"UTILITY OF EXTENDED FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA IN BLUNT CHEST TRAUMA – IT'S CLINICAL IMPLICATION AND DIAGNOSTIC ACCURACY COMPARED WITH CHEST X-RAY AND CLINICAL EXAMINATION"

IN GOVERNMENT RAJAJI HOSPITAL, MADURAI

DISSERTATION SUBMITTED FOR

MASTER OF SURGERY

BRANCH - I (GENERAL SURGERY)

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MADURAI MEDICAL COLLEGE

MADURAI, TAMILNADU, INDIA -625 020

(Affiliated to The Tamilnadu Dr.MGR Medical University, Chennai, Tamil Nadu)

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7. Thiru.Pala.Ramasamy, B.A.,B.L., Advocate, Palam Station Road, Sellur.
8. Thiru.P.K.M.Chelliah, B.A., Businessman,21, Jawahar Street, Gandhi Nagar, Madurai.

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.O.P.SENTHIL
Course	:	PG in MS, GENERAL SURGERY
Period of Study	:	2014-2017
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	Utility of extended FAST in Blunt Chest Trauma –Its Clinical implication and diagnostic accuracy compared with chest X-Ray and clinical examination
Ethical Committee as on	:	27.11.2015

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted

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DEAN
Madurai Medical College
Madurai-20

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IN GOVERNMENT RAJAJI HOSPITAL, MADURAI submitted by Dr.O.P.Senthil to the Tamil Nadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the requirement for the award of M.S. Degree Branch I (General Surgery) is a bonafide research work was carried out by him under my direct supervision & guidance.

Prof.DR.S.CHITRA M.S.,DGO, DNB(O.G),MNAMS,FACRS,FICS,
Professor of General Surgery,
Department of General Surgery,
Madurai Medical College,
Madurai.

Prof.Dr.D.MARUTHUPANDIANM.S., FICS.,FAIS,
Professor& Head of the Department,
Department of General Surgery,
Madurai Medical College,
Madurai.

DEAN
MADURAI MEDICAL
COLLEGE MADURAI

CERTIFICATE BY THE DEAN

This is to certify that the dissertation entitled ***"UTILITY OF EXTENDED FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA IN BLUNT CHEST TRAUMA – IT'S CLINICAL IMPLICATION AND DIAGNOSTIC ACCURACY COMPARED WITH CHEST X-RAY AND CLINICAL EXAMINATION"***

IN GOVERNMENT RAJAJI HOSPITAL,MADURAI is a bonafide research work done by **DR.O.P.SENTHIL.,** Post Graduate Student, Department of General Surgery, MADURAI MEDICAL COLLEGE AND GOVERNMENT RAJAJI HOSPITAL, MADURAI, under the guidance and supervision of **PROF.DR.S.CHITRA.,M.S**, Associate Professor Department of General Surgery,MADURAI MEDICAL COLLEGE AND GOVERNMENT RAJAJI HOSPITAL, MADURAI.

DATE: **Dr.M.R.VAIRAMUTHURAJU M.D., (G.M.)**

PLACE: MADURAI DEAN

MADURAI MEDICAL COLLEGE

DECLARATION

I, Dr.O.P.Senthil declare that, I carried out this work on, ***"UTILITY OF EXTENDED FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA IN BLUNT CHEST TRAUMA – IT'S CLINICAL IMPLICATION AND DIAGNOSTIC ACCURACY COMPARED WITH CHEST X-RAY AND CLINICAL EXAMINATION"***

IN GOVERNMENT RAJAJI HOSPITAL,MADURAI

"At the Department of General Surgery, Govt. Rajaji Hospital trauma care centre during the period of one year. I also declare that this bonafide work or a part of this work was not submitted by me or any others for any award, degree, diploma to any other University, Board either in India or abroad.

This is submitted to The Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfillment of the rules and regulations for the M.S. degree examination in General Surgery.

Place: Madurai

Date: Dr.O.P.Senthil

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My unit chief **Prof.Dr.S.CHITRA, M.S.**, has always guided me, by example and valuable words of advice and has given me his moral support. I will be ever grateful to him.I offer my heartfelt thanks to my unit Assistant Professors **Dr.D.Ashok chakravarty M.S., Dr.Celine Foustaina Mary M.S., Dr.C.Ganga D.P.M., M.S.,** for their constant encouragement, timely help and critical suggestions throughout the study and also for making my stay in the unit both informative and pleasurable.

My patients, who form the most integral part of the work, were always kind and cooperative. I pray to God give them courage and strength to endure their illness, hope all of them go into complete remission.

Place: Madurai.

Date:

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INTRODUCTION

Eventhough USG was used as an important diagnostic tool in 1970's it's role in trauma got it's lime light in 1996 when Rozycki et al introduced FAST (Focused Assessment with Sonography for Trauma). It's use was recognized and accepted as a secondary tool in ATLS (Advanced Trauma Life Support) since 1997.

The main advantage in doing an ultra sonography as a diagnostic tool in trauma is that it can be shifted to bed side and can be done by a surgeon/radiologist during resuscitation process. It is cost effective and can be available in even small centre. Since road traffic accidents were on the rise blunt injury chest & incidence of pneumothorax (>20% in major blunt trauma's) were also rising, more in the developing countries. pneumothorax is an acute emergency where timely intervention is needed to prevent mortality.

Pneumothoraces often are detected by means of a combination of clinical examination and chest radiography. Although these techniques are reliable for the detection of large pneumothoraces, a subtle pneumothorax may be difficult to detect in a trauma situation for several reasons. Pneumothorax may not be clinically evident if it does not cause substantial respiratory com- promise or if it causes only a subtle decrease in air entry, which may not be detectable at auscultation.

Till now chest X-ray is being used as a primary modality of investigation in blunt injury chest to rule out hemo-pneumothorax in many centres eventhough it's sensitivity and specificity is questionable. Problem with chest X-ray includes shifting unstable patient's to x-ray rooms is not practically possible, positioning a suspected spine injury patients for x-ray, radiation hazard and finally it's poor sensitivity in detecting pneumothorax. CT-chest is the gold standard investigation in detecting pneumothorax but it's cost, availability, radiation hazard limits it's use.

Use of ultrasound for chest injuries is a new modality of investigation in trauma which is gaining it's significance as it has no radiation hazard, can be done safely in pregnant women and children, cheap, available in most of the centres, can be shifted to bed side of the patient and can be done along with resuscitation process. This FAST (Focused Assessment with Sonography for Trauma) for chest injuries is termed as Extended Focused Assessment with Sonography for Trauma (EFAST).

This study is intended to check the utility of EFAST in blunt chest trauma and it's diagnostic accuracy in comparison with chest x-ray and clinical examination keeping CT chest as gold standard.

AIM AND OBJECTIVES:

Patient's who sustained blunt chest injuries still rely on chest x-ray or computed tomography as a primary modality of investigation to rule out pneumothorax which if present needs an immediate tube thoracostomy. These investigations has their own limitation's. since EFAST (Extended Focused Assessment with Sonography for Trauma) is cheap, can be done in bed side in unstable patient's, no radiation hazard and available easily, it is essential to prove it's diagnostic accuracy to be included in ATLS survey in future.

This study is to check the utility of EFAST in blunt chest trauma patient's who were admitted in government Rajaji Hospital trauma care centre, Madurai and it's diagnostic accuracy in comparison with clinical examination, chest x-ray keeping CT-chest as gold standard investigation.

REVIEW OF LITERATURE

Many trauma patients have injuries that are not apparent on the initial physical examination. Patients can present with distracting injuries or altered mental status. Significant bleeding into the peritoneal, pleural, or pericardial spaces may occur without obvious warning signs. The purpose of bedside ultrasound in trauma is to rapidly identify free fluid (usually blood) in the peritoneal, pericardial, or pleural spaces.

Physicians in Germany and Japan began using routine bedside ultrasound for trauma patients in the 1970's. In the United States emergency physicians started using this tool in the 1980's and FAST (Focused Assessment with Sonography for Trauma) has now become the initial imaging test of choice for trauma care in the United States and is part of the Advanced Trauma Life Support (ATLS) protocol developed by the American College of Surgeons.

Recently, plenty of studies were conducted which have shown that bedside ultrasound is better than, chest radiography for identifying a hemothorax or pneumothorax in trauma patients. For this reason some trauma centers have begun performing an extended FAST examination (EFAST), evaluating for pneumo- and hemothorax in addition to intraperitoneal injuries.

