



KSR/KSTR Guidelines for the Use of Diagnostic Imaging for COVID-19

COVID-19와 관련한 영상검사 사용에 대한 대한영상의학회/대한흉부영상의학회 권고안

Korean Society of Radiology, Guideline Committee, COVID-19 Sub-Committee
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The Korean Society of Radiology and the Korean Society of Thoracic Radiology have prepared recommendations for the use of diagnostic imaging for COVID-19 in various clinical scenarios. We have tried to grasp the situation in the real world, aggregated opinions from the chest radiologists, and reviewed available references, in order to suggest the most reasonable recommendations possible at this moment. As circumstances change and new evidences emerge, the recommendations should immediately be modified accordingly.

Index terms COVID-19; Coronavirus; Diagnostic Imaging; Guideline; Republic of Korea

서론

Coronavirus disease 2019 (이하 COVID-19)는 SARS-CoV-2에 의한 감염질환으로 상기도 및 하기도의 호흡기 질환을 유발하며 심한 경우 폐렴을 일으킨다. 초기 증상은 마른기침, 인후통, 발열 등이 보고되고 있으며(1) 증상이 없거나 후각/미각상실(2), 근육통 등의 비특이적

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증상을 나타내기도 한다. 무증상인 상태에서도 전염이 가능하며(3) 증상에 비하여 폐병변이 심한 경우도 있으며 급격한 악화를 보이는 경우도 있다.

COVID-19의 선별검사로서의 영상검사(흉부 X선 검사, 흉부 CT)의 역할

1) 증상이 없지만 역학적 또는 기타 이유로 선별 진료소를 방문하여 검사대상자가 되는 경우(무증상검사대상자) 흉부 X선 검사를 이용한 선별검사는 권고하지 않으며 흉부 CT 역시 권고하지 않는다.

2) 선별 진료소에 내원한 호흡기 관련 유증상자에 대해 폐렴의 조기 발견과 COVID-19 이외의 다른 질환의 배제를 위하여 흉부 X선 검사를 고려할 수 있다. 발열 또는 호흡기 증상이 있는 환자가 안심 진료소를 방문한 경우 흉부 X선 검사를 권고한다. 또한 흉부 X선 검사가 음성이라도 COVID 19-폐렴을 배제할 수 없다.

3) 흉부 CT는 ① 흉부 X선 검사에서 폐렴 소견이 뚜렷하지 않으나 임상적으로 폐렴이 의심되는 경우, ② 임상적으로 COVID-19 가능성이 높으나 reverse transcription polymerase chain reaction (이하 RT-PCR) 결과가 음성일 경우, ③ RT-PCR 결과를 기다리기 어려운 중증 환자 또는 다른 질환으로 시급한 수술, 시술 등이 필요한 경우, 개별적 위해-이득을 고려하여 검사를 시행할 수 있다. 비조영 흉부 CT를 권고하며 합병증이나 다른 질환이 의심되는 경우 조영증강 흉부 CT를 고려할 수 있다.

COVID-19 확진자 생활치료센터 영상검사 지침

1) 무증상 또는 경증 확진자가 생활치료센터에 입소할 때 추적검사의 기준으로 하기 위한 흉부 X선 검사의 시행을 고려할 수 있다.

2) 생활치료센터에 격리 중인 환자에 대해 환자의 상태와 임상 소견의 변화, 시설, 검사 인력을 고려하여 흉부 X선 추적검사를 시행할 수 있다.

3) 생활치료센터에서 흉부 X선 검사를 시행할 때는 이동식 X선 촬영 장치 또는 검진 버스 등을 이용하여 검사를 시행할 수 있다. 진단에 필요한 적절한 수준을 유지할 수 있도록 영상의 질 관리를 철저히 하여야 하며 법규에 의하여 방사선 방어 조치를 시행하여야 한다. 추적관찰을 위해 같은 환자는 동일한 장치로 검사할 것을 권고한다.

4) 영상검사의 판독은 경험 있는 의사에 의하여 시행되어야 하며 영상의학과 전문의의 판독 또는 자문을 권고한다.

5) 생활치료센터에서 시행한 흉부 X선 검사에서 폐침윤이 발생하는 경우 적극적인 임상 관찰이 필요하고 입원치료를 고려할 수 있다.

6) 의료진의 안전과 전파 방지를 위해 가능한 환자와의 접촉을 피하고 검사 장비에 대한 소독을 정기적으로 시행한다.

COVID-19로 입원한 환자의 영상검사 지침

1) 폐렴의 경과 관찰을 위하여 흉부 X선 검사를 통한 추적관찰을 권고한다.

2) 합병증 등이 의심될 경우 위해-이득을 고려하여 흉부 CT를 고려할 수 있다.

