Computerized tomography of the Thorax for surgical patients during the COVID-19 pandemic: Was it useful?

ABSTRACT

Objectives

Diagnostic challenges during the COVID-19 pandemic forced the radiology regulating body to adopt the use of CT Chest as a triage and diagnostic tool, which was subsequently abandoned. The Royal Wolverhampton hospital followed both protocols. Here, we investigate the evidence behind this decision within the context of surgical admissions during the COVID-19 peak in our hospital.

Methods

Retrospective data collection and analysis of all surgical admissions between the 1st of March to the 31st of May. Data was collected from the radiology and electronic portal looking into patients undergoing CT chest to diagnose the presence of C-19 as well as swab results.

Results

78 patients fulfilled our inclusion criteria. The scan either confirmed the presence or absence (4, 63 patients) of C-19 but was sometimes inconclusive (11 patients). Comparing these to the results of the swabs; CT showed sensitivity 42.86 %, Specificity 97.92%, and accuracy 90.91 %. In the inconclusive CT report group, chances of having a positive swab result were 45%: None of the scan results changed any of the surgical planning. Lymphocyte count in the context of surgical presentation did not have any statistical significance to predict the presence of C-19 (P=0.7). Cost implications on our cohort of patients for adding the chest CT is estimated to be around £31,000.

Conclusion

CT Thorax during the pandemic was a good negative predictor but had limited diagnostic value and did not change patient management. Newer, faster techniques of PCR swabs and antibody testing would be a better and cheaper alternative.

Advances in knowledge

This paper provides evidence to support the decision from the regulatory bodies not to use CT scan as a screening tool for COVID 19 diagnosis.

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INTRODUCTION

Every medical institution around the world was compelled to rise to the immense challenge posed by the COVID-19 pandemic. As of August 2020, it has infected over 22 million worldwide and caused the death of almost 800,000. At the beginning of the pandemic, diagnostic challenges were encountered due to the absence of expertise, as well as logistical difficulties in obtaining enough testing kits. The initial turnaround time for a confirmed PCR swab result in the U.K. was around 4 days; Thoracic CT offered a quicker and more promising alternative to diagnose and triage the disease.

British Society of Thoracic Imaging (BSTI) issued their first statement on 11th March 2020 stating[1], "BSTI have been discussing this with NHS England. The current position is that there is no recommended use of CT, beyond 'routine clinical care'. We are reassured that this has so far also been the position taken by the American College of Radiology, in recommendations published today. In a situation where numbers rise very rapidly, with increasingly ill patients requiring hospital admission, the role of CT may turn towards risk stratification and assessment of disease burden. Again, these discussions are ongoing with the Royal College of Radiologists and NHS England. We also have dialogue with our Italian colleagues.'' However, the following statement was released on 22nd May 2020, stating "As community prevalence of COVID-19 has dropped; and availability of RT-PCR has improved (including rapid tests generating results in 45-90 minutes), [so] the need for an alternative (i.e., CT chest) has diminished. Most acute hospitals will now receive RT-PCR results before the decision regarding operative management. Acute abdominopelvic CT already includes the lung bases; the incremental benefit of full thoracic scanning where RT-PCR is negative and community prevalence is dropping is likely to be negligible. We therefore suggest that there is no longer a need for routine CT of the entire thorax for patients undergoing acute abdominopelvic imaging[2]. The Royal College of Radiology had similar view to that mentioned above and they released their own statement[3].

The surgical department in Royal Wolverhampton Hospital decided to investigate our own outcomes during the COVID-19 pandemic to see if CT Thorax added any value to the management of surgical patients.

