

LOW-DOSE COMPUTED TOMOGRAPHY IN THE EARLY DIAGNOSIS OF PNEUMONIA CAUSED BY SARS-COV-2

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Relevance

Throughout life, people are exposed to radiation from both natural sources (cosmic radiation, radionuclides), and artificial sources (man-made). Radiation exposure is a constant accompaniment to life on Earth, and its impact is so insignificant that it cannot cause noticeable disruptions to the body's vital functions. With the growing use of CT scans worldwide, the relevance of these recommendations is currently increasing. According to published data from the United Nations Committee on the Effects of Radiation, CT scans account for 5% of the world's total radiation exposure, and contribute 34% to the collective radiation dose. Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2000 Report to the General Assembly, Annex D: Medical Radiation Exposures. New York : United Nations , 2000. Conventional chest X-ray remains the most commonly used tool for verifying and diagnosing the subsequent evolution of lung diseases, especially in the intensive care unit. It is not always possible to draw clear parallels between the computed tomographic image and the clinical condition of a patient with COVID-19 pneumonia. Clinicians sometimes rely solely on clinical indicators, which do not always allow one to suspect a critical stage of lung tissue damage. Therefore, it is important to monitor both the dynamics of clinical indicators and the results of CT scanning. Low-dose CT (LDCT of the lungs) allows for the visualization of lung tissue in three dimensions with much greater detail than with traditional fluorography or chest X-ray. Moreover, unlike traditional chest CT, the radiation exposure during the examination is significantly lower. Computed tomography (CT) of the lungs is one of the most frequently performed examinations in modern medicine. It allows for a layered view of the lungs. Low-density CT of the lungs is successfully used for the early detection of tuberculosis and malignant tumors. This examination allows for a clear picture of the lung condition and the appropriate treatment to maximize the chance of recovery. However, in the presence of severe symptoms, the informative value of LDCT is limited to lung tissue, so a chest CT scan or a chest CT scan with contrast is prescribed to detect serious complications or even the underlying cause of the disease hidden in adjacent organs and tissues. At the same time, computed tomography has become a very popular diagnostic tool for chest pathologies. Multislice computed tomography (MSCT) remains the most reliable and widely accepted method for diagnosing COVID -19 coronavirus infection with ground-glass opacities and community-acquired pneumonia in adults. This review will explore some clinical

insights into the diagnostic capabilities of LDCT. Numerous studies using CT scanning have provided new insights into the pathophysiology of COVID -19 (coronavirus infection with ground-glass opacities) and community-acquired pneumonia in adults, focusing particularly on the variation of lung tissue consolidation. However, the goal of the latest and fastest LDCT technology is dynamic, rather than static, visualization of lung ventilation.

Keywords: multispiral computed tomography, semiotics, pneumonia, SARS-CoV-2, COVID-19-associated pneumonia.

Purpose of the study

Improvements in diagnostics and differential diagnosis of COVID -19 coronavirus infection and community-acquired pneumonia using low-dose computed tomography (LDCT) and standard computed tomography (SDCT).

Practical significance

1. Introduce methods for preventing radiation doses by reducing the LDCT to 0.4–0.8 mSv in patients with community-acquired pneumonia and COVID-19.
2. Identification of military personnel at high risk of exposure to radiation ions and prevention of radiation-related diseases.
3. To evaluate the quality of LDCT and SDCT images and optimize the safety level of dosimetric parameters in patients receiving low doses of radiation.

Material research method

Nowadays, low-dose computed tomography is used to screen for pathological changes in the lungs of both nonspecific and specific origins (viral and bacterial pneumonia). In other words, lung screening is a low-dose CT scan used exclusively for lung examination. Low-dose CT is prescribed for examination of the respiratory system. Often, fluorography or X-ray alone is insufficient to monitor treatment progress and establish an accurate diagnosis. Both tests involve a higher radiation dose, so they are not recommended more than twice a year. Low-dose CT is a modification of chest CT that uses specialized software to significantly reduce radiation exposure with minimal loss of image quality. Chest CT reveals not only the condition of the lung tissue but also the trachea, bronchi, blood vessels, and lymph nodes. The scan can reveal damage to each of these organs, their developmental pathologies, tumors, as well as serious diseases such as tuberculosis, pneumonia, emphysema, and others. The high incidence of lung lesions in patients with COVID-19, including the development of viral pneumonia (VP), severe respiratory failure, leading to a socially significant increase in mortality, necessitates the most detailed possible characterization of pathological changes in the chest organs (CH), and in particular the lungs in this disease. Comparison of radiographic and pathological images of the lungs in patients with COVID-19. Medical Visualization. 2020; 24 (3): 37–53. Computed tomography