참고자료

흉부 CT 소견

일반적으로 폐렴을 진단하는데 있어 흉부 CT의 민감도는 높으나 특정 원인을 감별하는 특이도는 낮다. COVID-19 폐렴의 전형적인 흉부 CT 소견은 양측 주변부 폐를 주로 침범하는 다발성의 간유리 음영이며 앞쪽보다는 뒤쪽 폐를, 그리고 상부보다는 하부를 침범하는 경향이 있다(4-6). 돌조각 보도양상(crazy-paving appearance) 및 공기기관지 음영(air-bronchogram)이 동반할 수 있다. 순전한 폐경화나 흉수, 공동, 석회화, 림프절 비대는 상대적으로 드물다. 또한 드물게 역달무리징후(reversed halo sign)로 보일 수 있다(7). COVID-19 폐렴은 증상 발현 후 처음 한 달 동안 시간에 따라 변화를 보인다(8, 9). 증상 발현 첫 2일 이내에는 많게는 56%의 환자까지 정상 CT 소견을 보일 수 있으며 증상 발현 초기에는 양측 주변부 폐를 침범하는 간유리 음영이 상대적으로 덜 명확할 수 있다. 증상 발현 3~4일 이후에는 전형적인 흉부 CT 소견을 보이며 초기에 비하여 침범 범위 및 밀도(폐경화 및 선상음영)가 증가한다. 대개 증상 발현 후 10일을 전후하여 CT 소견이 최고조를 보이며 2주 이후 서서히 감소한다. COVID-19 폐렴의 장기간 변화를 관찰한 연구는 아직 없으며 폐섬유화를 동반한다는 근거 또한 아직 분명하지 않다.

중증의 COVID-19 환자에서 흉부 CT의 병변 범위가 넓고 밀도가 높으며(consolidation, crazy-paving appearance), 섬유화 소견이 보일 수 있으며(traction bronchiectasis), 림프절 비대 또는 흉수가 동반할 수 있다고 알려져 있다(10-12). 예후와 연관된 흉부 CT 소견은 알려진 바가 아직 없다.

흉부 CT 검사에서 고려할 사항

확진 환자에서 CT 검사의 이득-위해를 고려하여 꼭 필요한 경우에만 CT 검사를 시행하고(13), 각 기관의 감염관리지침에 따라 의료진의 안전 및 전파방지 조치를 취해야 한다.

환자와 의료진의 접촉을 최소화하기 위하여 비조영 CT를 권고한다. 숨을 충분히 참지 못할 수 있으므로 되도록 스캔시간을 짧게 하고 시간해상도를 높이는 것이 유리하다. 표준 또는 저선량 흉부 CT 프로토콜로 촬영할 수 있으며 환자 체형을 고려하여 결정한다. 불필요한 방사선 피폭을 최소화하여야 한다. 촬영 범위는 폐첨부터 폐기저부까지 포함하며 가능한 최대 흡기 시점에서 한 번의 호흡으로 전체의 촬영 범위를 포함한다. 영상 재구성은 간유리 음영을 잘 구분하기 위하여 3 mm 이하의 얇은 절편 영상으로 재구성하는 것을 권고하며 high-spatial-frequency algorithm을 이용하여 재구성한다. 추적관찰 검사가 필요한 경우 초저선량 흉부 CT 프로토콜 사용을 고려할 수 있다. 조영증강 CT의 이득이 분명하지 않으며 조영증강 CT 검사는 필요한 경우 고려할 수 있다.

저선량 이동식 X선 촬영 장치 및 이동형 콘빔 CT 장치

의료기관에서 일반적으로 이용하는 이동식 X선 촬영 장치 또는 이동형 검진 버스에 설치된 X선 촬영 장치는 흉부 X선 검사에 대한 영상의 질 관리를 하여야 하고, 법규에 의하여 방사선 방어 조치

를 시행하여야 한다. 최근 일부 보건소 등에서 손으로 잡고 촬영할 수 있을 정도로 소형인 초저선량 이동식 X선 촬영 장치를 사용하고 있다. 이러한 장치로 얻는 흉부 X선 검사에 대한 영상의 질 수준에 대한 자료가 없으므로 사용에 주의를 요한다. 한 환자를 같은 장치로 영상 소견의 변화를 추적관찰하는 용도로 사용하는 경우에는 사용을 고려할 수 있다.

이동형 콘빔 CT는 일반적인 CT에 비하여 시간해상도가 낮아 흉부를 검사할 때 호흡에 의한 흔들림에 의해 영상의 질이 저하되며 전체 폐를 모두 포함하여 검사할 수 없으며, 문헌에 보고된 영상 소견이나 검사의 정확도 등도 없다. 이동형 콘빔 CT를 흉부 검사에서 사용하는 것에 대해서는 아직 임상평가가 이루어지지 않았으며 확진자의 합병증 평가에 유용하다는 근거도 없다.

