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Relationship between balance function and trunk contraction measured by USG in mild stroke patients

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Objective
Some stroke patients may experience a reduction in mobility even though they have little motor or sensory deficit in the affected limb. Decreased control of trunk muscles is recognized to be the main reason in these cases and the importance of facilitating trunk stability is widely known in the course of rehabilitation. However relations between individual trunk muscle and the balance function are not sufficiently revealed. In this study, we measured thicknesses of trunk muscles in resting and contracted state by ultrasonography and identify the relationship between each muscle and balance function of mild stroke patients.

Methods
45 patients (27 males, 18 females; mean age 65.4 ± 13.2 years) with hemiparesis were enrolled and their scores of manual muscle test(MMT) in the affected legs were 4 or more. To measure the contractile ability of trunk muscles, we used ultrasonography by measuring the thickness of trunk muscles in both affected and unaffected side at rest and consecutively at contraction during proper motion. Measured muscles are rectus abdominis(RA), external oblique(EO), internal oblique(IO), transversus abdominis(TA), paravertebral muscle(PV) and iliopsoas(IP). Contractile ability was calculated by dividing the active thickness by the resting thickness. Ratio of contractile ability was calculated by dividing the unaffected side contractile ability by affected side contractile ability. For the functional evaluation of trunk balance, Scales for the assessment and rating of ataxia(SARA), Berg balance scale(BBS) and Timed up and go test(TUG) were conducted. We used student T-test to compare the Result of contractile ability of affected versus unaffected muscles, and Pearson's Correlation to get relationship between contractile ability or contractile ability ratio of each muscle and Results of balance assessments.

Results
General characteristics of the participants are described in Table 1. The average of age was 65.4 ± 13.24 years, and the average of NIHSS score was 3.40 ± 3.63. As the Result of hemiparesis, contractile ability of the affected side was confirmed to be decreased significantly in all measured muscles except TA. [Table 2] By the Pearson's correlation, the muscles which have significant correlation with balance scales were RA, and IO of the unaffected side and PV of the affected side. The ratios of contractile ability of RA, EO, IO, PV and IP had statistically significant correlation with Results of all balance scales of SARA, BBS and TUG.

Conclusion

In mild hemiparetic stroke patients, the contractile abilities of trunk muscles have correlation with balance function. Ultrasonographic measurement of trunk muscles can provide additional information about proper evaluation of functional deficit and to make selective rehabilitation training promoting balance function in mild stroke patients.

Table 1. Demographics and characteristics of patients (n=45)

Characteristics	Value
Sex Male : Female	27 (60) : 18 (40)
Age (yr)	65.4±13.24
BMI	23.76±3.20
SARA score	4.28±4.10
BBS score	47.46±7.75
TUG	16.07±8.25
Smoking Yes : No	9 (20) : 36 (80)
Cardiovascular disease Yes : No	5 (11.1) : 40 (89.9)
Hypertension Yes : No	25 (71.1) : 20 (28.9)
Diabetes mellitus Yes : No	8 (31.1) : 37 (68.9)
Atrial fibrillation Yes : No	4 (8.9) : 41 (91.1)
NIHSS	3.40±3.63
mRS	1.90±1.47

BMI, Body Mass Index; SARA, Scale for the assessment and rating of ataxia;
BBS, Berg balance scale; TUG, Timed Up and Go Test;
NIHSS, The National Institutes of Health Stroke Scale; mRS, Modified Rankin Scale

Table 2. Contractile ability of Trunk muscle

Muscle	Affected Side	Unaffected Side	P-value
RA	1.0882	1.1778	0.000*
EO	1.1542	1.2793	0.001*
IO	1.2927	1.1862	0.001*
TA	1.4418	1.6476	0.054
PVM	1.1300	1.1896	0.007*
IP	1.1720	1.2524	0.004*

*means statistically significant at 0.05 level.
RA, rectus abdominis muscle; EO, external oblique muscle; IO, internal oblique muscle; TA, transversus abdominis; PVM, paravertebral muscle;IP, iliopsoas muscle

Table 3 The relationship between Trunk balance and Trunk muscle contraction

Muscle		SARA	BBS	TUG
RA	Unaffected side Contractile ability	0.333*	-0.374*	0.212
	Affected side Contractile ability	-0.107	0.068	-0.137
	Ratio of Contractile ability	0.574*	-0.581*	0.440*
EO	Unaffected side Contractile ability	0.279	-0.272	0.116
	Affected side Contractile ability	-0.196	0.192	-0.263
	Ratio of Contractile ability	0.587*	-0.574*	0.433*
IO	Unaffected side Contractile ability	0.477*	-0.492*	0.416*
	Affected side Contractile ability	-0.130	0.123	-0.123
	Ratio of Contractile ability	0.681*	-0.690*	0.600*
TA	Unaffected side Contractile ability	-0.006	0.014	-0.013
	Affected side Contractile ability	-0.222	0.201	-0.198
	Ratio of Contractile ability	0.395*	-0.354*	0.3188
PVM	Unaffected side Contractile ability	0.039	0.073	-0.147
	Affected side Contractile ability	-0.301*	0.377*	-0.424*
	Ratio of Contractile ability	0.524*	-0.447*	0.386*
IP	Unaffected side Contractile ability	0.211	-0.257	0.193
	Affected side Contractile ability	-0.670	0.929	-0.002
	Ratio of Contractile ability	0.563*	-0.563*	0.418*

RA, rectus abdominis muscle; EO, external oblique muscle;
IO, internal oblique muscle; TA, transversus abdominis;
PVM, paravertebral muscle;IP iliopsoas muscle
Values are shown with correlation coefficient.
*means statistically significant at 0.05 level.