Diagnostic value of chest CT in outpatient for COVID-19 compare with RT-PCR

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Abstract

Objectives

The pneumonia caused by the 2019 novel coronavirus recently break out in Wuhan, China, and was named as COVID-19. With the spread of the disease, it bring numbers of casualties, so now we need a way could fast and accuracy diagnose the disease. This paper aims to compare two way for diagnose COVID-19 in outpatient: Chest CT and RT-PCR.

Materials and methods

The study picked 248 patients who treated in fever clinical of GanZhou people's hospital, their complete clinical and imaging data were analysed retrospectively. Epidemiological data, symptoms, laboratory test results include RT-PCR and the CT results include CT features, lesion location, lesion distribution of suspected COVID-19 infected patients were gathered.

Results

All of 248 patients, at last 20 patients confirmed COVID-19, 15 patients were confirmed in outpatient. More than 200 cases has laboratory test results disnormal. Only 15/248 patients had initial positive RT-PCR for COVID-19, 5 patients had COVID-19 confirmed by two or more RT-PCR. 50 cases(20.2%) had Ground glass opacity, 42 cases(16.9%) had Consolidation, 39 cases(15.7%) had Spider web pattern, 38 cases(15.3%) had Interlobular septal thickening. For lesion location, 22 cases(8.9%) involved Single lobe of one lung, 13 cases(5.2%) involved Multiple lobes of one lung, 174 cases(70.2%) involved Multiple lobes of both lungs, 9 cases(3.6%) involved Bilateral lower lungs, 25 cases(10.1%) involved Bilateral middle and lower lungs. Regarding the distribution of the lesions in the lung lobes, 119 cases(47.98%) involved Subpleural distribution, 19 cases(7.7%) involved Diffuse distribution, 7 cases(2.8%) involved Peribronchial distribution, 81 cases(32.7%) involved Mixed distribution.

Conclusion

Chest CT can be applied in outpatient to make early diagnosis with sensitivity and accuracy better than that of nucleic acid detection.

Trial registration

ChiCTR2000032574. Registered 3 May 2020. retrospectively registered

Introduction

In the end of 2019, an outbreak of serious and highly infectious pneumonia in Wuhan was caused by a new corona virus infection named COVID-19 (Corona Virus Disease 2019). By February 18, 2020, there are more than 70,000 confirmed cases with more than 1700 deaths[1, 2]. From the current epidemiological findings, the main characteristics of COVID-19: 1, It is mainly spread by respiratory droplets and close contact., aerosol transmission is possible in specific environment, and fecal-mouth is still to be determined. 2, The population was generally susceptible (R0 about 3.77), the incubation period ranging from 1 to 14 days, mostly 3 to 7 days. 3, Clinical symptoms varied, with fever (98.6%), fatigue (69.6%), dry cough (59.4%) as the main manifestations, other clinical symptoms include anorexia, myalgia, pharyngitis, dyspnea, runny nose, diarrhea, etc., or no obvious symptoms. 4, Effective drugs and virus vaccines are still in the research and development stage, the main treatment methods are symptomatic treatment, prevention and control of the situation is grim. The diagnosis of COVID-19 is based on contact history, clinical symptoms and laboratory examination such as WBC, procalcitonin (PCT), C reactive protein (CRP), lymphocyte count and real-time polymerase chain reaction (RT-PCR). RT-PCR is standard of the disease and widely applicable[3]. Recently, Xie reported 5/167(3%) patients who had negative RT-PCR for COVID-19 at initial presentation despite chest CT findings typical of viral pneumonia [4].

The purpose of this study was to compare two way for diagnose COVID-19 in outpatient: Chest CT and RT-PCR.
Patients

To avoid spread of COVID-19 and protect the medical staffs, our hospital sets the fever clinical and asks all the fevered patients treated in it. The study comprised 248 patients who presented with a history of 1) travel or residential history in Wuhan or local endemic areas or contact with individuals with fever or respiratory symptoms from these areas within 14 days. or 2) had fever or acute respiratory symptoms of unknown cause treated from 1 January 2020, to 29 February 2020, with complete medical records. All the patients'data were obtained through telephone communication with the doctor in charge or the patient and the patient's family. All the clinic doctors received training for how to standard sampling, got know typical CT manifestations.