Using ultrasound to evaluate for a pneumothorax is a relatively new concept but it is easy to learn. Pneumothoraces are common in trauma and more than half are missed on a supine chest radiograph. Bedside ultrasound has been shown to be more sensitive than CXR for detecting this lung injury. Using ultrasound to look for occult pneumothoraces is most important in situations where missing one could result in significant deterioration, especially patients requiring positive pressure ventilation or transport.

Plenty of studies were conducted to prove EFAST accuracy in pneumothorax. Some of which includes

Donmez [11]	2012	Turkey	Radiologist	CT, LS, LP	Linear	NC	Trauma
Abbasi [12]	2012	Iran	Emergency physician	LS, CT	Linear	NC	Trauma
Hyacinthe[a][13]	2012	France	Emergency physician	LS, CT, LP	Convex	NC	Trauma
Nandipati[b][14]	2011	United States	Emergency physician	LS, CT	Linear	C	Trauma
Nagarsheth [15]	2011	United States	Surgeon	CT, LS	Convex and linear	NC	Trauma
Xirouchaki[a][16]	2011	Greece	Intensivist	LS, CT, LP	Convex	NC	ICU
Brook [17]	2009	Israel	Radiologist	LS, CT	Convex	C	Trauma
Soldati [18]	2008	Italy	Emergency physician	LS, CT, LP	Convex	C	Trauma
Soldati [19]	2006	Italy	Emergency physician	LS, CT, LP	Convex	C	Trauma
Zhang [20]	2006	China	Emergency physician	LS, CT, LP	Convex, linear	NC	Trauma
Chung [21]	2005	South Korea	Radiologist	LS	Linear	C	Post-procedural
Kirkpatrick [22][c]	2004	Canada and United States	Surgeon	LS, CT, PDS	Linear	NC	Trauma

[a]Studies included multiple conditions; only pneumothorax patients were included.

[b]Only one intercostal space was examined in this study.

[c]Only patients with CT scans were included.

C consecutive sampling, *CT* comet tail (B-lines).

LP lung point, *LS* lung sliding, *NC* nonconsecutive (convenience) sampling. *PDS* power Doppler sign.

Donmez and his colleagues conducted a study in which One hundred thirty-six hemithoraces were assessed in 68 patients. A total of 35 pneumothoraces were detected in 33 patients. On USG, the diagnosis of pneumothorax was correct in 32 hemithoraces. In 98 hemithoraces without pneumothorax, USG was normal. With USG examination, there were three false-positive and three false-negative results. The sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy of USG were 91.4%, 97%, 91.4%, 97%, and 97%, respectively. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of CXR were 82.7%, 89.7%, 68.5%, 95%, and 89.5%, respectively. They concluded that thoracic USG is an accurate method that can be used in trauma patients instead of CXR for the detection of pneumothorax.

Yassir abdulrahman and his colleagues in 2015 conducted a similar study where a total of 305 BCT patients were included with median age of 34 (18–75). Chest CT was positive for pneumothorax in 75 (24.6 %) cases; of which 11 % had bilateral pneumothorax.

Chest CT confirmed the diagnosis of pneumothorax in 43, 41, and 11 % of those who were initially diagnosed by EFAST, CE, and CXR, respectively. EFAST was positive in 42 hemithoraces and its sensitivity (43 %) was higher in comparison to CXR (11 %). Positive and negative predictive value of EFAST were 76 and 92 %, respectively. The frequency of missed cases by CXR was higher in comparison to EFAST and CE. The lowest median score of missed pneumothorax was observed by EFAST. They concluded that EFAST can be used as an efficient triaging tool in BCT patients to rule out pneumothorax. Based on their analysis, they recommend EFAST as an adjunct in ATLS algorithm.

Abbasi, saeed and colleagues conducted a study From June 2009 until July 2009, a total of 153 patients were included. USG had a sensitivity of 86.4%, a specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 95.6%. Chest radiograph showed a sensitivity of 48.6%, a specificity of 100%, a positive predictive value of 100%, and a negative predictive value of 85.1%. The mean time to perform chest radiograph was 12 min, which was significantly higher than USG, with a mean time of 2 min. All missed pneumothoraces in USG evaluation were small in size. They finally concluded that after just a 2-hrs training course, emergency physicians showed a good success rate in finding pneumothoraces. Thoracic USG can be an easy to learn and an accurate diagnostic modality for the detection of traumatic pneumothorax in emergency departments.

In 2012 hyacinthe and his colleagues in france conducted a study to find out the accuracy of thoracic ultrasonography v combined chest radiograph and clinical examination in assessment of pneumothorax, hemo pnemothorax, hemothorax and contusion of lung in blunt injury chest patients. Among the 237 lung fields studied, they have documented

Pneumothoraces - 53,

Hemothoraces - 35, and

lung contusions -147 ,

keeping CT chest as a gold stardand investigation for confirmation of above mentioned diagnosis. The accuracy of diagnosis of ultrasonography was higher when compared with combined clinical and chest radiograpy CE + CXR, their respective areas under the receiver operating characteristic curves showed (AUC-ROC): mean 0.75 (95% CI) vs 0.62 in pneumothorax cases and 0.73 vs 0.66 for lung contusions respectively (all $P < .05$). the diagnostic capability of ultrasound chest is significantly increased in cases of severe injuries :

0.86 vs 0.70 with combined clinical examination and chest radiography(CE + CXR). In this study there is no significant difference in modalities for investigaton of hemothorax was found. they concluded that

ultrasonagraphy for chest is a investigation of choice with good sensitivity compared to combined clinical and radiographic examination for finding pneumothorax and lung contusions especially patients with hemodynamically unstable who needs resuscitation. CT chest is considered to be the gold standard investigation but it has its limitations. Regarding diagnostic ability next to CT, USG thorax is far more better.

Nandipati and colleagues of united states , prospectively analysed 204 trauma patients in our level I trauma center over a period of 12 (06/2007-05/2008) months in whom EFAST was performed. The patients' demographics, type of injury, clinical examination findings (decreased air entry), CXR, EFAST and CT scan findings were entered into the data base. Sensitivity, specificity, positive (PPV) and negative predictive values (NPV) were calculated. Of 204 patients (mean age – 43.01 ± 19.5 years, sex – male 152, female 52) 21 (10.3%) patients had pneumothorax. Of 21 patients who had pneumothorax 12 were due to blunt trauma and 9 were due to penetrating trauma. The diagnosis of pneumothorax in 204 patients demonstrated the following: clinical examination was positive in 17 patients (true positive in 13/21, 62%; 4 were false positive and 8 were false negative), CXR was positive in 16 (true positive in 15/19, 79%; 1 false positive, 4 missed and 2 CXR not performed before chest tube) patients and EFAST was positive in 21 patients (20 were true positive [95.2%], 1 false positive and 1 false negative). They concluded that in diagnosing pneumothorax EFAST has significantly higher sensitivity compared to the CXR (P = 0.02).

Nagarsheth and colleagues of united states in 2011 over a 24 months period over one hundred and twenty five patients undergo ultrasound thorax among which forty-six patients were excluded from the study due to lack of either a chest X-ray or chest CT scan. In 79 remaining patients pneumothorax was diagnosed in 22 patients by CT chest and among them 82% that is 18 patients were found on ultrasound thorax and 32% i.e., only 7 patients were diagnosed on chest X-ray. Thoracic ultrasound sensitivity was found to be 81.8 per cent and it's specificity was found to be 100 per cent, on the other hand chest x-ray sensitivity was found to be only 31.8 per cent and the specificity was found to be 100 per cent. The negative predictive value of thoracic ultrasound for pneumothorax was 0.934 and the negative predictive value for chest X-ray for pneumothorax was found to be 0.792. They recommend the use of chest ultrasound for detection of pneumothorax in trauma patients.

All of these studies shows it's growing interest in use of ultrasound in chest injuries. All of the studies concluded that ultrasound is the most sensitive modality of investigation to find pneumothorax compared to chest x-ray. Ultrasound is convenient, is a readily available bedside procedure, is easy to learn, is accurate for diagnosing pneumothorax, and avoids patient exposure to ionizing radiation.

TECHNIQUE OF EFAST

Focused bedside ultrasound can accurately detect fluid in the peritoneal and pleural cavities and air in the pleural cavity, and it is more reliable than physical examination.

Furthermore, use of bedside ultrasound in thoracoabdominal trauma expedites time to definitive care, because it can help determine whether an emergent intervention such as chest tube thoracostomy or trauma consultation and surgery are required.

