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Case Series

High Resolution Computed Tomography (HRCT) Findings in Seven Young Patients Affected by COVID-19 Disease: Can the Persistence of a Thymic Gland Provide a Defensive Influence?

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Abstract

COVID-19 pneumonia is a highly contagious viral pneumonia spread worldwide, caused by SARS-CoV-2. Adults may be more susceptible to disease, especially in those with comorbidities while young people show milder signs of the disease. Between January 1st and February 28th 2021, seven consecutive patients, ranging from 26 to 41 years, were admitted to our hospital with a diagnosis of COVID disease confirmed by a RT-PCR swab test. On HRCT, a Severity Index Score was performed to estimate pulmonary involvement. Focusing our attention on anterior mediastinum, we found that five of the seven cases enrolled had thymic gland. Two patients had not thymic gland. In our preliminary experience, five patients who had thymic gland showed a mild or negative clinical and radiological COVID-19 pneumonia. Instead, two patients who experienced severe COVID-19 pneumonia did not show the thymic gland. Further studies carried out prospectively are needed in order to exceed the limitations of this study and to ascertain the relationship between the persistence of the thymic gland as a protective factor against severe forms of COVID-19 pneumonia.

Keywords: COVID-19; Young patients; Thymic gland ; HRCT pattern

Introduction

A novel coronavirus SARS-CoV-2 was detected for the first time in Wuhan in December 2019 [1]. World Health Organization (WHO) decided to call the disease caused by this virus as Coronavirus disease 2019 (COVID-19) [2]. COVID-19 mostly affects the respiratory system, manifesting with varied clinical pictures ranging from mild upper respiratory tract illness to severe pneumonia with Respiratory Distress Syndrome (ARDS) and death [3]. The virus spreads through droplets and contact with an incubation period between 7-14 days [4]. In accordance to the Centers for Disease Control and Prevention (CDC) assay protocol, the gold standard to diagnose SARS-CoV-2 infection is next-generation sequencing or real-time Reverse Transcription Polymerase Chain Reaction (RT-PCR), methods applied to a respiratory tract sample [5].

Adults and the elderly with comorbidities such as cardiovascular disease, diabetes, chronic obstructive pulmonary disease, asthma, hypertension, or cancer, show more severe signs of the disease and a higher mortality rate than younger subjects without comorbidities. We want to focus our attention on young patients trying to correlate if their symptoms are related to radiological signs [6].

Between January 1st and February 28th, 2021, 7 consecutive patients ranging from 26 to 41 years old (mean age: 33 years old) were admitted to our hospital with a diagnosis of COVID disease confirmed by a positive RT-PCR swab test. They underwent a High Resolution Computed Tomography (HRCT) examination within 3 days after hospitalization due to their clinical condition. Two patients, based on their symptoms and first HRCT report, required some further CT scans. The first one had two follow-up CT examinations 7 and 14 days after initial CT while the second one underwent a follow-up CT scan 9 days from admission CT.

Clinical score: Quick COVID-19 severity index

Quick COVID-19 severity index (qCSI) is a score used to grade the clinical condition's severity of patients affected by COVID-19 at their admission, based on the respiratory rate, the oxygen saturation, and the oxygen flow rate [7]. This score represents a prognostic tool of early hospital respiratory failure among Emergency Department (ED) patients (Table 1).

Radiological score: CT severity index score

CT Severity Index Score is a semi-quantitative scoring system to estimate the pulmonary involvement including Ground-Glass Opacities–GGO, consolidations, stripes and bands, crazy paving pattern, halo sign [8]. A radiologist with 25 years of experience

Table 1: Quick COVID-19 severity index (qCSI).

Respiratory rate	Points	Pulse oximetry (lowest value recorded during the first four hours of the patient encounter)	Points	O_2 flow rate (L/min)	Points
<22 breaths/ min	0	>92%	0	≤ 2	0
23-28 breaths/min	1	89-92%	2	4-Mar	4
>28 breaths/ min	2	≤ 88%	5	6-May	5

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Table 2: CT Severity Index Score.

CT Severity Index Score points for each lobe	Rate of lobe involvement
0	0%
1	0-5 %
2	5-25 %
3	25-50 %
4	50-75 %
5	75-100 %

Table 3: Case 1.

