The Value of Extended Chest Computed Tomography Scan to the Neck in Adult Corona Virus Disease-19 Patients

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ABSTRACT:

BACKGROUND:
The coronavirus disease (COVID-19) pandemic has resulted in an unexpected high number of hospitalizations for pneumonia with multiorgan illness. It may be asymptomatic or may cause a wide range of symptoms. COVID-19 may cause inflammation in the larynx, trachea, bronchi, beside the lungs. In the diagnosis of COVID-19 patients, computed tomography (CT) with polymerase chain reaction tests has been reported to have a high sensitivity.

OBJECTIVE:
The study aimed to investigate the value of extended chest CT scan to the neck in adult COVID-19 patients.

PATIENTS AND METHODS:
This was a cross-sectional study including 120 patients who were admitted and treated at Al-Imamian Al-Kadhimiyain Medical City, Baghdad, Iraq, during the period from 1st April to 1st December 2021 due to signs and symptoms indicating for COVID-19 infection. Data was collected from patients or their relatives through direct interview and fulfilling prepared questionnaire. According to total severity score, the severity of COVID-19 disease in the chest was graded, also complete neck assessment was done especially lymph nodes (LNs), trachea and vocal cords by extended chest CT to the neck.

RESULTS:
There were two extended chest CT features differed significantly in COVID-19 patients from non-COVID-19 patients: higher number of thickened vocal cords and presence of cervical pathological lymph nodes (level II) in COVID 19 patients in compare to non-COVID -19 patients, also in comparison to mild and moderate cases, severe patients have three distinct characteristics. The mean internal tracheal diameter in severe cases was lower than either moderate or mild cases, the frequency of pathologic lymph nodes (level II) in severe was higher and all pathological cervical lymph nodes in severe cases were in right side and in comparison to mild or moderate cases there was a highly significant differences.

CONCLUSION:
 The most important findings in extended chest CT scan to the neck in adult COVID-19 patients are frequent vocal cord thickening and pathological lymph nodes of level II. These findings mostly associated with severe COVID-19 cases in addition to unilateral involvement of neck lymph nodes.

KEYWORDS: Corona virus infection (COVID-19), Chest Computed tomography imaging, Cervical lymph nodes; Lymphadenopathy.

INTRODUCTION:
COVID-19 initially appeared in Wuhan, China during December 2019 (1), The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19 infection and it can be asymptomatic or cause a wide range of symptoms, including minor upper respiratory tract infection symptoms to life-threatening sepsis [2], COVID-19 may cause inflammation in the larynx, trachea, bronchi, beside the lungs, and COVID-19 associated laryngotracheitis can be seen [3], Symptoms of the otolarynx were less common than respiratory symptoms. The most prevalent one was sore throat [4], Vocal complaints associated with respiratory complaints have been observed [5]. The sensitivity of non-contrast computed tomography (CT) in diagnosing patients infected by SARS-CoV-2 has been reported [6]. On CT imaging, normal lymph nodes are easily visible, and while evaluating nodal disease, various factors should be considered [7].

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PATIENTS AND METHODS:

This was a cross-sectional study including 120 patients who were admitted and treated at Al-Imamian Al-Kadhimiyain Medical City during the period from 1st April to 1st December 2021 due to signs and symptoms indicating for COVID-19 infection. COVID-19 patients were diagnosed based on computed tomography (CT) scan and positive (RT-PCR) results.

- **Inclusion Criteria**
  - ➢ All adult symptomatic patients suspected to have SARS-CoV-2 infection regardless PCR result.
- **Exclusion Criteria**
  - ➢ Pregnancy, Malignancy, Age <18 years and patients with known organs failure or immunocompromised prior to admission.

Data Collection

- ➢ Patient's demographics (age, gender, smoking status, and body mass index), comorbidities and chief complaints were collected through direct interview.
- ➢ CT-scan features of COVID-19 patients with complete neck evaluation, including lymph nodes, trachea and vocal cord.
- ➢ Severity score of CT scan of COVID-19 patients: Number of focal abnormalities, maximum diameter and total severity score divided cases into mild (0-50%), moderate (50-75%) and severe (75-100%) according to Li et al. 2020 method (8).
- ➢ Radiological parameters were: standardized normal vocal cord thickness was 3-5mm (9) measured in transverse plane at midpart of the cord. Men's tracheas have a transverse internal diameter of 15-25mm, whereas women's tracheas have a diameter of 10-21mm (10). Narrowest measurement then taken at three levels (subglottic, thoracic inlet and above carina levels). The lymph node's short axis diameter is measured perpendicular to the longest diameter, if the short-axis diameter in axial plane of level I or II lymph nodes exceed 11 mm, retropharyngeal nodes exceed 5 mm, and other cervical nodes exceed 10 mm, the nodes were deemed pathological (11).

