ORIGINAL ARTICLE

Comparative study between Lung ultrasound and Chest CT in diagnosis of traumatic pneumothorax

Abd El-Wahab A. S. Mohamed [a], Essa H. M. Ali [b], Ahmed Y. M. Amin [b,*]

[a] Department of Anesthesia, Intensive Care and Pain Management, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt
[b] Department of Emergency and Critical Care, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***A significant portion of all traumas occur in the chest. Almost 10% of trauma patients end up in the hospital because of this. Different kinds and levels of chest trauma cause different kinds of injuries, which in turn cause different kinds of consequences, and those outcomes show up in the corresponding death rate.***

Aim and objectives: ***Assessment of the use of chest computed tomography (CT) and lung ultrasound (US) in the diagnosis of pneumothorax in patients with a history of trauma, as well as comparisons between the two methods for the purpose of early detection and treatment of this condition.***

Subjects and methods: ***From December 2023 through December 2024, thirty trauma patients presenting with respiratory distress were enrolled in this comparative study. The patients were admitted to the emergency and critical care departments of Al-Azhar University Hospitals in Cairo, Egypt.***

Results: ***Twenty-four (80%) patients were diagnosed with traumatic pneumothorax by lung ultrasound. 26(86.67%) patients diagnosed with traumatic pneumothorax by chest CT. Chest ultrasound can detect traumatic pneumothorax with (Kappa=0.524) 88.5% sensitivity, 75% specificity, 95.8% PPV, and 50% NPV.***

Conclusion: ***In trauma patients with polytrauma or direct chest trauma, chest ultrasound is a quick, easy, readily available, and useful diagnostic technique for pneumothorax (Kappa=0.524) with an 88.5% sensitivity and 75% specificity.***

1. Introduction

Worldwide, chest trauma accounts for a sizable portion of all traumas. Approximately 10% of trauma admissions are attributed to it.[1]

There is a correlation between the associated mortality rate and the diversity of damage lesions encountered as a result of the many kinds and degrees of severity of chest trauma.[2]

One frightening complication of thoracic injuries is pneumothorax. An air leak into the pleural space happens when the visceral and/or parietal pleurae burst. Penetrating injuries (such as stab wounds or gunshot wounds) or blunt chest trauma resulting in rib fractures are two potential causes of traumatic pneumothorax.[3]

Although thoracic computed tomography (CT) scans are the most reliable imaging of the lungs, they are also the most costly and radiation-intensive option. Transporting critically ill patients from the intensive care unit to the radiology department is a high-risk operation that isn't always feasible due to the patients' haemodynamic and respiratory instability.[4]

Some have even gone so far as to say that lung ultrasound may diagnose pulmonary oedema and increased alveolar fluid (also known as interstitial syndrome) just as well as chest CT scans and X-rays do.[5]

The purpose of this research was to evaluate the diagnostic accuracy of chest computed tomography (CT) and ultrasound of the lungs in trauma patients with that of ultrasound of the lungs in order to better identify and treat pneumothorax as soon as it occurs.

Accepted 01 September 2025.
Available online 30 October 2025

* Corresponding author at: Emergency and Critical Care, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: ahmadgamalfarahat@gmail.com (Ahmed Y. M. Amin).

https://doi.org/10.21608/aimj.2025.402708.2642

2. Patients and methods

This comparative study aimed to diagnose and treat respiratory distress in thirty trauma patients hospitalised to the emergency and critical care units at Al-Azhar University Hospitals in Cairo, Egypt, from December 2023 to December 2024. Researchers at Egypt's Al-Azhar University's Faculty of Medicine received permission from an ethical review body. Signed informed consent forms were obtained from each and every patient.

Sample size calculation:

We used G. Power 3.1.9.2 (Universität Kiel, Germany) to determine the sample size. Previous research indicated that a sensitivity of 98.1% for ultrasonography and 52.7% for chest computed tomography in diagnosing traumatic pneumothorax, which informed the calculation of the sample size. Taking into account the following factors: The study's power was 80%, the α error was 0.05, and the allocation ratio was 1:1. A total of 30 patients were included in the sample after four cases were included to account for dropouts.

