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Facilitation of trunk muscles by abdominal bracing during walking in chronic low back pain patients

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Objective
The walking exercise and abdominal bracing are both recommended to chronic low back pain (LBP) patients. Trunk muscle activation pattern during walking has been investigated with surface electromyography (sEMG), and known to increase with faster walking speed. Since fast walking is difficult for patients with severe spinal stenosis or osteoarthritis, we aimed to see whether abdominal bracing combined with walking can be an alternative strategy. Therefore we designed this prospective experimental trial to quantify the activation of trunk muscles by sEMG at different walking velocities with or without abdominal bracing.

Method
Fourty eight patients with chronic LBP were recruited. In each patient, surface electrodes were placed over the multifidus of lower and upper lumbar levels, erector spinae of lower lumbar and thoracic levels, rectus abdominis, and external oblique muscles. During the walking exercise without abdominal bracing (non-braced walking), sEMG data were collected at the speed of 4 km/hr, 5km/hr, and 6 km/hr. Same protocol was repeated with the walking exercise with abdominal bracing. The amplitude of sEMG measured for quantitative evaluation of musle activation.

Result
Activation of all measured muscles significantly increased at higher speed during non-braced walking, and same tendency was found with abdominal bracing. It showed significantly higher activation in walking with abdominal bracing than non-braced walking at muscles of mutifidus (upper lumbar), erector spinae (lower lumbar, thoracic), and rectus abdominis at the speed of 4km/h. However, this difference was diminished at faster walking speed (5km/h for lower lumbar erector spinae, 6km/h for upper lumbar multifidus and thoracic erector spinae) except for rectus abdominis. The abdominal bracing in walking speed of 4km/h facilitated the same amount of muscle activation as non-braced walking of 5km/h in all muscles except rectus abdominis.

Conclusion
The walking with abdominal bracing activates trunk muscles more than non-braced walking. This effect is more prominent in lower speed so that it facilitated to the levels comparable to non-braced walking of faster speed. Therefore, patients who are unable to walk fast still can have similar training effect on lumbar trunk muscles by slow walking with abdominal bracing.

Table 1. Quantitative analysis of muscle activation during braced and non-braced walking exercise

| Non-braced vs. Braced analysis (paired T test)		Surface EMG amplitude (µV)								
		LV4 (non-braced)	LV4 (braced)	p-value	LV5 (non-braced)	LV5 (braced)	p-value	LV6 (non-braced)	LV6 (braced)	p-value
Multifidus (lower lumbal)	mean	18.55±9.32	19.53±8.49	0.226	20.88±10.33	21.16±8.57	0.692	24.47±11.74	23.30±9.37	0.146
	max	36.70±21.45	38.55±22.30	0.224	42.18±24.53	43.33±23.58	0.318	48.03±26.91	47.16±25.50	0.505
Multifidus (upper lumbar)	mean	19.95±11.81	22.50±11.89	**0.002**	22.61±12.43	24.45±10.92	**0.019**	28.94±14.68	28.71±11.96	0.835
	max	38.97±15.77	43.29±18.66	**0.008**	44.26±17.79	48.89±18.32	**0.006**	59.71±30.52	59.13±25.39	0.840
Erector spinae (lower lumbar)	mean	18.30±7.98	19.60±8.14	**0.016**	20.79±10.02	21.48±8.64	0.387	24.93±10.63	24.87±8.86	0.942
	max	40.71±19.54	43.22±19.93	**0.022**	47.11±26.04	47.89±22.11	0.747	57.97±33.15	55.45±24.74	0.509
Erector spinae (thoracic)	mean	15.96±6.65	18.16±9.49	**0.003**	17.52±6.57	20.82±8.99	**0.001**	22.98±10.39	24.27±11.75	0.295
	max	33.79±12.40	38.80±18.52	**0.007**	39.72±13.30	45.35±16.21	**0.006**	53.63±27.98	51.56±21.25	0.481
Rectus abdominis	mean	15.85±6.89	22.11±13.96	**<0.001**	17.56±7.68	24.63±15.23	**<0.001**	23.57±16.21	27.59±16.91	**0.003**
	max	29.77±16.64	45.41±37.47	**<0.001**	33.93±21.01	54.31±44.50	**<0.001**	48.01±41.02	60.10±54.01	**0.017**
External oblique (abdomen)	mean	7.36±6.07	8.89±10.74	0.141	8.41±7.36	10.03±11.92	0.069	11.70±11.40	11.38±9.30	0.760
	max	13.70±14.82	17.46±26.29	0.095	17.89±19.74	20.91±35.00	0.254	26.94±35.79	24.26±26.19	0.333
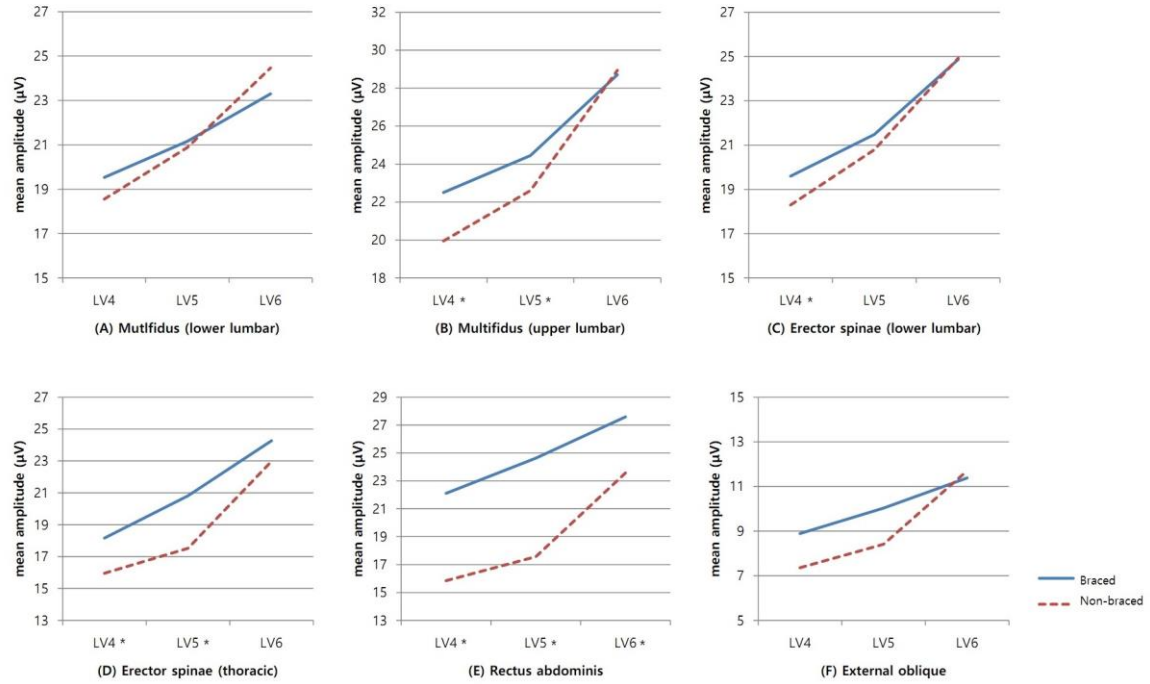
Fig 1. Quantitative data of muscle activation during braced and non-braced walking exercise. Solid line indicates braced walking and dashed line indicates non-braced walking for each muscles. Asterisk means significant difference between braced and non-braced walking. (A) Multifidus (lower lumbar) (B) Multifidus (upper lumbar) (C) Erector spinae (lower lumbar) (D) Erector spinae (thoracic) (E) Rectus abdominis (F) External oblique.