CT scan Protocol

Chest CT extend to the neck imaging was performed using a 64 – detector multislice helical CT scanner (SOMATOM Definition AS, Siemens, Germany), Patients were placed in a supine position and subjected to a thorough examination. After that, Multiplanes CT images were taken without contrast media injection during a single inspiratory breath – hold. From the costophrenic angle to the base of the skull, the scan was performed. CT scan parameters were as follows: X- ray tube parameters 100-120 KV, Automatic modulator ranging from 45-550 mAs depend on body mass index of the patient, Slice thickness of 0.5 mm, Rotation time 0.5 sec.; Pitch factor 1.2, Scanning length approximately (430) mm, exposure range (410) mm and exposure time (9.2) sec.

Statistical Analysis

➢ The mean and standard deviation of continuous variables with a normal distribution are shown. Categorical variables are represented by percentages. Continuous variables (in three groups) were compared using the Student t-test (in two groups) and analysis of variance (ANOVA). The Chi square test was used to make comparisons between categorical variables. All of the data was examined using SPSS for Windows, v.25.0; the data was statistically analyzed using IBM Corp, Armonk, New York, USA.

RESULTS:

Demographic Characteristics of the Patients:

This study included a total of 84 patients with COVID-19 (+ve PCR) and 36 patients suffering from non-specific chest pain or mild signs and symptoms of upper respiratory tract infection with (-ve PCR). The mean age of the patients was 51.02 ± 17.22 years which was similar to that of controls (51.1 ± 15.24 years) with no significant difference. Similarly, there were no significant differences between the two groups in term of gender distribution and smoking habits. Although COVID-19 patients had higher BMI than controls (25.54 ± 3.78 kg/m^2 vs. 24.34 ± 3.94 kg/m^2), the difference was not significant (Table 1).

Table 1: Demographic characteristics of the patients.

Variables	Controls (n=36)	Patients (n=84)	p-value
Age, years Mean± SD Range	51.1± 15.24 27.0-89.0	51.02±17.22 18-93	0.992
Gender Male Female	14(38.89%)%) 22(61.11%)	36(42.86%) 48(57.14%)	0.686
Smoking Never Ex/current	29(80.56%) 7(19.44%)	71(84.52%) 13(15.48%)	0.593
Body mass index, kg/m^2 Mean± SD Range	24.34±3.94 18-32	25.54±3.78 18-40	0.138

Clinical and imaging Characteristics of the Patients

Comorbidities, in general, were less common in controls than patients (70.24% vs. 55.56%) with non-significant difference. In particular, DM was more common among patients (45.23%) compared with controls (27.78%). However, the difference was not significant. The mean diameter of trachea in patients was 1.43±0.22 cm which was slightly lower than that of controls (1.49±0.2 cm) with no significant difference. The mean vocal cord thickness in patients was (7.07±1.58) which was higher than that in controls (6.43±2.0 mm) although the difference was not significant. However, the vast majority of patients (89.29%) had increased vocal cord thickening compared with 75% of controls with a significant difference. There was more enlarged cervical lymph nodes involvement in controls than patients (24, 66.67% vs. 44, 52.38%) with no significant difference. These LNs included level II (20 LNs in controls and 38 LNs in patients) and level III (4 LNs in controls and 6 LNs in patients). The mean short axis of level II LN in patients was 9.58±2.28 mm with 8 LNs (21.05%) were pathologic compared with 8.66±2.0 mm with no LNs (0%) was pathologic in control groups. Statistically, there was a significant difference between the two groups in the number of pathologic level II LNs. The affected sides of node were comparable between the two groups with no significant difference. The mean short axis of level III LN was identical in the two levels (7.1 mm) all of them were non-pathologic (table 2).

Table 2: Clinical and imaging Characteristics of the Patients.

