Dear Editor,

An outbreak of coronavirus disease in 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is a pandemic and public health emergency [1, 2]. COVID-19 has been largely studied as it negatively affects the lungs leading to pneumonia, acute respiratory distress syndrome, and pulmonary thrombotic phenomena [3–7]. However, the impact of this virus on respiratory muscles’ cytopathology had not yet been fully addressed.

Due to the large number of COVID-19 cases in Brazil, the Clinical Hospital of the Faculty of Medicine of the University of São Paulo has allocated all of its beds to receive patients with COVID-19, and unfortunately, it is expected that a large number of deaths will still occur. Although severe manifestations of COVID-19 that may lead to death are more common in older patients [3–5], several unexpected deaths have been reported in previously healthy young adults and teenagers [8, 9]. Thus, recently, we read an interesting issue published in your journal (Acta Cytologica from January to February 2020) concerning techniques in cytopathological specimens [10] that encouraged us to highlight the ultrasound-guided minimally invasive autopsies as a link between clinicians and cytopathologists.

Safety and cost-effective techniques in autopsy are essential in COVID-19 pandemic era. Thus, ultrasound-guided minimally invasive autopsies are both simple and significantly less risky in comparison to conventional autopsy, which allows to characterize the pathology of the SARS-CoV-2 [6, 11]. In traditional autopsy, the professional is exposed to more risks as a thoracotomy is needed for respiratory muscles sampling. However, ultrasound-guided minimally invasive autopsies targets small tissue fragments by needle puncture for diagnosis [12]. For the procedure, a portable SonoSite M-Turbo R (Fujifilm, Bothell, WA, USA) ultrasound with C60x (5–2 MHz Convex) multifrequency broadband transducer was employed as lower frequency ultrasound waves permit a more in-depth visualization of all the organs. After locating the target tissue, we used a Tru-CutR...
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We used a semi-automatic 14 G coaxial needle with 20 cm length for tissue puncture and collection, still using Sonosite for needle guidance. Samples from both diaphragm and intercostal muscles were fixed in formalin and embedded in paraffin [13]. Further, sections were stained with hematoxylin and eosin for general structure evaluation using parameters from The National Toxicology Program from the US Department of Health and Human Services [14].

From ethical approval of the Clinical Hospital of the Faculty of Medicine of the University of São Paulo (protocol #3951.904), we showed in Figure 1 our histopathological findings. We observed fiber degeneration that is characterized as cell swelling, hypereosinophilia, vacuolation, loss of striation, fragmentation, and rupture of cell cytoplasm. This process leads to atrophy, increasing the extracellular space (edema) that will be occupied by collagen fibers in response to muscle injury, which decreases muscle function. Recently, autopsy study showed that diaphragm muscle had increased collagen deposit in critically ill patients with COVID-19 infection [15], which is in accordance with muscle injury, as seen in our study using ultrasound-guided minimally invasive autopsy.

Despite the decline in postmortem examination rate due to COVID-19, autopsy remains the gold standard technique able to provide valuable knowledge about different pathologies. Thus, we hope that both our methodology and histological findings may shed a light in COVID-19 pathogenesis on respiratory muscles.

**Conflict of Interest Statement**

The authors have no conflicts of interest to declare.

**Funding Sources**

This study has not received any funding.

**Author Contributions**

R.A.B.N., M.D., P.H.N.S., and W.J.F. collected the samples, analyzed the results, and drafted the letter.
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