ISSN: 2582-6751
Journal of Clinical Medical Research

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Effectiveness of Awake Prone Positioning in Improving Oxygenation Among COVID-19 Patients in the Isolation Unit of Baghdad Teaching Hospital

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Citation: Noaman AZ, et al. Effectiveness of Awake Prone Positioning in Improving Oxygenation Among COVID-19 Patients in the Isolation Unit of Baghdad Teaching Hospital. Jour Clin Med Res. 2025;6(2):1-8.

https://doi.org/10.46889/JCMR.2025.6204

Received Date: 24-05-2025

Accepted Date: 09-06-2025

Published Date: 16-06-2025

Abstract

Background: Between April and October 2020, a randomized, prospective, cross-sectional study was conducted at the temporary COVID-19 isolation unit of Baghdad Teaching Hospital to evaluate the effectiveness of awake prone positioning in improving oxygenation among patients and delaying the need of intubation and None-Invasive Ventilation (NIVP).

Patients and Methods: A hundred and forty six (146) confirmed COVID-19 patients by PCR were included in this study. The patients' sample consisted of: 30 patients with oxygen saturations between 80-90% on O_2 mask, 87 patients with oxygen saturations between 70-80% on O_2 mask and 29 patients with oxygen saturations below 70% on simple O_2 mask.

Results: Awake prone position technique was used in all cases included in this study, the effectiveness of this technique was marked among patients with oxygen saturations between 80-90% that reached 100%, fair response was noticed among patients with oxygen saturations between 70-80%; the percentage of positive response of patients in this group reached 40%, this technique has no effect on patients with oxygen saturations below 70% since no positive response was recorded among them.

It should be noticed that awake prone positioning is not replacing the usual care for management given to patients with COVID-19 (Antibiotics, antipyretics, vitamins, anticoagulants and chest physiotherapy).

Recommendation: It's recommended to use prone positioning for patients with oxygen saturations above 70%.

Keywords: COVID-19; Awake Prone; Prone Position

Introduction

Coronavirus is a member of the RNA virus family that causes diseases in both animals and humans. The virus first began infecting humans in Wuhan, China, in 2019 and was subsequently named COVID-19. Commonly reported symptoms included fever, dry cough, dyspnea, loss of taste or smell, sore throat, headache, muscle or joint pain, skin rash, nausea or vomiting, diarrhea and chills. More severe manifestations were characterized by high fever (>38°C), confusion, loss of appetite and smell and chest pain [1-3]. The primary natural reservoir of the COVID-19 virus is believed to be bats, with possible transmission to humans via intermediate hosts such as palm civets. Human-to-human transmission occurs primarily through direct contact with infected individuals, particularly via respiratory droplets. Other possible modes include fecal-oral transmission and vertical transmission [5,6]. The rapid global pandemic, known as the COVID-19 pandemic. As of 2020, the virus had infected approximately 75 million people and caused 1.6 million deaths globally. In Iraq, there were around 587,000 confirmed cases and 12,750 deaths by the end of 2020 [7].

In this study it's difficult to consider the gender as a contributing factor to the outcome, that's due to the small number of included women in this study which could be due to the majority of infected women visited our hospital had mild symptoms and were instructed for home isolation. Men seemed to be at higher rates of fatality and severe form of COVID-19 infection than women and that were due to biological and social behaviors (smoking and stress) [8-18]. Estrogen levels in women played an important role in protecting women from being infected or developing severe symptoms [19].

For the purpose of the research, patients were divided into 3 groups with baseline oxygen saturation, with 70% being the cutoff between moderate to severe cases, However; Jiang Xie, et al., considered sever cases of COVID-19, has O_2 saturations below 90%, but patients participated in this study were far away from this level, the classification of patients followed in this study was a challenge, since 70% oxygen saturation considered as the cut-off point and the moderate and severe cases was classified accordingly [20].

Pathogenesis

The SARS-CoV-2 virus enters the host cells through S spike protein binding to ACE2 aided by TMPRSS2 protease. When the virus enters the cells, it induces pro-inflammatory cytokines response mainly (IL-6, IL-10 and tumor necrosis factor α) which leads to edema, degeneration and necrosis of these cells. These changes contribute to lung injury pathogenesis, hypoxia-related myocyte injury, body immune response, increased damage of myocardial cells and intestinal and cardiopulmonary changes. Infection with SARS-CoV-2 has been also shown to cause hypoxemia. These changes lead to accumulation of oxygen free radicals, changes in intracellular pH, accumulation of lactic acid, electrolyte changes and further cellular damage [8].