Points	On admission
qCSI	0
CT severity score	0
Thymic gland	Yes

Figure 1: A regular lung pattern is shown at CT. A thymic gland in the anterior mediastinum is seen.

reviewed chest CT scans of each patient at their admission to assign a CT Severity Score (Table 2).

Thymus: role and imaging on CT

Thymus is the primary site of T-cell development capable of generating self-tolerant, self major histocompatibility complex-restricted, immunocompetent T cells [9]. It increases in size until puberty when it may weigh approximately 25–30 g, after which time it is not required and so atrophies with age. This loss of functional status is often accompanied by the deposition of large amounts of fat, followed by a reduction of the immune response with age [10]. An analysis of the top five causes of death in the population over 65 years of age, shows that immune insufficiency may be overtly associated with infectious diseases [11]. On CT, thymus appear as a bilobed triangular structure located in the anterior mediastinum, anterior to the proximal ascending aorta, the pulmonary outflow tract and the distal superior vena cava before it enters the right atrium [12].

Case Series

Case 1

Male, 35 y.o., caucasian, with persistent fever > 38.5°C, dry cough but no other significant symptoms. Respiratory rate (0 pt); Pulse oximetry (0 pt); O_2 flow rate L/min (0 pt);

qCSI=0 pt. He underwent an HRCT examination, 2 days after his admission, with a CT severity index score=0 (Figure 1). Thymic gland was found (Table 3).

Case 2

Female, 28 y.o, caucasian, with fever > 38°C, dry cough, mild dyspnea.

Respiratory rate (1 pt); Pulse oximetry (0 pt); O_2 flow rate L/min (0 pt); qCSI=1 pt.

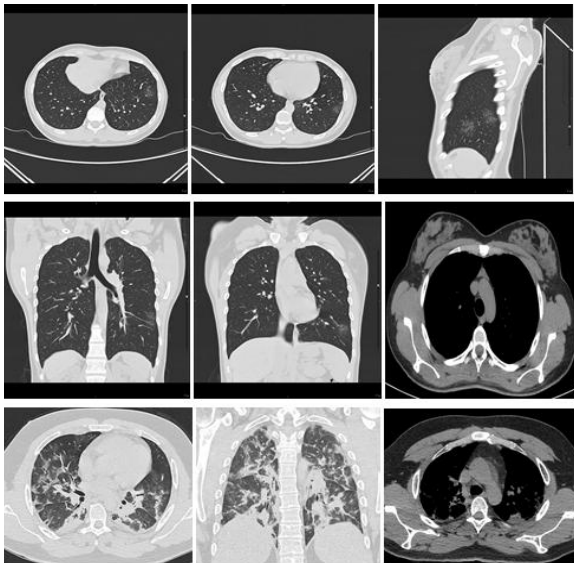

Figure 2: CT scan shows two rounded lobular ground glass opacity (GGO) affecting less than 5% of the entire left lower lobe. A thymic gland is seen in the anterior mediastinum.

Table 4: Case 2.

Points	On admission
qCSI	1
CT severity score	1
Thymic gland	Yes

She performed an HRCT examination, 3 days after her admission at our hospital, with a CT severity index score=1 (Figure 2). Thymic gland was found (Table 4).

Case 3

Male, 31 y.o., caucasian, presenting with fever, moderate dyspnea and hypoxemia.

Respiratory rate (1 pt); Pulse oximetry (2 pt); O_2 flow rate L/min (0 pt); qCSI= 3 pt.

He had two HRCT examsinations, on the day of admission and after 9 days. At the first exam CT severity index score was 21, whereas in the follow-up CT after 9 days CT severity index score was 11 (Figure 3). Absence of thymic gland (Table 5).

Case 4

Male, 26 y.o, caucasian, with fever, severe dyspnea and significant hypoxemia treated with O_2 therapy. Respiratory rate (1 pt); Pulse oximetry (5 pt); O_2 flow rate L/min (4 pt);

qCSI= 10 pt.

He had three HRCT examinations, on admission, and after 7 and 14 days from initial CT. The examination on admission showed a CT severity index score=15, whereas in both the second and the third examinations CT severity index score was 14 (Figure 4). Absence of thymic gland (Table 6).

