Was Lung Computed Tomography Necessary for Patients Receiving Selective Surgery From Low-risk Areas of COVID-19?

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Research article

Keywords: COVID-19, SARS-CoV-2, Computed tomography (CT), selective surgery

Posted Date: October 1st, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-80663/v1>

Abstract

Objective

Lung computed tomography (CT) image was considered as supplementary diagnostic criteria for COVID-19 in the newest diagnosis and treatment program; however, the diagnostic effectiveness of lung CT in patients that have a strict screening for symptoms, history and reverse transcription-polymerase chain reaction (RT-PCR) testing remain unclear. To share our experience about elective surgery during the COVID-19 pandemic and to analyze the effectiveness and necessity of lung CT for screening COVID-19 in elective surgery patients from low risk areas.

Methods

Based on the database of our Hospital Information System, participants were all patients receiving elective surgery in departments of general surgery, hepatological surgery, orthopedics, neurosurgery and urology at our hospital from 11 January, 2020 to 11 May, 2020.

Results

In total, 2375 patients (1150 females and 1225 males) were enrolled in this current study. The mean age was 52 years old, ranging from 6 to 94. All the RT-PCR results of these 2375 patients were negative, including the patients with fever. The most common features on lung CT were nodular lesions (n=624, 26.3%) and striplike lesions (n=467, 19.7%). While, there were only 120 patients (5.1%) with ground-glass opacities (GGO) and 54 patients (2.3%) with lung consolidations on the lung CT, which were ruled out the COVID-19 by the RT-PCR results, clinical manifestation, fever screen, contact history and travel history. During the hospital stay, a total number of 1085 patients were screened with temperature $\geq 37.3^{\circ}\text{C}$, which were ruled out COVID-19 by consultation of special fever clinic and respiratory department.

Conclusions

After strict screening for symptoms, history (contact COVID-19 patients or travelling to high-risk areas) and RT-PCR testing, lung CT image was not recommended as routine examination in patients receiving selective surgery from the low-risk areas of COVID-19.

Introduction

Beginning in December, 2019, a cluster of patients diagnosed with unknown viral pneumonia were reported in Wuhan City, Hubei Province, China [1]. Then the Chinese research team found that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was the pathogenic organism [2]. The World Health Organization (WHO) named coronavirus disease 2019 (COVID-19) caused by this new coronavirus, which can be spread through human-to-human contact. At the time of this writing, COVID-19 had infected >13,378,853 individuals in 216 countries and territories and had caused 580,045 deaths [3].

Nucleic acid testing of SARS-CoV-2 in sputum, throat swabs, and secretions of the lower respiratory tract samples by reverse transcription-polymerase chain reaction (RT-PCR) is the first line screening method of diagnosis [4]. However, the RT-PCR has some limitations. First, it needs rigorous laboratory practice and requires a long time. Second, false-negative results may often occur because of misoperation and insufficient viral specimen. Therefore, the reportedly diagnostic sensitivity of RT-PCR for COVID-19 is only from 50 to 79% [5,6,7]. The diagnosis and treatment program (7th version) published by the National Health Commission of the People's Republic of China had defined the diagnosis of viral pneumonia based on computed tomography (CT) features as one of the diagnostic criteria for COVID-19 [8]. According to the diagnostic criteria, the ground glass opacity (GGO) and lung consolidation involving bilateral and peripheral lung are characteristic CT features of COVID-19 pneumonia. And the recent research has reported the diagnostic sensitivity of CT typical findings of viral lung infection is 60-98% [9,10].

During the national COVID-19 pandemic, most elective surgical procedure has been cancelled across the world. Due to the particularity of our hospital, the elective surgery has been continuing after rigorous screening COVID-19. There is little literature about the elective surgery during the period of COVID-19 pandemic. Therefore, this current study is aimed to share our experience about elective surgery during the COVID-19 pandemic and to analyze the effectiveness and necessity of lung CT for screening COVID-19 in elective surgery patients.

Methods

Patients

After receiving approval from the institutional review board at our hospital, a retrospective analysis was performed on patients undergoing elective surgery in departments of general surgery, hepatological surgery, orthopedics, neurosurgery and urology at our center from 11 January, 2020 to 11 May, 2020. The diagnostic criteria of COVID-19 was determined by the diagnosis and treatment program (7th version) published by the National Health Commission of the People's Republic of China [8], which including epidemiological history (travelling and contact history), clinical manifestation, lung CT imaging characteristics, RT-PCR, viral gene sequence and virus specific Ig M/G.