Inclusion criteria:

Male and female patients over the age of 18, patients experiencing respiratory distress and oxygen desaturation due to blunt or penetrating direct trauma to the chest or multiple traumas, patients with a body mass index (BMI) ranging from 18 to 30 kg/m², and patients with consciousness levels of 15 to 15.

Exclusion criteria:

Patient refusal, pregnant patient, presence of flail chest, rib fracture, pneumomediastinum and hemothorax, chest wall deformities, additionally, patients who came in with surgical emphysema that was diagnosed clinically, patients who came in with potentially fatal pneumonia, and patients who have previously been treated with an intercostal drain inserted.

Methodology:

All patients were subjected to trauma survey assessment. Primary survey assessment:

Airway and C-spin protection: whether the airway was opened and protected or not. Protection of the spin by using the Philadelphia collar and other neck collars. Breathing and examination of the chest to assess respiratory distress grades. Inspection to Limited movement of the chest, trachea shifted, open chest wound, palpitation to subcutaneous emphysema, rib fracture, and tenderness, percussion for dullness, and auscultation for breath sounds.

Circulation and hemorrhage control; when the patient arrives, we give 1000-2000 ml of warm isotonic crystalloid. Insertion of IV access to search for the source of bleeding. If there is an external search of the wound at the chest, we do a chest x-ray, at the abdomen, we do a FAST scan, and at the pelvis and bone, we do an x-ray and classification of the patient according to hemorrhage. Disability examination of conscious level, pupil size, reaction, and spinal cord injuries.

Adjuncts to primary survey:

Equipment: ECG, Foley catheter, nasogastric tube, monitor vital signs, and pulse oximeter. Routine lab analysis: CBC, ABG, blood group. Investigation: x-rays, FAST, and E_FAST

Secondary survey assessment:

Take history (allergy, medication currently used, past illness if pregnant female, last meal, and mode of trauma and event related to trauma). Full examination of the body (head and neck, chest, abdomen, pelvis, genitals, and extremities).

Adjuncts to secondary survey:

Completely spin imaging in suspected spinal injury, Specialized diagnostic tests (CT abdomen, CT urology, angiography), and reevaluation, monitoring of vital signs, urine output, and pain control.

Assessment of revised trauma score:

A patient's respiration rate, systolic blood pressure, and Glasgow Coma Scale make up the Revised Trauma Score. A score of 0–12 is possible. A patient's RTS score determines their priority in START triage: 12 indicates delayed, 11 indicates urgent, and 3–10 indicates immediate. Since they are extremely unlikely to survive without a large number of resources, individuals with RTS below three are considered dead and should not receive certain treatment.

Chest ultrasound:

Right after the chest x-ray, a lung ultrasound was performed. Ultrasound of the chest, using transducers and frequencies optimised for sonobook machines (5-12 MHz linear array), is the gold standard for revealing the pleura, lung peripheral parenchyma, and the chest wall.

The method included axial scans alongside the intercostal gaps and longitudinal scans running vertically along the parasternal, midclavicular, axillary, and paravertebral lines, all of which are anatomical lines in the thorax. Typically, the back parts were checked while the patient sat, and the front parts were checked while the patient lay flat on their back. The images were taken from different angles to check for a sliding lung sign. View 1 was taken at the mid-clavicular line, view 2 was taken at the anterior axillary line, view three was taken at the mid-axillary line, and view 4 was taken at the posterior axillary line. The presence or absence of the sliding lung sign in any of these views prompted a more posterior scan to identify any lung point signs that might be present.

Patients were categorised as having a negative or positive pneumothorax based on whether or not they exhibited the lung sliding or lung point sign. Assuming a positive result, a pneumothorax is considered mild if the sliding lung sign is not present in views 1 and 2, moderate if it is not present in views 3–5, and huge if it is not present in any of the four views. Reanimative measures were maintained upon transfer to the surgical emergency unit. After that, a senior radiologist examined the patients using CT chest scans, which they subsequently reported.

Statistical analysis:

I used SPSS v26, which is developed by IBM and located in Chicago, IL, USA, for the statistical analysis. The data distribution was checked for normality using the Shapiro-Wilks test and histograms. The mean and standard deviation (SD) were used to display the quantitative parametric data. The non-parametric quantitative data were shown using the IQR and median. The frequency and percentage (%) of qualitative characteristics were displayed.

