A Review of Radiographic Findings in Sars-Cov-2 Patients

Denise Freitas Santana[1], Kárita Amanda Ribeiro de Melo[1],
Agrinazio Geraldo Nascimento Neto[1*], Wellington Carlos da Silva[1],
Fábio Alves dos Santos[1], Amanda Aguiar Barros[1],
Maisa Adriele Nalves da Silva[1], Lívia Gomes de Oliveira[1],
Leidimar da Silva Carvalho[1], Taynara Dantas Batista[1],
Larissa Lima dos Santos[1], Bianca de Andrade Nery[2],
Murilo de Sousa Reis[2] and Yan de Lima Borges[3]

[1]*Department of Physiotherapy, University of Gurupi (UnirG), Av. Rio de Janeiro, Gurupi, Tocantins, Brazil.*
[2]*Department of Medicine, University of Gurupi (UnirG), Av. Rio de Janeiro, Gurupi, Tocantins, Brazil.*
[3]*Department of Physiotherapy, Institute of Higher Education Raimundo Sá, Picos-Piauí, Brazil.*

Authors' contributions

Article Information

Review Article

Corresponding author: E-mail: agrinaziogeraldo@gmail.com;

ABSTRACT

Introduction: At the end of 2019, more specifically in December, the outbreak of the new coronavirus - Sars-Cov-2, which caused pneumonia, emerged in Wuhan, and soon spread throughout China, where researchers began to suspect a possible pandemic. , being a disease that causes a deficiency of structures of the respiratory system, leading to alterations in breathing functions, with respiratory muscle deficiencies and exercise tolerance. During the pandemic peak still in Wuhan, the main radiographic findings in hospitalized patients revealed bilateral opacity on computed tomography (CT) examination, lobular and subsegmental consolidation areas, ground-glass opacities, consolidation with rounded morphology, and peripheral pulmonary distribution.
Aims: Analyze through the available literature review the main radiological alterations caused by Sars-Cov-2.
Methodology: This is an integrative literature review using PubMed, Scielo, Google Scholar, Microsoft Academic databases. Inclusion criteria were complete and original articles in English and Portuguese. Duplicates and other literature reviews were excluded.
Results: Radiographic findings are different in the early and advanced phases of the disease, but characteristic signs such as the matte glass pattern were found in both phases.
Conclusion: The radiographic findings of patients diagnosed with COVID-19 are not the main criteria for clinical diagnosis, but knowledge of characteristic symptoms is fundamental. Therefore, the multidisciplinary team must discuss the radiological findings most common to the virus, this will directly aid early diagnosis, in addition to reducing the high mortality rates globally.

1. INTRODUCTION

At the end of 2019, more specifically in December, the outbreak of the new coronavirus – Sars-Cov-2, which caused pneumonia, appeared in Wuhan, and soon spread throughout China, where researchers began to suspect a possible pandemic [1]. After the pandemic collapse throughout Europe, and its spread throughout North America, Brazil had its first case on February 26, 2020 [2]. According to data in the Ministry of Health [3] (2020), the 61-year-old man was admitted to the Hospital Israelita Albert Einstein, on Tuesday (25/2), with a history of travel to Italy, Lombardy region, where he was later diagnosed with the new COVID-19.

According to the Ministry of Health (2020), the initial clinical picture of Sars-Cov-2 is characterized as a flu syndrome, however, mild, subfebrile initial cases can progress to progressive temperature rise and the fever is persistent beyond 3 -4 days, contrary to the decrease observed in cases of Influenza. The diagnosis depends on clinical-epidemiological investigation and physical examination.

Although immediate diagnosis and isolation of patients are the main measures for controlling this virus, the hypothesis of developing a more rigorous surveillance action plan, identifying a possible marker to assess the clinical condition of patients, developing studies to understand what factors are involved in the worsening of cases and deaths that are not part of the risk group (who develop severe forms of the disease) due to age because they are immunocompetent and do not have pre-existing diseases that are determining factors for the progression of the disease [4].

The mean incubation period is 5 days (1-20 days) and it is possible to transmit even in asymptomatic periods of the disease, although the greatest risk is after the onset of symptoms. It is estimated that each infected individual can transmit to another 2 or 3 people (mean 2.7). In the early stages of an outbreak, the number of cases tends to double every 7 days [2].

COVID-19 is a disease that causes the deficiency of respiratory system structures, leading to alterations in breathing functions, and respiratory muscle deficiencies and exercise tolerance may occur. In these patients. There are limitations of basic activities that involve mobility tasks, directly affecting the life activities of individuals [4].