Examination equipment and methods

During this period, noncontrast chest CT (A GE Discovery CT 750 HD CT system, slice thickness, 5 mm) and RT-PCR (Shanghai ZJ BI) was performed for these patients. All the laboratory examination result also recorded. Typical and atypical chest CT findings were recorded according to CT features previously described for COVID-19. Among all the upper respiratory sampling methods, oropharyngeal aspirate (OPS) had a higher positive rate within 2 weeks of symptom onset, and OPS was the least harmful to medical staff during sampling, so we use OPS swab sample for RT-PCR.

Data collection and Statistical analysis

Epidemiological data, symptoms, laboratory test results include RT-PCR, and the CT results of suspected COVID-19 infected patients were analysed retrospectively. SPSS 19.0 software was used for statistical analysis.

Results

All of 248 patients, include 126 men and 122 women, median age of 50 (interquartile range, 21–79) years, at last 20 patients confirmed COVID-19, 15 patients were confirmed in outpatient. All the patients with fever, 200 cases (80.6%) with cough, 101 cases (40.7%) with sputum, 221 cases (89.1%) with sore throat, 74 cases (29.8%) with muscle ache, 50 cases (20.2%) with chest tightness. The complaints of 219 patients (88.3%) included the above multiple symptom (Table 1).

Only 113 (45.6%) Cases has white blood cell count disnormal, 113 (45.6%) cases has lymphocyte count disnormal, 148 cases (59.7%) has C-reactive protein (CRP) increased, 98 (39.5%) cases has erythrocyte sedimentation rate increased, 168 (67.7%) cases the procalcitonin (PCT) increased. All patients had throat swab, followed by one or more RT-PCR assays. Only 15/248 patients had initial positive RT-PCR for COVID-19. 3 patients had COVID-19 confirmed by two RT-PCR nucleic acid tests (1 to 2 days), 2 patient by three tests (2-5 days) after initial onset (Table 2).

All patients underwent chest CT imaging examination. 50 cases (20.2%) had evidence of abnormal CT in first time compatible with Ground glass opacity, 42 cases (16.9%) had Consolidation, 39 cases (15.7%) had Spider web pattern, 38 cases (15.3%) had Interlobular septal thickening, 24 cases (9.7%) had Crazy paving pattern, 22 cases (8.9%) had Subpleural line, 27 cases (10.9%) had Bronchial wall thicken, 15 cases (6.0%) had Pleural effusion, 10 cases (4.0%) had Lymph node enlargement. For lesion location, 22 cases (8.9%) involved Single lobe of one lung, 13 cases (5.2%) involved Multiple lobes of one lung, 174 cases (70.2%) involved Multiple lobes of both lungs, 9 cases (3.6%) involved Bilateral lower lungs, 25 cases (10.1%) involved Bilateral middle and lower lungs. Regarding the distribution of the lesions in the lung lobes in the first chest CT, 119 cases (47.98%) involved Subpleural distribution, 19 cases (7.7%) involved Diffuse distribution, 7 cases (2.8%) involved Peribronchial distribution, 81 cases (32.7%) involved Mixed distribution (Table 3), (Fig. 1).
### Table 1
Patients characteristics

| Epidemiological data       | Patients (n = 248) |
|----------------------------|--------------------|
| **Age (years)**            |                    |
| Median age                 | 50                 |
| Range age                  | 21–79              |
| **Gender**                 |                    |
| Female                     | 122 (49.2%)        |
| Male                       | 126 (50.8%)        |
| **Epidemiological history**|                    |
| Yes                        | 56 (22.6%)         |
| No                         | 192 (77.4%)        |
| **Clinical symptoms**      |                    |
| Fever                      | 248 (100%)         |
| Cough                      | 200 (80.6%)        |
| Sputum                     | 101 (40.7%)        |
| Sore throat                | 221 (89.1%)        |
| Muscle ache                | 74 (29.8%)         |
| Chest tightness            | 50 (20.2%)         |
| Multiple symptoms (two or more) | 219 (88.3%)      |
Table 2
Laboratory test results