Positioning:

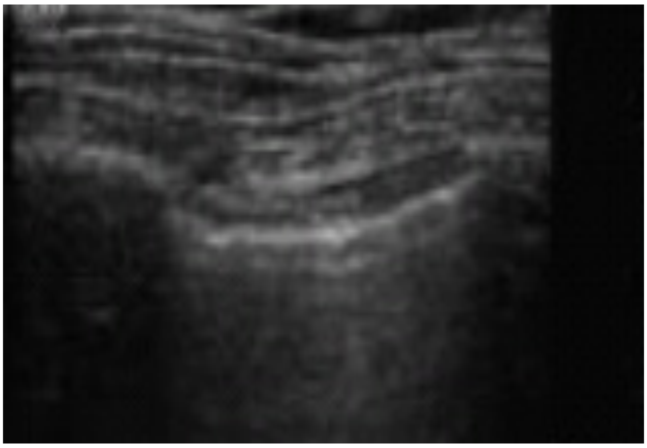
Most patients presenting with thoracoabdominal trauma will be positioned supine with the cervical spine immobilized.

Anterior Thoracic Views:

When using ultrasound to evaluate for a pneumothorax, the probe is usually placed on the anterior chest in the 3-4th intercostal space and midclavicular line. This is a starting point and a likely place to find a pneumothorax when the patient is in the supine position. Subsequent imaging can be done on any part of the chest wall if there is concern for a very small or loculated pneumothorax.

A high frequency vascular/small parts probe can be used for this exam, but a standard curvilinear abdominal probe will also work well. The most important part about this exam is decreasing the depth setting, so that the ultrasound image shows a maximum depth of about 4 cm. The probe is placed in a longitudinal position with the marker-dot pointed cephalad.

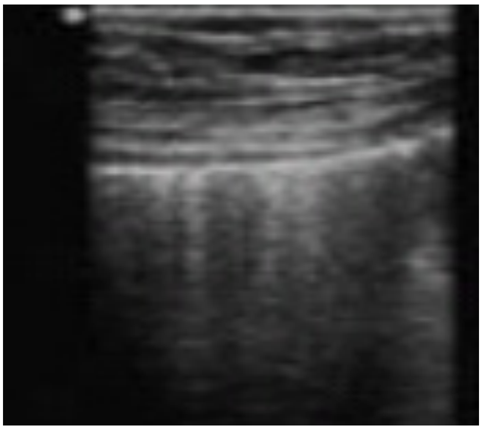
In this orientation rib shadows can be used to find the pleural plane. It is best to adjust the probe linearly until two ribs are apparent, one on each side of the image. Between the ribs the pleural interface will be apparent at the posterior border of the ribs. It is important to anchor the probe and hold it very still while looking for the sliding motion of the visceral pleura against the parietal pleura. If the "**sliding sign**" is not present, a pneumothorax is suspected. Comparing one side of the chest to the other may be helpful.



pneumothorax (absence of sliding sign)

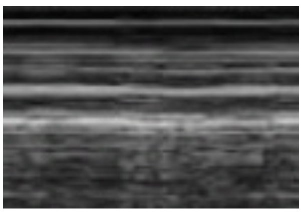
The upper rib/pleural line/lower rib profile has the appearance of a bat flying out of the screen and is referred to as the **bat sign**.

At the inferior edge of the thoracic cage, slide the probe laterally at the level of the 6th intercostal space in the anterior axillary line. Normal lung findings include visible sliding at the level of the pleura in B-mode and **comet tails**.



comet tail appearance

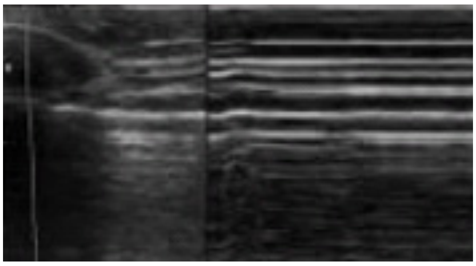
Comet tails are vertical reverberation artifacts arising from the pleural line. Lung sliding and the presence of comet tails are evidence of movement of the visceral on the parietal pleura. In M-mode, this normal lung sliding pattern is casually called the **seashore sign**.



seashore sign

Lung findings suggestive of a pneumothorax include the loss of pleural sliding, as there is loss of contact between the visceral and the parietal pleura.

A distinct pattern on M-mode commonly called the stratosphere sign will be present.

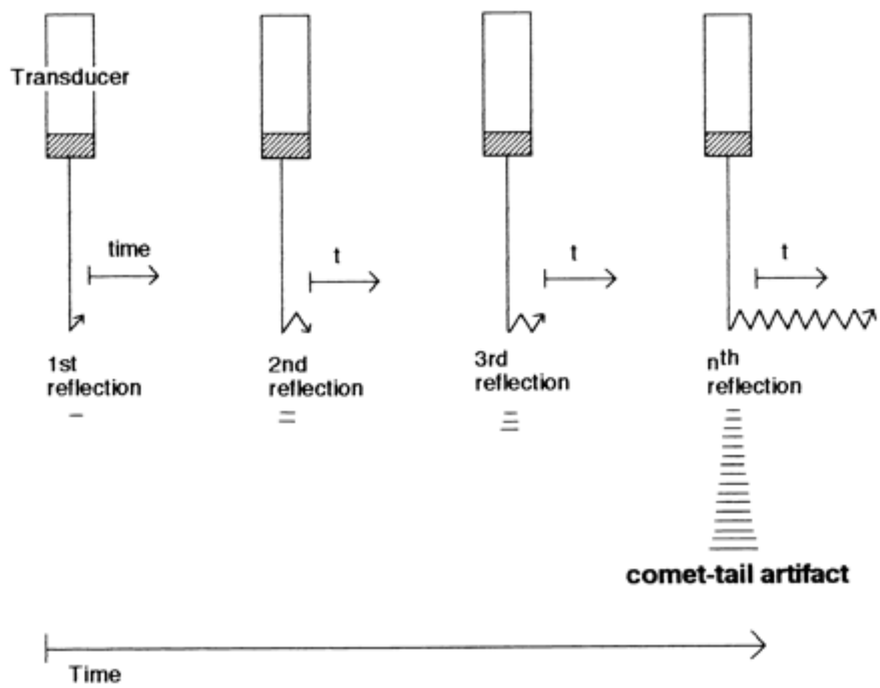


stratosphere/bar code sign

Some call this the **bar code sign**. Lung sliding may be absent in patients who are not spontaneously breathing, even in the absence of pneumothorax. If no lung sliding is present, the heartbeat may be visualized as pulsations of the expanded lung corresponding to the heart rate. This finding, referred to as the lung pulse, is equivalent to lung sliding. The lung point is the transition between collapsed and normally expanded lung. Although difficult to locate, the lung point is reportedly 100% specific for pneumothorax when present.

Mechanism of the artifact:

The comet-tail artifact appears when there is a marked difference in acoustic impedance between an object and its surroundings. The reflection of the beam creates a phenomenon of resonance. The time lag between successive reverberations is interpreted as a distance, resulting in a center that behaves like a persistent source, generating a series of very closely spaced pseudo-interfaces . The beam is "trapped" in a closed system, resulting in endless to-and-fro echoing . The figure below shows the mechanism. The path of the sound beam is shown as a function of time. When the beam meets the sub-pleural end of the thickened septum, it reflects indefinitely at a speed of 1,450 m/s, resulting in an artifact composed of all the micro-reflections. Each reflection of the beam is displayed on the screen behind the previous reflection. A distance of about 1 mm separates each reflection.



Mechanism of formation of an ultrasound lung comet

These interfaces yield, on the screen, a narrow-based laser-like ray extending to the edge of the screen. At the surface of the lung, the prominent element is air. Its acoustic impedance is very different from that of bone, parenchyma , and water. Bony tissues are not expected to be found at the surface of the lung. Normal lung contains predominantly air and little water, the comet-tail artifact described has the following features: it is related to a small water-rich structure, below the resolution of the ultrasound beam (which is about 1 mm), surrounded by air (resulting in a high impedance gradient). It is absent under normal conditions and present in alveolar-interstitial syndromes. This element has to be present at and all over the surface of the lung, and each element is separated from each other by an average distance of 7 mm. It is frequently found in the last intercostal space in normal subjects.

