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Role of complementary Ct chest in patients presenting with acute abdominal symptoms during covid-19 pandemic: a UK experience

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ABSTRACT

Background: In March 2020, the UK Intercollegiate General Surgery Guidance on COVID-19 recommended that patients undergoing emergency abdominal CT should have a complementary CT chest for COVID-19 screening.
Purpose: To establish if complementary CT chest was performed as recommended, and if CT chest influenced surgical intervention decision. To assess detection rate of COVID-19 on CT and its correlation with RT-PCR swab results. To determine if COVID-19 changes is reliably detected within the lung bases which are usually imaged in standard abdominal CT.
Methods: Patients with acute abdominal symptoms presenting to a single institution between 1st and 30th April 2020 who had abdominal CT and complementary CT chest were retrospectively extracted from Computerised Radiology Information System. CT COVID-19 changes were categorised according to British Society of Thoracic Radiology reporting guidance. Patient demographics (age and gender), RT-PCR swab results and management pathway (conservative or intervention) were recorded from electronic patient records. Statistical analyses were performed to evaluate any significant association between variables. p values ≤ 0.05 were regarded as statistically significant.
Results: Compliancy rate in performing complementary CT chest was 92.5% (148/160). Thirty-five patients (35/148,23.6%) underwent intervention during admission. There was no significant association ($p = 0.9085$) between acquisition of CT chest and management pathway (conservative vs intervention). CT chest had 57% sensitivity (CI 18.41% to 90.1%) and 100% specificity (CI 92% to 100%) in COVID-19 diagnosis. Three of ten patients who had classic COVID-19 changes on CT chest did not have corresponding changes in lung bases.
Conclusion: Compliance with performing complementary CT chest in acute abdomen patients for COVID-19 screening was high and it did not influence subsequent surgical or interventional management.

1. Introduction

COVID-19 was declared a pandemic by the World Health Organisation on 11th March 2020. In March and April 2020, the Royal College of Radiologists (RCR) and Surgical Royal Colleges issued statements recommending the use of pre-operative chest CT to exclude asymptomatic COVID-19 in both acute and elective cases [1–3]. It recommended that patients undergoing an abdominal CT scan for acute pain as an emergency presentation should have a CT chest at the same time, unless a CT chest had previously been performed within 24 h [1]. This guidance was adopted by our institution in April 2020.

In May 2020, the RCR has published revised guidance stating that routine pre-operative chest CT to screen for COVID-19 is no longer indicated and advises against a pre-operative CT chest unless a positive scan would postpone the operation [4]. Although the latest RCR guidance applies only to elective pre-operative scans, as we progress into this pandemic, we should consider applying the same principles for emergency abdominal CT scans due to the low sensitivity rate of CT in diagnosing COVID-19 and emergence of rapid COVID-19 tests to keep radiation dose to a minimum.

Abbreviations: COVID-19, SARS-CoV-2 disease 2019; CRIS, Computerised Radiology Information System; BSTI, British Society of Thoracic Radiology; RCR, Royal College of Radiologists; RT-PCR, reverse transcriptase polymerase chain reaction; EPR, electronic patient record.

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We performed a retrospective audit of all emergency CT Body examinations performed for patients presenting with acute abdomen between 1st and 30th April 2020 to our institution.

The main aim of this audit is to establish:

- if CT chest was performed in these patients as per Intercollegiate Guidance.
- if the complementary CT chest findings influenced surgical intervention decision.
- the detection rate of COVID-19 on CT and its correlation with COVID-19 RT-PCR swab results.
- if the presence of COVID-19 changes can be reliably detected within lung bases which would normally be included in standard CT abdomen and pelvis examinations.

2. Materials and methods

This project was approved by local institution as a service evaluation audit and informed consent was waived.

2.1. Cohort selection

CT scans of the abdomen and pelvis performed for evaluation of acute abdominal pain between 1st to 30th April 2020 were retrospectively extracted from Computerised Radiology Information System (CRIS). Exclusion criteria included trauma cases, abandoned examinations and repeat examinations within 48 h.