Aim of Study

This study aimed to evaluate the effectiveness of awake prone positioning in improving oxygenation and delay the need for NIPV and intubation in COVID-19 patients.

Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore, was exempt.

Patients and Methods

Patients

A hundred and ninety-six COVID-19 proven patients through PCR testing. Fifty patients were excluded from the research because they did not meet the inclusion criteria. Hundred and forty-six (137 males and 9 females) with severe symptoms were enrolled in this study. Those patients were admitted to Baghdad Teaching Hospital Temporary Isolation unit from April - October, 2020.

All patients that were included in this study were subjected to awake prone positioning regardless of chest CT findings whether they were mild, moderate or severe infiltrations, also take into consideration that the available NIPVs at that time could not cope with large number of patients admitted to the temporary isolation unit and was a limitation factor for the research. All the vitals of those patients (Blood pressure, Respiratory rate, pulse rate, oxygen saturations) were recorded by the researcher. Those patients did not receive the COVID-19 regimen (Antivirals and Plasma transfusions) according to the protocol established by the Ministry of Health of Iraq at that time, instead they received the standard care of management (antibiotics, antipyretics, Enoxaparine, vitamins and chest physiotherapy).

Inclusion Criteria

- Above 15 years of age of both genders and with shortness of breath

Exclusion Criteria

- Morbid obese patients with BMI>30
- Patients under 15 years old
- Pregnant women
- Patients with fracture spine or hip

This is a randomized prospective cross-sectional single center study, In which verbal consent from patients prior to proning was obtained. We used simple O_2 masks, pillows and monitor devices. The procedure employed in this research depended on (Guidance for Prone Positioning in Adult Critical Care, Intensive Care Society, UK, 2019).

All patients were told about the procedure which is summarized as:

- The patients lying flat on their stomachs; hands stretched on their sides
- Occasional uses of pillow below their chests for comfort purposes
- The patients were told to remain in this position as much as they can tolerate and then they would turn to either side for 30 min and after that lye on their backs
- During the process both respiratory rate and O_2 saturation were monitored plus patients' sense of relief or improvement every 5 minute

During this whole process O_2 mask was still on the patients. This process is repeated every 2-4 hours or when the patients feel the need to and the process continued for 6-14 days or until they transferred to specialized isolation center.

Some patients who couldn't tolerate the procedure, were given another approach to achieve the same results. The procedure included the patient sit on their beds, have a pillow put in their laps and the patients were asked to bend over the pillow with their elbows rest on the pillow and same monitoring were observed. The first 60 minutes of applying this procedure were crucial in either proceeding or terminating the whole process.

Prone Positioning

In the last few years, prone positioning has been used widely in ICU on patients with acute respiratory distress syndrome minimizing the time of intubation period and ICU Stay [14].

Prone positioning is a simple maneuver needs no complex equipments or techniques, employing prone positioning acts on decreasing ventilation/perfusion heterogeneity; decreasing pleural pressure and increasing regional ventilation in dependent lung regions near the diaphragm, reduced airway closure in dorsal lung regions attributable to a more uniform gravitational pleural pressure gradient, better secretions removal, increases in functional residual capacity, changes in regional diaphragm motion and redistribution of blood flow [15].

As COVID-19 pneumonia is the most common manifestation of the infection, it's worth using this technique to ease the condition and minimize their need for non-invasive (NIPV) and invasive mechanical ventilation. However, there is no large scale of studies for effectiveness on conscious COVID-19 patients yet showed that it has minimal to no effect in early stages of COVID-19 infection but more effect in late stages when the infection acts like typical ARDS, as the recruitment of lung tissue is much higher in this stage [16]. This was agreed by another study in the same concept [4].

The need for prone positioning is obvious in COVID-19 patients with critical level of oxygen saturations because they are at high risk of mortality during intubation which may reach 30-50% [2,17]. In addition, minimizing the exposure time of medical personals to the virus.

