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Short Communication

Predictive value of the CT Scan in comparison with laparotomy in the diagnosis of peritonitis in COVID-19 patients

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Abstract

Background and aims: The present study aimed to investigate the predictive value of the computed tomography (CT) scan in diagnosing peritonitis compared to laparotomy in COVID-19 patients.

Methods: This study evaluated 11 COVID-19 patients with suspected peritonitis. All patients underwent laparotomy because of free air detected within the abdomen on CT scans.

Results: The results demonstrated 9 (81.8%) true positive cases that were positive for peritonitis on both laparotomy and the CT scan and 2 (18.2%) false positive cases that were positive for peritonitis on the CT scan but negative for peritonitis on laparotomy. The sensitivity, specificity, and accuracy of CT scans in diagnosing peritonitis were 100%, 81.8%, and 81.8%, respectively, and 81.8% of peritonitis cases were correctly diagnosed on CT scans.

Conclusion: Based on the positive predictive value, 81.8% of peritonitis cases were correctly diagnosed on a CT scan. The overall mortality rates for patients with and without peritonitis were 4.44% and 50%, respectively.

Keywords: CT scan, Laparotomy, Peritonitis, COVID-19

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Introduction

Peritonitis is a medical condition that involves the inflammation of the lining of abdominal organs and can lead to sepsis and death if left untreated (1). Its symptoms include intense abdominal pain that exacerbates with movement, nausea and vomiting, fever, and a tender or swollen abdomen (2). Despite significant advancements in diagnostic techniques such as imaging and laboratory tests, quick diagnosis and management of peritonitis remain challenging for physicians practicing emergency medicine and surgery (3). The management of severe peritonitis necessitates surgical intervention (4). A computed tomography (CT) scan, combined with clinical symptoms, is employed as a non-invasive diagnostic method for diagnosing peritonitis, exhibiting high sensitivity and specificity (5).

During the early stages of the pandemic, coronavirus disease 19 (COVID-19) was primarily described as a severe respiratory syndrome (6). However, COVID-19 patients have also been observed to exhibit gastrointestinal symptoms, including anorexia, nausea, vomiting, diarrhea, and abdominal pain, in addition to respiratory symptoms (7). As a result of the COVID-19 outbreak, there has been a rise in peritonitis cases among infected individuals (8). Considering their overlap, distinguishing between peritonitis and gastrointestinal symptoms associated with COVID-19 is crucial. Therefore, utilizing accurate diagnostic methods is imperative.

According to the literature, no study has investigated the diagnostic value of CT scans for peritonitis in COVID-19 patients so far. Therefore, the present study seeks to determine the predictive value of the CT scan compared with laparotomy in diagnosing peritonitis in COVID-19 patients.

Materials and Methods

This study evaluated COVID-19 patients with suspected peritonitis who were hospitalized at Urmia Imam Khomeini Hospital between March 2020 and 2021. The COVID-19 diagnosis was based on a polymerase chain reaction test and chest CT scan. The medical records of these patients were reviewed for demographic and clinical symptoms at admission.

Only patients diagnosed with polymerase chain reaction confirmation and those who underwent abdominal or thoracic CT scans due to symptoms and suspicion of peritonitis were included in the study through the consensus method. All patients underwent laparotomy because of free air detected within the abdomen on CT scans. Laparotomy was deemed the gold standard for the definitive diagnosis of peritonitis, and negative or positive cases (the presence or absence of peritonitis) and pathological causes of peritonitis were determined during the procedure. The frequency of hospital mortality was

also determined, and patients with and without peritonitis who underwent laparotomy underwent a comparison. The sensitivity, specificity, and accuracy of the CT scan were calculated and then compared with the corresponding values obtained from laparotomy. Finally, all collected data were recorded and analyzed using checklists designed for this purpose.

Statistical analysis

Quantitative and qualitative variables were reported as means ± standard deviations (SD), as well as numbers and percentages using suitable tables and graphs, respectively. The chi-square test (or Fisher's exact test if necessary) was used to compare the frequency of mortality in patients with and without peritonitis. The sensitivity, specificity, and accuracy of CT scans compared to laparotomy were estimated using relevant formulas. The obtained data were analyzed using SPSS software (version 17), and a *P* value less than 0.05 was considered statistically significant. Moreover, sensitivity, specificity, and accuracy were calculated to determine the correct diagnosis of different protocols.

Results

In this study, 11 COVID-19 patients with suspected peritonitis were subjected to laparotomy due to the presence of free air in the abdomen on CT scans, including five men (45.5%) and six women (54.5%). The mean age of patients was 17.06 ± 9.59 years, with a median age of 56. The most common clinical symptom in patients was abdominal pain (100%), followed by nausea and vomiting, with a prevalence of 54.5%. Other clinical symptoms included anorexia (36.4%), shortness of breath (27.3%), diarrhea (18.2%), cough (18.2%), and weakness, malaise, and urinary retention, each in one patient (9.1%). Table 1 presents the frequency of each etiology of peritonitis, and every patient had one case (9.1%) of each etiology.

