ULTRASOUND NEWS

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Article

Importance of Lung Ultrasound Follow-Up in Patients Who Had Recovered from Coronavirus Disease 2019: Results from a Prospective Study

Alba Hernández-Píriz [1,2,3], Yale Tung-Chen [4,5,*], David Jiménez-Virumbrales [3,6], Ibone Ayala-Larrañaga [1], Raquel Barba-Martín [2,3,7], Jesús Canora-Lebrato [1,2,3], Antonio Zapatero-Gaviria [1,2,3] and Gonzalo García De Casasola-Sánchez [3,8]

In conclusion, lung injury associated with COVID-19 might take time to resolve. The findings in this report support the use of lung ultrasound in the short-term follow-up of patients recovered from COVID-19, as a radiation-sparing, easy to use, novel care path worth exploring.

One month after the initial study, **only 20.8% had complete resolution** on lung ultrasound. This percentage rose to **68.7% at 3 months**. Residual lesions were observed in a significant percentage of patients who recovered from moderate or severe ARDS (32.4% and 61.5%, respectively).

Keywords: coronavirus disease 2019 (COVID-19); severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); lung ultrasound (LUS); lung score

Abstract

Our objective was to assess the usefulness of lung ultrasound in the short-term follow-up (1 and 3 months) of patients with SARS-CoV-2 pneumonia, and to describe the progression of the most relevant lung ultrasound findings.

We conducted a prospective, longitudinal and observational study performed in patients with confirmed COVID-19 who underwent a lung ultrasound examination during hospitalization and repeated it 1 and 3 months after hospital discharge.

A total of 96 patients were enrolled. In the initial ultrasound, bilateral involvement was present in 100% of the patients with mild, moderate or severe ARDS. The most affected lung area was the postero-inferior (93.8%) followed by the lateral (88.7%). Subpleural consolidations were present in 68% of the patients and consolidations larger than 1 cm in 24%.

One month after the initial study, only 20.8% had complete resolution on lung ultrasound. This percentage rose to 68.7% at 3 months. Residual lesions were observed in a significant percentage of patients who recovered from moderate or severe ARDS (32.4% and 61.5%, respectively).

Table 2 Quantification of re-aeration and loss of aeration by the observation of changes of the LUS pattern in each of the 12 chest areas. The final score is the sum of the 12 areas

Re-aeration score	Loss of aeration score				
+1 point	+3 points	+5 points	−5 points	−3 points	−1 point
B1 to Normal	B2 to Normal	C to Normal	Normal to C	Normal to B2	Normal to B1
B2 to B1	C to B1			B1 to C	B1 to B2
C to B2					B2 to C

B1: multiple separated B-lines; B2: coalescent B-lines or light beam; C: consolidation

INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES

INTERNATIONAL SOCIETY FOR INFECTIOUS DISEASES

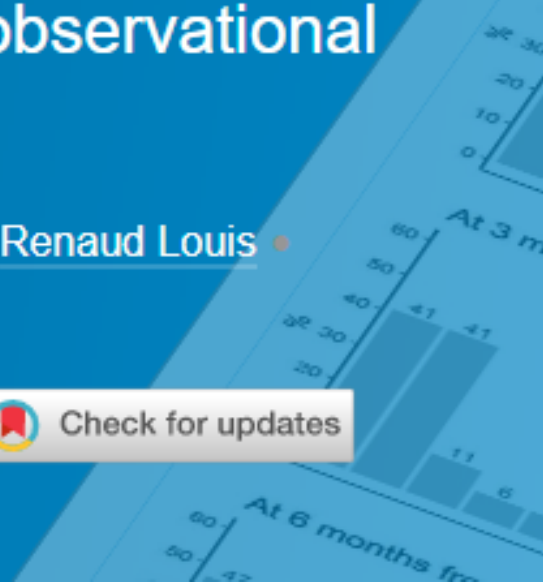
FULL LENGTH ARTICLE | VOLUME 109, P209-216, AUGUST 01, 2021

PDF [776 KB]

Long-term clinical follow-up of patients suffering from moderate-to-severe COVID-19 infection: a monocentric prospective observational cohort study

Gilles Darcis † • Antoine Bouquegneau † • Nathalie Maes • ... Michel Moutschen • Renaud Louis • Julien Guiot • Show all authors • Show footnotes

Open Access • Published: July 14, 2021 • DOI: https://doi.org/10.1016/j.ijid.2021.07.016 •



INTERNATIONAL JOURNAL OF INFECTIOUS DISEASES

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Highlights

- Post-coronavirus disease 2019 (COVID-19) conditions are common.
- The prevalence of tiredness up to 6 months after COVID-19 is high.
- The prevalence of shortness of breath up to 6 months after COVID-19 is high.
- Pulmonary function tests improved during follow-up.
- Chest computed tomography scan at 3 months after discharge showed that most images were improved.

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Long-term clinical follow-up of patients suffering from moderate-to-severe COVID-19 infection: a monocentric prospective observational cohort study

Gilles Darcis[a,†,*], Antoine Bouquegneau[b,†], Nathalie Maes[c], Marie Thys[c], Monique Henket[d], Florence Labye[e], Anne-Françoise Rousseau[f], Perrine Canivet[g], Colin Desir[g], Doriane Calmes[d], Raphael Schils[a], Sophie De Worm[a], Philippe Léonard[a], Paul Meunier[g], Michel Moutschen[a], Renaud Louis[d], Julien Guiot[d]

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ABSTRACT

Objectives

- Various symptoms and considerable organ dysfunction persist following infection with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). Uncertainty remains about the potential mid- and long-term health sequelae. This prospective study of patients hospitalized with coronavirus disease 2019 (COVID-19) in Liège University Hospital, Belgium aimed to determine the persistent consequences of COVID-19.

Methods

- Patients admitted to the University Hospital of Liège with moderate-to-severe confirmed COVID-19, discharged between 2 March and 1 October 2020, were recruited prospectively. Follow-up at 3 and 6 months after hospital discharge included demographic and clinical data, biological data, pulmonary function tests (PFTs) and high-resolution computed tomography (CT) scans of the chest.

Results

- In total, 199 individuals were included in the analysis. Most patients received oxygen supplementation (80.4%). Six months after discharge, 47% and 32% of patients still had exertional dyspnoea and fatigue. PFTs at 3-month follow-up revealed a reduced diffusion capacity of carbon monoxide (mean 71.6 ± 18.6%), and this increased significantly at 6-month follow-up ($P<0.0001$). Chest CT scans showed a high prevalence (68.9% of the cohort) of persistent abnormalities, mainly ground glass opacities. Duration of hospitalization, intensive care unit admission and mechanical ventilation were not associated with the persistence of symptoms 3 months after discharge.

Conclusion

- The prevalence of persistent symptoms following hospitalization with COVID-19 is high and stable for **up to 6 months after discharge**. However, biological, functional and iconographic abnormalities improved significantly over time.