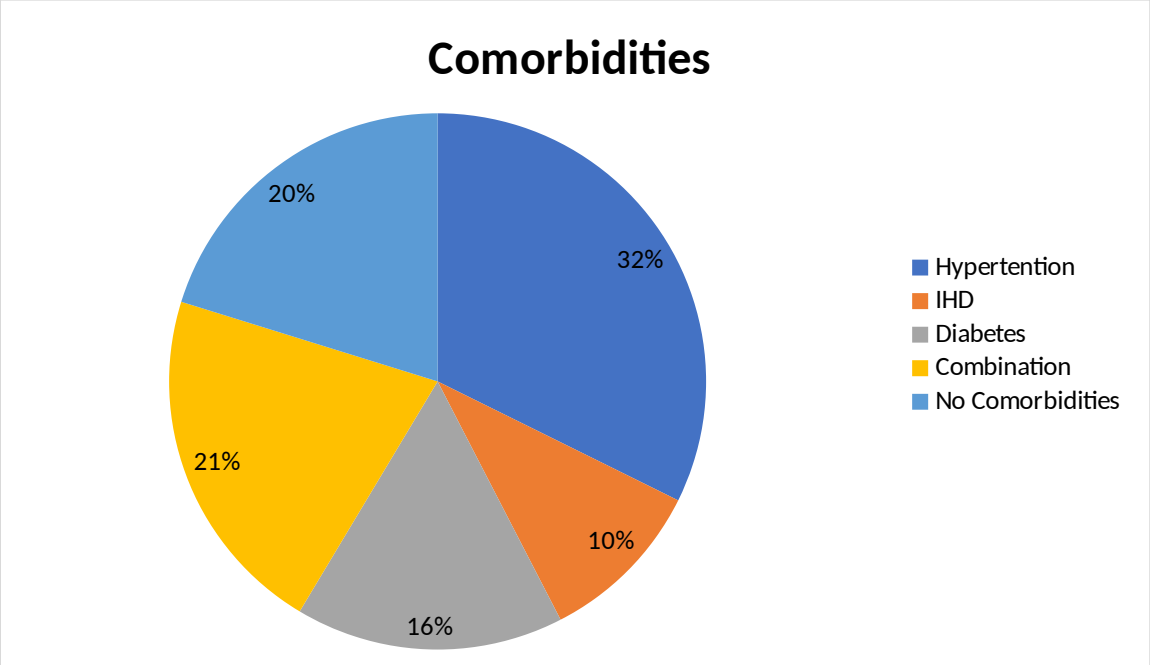
METHODS

Retrospective data were collected and analysed from all admissions between 1st March 2020 and 31st May 2020 i.e. starting from the rise of the pandemic in Royal Wolverhampton Hospital and the implementation of the new guidelines regarding CT scanning of the chest as a tool to triage or to investigate patient for possible COVID-19 . Our inclusion criteria included all surgical admissions, emergency or elective, any gender, and any age, those with a scan of their thorax, with or without a scan of the abdomen and pelvis to investigate their surgical pathology. Exclusion criterion was patients not undergoing CT Thoraces. Data were collected from our electronic clinical portal and scanned documents.

RESULTS

78 patients fulfilled the inclusion criteria: Our age range was 26 to 92 years, with a median of 72.5. All patients admitted had a suspected surgical pathology. 72 patients were emergency admissions while only 6 were elective, for cancer resection.

Data collected investigated patient's comorbidities including hypertension, diabetes, and ischaemic heart disease (IHD) (Chart 1)



COVID-19 or/ and nasopharyngeal swabs were sent on admission for 66 patients with available results. 12 patients did not have a swab (with no documented reason) and 21 patients (26.9%) had clinical and radiological signs of chest infection during their surgical admission. All these 21 patients had COVID-19 swabs sent except one who died and was not for escalation due to frailty. (Table1)

Table 1: Number of PCR swabs		
Swab positive	**Swab negative**	**Swab not done**
12	54	12

CT Thoraces offered to the 78 patients were reported by radiologists of varying grades, but all were counter-checked by a consultant within 24 hours if reported initially by a registrar. Reports reviewed by the collecting team were categorised into confirmed negative, confirmed positive and inconclusive. (Table 2)

Table 2: CT reporting	
CT reported Positive	4
CT reported Negative	63
CT reported Inconclusive	11

All the results were compared to the results of the swabs (Table 3), excluding the 12 patients who did not have swab sent, testing for sensitivity, specificity, and accuracy, (Tables 4). 45% of patients with CT reports that were inconclusive had a positive COVID-19 swab.

Table 3: Summing up of CT VS Swab results

CT reports		**Swab positive**	**Swab negative**
CT reported Positive	4	3	1
CT reported Negative	51	4	47
CT reported Inconclusive	11	5	6
Total	66	12	54

Table 4: Statistical calculations

Statistic	**Value**	**95% CI**
Sensitivity	42.86 %	9.90% to 81.59%
Specificity	97.92 %	88.93% to 99.95%
Positive Likelihood Ratio	20.57 %	2.47 to 171.34
Negative Likelihood Ratio	0.58	0.31 to 1.11
Disease prevalence	12.73	5.27% to 24.48%
Positive Predictive Value	75 %	26.48% to 96.15%
Negative Predictive Value	92.16 %	86.07% to 95.72%
Accuracy	90.91 %	80.05% to 96.98%

The number of patients requiring surgical intervention in our data capture were 22 (28%). Out of these, 7 patients were positive for COVID-19 and CT failed to identify all of them, although 6 were reported as inconclusive. 10 of these patients required ITU admission post-operatively, but only one was due to COVID-19 pneumonia. One patient died a few days after surgical intervention, but he was Covid19 negative on PCR and on CT. (Table 5)

Table 5: Patients requiring operative interventions

Operations	Positive swab	CT positive	CT Inconclusive	ITU admission	ITU for Covid	Mortality	Mortality from C-19
22	7	0	6	10	1	1	0

Assessing mortality in our cohort of patients, 6 patients (7%) died in the first 30 days from admission, out of which one was related to COVID-19 pneumonia confirmed by CT Chest and swab. However, their management did not require surgical intervention. The rest had normal CT Chest findings, 3 had negative swabs results and 2 had no swabs sent at all. (Table 6).

