

# Role of 5G-powered remote robotic ultrasound during the COVID-19 outbreak: insights from two cases

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**Abstract.** – The 2019 Novel Coronavirus disease (COVID-19) broke out in Wuhan, China in December 2019 and spread throughout the world. Early screening and early diagnosis play key roles in prevention and management of the epidemic. Attention should also be paid to the infection of health workers and shortage of medical resources in high-risk areas. Here, we report two cases of patients diagnosed with COVID-19 and evaluated by robotic ultrasound based on 5G-powered technology 700 km east of Wuhan. We here show the advantages of this kind of remote ultrasound scan, which could become a method for the diagnosis and assessment of COVID-19.

*Key Words:*

COVID-19, SARS-CoV-2, 5G-powered robot, Lung ultrasound.

able and already widely used in almost all hospitals<sup>2</sup>. 5G-powered remote robotic ultrasound is a type of ultrasound distantly conducted by robot based on 5G transmission technology. Operators conduct ultrasound scans remotely by controlling a robotic arm, thereby being protected from COVID-19 infection.

Here, we report two cases of patients confirmed by throat swab specimens tested with real-time Reverse Transcription-Polymerase Chain Reaction (rRT-PCR) for SARS-CoV-2 who were also remotely evaluated by 5G-powered robotic ultrasound, the results of which were consistent with CT scan. We summarize the advantages and discuss potential applications of 5G-powered remote robotic ultrasound for management of COVID-19.

## Introduction

An outbreak of Novel Coronavirus disease started in mid-December 2019 in Wuhan, Central China. Since then, the epidemic has rapidly spread throughout China and around the world.

At present, the nucleic acid test for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and chest computed tomography (CT) are the main methods for screening and diagnosis of the suspected patients in clinical practice<sup>1</sup>. Lung ultrasound can be used to evaluate several respiratory conditions and it produces results similar to those of chest CT. Ultrasound also involves no radiation exposure. It is repeat-

## Case 1

A 54-year-old man living in Wuhan presented with a cough for one week and was admitted to a local health center, without fever, sputum, dyspnea, or diffuse muscle or joint pain. He received antiviral and anti-infective treatments after a chest radiograph indicating lung infection. Later, the patient was confirmed to have COVID-19 by positive SARS-CoV-2 rRT-PCR test and was transferred to our mobile cabin hospital for isolation and further treatment. Upon admission, physical examination showed no fever and a body temperature of 36.7°C. Laboratory examination revealed normal counts of leukocytes ( $6.76 \times 10^9/L$ ), neutrophils (4.18

$\times 10^9/L$ ) and lymphocytes ( $1.99 \times 10^9/L$ ), and an elevated level of high-sensitivity C-reactive protein (7.47 mg/L).

Chest CT showed patchy high-density shadows and ground-glass opacities in both lungs (Figure 1A). Lung ultrasonography based on 5G-powered remote technology displayed increased B-lines and local pulmonary consolidation, suggesting this patient had pneumonia (Figure 1B).

### Case 2

A 37-year-old female resident of Wuhan was admitted to our mobile cabin hospital after a SARS-CoV-2 rRT-PCR test showed a positive result. She had experienced chest tightness for one week, which was relieved on admission. No respiratory symptoms such as dry throat, cough, sputum, runny nose or fatigue were observed. She experienced no fever, vomiting or diarrhea. Laboratory examination showed normal leukocyte ( $5.12 \times 10^9/L$ ) and neutrophil ( $2.84 \times 10^9/L$ ) counts, a low lymphocyte count ( $0.80 \times 10^9/L$ ), and an increased level of high-sensitivity C-reactive protein (9.34 mg/mL).

