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COVID-19 in Post-Operative Patients: Imaging Findings

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Abstract

Background: Coronavirus 2019 (COVID-19) in the post-operative period is challenging. Its clinical manifestations may have similarities to other septic, thoracic, or gastrointestinal post-surgical complications. Additionally, the post-operative period may be a time of increased risk for severe manifestations of COVID-19. We sought to evaluate the frequency of COVID-19 in a cohort of patients who had recently had operations who were undergoing imaging for acute symptoms and the role of chest computed tomography (CT) in this setting.
Patients and Methods: We included all patients who had chest CT for acute symptoms in the 15 days after a surgical procedure between March 1 and 31, 2020.
Results: Of 46 patients with acute post-operative symptoms requiring chest imaging, eight (17%) were ultimately diagnosed with COVID-19. Among them, five (62%) required mechanical ventilation and two (25%) died. All had abnormal chest CT with typical findings of COVID-19 in 87%. Computed tomography provided an alternate diagnosis in 53% of patients who did not have COVID-19. The average time between a COVID-19–positive chest CT and the polymerase chain reaction (PCR) confirmation was 1.2 days (range, 0–4 days).
Conclusion: COVID-19 is a serious post-operative condition associated with significant morbidity and mortality. Chest CT provides prompt diagnosis of COVID-19. In centers with a high prevalence of COVID-19, chest acquisition should be included in CT scans done for acute post-operative symptoms.

Keywords: complication; COVID-19; computed tomography; pneumonia; post-operative

The coronavirus 2019 (COVID-19) pandemic has affected the organization of surgical departments dramatically, especially in the most affected regions of the world. Elective surgeries have been reduced or postponed [1] and personnel and resources have been re-allocated. For patients having operations during a pandemic, the occurrence of COVID-19 during their hospitalization poses several threats including a high risk of disease transmission to healthcare professionals and other patients, especially if the diagnosis is delayed.

In the post-operative period, COVID-19 may also be associated with a poorer prognosis [2–4] because of factors such as general anesthesia and mechanical ventilation, blood loss/transfusion, and systemic inflammatory response syndrome associated with aggressive surgical management [5]. The diagnosis can also be challenging because symptoms of COVID-19 may be attributed to other common post-operative conditions.

Chest computed tomography (CT) has a high sensitivity for the diagnosis of COVID-19 [6] as well as other post-operative pulmonary complications. It can be an efficient triage tool for patients presenting with acute symptoms post-operatively. In this study, we sought to evaluate the frequency of COVID-19 in a cohort of patients undergoing chest imaging for acute post-operative symptoms, as well as the imaging appearance and the clinical course of these patients.

Patients and Methods

Study population

This monocentric retrospective cohort study included patients who had undergone chest CT between March 1 and 31, 2020 in a tertiary care center in Strasbourg University Hospital, Strasbourg, France, and who had had an operation in the previous 15 days. Surgical procedures were classified based on the likelihood of perioperative morbidity and mortality on a five-point scale, from very low risk procedures (1) to very high-risk procedure [5,7].

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Table 1. Clinical Characteristics of Patients with COVID-19

No.	Age (y)	Gender	Medical history	BMI (kg/m^2)	Surgery	Symptoms	POD	SpO_2	Temperature	WBC (g/L)	CRP (mg/L)	D-dimer (mcg/L)	COVID-19 findings on CT	CT severity score	SARS-CoV-19 PCR	Tracheal intubation	Max O_2	Other treatments	Evolution
1	28	F	Essential thrombocythemia	25	Laparotomy for small bowel resection after mesenteric venous thrombosis	Tachycardia 150 bpm Hyperthermia	2	92%	38.5°C	2,9	239	3800	Typical	3/5	Positive	Yes	F_IO_2 70%	Anticoagulation Antibiotherapy	Discharge at D17
2	31	M	Lennox–Gastaut syndrome Developmental disabiltiy	22	Left hemicolectomy for colonic necrosis	Cough Hyperthermia	9	98%	38°C	12.7	123	NA	Typical	1/5	Negative on day 9 Positive on day 11	No	2L	Anticoagulation Antibiotherapy	Discharge at D20
3	53	M	Diabetes	34	Laparoscopic cholecystectomy for acute cholecystitis	Cough Right upper quadrant abdominal pain	5	88%	38.3°C	4.4	166	NA	Typical	2/5	positive	No	6L	Hydroxychloroquin Antibiotherapy	Discharge at D10
4	45	F	None	24	Laparoscopy for IUD-associated pelviperitonitis	Hypoxemia	4	86%	37.6°C	32.58	249	6080	Typical	4/5	Positive	Yes	F_IO_2 65%	Antibiotherapy	Discharge at D24
5	45	M	Aortic valve replacement (mechanical) for infectious endocarditis 15 y before Hypertension	25	Aortic valve replacement for mechanical aortic valve failure	Hyperthermia Dyspnea	6	94%	39.1°C	11.9	103	3710	Typical	3/5	Negative on day 6 Negative on day 8 Positive on day 10	Yes	F_IO_2 100%	Antibiotherapy Anticoagulation Hemodialysis	Death at D43
6	62	M	Hypertension	29	Sigmoidectomy for perforated diverticulitis	Dyspnea	2	92%	37.5°C	6.15	223	NA	Typical	2/5	Positive	Yes	F_IO_2 50%	Antibiotherapy	Discharge at D25
7	73	F	Advanced ovarian carcinoma	20	Maximal cytoreductive surgery of ovarian peritoneal carcinomatosis	Hyperthermia	1	89%	38.2°C	2.1	43	NA	Typical	2/5	Positive	No	Optiflow 70L	Antibiotherapy	Death at D9
8	39	F	Severe traumatic brain Injury 20 y before	21	Surgical drainage of a submental abscess	Dyspnea Fall Femoral neck fracture	13	94%	37.3°C	11.5	140	NA	Indeterminate	1/5	Positive	Yes	F_IO_2 45%	Antibiotherapy	Discharge at D13