Results

This study included 146 patients of both genders and their numbers are as mentioned in Fig.1, Table 1

Male patients constituted the majority of the study population, representing 94%, while female patients accounted for only 6%.

As shown in Fig.2, Table 2, participants were categorized into three groups based on their baseline oxygen saturation levels:

- Group 1: included 30 male patients with oxygen saturation levels between 80-90%. No female patients were present in this group
- Group 2: consisted of 87 male patients with oxygen saturation levels ranging from 70-80%. Again, no female patients were included
- Group 3: comprised 20 male and 9 female patients with oxygen saturation levels below 70%

The target oxygen saturation level was >90% using simple oxygen mask. An excellent response to prone positioning was observed in patients with initial oxygen saturation between 70-80% demonstrated variable (fluctuating) response, whereas those with saturation <70% showed no significant improvement.

Regarding respiratory rate, the target was set at 20 Cycles Per Minute (CPM). Patient responses were recorded accordingly:

- Patients with initial respiratory rates between 22-26 CPM exhibited excellent improvement
- Those with rates between 26-28 CPM showed inconsistent (fluctuating) responses
- Patients with rates exceeding 20 CPM did not demonstrate any significant response to prone positioning

Male	Female	Total
137 (94%)	9 (6%)	146 (100%)

Table 1: Patients divided according to gender.

Gender	Group 1	Group 2	Group 3	Total
Male	30 (20.5%)	87 (59.5%)	20 (14%)	146
Female	0	0	9 (6%)	-100%

Table 2: Groups of patients according to gender and O2 saturations.

