The Validation of an Endurance Static Hold in Assessing Functional Status

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Disclosures:

INTRODUCTION: Sarcopenia is a disease of muscle failure fixed in muscle mass or function decrement that builds up over time. Sarcopenia has been associated with an increased risk of complications following a total joint arthroplasty. Commonly, maximal hand grip strength (HGS) can be used to diagnose sarcopenia and assess muscle function. While HGS is a well-accepted measure of overall physical fitness, it only tests a limited set of muscle groups and does not test muscle endurance. An endurance static hold (ESH) combines the principle of a traditional HGS assessment while looking at more generalized muscle function and testing muscle endurance at the same time. Overall, this study seeks to validate ESH in assessing muscle function by comparing it against other accepted measures of muscle function, namely, maximal HGS, timed up and go (TUGT), and body composition including skeletal muscle mass (SMM) and appendicular skeletal muscle index (SMI). The hypothesis is that ESH is a measure of muscle function.

METHODS: This prospective cohort study included two cohorts: study patients with history of knee or hip osteoarthritis and control subjects without. All subjects underwent the same study protocol, and consent was obtained from each participant before the study procedure began. Study procedures included bioimpedance analysis (BIA; InBody 770 or 970) to evaluate body composition variables like body fat mass (BMI), SMM, and SMI, TUGT, bilateral maximal HGS, ESH, and filling out patient reported outcomes (PROs). Participants underwent two ESH trials: the mass held during trial 1 was equal to half of each participant's mean HGS, and trial 2 mass was 10th percentile HGS by age and sex. The PROs included KOOS JR, HOOS JR, SF-36, PROMIS Physical Health, PROMIS Global Health, and the Baecke Questionnaire. Comparisons between and among the cohorts were done through t tests, Mann-Whitney U tests, and correlation analyses. Correlation analyses were also used to analyze all participants. Significance was set at alpha equal to 0.05 and normality was determined through Kolmogorov-Smirnov and Shapiro-Wilk tests. This study was approved by the institutional review board prior to study initiation.

RESULTS SECTION: 50 patients and 50 controls were enrolled in this study. The average age of the study group was 64 ± 12 years and the average age of the control group was 33 ± 16 years. 21 (42%) of the study group was male and 27 (54%) of the control group was male. Within the study group, 22 (44%) of patients had a BMI over 40 kg/m^2, classified as severely obese. The study group had more medical comorbidities than the control group. For instance, 25 (50%) of the study group had hypertension, compared to 1 (2%) of the control group. In general, the study group had weaker HGS, longer TUGT, larger SMI, and lower PRO results than the control group. The severely obese subset of the study group had considerable measures of SMM and SMI as well (Table 1). Additionally, ESH showed correlations with SMI and PRO scores (Table 2). SMM correlated positively and significantly against HGS and the second ESH trial in the entire patient population, the study group, and the severely obese subset of the study group (Table 3).

DISCUSSION: Given that ESH correlates with SMM and SMI positively and significantly, ESH is a measure of muscle function. It is also a measure of physical wellbeing as it correlates positively and significantly with some of the PRO scores. Additionally, given that ESH correlates with SMM positively and significantly in both the study group and the severely obese subset of the study group, ESH is a measure of muscle function in an osteoarthritic population and in osteoarthritic individuals with severe obesity. Furthermore, a sizeable amount of SMM was present in both the study group and the severely obese subset of the study group. Thus, ESH could be used as both a diagnostic tool and an exercise tool in helping patients know if they are gaining muscle mass, especially when analysis of SMM through BIA is unavailable. The limitations of this study include the control population not matching the osteoarthritic population in terms of age, the handle for the ESHs not being conducive to all hand sizes, and the ESH trials did not involve all participants lifting what could be their maximum weights. In light of these limitations, refining the ESH setup by having participants lift a heavier or standard weight or by creating deadlift handles specific to various hand sizes could help produce stronger correlations between ESH and the measures of muscle function.

SIGNIFICANCE/CLINICAL RELEVANCE: ESH is a measure of muscle function, especially in osteoarthritic patients and in osteoarthritic patients with severe obesity. It is also a measure of overall physical wellbeing.

TABLES AND FIGURES:

Table 1: Comparing Various Subject Groups Using Different Measures. While the study group had weaker measures of HGS, TUGT, and PRO results in comparison to the control group, it had comparable SMM measures and even a greater SMI. Even the severely obese subset of the study group had large measures of SMM and SMI. This indicates that these populations do have sizable measures of SMM that can be exercised.

	HGS (kg)	TUGT (s)	SMM (kg)	SMI (kg/m²)	PROMIS Physical Function Raw Score
Patients (n = 50)	28.09 ± 10.53	13.59 ± 7.602	33.31 ± 7.730	8.872 ± 1.602	77.84 ± 11.78
Controls (n = 50)	37.21 ± 10.23	8.021 ± 1.280	33.46 ± 7.681	8.164 ± 1.058	98.08 ± 2.029
Patients With a BMI Over 40 kg/m^2 (n = 22)	29.75 ± 12.03	15.18 ± 8.186	36.55 ± 8.009	9.895 ± 1.617	71.55 ± 11.55
Patients With a BMI Under 40 kg/m^2 (n = 28)	26.78 ± 9.198	12.33 ± 7.005	30.77 ± 6.583	8.068 ± 1.050	82.79 ± 9.500

Table 2: Correlation Coefficients of Various Measures of Muscle Function Versus the ESH Trials in All Participants. Given that ESH correlates significantly with SMI and the PRO scores, it is a measure of muscle function and physical well-being.

	SMI		TUGT		Baecke Questionnaire		SF-36 Energy/Fatigue	
	r	p	r	p	r	p	r	p
ESH 50% HGS	0.18	0.0709	-0.01	0.9236	0.18	0.0686	0.2068	0.0390
ESH 10th Percentile	0.24	0.0158	-0.09	0.3754	0.24	0.0162	0.24	0.0141

Table 3: Correlation Coefficients of SMM Against HGS and ESH. All of these coefficients are significant. Given that ESH correlates significantly with SMM in all three displayed populations, it is a measure of muscle function in all three of them.

	All Subjects (n = 100)				All Patients (n = 50)				Severely Obese Patients (n = 22)			
	HGS		ESH 10th Percentile		HGS		ESH 10th Percentile		HGS		ESH 10th Percentile	
	r	p	r	p	r	p	r	p	r	p	r	p
SMM	0.68	< 0.0001	0.28	0.0051	0.70	< 0.0001	0.30	0.0363	0.60	0.0034	0.47	0.0282