국외 학회의 권고안

국외 여러 나라의 학회에서도 흉부 CT를 일상적인 임상 목적을 넘어서 COVID-19의 1차 진단의 목적으로 사용하지 말 것을 권고하고 있으며 CT에서 정상이라는 것이 바이러스의 감염을 배제하지 못한다고 하였고, 폐농양이나 농흉 등 합병증이 의심되는 경우 고려할 수 있다고 하였다(14-18).

Supplementary Material

COVID-19와 관련한 영상검사 사용에 대한 대한영상의학회/대한흉부영상의학회 권고안의 영문 버전은 온라인 보충자료(Supplementary Material in the online-only Data Supplement)로 제공된다.

The English version of the KSR/KSTR Guidelines for the Use of Diagnostic Imaging for COVID-19 is provided as a Supplementary Material in the online-only Data Supplement (<http://dx.doi.org/10.3348/jksr.2020>).

Author Contributions

Conceptualization, Y.H.S., D.K.; investigation, J.K.N., Y.S.H., P.C.H., Y.H.S.; methodology, Y.H.S.; project administration, Y.H.S.; supervision, Y.H.S.; writing—original draft, J.K.N., Y.S.H., P.C.H., B.K.S.; and writing—review & editing, D.K., Y.H.S.

Conflicts of Interest

The author has no potential conflicts of interest to disclose.

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COVID-19와 관련한 영상검사 사용에 대한 대한영상의학회/ 대한흉부영상의학회 권고안

대한영상의학회 진료지침위원회 · COVID-19 소위원회
진광남¹ · 윤순호² · 박철환³ · 백경민⁴ · 도경현⁵ · 용환석⁶

대한영상의학회와 대한흉부영상의학회는 COVID-19 에서의 영상검사의 사용에 대하여 다양한 상황에서의 권고안을 마련하였다. 실제 현장의 상황을 파악하고, 흉부영상의학 전문의들의 의견을 수렴하였으며, 국외 학회의 권고안과 수집 가능한 문헌을 바탕으로 현 상황에서의 가장 합리적인 안을 제시하는 것이며 상황과 근거의 변화에 따라 유연하게 즉시 수정되어야 한다.

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KSR/KSTR Guidelines for the Use of Diagnostic Imaging for COVID-19

Korean Society of Radiology, Guideline Committee, COVID-19 Sub-Committee

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infection caused by SARS-CoV-2, which can result in upper or lower respiratory infections and in some serious cases, pneumonia. Reported early symptoms include dry cough, sore throat, and fever (1), but it can be asymptomatic or present as nonspecific symptoms, such as myalgia, anosmia, and dysgeusia (2). Asymptomatic transmission is known to occur (3); sometimes, the patients only suffer mild symptoms despite extensive pulmonary lesions on imaging, and sometimes the patients undergo rapid deterioration.

The Role of Imaging Studies (Chest Radiography, Chest CT) as Screening Tests for COVID-19

1. Screening with chest radiography (CXR) or chest CT is not recommended for asymptomatic individuals visiting COVID-19 screening clinics* for epidemiological or other unspecified reasons.

2. CXR may be considered in patients with respiratory symptoms visiting COVID-19 screening clinics for an early diagnosis of pneumonia or to rule out diseases other than COVID-19.

3. CXRs are recommended for patients with fever or respiratory symptoms visiting outpatient safe clinics[†]. However, the use of CXRs to rule out COVID-19 pneumonia is not recommended.

4. Chest CT can be done, after weighing individual risks and benefits, in these circumstances: 1) when pneumonia is suspected clinically although pneumonia is not definite on CXR, 2) when there is a high clinical suspicion for COVID-19 but with negative reverse transcription polymerase chain reaction (RT-PCR) results 3) critically ill patients or patients with other diseases who are in need of emergent operations or procedures who cannot wait for RT-PCR results.

Non-contrast chest CT is recommended, but contrast-enhanced chest CT may be considered when complications or other diseases are suspected.

Guidelines for the Use of Diagnostic Imaging for COVID-19 Patients in Community Treatment Centers for Isolation

1. CXRs may be considered when asymptomatic patients or patients with mild symptoms are admitted to community treatment centers[‡], as a reference for future follow-ups.

2. Follow-up CXRs may be performed in patients isolated in community treatment centers, after considering the changes in clinical manifestations of the patient and available resources and manpower for imaging studies.

3. When CXRs are performed in community treatment centers, portable X-ray machines or screening buses may be appropriate. A thorough image quality control should be done to maintain images of diagnostic quality, and appropriate measures for radiation protection and safety should be taken, complying with all relevant quality control regulations. For follow-up purposes, it is recommended to perform exams of a same patient using the same machine used for the initial exam.

