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REVIEW

COVID-19 imaging: Diagnostic approaches, challenges, and evolving advances

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Abstract

The role of radiology and the radiologist have evolved throughout the coronavirus disease-2019 (COVID-19) pandemic. Early on, chest computed tomography was used for screening and diagnosis of COVID-19; however, it is now indicated for high-risk patients, those with severe disease, or in areas where polymerase chain reaction testing is sparsely available. Chest radiography is now utilized mainly for monitoring disease progression in hospitalized patients showing signs of worsening clinical status. Additionally, many challenges at the operational level have been overcome within the field of radiology throughout the COVID-19 pandemic. The use of teleradiology and virtual care clinics greatly enhanced our ability to socially distance and both are likely to remain important mediums for diagnostic imaging delivery and patient care. Opportunities to better utilize of imaging for detection of extrapulmonary manifestations and complications of COVID-19 disease will continue to arise as a more detailed understanding of the pathophysiology of the virus continues to be uncovered and identification of predisposing risk factors for complication development continue to be better understood. Furthermore, unidentified advancements in areas such as standardized imaging reporting, point-of-care ultrasound, and artificial intelligence offer exciting discovery pathways that will inevitably lead to improved care for patients with COVID-19.

Key Words: COVID-19; Coronavirus; Pandemic; Diagnostic imaging; Radiography; Computed tomography; Outcomes; Future trends

Table 3 Four most common imaging modalities used in the diagnosis and management of coronavirus disease-2019 and their unique features/findings characterized by organ system

	Characteristic Features of COVID-19 by Imaging Modality			
Organ Systems Impacted by COVID-19	[1]CT	Ultrasound	Magnetic resonance imaging	Chest radiography
Pulmonary	[2]GGOs and reticular opacities; consolidations; [3]crazy paving pattern; multifocal and bilateral in a peripheral, sub-pleural, and posterior distribution	[4]B-line artifacts; irregularly thickened pleura; sub-pleural consolidations	Similar to CT	Interstitial reticular and reticulonodular patterns; alveolar hazy pulmonary opacities (equivalent to GGOs on CT); consolidations; multifocal & bilateral in a peripheral, sub-pleural, and posterior distribution
Cardiac	Cardiac thromboembolism	Pericardial effusion	Myocarditis; pericardial effusion	
Neurological	Stroke (ischemic/thromboembolic)	Venous sinus thrombosis	Stroke (ischemic/thromboembolic); venous sinus thrombosis, hyper-intensities	
Gastrointestinal	Wall thickening; edema; fluid filled intestinal lumen; mucosal hyper-enhancement; mesenteric vascular thrombi/ischemia	Portal vein thrombosis		
Genitourinary	Perinephric fat stranding	Renal vein/artery thrombosis		

Both pulmonary and extrapulmonary manifestations of coronavirus disease-2019 disease are detailed. Items are listed from the most common to the least common for each imaging modality and its associated organ system.

[1]Computed Tomography: refers to both computed tomography (CT) and CT angiography.

[2]Ground-glass opacities (GGOs): ground glass opacities.

[3]Crazy paving pattern: GGOs with superimposed intralobular lines and interlobular septal thickening.

[4]B-line artifacts: vertically oriented hyperechoic artifacts that originate from the pleura or from areas of consolidation. CT: Computed tomography; COVID-19: Coronavirus disease-2019; GGO: Ground-glass opacities.

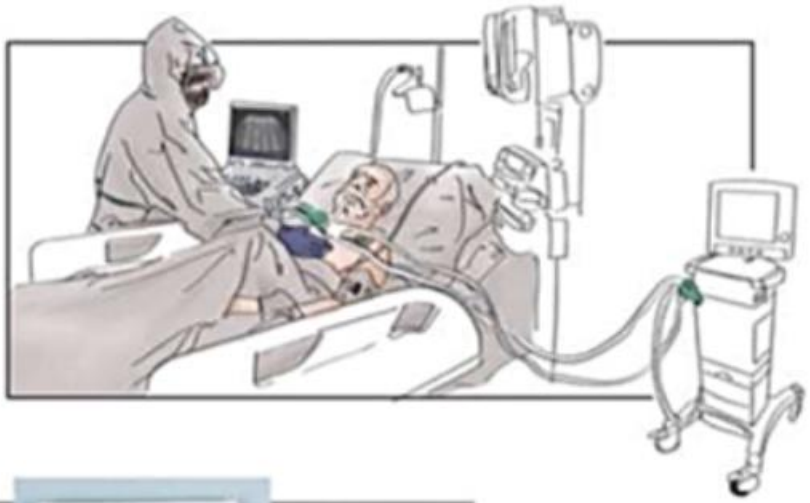
Point of care diagnostics

A recent study from Italy proposed a standardized acquisition protocol and scoring system for lung ultrasound in COVID-19 patients[36]. The acquisition protocol requires scanning of 14 areas (3 posterior, 2 lateral and 2 anterior) for 10 s. The scoring procedure is as follows: 0 = the pleural line is continuous and horizontal artifacts (A-lines) are present; 1 = the pleural line is indented, and vertical areas of white are visible; 2 = the pleural line is broken and below the breaking point are darker areas with corresponding white areas beneath, indicating areas of consolidation; 3 = the pleural line is broken, and the scanned area shows dense and diffuse white lung with or without darker areas of consolidation[36]. Additionally, a United States study developed a 6-zone protocol that emphasizes provider safety, image time acquisition, and focuses mostly on the posterior and lateral fields[131].

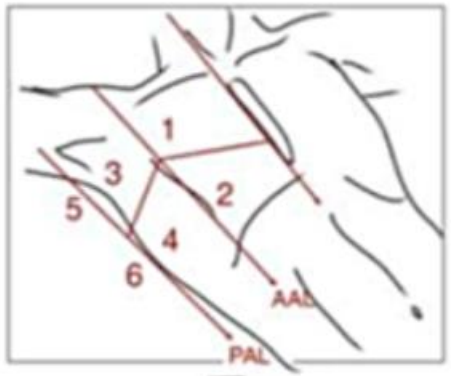
A LUS aeration score is assigned to each lung region

LUS aeration score in COVID

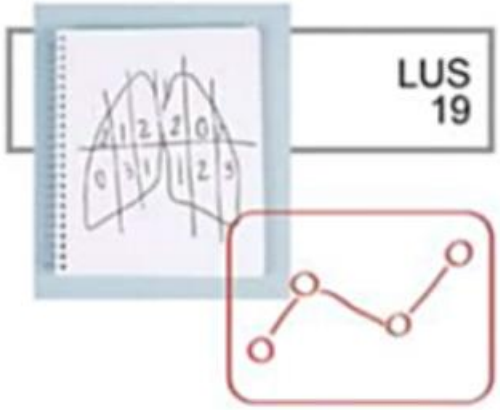
The ventilated patient is approached with adequate safety measures



A comprehensive scan is performed using 4 or 6 lung regions per side



A LUS aeration score is assigned to each lung region



The global LUS score is computed and the trend followed in time

LMICs COVID working group. *AJTMH 2021*; **104**:34

It is important to consider the logistical adjustments that need to be made when using POCUS in COVID-19 patients. For example, acquiring video loops instead of static images decreases image acquisition time and thus exposure time. Additionally, POCUS examinations should be performed in pairs with one healthcare provider coming in contact with the patient as to minimize transmission[132]. Furthermore, properly disinfecting machines and the associated equipment and materials involved per manufacturer specific guidelines is critical to ensuring safe use of POCUS in the management of patients with COVID-19[22,133-135].