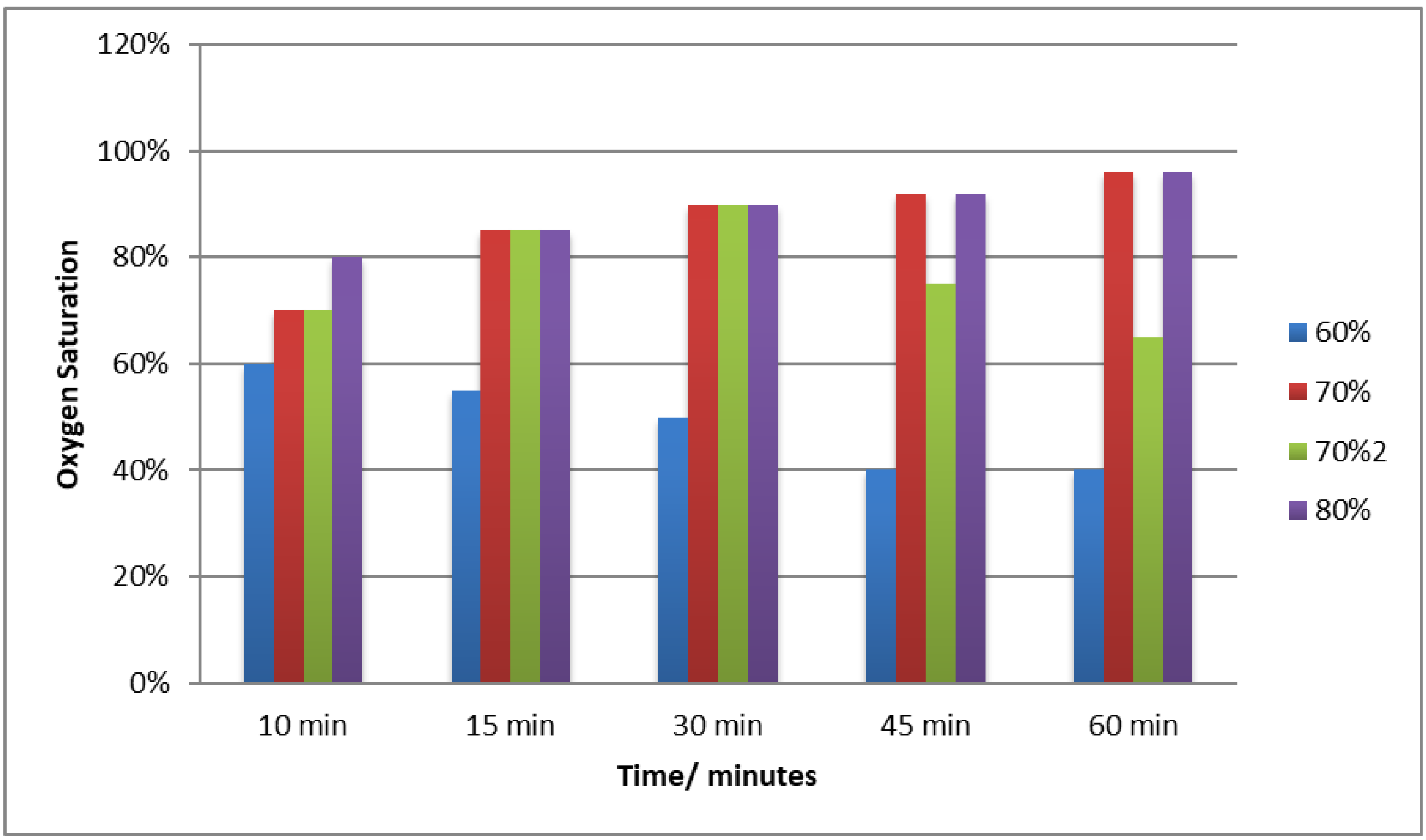

Figure 1: O_2 saturation response after applying awake prone position over time.