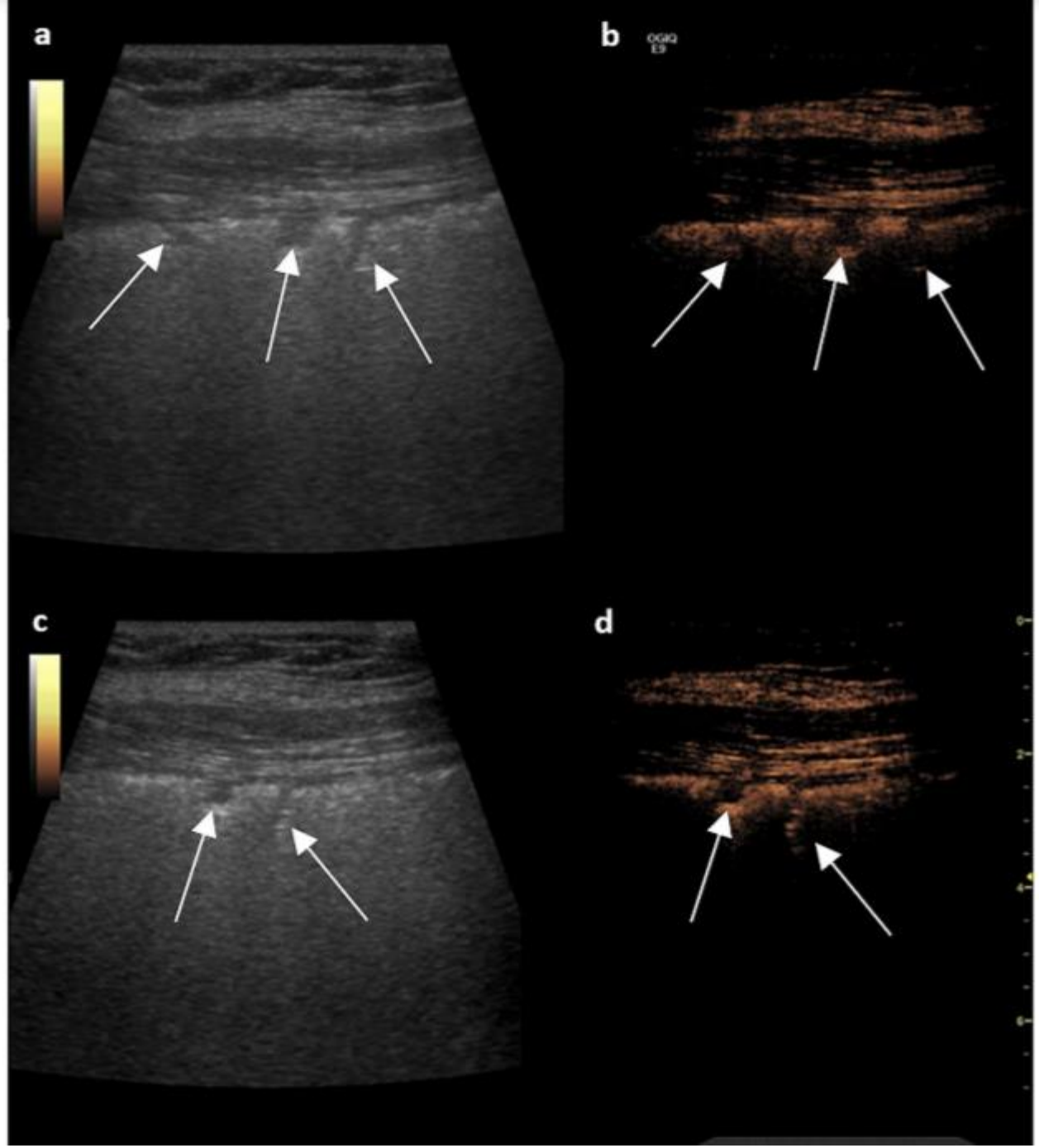
Intensive Care Med (2020) 46:1660–1662
https://doi.org/10.1007/s00134-020-06085-4

CORRESPONDENCE

Contrast-enhanced ultrasound (CEUS) of the lung reveals multiple areas of microthrombi in a COVID-19 patient

Alice Tee, Adrian Wong*, Gibran Timothy Yusuf, Deepak Rao and Paul S. Sidhu

A case of a 61-year-old woman (see Fig. 1) with severe COVID-19 and a negative CTPA study. We were able show that these areas of irregularity, labelled as **subpleural consolidation** by Peng et al. were avascular and therefore most likely to represent 3–5 mm microinfarcts. Conversely, non-thrombotic consolidation would be seen to have some enhancement; a process not appreciated using other imaging modalities due to the superior spatial resolution of ultrasound. Anecdotally, we have also seen these areas resolve with clinical improvement.
It is becoming apparent that severe cases of COVID-19 are characterised by hyperinfammation and a thrombotic phenomenon.
The theory of an underlying thrombotic process also corresponds with studies identifying admission D-dimer, prothrombin time and thrombocytopenia as prognostic markers [3]. Immuno-thrombosis is used to describe the interaction between platelets, coagulation factors and innate immune efector systems that, during an infection, results in secondary thrombus formation.