Cases which had complementary CT Chest within 24 h of CT abdomen and pelvis were recorded.

2.2. Image analysis

CT chest findings were assessed by three board certified (Fellowship of the Royal College of Radiologists) consultant radiologists of mixed subspecialties (gastrointestinal, genitourinary and chest radiology) and mixed years of experience (7, 9 and 26 years of consultant experience). No formal training session was held prior to reading but the CT COVID-19 changes were classed as “classic or likely COVID-19 changes”, “normal lungs”, “indeterminate changes for COVID-19” and “alternate diagnoses” according to guidance issued by British Society of Thoracic Radiology (BSTI) [5]. In cases with potential discordance, simultaneous reading was held and joint consensus was achieved with a chest radiologist arbiter. Presence or absence of COVID-19 changes in the lung bases which would ordinarily have been included in a standard CT abdomen and pelvis was also separately recorded.

2.3. Data collection and analysis

Patient demographics (age and gender) and RT-PCR swab results for COVID-19 were obtained from electronic patient records (EPR). Clinical notes were reviewed to determine if patients were conservatively managed or underwent some form of intervention (defined as surgery or radiological intervention). The types of intervention were also recorded.

Statistical analyses were performed using *t*-test and chi-square test for categorical variables. p values ≤ 0.05 were regarded as statistically significant.

3. Results

3.1. Cohort selection and compliancy rate

One hundred and sixty ($n = 160$) CT abdomen and pelvis examinations were performed between 1st to 30th April 2020. Of these, twelve were excluded from analysis (ten trauma cases, one abandoned examination and one repeat examination within 48 h). One hundred and forty-eight ($n = 148$) were included for analysis (Fig. 1). Of these, 8% (12/148) did not have complementary CT chest. This translates to 92% (136/148) compliancy rate with the Intercollegiate guidance requiring patients to have CT chest within 24 h of the CT abdomen and pelvis.

3.2. Patient demographics

There was no statistically significant difference in patient age nor gender between patients who had complementary CT chest and those

Table 1
Patient demographics.

	Complementary CT chest $N = 136$	No CT chest $N = 12$	p-Value
Age years, mean (SD)	59.1 (18.9)	48.6 (23.5)	0.0727*
Gender, n (%)			0.4536**
Male	72 (52.9%)	5 (41.7%)	
Female	64 (47.1%)	7 (58.3%)	

* Unpaired t-test.
** Chi-square test.

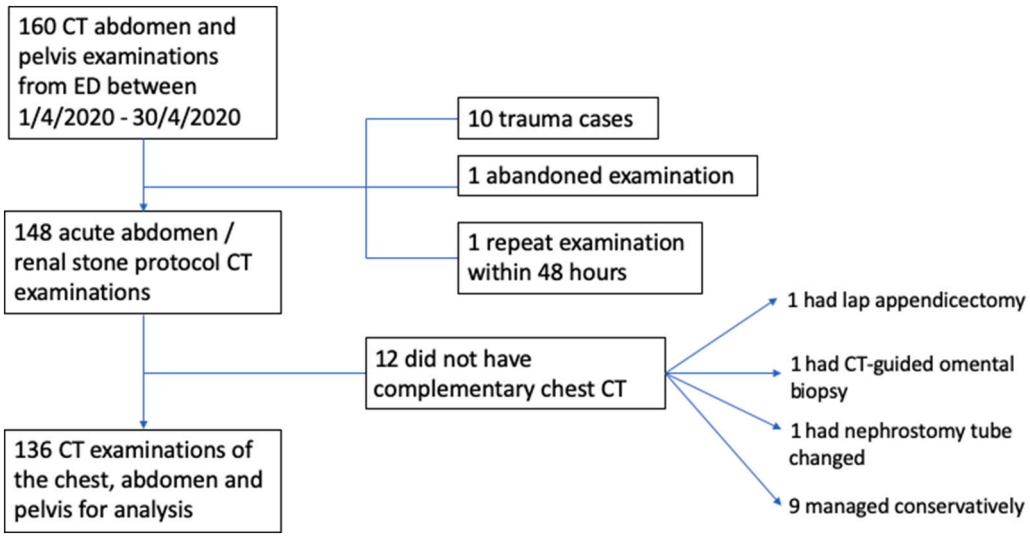

Fig. 1. Flowchart of cohort selection.