ANATOMY RELEVANT TO BLUNT CHEST TRAUMA

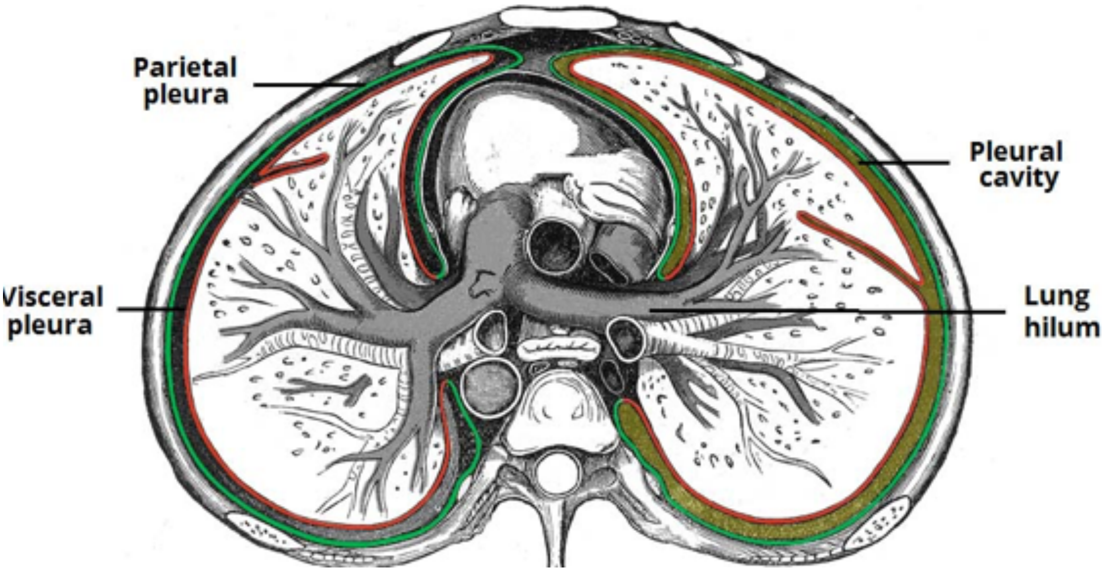
The thorax (or chest) is the region of the body between the neck and the abdomen. It is attened in front and behind but rounded at the sides. The framework of the walls of the thorax, which is referred to as the **thoracic cage,** is formed by the vertebral column behind, the ribs and intercostal spaces on either side, and the sternum and costal cartilages in front. Superiorly, the thorax communicates with the neck, and inferiorly it is separated from the abdomen by the diaphragm.

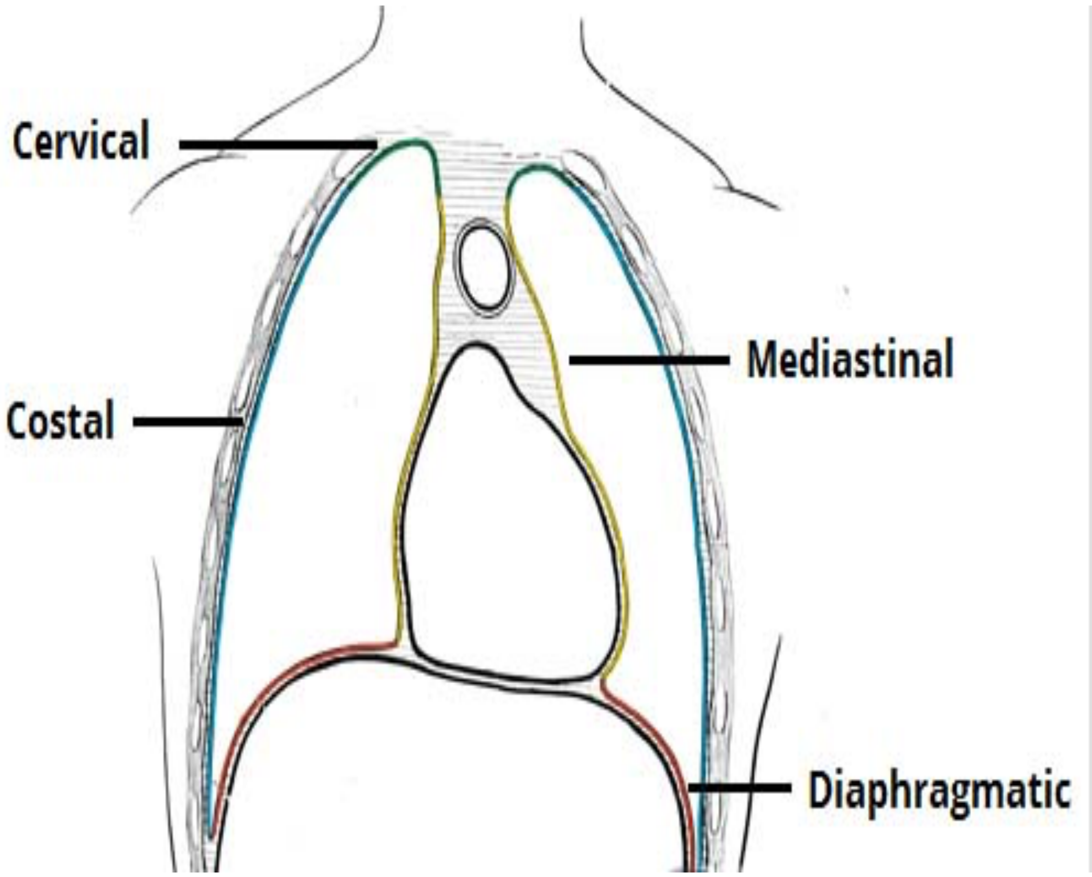
There are two pleurae in the body – one covering each lung. They consist of a **serous membrane** – this is a layer of mesothelial cells, supported by connective tissue.

Each pleura can be divided into two parts:

- **Visceral pleura** – covers the lungs.
- **Parietal pleura** – covers the internal surface of the thoracic cavity.

These two parts are continuous with each other at the **hilum** of each lung. There is a space between the visceral & parietal pleura known as pleural cavity.





The parts of the parietal pleurae.

Parietal Pleura:

The parietal pleura covers the internal surface of the thoracic cavity. It is thicker than the visceral pleura, and can be subdivided according to the part of the body that it is contact with:

- **Mediastinal pleura** – Covers the lateral aspect of the mediastinum (the central component of the thoracic cavity, containing a number of organ).
- **Cervical pleura** – Lines the extension of the pleural cavity into the neck.
- **Costal pleura** – Covers the inner aspect of the ribs, costal cartilages, and intercostal muscles.
- **Diaphragmatic pleura** – Covers the thoracic (superior) surface of the diaphragm.

Visceral Pleura

The visceral pleura covers the outer surface of the lungs, and extends into the interlobar fissures. It is continuous with the parietal pleura at the **hilum** of each lung (this is where structures enter and leave the lung).

Pleural Cavity

The pleural cavity is a **potential space** between the parietal and visceral pleura. It contains a small volume of serous fluid, which has two major functions.

It lubricates the surfaces of the pleurae, allowing them to slide over each other. The serous fluid also produces a surface tension, pulling the parietal and visceral pleura together. This ensures that when the thorax expands, the lung also expands, filling with air.

Pleural Recesses

Anteriorly and posteroinferiorly, the pleural cavity is not completely filled by the lungs. This gives rise to **recesses** – where the opposing surfaces of the parietal pleura touch.

There are two recesses present in each pleural cavity:

- **Costodiaphragmatic** – located between the costal pleurae and the diaphragmatic pleura.
- **Costomediastinal** – located between the costal pleurae and the mediastinal pleurae, behind the sternum.

These recesses are of clinical importance, as they provide a location where fluid can collect (such as in a pleural effusion).