| Laboratory date                          | Patients (n = 248) |
|------------------------------------------|--------------------|
| **White blood cell count, × 10^9/L**     |                    |
| Increased                                | 80 (32.3%)         |
| Decreased                                | 33 (13.3%)         |
| **Neutrophil count, × 10^9/L**           |                    |
| Increased                                | 99 (39.9%)         |
| Decreased                                | 14 (5.6%)          |
| **C-reactive protein (mg/L)**            |                    |
| Increased                                | 148 (59.7%)        |
| **Erythrocyte sedimentation rate**       |                    |
| Increased                                | 98 (39.5%)         |
| **PCT (ng/ml)**                          |                    |
| Increased                                | 168 (67.7%)        |
| **RT-PCR**                               |                    |
| Positive                                 | 15 (6.05%)         |
| Negative                                 | 233 (93.95%)       |
Table 3
Chest CT imaging manifestations

| CT features                        | Patients(n = 248) |
|-----------------------------------|------------------|
| Ground-glass opacity              | 50(20.2%)        |
| Consolidation                     | 42(16.9%)        |
| Spider web pattern                | 39(15.7%)        |
| Interlobular septal thickening    | 38(15.3%)        |
| Crazy paving pattern              | 24(9.7%)         |
| Subpleural line                   | 22(8.9%)         |
| Bronchial wall thicken            | 27(10.9%)        |
| Pleural effusion                  | 15(6.0%)         |
| Lymph node enlargement            | 10(4.0%)         |

| Lesion location                   |                  |
|-----------------------------------|------------------|
| Single lobe of one lung           | 22(8.9%)         |
| Multiple lobes of one lung        | 13(5.2%)         |
| Multiple lobes of both lungs      | 174(70.2%)       |
| Bilateral lower lungs             | 9(3.6%)          |
| Bilateral middle and lower lungs  | 25(10.1%)        |

| Lesion distribution               |                  |
|-----------------------------------|------------------|
| Subpleural distribution           | 119(47.98%)      |
| Diffuse distribution              | 19(7.7%)         |
| Peribronchial distribution        | 7(2.8%)          |
| Mixed distribution                | 81(32.7%)        |

Discussion

Coronaviruses are a family of viruses widely found in nature, and the newly discovered COVID-19 is the seventh known coronavirus to infect humans[7]. Due to the unpredictability, strong transmissibility and great harmfulness of novel coronavirus, it has brought great harm to the health and economy of people all over the country and even the world[8]. Early screening, isolation and treatment is the key to the prevention and control of COVID-19, Positive RT-PCR is the gold standard of diagnosis[9]. Since sampling of the upper respiratory tract is the most convenient and relatively comfortable method for patients, so we usual use it in outpatient department. But at the same time, nucleic acid detection is also affected by many other factors, such as sample quality, patient infection cycle, collection time, experimental factors and kit performance[10, 11]. In the outpatient, the conditions and equipment are limited, we can’t sampling lower respiratory samples [sputum, bronchoalveolar lavage fluid (BAL)]. As you know, outpatient is the first line in this epidemic, accurate and quick diagnosis is very important. We could admite the sick patient to the hospital in time, avoid the epidemic further expend. But the sensitivity of RT-PCR is not attained the clinical demand, more evidence about the clinical value of using chest CT in the diagnostic assessment of this disease will be available for clinicians to diagnosis of patients with COVID-19[12, 13].
Based on the results of this study we recommend: (1) All patients with typical clinical symptoms need a lung CT examination. Patients with typical lung signs should be admitted to the hospital for quarantine, receive further examination and treatment. For patients without visible lung signs but with clinical symptoms, we need to tell the patient to recheck the lung CT in 3–5 days. (2) Due to the time-consuming laboratory tests and the lack of viral substances in the samples, the RT-PCR positive rate is relatively low, so it cannot meet the needs of the growing infected population. If patients have clinical symptoms, contact history, and chest CT imaging characteristics of viral pneumonia that are compatible with COVID-19 infection, we need to carefully consider the isolation and treatment of these patients even if the RT-PCR test is negative. (3) Positive lung CT results instead of the positive RT-PCR should be used as a criterion of COVID-19. So clinicians and radiologists should recognize the importance of chest CT in the diagnosis of COVID-19, be familiar with the features and diagnostic points of the chest CT imaging.