There are many limitations to the use of POCUS in COVID-19 patients and the evidence supporting its use to date. For example, many of the studies conducted thus far were during a period of high prevalence of disease, which likely influences the diagnostic accuracy of POCUS[136]. Furthermore, inter-operator reproducibility of POCUS on COVID-19 patients is not known. This is especially valuable information as ultrasound is heavily operator dependent and inexperienced providers may not achieve optimal images[137]. However, in general, while there are limited studies and none that are prospective in nature in regard to POCUS in COVID-19, POCUS has many features that offer clinicians valuable data while managing COVID-19 patients [138,139]. More research is needed to better understand the role it plays in managing COVID-19 patients.

LUIGI PISANI

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Pragmatic Recommendations for the Use of Diagnostic Testing and Prognostic Models in Hospitalized Patients with Severe COVID-19 in Low- and Middle-Income Countries

Marcus J. Schultz [1,2,3,4], Tewodros H. Gebremariam [5], Case...

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Volume/Issue: Volume 104: Issue 3_Suppl

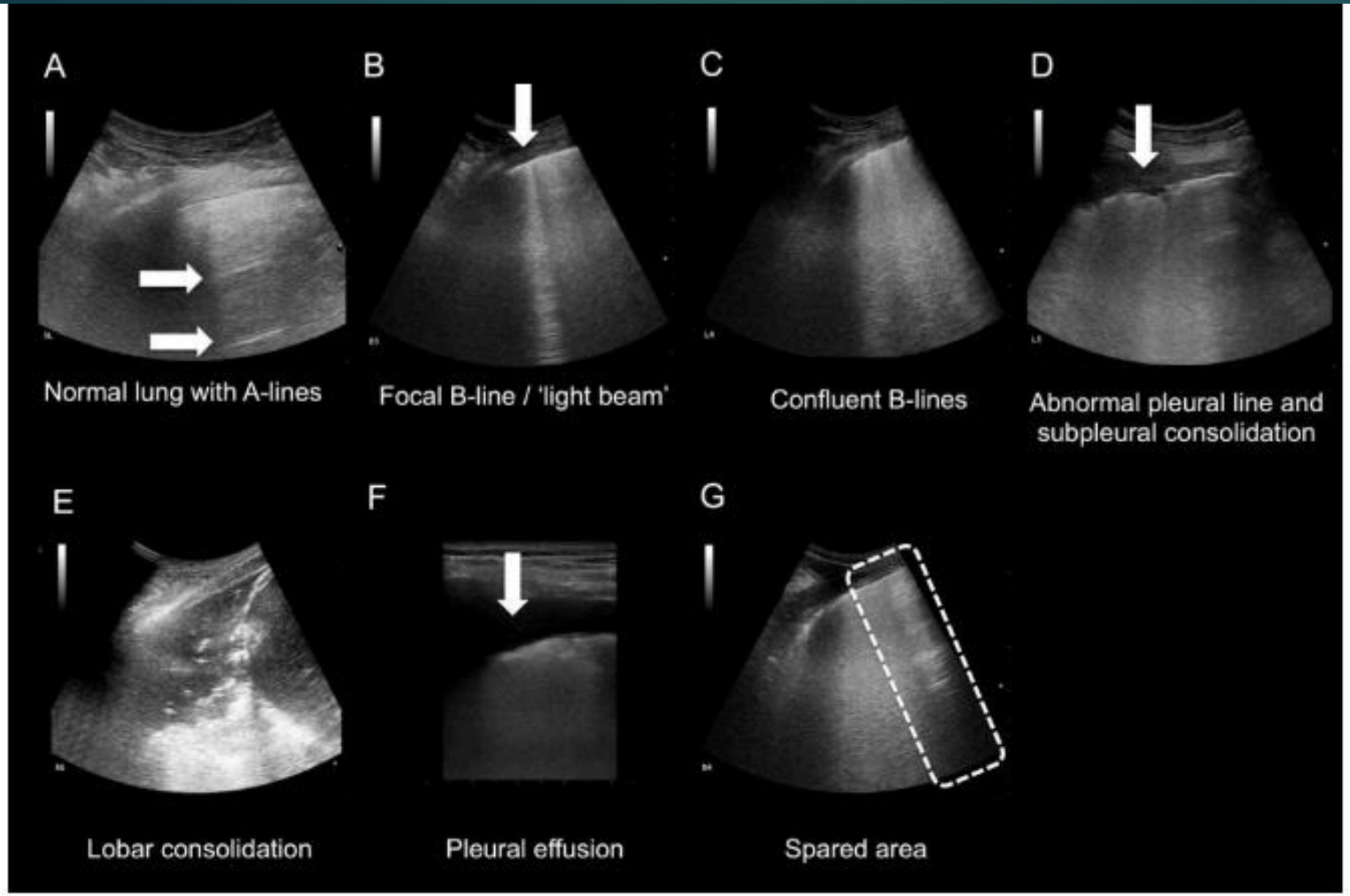
QUESTIONS

- We formulated four clearly defined questions regarding "microbiology and laboratory tests, imaging tools, and diagnostic and prognostic modeling":
- 1. In LMICs, which specific microbiology tests should be ordered for hospitalized patients to support a diagnosis of COVID-19?
- 2. In LMICs, which specific laboratory tests could be useful for hospitalized patients with severe COVID-19?
- 3. In LMICs, **what is the role of lung ultrasound in patients with severe COVID-19?**
- 4. In LMICs, are diagnostic and prognostic models useful in patients with severe COVID-19?

Recommendations and suggestions

- 1. In LMICs, where availability of standard CXR and CT is limited, we suggest using LUS to detect abnormalities to identify patients with possible COVID-19 (weak recommendation, low quality of evidence);
- 2. In LMICs, we recommend against the use of LUS to exclude COVID-19 (UG best practice statement);
- 3. In LMICs, we suggest using LUS in combination with clinical parameters to monitor progress of the disease and responses to therapy in COVID-19 patients (weak recommendation, low quality of evidence).

