Pulmonary function in early Parkinson's disease measured with EIT

Chenxi Zhang[1], Jia Deng[1], Hongying Jiang[1], Zhanqi Zhao[2],

1. Beijing Rehabilitation Hospital of Capital Medical University, Beijing, China. Correspondence to 6jhy@163.com.
2. Furtwangen University, Villingen-Schwenningen, Germany

Abstract: We analysed EIT data from 5 patients with Parkinson's disease during tidal breathing. The patients were in various disease stages and had different lung function. We demonstrated that intra-tidal gas distribution showed different patterns characterized the disease stages and maximal voluntary ventilation.

1 Introduction

Parkinson's disease (PD) is a progressive motor extrapyramidal disorder leading to disability and immobility. While most prevalent PD symptoms are motor function impairments, non-motor dysfunction may present earlier before motor impairments. PD may cause respiratory dysfunction [1]. However, due to their muscle weakness, spirometry such as forced vital capacity manoeuvre might not be conducted properly, so that the assessment of lung function could be sometimes difficult.
Electrical impedance tomography (EIT) may assess inspiratory efforts [2]. We conducted a preliminary study to assess whether an EIT-based parameter (intra-tidal gas distribution, ITGD) can be used to evaluate the degree of respiratory dysfunction in PD patients.

2 Methods

The study was approved by Ethics Committee of Beijing Rehabilitation Hospital, Capital Medical University. A total of 5 PD patients were included (modified Hoehn and Yahr stage, H&Y 1.5-3). The age ranged from 48 to 70 years and body mass index ranged from 19.8 to 25.4 kg/m^2. Only one patient was a smoker. Pulmonary function test was performed after oral administration of Parkinson's disease drugs. EIT measurement was conducted during quiet tidal breathing in sitting position. ITGD index calculating the tidal volume distribution during inspiration [3].

$$ITGD_k = \frac{\Sigma_{ROI}(I_{j,k}-I_{j,0})}{\Sigma_{Lung}(I_{j,k}-I_{j,0})} \times 100\% \qquad (1)$$

where ROI, region of interest, represents the dorsal regions or ventral regions. Pixel j and i are pixels that belong to ROI and the defined lung regions, respectively. Time point 0 depicts the beginning of inspiration. Inspiration time was divided into 8 equal parts (time point k). Averaging data from 1 minutes were conducted to reduce the variation during spontaneous breathing.
According to a previous study [4], predicted value for maximal voluntary ventilation (MVV) was the most sensitive parameter distinguishing the severity of PD. Therefore, the results were presented qualitatively according to the H&Y stages and MVV% predicted.

3 Results

Patients MVV% ranged from 37 to 102% (Fig. 1). The ITGD patterns were very different among patients. For patients with higher H&Y stages and low MVV%, ventral and dorsal distribution within inspiration separated from each other. As the PD severity decreased, the distribution between ventral and dorsal regions became more homogeneous.

4 Discussion and Conclusions

Respiratory muscle dysfunction is often presented in PD patients. Consequently, the reduction of the respiratory muscle strength might lead to the deterioration of pulmonary function. In a previous study, we have demonstrated that ITGD might reflect diaphragm activities and predict weaning outcomes [5]. In the present preliminary study, we found that it also reflected the H&Y stage and MVV% in PD patients. Further studies are warranted to confirm this finding.
In summary, the severity of respiratory dysfunction in PD patients might be assessed with EIT during tidal breathing.

References

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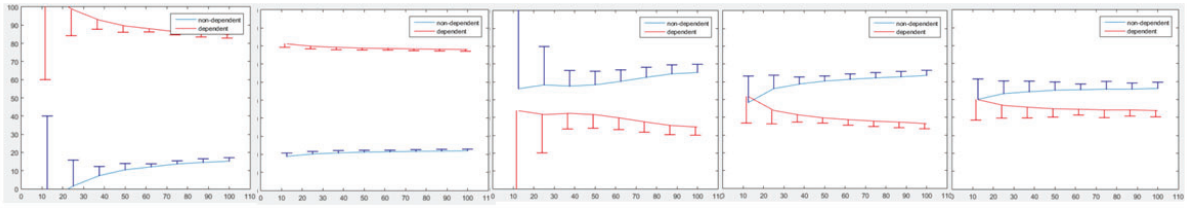

H&Y stage	3.0	3.0	2.0	2.5	1.5
MVV%	37	62	62	98	102

Figure 1: The intra-tidal gas distribution showing ventral (blue) and dorsal (red) regions distribution during inspiration. Mean and standard deviation of the inspirations during 1 minutes at different inspiratory fractions were plotted. Hoehn and Yahr (H&Y) stages and maximal voluntary ventilation (MVV) percent predicted of each individual patients are indicated underneath the plots.