4. Interpretation of the imaging studies should be done by experienced doctors, and interpretation or consultation by board-certified radiologists is recommended.

5. When pulmonary infiltrations develop on CXRs performed in community treatment centers, the patients need close clinical monitoring and admission to hospitals may be considered.

6. For the safety of medical personnel and prevention of the disease spread, avoid contact with patients if possible, and regular cleaning and disinfecting of equipment should be done.

Guidelines for Imaging Studies for Admitted Patients with COVID-19

1. Imaging follow-up with CXR is recommended for the patients with pneumonia.
2. When complications are suspected, chest CT may be considered, after considering the potential risks and benefits.

Definition

*Screening clinics: for individuals who have a history of visiting a foreign or dangerous area/dangerous place with or without fever or respiratory symptoms.

† Outpatient safe clinics: for patients with fever/respiratory symptoms but without clinical or epidemiological suspicion for COVID-19.

‡ Community treatment centers: for patients with asymptomatic or mild symptoms identified with COVID-19 through RT-PCR.

Relevant Information

Chest CT Findings

In general, the sensitivity of chest CT for diagnosing pneumonia is high, but the specificity for identifying the specific causative pathogens is low. Typical chest CT findings for COVID-19 pneumonia is multifocal peripheral ground-glass opacities (GGO) in both lungs, and they tend to affect the posterior and lower lungs rather than anterior and upper lungs (4-6). Crazy-paving appearance and air-bronchogram may be combined. Pure consolidation, pleural effusion, cavitation, calcification, or lymphadenopathy is relatively rare. Also, although not common, reversed halo sign may be seen (7). COVID-19 pneumonia shows temporal changes over the first month after onset of symptoms (8, 9). As many as 56% of the patient may have normal chest CT scans within first two days of the onset of symptoms, and bilateral peripheral GGO may not be prominent during the early stage of the disease. After three to four days from the symptom onset, the patients will show typical chest CT findings, with increase in the extent and density of the pulmonary infiltrates (consolidation and linear opacities). The peak levels of lung involvement in chest CT may be seen around 10 days from symptom onset and show gradual decrease after two weeks. Currently, there are no studies on long-term changes of COVID-19 pneumonia, and the evidence for development of pulmonary fibrosis is not definite.

In more severe cases of COVID-19, the extent of pulmonary lesions on chest CT is reported to be larger and denser (consolidation and crazy-paving appearance), with findings suggestive of fibrosis (traction bronchiectasis) and accompanied by lymphadenopathy or pleural effusion (10-12). Currently, there are no known imaging findings related to prognosis of the disease.

Considerations in Chest CT Exams

Chest CT should be performed in COVID-19 confirmed patients only when there are clear indications for CT (13), after weighing the risks and benefits. Appropriate infection control procedures should be done to ensure safety of the medical personnel and prevent the spread of the disease. In order to minimize the contact between the patient and medical personnel, noncontrast CT is recommended. Because the patient may not be able to hold breath sufficiently, it is advisable to shorten the scan time and increase temporal resolution. Standard or low-dose chest CT protocol may be used, depending on the body habitus of the patients. Unnecessary radiation exposure should be minimized. Scan range should be from the lung apices to the lung bases, which should be scanned in a single breath-hold at maximum end-inspiration. Image reconstruction with a slice thickness less than or equal to 3 mm using a high-spatial-frequency algorithm is recommended in order to better identify ground-glass opacity. When a follow-up exam is needed, the use of ultra-low dose CT protocol may be considered. There are no definite benefits of contrast-enhanced CT, but contrast-enhanced CT may be considered when necessary.

Low Dose Portable X-Ray Equipment and Mobile Cone-Beam CT

Image quality control should be done for portable X-ray machines used in medical institutions or X-ray machines on screening buses, and appropriate measures for radiation protection and safety should be taken, complying with all relevant quality control regulations.

Lately, low dose portable X-ray equipment that are small enough to be held with hands are being used in some public health centers. As there are no data on the image quality of CXRs acquired with these equipment, it should be used with caution. For the purpose of monitoring the changes in imaging findings of same patients, the use of low dose portable X-ray equipment may be considered.

Mobile cone-beam CT has lower temporal resolution than standard CT, making it prone to degraded image quality due to respiratory motion artifacts. Also, whole lungs cannot be examined with mobile cone-beam CT, and there are no imaging findings or accuracy of the exam reported in the literature. Evaluation of the use of cone-beam CT for chest imaging has not been done, and there is no evidence for its usefulness in evaluation of complications of COVID-19 patients.

Recommendations from Other Societies

Many other societies also recommend that chest CT should not be used for the primary diagnosis of COVID-19 beyond routine clinical purposes and can be considered if complications such as lung abscesses or empyema are suspected, and normal CT does not exclude the infection itself (14-18).

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