LUS PATTERN



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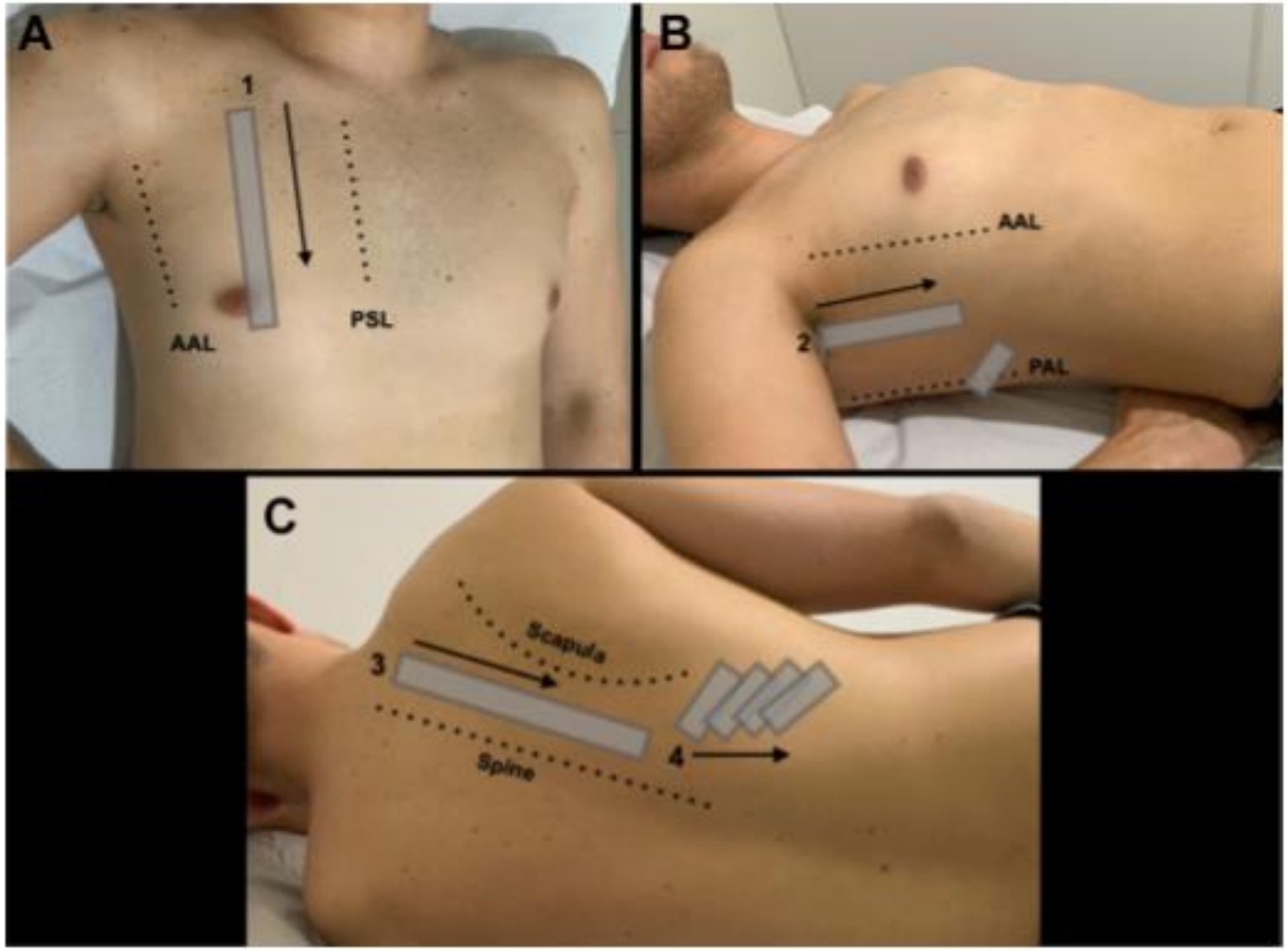

Figure 1 – *Proposed scanning protocol, placing extra emphasis on the posterior lung regions given the tendency of coronavirus disease 2019 to manifest in these areas. A, Zone 1, the intercostal spaces in the mid-clavicular line. B, Zone 2, the intercostal spaces in the mid-axillary line, plus the area just above the diaphragm in the posterior axillary line. C, Zone 3 (the intercostal spaces between the spine and scapula) and Zone 4 (the area beneath the scapula).* AAL = *anterior axillary line;* PAL = *posterior axillary line;* PSL = *parasternal line.*

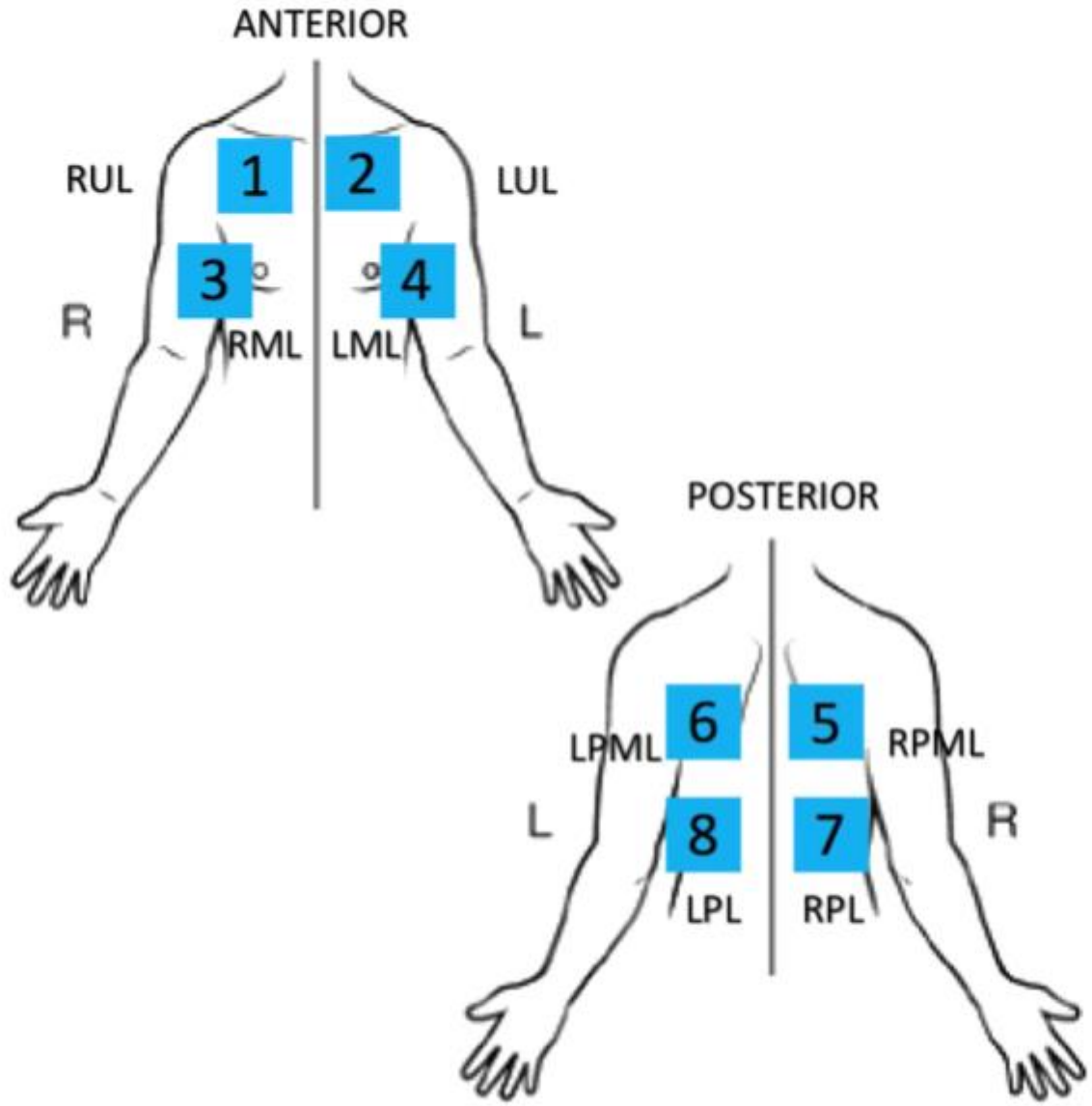

Figure 1. COVID-19 lung ultrasound protocol. RUL = right upper lobe; LUL = left upper lobe; RML = right middle lobe; LML = left middle lobe; LPML = left posterior middle lobe; RPML = right posterior middle lobe; LPL = left posterior lower lobe; RPL = right posterior lower lobe.

