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Comparison of diaphragm excursion between ultrasonography and fluoroscopy in brain injury patients

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Objective

Acquired brain injury not only causes weakness in the limb muscles, but it can also affect the respiratory system. Patients after acquired brain injury presented decreased pulmonary function and diaphragm excursion (DE) that can affect locomotion or activities of daily living. The radiological assessment of diaphragm excursion has traditionally relied upon fluoroscopic evaluation, but, several recent studies have used M-mode ultrasonography of for diaphragm excursion measurement. The Objective of this study was to determine whether assessment with ultrasonography or fluoroscopy differed, and which technique was more correlated with pulmonary function in patients with acquired brain injury.

Materials & Methods

From September 2017 to April 2018, we prospectively enrolled patients with acquired brain injury who were admitted to our general hospital. Patients underwent pulmonary function test (PFT), and DE was measured using M-mode ultrasonography and fluoroscopy on admission. A single experienced physiatrist who was blinded to PFT Results performed the DE evaluations. The transducer was positioned on the abdominal wall just below the ribs between the midaxillary line and the mammillary line, forming a 45° angle between the transducer and the surface of the abdominal wall in the cephalic direction using M-mode ultrasonography. For videofluoroscopy evaluation, we set a metallic round Object of diameter 2.6 cm in the field of X-ray, with the aim of allowing its visualization in the video recording. (Figure 1) The mean value after 3 attempts was used for analysis. The forced vital capacity (FVC), forced expiratory volume at 1 second (FEV1), FEV1/FVC, maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) were measured by another physiatrist who was blinded to DE, based on guidelines by the American Thoracic Society/European Respiratory society.

Results

The mean measured DE using ultrasonography was 1.33±0.54 cm for right side and 1.38±0.52 cm for left side. The mean measured diaphragm excursion using fluoroscopy was 1.80±0.66 cm for right side and 1.80±0.63 cm for left side. After adjusting age, sex, height, and weight, correlation coefficient between ultrasonography and fluoroscopy was 0.744 for right side and 0.631 for left side ($P < 0.05$). MIP and MEP were significantly associated with DE measured by fluoroscopy and ultrasonography for both right and left side ($P < 0.05$) (Figure 2). Whereas, PCF showed significant correlation with DE of left side ($P < 0.05$).

Conclusions

There is a significant correlation between measurement Method of DE between ultrasonography and fluoroscopy, especially for right side hemi-diaphragm. And respiratory muscle strength showed significant relationship with DE measured by both 2 Methods. M-mode ultrasonography could be an alternative Method for DE measurement in patients with acquired brain injury.

Table 1. Correlation analysis of pulmonary function test and diaphragm excursion

	Fluoroscopy		M-mode Ultrasonography	
	Right	Left	Right	Left
MIP (cmH_2O)	0.406*	0.441*	0.407*	0.417*
MEP (cmH_2O)	0.341*	0.377*	0.315*	0.690*
FVC (L)	0.075	0.251	0.017	0.058
FEV1 (L/min)	0.120	0.121	-0.028	-0.054
FEV1/FVC (%)	0.017	-0.068	0.044	-0.102
PCF (L/min)	0.158	0.387*	0.260	0.468*

MIP, Maximal inspiratory pressure; MEP, Maximal expiratory pressure; FVC, Functional Vital Capacity; FEV_1, forced expiratory volume at 1 second; PCF, Peak Cough Flow

* *P*-value <0.05

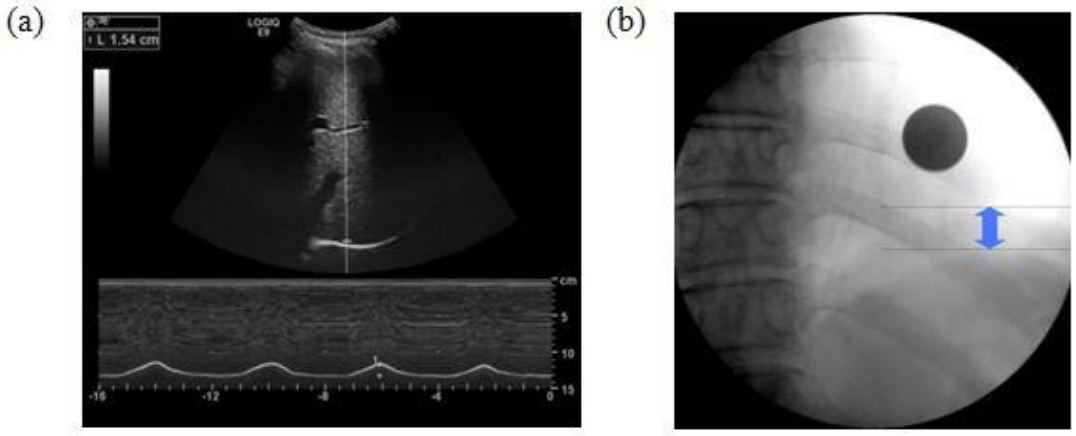

Figure 1. Measurement of diaphragm excursion using (a) ultrasonography and (b) fluoroscopy

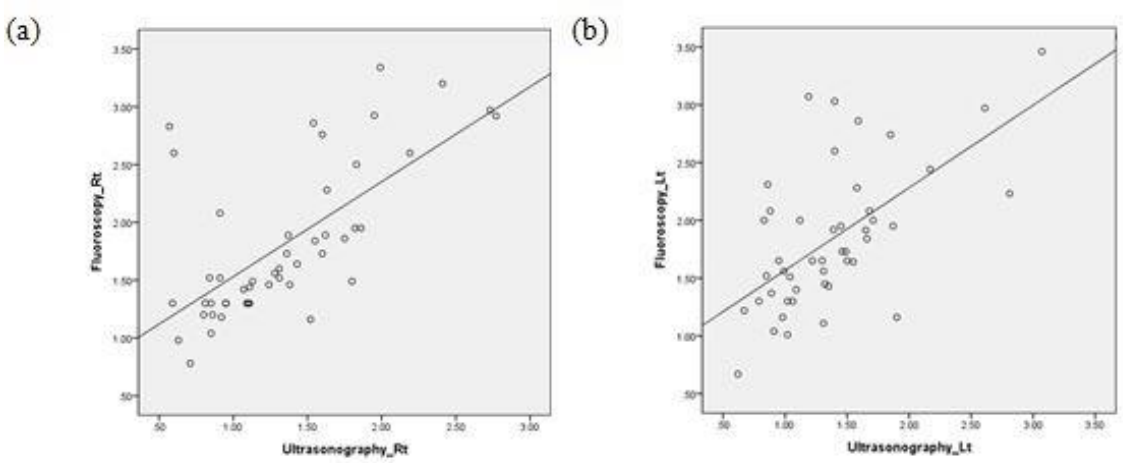

Figure 2. Correlation analysis of diaphragm excursion measurement using ultrasonography and fluoroscopy. Scatterplot of the correlation for (a) right and (b) left side.