Myoclonus Due to Acute-On-Chronic Hypercarbic Respiratory Failure

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KEYWORDS: Hypercarbia; Myoclonus; Asterixis; Chronic obstructive pulmonary disease; Respiratory failure

INTRODUCTION

Hypercarbic respiratory failure is defined by an elevation in the partial pressure of carbon dioxide in the blood and occurs when one or more elements of the respiratory system fail.[1] Intrinsic lung disease is the leading cause of hypercarbic respiratory failure and, within this category, chronic obstructive pulmonary disease (COPD) is the most common etiology. Hypercarbia is known to cause a wide array of neurological symptoms, ranging from somnolence to seizures, coma, and death. Therefore, identifying this diagnosis early in its course is essential.[2,3] In the appropriate clinical scenario, myoclonus may be a clue suggesting the presence of hypercarbic respiratory failure.[4]

CASE PRESENTATION

A 73-year-old man had history of COPD (on 3–4L of supplemental oxygen), myocardial infarction, heart failure with reduced ejection fraction, implantable cardioverter-defibrillator, atrial fibrillation, hypertension, and untreated obstructive sleep apnea. He presented to the emergency department with complaints of worsening dyspnea, generalized weakness, and tremors. On initial physical examination he was tachycardic and tachypneic, with shallow and diminished breath sounds throughout both lung fields. The patient was somnolent and exhibited psychomotor slowing. Prominent positive and negative myoclonus was appreciated in his bilateral upper > lower extremities, also involving the face and trunk [**Video, Part 1**].

Venous blood gases were consistent with acute-on-chronic hypercarbic respiratory failure (pH 7.26, pCO2 102 mmHg, HCO3 45.7 mmol/L, pO2 45 mmHg). Testing for SARS-CoV-2 was negative. Computed tomography of the chest demonstrated bibasilar consolidations/infiltrates and underlying chronic changes in the lung, without pleural effusion. Computed tomography of the head revealed no significant abnormalities.

Positive pressure non-invasive ventilation was initiated, and the patient was admitted to the step-down unit. Antibiotics, steroids, and nebulizer treatments were administered. Overnight he responded appropriately to ventilation, and the following day the patient was awake, oriented, and interactive. Myoclonus had fully resolved [**Video, Part 2**]. Repeat venous blood gas demonstrated a pH of 7.44, pCO2 of 60 mmHg, HCO3 of 40.8 mmol/L, and pO2 of 26.1 mmHg.

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https://vimeo.com/1189470556 [1:13]

Video part 1. Pre-treatment examination
Myoclonus in a patient with acute-on-chronic hypercarbic respiratory failure. The patient had both positive and negative myoclonus (asterixis) that preferentially involved the upper > lower extremities, but were also seen in his face and trunk.

Video part 2. Post-treatment examination
Following delivery of positive pressure non-invasive ventilation and improvement in hypercarbia, the patient's myoclonus resolved.

DISCUSSION

Myoclonus is a hyperkinetic, involuntary movement disorder that can be characterized by sudden, brief, lightning-like muscle contractions (positive myoclonus) or by abrupt cessation of muscle tone (negative myoclonus).[4] Asterixis represents a specific form of negative myoclonus that typically occurs in toxic-metabolic encephalopathies, most commonly hepatic and uremic encephalopathy, though it has also been reported in hypercapnic respiratory failure. The distribution of myoclonus may be generalized, focal, or multifocal.[4,5]

Among hospitalized patients, toxic-metabolic derangements are a common cause of myoclonus. Acute processes that may be associated with the development of myoclonus, and asterixis in particular, include uremic and hepatic encephalopathies, electrolyte abnormalities, or certain drug toxicities. Hypoxic-ischemic encephalopathy is another process that frequently leads to the development of myoclonus. Correctly identifying the etiology of myoclonus leads to physiology-based treatment.[6]

Hypercarbia is one often overlooked cause of both positive and negative myoclonus. Furthermore, there is a paucity of video cases in the literature illustrating the phenomenology of myoclonus in the context of hypercarbia. The pathophysiology of hypercarbia-associated myoclonus is incompletely understood. One theory is that elevated CO2 levels may lead to depressed afferent transmission and altered synaptic function between type Ia fibers of the muscle spindle and the alpha motor neuron, affecting neuromuscular function.[7] Additionally, hypercapnia-induced acidosis may modulate neuronal excitability through pH-dependent mechanisms, including inhibition of voltage-gated sodium and calcium channels, modulation of adenosine and adenosine triphosphate signaling pathways, and effects on GABAergic inhibitory circuits, which collectively influence cortical excitability and synaptic transmission.[8]

In addition to some of the more "classical" toxic-metabolic processes, the presence of myoclonus should prompt timely evaluation for possible CO2 retention and acute respiratory failure, as this can be potentially life-threatening. In this context, correction of hypercarbia should lead to gradual improvement in myoclonus. Hence, clinical examination of myoclonus may also assist in monitoring a patient's respiratory status and response to treatment.

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Disclosures

Study sponsorship/funding: No targeted funding for this manuscript. M.F. Villamar is the recipient of a Faculty Career Development Award from Brown Physicians, Inc.

Declaration of conflicting interests: Drs. Hilario Brugues, Tuladhar, and Merolli have no conflicts of interest to declare. Dr. Villamar has no conflicts of interest that are relevant to this manuscript. He has served as a consultant for Ceribell, Inc. and is recipient of a Career Development Award from Brown Physicians, Inc.

Acknowledgments: The authors thank the patient for consenting to this publication.

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