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Electrical Activity of the Diaphragm During Reverse Triggering - A Case Report

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Abstract

Reverse triggering is defined as diaphragmatic muscle contraction triggered by mandatory breath of ventilator. Reverse triggering induced double cycling and large tidal volume (V_T) in Pressure Control Ventilation (PCV).

An 81-year-old male was admitted to the ICU after tricuspid valve plasty. A close observation of graphic monitor showed a deflection of pressure waveform in the middle of mandatory breath. Electric activity of the diaphragm (EAdi) revealed diaphragmatic contraction following mandatory breath. When diaphragmatic contraction started at the end of mandatory breath it induced double-cycling. When it started at the middle of mandatory breath V_T increased. As spontaneous breathing increased, reverse triggering disappeared. While the consequences of reverse triggering are under discussion, in our case it led double cycling and large V_T, and it might be injurious. We should recognize it is more common than expected.

Keywords: Patient-ventilator synchrony; Double cycling; Ventilation; Sedation

Introduction

Patient-ventilator asynchrony is common and worrisome [1,2]. Reverse triggering is diaphragmatic muscle contraction triggered by mandatory breath and it is frequently overlooked [3]. It induces undesirable effects such as increased work of breathing and large tidal volume (V_T) [4]. We suspected reverse-triggering through close observation of graphic monitor and confirmed it by an electrical activity of the diaphragm (EAdi).

Case Report

An 81-year-old male (167 cm, 61 kg) was admitted to the ICU after tricuspid valve plasty. He was given fentanyl of 1100 mg and midazolam of 79 mg during general anesthesia. After admission to ICU, infusion of fentanyl was continued at 25 mg/h. Ventilator settings were Pressure Control Ventilation (PCV) 10 cm H_2O, inspiratory time 1.2 sec, frequency 12/min, inspiratory fraction of oxygen (F_IO_2) 0.5, and Positive End-Expiratory Pressure (PEEP) 6 cm H_20. Three hours later, Richmond Agitation-Sedation Scale was -5. The graphic monitor of the ventilator showed no pressure drop at the beginning of ventilator breath. However, through a close observation, pressure waveform had a deflection in the middle of mandatory breath, and some mandatory breaths led double cycling. Titration of ventilatory rate and inspiratory time did not solve the problems. We inserted EAdi catheter (Maquet, Wayne, New Jersey) trans nasally and monitored EAdi. The monitoring revealed regular diaphragmatic contraction initiated about 1 sec after start of mandatory breath (Figure 1) resulting in double cycling. When diaphragmatic contraction initiated earlier, it did not result in double cycling but large V_T (Figure 2). Fentanyl infusion was quitted, and 26 hours after admission, spontaneous breathing increased and both reverse triggering and double cycling disappeared in pressure support ventilation. The patient was extubated on the following day.

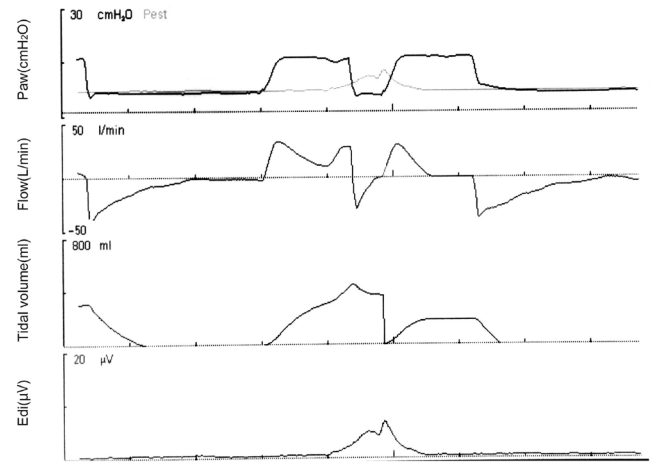

Figure 1: Traces are airway pressure, flow, tidal volume, an electrical activity of the diaphragm during mechanical ventilation in pressure control mode. Mechanical breath triggered neural effort and induced double cycling. (Paw=Airway pressure; EAdi=An electrical activity of the diaphragm).

Discussion and Conclusion

Reverse triggering was defined as neural efforts triggered by mandatory breath of ventilator [3]. It is easily overlooked [3,4]. EAdi enabled us to detect reverse triggering. EAdi or esophageal pressure monitoring are superior to detect inspiratory efforts of patients, however, they are not popular as daily monitoring of mechanically ventilated patients. In our case, we suspected patient-ventilator asynchrony because airway pressure waveforms exhibited a deflection in the middle of mandatory breath. While the consequences of reverse triggering are under discussion [4], it increased V_T even without double cycling. Reverse triggering sometimes caused double cycling and it also increased V_T. Graves et al. [5] found that changes in ventilatory rate and V_T could lead to a variety of regular and irregular patterns of coupling between patient and ventilator [5]. We tried the same strategy and failed to solve it. As we discontinued sedation and as regaining consciousness, reverse triggering disappeared.

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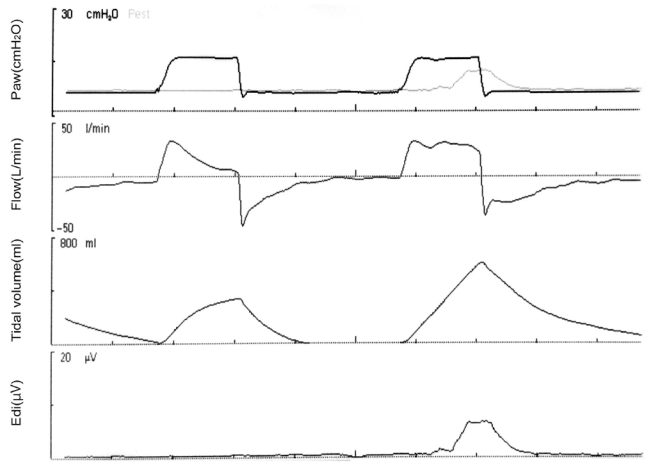

Figure 2: Traces are airway pressure, flow, tidal volume, an electrical activity of the diaphragm during mechanical ventilation in pressure control mode. Mechanical breath triggered neural effort and increased tidal volume. (Paw=Airway pressure; EAdi=An electrical activity of the diaphragm).

We recorded EAdi in a post-operative patient. It increased V_T and might be injurious [6]. We should recognize reverse triggering is more common than expected.

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