a
b
c
d

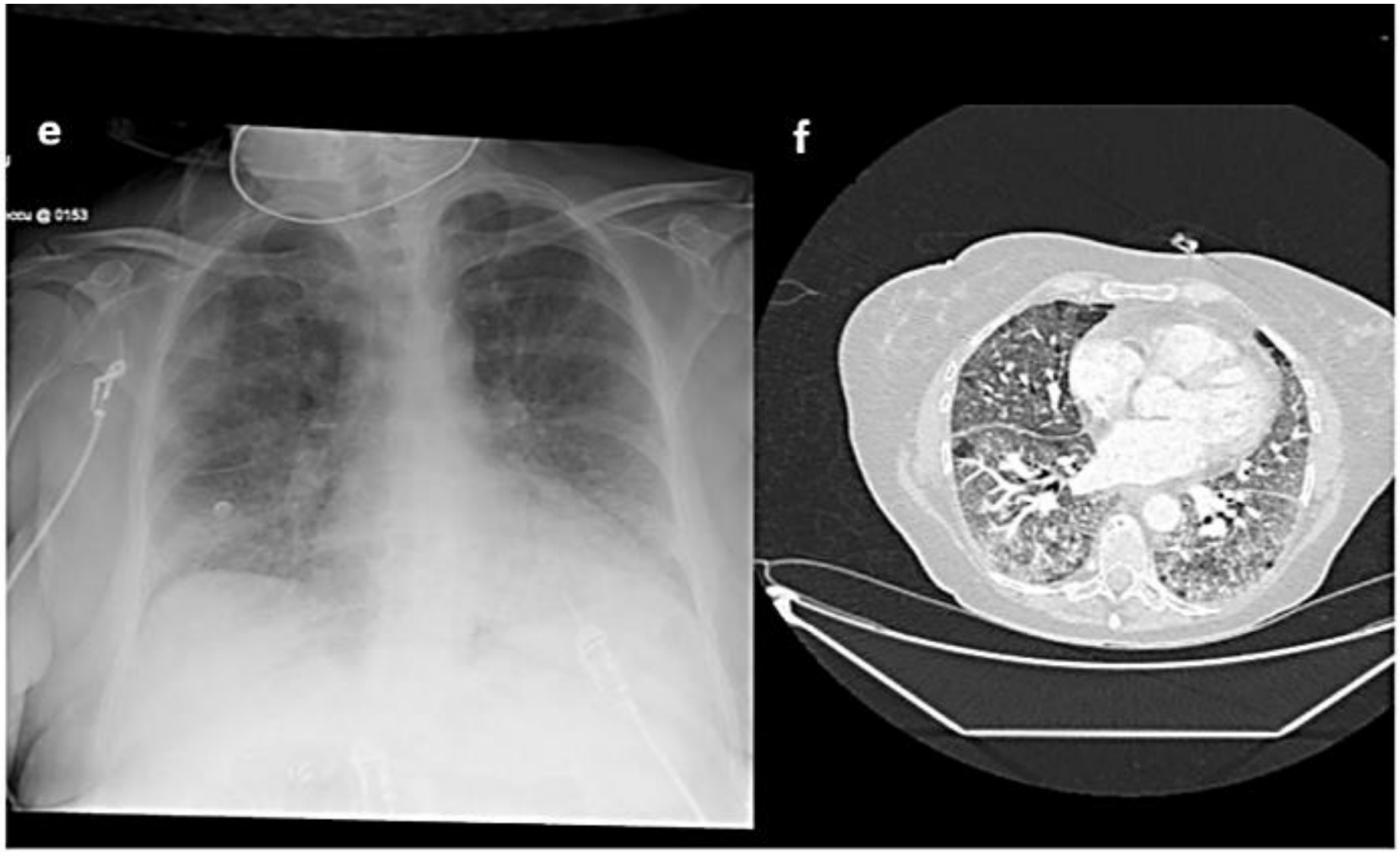


Fig. 1 **a** B mode lung ultrasound demonstrates subpleural consolidation (see arrows), a typical feature seen in COVID-19 pneumonia. **b** Simultaneous contrast enhanced lung ultrasound demonstrates non-enhancing subpleural areas which correspond to areas of infarction measuring just 3–5 mm, similar findings are present in all zones (**c**, **d**). **e** A chest radiograph demonstrates bilateral patchy peripheral infiltrates consistent with COVID-19 infection. **f** A CT PA shows signs typical for severe COVID-19 infection and no pulmonary embolism

Model
PULMOE-1603; No. of Pages 34
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Pulmonology xxx (xxxx) xxx–xxx

PULMONOLOGY

www.journalpulmonology.org

REVIEW

Applicability of lung ultrasound in COVID-19 diagnosis and evaluation of the disease progression: A systematic review☆

A.O. Peixoto[a], R.M. Costa[b,c], R. Uzun[a], A.M.A. Fraga[a], J.D. Ribeiro[a], F.A.L. Marson[a,d,e,*]

Conclusions: The use of LU in the evaluation of patients with COVID-19 should be encouraged due to its intrinsic characteristics; a low cost, radiation free, practical method, with easy to sanitize equipment, which facilitates structural evaluation of lung damage caused by SARS-CoV-2. With the increase in the number of studies and the use of ultrasound scans, LU has been shown as a useful tool to evaluate progression, therapeutic response and follow-up of pulmonary disease in the patients with COVID-19.

Abstract

Introduction:

The COVID-19 pandemic originated in China and within about 4 months affected individuals all over the world. One of the limitations to the management of the COVID-19 is the diagnostic imaging to evaluate lung impairment and the patients' clinical evolution,mainly, in more severe cases that require admission into the intensive care unit. Among image examinations, lung ultrasound (LU) might be a useful tool to employ in the treatment of such patients.

Methods: A survey was carried out on PubMed to locate studies using the descriptors: ((Lung ultrasound OR ultrasound OR lung ultrasonography OR lung US) AND (coronavirus disease-19OR coronavirus disease OR corona virus OR COVID-19 OR COVID19 OR SARS-CoV-2)). The period covered by the search was November 2019 to October 2020 and the papers selected reported LU in COVID-19.

Results: Forty-three studies were selected to produce this systematic review. The main LU findings referred to the presence of focal, multifocal and/or confluent B lines and the presence of pleural irregularities.