Variables	Controls (n=36)	Patients (n=84)	p-value
Comorbidities			
No	16(44.44%)	25(29.76%)	0.120
HTN	11(30.56%)	35(41.67%)	0.251
DM	10(27.78%)	38(45.23%)	0.074
IHD	1(2.78%)	7(8.33%)	0.472
Trachea diameter, cm			
Mean± SD	1.49±0.2	1.43±0.22	0.134
Range	1.1-1.9	1.0-1.9	
Vocal cord thickness, mm			
Mean± SD	6.43±2.0	7.07±1.58	0.062
Range	1.18-9.6	3.9-10.9	
Normal	9(25%)	9(10.71%)	0.045
Increased	27(75%)	75(89.29%)	
Enlarged lymph nodes			
No	12(33.33%)	40(47.62%)	0.148
Yes	24(66.67%)	44(52.38%)	
Level II LN short axis, mm			
Mean± SD	8.66±2.0	9.58±2.28	0.132
Range	4.5-11.0	6.2-14.0	
Pathological LN			
No	20(100%)	30(78.95%)	0.027
Yes	0(0%)	8(21.05%)	
Side			
Right	6(30%)	14(36.84%)	
Left	9(45%)	14(36.84%)	0.816
Bilateral	5(25%)	10(26.32%)	
Level III LN short axis, mm			
Mean± SD	7.1±2.42	7.1±1.73	0.992
Range	5.0-9.2	5.6-8.6	
Side Right	1(25%)	4(66.67%)	0.197
Left	3(75%)	2(33.33%)	

COVIDS Severity

COVID-19 severity was categorized according to the involvement of the lung based on total severity score of CT scan findings. Mild disease was reported in 41 of the patients (48.81%). Moderate disease in 29 patients (34.52%) and severe disease was found in 14 patients (16.67%).

Association of Demographic Characteristics with the Disease Severity

COVID-19 patients with severe disease had a non-significantly greater mean age (53.85±18.79 years) than those with moderate (51.72±13.3 years) or mild illness (49.56±19.27 years). The three groups had almost identical BMI with no significant differences. Furthermore, there were no significant differences in gender distribution or smoking patterns across the three groups. (Table 3).

Table 3: Association of Demographic Characteristics with the Disease Severity.

Variables	Mild (n=41)	Moderate (n=29)	Severe (n=14)	p-value
Age, years Mean± SD Range	49.56±19.27 18-93	51.72±13.3 22-67	53.85±18.79 18-71	0.702
Gender Male Female	16(39.02%) 25(60.98)	14(48.28%) 15(51.72%)	6(42.86%) 8(57.14%)	0.743
Smoking Never Ex/current	35(85.37%) 6(14.63%)	23(79.31%) 6(20.69%)	13(92.86%) 1(7.14%)	0.505
BMI, kg/m^2 Mean± SD Range	25.63±3.15 19-35	25.46±4.43 18-40	25.46±4.27 20-33	0.981

Association of Clinical and Imaging Characteristics with the Disease Severity

Comorbidity-free disease was documented in 73,71% of mild cases and 55.17% of moderate cases, much higher than in severe case (7.14%) with a significant difference. However, there was no particular disease had significant association with COVID-19 severity.

The mean internal tracheal diameter in severe cases was 1.27±0.17 cm which was significantly lower than either moderate (1.5±0.2 cm) or mild cases (1.43±0.22 cm).

Patients with moderate and severe COVID-19 had higher vocal cord thickness (7.1±1.35 mm and 7.84±1.7 mm, respectively) than patients with mild disease (6.79±1.65 mm) with significant differences. Of note, all patients with severe illness had increased vocal cord thickness compared with 89.66% of moderate cases and 85.36% of mild cases. However, the differences were not significant.

The frequency of pathologic level II LNs in severe cases 66.67% which was higher than that of moderate (14.29%) or mild cases (11.11%) with significant differences. However, all level II LNs in severe cases were in right side compared with 28.575% in moderate cases and 22.22% in mild cases with a highly significant differences (Table 4).

Table 4: Association of Clinical Characteristics with the Disease Severity.

