Neural inspiratory time detection from surface diaphragm electromyography

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1. Introduction

Electromyography is a technique for recording the electrical activity produced by respiratory muscles. The surface diaphragm electromyography (EMGdi) signal can be non-invasively recorded using electrodes in a bipolar configuration. The measurement of the EMGdi can be used to indirectly quantify the neural respiratory drive (NRD), which allows evaluating the level and pattern of the muscle activation [1]. Its use has contributed to improve patient-ventilation interaction in new modes of mechanical ventilation that assist patients in proportion to its respiratory efforts by evaluating the onset (n_{ton}) and offset (n_{toff}) of neural inspiratory time. Determining n_{ton} and n_{toff} can be challenging because muscle respiratory signals present a lower signal-to-noise ratio, when compared to conventional respiratory measures [2]. In this work, we present a novel method for determining the n_{ton} and n_{toff} of neural inspiratory time from EMGdi signals.

2. Materials and Methods

Ten healthy subjects carried out a respiratory protocol in which they breathe, progressively increasing their respiratory rate from 15 to 20, 24, 30 and 40 bpm every 16 respiratory cycles (Figure 1, left). To obtain the n_{ton}, a dynamic thresholding was established from the mode of the amplitude distribution of an EMGdi segment between two consecutives peaks by using the Gaussian kernel density estimation method. The determination of n_{toff} was considered as the time when the EMGdi signal has decreased to 70 % of its peak value (Figure 1, middle) [2]. To overcome the problem of the electrocardiographic interference, the fixed sample entropy (fSampEn), a robust technique against impulsive noise was used [1]. The n_{ton} and n_{toff} were compared to indirect estimates of neural onset and offset based on a zero-crossing criterion from respiratory airflow signal.

3. Results

The Bland–Altman analysis between the n_{ton} and n_{toff} detected in the airflow and EMGdi showed a global bias of 46 ms, with limits of agreement lower than 360 ms for onset and offset comparisons (Figure 1, right).

4. Conclusions

This study proposes a reliable method for estimating the neural inspiratory time (n_{ton} and n_{toff}), from surface EMGdi signals, which does not require filtering the cardiac interference preserving most of its spectral content.

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References

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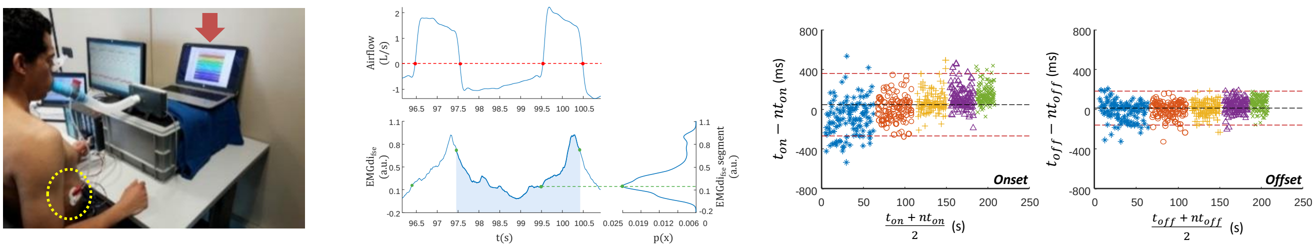

***Figure** 1. Left: Breathing protocol. Middle: Procedure for determining onset and offset time. Right: Comparison of onset and offset times detected in the airflow and EMGdi signals, in the respiratory protocol.*