Peripheral arterial disease (PAD) affects an estimated 8.5 million adults in the United States and up to 20% of older adults [1–3]. The majority of individuals with PAD complain of leg symptoms including the hallmark complaints of exertional leg pain, fatigue, and cramping [1,4]. In an effort to alleviate exertional leg symptoms, patients with PAD frequently decrease their activity levels resulting in a vicious cycle of inactivity and accelerated functional decline [5,6]. Individuals with PAD demonstrate slow gait speeds and 6-min walk distances (6MWDs) that are 50% less then healthy older individuals [7,8], contributing to an increased risk for a loss of independence and global disability [9]. Even individuals with asymptomatic PAD experience balance and mobility declines compared to those without PAD [4,6].

Assessments of mobility and lower extremity function are recommended for those with PAD [10], but more global assessments of function that include more than just lower extremity function are often overlooked in this population. Early detection of declines in mobility and global function would allow for interventions before large deteriorations resulting in a loss of independence occur. The Short Physical Performance Battery (SPPB) is one common measure used to assess the lower extremities and mobility in older adults with chronic diseases, like PAD, and is a predictor of disability and risk for institutionalization in the elderly [11,12]. However, due to the relative ease of tasks assessed, many impaired individuals may approach or achieve the maximum score [13,14]. This “ceiling effect” may be particularly problematic for the clinical diagnosis of early functional declines in older adults providing a false sense of good health or well-being [13]. Furthermore, the SPPB does not include any assessment of upper extremity function and may underestimate functional limitations present in older adults. The Modified Physical Performance Test (MPPT) is another metric of mobility function routinely used in older adult populations, but differs in that it includes whole body skills, such as stair climbing, integrated tasks of gross, and fine motor such as stooping to pick up a penny, and upper extremity activities like donning and doffing a jacket [15–18]. The use of these more complex and whole body tasks may allow for a better determination of early functional declines in this population. The aim of this study was to compare the MPPT and SPPB as metrics of mobility and function in older men with PAD.

Methods

Study design

Potential patients were recruited from the Baltimore Veterans Affairs Medical Center vascular clinic. All community-dwelling veterans with an existing diagnosis of PAD who were independently ambulatory without open wounds, gangrene, or a history of lower extremity amputation, and were seen in the clinic between August 2014 and August 2015 were approached for participation in this study. All procedures were approved by the Institutional Review Board at the University of Maryland, Baltimore. Prior to any testing, all individuals provided written informed consent. For each participant, all questionnaires and functional tests were completed in the same order on the same day. Confirmation of PAD diagnosis, ankle-brachial index, years since diagnosis of PAD, previous surgical treatment of PAD, medication use, and comorbid conditions were determined by reviewing medical records.

Objective measures of function

Prior to testing, all individuals were instructed to wear comfortable clothes and shoes and were notified they would be performing walking and balance tests. Objective measures of mobility function included the SPPB, MPPT, time to ascend and descend nine-stairs, 6MWD, and gait speed. The SPPB is a standardized measure of lower extremity and mobility function in older adults and those with comorbid conditions that examines three tasks: standing balance, repeated chair stands, and regular gait speed [12]. Each item is scored 0–4 with the composite score totaled out of 12. A score of <10 indicates poor mobility function. The MPPT is a nine-item test that includes the same standing balance tasks and repeated chair stands of the SPPB as well as several additional tasks including fast-gait speed over a 50-foot walk, timed ascent of one flight of stairs, ability to ascend and descend four flights of stairs, donning and doffing a coat, picking up a penny, placing a book on a shelf, and safely turning 360° [19]. The scores range from 0 to 4 for each item. Scores of <32 indicate at least a mild degree of mobility limitation [19]. Chair stands and standing balance tests were performed once with the time for each test recorded and later scored for both the SPPB and the MPPT. Self-selected gait speed for the SPPB was measured first followed by fast gait speed for the MPPT. Time for stair ascent and stair descent was calculated as the average of three attempts on a standard set of nine-stairs. The same set of stairs was used for all participants. Patients also completed a standardized 6-min walk over ground. For all tests, patients were allowed to use any walking aid they used on a daily basis and adequate rest was provided between all tests. All tests were performed in the same location with the equipment standardized between all participants.

Self-reported quality of life and mobility function

Health-related quality of life was determined using the Medical Outcomes Study Short-Form (SF-36) General Health Survey [20]. Both the Physical Health and Mental Health Summary Scores were calculated for all individuals. Self-reported mobility function was assessed via the Walking Impairment Questionnaire (WIQ) [21] in which patients reported their difficulty walking various distances, speeds, and ascending multiple flights of stairs.