However, most lung infections are mild, but severe or critical forms are also described, especially in patients in risk groups who may have dyspnea, hypoxemia, pulmonary involvement in imaging studies, respiratory

failure, shock, and multiple organ failure. Chest CT can help in the diagnosis of this disease, but it cannot be confirmed or excluded in isolation. When rt-PCR (Polymerase chain reaction with reverse transcription - initial diagnosis of Covid-19) was used as a reference, chest CT presents high sensitivity (97%), but low specificity (25%), given the overlap of findings with pulmonary infections of different etiologies [5,6].

During the pandemic peak in Wuhan, the main radiographic findings in hospitalized patients revealed bilateral opacity on computed tomography (CT) examination, lobular and subsegmental areas of consolidation, matte glass opacities, consolidation with rounded morphology, and peripheral pulmonary distribution [7].

Based on bibliographic referencing, the aim of this study is to analyze the manifestations of tomography in the different stages of the disease's evolution. This review will help healthcare professionals better understand these changes and design more accurate treatment methods. This study reports the main radiographic findings in patients diagnosed with Sars-Cov-2, in addition to understanding the radiologic manifestations before and after 7 days of diagnosis.

2. MATERIALS AND METHODS

To identify the articles on the subject, a search was performed in the Databases PubMed, Scielo, Google Scholar, Microsoft Academic. Imaging exams are part of the routine of all health professionals, to better outline the objectives and treatments for patients. However, during the period of the survey for the curve of the new Covid-19, it is important for all professionals on the front line to be conversant with imaging findings of Covid-19. The search strategy on the subject consisted of the use of the keywords:

1. Imagenologia,
2. Sars-Cov -2,
3. Radiography
4. Covid-19 5

After consulting the databases and applying the search strategy, repeated studies were identified between the different searches. The inclusion criteria of the articles were: original and research

articles that conceptualize imaging tests in patients diagnosed with symptomatic Sars-Cov-2. The study was carried out in different types of research fields, covering research completed in the Portuguese, English, and Spanish.

The excluded articles were grouped in the order: repeated, irrelevant, review, other publication formats in addition to other languages. Also, manual searches were made in bibliographic references of the original articles found with the predetermined keywords.

3. RESULTS AND DISCUSSION

Despite their age, all individuals can be infected with Sars-Cov-2 and experience respiratory complications. Therefore, groups of middle-aged and elderly people are the most affected. Pneumonia is the most frequent and severe manifestation of the infection. In general, the most frequent symptoms of these patients are fever, cough, and dyspnoea. Bilateral infiltrates, not always detected on X-rays, still requiring a computed tomography (CASTRO et al., 2020).

According to studies by Yang et al., (2020), where they corroborate that CT is highly recommended because this test is very sensitive to the detection of diseases in the early stage, alterations that are not discovered and subtle on chest X-ray. Computed tomography of the chest can demonstrate almost all abnormalities, including early mild exudative lesions.

The spectrum of clinical presentation is broad, from asymptomatic to patients with the critical disease. Most lung infections are mild, but severe or critical forms are also described, especially in the elderly and individuals with comorbidities, and may have dyspnea, hypoxemia, large pulmonary involvement in imaging studies, respiratory failure, shock, and multiple organ failure [6]. However, several studies have reported the most common radiographic findings found in patients with Sars-Cov-2 diagnosis.

Jin et al. [8] reported a study conducted with 5 patients diagnosed with Covid-19, with the main objective of chest x-ray, where it was possible to find common findings in both patients studied were: matte glass opacity, bilateral, multifocal, mixed lesions, and consolidation in the pulmonary parenchyma. Only in one of the patients studied it was possible to observe
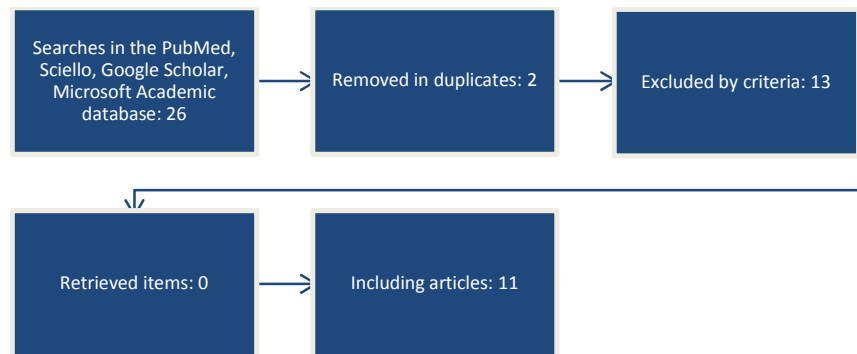
Fig. 1. Flowchart of identification and selection of articles. (prepared by the authors, 2020)

through imaging the presence of traction bronchiectasis. Fig. 2 shows the radiographic result of one of the patients studied.