EACVI
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WEBINAR

14 April 2020

COVID-19: how to use
and interpret lung ultrasound?

LUS score

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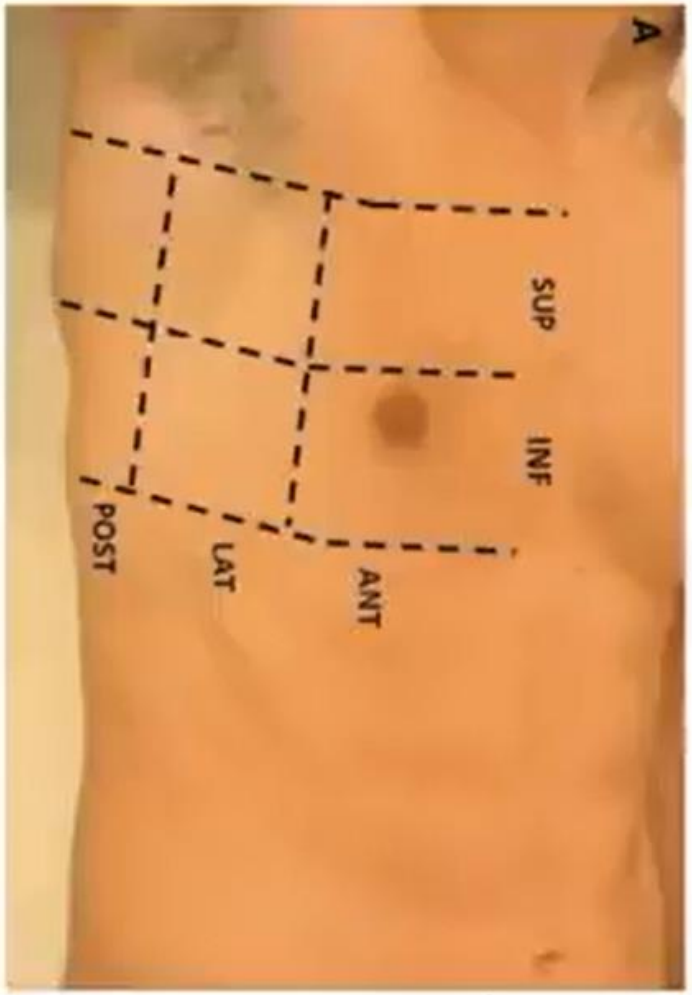
Lung ultrasound score and corresponding ultrasound patterns

Points	Degrees of lung aeration	Patterns	
0 point **0**	Normal aeration	Horizontal ***A-lines*** (or no more than two B-lines)	
1 point **1**	Moderate loss of aeration	**Multiple B-lines** at least 3 B-lines or coalescent B-lines covering ≤ 50% of the screen	
2 points **2**	Severe loss of aeration	**Multiple B-lines** B-lines covering >50% of the screen	
3 points **3**	Complete loss of aeration	**Multiple B-lines** Consolidation	



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Beware of Z-lines

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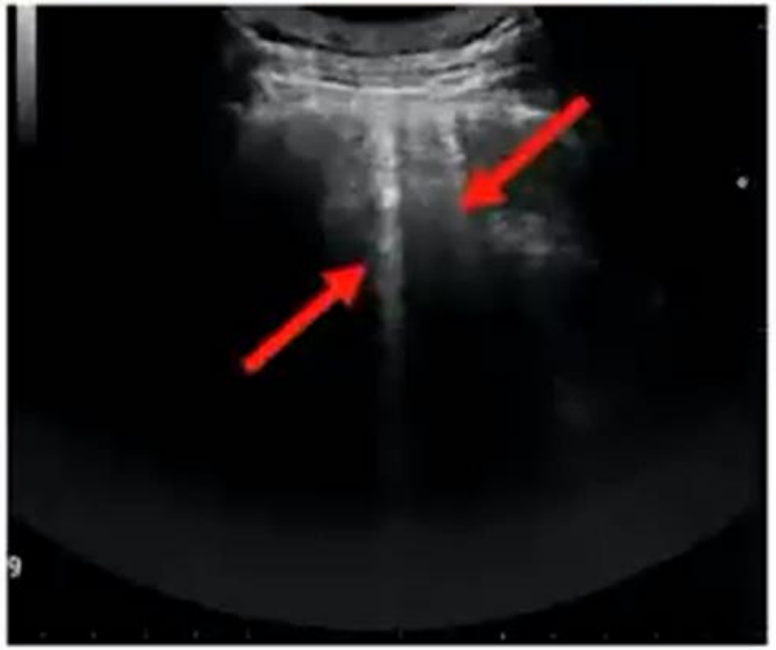

Table 1. Characteristics of sonographic B-lines

Characteristic	Comments
Arise from the pleural line	Always true Common feature to Z-lines (whose origin is, however, less defined)
Move synchronously with lung sliding (with respiration)	Always true Z-lines do not clearly move with lung sliding
Erase A-lines	A-lines may still be visible, but are covered/erased by B-lines at the intersection point Z-lines do not erase A-lines
Hyperechoic	Similar echogenicity as the pleural line Z-lines are usually less hyperechoic than the pleural line
Well defined	Quite subjective Usually better defined compared with Z-lines
Extend to the bottom of the screen without fading	May partially depend on the machine setting Z-lines usually fade away before reaching the bottom of the screen

ESC

WesternSono Point-of-Care Ultrasound Series

Common Pitfalls in Lung Ultrasound

Katie Wiskar
Western University CCUS Fellow
UBC GIM PGY5

Thanks to Dr Robert Arntfield

AJUM November 2010; 13 (4): 37–45

Duplex ultrasound in the assessment of lower extremity venous insufficiency

Martin Necas

Waikato Hospital, Vascular Laboratory, Hamilton, Tristram Vascular Ultrasound, Tristram Clinic, Hamilton and Unitec New Zealand, School of Health, Postgraduate Studies – Ultrasound, Waitakere Campus, Ratanui St, Henderson, Auckland, New Zealand.
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Introduction

The purpose of this paper is to provide a focused overview of the key concepts in the assessment of lower limb chronic venous insufficiency (CVI) with an emphasis on specific techniques which can assist the sonographer or sonologist in achieving an accurate and time-efficient examination. In the context of this paper, CVI will pertain to lower extremity superficial and/or deep venous incompetence of any degree leading to the classic clinical signs of venous disease including: varicose veins, peripheral swelling and skin changes. This paper is by no means a comprehensive review of all issues surrounding CVI and duplex scanning. Interested readers are directed to the reference section for a selection of landmark papers and further reading.