Data analysis

Data were analyzed with IBM SPSS Statistics 22.0 (IBM, Armonk, NY). Descriptive statistics were calculated for demographic variables and dependent measures. For our primary aim to evaluate the use of the MPPT as a functional measure, McNemar's test for correlated proportions was used to compare the number of individuals classified as mobility-limited by the MPPT (score <32) [19] and the SPPB (score <10) [12]. In order to further evaluate the potential mobility differences among individuals who were classified as mobility-limited on the MPPT but not the SPPB all patients were classified into one of three groups: 1) not limited on the MPPT (score ≥32) or the SPPB (score ≥10), 2) mobility-limited on the MPPT (score <32) but not the SPPB (score ≥10), and 3) mobility-limited on both the MPPT (score <32) and the SPPB (score <10). Data were initially assessed to ensure normal distribution. All variables except stair ascent and descent were found to be normally distributed. One-way ANOVA with linear trend analyses compared the functional status on both objective and self-reported measurements among the groups for all variables except stair ascent and descent. When the ANOVA was significant, post-hoc tests were used to determine pair-wise difference between the means of the three groups. Stair ascent and descent were not normally distributed and the Kruskall-Wallis test was used to determine difference among the groups. When the Kruskall-Wallis tests were significant a Mann-Whitney U test was used as a post-hoc analysis to determine pair-wise differences among the groups. Pearson correlation coefficients were calculated to determine relationships between the MPPT and all other functional tests. The level of significance for all tests was set at $p \leq 0.05$.

Results

Participant characteristics

A total of 54 men enrolled in the study and 51 completed all testing. Three individuals were initially consented and completed all questionnaires, but due to time constraints were unable to complete the functional testing and were removed from the analysis. The majority of individuals were overweight or obese, and were current or former smokers with multiple comorbid conditions including a history of hypertension, dyslipidemia, and coronary artery disease (Table 1). No significant differences were found between the groups for body mass index, smoking status, years since diagnosis, ankle brachial index, or comorbid conditions.

Identification of early functional declines and mobility disability by MPPT and SPPB

Although all patients classified as mobility-limited by the SPPB were also mobility-limited by the MPPT, the reverse was not true as more individuals were classified as mobility-limited based on the MPPT scores compared with the SPPB score ($p < 0.001$). According to the MPPT, 78% (40/51) were classified as mobility-limited, while on the SPPB only 49% (25/51) of individuals demonstrated mobility limitations. Approximately half of all patients were considered limited on both the MPPT and SPPB (25/51) and only eleven were classified as not limited on either the MPPT or the SPPB. Nine of 51 individuals scored the maximum of 12 on the SPPB (~18%) whereas only 2 of 51 (~4%) scored the maximum of 36 on the MPPT. The patients who were classified as not mobility-limited on either MPPT or SPPB were significantly younger (mean difference: 7.5 years, 95% CI: −13.5 to −1.55; p

=0.02) than the individuals limited in the MPPT but not the SPPB (Table 1). There was no difference in age between those limited on the MPPT and individuals limited on both the MPPT and SPPB (mean difference 3.8 years, 95% CI: −8.8 to −1.08; p =0.123).

Across the three groups, there was a significant linear trend for differences in all objective and self-reported functional measures (Table 2). Compared with the not limited in the MPPT or SPPB group, these trends revealed lower mobility, physical and mental health function in the MPPT limited, and the MPPT and SPPB limited groups in a stepwise manner. Notably, when patients identified as mobility-limited only by the MPPT were directly compared with patients not identified as mobility-limited WIQ scores were 21%–27% lower, stair ascent time was 45% higher, and there were tendencies for 17% lower 6MWD and 18% slower gait speed. Finally, when comparing those who were limited on the MPPT versus those who were limited on both the MPPT and SPPB, additional functional deficits were found for the MPPT, SPPB, WIQ, SF-36 physical function composite score, stair descent time, and gait speed.

Regarding differences between the MPPT and SPPB, the components that contributed to low MPPT scores of the MPPT limited group revealed that 100% of patients displayed slow times ascending a flight of stairs, 80% exhibited deficits in donning and doffing a jacket, 60% showed difficulty in picking up a penny from the ground, and 40% in placing a book on a shelf. The majority of individuals also demonstrated the ability to ascend and descend 4 flights of stairs and complete a 360° turn with only 20% of individuals demonstrating difficulty with these tasks.

Correlations of the MPPT and SPPB with all other functional measures

We also evaluated the strength of relationships between MPPT and measures of function. For the WIQ and SF-36, correlations ranged for the MPPT from r =0.42–0.55, p <0.01 and for the SPPB r =0.43–0.60, p <0.01. The most noteworthy difference between correlations for the MPPT and SPPB was for 6MWD where the MPPT correlated moderately (r =0.53, p <0.001), while the SPPB was only weakly correlated (r =0.38, p =0.007).

