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Case Report

High parasternal intercostal muscle thickening prior to intubation in COVID-19 infection ☆

Abdallah FAYSSOIL, MD[a,b,], Robert CARLIER, MD[c], Nicolas MANSENCAL, MD[b], Frédéric LOFASO, MD[d], Djillali ANNANE, MD[e]*

[a] *Raymond Poincaré Hospital, Echo Lab, APHP, Boulevard Raymond Poincaré, Garches, France*
[b] *Department of Cardiology, Ambroise Paré Hospital, Assistance Publique-Hôpitaux de Paris (AP-HP), Centre de référence des cardiomyopathies et des troubles du rythme cardiaque héréditaires ou rares, Université de Versailles-Saint Quentin (UVSQ), Boulogne, France*
[c] *Department of Radiology, APHP, Hôpitaux R. Poincaré-A Paré, DMU Smart Imaging, GH Université Paris-Saclay, Boulevard Raymond Poincare, Garches, France*
[d] *Service d'Explorations Fonctionnelles Respiratoires, Université Paris-Saclay. AP-HP, Hôpital Raymond Poincaré, 92380, Garches, France*
[e] *Intensive Care Unit, Raymond Poincaré Hospital, Boulevard Raymond Poincaré, Garches, APHP, France*

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ABSTRACT

Acute hypoxemic respiratory failure (AHRF) is a major complication of COVID-19 pneumonia and parasternal intercostal muscle thickening may be used as a biomarker to assess inspiratory effort. We report the case of a high utilization of parasternal intercostal muscle prior to the introduction of invasive ventilation in a 66-year old male none vaccinated COVID -19 patient admitted in hospital because of AHRF.

Introduction

Acute hypoxemic respiratory failure (AHRF) is a major complication of COVID-19 pneumonia. Parasternal intercostal muscle can be solicited to cope with the acute respiratory failure and the increased load. Ultrasound can be used to assess parasternal intercostal muscle [1]. We report the case of a high utilization of parasternal intercostal muscle prior to the introduction of invasive ventilation in a 66-year old male none vaccinated COVID -19 patient admitted because of AHRF.

Parasternal intercostal muscle was assessed using a linear probe positioned between the second and the third ribs, laterally in a sagittal plane, 3-4 cm from the sternum; the parasternal muscle was analyzed and visualized, using B mode, as a 3-layered biconcave structure (Fig. 1). The mus-

AHRF, acute hypoxemic respiratory failure; HFNC, high flow nasal cannula; TFic, parasternal muscle intercostal thickening fraction.

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* *Corresponding author.* A. Fayssoil
E-mail address: abdallah.fayssoil@aphp.fr (A. FAYSSOIL).

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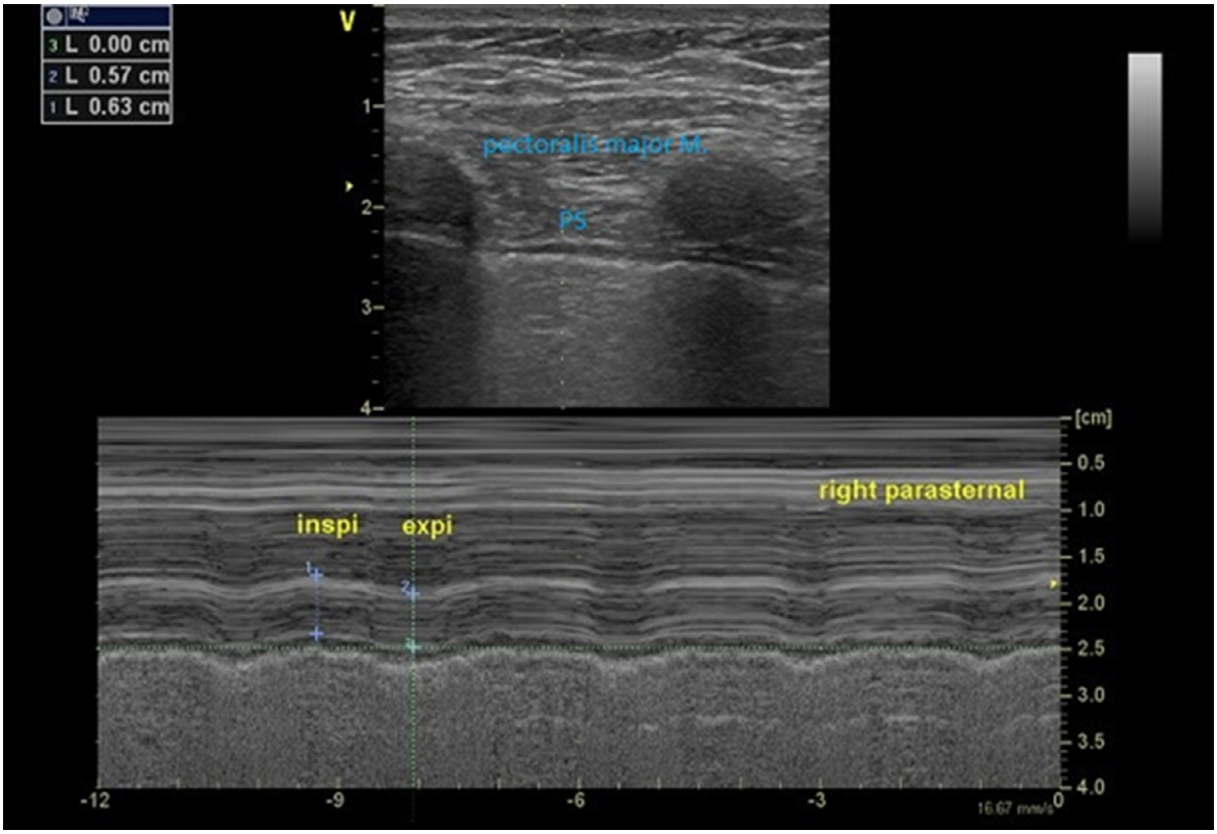