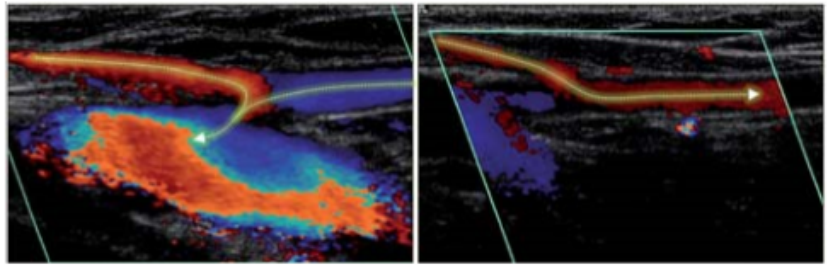

Fig. 14: Competent SFJ with GSV reflux supplied by the IEV. Left image: Normal competent SFJ showing the inferior epigastric vein (IEV) and great saphenous vein (GSV). Right image: The SFJ is competent, but flow from the IEV is seen to reflux down the GSV.

GSV lies medial to the AASV. (Figs. 11, 12)

- Short-course duplications of the GSV and SSV are not uncommon but full length duplications are rare.
- The location of the SPJ varies considerably (medial, lateral, at knee crease, above knee crease, absent, duplicated).
- The SPJ is often absent and the SSV may drain via a Thigh Extension (TE SSV) into other vessels. When the SPJ drains via the TE SSV and posterior thigh circumflex vein (PTCV) into the GSV, the vein is called the vein of Giacomini.
- The GSV and SSV communicate via intersaphenous connections especially in the calf. Intersaphenous connections may acts as pathways for reflux.

Detailed diagram of the most common superficial veins and their accepted international nomenclature[14,15] is provided in Fig. 12. It should be noted that not all the veins demonstrated in Fig. 12 are present in every patient.

Common patterns of superficial reflux

Most primary lower extremity varices are caused by reflux at the level of the SFJ or SPJ. Perforator incompetence can contribute to CVI or can be the consequence of underlying

the GSV) requires assessment. It is sufficient to use color Doppler the majority of the time.

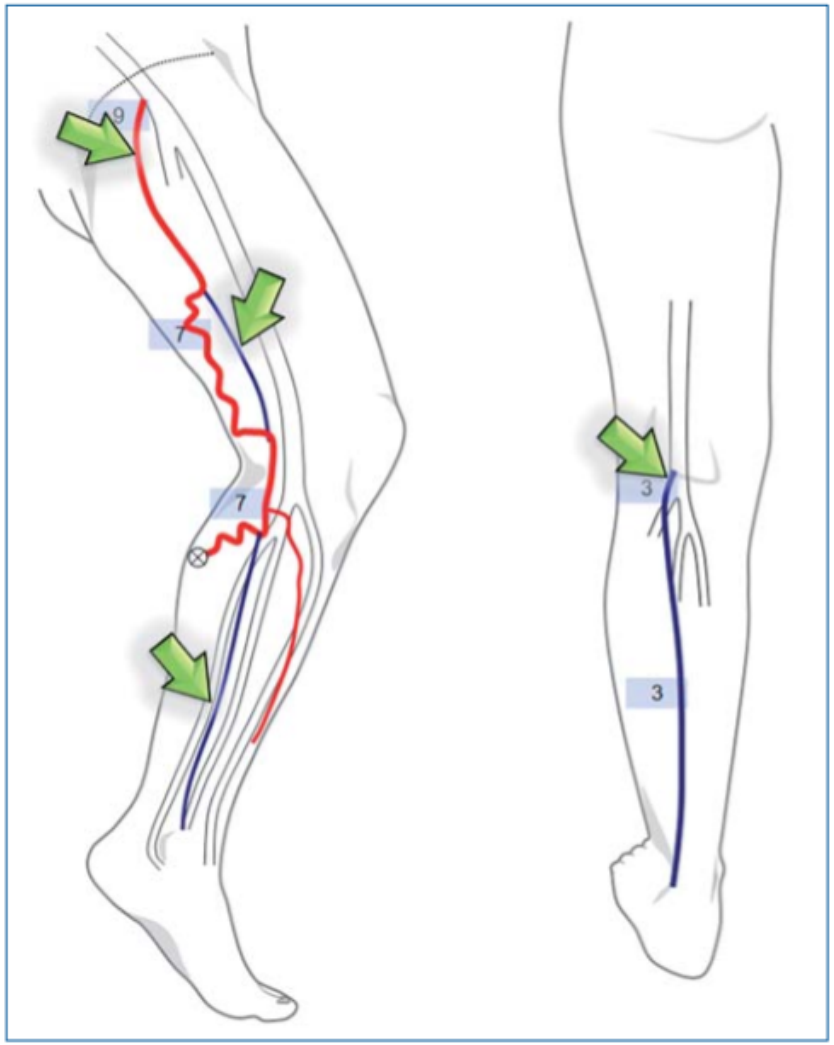

Fig. 16: Duplex sampling sites. Assessment for reflux can be easily targeted so that relatively few locations along the superficial venous tree require color or spectral Doppler sampling. The patient below demonstrates primary varicose veins in the GSV territory with several tributaries. Arrows indicate the few locations which need to be tested.

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Thyroid and COVID-19: a review on pathophysiological, clinical and organizational aspects

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REVIEW

Thyroid and COVID-19: a review on pathophysiological, clinical and organizational aspects

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Discussion

Currently, we know that SARS-CoV-2 could lead to short-term and reversible thyroid dysfunction, but thyroid diseases seem not to affect the progression of COVID-19. Adequate management of patients with thyroid diseases remains essential during the pandemic, but it could be compromised because of healthcare service restrictions. Endocrine care centers should continuously recognize and classify priority cases for in-person visits and therapeutic procedures. Telemedicine may be a useful tool for managing patients not requiring in-person visits.

Abstract

Background Thyroid dysfunction has been observed in patients with COVID-19, and endocrinologists are requested to understand this clinical issue. Pandemic-related restrictions and reorganization of healthcare services may affect thyroid disease management.

Objective and methods To analyze and discuss the relationship between COVID-19 and thyroid diseases from several perspectives. PubMed/MEDLINE, Google Scholar, Scopus, ClinicalTrial.gov were searched for this purpose by using free text words and medical subject headings as follows: "sars cov 2", "covid 19", "subacute thyroiditis", "atypical thyroiditis", "chronic thyroiditis", "hashimoto's thyroiditis", "graves' disease", "thyroid nodule", "differentiated thyroid cancer", "medullary thyroid cancer", "methimazole", "levothyroxine", "multikinase inhibitor", "remdesivir", "tocilizumab". Data were collected, analyzed, and discussed to answer the following clinical questions: "What evidence suggests that COVID-19 may induce detrimental consequences on thyroid function?"; "Could previous or concomitant thyroid diseases deteriorate the prognosis of COVID-19 once the infection has occurred?"; "Could medical management of thyroid diseases influence the clinical course of COVID-19?"; "Does medical management of COVID-19 interfere with thyroid function?"; "Are there defined strategies to better manage endocrine diseases despite restrictive measures and in-hospital and ambulatory activities reorganizations?".