The flowchart of inpatient admission in our hospital was shown in **Figure 1**. All patients and attendants were asked at outpatient by a screening-questionnaire including symptom, contact with COVID-19 patients and travel history. According to the elevated level in epidemic prevention of public health emergency by our country and hospital, RT-PCR for COVID-19 and lung CT were demanded in both patient and attendant.

RT-PCR for COVID-19

The RT-PCR for COVID-19 was performed using throat swabs by TaqMan One-Step RT-PCR Kits from DaAn Gene Co., Ltd of Sun Yat-Sen University or Maccura Biotechnology Co., Ltd, both of which have

approved use by the China Food and Drug Administration (CFDA). Each patient was required at least twice RT-PCR for COVID-19. And the RT-PCR results were extracted from the department of microbiology in our hospital.

Lung CT protocols

All lung CT examinations were obtained on one of the three CT system (*uCT 510, United Imaging, China; Brilliance iCT 256, Philips, Dutch; Optima CT660, GE, America*) with patients in supine position during end-inspiration. The main scanning parameters were as follows: tube voltage = 120 kVp, automatic tube current modulation = 40-100 mAs, matrix = 512 × 512, slice thickness = 10 mm, field of view = 320 mm × 320 mm. Lung CT imaging features were reviewed and evaluated by at least two experienced radiologists. The lung CT features included GGO, lung consolidation, reticulation or thickened interlobular septa, striplike lesions, nodular lesions, bronchial dilatation, pleural thickening, pleural effusion and calcification or old lesions. The terms of lung CT features were defined in strict accordance with the Fleischner Society guidelines [11].

Statistical analysis

All the statistical analysis was performed using SPSS 22.0 (SPSS Inc. Chicago, IL). Patients' general data was reported using descriptive statistics. Quantitative variables were presented as mean with standard deviation (SD) or range and qualitative variables were displayed as counts and percentages.

Results

General description

A total number of 2375 patients with complete data admitted to our medical center were retrospectively enrolled in this current study. There were 1150 females and 1225 males. The mean age was 52 years old, ranging from 6 to 94. The median total length of stay (LOS) was 13 (P25, P75: 9, 18). And the median preoperative LOS was 7 (P25, P75: 4, 8) days and the postoperative LOS was 6 (P25, P75: 4, 10) days.

According to surgery department, the patients number of surgical indications were distributed as follows: 912 (38.4%) general surgery patients, 285 (12%) hepatological surgery patients, 532 (22.4%) orthopedics surgery patients, 437 (18.4%) neurosurgery patients and 209 (8.8%) urology surgery patients.

Comorbidities and laboratory testing results

The comorbidities and laboratory testing results were shown in **Table 1**. The most comorbidities are hypertension (16.4%) and diabetes (7.2%). Because of the different requirements for laboratory tests in these five departments, some laboratory testing results were incomplete, such as the c-reactive protein, interleukin-6, erythrocyte sedimentation rate and d-dimer, etc. The mean white blood cell and lymphocyte count were $6.6 \times 10^9/L$ and 29.2%, ranging from $1.83 \times 10^9/L$ to $39.95 \times 10^9/L$ and from 1.6% to 70.5%.

And our research sample brought into some primary liver, kidney and infectious diseases, therefore some specific testing results of these diseases were much higher than the normal value.

Results of RT-PCR and Lung CT

All the RT-PCR results of these 2375 patients were negative, including the patients with fever.

The lung CT features of the 2375 patients were presented in **Table 2**. Up to 888 (37.4%) patients had no abnormality on the lung CT. There were only 120 patients (5.1%) with ground-glass opacities (GGO) and 54 patients (2.3%) with lung consolidations on the lung CT, which were ruled out the COVID-19 by the RT-PCR results, clinical manifestation, fever screen, contact history and travel history. And the most common features were nodular lesions (n=624, 26.3%) and striplike lesions (n=467, 19.7%). And these lung CT abnormal manifestation were treated symptomatic treatment according to consultation by the respiratory or thoracic doctors.