Fig. 1 – Right parasternal intercostal muscle analysis using ultrasound in a COVID-19 patient on HFNC. Note the ventral motion of the parasternal intercostal muscle during inspiration in the context of COVID-19 acute respiratory failure. HFNC: high flow nasal canula; Inspi: inspiration; Expi: expiration; PS: parasternal intercostal muscle; M.: muscle.

cle parasternal thickness was measured above the pleural line between the 2 hyper-echogenic layers. This technique is feasible and reproducible [2, 3]. Parasternal muscle intercostal thickening fraction (TFic) was calculated from the measurement of the parasternal intercostal thickness end expiratory and the parasternal intercostal thickness end inspiratory using the following formula: TFic = (end inspiratory parasternal intercostal thickness - end expiratory para sternal intercostal thickness)/end expiratory parasternal intercostal thickness [2].

Case report

A 66-year old male none vaccinated COVID -19 patient was admitted in ICU (Intensive Care Unit) because of acute AHRF. Laboratory confirmation for SARS-Cov-2 was done from real-time reverse transcriptase-polymerase reaction (RT-PCR) assay from nasopharyngeal swab. Chest CT scan showed significant lung features with ground glass opacities and bilateral patchy shadows (disease extent severe 50%-75%) (Fig. 2). His past medical history was pertinent for arterial hypertension, diabetes, dyslipidemia and obesity. He took daily aspirin, fibrate, angiotensin receptors blockers, thiazide diuretic, and calcium channel blockers. Diabetes was treated with insulin and metformin. He complained of fever, dyspnea occurred 10 days prior to hospital's admission. At admission in the emergency department, oxygen saturation measured with pulse oximetry was at 66%, increasing to 93% with the introduction of oxygen support (15 liters per minute) and respiratory rate was at 28 cycles/min. Heart rate was at 105 bpm and arterial systolic and diastolic blood pressures respectively 140 mmHg

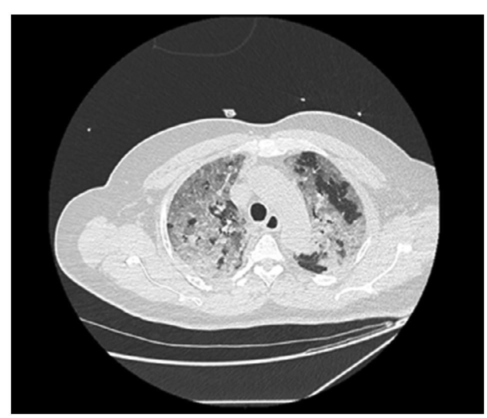

Fig. 2 – Chest CT scan showing significant lung features with ground glass opacities and bilateral patchy shadows.