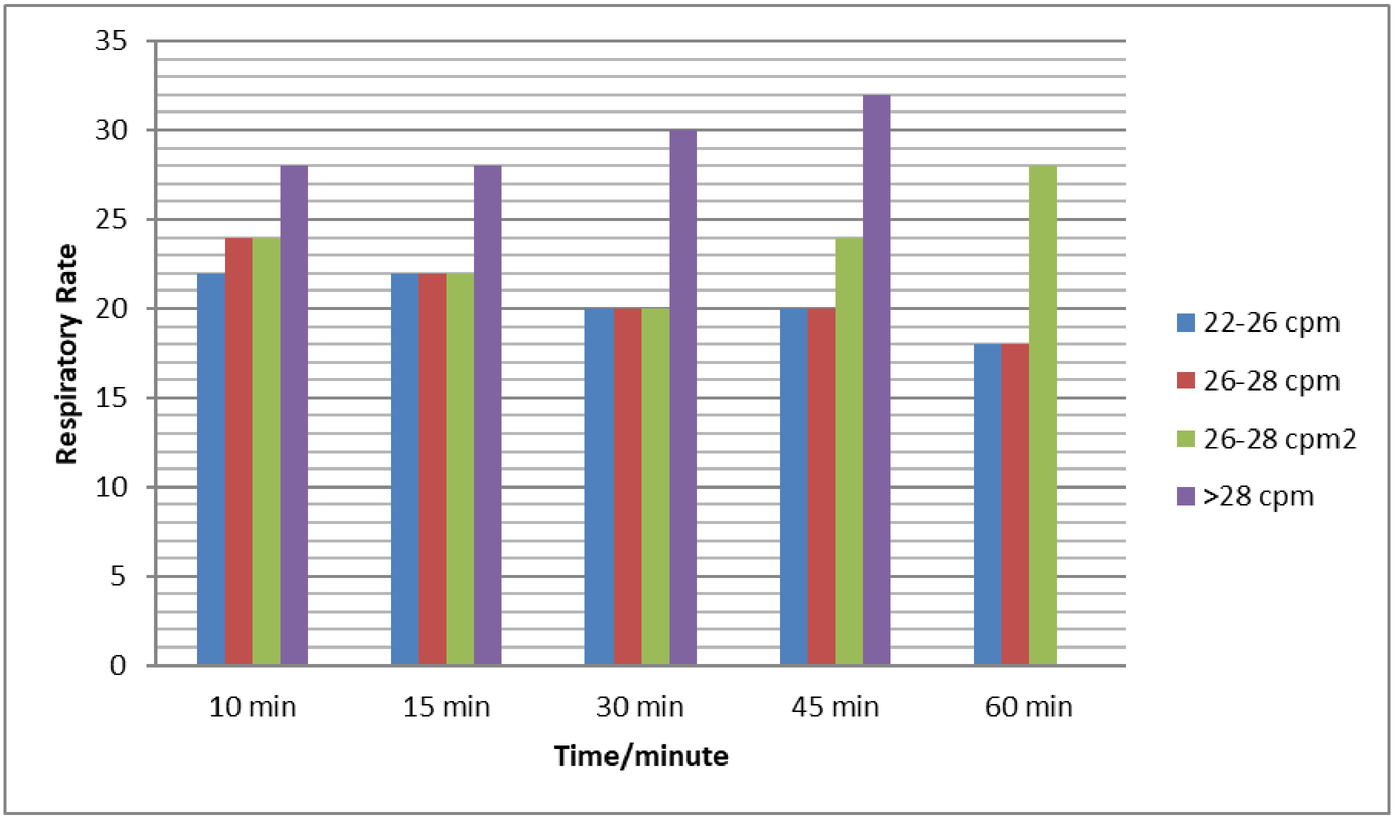

Figure 2: Respiratory rates response in 60 minutes of applying awake prone position in each group.

Discussion

The respiratory system is the primary system affected in SARS-CoV-2 and multiple infiltrates of both lungs may be present. The pathology of the lungs shows microscopic bilateral diffuse alveolar damages, cellular fibromyxoid infiltrates and interstitial mononuclear inflammatory infiltrates with lymphocyte domination [9].

The cardiovascular system is usually involved in COVID-19 infection. Biomarkers such as elevated highly sensitive troponin-T, natriuretic peptides and IL-6 are prognostic and their progressive rise is associated with poor outcomes. The inflammation of the vascular system results in the following changes: diffuse microangiopathic thrombi, inflammation of cardiac muscle (myocarditis) and cardiac arrhythmias, heart failure and acute coronary syndrome. These cardiovascular complications may cause death [10]. Notch signaling is known to be a major regulator of cardiovascular function and it is also implicated in several biological processes mediating viral infections. Recently it has been debated whether targeting Notch signaling can prevent SARS-CoV-2 infection and interfere with the progression of COVID-19-associated heart and lung disease pathogenesis [11].

Gastrointestinal manifestations of COVID-19 include diarrhea, nausea, vomiting and abdominal pain was reported. SARS-CoV-2 also causes liver injury, in most cases, the liver injury was transient and mild. However, severe liver dysfunction or injury has been reported in patients with severe disease. It is not clear whether the observed SARS-CoV-2-associated liver injury is caused by direct viral injury or if it is related to hepatoxic drugs, coexisting systemic inflammatory changes, sepsis, respiratory distress syndrome-induced hypoxia or multiple organ failure [12].

There is clinical evidence that the SARS-CoV-2 has potential neuropathic properties. Several neurologic related symptoms have been reported, including headaches, dizziness, seizure, decreased level of consciousness, acute hemorrhagic necrotizing encephalopathy, agitation and confusion [13].

In this randomized prospective cross-sectional single center study with 146 COVID-19 patients subjected to awake prone positioning while on regular oxygen masks, our findings showed that 65 patients (44.5%) showed marked response on awake prone position and they were weaned to room air 6 days later and were discharged home. 52 patients started to response at the first 30 minutes but then relapsed and their oxygen demands increased and the process had to be terminated at 60 minutes after applying the prone position. This outcome can likely be attributed to the extent of lung damage in these patients. During prone positioning, the more severely damaged areas of the lung were positioned superiorly, potentially allowing pulmonary debris to gravitate toward the relatively healthier lung tissue. This may have led to further hyoxemia and clinical deterioration. A total of 29 patients were unable to tolerate the proning procedure from the outset; in these cases, the intervention was terminated early. All of these patients subsequently required ICU admission and unfortunately died. Additionally, the use of anticoagulants did not appear to influence patient outcomes, as all individuals received the same anticoagulation regimen during their stay in the temporary isolation unit.

Awake prone positioning had a clear effect not only on O_2 saturations but also on respiratory rate in each group. Patients with saturation between 80-90% showed marked response to proning within 30 minutes of starting the procedure with respiratory rates returning to near normal. Relapsing occurred among patients with saturations between 70-80% after 60 minutes from proning when they showed excellent response in the first 30 minutes, with percentage reaching 60%. There is no decent explanation for this relapse, It's fair to argue for that the relapsed group in the present study could have damaged posterior lung tissue more severe than the anterior part, so when the patient is in the prone position, the damaged lung tissue became up then mucous and lung debris take time to come down by gravity effect to the anterior part of the lung (less damaged) and that may explain the relapsing happened 30 minutes later.