COVID-19 = coronavirus 2019; BMI = body mass index; POD = postoperative day; SpO_2 = peripheral capillary oxygen saturation; WBC = white blood cell count; CRP = C-reactive protein; CT = computed tomography; PCR = polymerase chain reaction; SARS-CoV-19 = severe acute respiratory syndrome coronavirus-2; Max O_2 = maximal oxygen therapy; F_IO_2 = fraction of inspired oxygen; NA = not available.

Table 2. Comparison between COVID-19 and Non-COVID-19 Patients

	COVID-19 $n=8$	*Non-COVID-19* $n=38$	*p*
Age	47 ± 15	65 ± 14	<0.05
Male gender	4 (50%)	17 (44%)	0.7916
BMI	25 ±4.6	27 ±3.6	0.1286
Surgery risk level	3.6±0.9	3.5±0.8	0.7017
Oncologic surgery	1 (13%)	10 (26%)	0.4163
Days to surgery	2.8±3.9	5.9±4.9	0.0376
Hospital length of stay (d)	20.1± 11	13.3± 7	<0.05
Requiring mechanical ventilation	5 (63%)	8 (21%)	<0.05
30-day mortality	25%	16%	0.5427

COVID-19 = coronavirus 2019; BMI = body mass index.

Clinical and biologic evaluation

Demographic and medical history, data concerning the surgical procedure, post-operative clinical and biologic data, need for intensive care, oxygen therapy, mechanical ventilation, and one-month mortality were recorded. All COVID-19 cases were confirmed by a positive severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) reverse transcription-polymerase chain reaction (RT-PCR).

Imaging data

For each patient, post-operative chest CT images were reviewed by an experienced radiologist blinded to the clinical and biologic data. Findings of lung lesions were classified as typical appearance for viral pneumonia, indeterminate appearance (possible viral pneumonia), atypical appearance for viral pneumonia (preferred alternate diagnosis) and no pneumonia, following the recommendations of the Radiological Society of North America [8].

In cases of typical or possible viral pneumonia, the percentage of abnormal lung parenchyma was visually estimated on a scale from one to five (one, ≤10%; two, 11%–25%; three, 26%–50%; four, 51%–75%; and five, >75%). Other findings, such as pleural effusion, pulmonary embolism, non-viral pneumopathy, acute decompensated heart failure, and lung atelectasia were also reported.

Statistical analysis

Continuous variables are presented as mean ± standard deviation (SD) and were compared using the Student t-test. Qualitative variables are presented as numbers and percentages and were compared using the χ^2 test or Fisher exact test as appropriate. Significant difference between groups was considered when p value <0.05.

Ethical considerations

The study was approved by the Institutional Review Board (ref CE/2020-46); written informed consent was waived because of the retrospective nature of this study.

Results

Between March 1 and 31, 2020, 46 patients underwent post-operative chest CT, with an average time to surgery of 5.5 days (range, 0–12). Among them, eight (17%) patients were found to have COVID-19, confirmed by a positive SARS-CoV-2 RT-PCR in 100% of the cases.

Type of surgery

Operations were performed for acute surgical pathologies in 31 cases (67%), oncologic pathology in 11 cases (24%), kidney transplantation in one case (2%), and elective surgery in three cases (7%). Surgical procedures were abdominal (38%), cardiothoracic (18%), head and neck (11%), orthopedic (12%), and gynecologic (11%). Surgical procedure risk level was similar between COVID-19 and non-COVID-19 patients (3.6 and 3.5. respectively).