and 74 mmHg. A high flow nasal cannula (HFNC) (fraction of inspired oxygen FIO2 at 1.0; gas flow rate at 60 L/min) was introduced at admission in the ICU. Blood gas exchange results were as follow: pH 7.46, PCO2 5.8 kPa, PO2 13.3 kPa, bicarbonates at 32 mmol/L and lactates 2.4mmol/L. Other biological results were as follow: Nt proBNP (brain natriuretic peptid) 541 ng/L, troponin T (hs) at 25 ng/L, reduced lymphocytes (470/mm^3), creatininemia at 131 micromol/L, hemoglobin 8.2 g/gL and D-dimers at 2132 ng/mL. Electrocardiogram showed sinus rhythm with right bundle branch block. The patient was treated with steroids and antibiotics. The ROX index [5], that is an index to predict intubation in patients on HFNC, was at 3.6. The ROX index is the ratio of oxygen saturation/FIO2 to respiratory rate [5]. Since the patient remains unstable with high rest dyspnea, at bedside, a cardiac ultrasound was performed 2 days after the ICU admission, coupled with diaphragm and parasternal ultrasound. Doppler Echocardiography disclosed normal left ventricular ejection fraction, reduced global longitudinal strain of the left ventricle (-13%) and normal left ventricular diastolic loading, and normal arterial pulmonary pressure. Diaphragm ultrasound found a right diaphragm inspiratory motion at 14 mm. We found a high utilization of the parasternal intercostal muscle attested by a parasternal intercostal muscle TFic at 11%. The respiratory function worsened despite HFNC and invasive ventilation was introduced. The evolution was unfavorable with the onset of acute respiratory distress syndrome (ARDS), pulmonary arterial hypertension without pulmonary embolism, right ventricular dilation, and acute renal failure requiring the introduction of renal replacement therapy and ventilator-associated pneumonia treated with antibiotics. Twelve days later post ICU admission, the patent died from refractory shock and multi-organ failure.

Discussion

We report here the case of a high utilization of parasternal intercostal muscle prior to the introduction of invasive ventilation in a COVID-19 patient. The patient was on spontaneous ventilation and respiratory system was supplied using HFNC. Spontaneous breathing may expose patients to P-SILI (patient self-inflicted lung injury) [4]. In fact, in patients on spontaneous breathing, respiratory muscles work to provide a pressure gradient allowing the air to enter in the alveolar, *via* the transpulmonary pressure that is the difference between airway pressure and pleural pressure. However, the onset of vigorous breathing may induce more negative swing in the alveoli pressure in comparison with the hydrostatic trans vascular pressure; this phenomena may cause lung edema [5]. In this context, monitoring inspiratory effort may be essential to avoid lung injury aggravation in COVID-19. Since traditional invasive methods used to assess inspiratory effort that include pressure time product and work of breathing measurement require an invasive approach (esophageal and gastric pressures using catheters) and since these techniques cannot be done routinely in ICU, respiratory ultrasound may help to evaluate and monitor patients. Parasternal intercostal muscle has been used as a biomarker to assess neural respiratory drive and respiratory effort using electromyogram [6]. Recently, ultrasound has been proposed to assess parasternal intercostal muscle [7]. In normal situations, at rest, normal end expiratory parasternal intercostal muscle thickness is at 2.8 mm whereas parasternal intercostal muscle thickening fraction (TFic) is at 3% [7]. During inspiration, parasternal intercostal muscle moves ventrally and straightens, as reported by Cala et al [2] and attested by this case report. Parasternal intercostal muscle thickening has been reported to be an index of inspiratory effort [1].

HFNC improves oxygenation and inspiratory effort in patients with AHRF [8]. In patients with COVID-19, a reduction in oxygenation failure was found with the utilization of HFNC; however HFNC did not affect 90-days mortality [9]. Finally, a ROX index less that 3.83 at H12 in patients on HFNC was reported to predict HFNC failure [10]. In this case, the ROX index was calculated at H48 and was at 3.6. This physiological index may be coupled with parasternal ultrasound. Prospective studies are warranted to assess the potential application of parasternal intercostal ultrasound in COVID-19 patients.

In conclusion, this case illustrates the physiological process involved in severe COVID-19 patients and highlights the potential application of this technique to stratify COVID-19 patients with AHRF.

Patient consent

Informed consent for publication of their case was obtained from the patient.

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