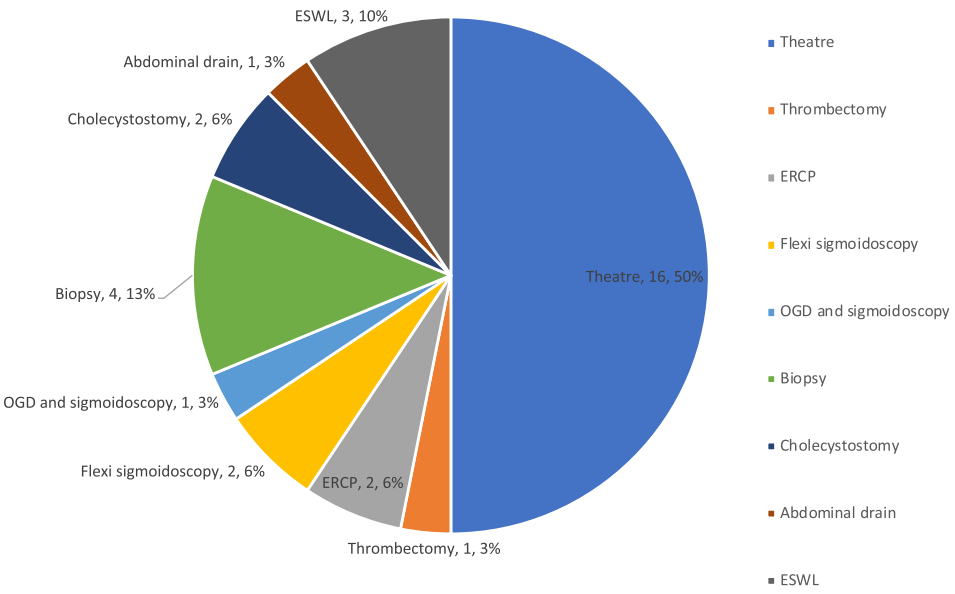

Fig. 2. Pie chart of types of interventions performed in patients who had complementary CT chest and subsequent intervention.

Table 2
Patient characteristics between patients managed with intervention vs conservative management.

	Intervention $N = 35$	Conservative $N = 113$	p-Value
Age years, mean (SD)	58.2 (21.0)	59.2 (18.5)	0.8007*
Gender, n (%)			0.1422**
Male	22(62.9%)	55(48.7%)	
Female	13(37.1%)	58(51.3%)	
Complementary CT Chest, n (%)			0.9085**
Yes	32(91.4%)	104(92.0%)	
No	3(8.6%)	9(8.0%)	

* Unpaired t-test.
** Chi-square test.

who did not (Table 1).

3.3. Subsequent intervention

Thirty-five patients (23.6%, 35/148) had some form of intervention during admission. These included three patients who did not have complementary chest CT but proceeded to have intervention (one had appendicectomy, one had an omental biopsy and one had nephrostomy tube change).

Fig. 2 depicts the types of interventions performed for the remaining 32 patients who had complementary CT chest. Sixteen patients (50%, 16/32) underwent surgery under general anaesthetic (GA). Other interventions considered to be an aerosol generating procedure that include ERCP (one patient), OGD and sigmoidoscopy (one patient), and flexible sigmoidoscopy (two patients). Total number of patients who underwent aerosol generating procedures (GA and endoscopies) is 21, representing 15.4% of 136 patients who had full body scans.

There was no significant association ($p = 0.9085$) between acquisition of complementary CT chest and patient management pathway (conservative vs intervention). There was no significant difference in age ($p = 0.8007$) nor gender ($p = 0.1422$) between these two groups of patients (Table 2).

Table 3
CT chest findings with corresponding COVID-19 RT-PCR test results in all patients who had complementary CT chest.