Assessment of the accuracy of diagnostic tests: diagnostic sensitivity: it quantifies the frequency of accurate diagnoses in treatment cohorts. Measures the frequency of false negative results in a healthy population; this is known as diagnostic specificity. As a percentage of all positive findings, the proportion of actual positive results is known as positive predictive value (PPV). The NPV, or negative predictive value, is the proportion of negative outcomes that are actually negative out of all the negative outcomes.

3. Results

Table 1. Demographic data and comorbidities of the studied patients.

		N=30
AGE (YEARS)	Mean ±SD	45.8±12.96
	Range	23-75
SEX	Male	20(66.67%)
	Female	10(33.33%)
WEIGHT (KG)	Mean ±SD	78.9±14.17
	Range	59-105
HEIGHT (M)	Mean ±SD	1.7±0.07
	Range	1.6-1.82
BMI (KG/M^2)	Mean ±SD	27.1±5.08
	Range	18.4-36
COMORBIDITIES	Diabetes mellitus	13(43.33%)
	Hypertension	10(33.33%)
	COPD	4(13.33%)

BMI: Body mass index, COPD: Chronic obstructive pulmonary disease.

The mean age (±SD) was 45.8(±12.96) years, with a range of 23–75 years. Ten (33.33%) females and twenty (66.67%) guys were present. With a mean value (±SD) of 78.9 (±14.17) kg, the weight ranged from 59 to 105 kg. The height had a mean value (±SD) of 1.7 (±0.07) m and varied from 1.6 to 1.82 m. The mean (±SD) BMI was 27.1 (±5.05) kg/m2, with a range of 18.4 to 36 kg/m2. Thirteen individuals (43.33%) had diabetes mellitus. Ten individuals (33.33%) had hypertension. Four patients (13.33%) had COPD, (table 1).

Table 2. Mechanism of injure of the studied patients.

	N=30
MVC	18(60%)
FFH	6(20%)
FDS	2(6.67%)
LOCAL TRAUMA	4(13.33%)

Data presented as frequency (%), MVC: Motor vehicle collision, FFH: Falling from height, FDS: Falling downstair.

Mechanism of injure was MVC in 18(60%) patients, FFH in 6(20%) patients, FDS in 2(6.67%) patients and local trauma in 4(13.33%) patients, (table 2; figure 1).

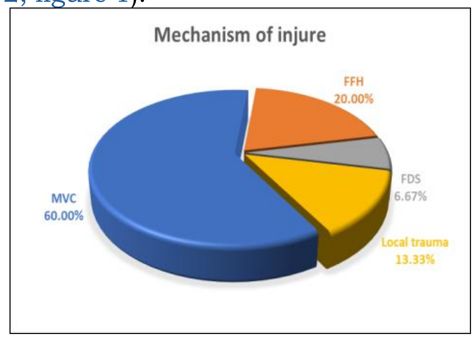

Figure 1. Mechanism of injure of the patients that were examined.

Table 3. Vital signs and RTS of the patients that were examined.

		N=30
SBP (MMHG)	Mean ±SD	115.8±17.72
	Range	86-138
DBP (MMHG)	Mean ±SD	68.8±11.95
	Range	51-87
HEART RATE (BEATS/MIN)	Mean ±SD	102.6±15.67
	Range	75-130
TEMPERATURE (°C)	Mean ±SD	37.8±0.63
	Range	36.8-38.7
RESPIRATORY RATE (BEARTHS/MIN)	Mean ±SD	18.8±3.73
	Range	13-24
RTS		6 (5-7)

Data presented as mean ±SD or median (IQR), SBP: Systolic blood pressure, DBP:Diastolic blood pressure, RTS:Revised trauma score.

The mean (±SD) SPB was 115.8(±17.72) mmHg, with a range of 86-138 mmHg. The mean (±SD) DBP was 68.8(±11.95) mmHg, with a range of 51-87 mmHg. The mean heart rate (±SD) was 102.6 (±15.67) beats per minute, with a range of 75 to 130 beats per minute. The mean temperature (±SD) was 37.8(±0.63) °C, with a range of 36.8 to 38.7 °C. The mean (±SD) respiratory rate was 18.8 (±3.73) breaths/min, with a range of 13–24 breaths/min. The RTS score's median (IQR) was 6 (5-7), (table 3).