The studies of Filho et al. [9] agree with the previous study, the author corroborates that most of the cases currently published present similar tomographic findings, predominantly alveolar alterations, such as matte glass opacities, focal consolidations, and mixed opacities (including inverted halo opacities), usually with bilateral and multifocal involvement, peripheral distribution and predominance in the middle, lower and posterior pulmonary fields as can be observed in Fig. 3.

The research by Zhou et al. [10], shown in Table 1 above, reports the main radiographic findings in patients in the advanced phase and initial phase of the disease. The frosted glass signal significantly decreased in the advanced phase compared to the initial phase. The authors corroborate that these changes suggest that the frosted glass pattern was a significantly early sign in the course of the disease in the advanced phase, the involvement of the pulmonary parenchyma and interstice was aggravated, but was accompanied by changes in repair. There was no significant difference between early-stage disease versus advanced-stage disease in terms of consolidation, a sign of microvascular dilation, pleural thickening, and pleural retraction sign.

Farias et al. [11] mention another sign that has been presenting in symptomatic patients of Sars-Cov-2 - the designation of the halo sign- which was not very common in the first reports of the disease and also little commented in the literature, but reported in more recent studies. This signal is characterized as a zone of low attenuation (in frosted glass), in the form of a halo, surrounding a mass or nodule (Fig. 4). The author also reports that although the halo sign is

not characteristic of the disease, knowledge about it is fundamental for better management of the disease.

Studies presented bring tomography findings very similar, in the pictorial essay by Rosa et al., [12] bring results from different patients at different stages of the disease, the common findings <7 days are: ground-glass opacities associated or not with reticulations, thickening of the interlobular septa, inverted halo sign, pulmonary consolidations, air bronchogram, and lymphadenomegaly. Other common findings> 7 days were: bilateral pleural effusion, small ground-glass opacities, lobular consolidations, also showing signs of an inverted halo.

Chang et al. [13] evaluated the tomography of 40 patients, it was possible to analyze that 37 of these had ground-glass opacities - representing a very common sign in most of the individuals evaluated. Another very common sign found in Hu's study (2019) was the "spider's web sign" which is defined as a triangular or angular GGO in the subpleural lung with internal interlobular septa thickened like a network; the adjacent pleura is pulled giving a shape similar to a spider web, this finding is highly specific for COVID-19.

As of the date of the creation of this document, no evidence of a cure for the disease has been emphasized, with hundreds of tests being carried out in Brazil and worldwide, imaging tests are essential to understand the patient's clinic. According to the Brazilian School of Imaging and Diagnostic Imaging (2020), it follows recommendations for the use of imaging tests:

- X-ray: may be indicated in bedridden patients or without conditions for COMPUTED TOMOGRAPHY (CT), especially when there are clinical worsening/ suspected complications.

- Ultrasound: may be indicated in bedridden patients or without CT conditions, especially when there are clinical worsening/suspected complications.

- CT: can be performed in patients with worsening of symptoms and/or development of complications.
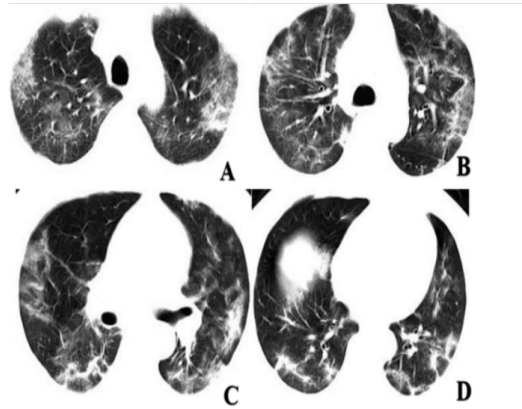