Table 6: Mortality outcomes

Mortality	Positive Swab	Negative swab	No swab	CT Negative	CT positive	ITU	Operation
6	1	3	2	5	1	1	1

Exploring whether lymphocyte count plays a role in the context of surgical admission to predict COVID-19 status, they were found to be below the normal range in 56 patients (71%). From these, 8 had a positive swab, 9 did not have a swab and the rest were negative. No statistical correlation was found on linear regression between lymphocyte level and swab status [P value = (0.7)].

Estimating the cost implication on our hospital from the use of CT Chest scans during the pandemic was difficult as the tariff was based on rental, but it has been estimated to add at least £400 for each patient. This adds up to £31,000 of extra cost, compared to the cost of PCR COVID-19 swabs which range from £75-150 per test. Furthermore, turnover time for the swab results is much quicker and hence is considered more efficient.

DISCUSSION

The SARS-CoV-2 virus is not the first to cause a pandemic, but it is one that has overstretched all existing medical resources, whether it be labour or financial. There is a general lack of scientific evidence in the global management of this pandemic on both medical and social aspects and although more evidence is currently being populated, so far nothing has been validated.

Regarding our subject of discussion: the benefit of CT Thorax as a triage or diagnostic tool during the pandemic, there were multiple metanalyses that had interesting results.

Meng et al had investigated and done metanalysis for 103 studies with 5,673 patients dating from January 1st, 2020 to April 3rd, 2020. 64 studies estimated the sensitivity of chest CT imaging in COVID-19 to be 96% (95% CI, 0.93–0.99). The sensitivity of CT scan in confirmed patients under 18 years old was only 66% (95% CI, 0.15–1.00). The most common imaging manifestation was ground-glass opacities (GGO) which was found in 75% (95% CI, 0.68–0.82) of the patients. The pooled probability of bilateral involvement was 84% (95% CI, 0.81–0.88). The most commonly involved lobes were the right lower lobe (84%, 95% CI, 0.78–0.90) and left lower lobe (81%, 95% CI, 0.74–0.87). They described the quality of evidence as low[4].

Kim et al investigated the same subject as well and analysed 68 articles. The pooled sensitivity was 94% (95% CI: 91%, 96%; I2=95%) for chest CT and 89% (95% CI: 81%, 94%; I2=90%) for RT-PCR. The pooled specificity was 37% (95% CI: 26%, 50%; I2=83%) for chest CT. For chest CT scans, the positive predictive value (PPV) ranged from 1.5% to 30.7%, and the negative predictive value (NPV) ranged from 95.4% to 99.8%. For RT-PCR, the PPV ranged from 47.3% to 96.4%, while the NPV ranged from 96.8% to 99.9%. The sensitivity of CT was affected by the distribution of disease severity, the proportion of

patients with comorbidities, and the proportion of asymptomatic patients (all $p < 0.05$). The sensitivity of RT-PCR was negatively associated with the proportion of elderly patients ($p = 0.01$)[5].

All the patients in our cohort that were diagnosed positive on CT scan and confirmed by PCR swab had clear radiological features of consolidation and ground−glass opacities in both lungs. Nevertheless, patients whose CT scans were inconclusive, but swabs were positive, showed patchy consolidation with no evidence of ground−glass opacities which made the diagnosis very difficult.

Zhu et al metanalysis examined different appearances on CT scanning in COVID-19 patients. Their analysis included 34 retrospective studies, involving a total of 4121 patients with SARS-CoV-2. 73.8% of patients had bilateral lung involvement (95% confidence interval [CI]:65.9%−81.1%), 67.3% had multilobar involvement (95% CI: 54.8%−78.7%) and just a few (8.4%) patients showed normal CT findings. The most common changes in lesion density were ground−glass opacities (68.1%, 95% CI: 56.9%−78.2%). Other changes in density included air bronchogram sign (44.7%), crazy−paving pattern (35.6%), and consolidation (32.0%). Patchy (40.3%), spider web sign (39.5%), cord−like (36.8%), and nodular (20.5%) were common lesion shapes in patients with COVID−19, too. Pleural thickening (27.1%) was found in some patients. Lymphadenopathy (5.4%) and pleural effusion (5.3%) were rare[6].

Similarly, Wan et al reported a total of 14 articles including 1115 patients. In the lesion patterns on chest CTs, pure ground-glass opacities (GGO) (69%, 95% CI 58-80%), consolidation (47%, 35-60%) and “air bronchogram sign” (46%,25-66%) were more common than the atypical lesion of “crazy-paving pattern” (15%, 8-22%). 70% (95% CI 46-95%) of cases showed a location preference for the right lower lobe, 65% (58-73%) of patients presented with more or equal 3 lobes involvement. Meanwhile, 42% (32-53%) of patients had all five lobes involved, and 67% (55-78%) showed a predominant peripheral distribution[7].

In conclusion, as proven in our cohort of surgical patients, CT is an expensive tool that is good to rule out SARS-CoV-2 virus but is not advisable to be used as a diagnostic tool. PCR swabs, especially the new generation, is a quick, safe test with no exposure to radiation.

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