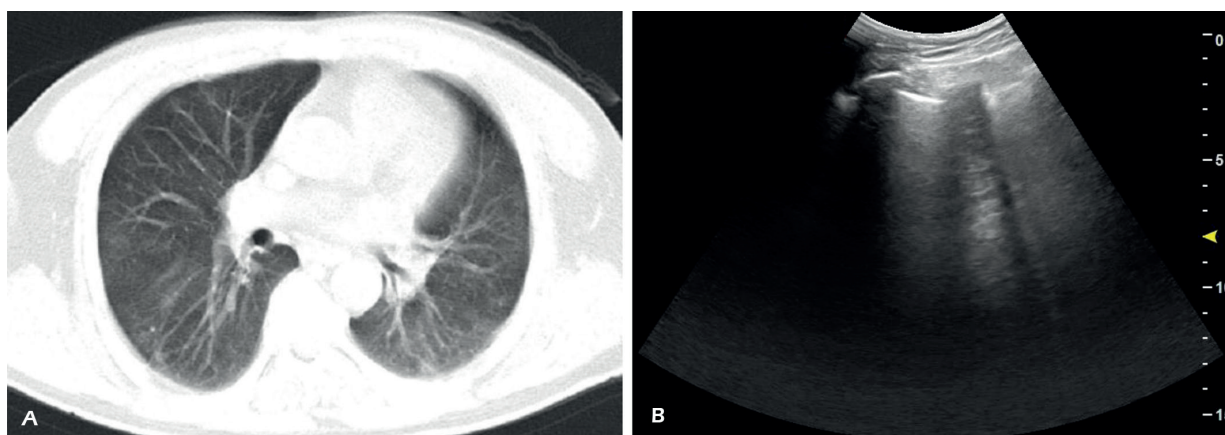
Chest CT showed multiple nodules that appeared to be inflammatory lesions in both lungs (Figure 2A). Later, 5G-powered remote robotic ultrasound showed a partially thickened pleura line and intensive B lines, consistent with signs of pneumonia (Figure 2B).

## Discussion

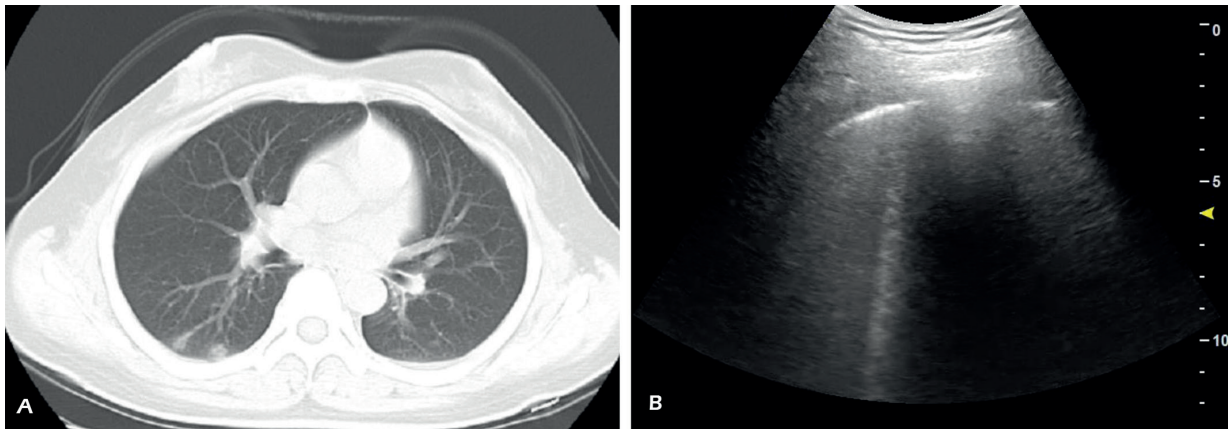
We here reported the first use of remote lung ultrasound based on 5G-powered robotic tech-

nology in the context of the COVID-19 outbreak worldwide. In these two cases, we performed the ultrasound scan in east China's Hangzhou, Zhejiang Province (700 km away from Wuhan), and evaluated two patients confirmed to have COVID-19. The ultrasound scan was performed using 5G-powered transmission technology. We found that 5G-powered remote robotic ultrasound could clearly and accurately detect lung lesions. The results of the lung ultrasound were consistent with chest CT scans. Hence, 5G-powered remote robotic ultrasound may become a suitable choice for diagnosis and monitoring patients with COVID-19 infection.

