Validity of the Strength and Flexibility Domains Comprising a Novel Performance-Based Measure of Functional Risk for Osteoporotic Fracture

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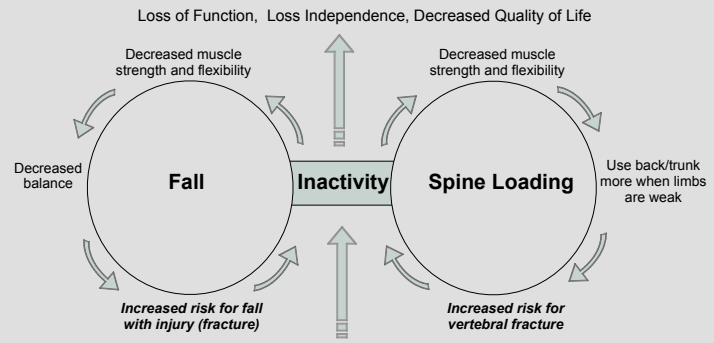
Background

Loss of strength and flexibility in older adults can increase the risk for injurious falls resulting in osteoporotic fracture.[1-2] Strength and flexibility are fundamental components of movement. If a patient has impairment in these fundamental areas, neuromuscular adjustments that could increase spine load or postural sway can place the individual at greater risk to fracture due to a fall or increased compression on the spine.[3] As a result, the individual can lose function, independence and quality of life (see Figure 1). A safe method is needed to assess strength and flexibility as it relates to a functional risk for osteoporotic fracture. The Safe Functional Motion test (SFM), of the Bone Safety Evaluation, is a functional physical performance assessment developed to assess functional risk for fracture.[4] This test is comprised of 6 domains: upper body (UB) flexibility, lower body (LB) flexibility, UB strength, LB strength, balance, and spine loading) . Performance during 10 standardized tasks is observed and rated on an ordinal scale.

Purpose

The purpose of this study was to determine convergent construct validity of the 4 domains of the SFM related to flexibility and strength.

Figure 1: Cycle of Inactivity Can lead to Fracture©



Methods

A cross sectional study of 30 older adults with low bone mass, mean (range) age of 71.47 (53-91), was conducted. See Table 1 for demographics of sample population. The same researcher conducted all tests, the same goniometer, plinth height and chair were used for all tests. Performance on the SFM was scored. Goniometry measures of range of motion (ROM, UB: shoulder and elbow flexion; LB: hip extension in standing - facing a wall, hip external rotation on plinth, hip flexion with knee extended - long sitting on plinth with back supported), hip flexion knee flexed edge of plinth, knee flexion in standing, and ankle dorsiflexion in long sitting on plinth) and measures of UB muscle strength (manual muscle testing of UB shoulder and elbow flexors on a 10 point scale; dynamometry measures of isometric grip strength) were acquired bilaterally. Functional LB muscle strength was assessed using the Timed up and Go (TUG). Duplicate measures of ROM and strength were averaged. Right and left grip strength measures were combined. Overall values for UB and LB ROM and UB muscle strength on manual testing were generated. Convergent construct validity was assessed using the Spearman rho correlations of the scores on the SFM domains related to flexibility and strength with comparable clinical measure. Overall scores for flexibility and strength domains were also compared. Statistical analyses were conducted using Sigma-Stat version 3.5.

Table 1: Demographics of the Study Participants

Demographics	Population
Demographics	*n*
Gender (men/women)	3/27
Falls within the past year	9
Injurious falls within the past year	1
Fracture History (vertebral/hip/wrist/other)	29/3/9/24

Table 2: Summary Statistics Describing the Balance, Strength and Flexibility of the Study Participants

Test (measurement)	Median	25% Quartile	75% Quartile
UB Flexibility Domain (maximum score = 4)	4	4	4
LB Flexibility Domain(maximum score = 6)	5	3	6
Flexibility Domains (maximum score = 10)	9	7	10
UE ROM (degrees)	568.8	552.0	589.5
LE ROM* (degrees)	766.8	700.5	804.5
Composite ROM (degrees)	1331.8	1249.0	1391.5
UB Strength Domain (maximum score- = 8)	8	7	8
LB Strength Domain (maximum score = 6)	5	3	6
UB+LB Strength Domains (maximum score = 14)	12	11	13
Composite Strength (summed MMT grades)[1]	34.5	31	36
Grip* (lb)	50.1	42.8	59.5
TUG (seconds)	13	12	17

*Normally distributed (mean (SD): grip = 52.5 (17.4); LE ROM = 748.4(63.9)
[1] MMT scale 1-10 for 4 muscle groups (right and left elbow flexion and shoulder flexion) resulting in a maximum score of 40.

Table 3: SFM and Comparison Test Correlations

Clinical Measures	SFM Test: Flexibility Domain Scores		
	UB	LB	UB + LB
UB ROM (Flexibility)	-0.179	0.515**	0.424*
LB ROM (Flexibility)	0.097	0.636***	0.582***
Composite ROM (Flexibility)	0.033	0.655***	0.581***
TUG	-0.158	-0.601***	-0.576***
	SFM Test: Strength Domain Scores		
	UB	LB	UB + LB
UB MMT	0.319	0.247	0.402*
Grip Strength (lb)	-0.008	0.409*	0.365*
TUG (sec)	-0.551***	-0.581***	-0.659***

Associations between SFM domain scores and clinical measures (* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$)

Results and Conclusions

Data used to establish correlations between the SFM domains and the clinical measures of strength, flexibility and physical function/balance are presented in Table 2. SFM and comparison test correlations are presented in Table 3. SFM LB strength and flexibility domains have acceptable validity with the expected associations for muscle strength observed. UB and LB strength domains can be combined into a single domain as an estimate of global strength and mobility. LB Flexibility is associated with LB ROM, UB ROM, composite ROM and TUG. Validity of the UB strength and flexibility domains could not be established using MMT and goniometry measures of shoulder and elbow flexion, respectively. The UB flexibility domain is a four-point scale and both UB flexibility and strength domains have ceiling effects due in part to standard performance limits imposed for safety (see NOF ISO 2009 poster titled, "Novel Performance-Based Measure of Functional Risk for Osteoporotic Fracture has Excellent Reliability and Good Convergent Construct Validity"). The SFM was designed to measure patient selection of movement patterns that may contribute to risk for fracture. The contribution of these domains to prediction of risk for falls and osteoporotic fracture requires further investigation.

References

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