(CT) of the chest organs is one of the most widely used examinations due to its excellent quality of imaging of lung structures. Depending on the patient's constitution, the radiation dose from a standard CT scan of the chest organs can be up to 8 mSv (millisieverts). There are several methods for reducing the radiation dose during a CT examination. The simplest method is to reduce the energy voltage or current supplied to the X-ray tube. However, reducing the radiation dose inevitably leads to an increase in digital noise. To combat this, a technique of iterative reconstruction of raw data was developed, the latest generation of which is model-based iterative reconstruction (MIR), which has the least sensitivity to the appearance of digital noise with a decrease in current. MIR technology itself does not reduce radiation exposure, but helps maintain image quality at low radiation doses by eliminating digital noise. Previous studies have shown the possibility of reducing the radiation exposure to <1 mSv while maintaining the diagnostic quality of the obtained images. However, there is evidence that in the Australian population undergoing CT examination, the incidence of cancer is 24% higher than in the population who did not undergo CT scanning Mathews JD, Forsythe AV, Brady Z., Butler MW, Goergen SK, Byrnes GB, Giles GG, Wallace AB, Anderson PR, Guiver TA, McGale P., Cain TM, Dowty JG, Bickerstaffe AC, Darby SC Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence : data linkage study of 11 million Australians . *Br . Med . J.* 2013; f2360. [1]. In this regard, reducing the radiation load during CT examinations has become one of the key issues in reducing cancer risks in the population. A significant contribution to reducing the radiation load on the population has been the development of new algorithms for reconstructing CT images. The iterative reconstruction algorithm was introduced in 2009 to replace the previously existing algorithm of backprojection of weighted filtered projections (filtered back Iterative reconstruction (FBP) improves image quality and reduces noise compared to FBP, resulting in images of the same quality at a reduced radiation dose. Iterative reconstruction (from the English "iterative" - repetitive) repeats the reconstruction several times to better evaluate mathematical assumptions, resulting in images with lower noise (Padole A., Ali Khawaja R.D., Kalra M.K., Singh S. CT radiation dose and iterative reconstruction techniques . *Am . J. Roentgenol .* 2015; 204 (4): W384–W392. [2]. The ultimate goal of all iterative reconstructions is to isolate noise and obtain an image that is as close as possible to the real object, which results in the possibility of reducing the dose during CT examination. It should be understood that iterative reconstruction itself does not reduce the radiation dose, but allows maintaining image quality at lower dose values Mayo-Smith WW, Hara AK, Mahesh M., Sahani DV, Pavlicek W. How I do it : managing radiation dose in CT. *Radiology .* 2014; 273 (3): 657–672. [3]. The main advantage of model-based iterative reconstructions (MIR) is the ability to reduce the radiation dose while maintaining and even improving image quality compared to FBP

Aurumskjold ML, Ydstrom K., Tingberg A., Soderberg M. Model-based iterative reconstruction enables the evaluation of thin-slice computed tomography images without degrading image quality or increasing radiation dose . Radiation Protection Dosimetry . 2016; 169 (1–4): [4]. Data have been published on the possibility of reducing the dose by an average of 65–70% of the standard, and in some studies by 90% [5, 6] or more while maintaining the diagnostic quality of the image. For example , A. Neroladaki And Co - authors Neroladaki A., Botsikas D., Boudabbous S., Becker CD, Montet X. Computed tomography of the chest with model-based iterative reconstruction using a radiation exposure similar to chest X-ray examination: preliminary observations. Eur . Radiol . 2013; 23 (2): 360–366 [6] practically compared ultra-low-dose CT with chest radiography in two projections. Most studies have established an increase in objective image quality when using MIR compared to FBP, confirmed a decrease in image noise by 60–90% and an increase in the contrast-to-noise ratio by 3–6 times. Considering that examination of the chest organs is one of the most frequently used CT scanning methods, studying the possibility of optimizing the radiation load during this examination seems extremely promising. The use of MIR opens up opportunities for the development of new low-dose scanning protocols. Since the advent of MIR technology, many researchers have become interested in the potential for achieving radiation exposures of less than 1 mSv during chest CT , which could make CT virtually equivalent to chest X-rays in two projections. A large body of data has been published on the use of MIR in submillisievert chest CT with radiation exposures of less than 0.4 mSv . MIR allows for the detection of the same number of solid lesions during UDCCT with a radiation exposure of 0.16 mSv as during LDCT with a radiation exposure of more than 1 mSv. Neroladaki A., Botsikas D., Boudabbous S., Becker CD, Montet X. Computed tomography of the chest with model-based iterative reconstruction using a radiation exposure similar to chest X- ray examination : preliminary observations . Eur . Radiol . 2013; 23 (2): 360–366. [6]. Diagnostic image quality in NDCT was achieved for almost all types of pulmonary pathology. The exceptions were changes with reduced density (emphysema or air traps) and focal changes of the “ground glass” type less than 4 mm. Only 60% of changes with reduced density were diagnosed, the majority of non-visualized pathologies were located in the upper parts of the lungs [10]. Similar data on worse visualization of emphysema and foci of the “ground glass” type were published in other studies Laqmani A., Avanesov M., Butscheidt S., Kurfurst M., Sehner S., Schmidt-Holtz J., Derlin T., Behzadi C., Nagel HD, Adam G., Regier M. Comparison of image quality and visibility of normal and abnormal findings at submillisievert chest CT using filtered back projection , iterative model reconstruction (IMR) and iDose4™. Eur. J. Radiol . 2016 ; 85 (11): 1971– 1979. [11]. YH Ju Ju YH, Lee G., Lee JW, Hong SB, Suh YJ, Jeong YJ Ultra-low-dose lung screening CT with model-based iterative reconstruction: an assessment