5G-powered remote robotic ultrasound is a type of remote ultrasonography based on parallel robot technology. Technical support for this technique is provided by telecommunication giant China Telecom and tech giant Huawei. The operator manipulates a simulated robotic hand to remotely control the robotic arm at the patient end (Figure 3). An ultrasound probe is fixed on the robotic arm to scan the patient. Up to 2GB of ultrasonic image data from a lung ultrasound scan lasting a few minutes is produced and transmitted at high speed with low latency<sup>3</sup>. This equipment achieves the real-time image acquisition across long distances and it has the following advantages. First of all, clinicians can be protected by remotely monitoring patients without any personal contact and obtain lung ultrasonic images directly. The robotic arm can reduce the number of doctors and nurses who come into contact with the patient. This is important because the large number of health workers who have become infected with COVID-19 has already become a severe problem.



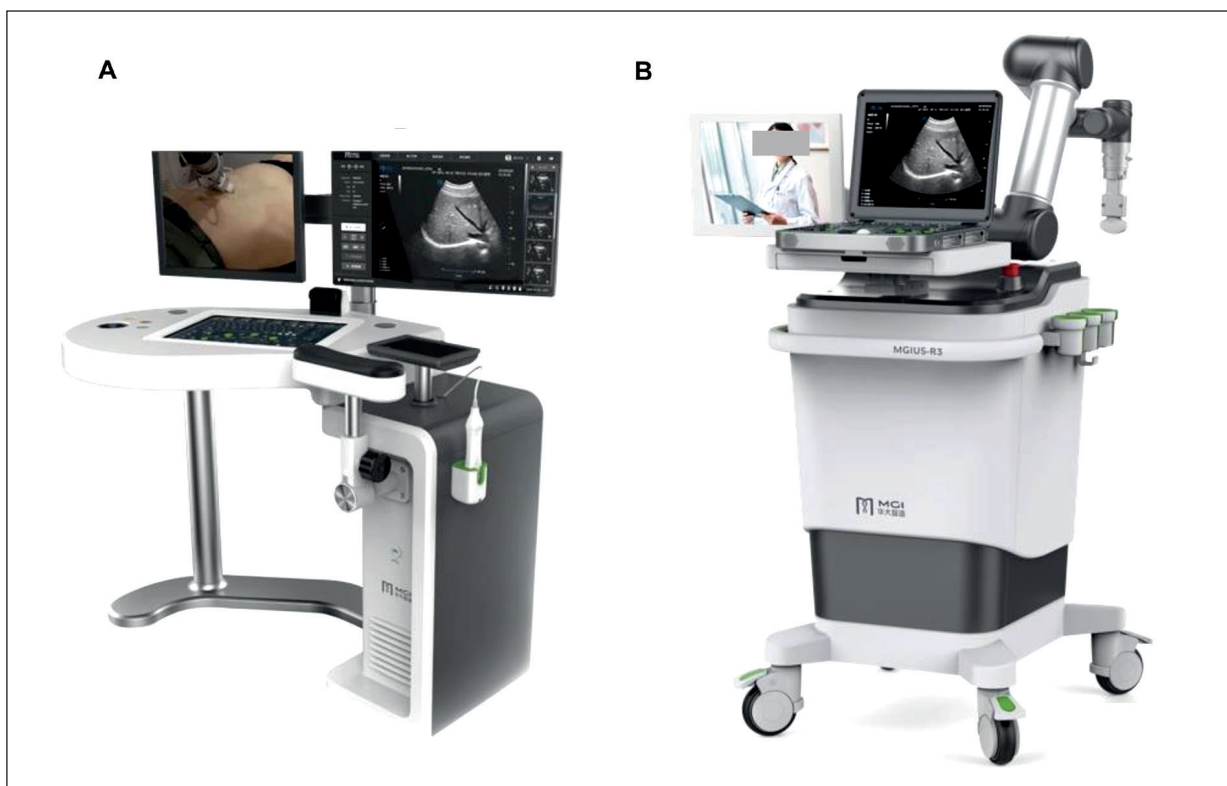
**Figure 1.** Results of chest CT and 5G-powered remote robotic ultrasound for the 54-year-old male patient in Case 1. **A**, CT scan shows patchy high-density shadows with blurred edges, and ground-glass opacity in both lungs. **B**, Lung ultrasonography based on 5G-powered robotic technology displays increased B-lines and local pulmonary consolidation.