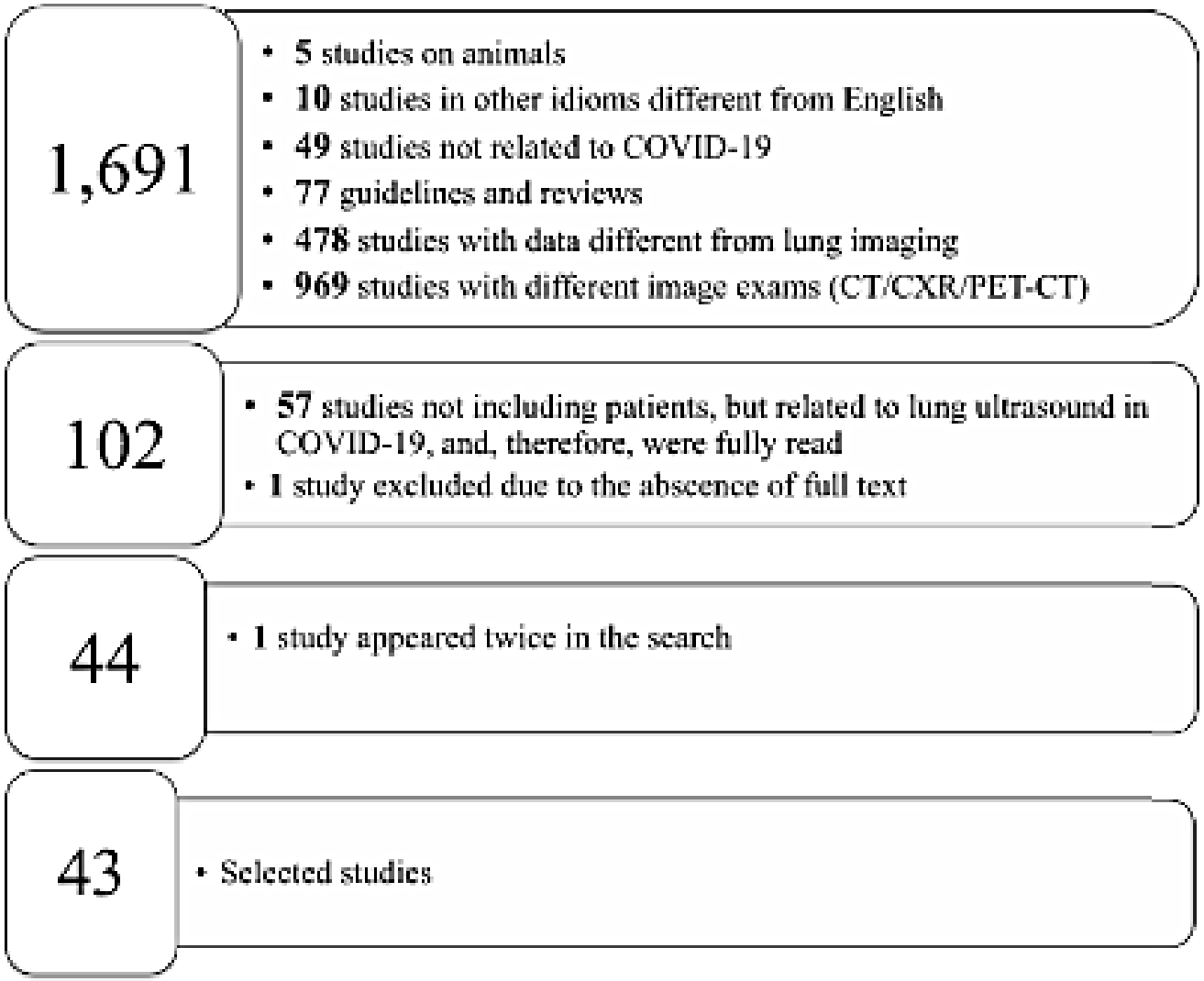


Figure 1 The systematic review flowchart. The systematic review was carried out using the data base PubMed/Medline and according to the preferred reporting items for systematic review and meta-analysis (PRISMA) covering the period from November 2019 to October 2020. The following descriptors guided the search: ((Lung ultrasound OR ultrasound OR lung ultrasonography OR lung US)

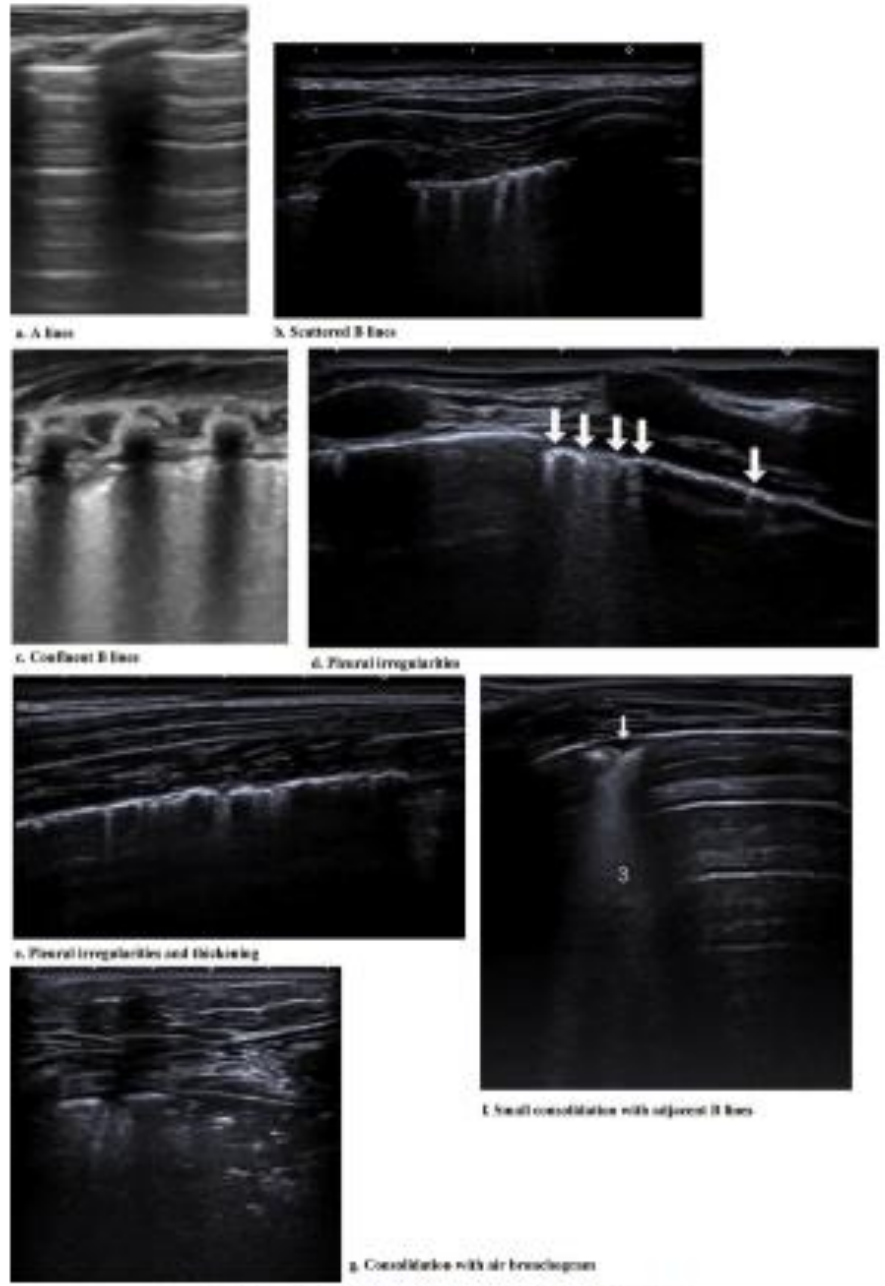
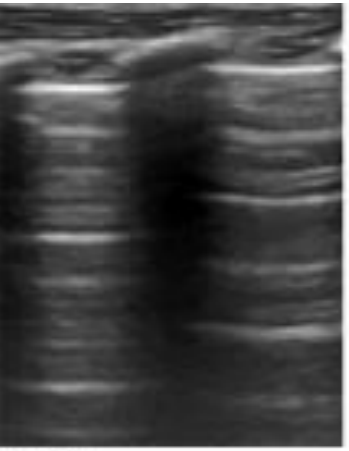
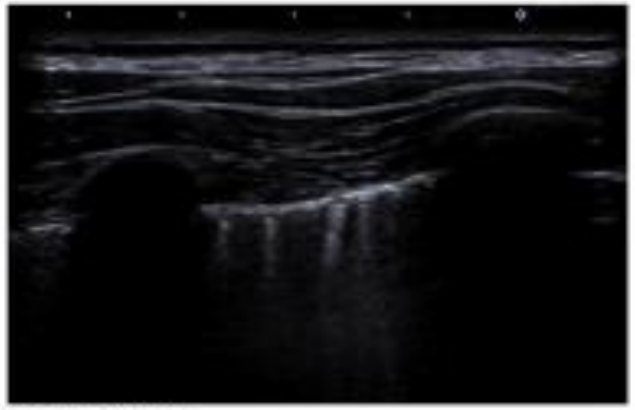


Figure 2 Findings of the LU imaging described in the study.