Results SARS-CoV-2 may induce thyroid dysfunction that is usually reversible, including subclinical and atypical thyroiditis. Patients with baseline thyroid diseases are not at higher risk of contracting or transmitting SARS-CoV-2, and baseline thyroid dysfunction does not foster a worse progression of COVID-19. However, it is unclear whether low levels of free triiodothyronine, observed in seriously ill patients with COVID-19, may worsen the disease's clinical progression and, consequently, if triiodothyronine supplementation could be a tool for reducing this burden. Glucocorticoids and heparin may affect thyroid hormone secretion and measurement, respectively, leading to possible misdiagnosis of thyroid dysfunction in severe cases of COVID-19. High-risk thyroid nodules require a fine-needle aspiration without relevant delay, whereas other non-urgent diagnostic procedures and therapeutic interventions should be postponed.

Discussion Currently, we know that SARS-CoV-2 could lead to short-term and reversible thyroid dysfunction, but thyroid diseases seem not to affect the progression of COVID-19. Adequate management of patients with thyroid diseases remains essential during the pandemic, but it could be compromised because of healthcare service restrictions. Endocrine care centers should continuously recognize and classify priority cases for in-person visits and therapeutic procedures. Telemedicine may be a useful tool for managing patients not requiring in-person visits.

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The Association of Subacute Thyroiditis with COVID-19: a Systematic Review

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COVID-19

The Association of Subacute Thyroiditis with COVID-19: a Systematic Review

Muhammad Aemaz Ur Rehman[1] · Hareem Farooq[1] · Muhammad Mohsin Ali[2] · Muhammad Ebaad Ur Rehman[3] · Qudsia Anwar Dar[4] · Awab Hussain[1]

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Abstract
The multisystem effects of SARS-CoV-2 encompass the thyroid gland as well. Emerging evidence suggests that SARS-CoV-2 can act as a trigger for subacute thyroiditis (SAT). We conducted a systematic literature search using PubMed/Medline and Google Scholar to identify cases of subacute thyroiditis associated with COVID-19 and evaluated patient-level demographics, major clinical features, laboratory findings and outcomes. In the 21 cases that we reviewed, the mean age of patients was 40.0 ± 11.3 years with a greater female preponderance (71.4%). Mean number days between the start of COVID-19 illness and the appearance of SAT symptoms were 25.2 ± 10.1. Five patients were confirmed to have ongoing COVID-19, whereas the infection had resolved in 16 patients before onset of SAT symptoms. Fever and neck pain were the most common presenting complaints (81%). Ninety-four percent of patients reported some type of hyperthyroid symptoms, while the labs in all 21 patients (100%) confirmed this with low TSH and high T3 or T4. Inflammatory markers were elevated in all cases that reported ESR and CRP. All 21 cases (100%) had ultrasound findings suggestive of SAT. Steroids and anti-inflammatory drugs were the mainstay of treatment, and all patients reported resolution of symptoms; however, 5 patients (23.8%) were reported to have a hypothyroid illness on follow-up. Large-scale studies are needed for a better understanding of the underlying pathogenic mechanisms, but current evidence suggests that clinicians need to recognize the possibility of SAT both in ongoing and resolved COVID-19 infection to optimize patient care.

Keywords COVID-19 · SARS-CoV-2 · Subacute thyroiditis · De Quervain's thyroiditis · Viral thyroiditis

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Conjunctivitis as sole symptom of COVID-19: A case report and review of literature

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Five studies have described biomicroscopic findings of COVID-19 patients with conjunctivitis.10–14 Ocular symptoms have emerged as the first symptom in all but one of these cases. Ocular complaints have been reported within a spectrum of **red eye**, **watery discharge, photophobia, foreign body sensation**, and **eyelid edema.** Remarkable details in the slit-lamp examination were serous secretion, follicular reaction in the upper and lower eyelid conjunctiva, chemosis, keratoconjunctivitis, and pseudomembranous inflammation. In four of these cases, SARS-CoV-2 viral RNA was detected in the swab samples taken from the conjunctiva.10

Figure 1. A follicular conjunctival reaction in the upper and lower fornices, serous secretion, and mild chemosis in the right eye of the patient two days before the diagnosis of COVID-19.

Conclusion=

Conjunctivitis may appear to be the only sign and symptom of COVID-19, and these patients may not have fever, fatigue, or respiratory symptoms that may cause suspicion.

Case report

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Abstract

Introduction: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a novel virus causing an ongoing pandemic in 2020. Although the symptomatic patients infected by SARS-CoV-2 generally show respiratory distress, atypical manifestations such as conjunctivitis are also observed. A series of cases are reported in which reverse transcriptase polymerase chain reaction (RT-PCR) testing on tears had demonstrated the presence of the virus. However, the transmission of the virus through ocular fluids remains unknown.

Case description: In this case report, the development of conjunctivitis is presented as the sole symptom of a new coronavirus disease 2019 (COVID-19) in an emergency health care worker. The patient's first application was to the ophthalmology clinic due to redness, stinging, tearing, and photophobia for one day in the right eye. The patient had no symptoms of fever, cough, shortness of breath, or fatigue. Two days later, the RT-PCR test, blood analysis, and chest computed tomography (CT) were applied to the patient for being in contact with a COVID positive patient. Conjunctival swabs did not identify SARS-CoV-2 by RT-PCR. However, nasopharyngeal swab and blood test confirmed the diagnosis of COVID-19. Chest CT did not show pneumonia.

Conclusion: This phenomenon shows that conjunctivitis may occur as a sole manifestation of COVID-19 which needs to be carefully evaluated by health care workers and eye care professionals during the pandemic.

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Retinal manifestations in patients following COVID-19 infection: A consecutive case series

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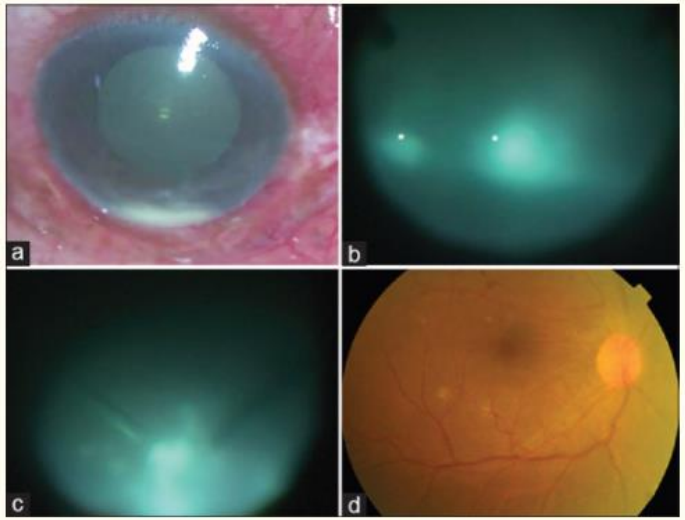