Conclusions

The sensitivity and accuracy of chest CT is better than nucleic acid detection for diagnosis of COVID-19, so we think chest CT play a more important role in outpatient.

Declarations

Ethical Approval and Consent to participate

This case series was approved by the institutional ethics board of GanZhou people's hospital (No. 2020003).

Consent for publication

No individual participant data is reported that would require consent to publish from the participant (or legal parent or guardian for children).

Availability of supporting data

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Competing interests

The authors declare that they have no competing interests.

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Not applicable.

Authors' contributions

Zhang Weiwei designed this project. Zhang Weiwei and Zhang Min collected the data. Zhu Meifen were responsible for the statistical analysis. Zhang Weiwei wrote the draft. Zhang Weiwei and Zhang Min revised this draft. Zhu Meifen finalized this manuscript. All the authors approved the final version of this manuscript.

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**References**

1. World Health Organization. Novel coronavirus (2019-nCoV) Situation report-22.2020.https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200221-sitrep-22-ncov.pdf Published on February 11, 2020.

2. World Health Organization. Novel coronavirus (2019-nCoV). Situation report 28.https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200216-sitrep-27-covid-19.pdf Published on February 17, 2020.

3. Yang Y, Lu QB, Liu MJ, et al. Epidemiological and clinical features of the 2019 novel coronavirus outbreak in China[J]. medRxiv, 2020.

4. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiology 2020.https://doi.org/10.1148/radiol.2020200343 Published online Feb 12, 2020.

5. World Health Organization. Laboratory testing for 2019 novel coronavirus (2019-nCoV) in suspected human cases, interim guidance.https://www.who.int/publications-detail/laboratory-testing-for-2019-novel-coronavirus-in-suspected-human-cases-20200117.

6. Tang P, Louie M, Richardson SE, et al. Interpretation of diagnostic laboratory tests for severe acute respiratory syndrome: the Toronto experience. CMAJ. 2004 Jan;6(1):47–54. 170.

7. World Health Organization Coronavirus disease 2019 COVID-19 Situation Report.

8. Chaolin H, Yeming W, Xingwang L, et al. The lancet, Published Online January 24, 2020. https://doi.org/10.1016/S0140-6736(20)30183-5.

9. PHLN guidance on laboratory testing for 2019-nCoV Network PHL. PHLN guidance on laboratory testing for 2019-nCoV. https://www.health.gov.au/sites/default/files/documents/2020/02/phln-guidance-on-laboratory-testing-for-sars-cov-2-the-virus-that-causes-covid-19.docx.

10. Charlton CL, Babady E, Ginocchio CC, et al. Practical guidance for clinical microbiology laboratories: viruses causing acute respiratory tract infections[J]. Clin Microbiol Rev. 2018;32(1):e00042-00018. DOI:10.1128/CMR.00042-18.

11. Chan KH, Poon LL, Cheng VC, et al. Detection of SARS coronavirus in patients with suspected SARS[J]. Emerg Infect Dis. 2004;10(2):294–9. DOI:10.3201/eid1002.030610.

12. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, Tao Q, Sun Z, Xia L. Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology. 2020. doi:10.1148/radiol.2020200642.

13. Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiology 2020.https://doi.org/10.1148/radiol.2020200343. Published online Feb 12, 2020.

**Figures**
Figure 1

Examples of typical chest CT findings compatible with COVID-19 pneumonia. Chest CT shows extensive ground-glass opacities, consolidation, spider web pattern and interlobular septal thickening.