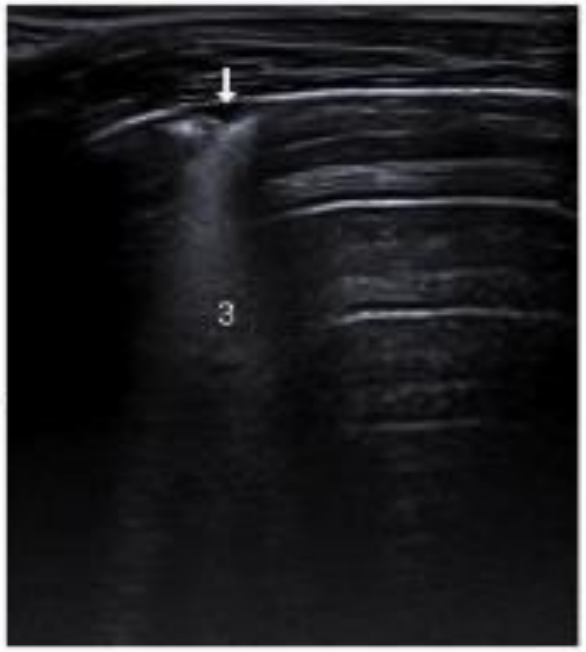


a. A lines

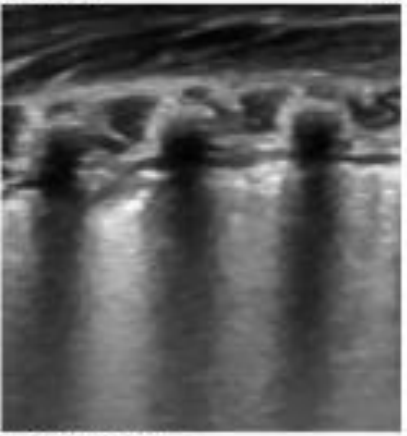


b. Scattered B lines

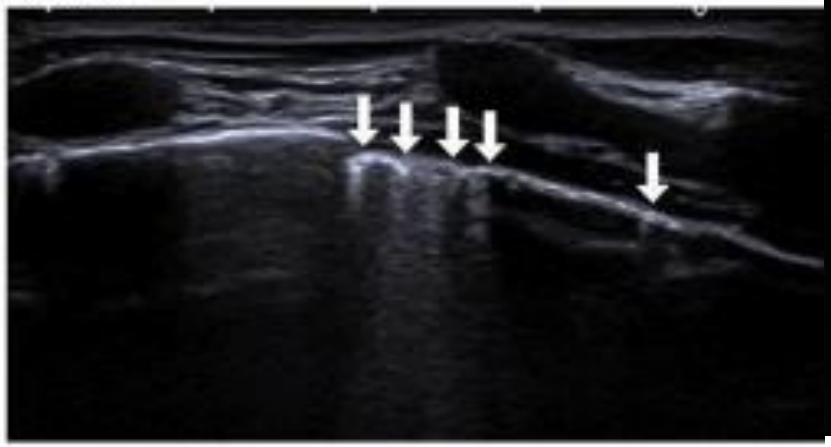
c. Pleural irregularities and thickening



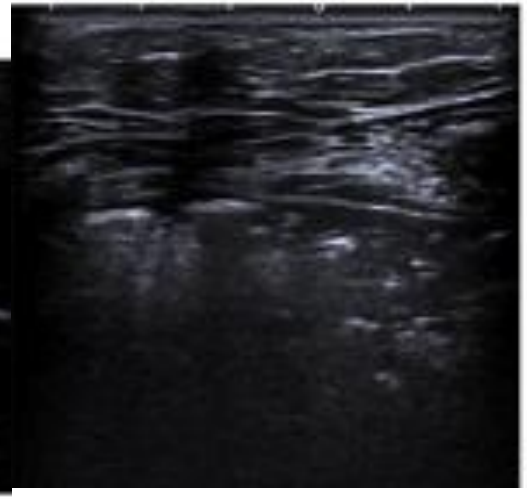
f. Small consolidation with adjacent B lines



c. Confluent B lines



d. Pleural irregularities



g. Consolidation with air bronchogram

Highlights

LU findings presented correlation with HRCT images. LU can be used in respiratory system propaedeutics as an alternative to the ‘‘stethoscope use’’. Special clothing and individual protection equipment are indispensable, since the manipulation of the stethoscope in pulmonary evaluation might create contamination risks for the health professionals and patients.

COVID-19 normally induces a bilateral and diffuse interstitial pneumonia with asymmetric lesions and uneven distribution, mainly involving the **lung periphery**, which makes it particularly suitable for investigation using LU. Studies have identified potential correlation between the LU patterns and the patients’ clinical outcome. One of the assays in this study reported that each pulmonary area could be in a different stage of the disease, therefore, the global evaluation of the lungs is fundamental.

The POCUS allows for hemodynamic, cardiac and vascular evaluations (thromboembolic phenomena ---- deep venous thrombosis).

LU should be associated to the multisystem point-of-care exam, since the SARS-CoV-2 infection might be linked to myocarditis and a high incidence of thromboembolic events. Thus, multi-organ ultrasound evaluation in early treatment is useful to screening these complications at the bedside.

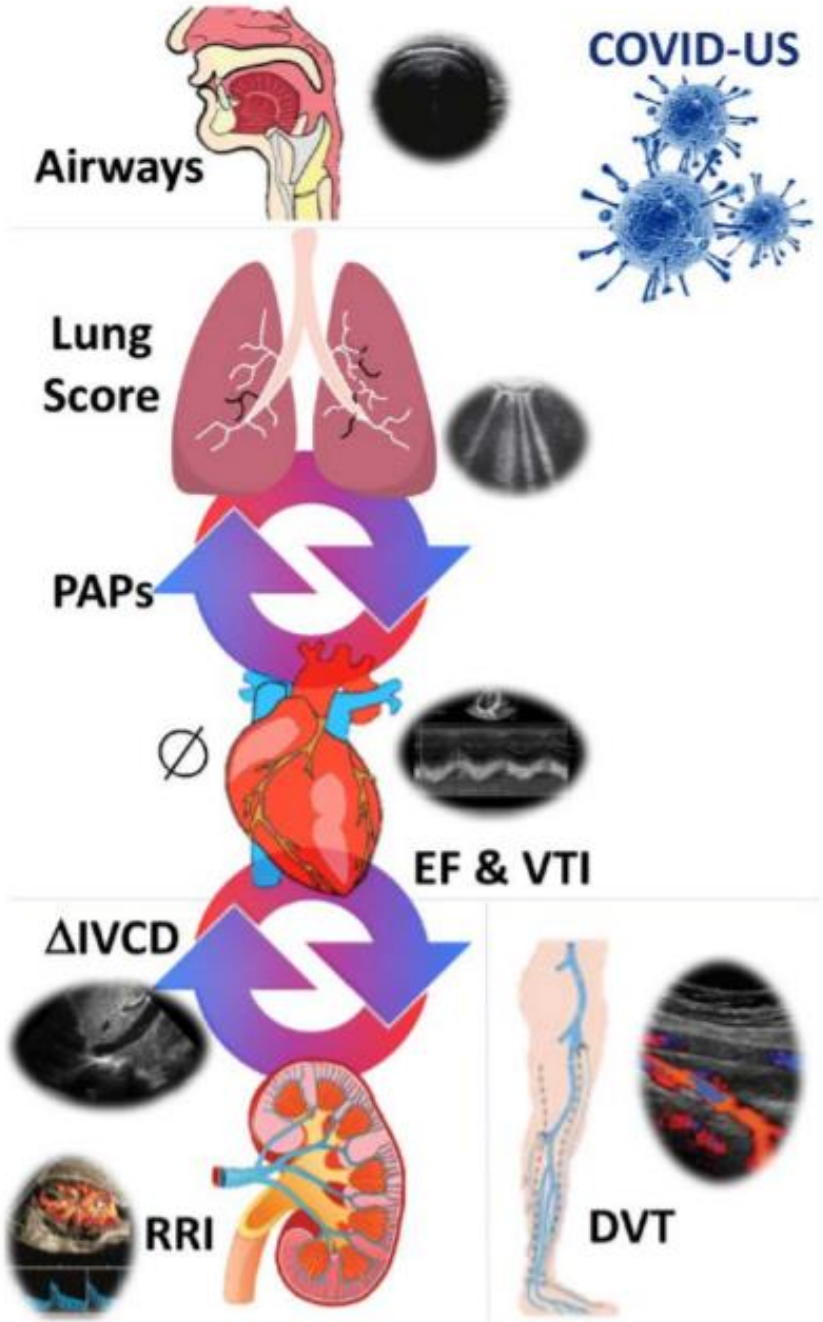
BRIEF REPORTS, BOOK & MEDIA REVIEWS, CORRESPONDENCE, ERRATA: LETTERS TO THE EDITOR