Ruling out COVID-19 with febrile patients

During the hospital stay, a total number of 1085 patients were screened with temperature $\geq 37.3^{\circ}\text{C}$. There were 306 preoperative fever and 801 postoperative fever, including 22 patients with both preoperative and postoperative fever. All the patients with fever were firstly transferred to isolation wards with only one patient and one attendant. And then these fevers were consulted by special fever clinic and respiratory doctors. Some of these patients were asked to receive another RT-PCR and/or lung CT to rule out COVID-19. The patients with fever were treated by principles of surgical fever management as following methods: oral or intravenous rehydration, physical cooling, antipyretics and/or antibiotic treatment. The temperature of all patients returned to normal on the day of discharge.

Discussion

Early and accurate diagnose of COVID-19 plays an important role in disease treatment and control. According to the 7th version diagnosis and treatment program by the National Health Commission of China [8], the method of definitive diagnosing suspected cases of COVID-19 involves RT-PCR testing, deep sequencing and immunoglobulin (Ig) M/E. And the typical lung CT findings is demonstrated to help in early screening of patients with suspected COVID-19. Based on the results of this current study, we do not recommend routine lung CT examination for screening COVID-19 in low-risk areas among patients undergoing selective arthroplasties.

The typical clinical manifestation of COVID-19 is not specific, while the reported symptoms range from mild to severe, with some severe patients leading to death. The most commonly symptoms are fever, cough, fatigue, various degrees of pneumonia and dyspnea. Also, there are some less common symptoms including headache, myalgia, nasal obstruction, runny nose, expectoration and diarrhea [1]. In our current study, there were 1085 patients with fever and without other specific symptoms of COVID-19. And these 1085 patients were excluded COVID-19 by special fever clinic and respiratory department

consultation with RT-PCR or lung CT scan again. Our experience for preoperative and postoperative fever is that patient and attendant isolation is the first step and that the second step is to consult special fever clinic and respiratory department with or without further to screen RT-PCR testing or lung CT scan.

RT-PCR testing has been regarded as the gold standard for COVID-19 diagnosis. Although gene sequencing has shown that SARS-CoV-2 shared around 80% identity sequencing with SARS-CoV, which also resulted in 8096 confirmed deaths all over the world in 2002-2003 [12]. Many previous studies suggested that RT-PCR of COVID-19 was different from SARS-CoV, which had modest viral loads in the early stage and peaked approximately 10 days after symptoms onset [13]. Xiao *et al* [14] explored the correlation between clinical characteristics and viral shedding in COVID-19 patients and they found that prolonged viral nucleic acid conversion tended to be older with more comorbidities. In our study, RT-PCR testing was also identified as the gold standard for COVID-19 diagnosis. And there is no confirmed patient with COVID-19. Therefore, RT-PCR is recommended as an effective screening test in low-risk areas.

Lung CT is considered as the primary screening tool for diagnosis and monitoring the care of COVID-19, which helps in early detection of lung abnormalities for ruling out patients with highly suspected cases, especially in patients with an initial negative RT-PCR testing result [10]. Ai *et al* [15] reported the results of lung CT features and RT-PCR testing of 1014 cases and found the sensitivity and specificity of lung CT imaging for COVID-19 diagnosis was 97% and 25%, respectively. And of 308 patients with negative RT-PCR result, the lung CT images showed COVID-19 with lung lesions consisting of GGO (41%) and consolidation (56%). In our study, the most common features found on the lung CT images were nodular lesions (26.3%) and striplike lesions (19.7%), which needed no special treatment. However, the positive rate of GGO and consolidation on the lung CT image were only 5.1% and 2.3%, respectively. And all these patients with positive lung features were ruled out COVID-19 by clinical manifestation, contact and travelling history and negative RT-PCR. The diagnostic effectiveness of lung CT in our current population is almost zero.

What is more, exposure to radiation with lung CT scan could be a potential risk for patients receiving elective surgery. The dose length product for a lung CT scan was average 110 (range 78 to 160) mGy/cm, which is much higher than the dose of chest radiographs [16]. As a result, we do not recommend routine lung CT examination for diagnosing COVID-19 in low-risk areas after strict screening for symptoms, history and RT-PCR.