Table 4. Results from the patients' lab tests.

		N=30
PH	Mean ±SD	7.4±0.06
	Range	7.27-7.47
PCO_2 (MMHG)	Mean ±SD	46.6±6.86
	Range	37-56
PO2 (MMHG)	Mean ±SD	56.8±15.31
	Range	35-80
HEMOGLOBIN (G/DL)	Mean ±SD	10.3±2.02
	Range	7.3-13.9
HEMOTOCRIT (%)	Mean ±SD	29.9±5.14
	Range	22-37
PLATELETS (109/L)	Mean ±SD	177±73.29
	Range	74-315
TOTAL LEUCOCYTE COUNT (109/L)	Mean ±SD	13.9±6.73
	Range	2.4-23.3

The mean PH value (±SD) was 7.4(±0.06), with a range of 7.27 to 7.47. A mean value (±SD) of 46.6(±6.86) mmHg was found for PCO2, which varied between 37 and 56 mmHg. A mean value (±SD) of 56.8(±15.31) mmHg was found for PO2, which varied between 35 and 80 mmHg. The haemoglobin had a mean value (±SD) of 10.3(±2.02) g/dl and varied from 7.3 to 13.9 g/dl. Hemotocrit had a mean value (±SD) of 29.9(±5.14)% and varied from 22–37%. The mean platelet count (±SD) was 177(±73.29) 109/L, with a range of 74-315 109/L. With a mean value (± SD) of 13.9(±6.73) 109/L, the total leucocyte count varied from 2.4 to 23.3 109/L, (table 4).

Table 5. Traumatic pneumothorax was diagnosed in the individuals under study using chest CT and lung ultrasonography.

		N=30
TRAUMATIC PNEUMOTHORAX BY LUNG ULTRASOUND	Present	24(80%)
	Absent	6(20%)
TRAUMATIC PNEUMOTHORAX BY CHEST CT	Present	26(86.67%)
	Absent	4(13.33%)

Data presented as frequency (%), CT: Computed tomography

Twenty-four (80%) patients diagnosed with traumatic pneumothorax by lung ultrasound. 26(86.67%) patients diagnosed with traumatic pneumothorax by chest CT, (table 5; figures 2&3).

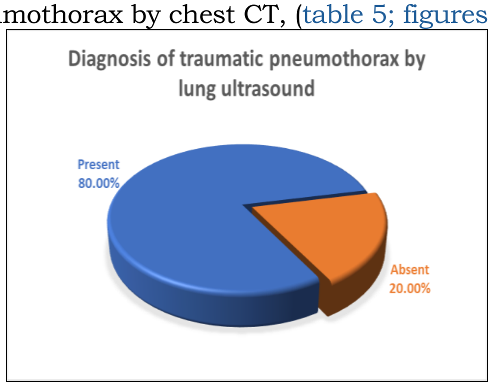

Figure 2. Diagnosis of traumatic pneumothorax by lung ultrasound of the studied patients.

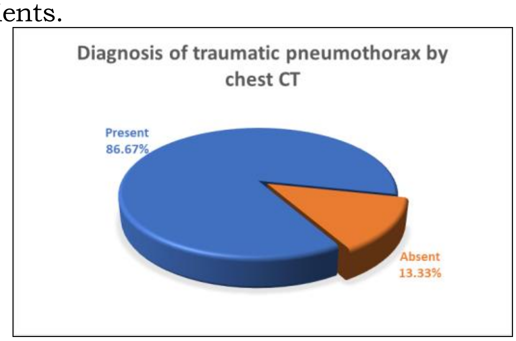

Figure 3. Diagnosis of traumatic pneumothorax by chest CT of the studied patients.

Table 6. Role of lung ultrasound in diagnosis of traumatic pneumothorax compared to chest CT.

		CHEST CT		P VALUE
		Present	Absent	
LUNG ULTRASOUND	Present	23	1	0.625
	Absent	3	3	
SENSITIVITY		88.5%		
SPECIFICITY		75%		
PPV		95.8%		
NPV		50%		
ACCURACY		86.7%		
KAPPA		0.524		

Suprasternal sonography can confirm the correct placement of endotracheal tube compared to capnography with (P=0.625 and Kappa=0.524) 88.5% sensitivity, 75% specificity, 95.8% PPV and 50% NPV, (table 6).