COVID-19: The New Ultrasound Alphabet in SARS-CoV-2 Era

Anile, Antonio MD; Castiglione, Giacomo MD; Zangara, Chiara MD; Calabrò, Chiara MD; Vaccaro, Mauro MD; Sorbello, Massimiliano MD

Author Information

Anesthesia & Analgesia: November 2020 - Volume 131 - Issue 5 - p e232-e234
doi: 10.1213/ANE.0000000000005142



C: cardiac evaluation 1. Cardiac chambers diameters and kinesis 2. Pericardium (effusion, tamponade) 3. pulmonary artery pressure 4. ejection fraction% 5. inferior vena cava diameter variations differential

O: outputs 1. renal resistive index 2. velocity-time integral

V: ventilation 1.B-lines patterns 2. B-lines spatial distribution 3. Hyperinflation and recruitment response 4. Lung score 5. Search for pneumothorax/effusion

I: intubation 1. Prediction of difficult laryngoscopy/intubation 2. Endotracheal intubation confirmation

D: Doppler and deep venous thromboembolism/ pulmonary embolism

Figure. COVID-US applications for monitoring of COVID-19 ICU patients (see text for details). IVCD indicates inferior vena cava diameter variations differential; COVID-19, coronavirus disease 2019; DVT, deep venous thrombosis; EF, ejection fraction; ICU, intensive care unit; PAPs, pulmonary artery pressures; RRI, renal resistive index; US, ultrasound; VTI, velocity-time integral.

TAU TRANSLATIONAL ANDROLOGY AND UROLOGY

Transl Androl Urol. 2020 Oct; 9(5): 1897–1900.
doi: 10.21037/tau-20-900

PMCID: PMC7658157
PMID: 33209652

The testis in patients with COVID-19: virus reservoir or immunization resource?

Federica Barbagallo,[1] Aldo E. Calogero,[1] Rossella Cannarella,[1] Rosita A. Condorelli,[1] Laura M. Mongioì,[1] Antonio Aversa,[2] and Sandro La Vignera[1]

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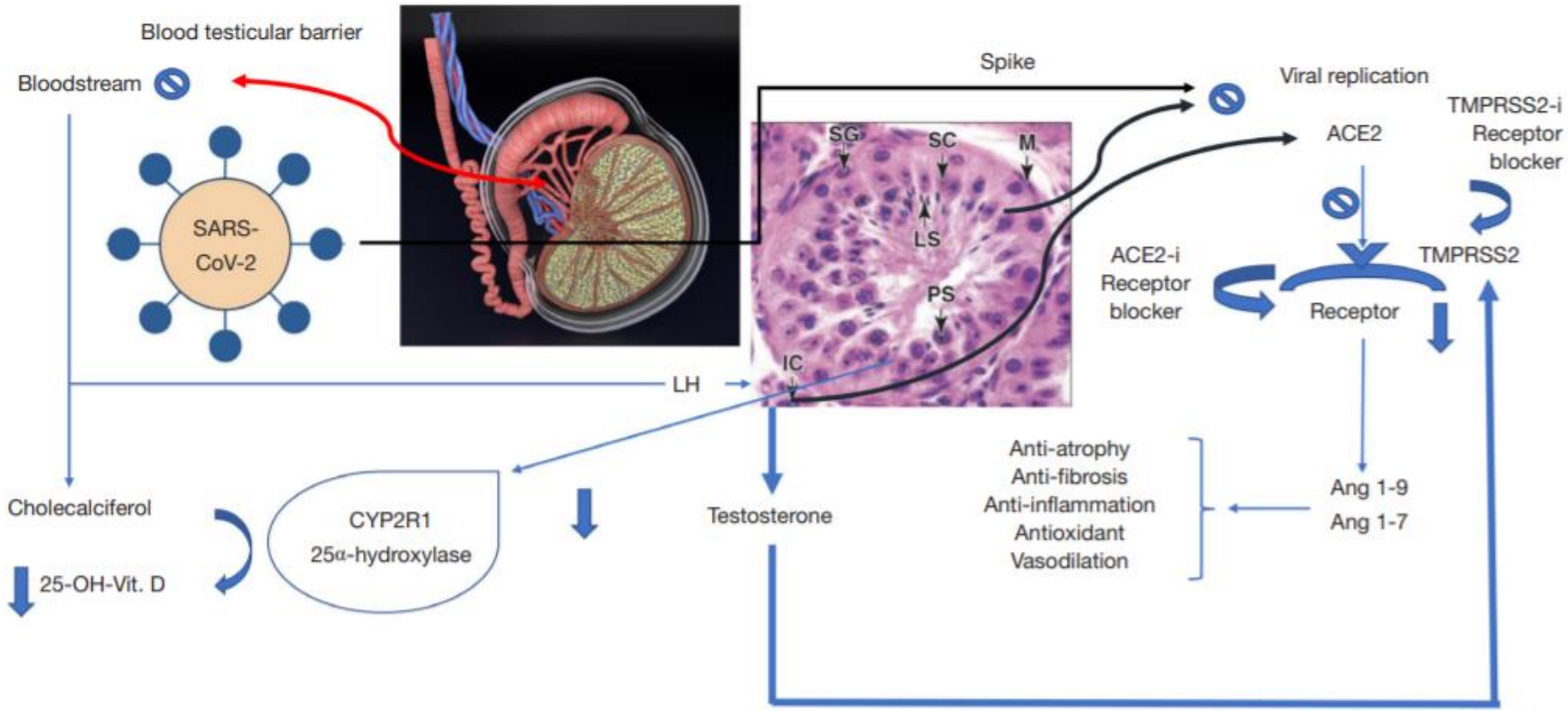


Figure 1 Putative mechanisms of action of SARS-CoV-2 within the testis. Viral spike protein may penetrate the blood-testicular-barrier and, after putative replication, may interact with ACE2 receptors expressed in Leydig and germ cells. The binding of SARS-CoV-2 spike protein to ACE2 down-regulates downstream receptor, thus decreasing its beneficial effects on atrophy/fibrosis/inflammation exerted through Ang 1-9 and Ang 1-7 activation. Also, the possible presence of reduced secretion of LH that frequently such as in patients with hypothalamic-pituitary dysfunction, metabolic hypogonadism, and late-onset hypogonadism, may further contribute in the establishment of low testosterone levels and vitamin D 25-hydroxylation. This is an important protective mechanism leading to TMPRSS2 activation, which has a pivotal role in regulating virus entry into the testis. Finally, when compensatory mechanisms fail, orchitis determined by IgG precipitation in the seminiferous epithelium of SARS testes may represent a complication of SARS [Xu J, Qi L, Chi X, Yang J, Wei X, Gong E, Peh S, Gu J. Orchitis: a complication of severe acute respiratory syndrome (SARS) 2006;74:410-6] and suggests that the reproductive functions should be followed and evaluated in recovered male COVID-19 patients.