PNEUMOTHORAX

Pneumothorax is nothing but collection of gas or air in the potential space between the parietal pleura and visceral pleura, which can interfere with the oxygenation process and/or ventilation process. Clinical findings in a pneumothorax patient depends on the magnitude of injury, amount of lung which gets collapsed and associated chest wall injuries. In some cases pneumothorax is so large that it may cause mediastinal shift and cardiovascular collapse. Collection of air between parietal and visceral pleura can occur in two main routes

- Either from outside through the chest wall
- Or from the viscera (lung) inside

INCIDENCE:

Acute trauma fulfills the criteria to classify the disease for a global pandemic, being these a frequent source and substantial contribution to morbidity and mortality in the last decades all over the world. However, there has been a significant effort to diminish its impact on humanity. The acute trauma is without a doubt the largest cause of death, taking more lives than HIV, AIDS, tuberculosis, and malaria combined. Acute trauma and injuries due to violence are a growing public health concern which causes 1 out of 10 deaths each year [1,2]. On a global scale every minute nine people die from traumatic injuries; approximately 5.8 million people die every year from non-intentional traumatic injuries and violence. Traffic accidents make up 1.3 million, suicides, 844,000, and homicides 600,000 are the leading cause for these numbers. The majority of these deaths (91%) occur in underdeveloped countries. Many traumatic lesions require immediate surgical treatment, but in many non developed countries emergency surgery is not readily available due to lack of workforce, medical equipment, and lack of safe anesthesia [3]. Blunt chest trauma produces 25% of traumatic deaths; these injuries contribute up to 50% of global mortality caused by trauma. Blunt chest trauma is commonly associated with multiple organ damage that favor catastrophic patient outcome. A study with 22,613 patients over 16 years of age, with blunt thoracic trauma (AIS Chest ≥ 2) pulmonary, cardiac, and vascular lesions were found to be predictors of negative outcome while chest wall lesions -except bilateral flail thorax due to multiple costal fractures- will not influence significantly the mortality rate. Some non-thoracic factors such as; age, blood transfusion, arterial hypotension, and severe lesions were also predictors for the elevated mortality rate

The studies of Battle et al. with blunt thoracic trauma found that the patients over the age of 65, who have three or more rib fractures, pneumonia, and pre-existing cardiopulmonary diseases had a higher mortality rate, and the cases with flail thorax had a higher mortality rate which was ISS ≥31, age ≥65 years. In the last group pulmonary contusion, flail thorax, and prolonged hospitalization were consistently associated with higher mortality rate. Thoracic trauma is responsible for 25% of all the deaths by trauma; when it is associated with other lesions, produce a fatal outcome in an additional 50% of polytrauma especially if cardiovascular system is involved.

INCIDENCE IN INDIA

Thoracic injuries are found to be the primary or a contributing cause of about a quarter of all trauma related deaths in India. The mortality rate in these cases is about 10%. Thoracic injuries account for 20-25% of deaths due to trauma. Approximately, 16,000 deaths per year in India alone are a result of chest trauma.[2] The increased prevalence of penetrating chest injury and

improved pre hospital and intra operative care have led to increasing number of critically injured but potentially salvageable patients presenting to trauma center. Chest trauma contributes to major accidental injuries in India, due to increased incidence of vehicular accidents (6% of global vehicular accidents) due to increased road traffic, availability of new high-speed vehicles, and ignorance or unawareness of traffic rules.[3,4] A very few studies have been conducted to analyze its magnitude and management in Indian scenario.

Jigar v. shah et al conducted a study regarding epidemiology of chest trauma in 2014 – 15 in 100 patients and compared his study with few other ones and reported as follows

Series	**Blunt chest trauma (%)**	**Penetrating chest trauma (%)**
Ozgen and Duygulu (1971-1980)	949 (65.4)	504 (34.7)
Kulshrestha *et al*. (January 1983-July 1985)	149 (63.1)	87 (36.9)
Bispebjery Hospital (1973-1978)[4]	181 (80.6)	75 (9.3)
Jigar et al	95 (16.25)	5 (0.41)

series	Sternal #	Clavicle #	Flial chest	Scapula #	**Hemo-pneumothorax**	Hemo thorax
Kulshrestha *et al*.	2.10	14.1	-	6.7	**-**	-
Ramussen *et al*.	2.15	-	10.7	-	**30**	22
Shorr *et al*.	4.95	8.3	10.3	4.85	**21.5**	10.4
Laustelia	5.59	-	-	-	**-**	-
Jigar *et al*	1	8	17	9	**5**	20

They concluded that the outcome and prognosis for the majority of chest trauma are excellent. Majority of these cases (>80%) require either no invasive therapy or may require an intercostal tube drainage at most.

Type of thorax injuries

The type of traumatic chest injuries varies widely and essentially depends on the violent environment or the kinematics and severity of the accidents in the diverse geographical regions around the world. The injuries are divided into four groups:

1. Thoracic wall,
2. Lung,
3. Mediastinum, and
4. Diaphragmatic wounds.

Pulmonary lesions:

This type of lesions can be moderate to severe with imminent death. The clinical skills during pre-hospital care and in the emergency room are essential to determine if there is pulmonary damage as described in the following paragraphs.

Simple pneumothorax: It refers to a non-complex lesion that contains air within the pleural cavity, non-progressive injury, usually secondary to rib fractures or bronchial ruptures that produces a small pulmonary collapse. Typically is a non-life- threatening damage and most patients are hemodynamically stable, with reduced respiratory sounds, thoracic hyper resonance to percussion, with or without hypoxia. Diagnosis can be corroborated with a USG/chest X-ray. Is important to mention that the trachea can be identified in the middle line unlike the tension pneumothorax. Pleural catheter being the standard treatment, however, conservative treatment is another option management in some cases.

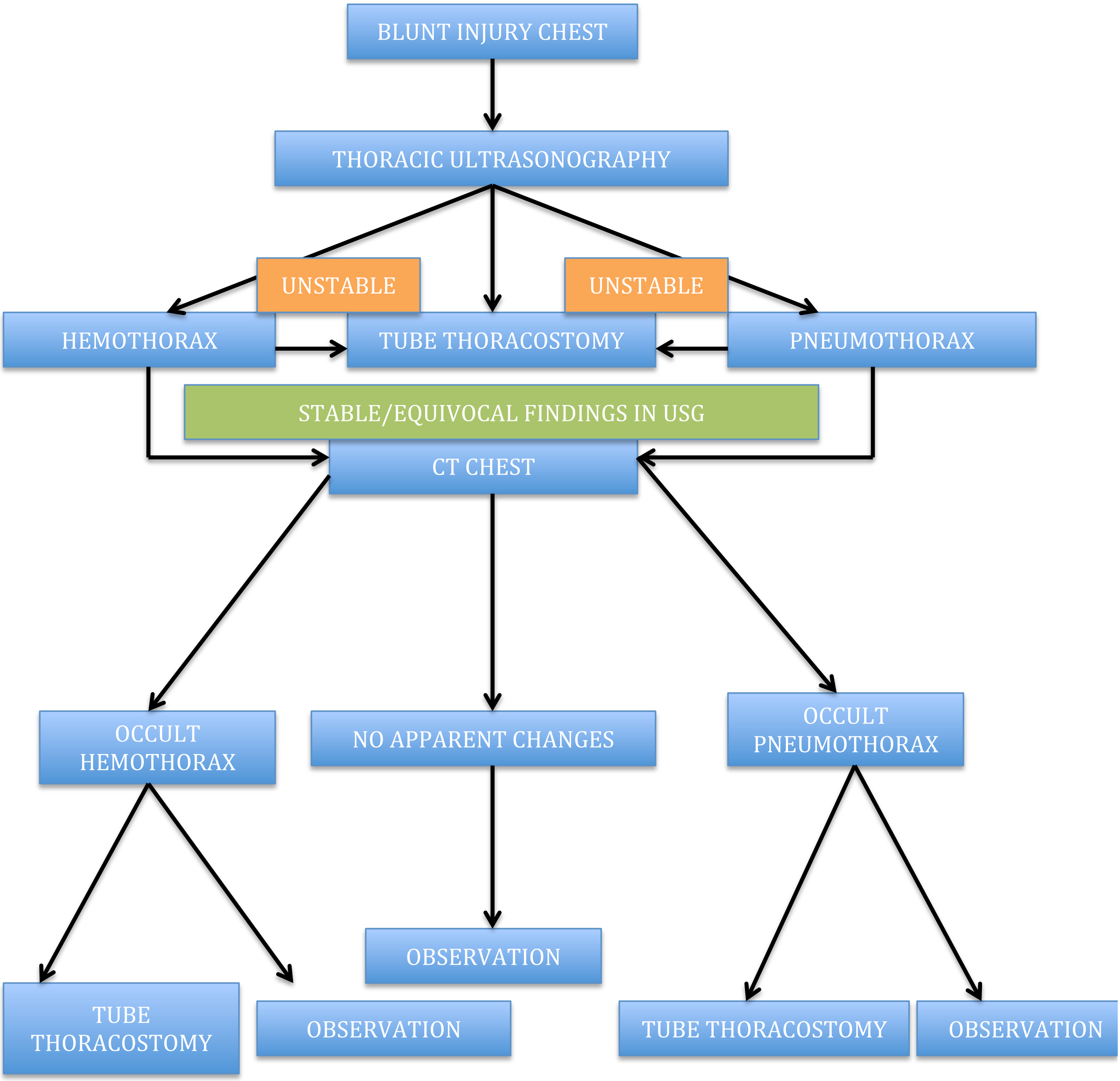
Tension pneumothorax: In contrast with previous injury, these patients are in extreme risk of death if a pleural catheter is not inserted immediately. It pertains to a unidirectional valve effect that does not allow the interpleural air outflow which has been accumulating to the point of becoming hypertensive, creating severe collapsed lung, with dangerous contralateral deviation of the mediastinal organs. There is a reduction in venous return. The clinical diagnosis must be immediate,if doubtful EFAST should be done and usually there is no time for a chest X-ray. There are clinical signs of shock, hypoxia, chest hyper resonance and diminished or abolished respiratory murmurs. The affected hemithorax is hyper expanded, with an evident inspiration decrease. This pertains to a super acute and nervousness patient in need of immediate decompression with a thorachostomy needle that transforms a hypertensive pneumothorax in an open pneumothorax. Afterwards, a chest tube is placed and a USG/ chest-X-ray is taken to verified diagnosis and proper interpleural tube placement.