Fig. 2. Image examination performed in the study by jin et al. [8] shows the evolution of infiltrates and pulmonary opacities. Fig. a shows diffuse lung lesions, its evolution to b, c, and e reports an increase in the thickness of the lung lesion
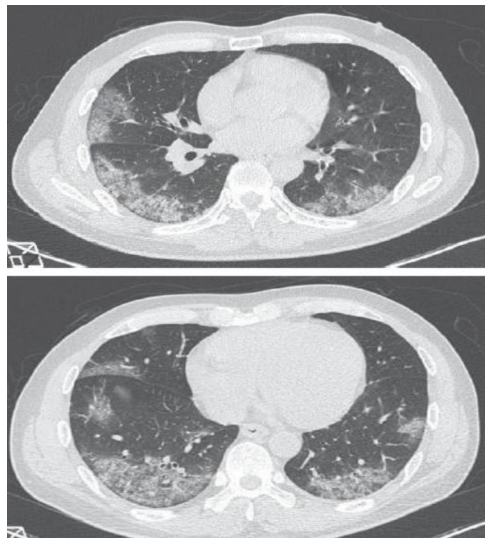

Fig. 3. Tomography of the study by Filho et al., [9]

Table 1. A study by Zhou et al., [10] in the early and advanced stages of the disease

| Author	Disease phase	Radiographic findings
Zhou et al., [10] Egypt et al., 2020.	Initial < to 7 after Symptom onset	Major lesions in the right lower lobe of the lungs, due to the virus being more likely to invade the branches of the lower lobar bronchus and cause infection. Presentations in frosted glass, signs of bilateral or unilateral pulmonary consolidation more reticular pattern.
	Advanced > to 7 after symptom onset	Septal thickening and reticular changes overlap with alveolar alterations have also been described and reflect concomitant interstitial involvement, fibrotic striations, pleural effusion, vacuolar signal, aerial bronchogram, fibrotic striae, and subpleural transparent line.
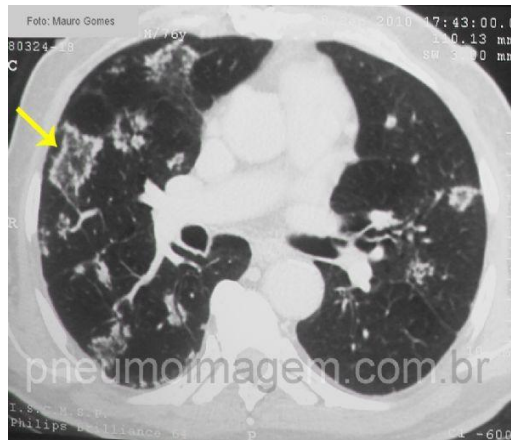
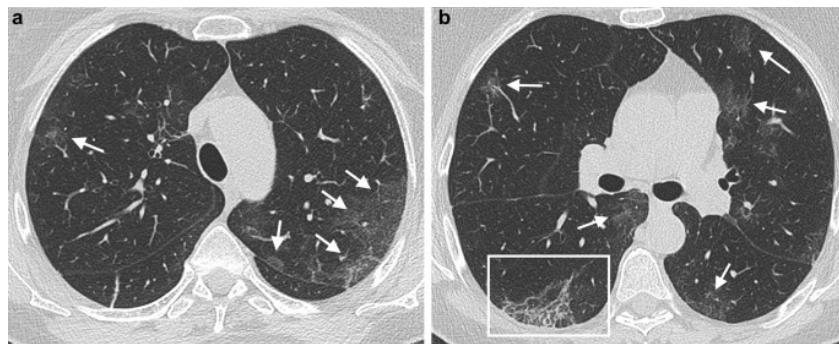**Fig. 4. Halo sign described by pneumoimagem.com.br (2020)**

Fig. 5. the highlighted signs present the findings in the spider web
Source: Cellina et al., [14]

The Brazilian School of Imaging and Diagnostic Imaging also points out that, these recommendations are up to the present moment, and can be redefined based on new evidence regarding the situation [12].

4. CONCLUSION

Sars-Cov-2, despite being a new pathology, bringing several difficulties for the scientific society to carry out its treatment, health professionals continue to engage to carry out the necessary support to reduce complications caused by the virus. Radiology has an important role to play in the natural history and prognostic course of the disease, in the knowledge of the underlying condition of the lung parenchyma, in the evaluation of the therapy provided, and in the clinical and radiological recovery. However, the radiographic findings of patients diagnosed with COVID-19 are not the main means for clinical diagnosis, but knowledge of the involvements is fundamental to outline the objectives and conducts for these individuals. Therefore, the

multidisciplinary team must discuss the radiological findings most common to the virus, this will directly influence to identify the disease earlier, in addition to reducing the high mortality rates in the world.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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