Conclusion

Evidence suggests that the testis may be vulnerable to SARS-CoV2 infection. Thus, the reproductive function should be followed and evaluated in COVID-19 male patients, especially in young men. At the same time, the susceptibility of males to severe disease has been constantly reported in these months and men show worse clinical outcomes than women.

Although the etiology is probably multifactorial, the effects of sex hormones on the expression of ACE2 could help in explaining this different susceptibility and lethality between sexes (22). Finally, we speculate that the male gonad may have a potentially important role in the onset of adaptive immune response to COVID-19. It would be interesting to know the disease course for COVID-19 patients with a normal gonadal function or with previous testicular pathologies.

Few data are still available about the link between COVID-19 and male reproductive system but many questions are already open and need to be answered.

Cellular & Molecular Immunology

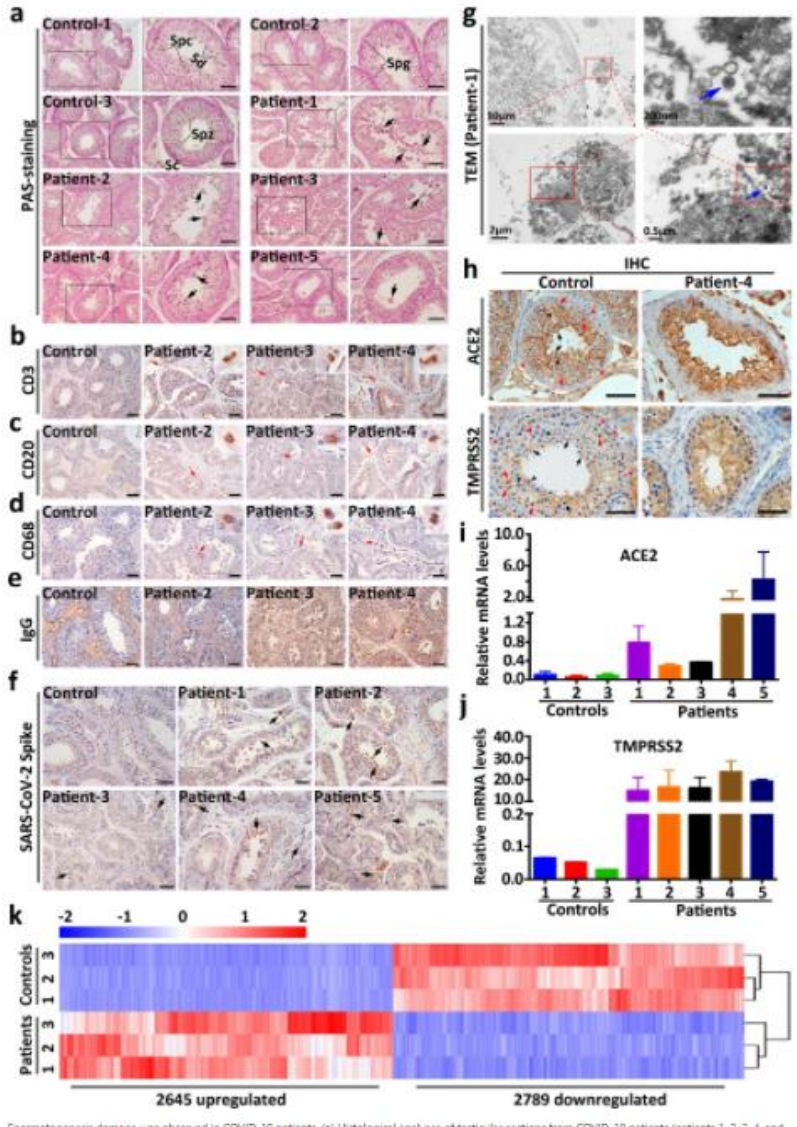
Correspondence | Published: 14 December 2020

Pathological and molecular examinations of postmortem testis biopsies reveal SARS-CoV-2 infection in the testis and spermatogenesis damage in COVID-19 patients

Xixiang Ma, Chuhuai Guan, Rong Chen, Yunyun Wang, Shenglei Feng, Rongshuai Wang, Guoqiang Qu, Sijia Zhao, Fengli Wang, Xiaoli Wang, Dingyu Zhang, Liang Liu ✉, Aihua Liao ✉ & Shuiqiao Yuan ✉

Cellular & Molecular Immunology **18**, 487–489 (2021) | Cite this article

Our findings provide direct evidence that SARS-CoV-2 can infect the testis and GCs, indicating the potential impact of the COVID-19 pandemic on spermatogenesis and male fertility. Nevertheless, further study is essential to reveal the underlying mechanism of SARS-CoV-2 infection of testicular cells and the correlation of testis infection with the clinical course of COVID-19.



Spermatogenesis damage was observed in COVID-19 patients. (**a**) Histological analyses of testicular sections from COVID-19 patients (patients 1, 2, 3, 4, and 5) and uninfected controls (controls 1, 2, and 3) showing numerous degenerated germ cells sloughing into the lumen of the seminiferous tubules of all five COVID-19 patients; normal spermatogenesis was observed in control patients. Spg spermatogonia, Spc spermatocytes, Sd spermatids, Spz spermatozoa, Sc Sertoli cells. Arrows indicate degenerated germ cells. Scale bar = 100 µm. Representative CD3 (**b**), CD20 (**c**), C68 (**d**), and human IgG (**e**) immunohistochemical staining images in the testicular sections of control and COVID-19 patients (patients 2, 3, and 4) are shown. Scale bar = 100 µm. The right upper image represents a magnified inset for each positive cell stain. (**f**) Representative SARS-CoV-2 spike protein immunohistochemical staining images in the testicular sections of control and COVID-19 patients (patients 1, 2, 3, 4, and 5) are shown. Black arrows indicate SARS-CoV-2 spike S1-positive cells. Scale bar = 100 µm. (**g**) Electron microscopy of the testis from COVID-19 patient 1, showing coronavirus-like particles suggestive of viral infection (viral particles are highlighted by blue arrows). (**h**) Representative ACE2 (upper panel) and TMPRSS2 (lower panel) immunohistochemical staining images in the testicular sections of a control and COVID-19 patient (patient 4) are shown. Black arrows indicate round spermatids; black arrowheads indicate pachytene spermatocytes; red arrows indicate Sertoli cells; red arrowheads indicate spermatogonia. Scale bar = 100 µm. RT-qPCR analyses of relative ACE2 (**i**) and TMPRSS2 (**j**) mRNA levels in controls (controls 1, 2, and 3) and COVID-19 patients (patients 1, 2, 3, 4, and 5). Each color bar represents one sample. (**k**) Heat map of genes significantly deregulated in the testes of COVID-19 patients compared to those in the testes of controls.