Open pneumothorax: It’s the easy entry of air into the pleural cavity through a great chest wall penetrating wound, usually greater than

70% of the tracheal diameter. This type of pneumothorax can become hypertensive. There are ventilatory changes and its diagnosis is evident. “Sucking and bubbling” can be seen when air is entering and exiting the pleural space in the site of injury. The diagnosis is confirmed with a USG/plain X-ray and treatment consists of high naso-oral oxygen flow, pleural tube placement and/or a chest wall occlusive wound healing procedure.

Diagnosis

Timely and accurate diagnosis of trauma victims should be in the hands of the most qualified professionals. General algorithm of the evaluation and management of patients with chest trauma is given below



ALGORITHM FOR EVALUATION AND MANAGEMENT OF BLUNT INJURY CHEST

Primary evaluation: In primary assessment of chest trauma patients the process of diagnosis and prompt treatment should be started simultaneously, searching and managing life-threatening lesions such as airway obstruction, tension pneumothorax, open pneumothorax, massive hemothorax, flail chest and cardiac tamponade. It is mandatory to monitor ECG, blood pressure, pulse oximetry and capnography. In this primary evaluation ultrasound and blood gases are taken and decide whether to intubate the trachea, needle thorachostomy, chest tube thoracotomy in the emergency room, and/or pericardiocentesis.

Secondary assessment: Once the life-threatening lesions are identified and treated a more extend and meticulous evaluation must be done. The first step is to make a complete and detailed review of the case. If there are relatives or friends we must obtain complete data of the patient's medical history that can be relevant for the immediate comprehensive management: diabetes, hypertension, heart disease, lung disease, possible pregnancy, drug addiction, medications, etc. It is also important to collect data on the kinematics of trauma: type of accident or aggression, bleeding at the site, killed, etc. We must review all chest wall, lung parenchyma, diaphragms, mediastinal silhouette and other extra-pulmonary or thoracic injuries. If there is any diagnostic doubt and patient conditions permit, we may request a CT, CT angiography.

Once the diagnosis is definitive, management is required and the patient can be sent home, to hospitalization, to the surgery room, or to the intensive care unit.

Pre-surgical evaluation:

The assessment must be fast, opportune and at the same time of resuscitation and anesthetic induction. Even after and during anesthesia it is important to obtain more patient data, and overall data about trauma kinetics, transportation and emergency room arrival. If possible, inquire about patient medical history.

Treating shock:

The prompt reinstatement of the circulatory volume is critical to restore the supply of oxygen and prevent cell death, especially in vital organs like the brain, heart, liver, kidneys and lungs. While handling the shock usually starts at the site of the accident and in the emergency room, as anesthesiologists we must continue the measures set out above, setting the type and volume used in each patient to prevent further damage in the perioperative period, as to adjust the doses of vasoactive drugs, anti-arrhythmic, etc.

Airway management:

The patients with trauma must be considered as a difficult airway case, with high possibility of a full stomach and cervical spine injury. The primary goal is to provide adequate oxygenation and prevent further damage. Possible airway obstructions need to be correct, start mask ventilation and tracheal intubation with protective airway maneuvers and rapid sequence .

Choice of anesthetic drugs:

There are many different alternatives of anesthetic drugs, but these are chosen in relation to the physical condition of each patient, type of trauma, drug availability and experience of each anesthesiologist. General anesthesia is by far the most used and regional techniques are used for postoperative analgesia. When patients are hemodynamic instable, we must be extra careful with the dosage of inductor agents and maintenance.

ICU treatment considerations

All patients with moderate or severe chest injuries should be admitted to the ICU, especially when they have been operated or when they require mechanical ventilation. It is necessary to pay special attention to four parameters: intravenous fluids, mechanical ventilation, analgesia and management of concomitant injuries.

Intravenous fluids:

The type and volume of intravenous fluids for these patients is an issue whit an ongoing debate and no consensus have been universally approved. Therapeutic alternatives are multiple and in patients with chest trauma the main goal is the restoration of circulating volume, shock management, without overloading in order to avoid serious lung inflammatory changes that alter hematosis. It should maintain cerebral, myocardial, lung, liver and kidney perfusion to prevent further damage as already mentioned. Colloids with starches are useful in the initial resuscitation phase and are safe during surgery, but its use has recently been questioned, as they have the possibility of serious side effects, including acute renal failure. Also human albumin and hypertonic solutions have very limited indications in these patients.

Ventilatory support:

Patients with pulmonary contusion, respiratory failure or abnormalities in blood gases (pO_2 <60 mmHg and pCO_2> 60 mmHg) require some type of ventilatory support. Pneumothorax should be resolved with a chest tube before starting mechanical ventilation to prevent a secondary tension pneumothorax. When there is a bronco pleural fistula the patient should have a thorachostomy tube to avoid persistence of the fistula. When the fistula is large it is convenient to opt for independent lung ventilation. In cases whit pulmonary contusion it is recommended to use intermittent positive pressure ventilation. Use predetermined volume or pressure mode, low tidal volumes, airways low pressure, with low oxygen concentration with the aim to protect the lung. The high PEEP (14-16 cm H_2O) is reserved for cases with severe pulmonary compromise. Hypercapnia can be tolerated provided that the pH exceeds 7.2. There are patients who can tolerate ventilatory non-invasive methods.

Pain treatment:

Management of acute traumatic pain and acute postoperative pain in this clinical scenario is mandatory in order to avoid more complications due to the hyper adrenergic state of these patients. Intravenous pure agonist opioids like morphine, fentanyl, and remifentanil are effective in most patients. It is also possible to use opioids patches with fentanyl or buprenorphine for transdermal opioids delivery. This type of administration is non-invasive, effective and safe. It is judicious to combine opioids with non-opioids drugs. Although intravenous opioids are the most appropriate drugs, epidural analgesia is associated with a significant outcome improvement in multiple ribs fractures patients. Some peripheral nerve blocks with local anesthetics can be used; intercostal, paravertebral, or interpleural.

The trauma of the chest is a disease that has worsened due to the modernity that means worldwide increases in violence and accidents. This is a serious condition, which often multifaceted growing involves other anatomical regions that merit simultaneous treatment.

Ideal management should be multidisciplinary and ideally start before their arrival at the hospital and maintain it during transport, in the emergency room, the operating room and then in ICU. Early diagnosis and early aggressive management are the key to bring down morbidity and mortality.

TUBE THORACOSTOMY:

Up to 85% of all thoracic injuries can be managed with nothing more than a tube thoracostomy. In most cases, the placement of a chest tube is urgent but may still be performed in a controlled manner that includes strict sterile preparation and excellent surgical technique is of great importance given the morbidity associated with an empyema that can result from improper chest tube placement.

The chest should be prepared appropriately using more than just a splash of povidone-iodine (Betadine) as well as wide draping to maintain the sterility of the field and the tube to be placed.

The skin incision should be at the level of the nipple to stay superior enough to avoid the highest reach of the diaphragm. A tunnel is created in a superior direction and the chest is entered bluntly in an interspace above the skin incision. The lung is palpated to confirm chest entry and evaluate for intrathoracic adhesions. A tube large enough to drain blood (typically 32 to 36 Fr) is then advanced superiorly through the incision and posterior to the lung. Chest tubes that are being placed only for a pneumothorax can be positioned in the anterior hemithorax. A valuable maneuver is to spin the tube to confirm that it is not kinked, which would result in poor drainage. The thoracostomy is then connected to an underwater drainage device providing 20 cm H_2O suction.