Figure 1

(a) Intraoperative photograph of the right eye shows severe ciliary congestion and hypopyon. (b) Intra-operative photograph during pars plana vitrectomy shows dense and dry vitreous lesions (asterisk) (c) Snowball like opacities noted in the inferior periphery (d) Same eye shows compete resolution with clear media and normal fundus at 6 weeks

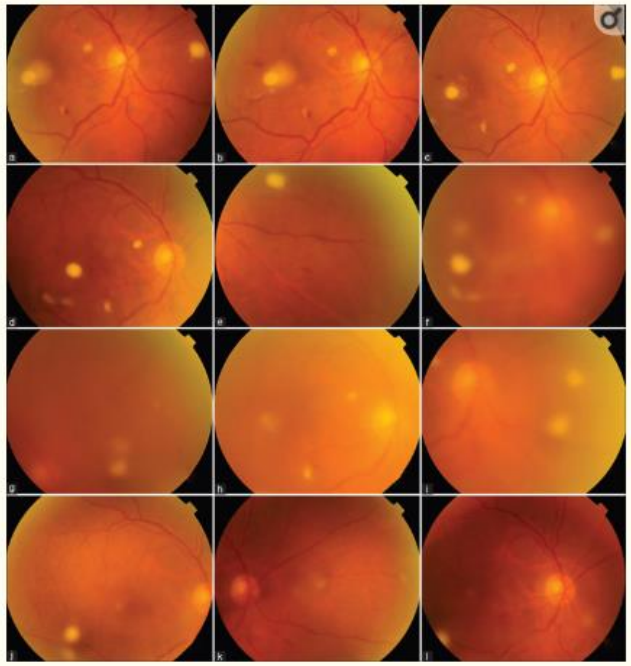

Figure 2

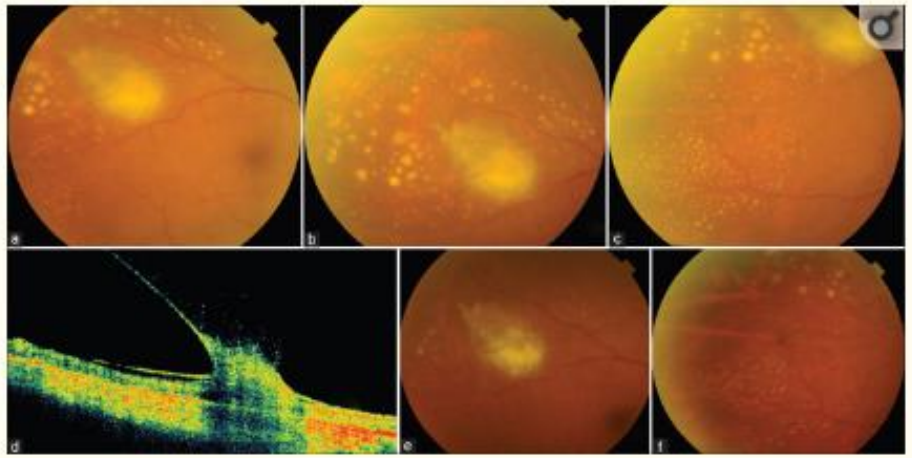

Figure 3

(a) Large choroidal abscess with active appearing center and resolving activity at edges supero-temporal to the right macula. (b and c) Multiple miliary lesions around the choroidal abscess in temporal and inferotemporal fundus. Lesions are larger and irregular closer to the abscess, becoming smaller, punctate with smoother edges further from it. (d) OCT showing epiretinal membrane and vitreous traction over the choroidal abscess. (e and f) Significant resolution of choroidal abscess and miliary lesions 6 weeks after initiating anti-tubercular therapy

Abstract

Purpose: To describe retinal manifestations seen in patients associated with COVID-19 infection at a multi-specialty tertiary care hospital in Southern India.

Methods: In this retrospective chart review, all consecutive cases presenting to the Retina-Uveitis service from May 2020 to January 2021 with retinal manifestations associated with COVID-19 infection or its sequelae or as a result of treatment given for COVID-19 were included.

Results: : Of the 7 patients, 3 were female, and 4 were male. Four patients had onset of symptoms during the active phase of COVID-19 infection. Four had bilateral and three had unilateral involvement. The manifestations ranged from mild to vision threatening. Vision threatening manifestations included infections: endogenous endophthalmitis, candida retinitis and tubercular choroidal abscess and bilateral pre-foveal hemorrhages. Milder manifestations included paracentral acute middle maculopathy, central serous chorio-retinopathy and voriconazole induced visual symptoms. Final visual acuity was 6/36 or better in the four severe cases and 6/9 or better in the mild cases.

Conclusion: This study highlights the retinal manifestations associated with COVID-19 infection and its sequelae. As these patients presented with an association with COVID-19 (either during or after recovery), ophthalmologists should be vigilant and screen for such entities in case of complaints of visual symptoms or in the presence of systemic sepsis. The outcomes can be good with prompt and aggressive management.

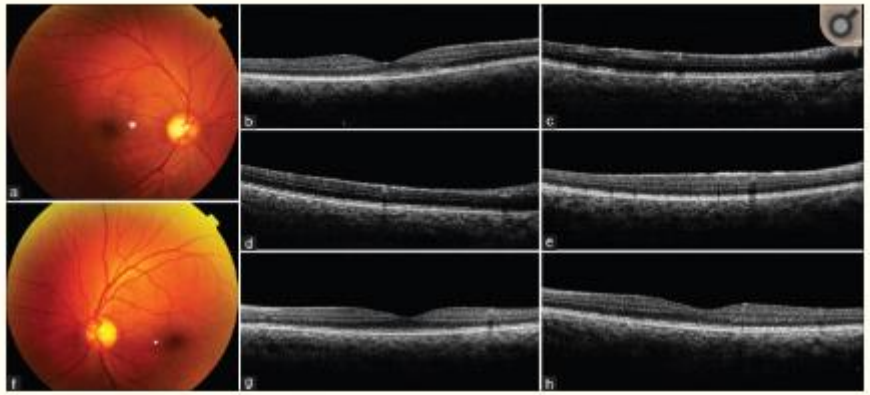

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Figure 4

(a) Triangular greyish-white lesion (asterisk) of AMN (b) Corresponding OCT shows disruption of external retinal layers (c and d) Focal areas of hyper-reflectivity with deeper shadowing of PAMM. (e) OCT right eye: diffuse hyper-reflectivity of entire inner retinal surface (f) Small greyish-white lesions in superficial retina nasal, inferonasal and temporal to the foveal center in left eye. (g) Corresponding OCT shows hyper-reflective lesion with underlying shadowing (h) OCT left eye showing diffuse hyper-reflectivity of the inner retinal surface

While there are isolated case reports of COVID-19 related retinal manifestations, this is the first single large case series of diverse retinal manifestations of COVID-19 infection, some of these not reported, ranging from medication related mild adverse effects and post viral complications like PAMM and pre-foveal hemorrhages to grave sight-threatening ocular infections such as endophthalmitis, candida retinitis & tubercular choroidal abscess. Even in the severe cases, we could institute therapy promptly and our patients were able to recover well, suggesting an overall good prognosis in this subset of patients.

