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Optimum Threshold Estimation of Thorax CT Scan for COVID-19 Diagnosis in a Single Center in Cameroon

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Abstract

Objective: To evaluate the lung CT scan as a possible predictive diagnostic method for COVID-19 in the Cameroonian context. Methods: We designed a cross sectional study. Suspected cases of COVID-19 during the first wave at the national social insurance fund (NSIF) hospital were screened with both COVID-19 with lung CT scan and a PCR test. Univariate analysis was performed for sample description and multivariate analysis to assess the correlation between positive results for the PCR and other parameters. We estimated the optimum threshold of sensitivity/specificity, and area under curve using the empirical method and package. Results: A total of 62 suspected COVID-19 cases were recorded, predominantly males (Sex Ratio = 2.2) with a median age of 58.5 (IQR = 19.7). Among our 62 patients, 29 (46.8%) were confirmed COVID-19 cases with positive PCR results. All the patients had a thorax CT scan with a median impairment of 40% (IQR = 20%). The optimum threshold estimate for CT scan for COVID-19 infection diagnosis was 60% (95% CI = 25% - 80%). Overall, the sensitivity and specificity estimates were 0.30 (95% CI = 0.15 - 0.49) and 0.87 (95% CI = 0.70 - 0.96), respectively, leading to an Area Under Curve (AUC) estimate of 0.59 (95% CI = 0.46, 0.71). Conclusion: In this setting, lung CT scan was neither sensitive nor specific to predict COVID-19 disease.

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#First author: Anne Esther Njom Nlend and Landry Bonyomo are both first author for this paper.

Keywords

COVID-19, CT Scan, Lung, Diagnosis

1. Introduction

In December 2019 in Wuhan-China patient 0 was diagnosed with what will become a worldwide deadly pandemic, starting the third corona virus pandemic, the most extensive and deadliest thus far [1]. To date, almost 6 million deaths have been recorded at globally for over 400 million of cases reported [2]. COVID-19 is a disease caused by SARS (Severe Acute Respiratory Syndrome) COV 2. It is a respiratory RNA [3] [4] virus transmitted in humans through saliva droplets. Its pathogenesis is associated with respiratory tropism [4] [5] [6] which is responsible for, among other things, serious broncho-alveolar lesions resulting in an overall lethality less than 2% [2].

Even though Sub Saharan Africa remained least affected, most African countries had registered multiple cases such as Tunisia, which is the most affected African country. These countries organized the fight against this disease and are currently administering COVID-19 vaccines. In Cameroon more than one million doses have been administered with a dose administration rate of 6856 per 100,000 [2] which means only 7.8% of the target [7]. However, the pandemic is still ongoing with various mortality rates depending on the country [2]. With emerging variants, it is quite important to describe the clinical features of the acute infection within the different waves, and the process and reliability of diagnosis, characteristics of the disease, comorbidities and aged-related risks. More importantly, a description of the clinical manifestations of the disease in the lungs.

In Cameroon, the first case was diagnosed on 6th March 2020 [8]. The health system's response was organized around management confirmed cases in designated COVID-19 treatment centers (CTC), while other hospitals dealt with suspected cases with timely reference to CTC when the diagnosis was confirmed. Majority of health facilities followed a management algorithm based on: first, the clinical assessment of the patient to determine if the patient profile fit a suspected case, second, the diagnosis had to be confirmed by PCR/Rapid diagnostic tests. The confirmed cases were then classified according to the severity. The initial paraclinical tests required only a chest X-ray, and did not include Computerized Tomography (CT) scans even in patients with severe symptoms [9]. Considering the low testing capacity at the early stage of the outbreak and the interest of the scientific community for CT scan as an alternative, we designed this study to assess the correlation between abnormalities of the lung detected by CT scan and its reliability in detecting and confirming active COVID-19 infection.

2. Materials and Methods

2.1. Study Setting and Design

We conducted our study at the National Social Insurance Fund (NSIF) hospital in Yaoundé located in Essos (Essos Hospital Centre). It is a tertiary health facility. Although it was not designated as a COVID-19 treatment center, we came across suspected cases, from which we conducted a cross sectional study for patients admitted in the ICU or the medical ward during the first wave of COVID-19.

2.2. Study Participants

We included patients who were screened with a COVID-19 checklist to evaluate the degree of exposure [10] through the different entry points. Patients admitted to the hospital with signs suspecting COVID-19 disease were transferred to the dedicated sector. All patients benefited from both a biological assessment by PCR test for the diagnosis of COVID-19 and a chest CT scan to assess lung damage. These images were interpreted by a radiologist and classified according to COVID-19 reporting Data System (CORADS) classification [11].

2.3. Procedures and Treatment

The therapeutic management of suspected patients with COVID-19 was anticipated in accordance with the guidelines developed by the Ministry of public Health [9] and by the public health emergency council [12].