of image quality and lesion conspicuity. *Acta Radiol* . 2018; 59 (5): 553– 559. <https://doi.org/10.1177%2F0284185117726099> [12] in their study of patients with an average BMI = 27 and a radiation dose of 0.4 mSv note that UDC CT allows identifying focal changes of the “ground glass” type, but recommend performing a control (follow-up) CT with a standard dose for differential diagnosis. Coronavirus pneumonia is not like ordinary pneumonia. There is a “ground glass symptom”, which is detected only by CT scanning and a regular X-ray will not see it in the early manifestations. For example, PCR reveals whether a person is infected or not, that is, it reveals the presence of the virus in the body. Fever, muscle and joint pain are all manifestations of coronavirus infection. One of the complications of coronavirus is coronavirus pneumonia. Indeed, coronavirus pneumonia presents differently and is difficult to detect with a standard X-ray. Many of our CT scanners are multi-slice , so they don't produce a significant radiation dose. A chest CT scan, in particular, produces a radiation dose of 2-3 millisieverts , which is the acceptable dose. There's also low-dose CT, which is designed to minimize radiation exposure.

low-dose scanning protocols plays an important role in optimizing CT , allowing for the acquisition of necessary diagnostic information while significantly reducing radiation exposure and, consequently, potential harm to patients. In addition to CT, traditional radiography, and in rare cases, ultrasound and magnetic resonance imaging (MRI) can be used to detect COVID-19-associated pneumonia [Habert et [al ., 2021]. Each of these methods has its advantages and disadvantages. Lung ultrasound has been recognized as a safe alternative to CT scanning, not involving exposure to ionizing radiation. However, the practical applicability and informativeness of this study have been controversial. Some studies show a high level of agreement between the results of ultrasound and CT examinations of the lungs [Wang et al ., 2021], while others note the subjectivity and operator dependence of ultrasound [Quarato et [al ., 2021]. For this reason, it is recommended (in certain cases) for examining seriously ill patients, pregnant women, and children [Vetsheva et al ., 2020]. Chest radiography is widely available and is less operator-dependent than ultrasound. Therefore, it can be used as a first-line imaging modality for suspected COVID-19, regardless of the patient's laboratory status [Ghosh et al ., 2021], especially in mild forms of the disease. At the same time, radiography has a relatively low sensitivity [Sadiq et al ., 2021] compared with CT. MRI appears to be a promising modality for the safe diagnosis and assessment of the severity of pneumonia caused by COVID-19 [Vasilev et al ., 2021]. However, its widespread use during a pandemic is limited by a number of factors, such as availability, long study times, and the difficulty of sterilizing equipment [Collins et al ., 2022].

Conclusion

For the first time, it has become possible to diagnose and obtain high-quality

images while reducing and preventing radiation exposure to military personnel using low-dose computed tomography (LDCT) (0.4–0.8 mSv) for the early diagnosis of COVID-19 and community-acquired pneumonia.

To determine the level of continuous radiation exposure of military personnel equipped with communications and electronic warfare equipment, as well as

- a) using LDCT (0.4–0.8 mSv) interstitial community-acquired pneumonia.
- b) Prevention of radiation exposure in military personnel.
- c) compared LDCT and SDCT.

For the first time, the dosimetric method was used to determine the magnitude of radiation exposure on military personnel, especially related to the effects of radiation from communication transmitters and radio frequency devices; possible diseases that may arise as a result of excessive radiation exposure among military personnel, and measures for their prevention, were developed and implemented.

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