Among the patients who were positive for peritonitis, 4 (4.44%) died, and in patients without peritonitis, 1 (50%) died. No significant difference was observed between the two groups ($P = 0.73$, Table 1).

In all 11 patients, free air inside the abdomen was observed on a CT scan, in which peritonitis was suspected. Based on laparotomy, 9 (81.8%) patients were positive for peritonitis; in two patients (18.2%), an exploratory laparotomy was performed, which was negative for peritonitis. Therefore, considering laparotomy as the gold standard, nine true positive cases were positive for peritonitis on both laparotomy and the CT scan, and two false positive cases were positive for peritonitis on the CT scan but negative for peritonitis on laparotomy. There were no negative cases on the CT scan but positive on laparotomy (false negative) or negative on both modalities (true negative) (Table 2).

The CT scan's sensitivity, specificity, and accuracy in diagnosing peritonitis were 100%, 81.8%, and 81.8%, respectively. Thus, based on the positive predictive value, 81.8% of peritonitis cases were correctly diagnosed on the CT scan. The negative predictive value and specificity were not calculable since there were no true negative or false negative cases (Table 2).

Discussion

Emerging evidence suggests that COVID-19 infection is not limited to the respiratory system alone. Affected individuals often display gastrointestinal manifestations, which overlap with the symptoms of peritonitis (9). The current study compared the diagnostic efficacy of CT scans and laparotomy in diagnosing peritonitis in

Table 1. Frequency of peritonitis causes and comparison of death frequency in patients with and without peritonitis

Cause of peritonitis	Frequency	Percent
Rectal perforation	1	9.1
Abdominal volvulus (sigmoid)	1	9.1
Cecum and spleen ischemia	1	9.1
Duodenal ulcer perforation	1	9.1
Perforation of the cecum	1	9.1
Rectal cancer	1	9.1
Uterine perforation following abortion	1	9.1
Intra-abdominal abscess	1	9.1
Sigmoid tear	1	9.1

	Patients with peritonitis, n (%)	Patients without peritonitis, n (%)	*P* value[a]
Death	4 (44.4)	1 (50%)	0.73
Healthy discharged	5 (55.6%)	1 (50%)	

[a] Fisher's exact test.

Table 2. Diagnostic value of CT scan for peritonitis in COVID-19 patients and distribution of positive and negative cases (true and false) based on laparotomy as the gold standard

	Results (N)				Validity Indicis		
All patients (N = 11)	**TP**	**TN**	**FP**	**FN**	**Sensitivity**	**Specificity**	**Accuracy**
	9	0	2	0	100%	81.8%	81.8%

CT scan	Laparotomy	
	Positive (+)	Negetive (-)
Positive (+)	9 (81.8%)	2 (18.2%)
Negetive (-)	0 (0%)	0 (0%)

Note. CT: Computed tomography; TP: True positive; TN: True negative; FP: False positive; FN: False negative.

COVID-19 patients.

The results revealed that abdominal pain, nausea and vomiting, and anorexia were the predominant clinical manifestations in COVID-19 patients who underwent laparotomy due to the identification of free air within the abdomen on CT imaging. Furthermore, the sensitivity and positive predictive value of CT imaging for diagnosing peritonitis were determined to be 100% and 81.8%, respectively, indicating a high level of diagnostic accuracy.

To the best of our knowledge, a few prior investigations have assessed the diagnostic efficacy of CT scans in detecting peritonitis among COVID-19 patients. Bader et al (8) reported that abdominal CT scans had the highest diagnostic accuracy with a sensitivity of 97.2% compared to conventional radiography and ultrasonography, which had sensitivity rates of 66.2% and 44.3%, respectively, which is consistent with the findings of our investigation. In another study, Soriano et al demonstrated that secondary peritonitis was diagnosed in 95.6% of patients based on criteria such as leukocytosis and positive ascitic fluid culture and in 85% of patients based on CT scan findings after their peritonitis was confirmed by surgery (9). Moreover, Baykara et al evaluated the predictive value of abdominal ultrasound and CT scans in diagnosing acute appendicitis in children. They found that CT scans had a positive predictive value, negative predictive value, and accuracy of 88.8%, 55.1%, and 81.8%, respectively (10).

Contrary to the results of the current study, an abdominal CT scan in peritonitis typically shows enhanced ascetic fluid and thickened and nodular peritoneum (4). As a result, the diagnostic sensitivity of the abdominal CT scan ranged from 0% to 69% in previous research (11). Therefore, using an abdominal CT scan to diagnose peritonitis depends on radiologists' interpretation and may be of limited value (5).

The clinical presentation and prognosis of peritonitis rely on various factors, including the duration of the abdominal infection, the site of perforation, and the patient's overall health status. However, timely diagnosis and prompt management can mitigate the risks of complications and mortality associated with intra-abdominal infections (12,13). Studies have shown that delaying surgical intervention increases the likelihood of postoperative mortality in patients who undergo emergency laparotomy for perforated peritonitis (14). Hence, it is crucial to exercise caution in the selection of imaging modalities to prevent any delays in the definitive management of the disease, minimize the patient's exposure to ionizing radiation, and prevent any provision of inaccurate information during the diagnostic process, which may lead to inappropriate treatment decisions (15).