There are several limitations in the present study. First, this is a retrospective study and may have some data bias. Second, we do not manage a real patient with COVID-19, which may result in some experience loss. On the other hand, the flowchart of prevention and control COVID-19 in our hospital was worthy of reference. While our hospital has maintained an admission rate more than 60% from pandemic, there is no conformed patient with COVID-19 during hospital stay.

In conclusion, after strict screening for symptoms, history (contact COVID-19 patients or travelling to high-risk areas) and RT-PCR testing, lung CT image was not recommended as routine examination for patients receiving selective surgery from the low-risk areas of COVID-19.

Declarations

Ethical Approval

The study was approved by the Medical Ethics Committee of the Chinese PLA General Hospital and performed in accordance with the ethical standards in the 1964 Declaration of Helsinki.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare no conflict of interest.

Funding

This work was supported by grants from the Beijing Municipal Natural Science Foundation (No. 7192199), the Youth Support Project of Chinese PLA General Hospital (No. QNF19015) and the National Key Research and Development Program of China (No. 2020YFC2004900).

Author Contributions

Jun Fu, Wei Chai, and Qiang Lu make substantial contributions to conception and design and to draft the article, Zhida Chen, Xinghua Xu, Lichao Pan, Liangyou Gu, Chi Xu and Yinqiao Du make substantial contributions to acquisition of data, Ming Ni and Jiying Chen make substantial contributions to analysis and interpretation of data. Qilin Yu participates in revising the article. All authors of this paper have read and approved the final version submitted.

Acknowledgments

We thank Hebin Che and Wanguo Xue from the Big Data Center of Chinese PLA General Hospital for helping data collection.

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Tables

Table 1. Comorbidities and laboratory testing results of patients (n=2375)

Characteristics	Mean and range	Number (%) of patients
Laboratory marker		
White blood cell ($10^9/L$)	6.6 (1.83-39.54)	2015 (84.8%)
Lymphocyte count (%)	29.2 (1.6-70.5)	2015 (84.8%)
Platelet count ($10^9/L$)	232.0 (30-735)	2014 (84.8%)
Haemoglobin (g/L)	130.7 (44.0-214.0)	2016 (84.9%)
C-reactive protein (mg/dL)	1.2 (0.04-16.45)	1200 (50.5%)
Interleukin-6 (pg/mL)	53.72 (1.5-5000)	761 (32.0%)
Erythrocyte sedimentation rate (mm/h)	9.7 (1.0-104)	430 (18.1%)
Alanine aminotransferase (U/L)	21.7 (0.3-858.8)	2028 (85.4%)
Aspartate aminotransferase (U/L)	19.9 (5.3-1068)	2028 (85.4%)
Albumin (g/L)	41.6 (20.8-57.9)	2028 (85.4%)
Total bilirubin ($\mu\text{mol/L}$)	13.7 (1.7-623.8)	2024 (85.2%)
Glucose (mmol/L)	5.5 (1.7-26.7)	2029 (85.4%)
Creatinine ($\mu\text{mol/L}$)	69.6 (17.5-671.2)	2030 (85.5%)
Activated partial thromboplastin time (s)	36.8 (22.6-68.1)	1904 (80.2%)
Fibrinogen (g/L)	3.2 (1.15-13.25)	1906 (80.3%)
D-dimers (ug/mL)	0.79 (0.01-20)	1423 (59.9%)
Comorbidities		
Chronic pulmonary disease	-	15 (0.6%)
Diabetes	-	172 (7.2%)
Hypertension	-	390 (16.4%)
Chronic renal failure	-	10 (0.4%)
Cardiovascular disease	-	49 (2.1%)
Cerebrovascular disease	-	24 (1.0%)

Table 2. Lung computed tomography features of patients (n=2375)

Lung CT features	Number (%) of patients
No abnormality	888 (37.4%)
Ground-glass opacity	120 (5.1%)
Lung consolidation	54 (2.3%)
Reticulation/thickened interlobular septa	167 (7.0%)
Striplate lesions	467 (19.7%)
Nodular lesions	624 (26.3%)
Bronchial dilatation	56 (2.4%)
Pleural thickening	89 (3.7%)
Pleural effusion	89 (3.7%)
Calcification/old lesions	155 (6.5%)

Figures

Figure 1

The flowchart of inpatient admission in our hospital.