4. Discussion

Pneumothorax can be detected using a variety of imaging methods. It is commonly recognised that traumatic pneumothorax can be identified using chest computed tomography (CT). Occult pneumothorax (OP), on the other hand, is a type of pneumothorax that is not discovered prior to a chest CT scan and might result in major difficulties for the patient.[6]

The literature on critical care and emergency medicine is beginning to focus more on chest ultrasonography (CUS). Recently, the US has been utilised to evaluate lung diseases such as pneumothorax. CUS can be used as a reliable and accurate alternative to chest radiography.[7]

The age range in this study was 23–75 years old, with a mean age (±SD) of 45.8(±12.96) years. Ten (33.33%) females and twenty (66.67%) guys were present. With a mean value (±SD) of 78.9(±14.17) kg, the weight ranged from 59 to 105 kg. With a mean value (±SD) of 1.7(±0.07) m, the height ranged from 1.6 to 1.82 m. The mean (±SD) BMI was 27.1(±5.05) kg/m2, with a range of 18.4–36 kg/m2. Thirteen individuals (43.33%) had diabetes mellitus. Ten individuals (33.33%) had hypertension. Four patients (13.33%) had COPD.

Also, Ahmed et al.,[8] carried out a cross-sectional observational study on 160 individuals who had suffered traumatic pneumothorax. They stated that around 77.5% of the population was male. The patients' average age was 31.75±9.17 years.

Comparable with our study, Abu Arab et al.,[9] evaluated the accuracy and utility of the bedside US chest and CT chest in diagnosing traumatic pneumothorax, as well as their capacity to measure its extent, in a prospective clinical research involving 200 patients who had experienced chest trauma. They discovered that around 80% of their patients were men. The typical age of the patients is 27, with up to 60% of them being in their 30s.

Also, Jahanshir et al.,[10] conducted a prospective study in 157 patients with blunt chest trauma. They showed that the majority were male, which was 134(85.4%). The mean age was 38.3(SD:18.57) years.

In the current study, the mechanism of injury was MVC in 18(60%) patients, FFH in 6(20%) patients, FDS in 2(6.67%) patients, and local trauma in 4(13.33%) patients.

Near to the findings of the current study, Ezzabad et al.,[11] found that the mechanism of injury was accidents in 70% and falls in 30% patients.

Also, Elgazzar et al.,[12] reported that the mechanism of injury was road traffic accident (40%) and traumatic causes (10%) among the patients with pneumothorax.

Comparable with the findings of this study, Abu Arab et al.,[9] found that the mechanism of injury was MVC (67%), FHH (19%), FDS (3%), and local trauma (3%) among the patients with pneumothorax.

Similar to our study, Elgazzar et al.,[11] the average heart rate was 103±15 beats per minute. Blood pressure (SBP) averaged 113(±14) mmHg, and diastolic blood pressure (DBP) was 69(±9) mmHg.

The pH values in this investigation varied from 7.27 to 7.47, with an average of 7.4 (±SD) and a standard deviation of 0.06. With a mean value (±SD) of 46.6(±6.86) mmHg, PCO2 varied from 37 to 56 mmHg. The levels of PO2 varied between 35 and 80 mmHg, with an average value of 56.8 mmHg (±15.31 mmHg). The haemoglobin levels varied from 7.3% to 13.9% by g/dl, with an average of 10.3% (±2.02%) by g/dl. The range of hemocrit values was 22% to 37%, with an average value of 29.9% (±5.14%) %. The mean value (±SD) of the platelets was 177(±73.29) 109/L, and they varied from 74 to 315 109/L. With an average value (±SD) of 13.9(±6.73) 109/L, the total leucocyte count varied from 2.4-23.3 109/L.

In line with the findings of this study, Elgazzar et al.,[12] found that the mean pH was 7.37±0.05. The mean PCO2 was 47(±5) mmHg and PO2 was 59(±13) mmHg. The mean hemoglobin was 10.5(±1.7) g/dl. Hematocrit was 30(±4) %. The mean platelets were 197(±62) 109/L. The mean total leukocyte count was 12.9(±5.4) 109/L.

In the present study, 24(80%) patients were diagnosed with traumatic pneumothorax by lung ultrasound. 26(86.67%) patients were diagnosed with traumatic pneumothorax by chest CT.