| Variables	Mild (n=41)	Moderate (n=29)	Severe (n=14)	p-value
Comorbidities				
No	30(73.17%)	16(55.17%)	1(7.14%)	0.034
HTN	12(29.27%)	12(41.38%)	7(50%)	0.774
DM	23(56.1%)	9(31.03%)	6(42.86%)	0.114
IHD	2(4.88%)	4(13.79%)	1(7.14%)	0.407
Trachea diameter, cm				
Mean± SD	1.43 ± 0.22^a	1.5 ± 0.2^a	1.27 ± 0.17^b	0.004
Range	1.0-1.9	1.2-1.9	1.0-1.5	
Vocal cord thickness, mm				
Mean± SD	6.79 ± 1.65^a	7.1 ± 1.35^b	7.84 ± 1.7^b	0.099
Range	3.9-10.9	4.3-9.6	6.1-10.9	
Normal	6(14.63%)	3(10.34%)	0(0%)	0.310
Increased	35(85.36%)	26(89.66%)	14(100%)	
Enlarged lymph nodes				
No	18(43.9%	14(48.28%)	8(57.14%)	0.690
Yes	23(56.1%)	15(51.72%)	6(42.86%)	
Level II LN short axis, mm				
Mean± SD	9.5±2.44	9.65±2.63	10.07±0.48	0.877
Range	6.2-14	6.2-13	9.7-13	
Pathological LN				
No	16(88.89%)	12(85.71%)	2(33.33%)	0.011
Yes	2(11.11%)	2(14.29%)	4(66.67%)	
Side				
Right	4(22.22%)	4(28.57%)	6(100%)	<0.001
Left	4(22.22%)	10(71.43%)	0(0%)	
Bilateral	10(55.56%)	0(0%)	0(0%)	
Level III LN short axis, mm				
Mean± SD	7.6±1.73	5.6±0.0	----------	0.423
Range	5.6-8.6	5.6-5.6		
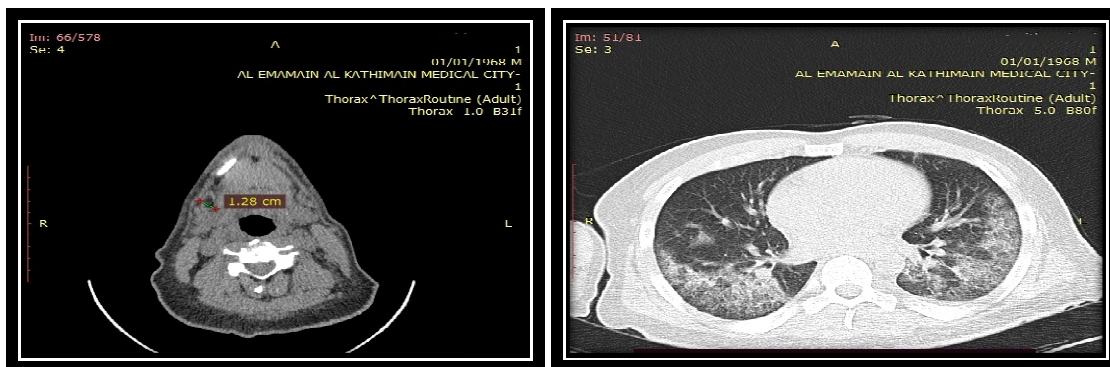
Figure 1: Axial image of non-enhanced chest Ct scan extended to the neck of 53 years old COVID 19 patient shows bilateral sub pleural ground glass opacities (moderate case) in lung window with right side pathological neck lymph node at level II with a short axis (12.8) mm (Adapted from Kadhimiya Teaching Hospital).
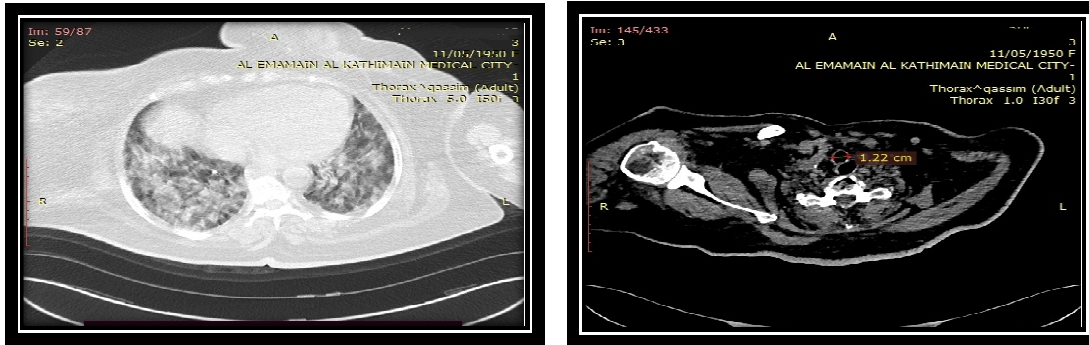
Figure 2: Axial image of non-enhanced chest Ct scan extended to the neck of 71 years old COVID 19 patient shows diffuse bilateral ground glass opacities (severe case) in lung window with narrowing of internal tracheal diameter (1.2) cm at thoracic inlet level (Adapted from Kadhimiya Teaching Hospital).
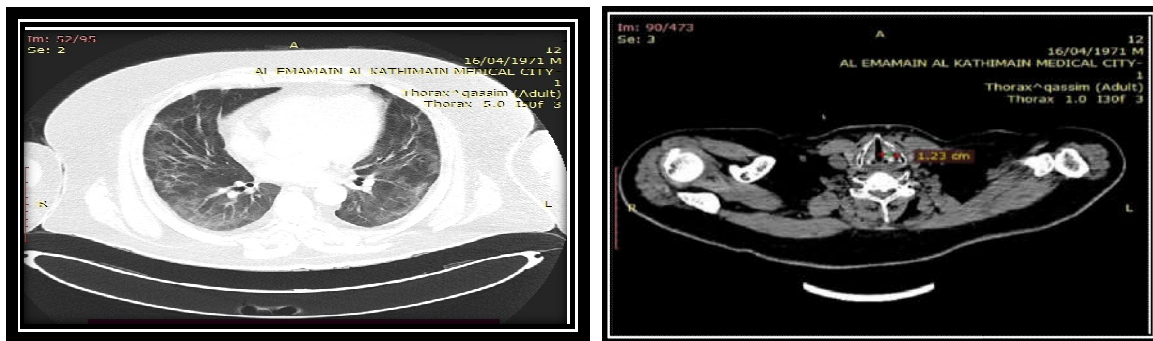