Clinical and biologic data

Symptoms for which a CT was ordered were hyperthermia in 23 cases, acute respiratory symptoms in 12 cases, and abdominal pain in 11 cases.

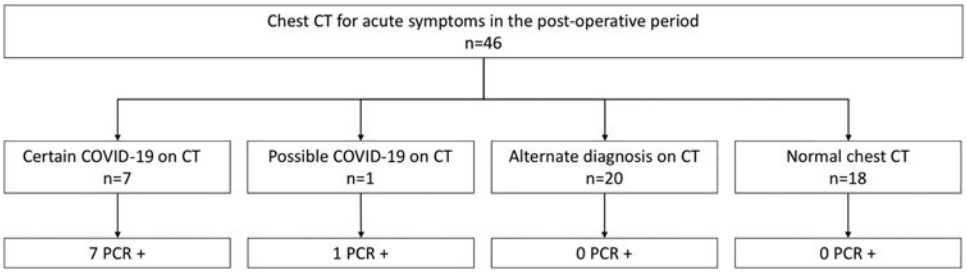

FIG. 1. Synthesis of imaging findings. CT = computed tomography; COVID = coronavirus 19; PCR = polymerase chain reaction

Table 3. Imaging Features of Patients with COVID-19

No.	*Scan type*	*COVID-19 lesions*	*COVID-19 CT severity score*	*Pleural fluid*	*Pulmonary embolism*	*Other findings*
1	CTPA	Nodular and confluent GGO Condensations Basal predominance	3/5	Mild, bilateral	No	No
2	CT TAP	Subpleural linear opacities Condensations	1/5	No	No	Post-operative pelvic abscess
3	CT TAP	Nodular and confluent GGO Upper-lobe predominance	2/5	No	No	Right diaphragmatic elevation
4	CT TAP	Confluent GGO and condensations	4/5	Moderate, bilateral	No	Post-operative peritoneal effusion
5	CT TAP	GGO Linear opacities	1/5	Mild	No	No
6	CT TAP	Nodular GGO Linear opacities	2/5	No	No	Post-operative peritoneal effusion
7	CT TAP	Nodular GGO	2/5	Moderate Unilateral	No	Post-operative peritoneal effusion
8	CT Chest	Subpleural linear opacities	1/5	No	No	No

COVID-19 = coronavirus 2019; CTPA = computed tomography pulmonary angiogram; CT TAP = computed tomography thoracic, abdominal, and pelvic; GGO = ground-glass opacities.

Table 1 shows the detailed clinical and biologic characteristics of the patients with COVID-19.

The average age of patients with COVID-19 patients was 47 years (range, 17–28), average hospital stay was 20.1 days (range, 9–43). Mechanical ventilation was needed for five patients (62%) and two patients died (25%). Table 2 shows the comparison of COVID-19 and non-COVID-19 patients characteristics.

Chest CT data

Chest CTs were done with contrast injection in 36 patients (78%). In patients with COVID-19, chest CT was positive in all cases (Fig. 1), the two most common findings were ground-glass opacities and subpleural linear opacities (Table 3). Pleural effusion was seen in half of the cases. Computed tomography severity score was 1.9 on average, similar in deceased and survivors. Figures 2 and 3 show examples of COVID-19 images.

The average time between a COVID-19–positive chest CT and the first positive RT-PCR was 1.2 days (range, 0–4 days). In non-COVID-19 patients, CT was abnormal in 22 patients (58%). The most common findings were acute decompensated heart failure (23%), non-viral pneumopathy (23%), pulmonary embolism (9%), lung atelectasis (9%), and pleural effusion (9%).

Discussion

During a one-month period (March 2020), COVID-19 was found in 17% of chest CT scans from symptomatic patients who recently had operations, a frequency comparable to the most frequent cardiopulmonary post-operative complications (non-viral pneumopathy, pulmonary embolism, acute heart failure).

It is well-known that the occurrence of a post-operative pulmonary complication increases mortality, length of hospital stay, and healthcare costs substantially [9]. We found

