Correlation between diaphragmatic movement and pulmonary function in acute stroke patients

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BACKGROUND AND AIM

The effects of stroke on respiratory muscle function and the strategies to improve it are the focus of many research studies. The diaphragm muscle is considered as a major determinant of ventilator function and any reduction in its movement may contribute to respiratory dysfunction in stroke patients.
The aim of this study was to investigate the correlation between pulmonary function and diaphragmatic movements after inspiratory training in acute ischemic stroke patients.

METHODS

Twenty-two ischemic stroke patients (71.14±5.54 years old, 12 men, 13 right hemiparesis, with light to moderate stroke severity NIHSS scale 9±2.6) in the acute period and after mobilization was indicated (no later than 48 hours) were recruited. The assessment methods used were: spirometry measuring forced vital capacity (FVC), forced expiratory volume at one second (FEV1), peak expiratory flow (PEF), inspiratory capacity (IC) and ultrasonography for detection of the hemi diaphragmatic movement in relaxed (R) and in deep (D) breathing. After three attempts, the best achievement was reported. The measurements are conducted in semi-sitting position from 30° to 45°.
All patients underwent physiotherapy to facilitate or stimulate their functional recovery, including bed activities, techniques to facilitate breathing, sensory and transfers training, standing, and walking. The feedback breathing device for inspiratory training was applied in semi-sitting position with the instruction to make 5 repetitions with 1 to 3 minutes rests between them, at least 4-5 times a day, every day of the week, for 10 days.

RESULTS

At the onset of the study we noted a tendency for significant increase in the amplitude in voluntary deep breathing ($p<0.05$) and insignificantly increased amplitude in relaxed breathing of the less affected hemi diaphragm (Fig. 1). After one-month of inspiratory training, the trend of the difference between the amplitudes of the more affected and less affected domes continues to be present (30,88±4,34 mm, $p<0.001$) in patients with left and with right hemiplegia (30,64±5,47 mm, $p<0.001$).
FVC positively correlate with the amplitude of the diaphragm dome of hemiplegic ($r=0,605$, $p<0,01$) and nonhemiplegic side at the beginning($r=0,514$, $p<0,05$). Strong, statistically significant correlation was found between IC and the less affected dome in deep breathing at the end of the period ($r=0,700$, $p<0,000$) (Table 1, Fig.2).

DISCUSSION

The present study displayed greater mobility of the diaphragm of the nonhemiplegic side, continuing after a month of inspiratory training, which correlates with the patient's pulmonary function. There was a smaller difference in the amplitude of the affected/unaffected side during calm breathing and a more distinct difference during voluntary inhalation.

Disclaimer: None of the authors or their institution received commercial financial assistance related to this study. All authors contributed to the design, analysis, interpretation of data, intellectual content and approved its final version.