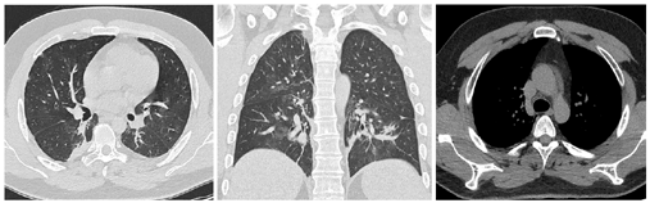

Figure 3: CT on admission: multiple, bilateral, patchy and confluent GGO with thickened septea and "crazy paving" pattern in association with segmentary consolidations in lower lobes. Follow-up CT examinations, 9 days later shows significant reduction in extension and density of GGO and consolidation areas too. Note the absence of thymic gland.

Table 5: Case 3.

Points	On admission	After 9 days
qCSI	3	
CT severity score	21	11
Thymic gland	No	

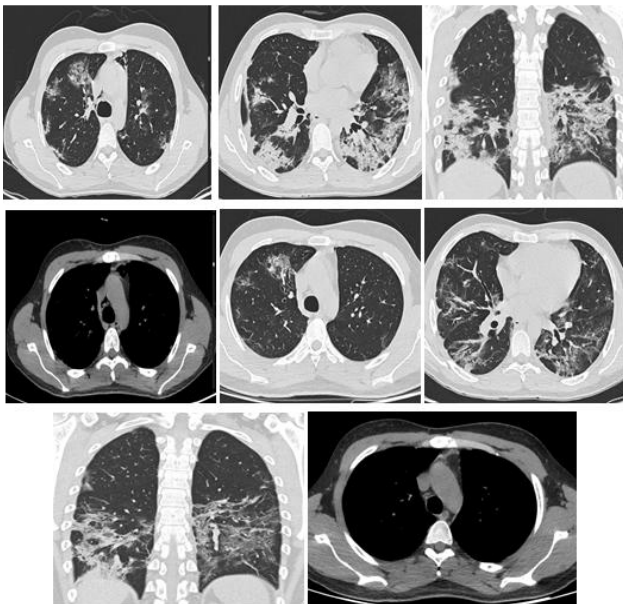

Figure 4: CT on admission: multiple, bilateral, partially confluent consolidations especially in lower lobes, associated with lobular GGO, "crazy paving" pattern and pneumomediastinum. Follow- up CT at 7 days: no significant consolidations in left lower lobe replaced by fibrotic streaks and bands. Mild reduction in extension of consolidations in right lower lobe. No more pneumomediastinum.
Follow-up CT at 14 days: more fibrotic streaks and bands than consolidation areas but no changes in extension of affected parenchyma. New pneumomediastinum along the left main bronchus.
Note the absence of thymic gland.

Case 5

Female, 34 y.o, caucasian, with mild but persistent fever.

Respiratory rate (1 pt); Pulse oximetry (0 pt); O_2 flow rate L/min (0 pt); qCSI = 1 pt

She had an HRCT exam, showing no significant radiological pattern of COVID-19 disease (CT severity index score=0) (Figure 5). Thymic gland was found (Table 7).

Table 6: Case 4.

Points	On admission	After 7 days	After 14 days
qCSI	0		
CT severity score	15	14	14
Thymic gland	No		

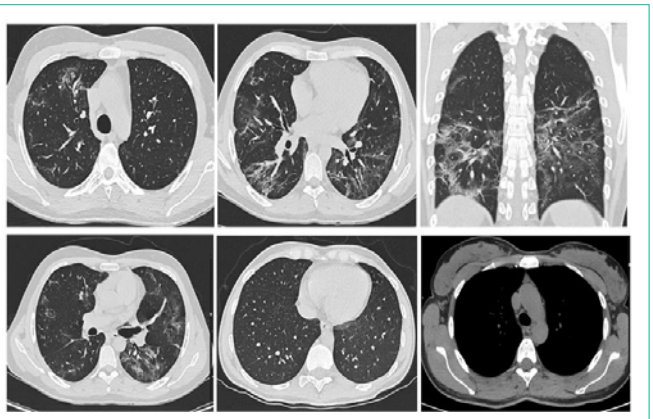

Figure 5: CT scan, showing a regular lung pattern.
Thymic gland is revealed in the anterior mediastinum.

Table 7: Case 5.