Discussion

This study compares the use of the MPPT and SPPB as functional and mobility measures in older men with PAD. Using the MPPT nearly 80% of the individuals with PAD in this study (40 out of 51) are at or below the threshold for functional limitations. This is in agreement with our other functional tests and poor mobility is apparent in this group of men with PAD as the majority of patients in this study demonstrate 6MWDs less than 400 m, nearly 30% below what is expected [22], and gait speeds far below the norm of 1.2 m/s [23]. These findings indicate persons with PAD are at an increased risk for disability, institutionalization, morbidity, and mortality related to their poor mobility function [24].

Compared to the 80% of individuals identified as having mobility and functional deficits on the MPPT, the SPPB scores identify ~25% fewer patients with limitations (25 out of 51). The MPPT includes a variety of higher skilled mobility and upper extremity challenges that are not part of the SPPB. This study shows that patients who were limited on the MPPT, but

not the SPPB generally experience difficulty in tasks that require higher level balance skills (such as picking a penny up off the ground), the coordinated use of the upper extremities (such as donning and doffing a coat) or are more demanding physically (such as the timed ascent of stairs). This indicates that patients with PAD suffer from not only lower extremity dysfunction, but also a more global burden of disability that includes balance and upper extremity dysfunction. However, due to the focus on complaints of leg pain with activity in PAD additional limitations, such as difficulties with the upper extremity or balance, may be overlooked clinically contributing to overall functional declines and global disability.

The additional components of the MPPT, compared to the SPPB, may enable the detection of additional functional declines or declines at an earlier stages compared to the SPPB. In the group limited on the MPPT but not the SPPB we found that 100% of individuals were unable to complete stair ascent in under 5 s, yet the majority of individuals in this group retain the ability to ascend and descend four flights of stairs. This most likely indicates an early decline in function with an inability to quickly complete a task. It is likely that over time and without intervention these participants would continue to slow in stair ascent until they lose the ability to ascend and descend four flights of stairs.

The notion that the MPPT may detect early functional declines is also reinforced by the finding that in the ~25% of patients who are classified as mobility-limited according to the MPPT, but not the SPPB, functional declines are evident by lower WIQ scores, 6MWDs, gait speed and stair ascent/descent time compared to the not limited group. This further suggests that the MPPT may be capable of detecting decreases in function at an earlier stage in individuals with PAD. An important finding as early intervention before functional deficits progress may prevent frailty [25]. Furthermore, 18% of patients with PAD achieved the maximum score on the SPPB, a level similar level to what others report [14], while less than 4% of individuals did so on the MPPT, reducing the potential for misdiagnosis by achieving a “ceiling effect.” Previous studies show that up to 77% of community dwelling individuals may reach a ceiling score with the SPPB, indicating that the SPPB may not be optimal for detecting initial declines in mobility function in a high proportion of patients [26]. Collectively, these support our hypothesis that the MPPT is a useful metric of mobility and global function in patients with PAD to determine early deteriorations and possibly allow for earlier interventions. The use of the MPPT in future PAD interventional studies may be beneficial as it has a greater scoring range, potentially identifying individuals at risk for deficits earlier by obviating the ceiling effects commonly found with the SPPB.

While the results of this study appear to have clinical relevance for the detection of early declines in both mobility and general function in patients with PAD, we recognize that this is a cross-sectional study; thus, only limited conclusions can be drawn about the MPPT’s ability to detect change after intervention. Further, the somewhat small sample of only men, and inability to account for unknown variables such as medication use and socioeconomic factors limit generalizability. However, we did consistently find that patients with PAD displayed low levels of function and the MPPT appears to be a clinically useful measure that may detect more global functional deficits than the SPPB in this population. Future studies are needed to determine the effect of sex since our study focused exclusively on men and whether the MPPT is also more sensitive and appropriate to detect changes in mobility

function following exercise or other rehabilitation interventions compared to the SPPB in older adults with severe PAD.

Conclusions

In conclusion, these findings suggest the wider scoring range, use of upper extremity and whole body skills, and the integration of gross and fine motor tasks in the MPPT make it an appropriate measure for the timely identification of declines in function and mobility in older males with PAD. These results further suggest that the function and mobility limitations associated with PAD extend beyond just slow walking times. The identification of global disability using the MPPT, rather than the SPPB, in this population would allow for earlier clinical detection of functional limitation in patients with PAD and the initiation of rehabilitation interventions to mitigate more severe global functional declines and disability.

