Identifying asynchronies: Early cycling

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Abstract

Mechanical ventilation is a lifesaving treatment but can be associated with some complications such as ventilator-induced lung injury, ventilator associated pneumonia or ventilation induced diaphragm dysfunction. Although partial ventilatory support is preferred to limit some of the complications associated with controlled mechanical ventilation, there could be some problems like asynchrony between the patient and the ventilator. Asynchronies occur when the ventilator's breath delivery does not match the patient's ventilatory pattern or is inadequate to meet their flow demand.
Asynchronies can lead to patient's discomfort, prolong mechanical ventilation, intensive care unit stay and mortality.
Early cycling occurs when the patient's neural inspiratory time is longer than the inspiratory time imposed by the ventilator. It is a common cause of double trigger.

Keywords: mechanical ventilation, Asynchrony, early cycling, double trigger

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Patient-ventilator asynchrony is a commonly problem in mechanically ventilated patients. [1] Some studies suggest that asynchrony is associated with prolonged mechanical ventilation and unsuccessful weaning. [2] It is also one of the most cited reasons for giving sedation during mechanical ventilation. [3]

Asynchronies occur when there is a mismatch between the ventilator and the patient in terms of demand or breath delivery timing. [4] Any mismatch between neural Ti/Te (Ti - Inspiratory time, Te - Expiratory time) and ventilator Ti/Te or any mismatch between patient's demand and ventilator supply leads to patient-ventilator asynchrony. [3]

Ventilatory over assistance or under assistance translates to different types of asynchronies with different effects on patients. [4] Optimal patient-ventilator interaction is crucial to assure comfort with mechanical ventilation and to avoid poor outcomes. [5] Studies show that changing ventilator settings in response to patient's breathing pattern is more effective, and more rational than, increasing sedation. [3]

Ideally, during assisted modes of support, the end of mechanical inspiration should coincide with the end of neural inspiration. However, this rarely happens. [6] Usually the ventilator flow stops either before or after the patient stops his inspiratory effort: expiratory asynchrony. [7]

If mechanical inspiration ends before neural inspiration, then ventilator assistance will cease while the inspiratory muscles continue to contract (early cycling). This asynchrony may cause double triggering, [8] overestimation of patient breathing frequency [6] and increased work of breathing. [3]

At the end of mechanical inspiration, muscle pressure (Pmus) continues to increase and, because the inspiratory flow is zero or is reversed, the muscle tension is applied to overcome the elastic recoil of the respiratory system. If the respiratory system volume decreases rapidly, Pmus may be greater than elastic recoil. Airway pressure could decrease below PEEP and this will trigger the ventilator (double triggering). [6]

For both volume and pressure control, this is recognized in the expiratory flow waveform as a distortion of the peak expiratory flow and disruption of the normally smooth exponential flow decay of passive expiration. [9]

Proposed remedial action: increase inspiratory time, check cycling off in pressure support, consider proportional modes utilization. [10]