Tube thoracostomies that drain large amounts of blood on initial placement or demonstrate ongoing output may indicate active intrathoracic bleeding that requires thoracotomy. Typically, immediate thoracotomy is indicated for more than 1500 mL of blood drained on chest tube insertion or more than 300 mL/hr for 3 hours.

Although these values clearly may be associated with intrathoracic bleeding, the decision to operate should be carefully considered, especially with regard to the immediate output. Occasionally, chest tubes that initially drain 1500 mL but then have little ongoing output in the setting of hemodynamic stability indicate bleeding from a lung laceration, which ceases with lung reexpansion and may not require or bene t from thoracotomy.

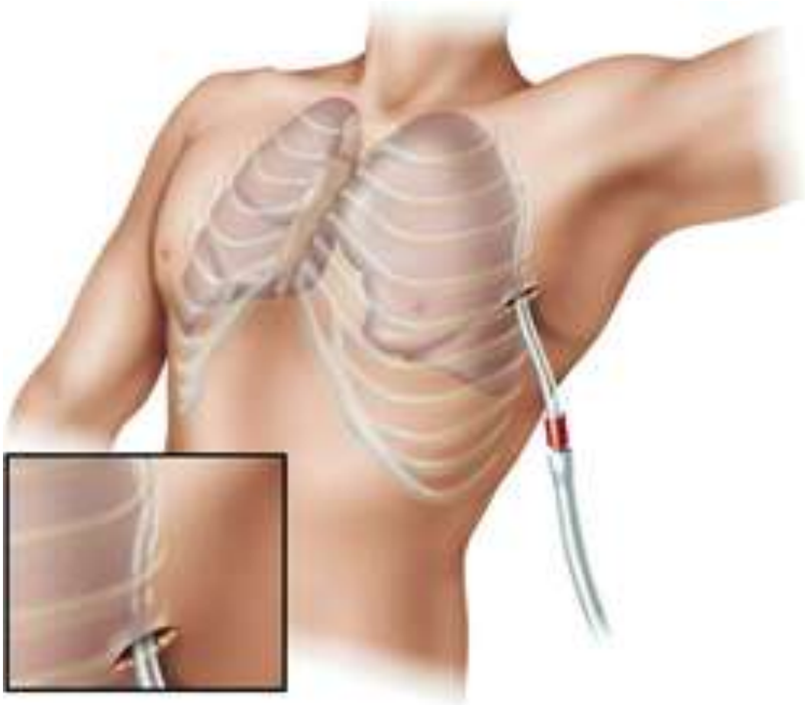
Other indications for immediate thoracotomy include

1)massive air leak with associated pneumothorax or

2)drainage of esophageal or gastric contents from the chest tube.

The choice of thoracic approach depends on the presumed injured structures. Access to the lungs, pulmonary vasculature, and hemidiaphragm is through a posterolateral thoracotomy that is best performed through the fifth interspace, with or without removal of the fifth rib. On the right, this incision also exposes the proximal and mid esophagus, as well as the trachea and bilateral main stem bronchi. A left thoracotomy is valuable for approaching the distal esophagus, the left lung, the left ventricle, the descending aorta, and the left subclavian artery.

A median sternotomy can be a highly versatile approach, allowing exposure of the right heart, ascending aorta, aortic arch with right-sided arch vessels, and pulmonary vasculature.



Complications

- Infection.
- Displacement and inadequate functioning.
- Injury to intercostal vessels and bleeding.
- Pain at the site of ICT placement.

Fractures of the ribs are the most common thoracic injury following blunt trauma, with almost 80% of patients with chest injuries sustaining one or more fractures. The chest wall is also commonly involved during penetrating mechanisms, present in 25% of penetrating chest trauma cases. The mortality rate associated with chest wall injuries following blunt trauma is approximately 10%; it exceeds 20% for penetrating injuries.

Rib fractures typically occur secondary to compression of the thoracic cage in an anteroposterior or lateral direction that often will dictate the location of the cortical disruption along the rib. Steering wheels and seatbelts are commonly identified as the impinging structure resulting in a fracture. In its most severe form, large amounts of energy transferred to the chest wall can result in the creation of a flial segment, defined as two or more adjacent ribs that are each fractured in two or more locations. This results in a separation of a segment of the chest wall.

Although pulmonary mechanics can be disrupted in the setting of a flial segment, the greatest physiologic insult is caused by the underlying pulmonary contusion that almost invariably occurs. A pneumothorax occurs with compression of the chest that tears the surface of the lung through a blow-out type mechanism or via laceration from a fractured rib, causing the accumulation of air in the pleural space. Similarly, bleeding from the injured chest wall or lacerated lung can result in a hemothorax as blood accumulates in the pleural space.

Rib fractures can vary greatly in severity, depending on the number present and patient characteristics. Associated pain can be severe and a great concern is the development of respiratory infections. Aggressive analgesia should be provided to allow adequate pulmonary toilet and promote comfort.

Adequate analgesia can be achieved with IV narcotics in mild cases but, in more severe cases, patients benefit greatly from the provision of epidural analgesia. Epidural analgesia after chest wall injuries has been associated with fewer ventilator days, shorter intensive care unit length of stay, and fewer hospital days.

Bulger and coworkers have demonstrated fewer pulmonary infections and decreased duration of mechanical ventilation with the use of epidural analgesia in patients with three or more rib fractures. Non-steroidal antiinflammatory drugs (NDAIDs) are also beneficial in conjunction with narcotics. Aggressive pulmonary toilet, including deep breathing, frequent coughing, and incentive spirometry, should be highly encouraged. Chest physical therapy and positive expiratory pressure exercises may also be beneficial. Severe chest wall injuries with pulmonary failure may require mechanical ventilation.

There has been renewed interest in the operative fixation of rib fractures, although the optimal indications to perform these procedures and their associated benefit remains incompletely defined. Sternal fractures are managed similar to rib fractures requiring analgesia and pulmonary toilet.

Occasionally, sternal fractures result in the development of a mediastinal hematoma. Although these typically do not require specific treatment, the presence of active bleeding from the adjacent internal mammary artery may require angioembolization or open ligation in the setting of hemodynamic instability.

The management of pulmonary contusion is largely supportive. Patients should be monitored for indications of respiratory decompensation such as hypoxemia, increased work of breathing, and agitation, which mandate intubation and mechanical ventilation. Pulmonary function is supported until the physiologic insult related to the contusion resolves.

CLINICAL DIAGNOSIS OF PNEUMOTHORAX:

History of trauma, painful breathing, cough, haemoptysis, pain in the chest wall, sometimes external wound may be present (in communicating wounds).

A pneumothorax patient may present with a spectrum from stable asymptomatic picture or a life threatening respiratory distress .some of the symptoms include pleuritic chest pain, breathlessness, palpitation, diaphoresis and in case of tension pneumothorax cyanosis may be present. Findings on auscultation also depends mainly on the extent of pneumothorax after the trauma. Central nervous system manifestations like altered mental status is usually rare with isolated blunt chest trauma.

Clinical findings may include:

- Tenderness over the fracture site.
- Most of the time presents with tachypnea.
- Surgical emphysema with palpable crepitus may be present.
- Acute respiratory distress/arrest.
- Mediastinal shift to contralateral side can occur with a large

tension pneumothorax so as the tracheal deviation.

- Diminished breath sounds on the affected side is one of the common findings in pneumothorax. But in some cases even with large pneumothorax this finding may not be evident.
- In case of large pneumothorax

  Clinical examination might show hyper resonance at the affected areas due to the presence of air beneath the chest wall.
- Tactile fremitus is reduced.
- Other added lung sounds like rales , rhonchi may be present.

Findings in cardiovascular system in a blunt chest trauma:

- Tachycardia:

  Increased heart rate is the most common sign in a case of pneumothorax. If the heart rate is more than 140 beats per minute the we should suspect a tension pneumothorax.
- Pulsus paradoxus
- Jugular venous distention:

  In a tension pneumothorax patient with a normal bllod pressure jugular venous distension may be seen. It is usually absent in case of hypotensive patients.
- Hypotension:

Hypotension per se is not an early finding in acase of pneumothorax. Eventhough tension pneumothorax can present with a hypotension, it is usually a late complication due to cardiovascular collapse that occurs as a result of hypoxic insult to heart.