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IMPLICATIONS FOR REHABILITATION

- Individuals with peripheral arterial disease have low activity levels and are at risk for a loss of independence and global disability.
- Early detection of decline in mobility and global function would allow for interventions before large changes in ambulatory ability or a loss of functional independence occur.
- This study shows the Modified Physical Performance Test may be an appropriate test to identify early decline in function in men with peripheral arterial disease.

Table 1

Demographics and clinical characteristics of patients with PAD classified by mobility status.

	Not limited (*n* =11)	Limited by MPPT not by SPPB (*n* =15)	Limited by MPPT and by SPPB (*n* =25)
Age (years)	64.3 (58.5–70.0)	71.8 (67.0–76.6)[a]	67.9 (65.4–70.5)
Body mass index (kg/m^2)	26.2 (23.1–29.3)	26.3 (24.1–28.5)	29.6 (27.4–31.9)
Race (% African American)	73%	60%	52%
Ankle-brachial index (lowest side)	0.71 (0.57–0.84)	0.64 (0.56–0.72)	0.60 (0.54–0.66)
Years since diagnosis	6.3 (2.2–10.4)	7.2 (4.1–10.5)	6.3 (2.2–10.4)
Current smokers	55%	60%	48%
Past smokers	36%	40%	52%
Prior revascularization procedure	18%	53%	32%
Number of comorbid conditions	5.3 (3.6–7.0)	5.1 (4.1–6.0)	6.5 (5.4–7.6)
Hypertension	90%	87%	88%
Diabetes	55%	40%	64%
Dyslipidemia	91%	87%	92%
Coronary artery disease	52%	40%	46%
Prior myocardial infarction	27%	0%	24%
Heart failure	9%	0%	16%
Chronic renal disease	18%	13%	24%

Data are means (95% CI) or percentages of group. Patients were identified as limited by the MPPT if the score was less than 32; patients were identified as mobility-limited by the SPPB if the score was less than 10.

[a] Significant difference between Limited by MPPT and not SPPB, and Not Limited, p =0.02.

Table 2

Difference in function between patients classified as mobility-limited by the Modified Physical Performance Test and the Short Physical Performance Battery.

	Not limited (*n* =11)	Limited by MPPT, not by SPPB (*n* =15)	Limited by MPPT and by SPPB (*n* =25)	ANOVA *F*-statistic and *p*-value
MPPT	34.2 (33.6–35.0)	30.5 (29.6–31.4)[a]	26.0 (24.1–27.8)[a,b]	F=26.2; p <0.001
SPPB	11.2 (10.7–11.8)	10.7 (10.2–11.2)	7.9 (7.4–8.4)[a,b]	F=59.3; p <0.001
WIQ distance (%)	51.4 (31.7–71.0)	30.3 (14.8–45.8)[a]	19.8 (11.9–27.6)[a]	F=6.5; p =0.003
WIQ speed (%)	57.5 (33.8–81.1)	34.9 (20.6–49.1)[a]	26.8 (20.9–32.7)[a]	F=6.5; p =0.003
WIQ stairs (%)	84.2 (72.3–96.0)	57.1 (32.0–82.1)[a]	34.2 (23.6–44.8)[a,b]	F=10.6; p <0.001
SF-36 physical function	43.3 (38.4–48.3)	38.7(34.0–43.5)	32.3 (28.9–35.6)[a,b]	F=8.0; p <0.001
SF-36 mental function	58.2 (54.5–62.0)	54.4 (49.9–59.0)	48.8 (43.4–54.4)[a]	F=3.3; p =0.04
Stair ascent (sec)	4.4 (3.7–5.11)	6.4 (5.5–7.2)[a]	6.8 (5.9–7.6)[a]	X^2=16.1 p <0.001[c]
Stair descent (sec)	3.9 (3.0–4.7)	5.5 (5.0–6.0)[a]	7.2 (5.9–8.5)[a]	X^2=17.5 p <0.001[c]
6-min walk distance (m)	382 (313–451)	316 (267–367)	279 (246–313)[a]	F=5.2; p =0.009
Gait speed (m/s)	1.1 (0.9–1.2)	0.9 (0.8–1.0)	0.8 (0.7–0.9)[a,b]	F=8.0; p =0.001

Data are means (95% CI). *p* values represent *p* values from overall one-way ANOVA identifying differences between groups. Patients were identified as limited by the Modified Physical Performance Test (MPPT) if the score was less than 32; patients were identified as mobility-limited by the Short Physical Performance Battery (SPPB) if the score was less than 10. WIQ: Walking Impairment Questionnaire; SF-36: Short-Form 36.

[a] Significant difference compared with the Not Limited group, p <0.05.

[b] Significant difference compared with the Limited MPPT group, p <0.05.

[c] Indicates that a Kruskal-Wallis test was used to examine differences among the groups..