**Figure 2.** Results of chest CT and 5G-powered remote robotic ultrasound for the 37-year-old female patient in Case 2. **A**, Chest CT showing multiple nodules appearing to be inflammatory lesions in both lungs. **B**, 5G-powered remote lung ultrasound displaying partially thickened pleura line and intensive B lines.

The health care professionals become infected because they must perform non-stop clinical rotations and there is a growing shortage of protective equipment. Second, depending on the type of 5G-powered long-distance transmitting technol-

ogy available, doctors in outbreak-free areas may remotely assist to operate real-time ultrasound scan to patients in high-risk areas, alleviating the pressure of shortages of medical resources and promoting effective allocation. Third, this kind of



**Figure 3.** 5G-powered remote robotic ultrasound device (diagrams provided by MGI Tech Co., Limited). **A**, The tech room where the operator manipulates the robotic arm with the simulated robotic hand. **B**, The patient room for scanning patients with the robotic arm remotely.

robotic ultrasound can be performed anywhere, at the patient's bedside or even in the patient's home. The robotic arm is movable and easy to use, allowing clinicians to collect lung images directly and monitor patients remotely. This also reduces the possibility of cross-infection because suspected patients do not need to go to common place for diagnosis and evaluation.

Because lung abnormalities may develop before clinical manifestations appear and nucleic acid detection becomes possible, experts have recommended early chest CT for screening suspected patients<sup>4</sup>. However, chest CT has limitations for children and pregnant women because they must avoid radiation exposure, and it is difficult to perform on patients in critical condition who cannot be moved. In addition, the enclosed environment of CT may contribute to the spread of the coronavirus. Many hospitals, such as a number of community hospitals, are not equipped with CT and so cannot perform chest CT scans.

In these two cases, we find that ultrasound can detect features of pneumonia in the lungs of infected patients and it shows specific advantages over chest CT. The lung ultrasound manifestations of COVID-19 include irregular B lines, thickened pleural lines, scattered consolidation and, rarely, pleural effusion<sup>5,6</sup>. One limitation of lung ultrasound is that it cannot clearly detect lesions deep in the lungs ascribable to the gas blocking the ultrasound transmission<sup>6</sup>. According to our experience, the lesions associated with COVID-19 are mostly concentrated in the periphery of the lungs during the early stage of the disease, so ultrasound can still be used for the initial screening of suspected patients, monitoring the progression of the disease, and identification of patients at low-risk. It also has the advantages of repeatability, absence of radiation, and ease of use. Compared with ordinary ultrasound, 5G-powered remote robotic ultrasound has the added advantages of protecting operators, alleviating the pressure of medical equipment shortages, and considerable portability.

## Conclusions

We here report two cases of patients with SARS-CoV-2 infection evaluated by 5G-powered remote robotic ultrasound and describe the advantages of this method and the possibility of popularizing it for diagnosis and monitoring of

COVID-19 cases in clinical practice. 5G-powered transmission technology could support big data, cloud computing and artificial intelligence, contributing to various aspects of the fight against the epidemic.

## Conflict of Interest

The Authors declare that they have no conflict of interests.

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## Ethics Approval and Consent to Participate

This study was approved by the Medical Ethics Committee of Zhejiang Provincial People's Hospital, and the requirement of informed consent was waived since the two patients' information was anonymized to ensure privacy.

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## Authors' Contribution

Rizhen Yu performed patient record management, literature review and drafted the manuscript. Chengzhong Peng and Ruizhong Ye conducted the 5G-powered remote robotic ultrasound. Qiang He and Yaqing Li, treated the patients, organized this study, reviewed clinical and laboratory data, and offered constructive suggestions. All authors have read and approved the final manuscript.

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