RT-PCR test results CT chest findings	Positive	Negative	No PCR Test	TOTAL
Classic or likely COVID-19 changes	4	0	6	10
Normal	1	28	58	87
Indeterminate changes	0	6	4	10
Alternate diagnosis	2	10	17	29
TOTAL	7	44	85	136

Table 4
Sensitivity and specificity table.[a]

RT-PCR test results CT chest	Positive	Negative	Total
Positive	4	0	4
Negative (normal or indeterminate appearances or alternate diagnoses on CT)	3	44	47
Total	7	44	51

[a] Patients who did not have RT- PCR test (85) were excluded from calculation of sensitivity and specificity.

3.4. COVID-19 lung changes and RT-PCR swab

Of the patients who had complementary CT chest ($n = 136$), ten (7.4%) demonstrated lung changes classic for or likely COVID-19, 87 (64%) had normal lung appearances, ten (7.4%) had lung changes indeterminate for COVID-19 and the remaining 29 (21.3%) had CT findings compatible with other diagnoses (Table 3).

Of patients who had complementary CT chest (n = 136), only 51 (37.5%) had an RT-PCR swab test for COVID-19 (Table 3).

Six of ten patients with classic COVID-19 changes on CT did not have an RT-PCR test. The remaining four with classic CT changes tested positive for COVID-19 on RT-PCR, yielding a positive predictive value 100%.

Sensitivity (95% CI) and specificity (95% CI) of CT chest in detecting COVID-19 was 57.1% (18.41% to 90.1%) and 100% (92% to 100%) respectively. Accuracy (95% CI) was 94.1% (83.7% to 98.77%). See Table 4.

3.5. COVID-19 changes within lung bases

Of the 10 patients with classic COVID-10 CT appearance, seven cases

had these changes affecting lung bases.

4. Discussion and conclusion

Our compliancy rate in performing complementary CT chest in patients who presented with acute abdomen was 92% in April 2020.

Our results have shown that there is no significant association between acquisition of complementary CT chest and patient management pathway in terms of intervention vs conservative. This was also reported by Chetan, et al. [6] who found that CT chest screening for COVID-19 did not change surgical management in their acute abdominal emergency cohort. Our study consisted of a higher number of patients who underwent emergency surgery (16 vs 2).

The data showed that only a quarter (25%) of patients who went to theatre had an RT-PCR swab test performed. This further suggests that patients presenting with an acute abdomen are likely to undergo surgery or the required intervention regardless of the CT chest findings or swab results, as long as there is a clinical need and urgency. Our institution has since changed its practice. Every acute admission is now screened for COVID-19 with RT-PCR regardless of presence of COVID-19 symptoms. Patients who undergo elective surgery are required to be asymptomatic and to self-isolate for 14 days prior to surgery and are tested for COVID-19 with RT-PCR swab test.

In cases of surgical intervention, these were performed with full personal protective equipment (PPE) regardless of COVID-19 status. Our study showed that only 15% (21/136) of patients who had complementary CT chest went on to undergo an aerosol generating procedure, this raises the question of whether additional chest irradiation of the other 85% of patients is really justifiable.

Whilst the National Health System (NHS) does not bill patients for medical treatment, there remains a financial impact on the NHS in performing these additional CT examinations. According to the tariffs provided by our institution, the reimbursed cost for a CT abdomen and pelvis was £122 and the cost of a CT thorax abdomen and pelvis was £137, a net additional cost of £15. Note that this does not include any radiologist interpretation cost. Without any significant benefit from obtaining a complementary CT thorax in the management of an acute abdomen patient, the above additional expense could have been avoided.

Our results show that CT had high specificity (100%) and accuracy (94%) but only moderate sensitivity (57%) for the diagnosis of COVID-19 using RT-PCR swab results as reference standard. This is similar to sensitivity rate of 61% reported in literature [7,8]. However, confidence interval values were limited by the small sample size. In addition, there have been reports of low sensitivity of RT-PCR swabs [9,10].