The result of the present study is supported by another study that was conducted by Ziqin Ng, et al. They studied the awake proning on 10 COVID-19 patients with severe pneumonia and stated that awake proning showed improvement in respiratory efforts and delayed intubation needed among COVID-19 with acute respiratory failure [21]. On the other hand, A study of Carlos Ferrando, et al., contradicted the results of this study, since their study used high flow nasal oxygenation with awake prone positioning on 199 COVID-19 patients with acute respiratory distress, they concluded that awake prone positioning with high flow nasal oxygen therapy did not affect the respiratory efforts and did not delay the need for intubation but it had a negative impact on the patients by delaying the intubation [22]. Although the results of Carlos's study contradicted our results, the approach applied by them is different from our approach. In their goal was to compare awake prone position using HFNO with HFNO alone and they found there was no difference in between the two methods. It's not in the interest of our research is to compare awake PP with any other methods, our goal is limited to improve oxygenation and delay the need of NIPV and intubation.However; the failure in using awake PP in their study could be due to excessive PEEP subjected to their patients, which may cause over distention of normal alveoli which increases the capillary resistance, redistribute the blood to other organs and causes reduction in ventilation perfusion and worsening hypoxemia [23].

Awake prone positioning did not demonstrate any clinical benefit in COVID-19 patients with oxygen saturations below 70%. This lack of response may be due to the severity of lung involvement in these patients, where extensive alveolar damage and reduced lung compliance limit the physiological benefit of prone positioning. In contrast, the findings of this study strongly support the use of awake prone positioning as part of routine management in patients with oxygen saturation above 70%. The rationale is based on the observed improvement in oxygenation and respiratory rate in these patients, likely due to enhanced ventilation-perfusion matching, alveolar recruitment and reduction in dorsal lung compression. Therefore, implementing awake prone positioning early in the course of hypoxemic respiratory failure- before oxygen saturation drops below critical thresholds-may help avoid further deterioration and reduce the need for invasive interventions.

Conclusion

This study demonstrated that awake prone positioning is effective in improving oxygenation and respiratory rate among COVID-19 patients with moderate hypoxemia, particularly those oxygen saturations above 70%. Patients with baseline saturations between 80-90% showed the most consistent and favorable responses, while those between 70-80% exhibited variable improvement. In contrast, patients with oxygen saturations below 70% did not benefit from the intervention, likely due to advanced pulmonary damage and impaired alveolar recruitment capacity. These findings suggest that awake prone positioning should be considered as a routine supportive strategy in the early management of hypoxemic COVID-19 patients to delay or potentially avoid invasive ventilation, provided that the oxygen saturation is ≥70%.

Limitations

Several limitations should be acknowledged in this study:

1. Single-center design: The study was conducted in a single isolation unit, which may limit the generalizability of the findings to other settings with different resources or patient populations
2. Lack of control group: Without a non-proned comparison group, it is difficult to definitively attribute observed improvements solely to the prone positioning
3. Subjective response assessment: Clinical responses, such as tolerance to the prone positioning and improvement in symptoms, were partially based on clinical judgment rather than standardized scoring systems
4. Short-term outcomes: The study focused primarily on immediate improvements in oxygenation and respiratory rate. Long-term outcomes such as ICU admission, duration of the hospital stay or mortality were not comprehensively analyzed
5. No imaging correlation: The extent of lung involvement was not quantified using imaging modalities (e.g., chest CT), which could have provided a clearer understanding of the relationship between radiological severity and response to proning
6. Uniform treatment protocol: All patients received the same pharmacological treatment (including anticoagulants), preventing analysis of how medication variability might interact with prone positioning outcomes

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Consent to Participate

Informed consent was also obtained from each subject who participated in the study.

Financial Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Acknowledgment

I am obliged to thank Government of Iraq (Ministry of health/ Medical city/ Baghdad teaching Hospital/Emergency Department) for their unlimited supporting this research.

Data Availability

Data is available for the journal. Informed consents were not necessary for this paper.

Author's Contribution

All authors contributed equally for this paper.

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