The Journal of the Acoustical Society of America

Free . Submitted: 16 February 2021 . Accepted: 13 April 2021 . Published Online: 27 May 2021

Deep learning applied to lung ultrasound videos for scoring COVID-19 patients: A multicenter study

The Journal of the Acoustical Society of America **149**, 3626 (2021); https://doi.org/10.1121/10.0004855

Federico Mento[1,b)], Tiziano Perrone[2], Anna Fiengo[2], Andrea Smargiassi[3], Riccardo Inchingolo[3], Gino Soldati[4], *and* Libertario Demi[1,c)]

ABSTRACT

In the current pandemic, lung ultrasound (LUS) played a useful role in evaluating patients affected by COVID-19. However, LUS remains limited to the visual inspection of ultrasound data, thus negatively affecting the reliability and reproducibility of the findings. Moreover, many different imaging protocols have been proposed, most of which lacked proper clinical validation.

To address these problems, we were the first to propose a standardized imaging protocol and scoring system. Next, we developed the first deep learning (DL) algorithms capable of evaluating LUS videos providing, for each video-frame, the score as well as semantic segmentation. Moreover, we have analyzed the impact of different imaging protocols and demonstrated the prognostic value of our approach.

In this work, we report on the level of agreement between the DL and LUS experts, when evaluating LUS data. The results show a percentage of **agreement between DL and LUS experts of 85.96%** in the stratification between patients at high risk of clinical worsening and patients at low risk. These encouraging results demonstrate the potential of DL models for the automatic scoring of LUS data, when applied to high quality data acquired accordingly to a standardized imaging protocol.

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Free . Published Online: 02 December 2020

Is lung ultrasound a predictor of worsening in Covid-19 patients?

The Journal of the Acoustical Society of America **148**, 2692 (2020); https://doi.org/10.1121/1.5147453

Umberto Sabatini

Average LUS score was **20.4 (SD 8.4)) in patients without with worsening**

And LUS score **was 29.2 (SD 7.3) in patients with worsening**

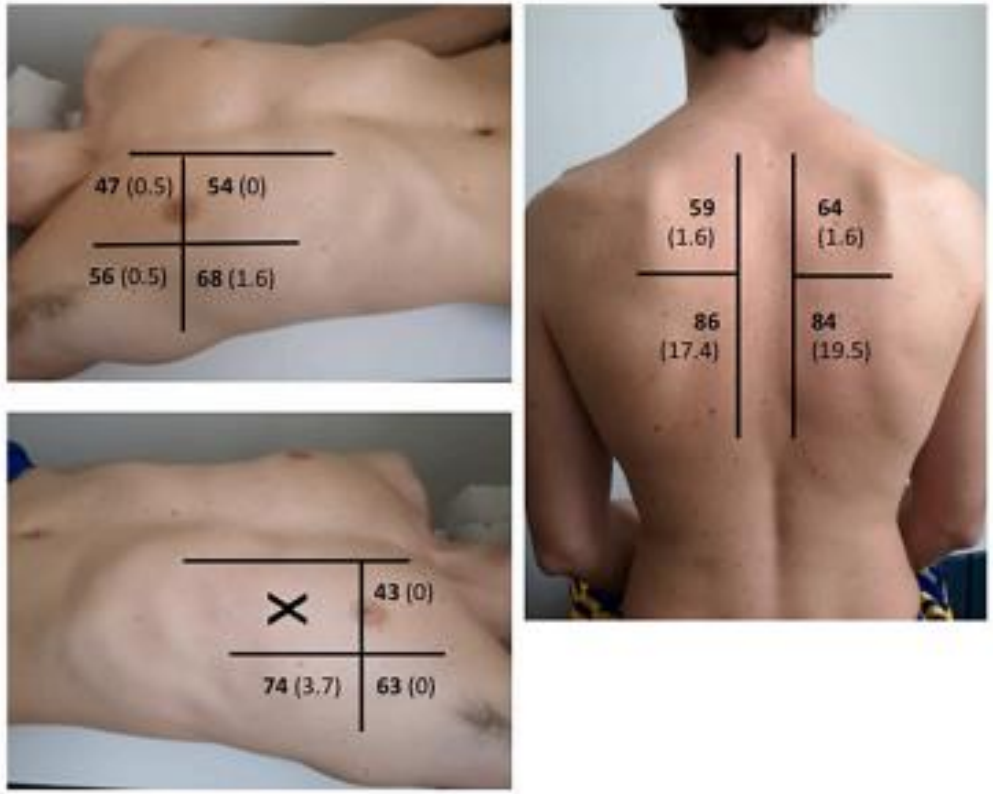

Fig. 2. Analysis of regional score: percentage of patients with positive region (score >1) in bold. Percentage of patients with consolidation in brackets.

Table 3
LUS scores and outcomes.

LUS AT ADMISSION			
PRIMARY OUTCOME	Total (no. 190)	Non D/ICU (no. 165)	D/ICU (no. 25)
Total score – median (IQR)	10 (6-16)	10 (6-15)	15 (12-20)
NPR score – median (IQR)	7 (5-10)	7 (4-10)	10 (8-11)
Anterolateral score - median (IQR)	5 (3-9)	5 (2-8)	9 (7-12)
Consolidation – no. (%)	46 (24.2)	38 (23.0)	8 (32.0)
SECONDARY OUTCOME	Total (no. 165)	Non CPAP (no. 129)	CPAP (no. 36)
Total score – median (IQR)	10 (6-15)	8 (5-12)	16 (12-18)
NPR score – median (IQR)	7 (4-10)	6 (4-9)	10 (7-11)
Anterolateral score - median (IQR)	5 (2-8)	4 (2-7)	8 (6-10)
Consolidation – no. (%)	38 (23.0)	22 (17.1)	16 (44.4)
LUS AFTER 72 HOURS			
PRIMARY OUTCOME	Total (no. 128)	Non D/ICU (no. 118)	D/ICU (no. 10)
Total score – median (IQR)	11 (6-18)	11 (6-16)	22 (22-24)
SECONDARY OUTCOME	Total (no. 118)	Non CPAP (no. 92)	CPAP (no. 26)
Total score – median (IQR)	11 (6-16)	8 (5-14)	18 (14-20)

LUS=lung ultrasound; NPR=number of positive region; D/ICU=death or transfer to ICU; CPAP=continuous positive airways pressure; IQR=inter-quartile range.