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Effects of abdominal electrical stimulation on respiratory function in subacute stroke patients

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Objective
Respiratory muscle weakness and reduced respiratory function are common complication in stroke patients. Respiratory muscle weakness may cause pulmonary infection by reducing coughing and expectoration of sputum. Reduced respiratory function makes stroke patients exhausted easily and limit receiving intensive rehabilitation. Functional electrical stimulation (FES) cause muscle contraction by applying electrical pulse to motor nerves. FES is widely used to enhance muscle strength in stroke patients. Many studies have established that abdominal FES improve respiratory function in spinal cord injury patients, however there is lack of studies on stroke patients. The aim of this study was to investigate the effect of abdominal FES on respiratory function in subacute stroke patients.

Methods
A randomized control study was performed on participants who were admitted to the department of physical medicine and rehabilitation. Inclusion criteria were as follow: 1) stroke was diagnosed by CT or MRI 2) first stroke attack (diagnosed within 6 months); 3) moderate to severe hemiplegia (manual muscle test<grade 3); 4) proper cognitive function (Mini Mental State Examination ≥ 18); 5) older than 19 years. All participants were divided into two groups; abdominal FES and control group. Two groups underwent 30 minutes bedside respiratory training by using incentive spirometer 5 times a week for 3 weeks. In addition to bedside respiratory training, abdominal FES group underwent 30 minutes abdominal FES, 5 times a week for 3 weeks. Pulmonary function test (PFT) and physical function tests including Berg balance scale (BBS), Modified Barthel index (MBI) were performed before and after the intervention. Respiratory function was assessed by PFT subscales including Forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1), FEV1/FVC, Peak cough flow (PCF).

Results

Total 10 post-stroke patients were enrolled for this study. Five patients were allocated to abdomen FES group and five patients were allocated to control group (Table 1). All result parameters showed no statistically significant difference between pre and post interventions in each group. However, ΔFEV1 in abdominal FES group shows significant improvement than that in control group ($p<0.05$) (Table 2). BBS and MBI show improvement between pre and post interventions in both groups.

Conclusion

In stroke patients, abdominal FES may have possibility to improve pulmonary function. This study showed that applying abdominal FES can be recommended in case of relatively severe hemiplegic stroke patients. However, because of small sample size, larger sample size will be needed to clarify these results.

Table 1. Demographic and stroke-related characteristics

Variable	Abd FES (N = 5)	Control (N = 5)
Age (yrs)	66.0±19.8	71.0±2.8
Sex		
Male	2(40%)	1(20%)
Female	3(60%)	4(80%)
Since onset (days)	46.0±36.8	31.5±0.7
Etiology		
Infarction	3(60%)	3(60%)
Hemorrhage	2(40%)	2(40%)
K-MMSE	27.5±2.1	21.5±0.7

K-MMSE, Korean version of Mini-mental status exam; Abd FES, abdominal FES group
Values are presented as number(%) or mean±standard deviation.

Table 2. rison between 2 groups; Pre and Post treatment

Variable	Group	Pre	Post	p-Value	Δ (Post - Pre)	p-value
FVC (% predicted)	A	85.0 ± 1.41	89.5 ± 0.71	0.250	4.5 ± 2.12	0.121
	C	73.5 ± 20.5	75.5 ± 2.12	0.180	2.0 ± 1.41	
FEV1 (% predicted)	A	93.5 ± 9.2	99.5 ± 9.2	0.089	6.0 ± 0.0	0.048*
	C	88.0 ± 28.3	89.0 ± 18.4	0.655	1.0 ± 9.9	
FEV1/FVC (% predicted)	A	85.0 ± 5.7	85.5 ± 3.5	0.655	0.5 ± 2.1	0.088
	C	71.5 ± 2.1	70.5 ± 4.9	0.317	-1.0 ± 7.0	
PCF (% predicted)	A	82.0 ± 25.5	88.0 ± 14.1	0.180	6.0 ± 11.3	0.122
	C	44.0 ± 4.2	46.0 ± 9.9	0.655	2.0 ± 14.1	
BBS	A	8.5 ± 0.7	38.0 ± 19.8	0.180	29.5 ± 20.5	0.439
	C	9.0 ± 5.7	30.0 ± 19.8	0.150	21.0 ± 14.1	
MBI	A	45.5 ± 34.6	68.5 ± 6.36	0.250	23.0 ± 41.0	0.586
	C	15.0 ± 4.2	34.0 ± 11.3	0.180	19.0 ± 15.6	

A, abdominal FES group; C, control group
FVC, forced vital capacity; FEV1, forced expiratory volume in 1 second; PCF, peck cough flow; BBS, berg balance scale; MBI, modified barthel index
Data were reported as mean±standard deviation.
* P < 0.05