Ahmed et al.,[8] showed that there were 50(31.2%) patients were diagnosed with traumatic pneumothorax by lung ultrasound. 53(33.1%) patients were diagnosed with pneumothorax by CT.

Similar to the results of the current study, Elgazzar et al.,[12] reported that there were 35(70%) patients who were diagnosed with traumatic pneumothorax by ultrasound, while 42(84%) had confirmed diagnosis of pneumothorax with CT.

In this regard, Abu Arab et al.,[9] found that 47(11.75%) patients were diagnosed with traumatic pneumothorax by lung ultrasound. 45(95.74%) patients were diagnosed with traumatic pneumothorax by chest CT. These differences may be also attributed to different sample size, populations and demographic area.

In the current study, chest ultrasound can detect traumatic pneumothorax with (Kappa=0.524) 88.5% sensitivity, 75% specificity, 95.8% PPV and 50% NPV and 86.7% accuracy.

Nearly, Jahanshir et al.,[10] found that the US results for pneumothorax sensitivity was 75.0%, specificity 100%, PPV 100% and NPV 94.9%.

Limitations: The study excluded patients with haemothorax, had a small sample size, and was conducted at a single centre.

4. Conclusion

In trauma patients with polytrauma or direct chest trauma, chest ultrasound is a quick, easy, readily available, and useful diagnostic technique for pneumothorax (Kappa=0.524) with an 88.5% sensitivity and 75% specificity.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. Ge Ibrahim SR, Abdelaziz AE. Retrospective statistical study of thoracic trauma patients in Al-hussein hospital, Al-Azhar university. The Egyptian Journal of Hospital Medicine. 2021; 84(1): 1650-1654.
2. Nsengiyumva B, Henry MB, Kuntz HM, et al. Chest trauma epidemiology and emergency department management in a tertiary teaching hospital in Kigali, Rwanda. Afr J Emerg Med. 2022; 12(4): 428-431.
3. Ali S, Kumar A, Kumar R, et al. Prediction of outcomes of chest trauma using chest trauma scoring system at a rural tertiary health-care facility. Saudi Journal for Health Sciences. 2024; 13(1): 42-48.
4. Khorsand S, Chin J, Rice J, et al. Role of Point-of-Care Ultrasound in Emergency Airway Management Outside the Operating Room. Anesth Analg. 2023; 137(1): 124-136.
5. Siwik D, Apanasiewicz W, Żukowska M, et al. Diagnosing Lung Abnormalities Related to Heart Failure in Chest Radiogram, Lung Ultrasound and Thoracic Computed Tomography. Adv Respir Med. 2023; 91(2): 103-122.
6. Park IH, Kim CW, Choi YU, et al. Occult pneumothorax in patients with blunt chest trauma: key findings on supine chest radiography. J Thorac Dis. 2023; 15(8): 4379-4386.
7. Kameda T, Ishii H, Oya S, et al. Guidance for clinical practice using emergency and point-of-care ultrasonography. Acute Med Surg. 2024; 11(1): e974.
8. Ahmed SA, Abdulqader SK, Shakir NA. The efficacy of bedside chest ultrasound in the detection of traumatic pneumothorax. The Open Neuroimaging Journal. 2024; 17(1).
9. Abu Arab W, Abdulhaleem M, Eltahan S, et al. Comparative study between bedside chest ultrasound and chest CT scan in the diagnosis of traumatic pneumothorax. Cardiothorac Surg 29, 15 (2021). https://doi.org/10.1186/s43057-021-00051-6
10. Jahanshir A, Moghari SM, Ahmadi A, et al. Value of point-of-care ultrasonography compared with computed tomography scan in detecting potential life-threatening conditions in blunt chest trauma patients. Ultrasound J. 2020; 12(1): 36.
11. Ezzabad AR, Azimi S, Yazd AK, et al. Investigating the accuracy of portable ultrasonography in diagnosis of traumatic thoracic lesions compared to CT scan. Onkologia i Radioterapia. 2024; 18(5).
12. Elgazzar AG, Okab AA, Aglan BM, et al. Role of Chest Ultrasound in Detection of Pneumothorax in Critical Care Unit Patients. Benha Journal of Applied Sciences. 2022; 7(5): 77-84.