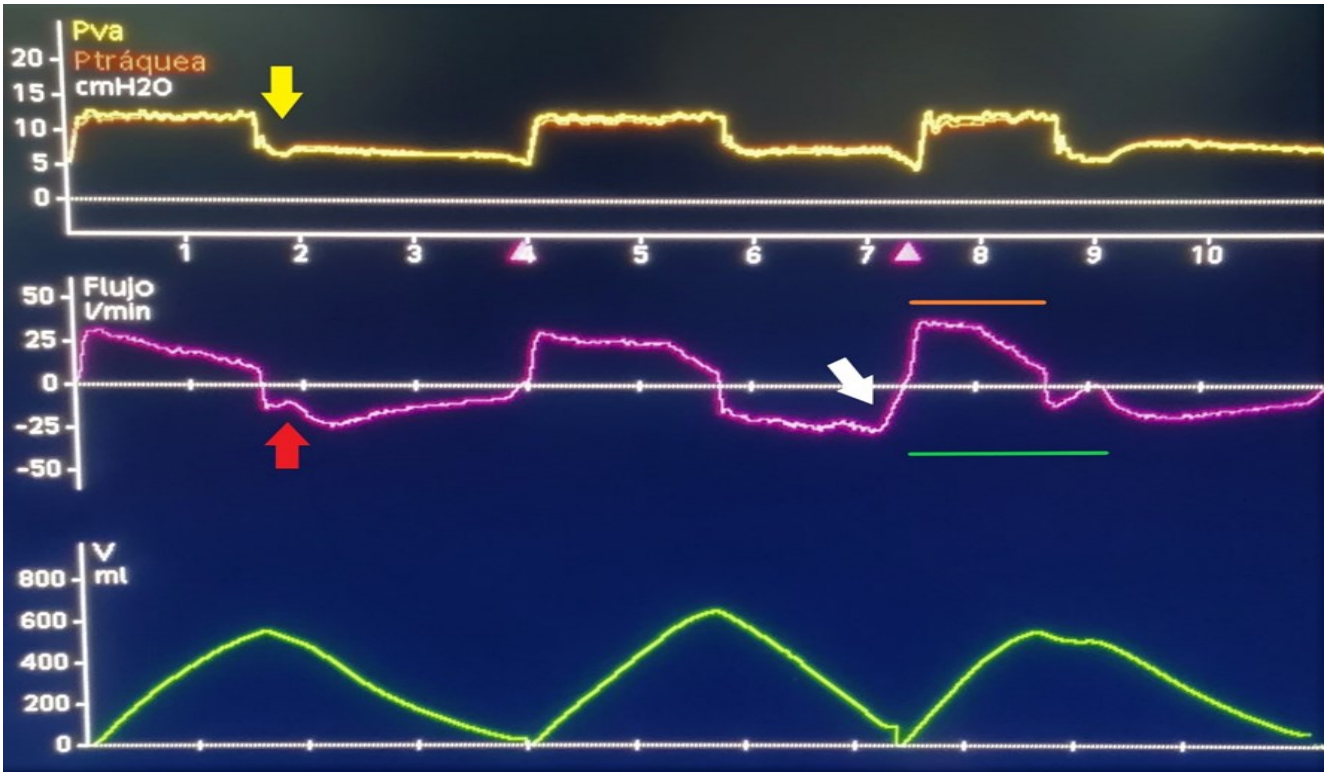

Figure 1: Early cycling in pressure support. From top to bottom: pressure-time, flow-time and volume-time curves. Cycling criterion set at 30%. We can see the continuous inspiratory effort of the patient in the expiratory flow curve: convex pattern (red arrow) and a concavity in the pressure-time curve (yellow arrow). Mechanical inspiratory time: orange line. Neural inspiratory time: green line. We can also see air trapping (white arrow)

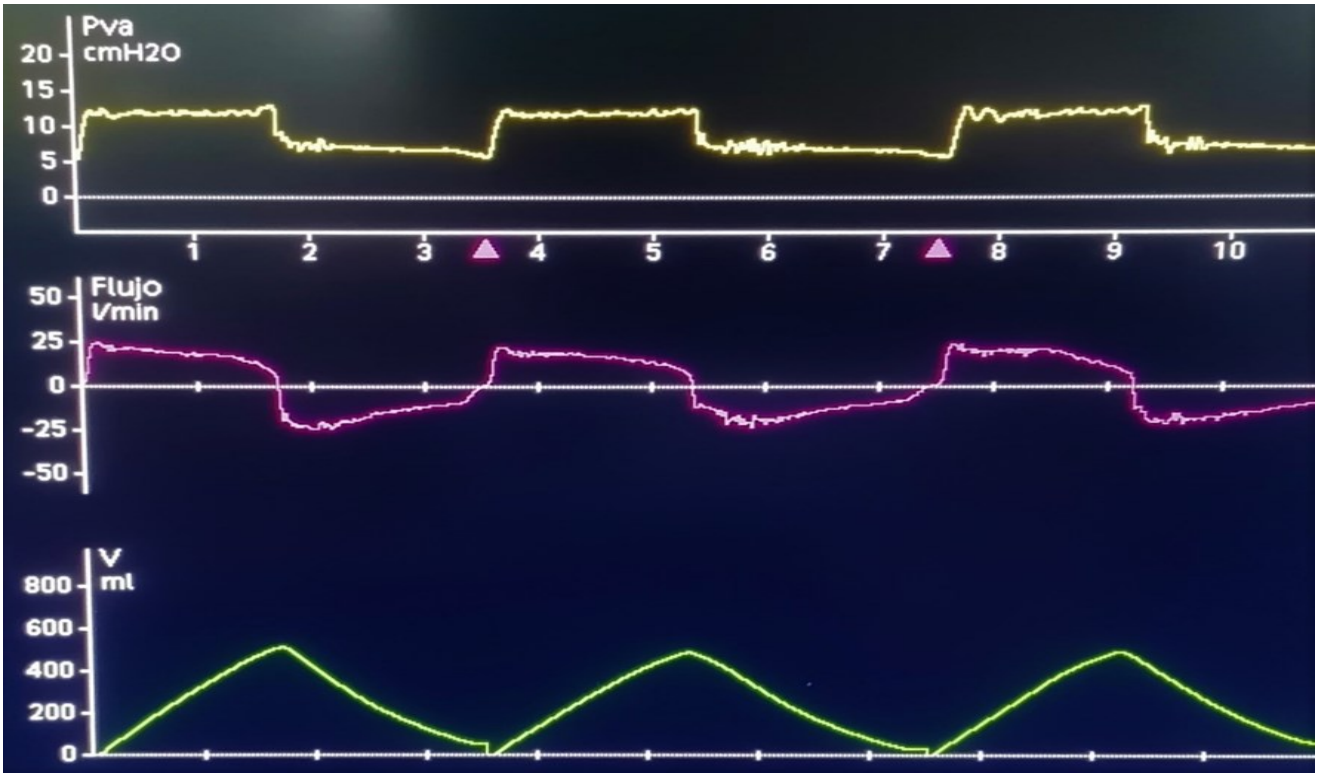

Figure 2: Partial correction of early cycling. The cycling criterion was reduced to 20%, which increased the mechanical inspiratory time trying to match the neural inspiratory time

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