2.4. Data Collection in Analysis

Data were sourced from Essos Hospital Center's files and imported to R software version 4.0.2 for data analysis. Univariate analysis was performed for sample description and multivariate analysis to assess the correlation between positive results for the PCR and other parameters. The R package "ThresholdROC" was especially useful for estimation of the optimum threshold, and the empirical method was used. Results were displayed in tables and figures.

3. Results

3.1. Patients' Characteristics

During the study period 62 suspected COVID-19 cases were recorded, predominantly males (sex ratio = 2.2) with a median age of 58.5 (IQR = 19.7). Among our 62 patients, 29 (46.8%) were confirmed as COVID cases with positive PCR. All the patients had a thorax CT scan with a median impairment of 40% (IQR = 20%) (**Table 1**).

3.2. Reason for Consultation

The patients screened for this study came to the hospital for the following reasons: fatigue (n = 25) routine consultation (n = 23) which made a draw with dyspnea (n = 23) followed by cough (n = 10) and last fever (n = 9).

3.3. Impairment

In our series, most patients (96.87% n = 62) presented similar fibrotic and ground glass lesion their extent ranged from 0% to 87% with a median of 40% (**IQR** = 25 - 50). We noticed a case with positive PCR 0% impairment.

3.4. PCR Outcome

PCR outcome was considered the gold standard in the diagnosis of COVID-19 infection. Three parameters were analyzed including age, sex and the CT scan findings. Among this only age was associated with positive PCR outcome (P value: 0.045) (Table 2).

3.5. CT Scan & Threshold

The optimum threshold estimate of CT scan for COVID-19 infection diagnosis was 60% (95% CI = 25% - 80%). With this threshold, the matrix confusion and performances of this threshold were summarized in the Table 3 and Table 4.

Overall, the sensitivity and specificity estimates were 0.30 (95% CI = 0.15 - 0.49) and 0.87 (95% CI = 0.70 - 0.96), respectively, leading to an Area Under Curve (AUC) estimate of 0.59 (95% CI = 0.46, 0.71) (Figure 1 and Figure 2).

Table 1. Univariable description of sample (Socio-demographic, PCR and Thorax CT scan outcome).

	n	%
Sexe		
Female	19	30.6
Male	43	69.4
PCR Result		
Negatif	33	53.2
Positif	29	46.8
Age		
Min = 7, Max = 87		
Median = 58.5, IQR = 19.7		
Thorax CT scan		
Min = 10%, Max = 87%		
Median = 40, IQR = 20%		

Table 2. Characteristics distribution of the sample by the PCR outcome.

Label	Levels	Negative 33 (53.2)	Positive 29 (46.8)	p
Age	Median (IQR)	53.0 (22.0)	61.0 (14.0)	0.045
Gender	F	12 (36.4)	7 (24.1)	0.444
	M	21 (63.6)	22 (75.9)	
Thorax CT scan	Median (IQR)	30.0 (15.0)	40.0 (40.0)	0.170

Table 3. Confusion matrix for PCR diagnosis vs TDM-thorax.

TDM-thorax outcomes	PCR outcomes		
	Negative	Positive	Total
Negative (TDM-thorax < 60)	27	21	48
Positive (TDM-thorax ≥ 60)	9	4	13
Total	36	25	61

Table 4. Performance assessment of TDM-thorax for COVID-19 detection.

Metrics	Estimate (95% CI)
Sensitivity	0.30 (0.15, 0.49)
Specificity	0.87 (0.70, 0.96)
Positive predictive value	0.69 (0.39, 0.91)
Negative predictive value	0.56 (0.41, 0.71)
Accuracy (AUC)	0.59 (0.46, 0.71)

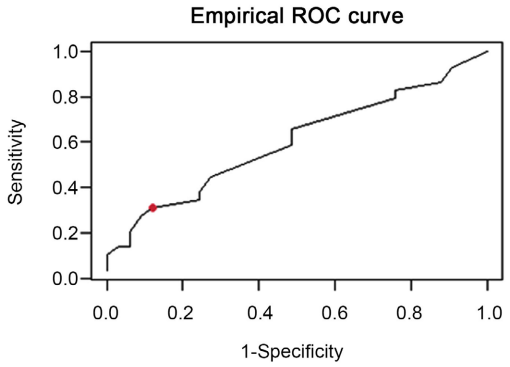

Figure 1. Empirical ROC curve.