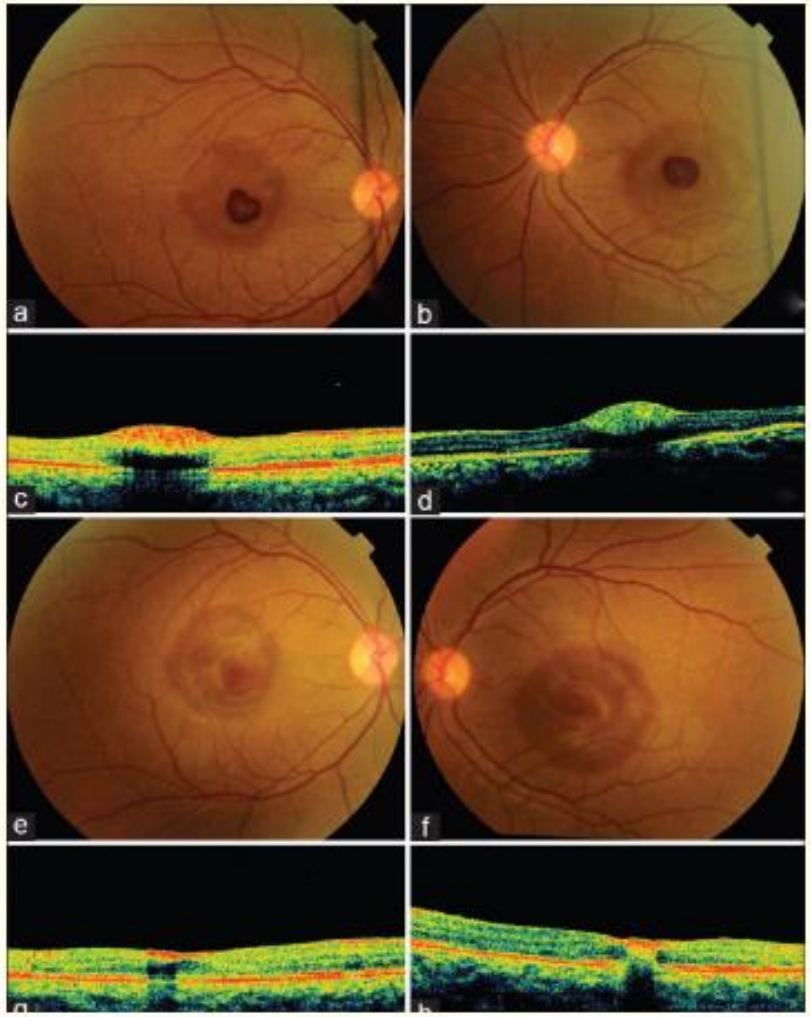

Figure 6

Bilateral pre-foveal hemorrhage of the right (a) and left eye (b) in a young lady with post COVID-19 sepsis. OCT of the right eye (c) and left eye (d) showing pre-foveal location of the hemorrhage with underlying shadowing. One month later, there is almost complete resolution of the pre-foveal heme in the RE (e) and LE (f) Corresponding optical coherence tomography scans show residual paracentral pre-foveal heme in the RE (g) and intra-retinal heme in the LE (h)

COVID-19 and Eye: A Review of Ophthalmic Manifestations of COVID-19

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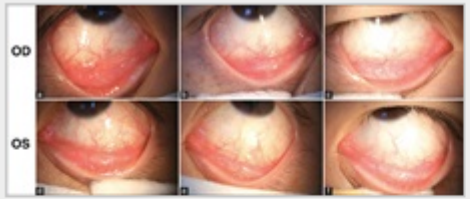

Figure 1: Follicular conjunctivitis following COVID-19: A 30-year-old man developed bilateral follicular conjunctivitis 13 days after mild COVID-19 infection. Slit lamp examinations showed evidence of acute viral conjunctivitis. (a and d)The examination on illness day 13 showed moderate conjunctival injection and inferior palpebral conjunctival follicles. (b and e) Examinations on illness day 17 and (c and f) illness on day 19 demonstrated that treatment with ribavirin eye-drops gradually improved the patient's symptoms. (Reproduced with permission from Chen L, Liu M, Zhang Z, Qiao K, Huang T, Chen M, Xin N, Huang Z, Liu L, Zhang G, Wang J. Ocular manifestations of a hospitalised patient with confirmed 2019 novel coronavirus disease. Br J Ophthalmol. 2020;104:748-51)

Figure 2: Vasculitic retinal vein occlusion as a manifestation of COVID-19: A 52-year-old patient presented with the diminution of vision in the left eye 10 days after he tested positive for SARS-CoV-2. (a) Fundus photograph demonstrating inferior hemiretinal vein occlusion with superonasal branch retinal vein occlusion. (b) Fundus fluorescein angiogram showing the presence of dilated tortuous vein

(c) Spectral domain optical coherence tomography illustrating the presence of serous macular detachment (Orange arrow), cystoid macular edema, cysts located in outer nuclear layer (Blue arrow), inner nuclear layer (Red arrow) and ganglion cell layer (Green arrow) and disorganization of retinal inner layers (Yellow arrow)

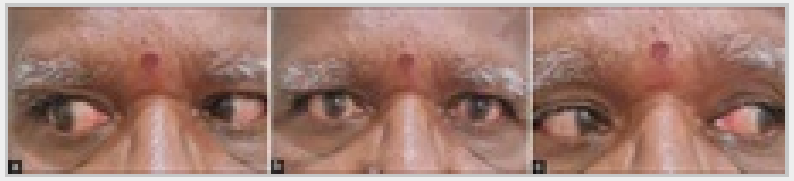

Figure 8: Sixth nerve palsy after COVID-19: A 64-year-old male presented with acute onset diplopia. (a) On examination there was right abduction limitation with (b) orthophoria in primary gaze and (c) normal adduction of right eye. (Contributed by Rachna Vinaya Kumar, Paediatric ophthalmology, Neuro-ophthalmology and Adult Strabismus Services, Apollo Eye Institute, Apollo Hospitals, Hyderabad, India)

Figure 9: Acute dacryoadenitis manifesting with COVID-19: A 10-year-old girl developed painful, progressive left eyelid swelling and lacrimal gland mass concurrently with a mild COVID-19 infection. (Contributed by Ayushi Agarwal, Guru Nanak Eye Center, New Delhi, India)

Figure 10: Rhino-orbito-cerebral mucormycosis following COVID-19 infection: (a) Clinical picture of a 61-year-old, diabetic, male who developed left eye periocular edema, complete ptosis, ophthalmoplegia, (b) proptosis, conjunctival congestion, and severe chemosis 17 days after moderate to severe COVID-19 infection treated with steroids. (Reproduced with permission from Sen M, Lahane S, Lahane TP, Parekh R, Honavar SG. Mucor in a viral land: A tale of two pathogens. Ind J Ophthalmol 2021;69:244-52.)