This study had some limitations. The limited number of patients may have influenced the results. The second limitation was the inability to test all patients for *severe acute respiratory syndrome coronavirus 2* infection during the initial phase of the COVID-19 pandemic to confirm the absence of preoperative infections. This was because the screening protocol was implemented a few days after the study began. Patients were screened using high-resolution chest CT scans and symptom evaluations during this brief period.

Conclusion

Based on the findings of this study, a CT scan is a viable and dependable diagnostic technique for identifying peritonitis in COVID-19 patients. This is attributed to its remarkable sensitivity, positive predictive value, and accuracy. Consequently, a CT scan may be considered a less invasive option compared to laparotomy, which would aid in avoiding any unwarranted surgical procedures for the diagnosis of peritonitis in COVID-19 patients.

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Competing Interests

The authors declare that there is no conflict of interests.

Ethical Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was obtained from the Ethics Committee of Urmia University of Medical Sciences (No. IR.UMSU.REC.1400.348).

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References

1. Sharma S, Singh S, Makkar N, Kumar A, Sandhu MS. Assessment of severity of peritonitis using mannheim peritonitis index. Niger J Surg. 2016;22(2):118-22. doi: 10.4103/1117-6806.189009.
2. Reust CE, Williams A. Acute abdominal pain in children. Am Fam Physician. 2016;93(10):830-6.
3. Ayandipo OO, Afuwape OO, Irabor DO, Abdurrazzaaq AI, Nwafulume NA. Outcome of laparotomy for peritonitis in 302 consecutive patients in Ibadan, Nigeria. Ann Ib Postgrad Med. 2016;14(1):30-4.
4. van Ruler O, Boermeester MA. Surgical treatment of secondary peritonitis: a continuing problem. Chirurg. 2017;88(Suppl 1):1-6. doi: 10.1007/s00104-015-0121-x.

5. Wetherell J, Woolley K, Chadha R, Kostka J, Adilovic E, Nepal P. Idiopathic sclerosing encapsulating peritonitis in a patient with atypical symptoms and imaging findings. Case Rep Gastrointest Med. 2021;2021:6695806. doi: 10.1155/2021/6695806.
6. Fan E, Beitler JR, Brochard L, Calfee CS, Ferguson ND, Slutsky AS, et al. COVID-19-associated acute respiratory distress syndrome: is a different approach to management warranted? Lancet Respir Med. 2020;8(8):816-21. doi: 10.1016/s2213-2600(20)30304-0.
7. Perisetti A, Goyal H, Gajendran M, Boregowda U, Mann R, Sharma N. Prevalence, mechanisms, and implications of gastrointestinal symptoms in COVID-19. Front Med (Lausanne). 2020;7:588711. doi: 10.3389/fmed.2020.588711.
8. Bader FG, Schröder M, Kujath P, Muhl E, Bruch HP, Eckmann C. Diffuse postoperative peritonitis -- value of diagnostic parameters and impact of early indication for relaparotomy. Eur J Med Res. 2009;14(11):491-6. doi: 10.1186/2047-783x-14-11-491.
9. Soriano G, Castellote J, Alvarez C, Girbau A, Gordillo J, Baliellas C, et al. Secondary bacterial peritonitis in cirrhosis: a retrospective study of clinical and analytical characteristics, diagnosis and management. J Hepatol. 2010;52(1):39-44. doi: 10.1016/j.jhep.2009.10.012.
10. Baykara AS, Kılıç MÖ. Diagnostic value of ultrasonography and computed tomography in pathology-confirmed acute appendicitis in children. Res Sq [Preprint]. October 26, 2022. Available from: https://doi.org/10.21203/rs.3.rs-2187355/v1.
11. Akhan O, Pringot J. Imaging of abdominal tuberculosis. Eur Radiol. 2002;12(2):312-23. doi: 10.1007/s003300100994.
12. Riché FC, Dray X, Laisné MJ, Matéo J, Raskine L, Sanson-Le Pors MJ, et al. Factors associated with septic shock and mortality in generalized peritonitis: comparison between community-acquired and postoperative peritonitis. Crit Care. 2009;13(3):R99. doi: 10.1186/cc7931.
13. De Pascale G, Antonelli M, Deschepper M, Arvaniti K, Blot K, Brown BC, et al. Poor timing and failure of source control are risk factors for mortality in critically ill patients with secondary peritonitis. Intensive Care Med. 2022;48(11):1593-606. doi: 10.1007/s00134-022-06883-y.
14. Rai A, Huda F, Kumar P, David LE, S C, Basu S, et al. Predictors of postoperative outcome in emergency laparotomy for perforation peritonitis; a retrospective cross-sectional study. Arch Acad Emerg Med. 2022;10(1):e86. doi: 10.22037/aaem.v10i1.1827.
15. Ross JT, Matthay MA, Harris HW. Secondary peritonitis: principles of diagnosis and intervention. BMJ. 2018;361:k1407. doi: 10.1136/bmj.k1407.