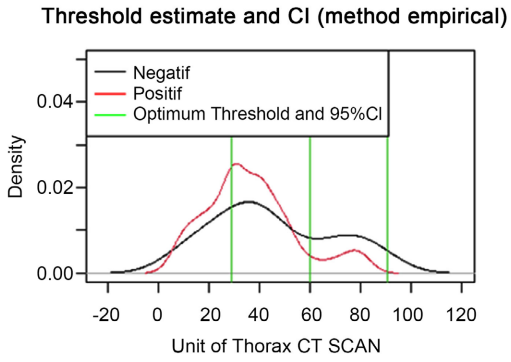

Figure 2. Estimates of the probability density functions for positive and negative cases of COVID-19 from PCR test, respectively. Also the threshold estimate and its 95% confidence interval are depicted.

4. Discussion

This work primarily aimed to assess the predictive value of lung CT scan for the

diagnosis of COVID-19 disease. The main resulting observations on the study population are similar to previous data on male predominance amongst COVID infected patients [13] [14]. Most patients came to the hospital for symptoms found in the top 3 of a study in France [15]. However, our observations differ from the one observed in Cameroon [14]. Possibly, due the differences of the samples, as our center was primarily reserved for suspected cases before transfer to COVID-19 centers, the rate of positivity for the COVID test was comparatively lower than the one reported at dedicated COVID-19 care sites, which welcomed both suspected and confirmed cases [9] [14]. Apart from the age of our suspected patients, the factors associated to COVID-19 disease reported in the literature were not found in our population, in particular comorbidities and sex [9] [14] [16] [17]. However, age was found to be associated with both the occurrence and severity of COVID-19 disease [17]. Regarding abnormalities of the lung parenchyma, we found a high rate of scannographic abnormalities in patients with a negative COVID-19 PCR test. This is consistent with data from the literature, which supports the indication of a lung CT scan in case of pulmonary clinical signs in suspected patients despite a negative PCR test [17]. The type of lung abnormalities observed in this setting follows the knowledge previously gathered; stating that of all the lesions observed ground glasses lesions are the first type of lesions observed in COVID-19 cases [18]. Our finding shows clearly that PCR positive patients had the same lung impairment as the negative ones this might be explained by the rage of etiology corresponding to the ground glasses lesion as MOUBACHIR *et al.* found [19]. They stated the main etiology is sarcoidosis it was confirmed by M.Zerraa *et al.* [20]. Although these two studies can be seen as outdated for not being cotemporary to COVID-19; they certainly demonstrate the wide range of etiologies when it comes to ground glasses lesions (from pulmonary edema to auto immune disorder) explaining the great number of negative PCR. Our data confirm the low sensitivity of pulmonary computed tomography for the diagnosis of COVID-19, and reinforce the need for precise indications for this examination [21]. However, other prior studies show discordant results to our findings [22] [23]. On the one hand, Ai T. *et al.* found good sensitivity and poor specificity. This difference might be due to the larger sample size based only on COVID-19 confirmed cases. On the other hand, a study by Fang Y, *et al.* had a sample like ours but was constituted solely of confirmed cases resulting in a good sensitivity. KHERAD *et al.* [24] have emphasized the imperfect sensitivity and limited specificity including the limitation of access to timely CT scans. Altogether, the increase in the use of CT scans around the world has led to contradictory guidelines [25] [26]. Meanwhile, lung CT scans are useful in the initial phases of COVID-19 infection for specific indications [26] included in diagnostic algorithms in the presence of pulmonary symptoms and respiratory distress. Finally, Cameroonian data are very different to those observed in Italy, which showed a very high predictive positive value for the CT scan making it good reference for recognizing COVID-19 patients while waiting for RT-PCR confirmation [27]. In our context, we found a low sensitivi-

ty with a too large confidence interval but a relatively good specificity with an acceptable positive predictive value but with a large confidence interval. These data's disqualifies the computed tomography as a diagnostic tool for COVID-19. The differences in our conclusion are explained by the procedures used in the study in Italy where PCR was repeated multiple times when the computed tomography was suggestive.

5. Conclusion

In conclusion, in this setting, lung CT scan for detection of COVID-19, shows poor sensitivity and better specificity. The poor performances of CT scans for COVID-19 infection diagnosis as compared to PCR diagnosis confirm the former as a "NO GO" for the diagnosis of COVID-19. However, it suggests that CT scans may be more suitable to assess severity, monitor the evolution and exclude other diagnoses as recommended elsewhere.

Ethical Approval

Administrative authorization was given by the Essos Hospital Center for this study. As part of the monitoring of pandemic data, a specific ethical clearance (2020/13/CE-CHE) was granted, and all data were anonymized with a single identifier.

Consent for Publication

NA.

Availability of Data and Materials

All data and materials are available upon request.

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Authors' Contributions

Study design: LB, SA, SNN, AENN;
Data collection LM, MN, BM and CS;
Data curation: ABS, SA, AENN;
Data analysis ABS;
Supervision AENN;
Writing initial draft: LB and AENN;
Editing: AENN, ABS, CS.
All authors reviewed and approved the final version.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this pa-

per.

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