Figure 3: Axial image of non-enhanced chest Ct scan extended to the neck of 50 years old COVID 19 patient (+ve PCR) shows bilateral diffuse ground glass opacities (severe case) in lung window with marked thickening of the vocal cord (12) mm (Adapted from Kadhimiya Teaching Hospital).

DISCUSSION:

According to the results of the study, two extended chest CT features differed significantly in COVID-19 patients from non-COVID-19 patients and in severe cases compared to the mild and moderate cases: these were higher number of thickened vocal cord and the presence of more pathological lymph nodes. These findings are consistent with results of many studies addressing this issue despite its scarcity.

Impaired vocal fold movement identified in 76% and vocal fold edema were found in 60% of ICU patients infected with COVID-19 (Osbeck Sandblom et al. 2021) [12].

After two months of infection, more than half of the COVID-19 patients experienced dysphonia, the majority of which was mild. (Rouhani et al. 2020) [13].

More severe effects also reported, in a study on 20 patients with post COVID-19 dysphonia, 40% of cases were diagnosed as unilateral vocal cord paralysis (Naunheim et al. 2020) [14].

Significant CT scan characteristic was noted in the present study that most enlarged cervical lymph nodes were located in level II. This finding is near similar to results of Lea et al. (2021) [15] that state the most important affected cervical lymphadenopathy were located in level II which drain pharyngeal structures. They believed that the COVID-19 virus would cause inflammation of the naso- oropharynx and clinically causing sore throat and nasal symptoms.

Other interesting finding in our study especially seen at severe cases, there was a unilateral involvement of the lymph nodes. This is in accordance with study done in North America (Rajasekaran and Krakovitz.2013) [16] which reported that unilateral cervical lymphadenopathy is associated with viral upper respiratory tract infection.

In the present study, severe COVID-19 was associated with reduced internal diameter of trachea compared with mild and moderate cases. This is in accordance with the study of Ünlü et al. (2021) [17] which indicated that tracheal stenosis is associated with severe disease and poor prognosis.

Limitations:

The CT findings in other extra-pulmonary tissues and organs such as auditory canals and nasal passages were not possible to be recognized, also the difficulties in examining of patients mouth (for ulcer or abscess) and teeth (for dental caries) that may involve cervical lymph nodes, beside to confirmed patients with COVID-19 were not followed up after hospital discharge, lastly no biopsy was performed for enlarged lymph nodes, through which the real causative pathogen could be detected.

CONCLUSION:

The most important findings in extended chest CT scan to the neck in adult COVID-19 patients are frequent vocal cord thickening and pathological lymph nodes of level II. These findings mostly associated with severe COVID-19 cases in addition to unilateral involvement of neck lymph nodes.

Recommendations:

Vocal cord manifestations and pathological lymph nodes obtained by CT scan should be considered in treatment of patients with COVID-19, especially severe cases. Also if there are positive neck findings in COVID -19 patient, further study is recommended like ultrasonography (US) or magnetic resonance imaging (MRI).

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