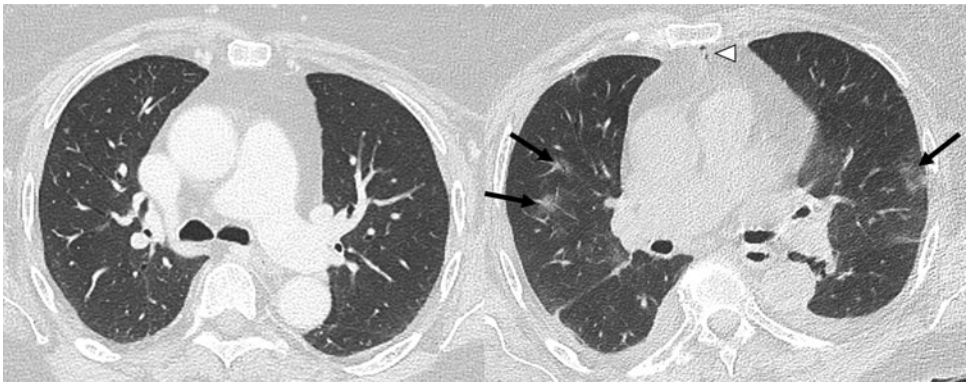

FIG. 2. Baseline (left) and post-operative (right) chest computed tomography (CT) of patient 7, showing the appearance of diffuse round ground-glass opacities (arrows) and minimal post-operative pneumomediastinum (arrowhead).

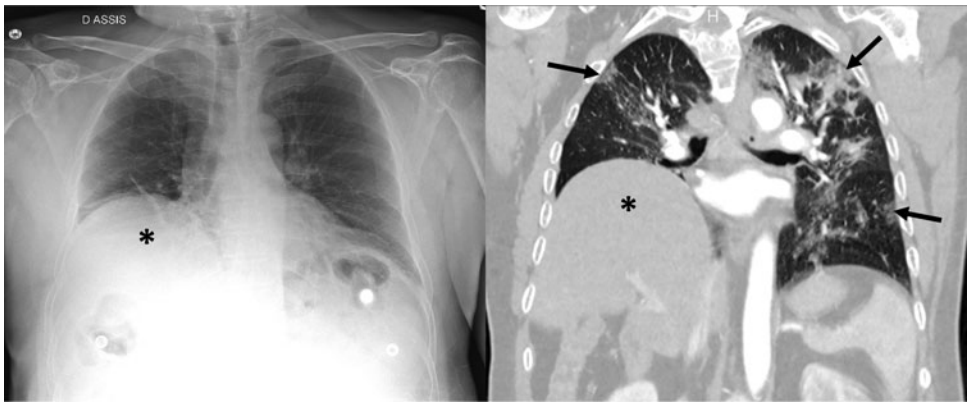

FIG. 3. Pre-operative chest radiograph (left) and post-operative chest computed tomography (right) of patient 3, showing the appearance of diffuse ground-glass opacities with superior lobe predominance (arrows). Note a right diaphragmatic elevation (asterisk) that was present pre-operatively.

that compared with other complications, post-operative COVID-19 led to longer hospital stay and more frequent need for mechanical ventilation in the post-operative period. These results agree with previously published studies [2–4]. The one-month mortality did not differ substantially between COVID-19 and non-COVID-19 patients, but it is possible that the younger age of the first group in our cohort may have been a protective factor.

Given the short time between surgery and post-operative symptoms in our study, which is inferior to the average incubation time of COVID-19 in the literature [10], it is plausible that some of the patients with COVID-19 had been infected in the community settings. This may support systematic pre-operative screening, especially in regions with the highest viral strain, which may help the decision to postpone elective or oncologic surgery or to isolate infected patients.

Our study supports the use of chest CT for rapid diagnosis of COVID-19 in post-operative settings. If there is an indication of abdominal scan for acute post-operative symptoms, systematic chest scanning should be included. More generally, chest CT is useful in unexplained post-operative symptoms, because it can detect atypical presentation of COVID-19 and allows broad differential diagnosis. Although RT-PCR on respiratory tract samples is the reference diagnosis method for SARS-CoV-2 infection, its results may be different or unavailable after-hours and its first-line use may be limited in cases of non-respiratory symptoms such as abdominal pain and altered mental status. Imaging findings of COVID-19 in the post-operative period may be different than in community settings, with more frequent pleural effusion and atelectasis, which are common after general anesthesia.

Data about pulmonary embolism being more frequent in patients with COVID-19 [11] may lead to widespread use of intravenous contrast in post-operative settings, a period that is already at higher risk of thromboembolic events.

Our work has several limitations. The population and viral prevalence reflect the epidemiologic situation of the geographical area of our center and may not be extrapolated elsewhere. The population size is limited and mostly includes emergency surgery, which reflects the decreased surgical activity in response to the viral outbreak. Some underestimation of the frequency of SARS-CoV-2 infection may have occurred because asymptomatic patients may not have been included in the absence of systematic screening of inpatient population.

Conclusion

In this study COVID-19 was found in 17% of chest post-operative CT scans and lead to increased hospital length of stay and need for mechanical ventilation. Chest CT is an efficient and rapid way to diagnose post-operative COVID-19 during the pandemic.

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Author Disclosure Statement

No competing financial interests exist.

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