Points	On admission
qCSI	1
CT severity score	0
Thymic gland	Yes

Case 6

Female, 37 y.o, caucasian, with mild but persistent fever, no other significant symptoms.

Respiratory rate (0 pt); Pulse oximetry (0 pt); O_2 flow rate L/min (0 pt); qCSI = 0 pt.

She had an HRCT exam with a CT severity index score= 0 (Figure 6). Thymic gland was revealed (Table 8).

Case 7

Female, 41 y.o, caucasian, with moderate (38°C) fever persistent for 3 days.

Respiratory rate (0 pt); Pulse oximery (0 pt); O_2 flow rate L/min (0 pt); qCSI = 0 pt

She performed an HRCT exam, showing CT severity index score of 3 (Figure 7). Thymic gland was found (Table 9).

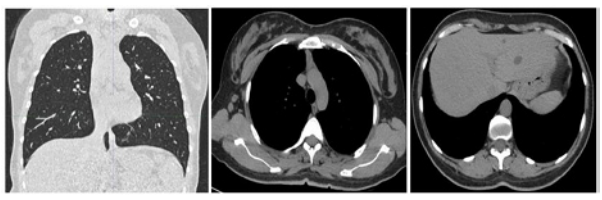

Figure 6: Some stripes are shown at the left lung base.
Thymic gland is seen in the anterior mediastinum.

Table 8: Case 6.

Points	On admission
qCSI	0
CT severity score	0
Thymic gland	Yes

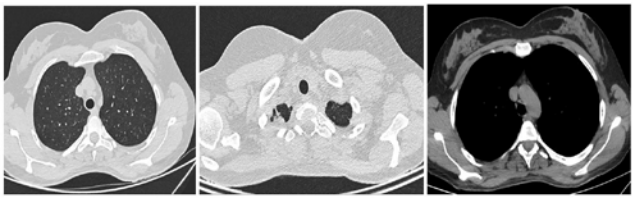

Figure 7: CT exam shows lobular ground glass opacities, especially localized in both upper lobes; fibrotic stripes and bands at both lung apex and lung bases. A tiny thymic gland is seen in anterior mediastinum.

Table 9: Case 7.

Points	On admission
qCSI	0
CT severity score	3
Thymic gland	Yes

Discussion

COVID-19 pneumonia is a new highly contagious viral pneumonia spread all over the world, caused by a novel coronavirus (SARS-CoV-2) of still unclear origin. The adults may be more susceptible to the disease, due to pre-existing conditions including hypertension, diabetes, heart disease and smoking, which could weaken their ability to ward off infections but immunosenescence could play an important role in the severity of this disease. Immune system aging is characterized by the paradox of immunosenescence (insufficiency) and inflammation (over-reaction), which incorporate two sides of the same coin, resulting in immune disorder.

Immunosenescence refers to disruption in the structural architecture of immune organs and dysfunction in immune responses, resulting from both aged innate and adaptive immunity. Age-related adaptive immune system deviations, particularly altered T-cell function, are derived from age-related thymic atrophy or involution, a hallmark of thymic aging [13]. This could be the explanation why older subjects or otherwise with atrophy of the thymic gland may show more severe signs of Sars-CoV-2 disease, and, moreover, as in the cases presented, young subjects still showing thymus in CT, have a milder symptomatology and a pulmonary CT pattern of COVID-19.

In our preliminary experience, patients who had the thymic gland showed a mild or negative clinical and radiological picture of COVID-19 pneumonia. Differently, we observed that the two patients who experienced severe COVID-19 pneumonia did not show the thymic gland. Of course, prospective and multicentric studies with a larger series are needed in order to ascertain the relationship between the presence of a thymic gland playing a potential role of protective factor and the severity of COVID-19 pneumonia. We understand that pathophysiology of COVID-19 is likely to rely on unraveling of interplaying mechanisms, including SARS-CoV-2 virulence, human immune response, and complex inflammatory reactions with coagulation playing a major role.

In conclusion, although COVID-19 pneumonia is considered a dangerous illness for the adults and the elderly, especially in those with comorbidities, focus on young patients is mandatory. Whereas radiological findings are similar to the pulmonary patterns revealed in the adults and the elderly patients, the persistence of a thymic gland might be related to patients presenting with a more favourable clinical and radiological pattern of COVID-19 infection [14].

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