The lung bases are routinely included in CT abdomen and pelvis examinations. However, our study suggests that the lung bases are spared in 30% (three in ten) patients with classic COVID-19 changes on CT. In April, there was report of unpublished studies suggesting that COVID-19 pulmonary changes are visible in the lung bases and this may obviate requirement to undertake additional CT chest for screening (2). However, our findings did not support this suggestion.

We note that this is a retrospective study reliant on documentation on EPR. The sample size is not large and only considers data in April 2020, which is the only data available to date as this guidance was only put into place on 30th March 2020 in our institution. Despite the use of standardised reporting guidance from BSTI, there remains intra-observer and inter-observer variability in reporting COVID-19 changes on CT. However, with a mix of subspecialty between readers, which we believe is more representative of general and acute radiology practice, the results should still be reproducible.

5. Conclusion

Compliance with initial Intercollegiate Surgical Guidelines for complementary CT chest in patients presenting with acute abdominal pain was high. However, the acquisition of complementary CT chest in patients presenting with acute abdomen did not influence subsequent management such as surgical or other intervention.

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References

[1] Intercollegiate General Surgery Guidance on COVID-19 UPDATE|The Royal College of Surgeons of Edinburgh. The Royal College of Surgeons of Edinburgh. https://www.rcsed.ac.uk/news-public-affairs/news/2020/march/intercollegiate-general-surgery-guidance-on-covid-19-update. Published 2020. Accessed March 27, 2020.

[2] Statement on use of CT chest to screen for COVID-19 in pre-operative patients|The Royal College of Radiologists. Rcr.ac.uk (web archive link, 30 April 2020). https://www.rcr.ac.uk/college/coronavirus-covid-19-what-rcr-doing/clinical-information/role-ct-chest/role-ct-screening-0. Published 2020. Accessed April 30, 2020.

[3] The role of CT chest in patients presenting acutely and requiring an abdominal CT|The Royal College of Radiologists. Rcr.ac.uk (web archive link, 27 March 2020). https://www.rcr.ac.uk/college/coronavirus-covid-19-what-rcr-doing/clinical-information/role-ct-chest/role-ct-chest. Published 2020. Accessed March 27, 2020.

[4] The role of CT in screening elective pre-operative patients|The Royal College of Radiologists. Rcr.ac.uk (web archive link, 14 May 2020). https://www.rcr.ac.uk/college/coronavirus-covid-19-what-rcr-doing/clinical-information/role-ct-chest/role-ct-screening. Published 2020. Accessed May 14, 2020.

[5] BSTI CT reporting proforma: COVID-19 version 2 13.04.2020. Bsti.org.uk (web archive link, 23 June 2020). http://www.bsti.org.uk/media/resources/files/BSTI_COVID_CT_Proforma_v2_13.04.2020.docx. Published 2020. Accessed June 23, 2020.

[6] Chetan M, Tsakok M, Shaw R, et al. Chest CT screening for COVID-19 in elective and emergency surgical patients: experience from a UK tertiary centre. Clin Radiol 2020. https://doi.org/10.1016/j.crad.2020.06.006.

[7] Isikbay M, Hope M, Raptis C, et al. CT on the diamond princess: what might this tell us about sensitivity for COVID-19? Radiology: Cardiothoracic Imaging 2020;2(2):e200155. https://doi.org/10.1148/ryct.2020200155.

[8] Inui S, Fujikawa A, Jitsu M, et al. Chest CT findings in cases from the cruise ship "Diamond Princess" with coronavirus disease 2019 (COVID-19). Radiology: Cardiothoracic Imaging 2020;2(2):e200110. https://doi.org/10.1148/ryct.2020200110.

[9] Ai T, Yang Z, Hou H, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology 2020:200642. https://doi.org/10.1148/radiol.2020200642.

[10] Yang Y, Yang M, Shen C, et al. Evaluating the accuracy of different respiratory specimens in the laboratory diagnosis and monitoring the viral shedding of 2019-nCoV infections. 2020. https://doi.org/10.1101/2020.02.11.20021493.