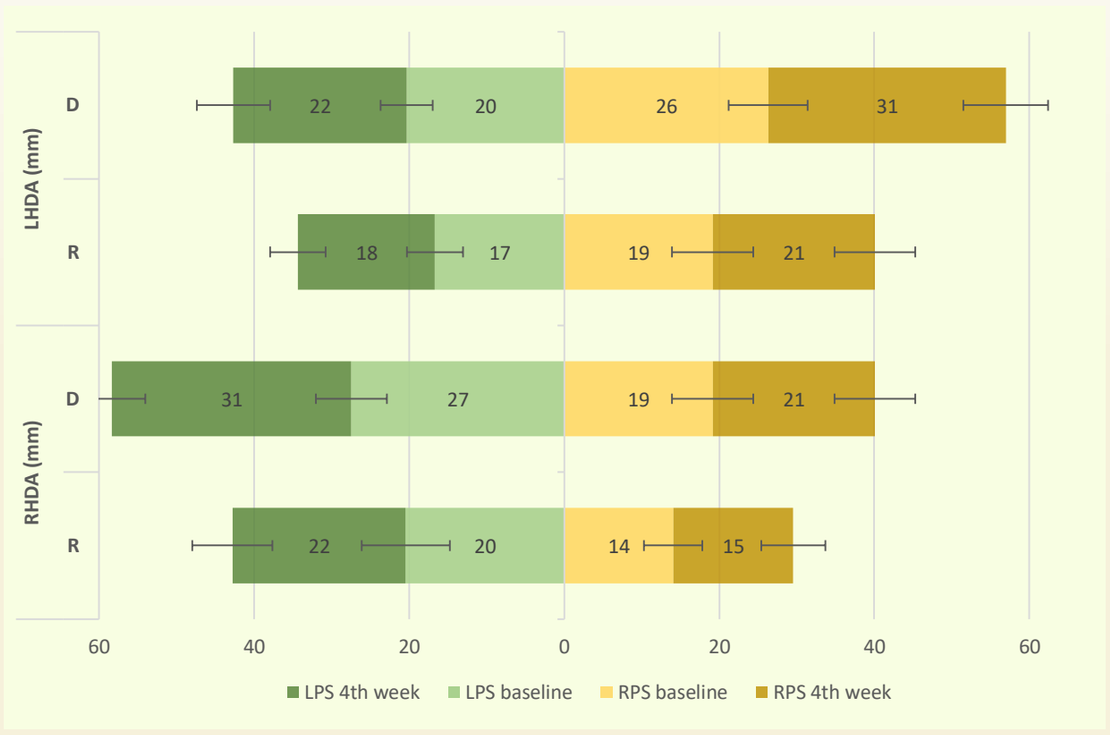

Fig.1. Comparison between hemi diaphragm amplitude relative to the affected side. *LHDA – Left hemi diaphragm amplitude; RHDA – Right hemi diaphragm amplitude; LPS - Left paretic side; RPS - Right paretic side; R – relaxed breathing; D – deep breathing*

Table 1. Correlation between diaphragmatic movement and pulmonary function

	baseline				4th week			
	AAR	**AAD**	**ALR**	**ALD**	**AAR**	**AAD**	**ALR**	**ALD**
FVC (l)	0,605 p<0,01		0,514 p<0,05	0,516 p<0,05	0,609 p<0,001	0,618 p<0,005	0,478 p<0,05	0,513 p<0,05
IC (ml)				0,463 p<0,05	0,425 p<0,05		0,527 p<0,05	0,700 p<0,000

Pearson's correlation coefficients was used. FVC – Forced Vital Capacity; IC – Inspiratory Capacity; AAR - Amplitude Diaphragm Affected Side Relaxed Breathing; AAD - Amplitude Diaphragm Affected Side Deep Breathing; ALR - Amplitude Diaphragm Less Affected Side - Relaxed Breathing; ALD - Amplitude Diaphragm Less Affected Side - Deep Breathing

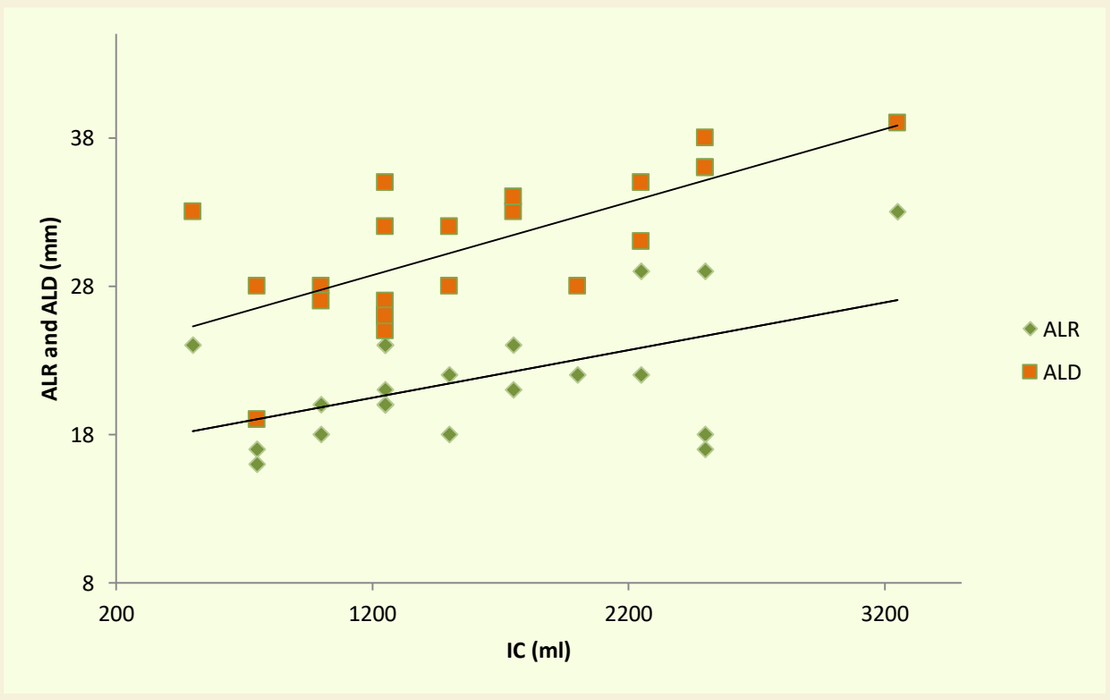

Fig.2. Correlation between Inspiratory Capacity and less affected hemidiaphragm.
IC – Inspiratory Capacity; ALR - Amplitude Diaphragm Less Affected Side - Relaxed Breathing; ALD - Amplitude Diaphragm Less Affected Side - Deep Breathing

CONCLUSION

There is a tendency for patients to compensate reduced diaphragmatic mobility with the nonparetic side. Further studies are needed to investigate the appropriate therapeutic modalities of pulmonary training in acute stroke patients in order to counteract this tendency and to train to restore function of the paretic side.