- In some rare cases cardiac apical displacement may be seen.

Life threatening chest injuries:

Inspection	Palpation	Percussion	Auscultation	Diagnosis
Restricted Chest move	CCT=+/-	Hyper-resonant	B.S= Dec/ -	Tension Pneumothorax.
Open wound	CCT=+/-	Hyper-resonant	B.S=Dec/-	Open Pneumothorax
Restricted chest move	CCT=+/-	Dullness	B.S=Dec/-	Massive Haemothorax
Paradoxical movement Asymetry	CCT=+	Dull/Hyper	B.S=Dec/-	Flail Chest with pulmonary contusion

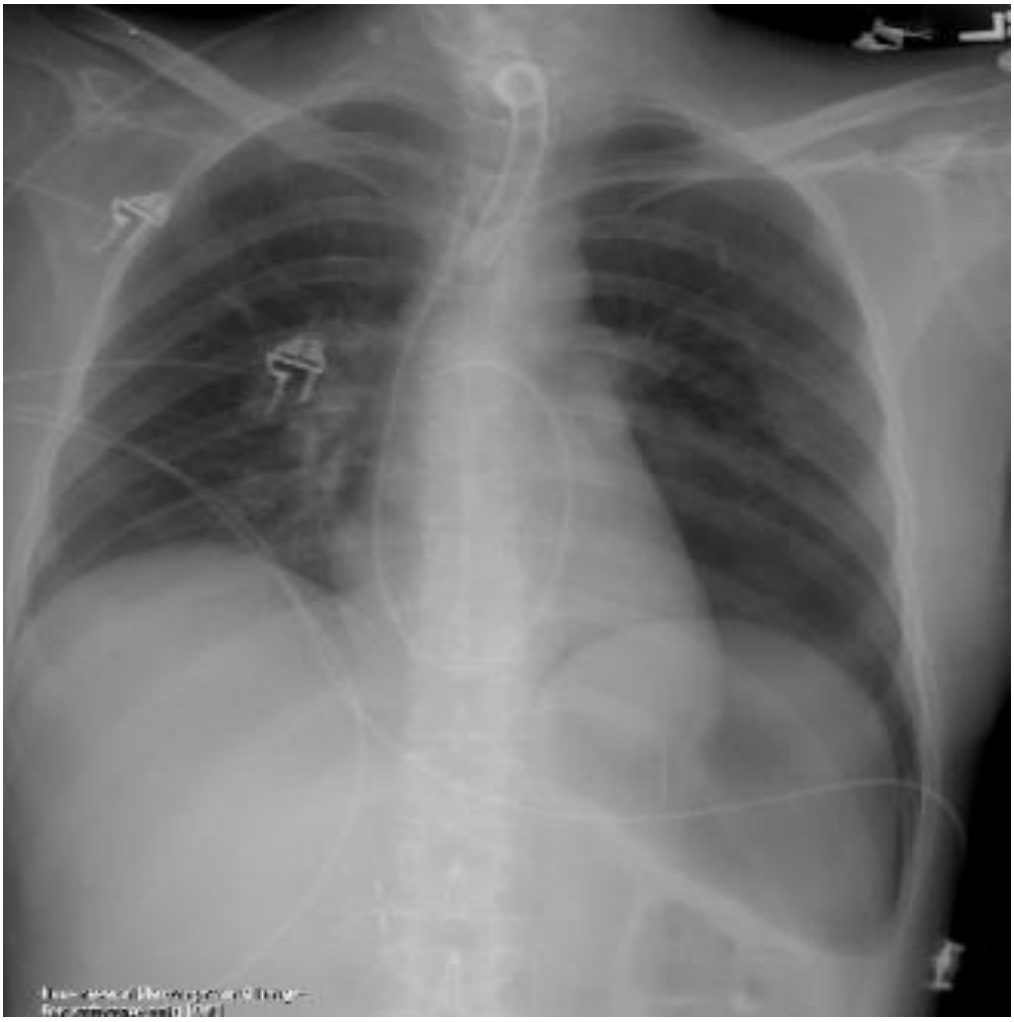
CHEST X-RAY FINDINGS:

The diagnosis of pneumothorax is established by demonstrating the outer margin of the visceral pleura (and lung), known as the pleural line, separated from the parietal pleura (and chest wall) by a lucent gas space devoid of pulmonary vessels. The pleural line appears in the image below).

The pleural line may be difficult to detect with a small pneumothorax unless high-quality posteroanterior and lateral chest films are obtained and viewed under a bright light. A skin fold may mimic the pleural line; usually, the patient is asymptomatic.

In erect patients, pleural gas collects over the apex, and the space between the lung and the chest wall is most notable at that point.

In the supine position, the juxtacardiac area, the lateral chest wall, and the subpulmonic region are the best areas to search for evidence of pneumothorax (see the image below). The presence of a deep costophrenic angle on a supine film may be the only sign of pneumothorax; this has been termed the deep sulcus sign.



The most common radiographic manifestations of tension pneumothorax are mediastinal shift, diaphragmatic depression, and rib cage expansion.

Any significant degree of displacement of the mediastinum from the midline position on maximum inspiration, as well as any depression of the diaphragm, should be taken as evidence of tension, although a definite diagnosis of tension pneumothorax is difficult to make on the basis of radiographic findings. The degree of lung collapse is an unreliable sign of tension, since underlying lung disease may prevent collapse even in the presence of tension. Pleural effusions occur coincident with pneumothorax in 20–25% of patients, but they usually are quite small. Hemopneumothorax occurs in 2–3% of patients with spontaneous pneumothorax. Bleeding is believed to represent rupture or tearing of vascular adhesions between the visceral and parietal pleura as the lung collapses.

False positives/negatives

Differentiating the pleural line of a pneumothorax from that of a skin fold, clothing, tubing, or chest wall artifact is important. Careful inspection of the film may reveal that the artifact extends beyond the thorax or that lung markings are visible beyond the apparent pleural line. In the absence of underlying lung disease, the pleural line of a pneumothorax usually parallels the shape of the chest wall.

Artifactual densities usually do not parallel the course of the chest wall over their entire length. Avascular bullae or thin-walled cysts may be mistaken for a pneumothorax. The pleural line caused by a pneumothorax usually is bowed at the center toward the lateral chest wall. Unlike in pneumothorax, the inner margins of bullae or cysts usually are concave rather than convex and do not conform exactly to the contours of the costophrenic sulcus. A pneumothorax with a pleural adhesion also may simulate bullae or lung cysts.

EFAST FINDINGS:

Equipment

A portable ultrasound machine with a high-frequency (5-10 MHz) linear probe is typically used. A curvilinear, low-frequency probe (2-5 MHz) is employed by some sonographers; although it is more difficult to use accurately, it allows the entire E-FAST examination to be performed without any switching of probes. Most studies evaluating the sensitivity of bedside ultrasonography in detecting pneumothoraces have used high-frequency linear probes, which are the standard recommendation for novice practitioners.

Patient preparation

Sedation is typically not required for bedside ultrasonography. The patient should be placed in a supine position (see the image below). If it is clinically necessary, the patient may also be examined while sitting upright, but this positioning may reduce the sensitivity of ultrasonography for detecting small pneumothoraces.

Technique

Ultrasonographic evaluation for pneumothorax

Examination should begin with the patient in a supine position and at the most superior portion of the chest, which should correspond to the least gravitationally dependent area of the thorax. This is usually in the third or fourth intercostal space in the mid-clavicular line.

Although there is no absolute standard, examination of 2 or 3 interspaces is generally recommended for a complete examination. Increasing the number of interspaces evaluated on thoracic ultrasound will increase the sensitivity of the exam.

The ribs are identified; these will appear hyperechoic, and their acoustic shadows will appear as hypoechoic rays extending from the ribs. The interspace between the 2 ribs is used as a fixed anatomic landmark during the examination. Next, the pleural line is identified; this is a hyperechoic line found at the inferior border of the space between the 2 ribs.

Ultrasonographic findings suggestive of a pneumothorax have been thoroughly researched and are well described in the literature. The following is a summary of the most routinely used diagnostic signs.

Findings suggestive of pneumothorax

The presence of a pneumothorax is characterized by the following findings:

(1) The absence of pleural (lung) sliding;

(2) The absence of so-called comet-tail artifacts, also referred to as B-lines;

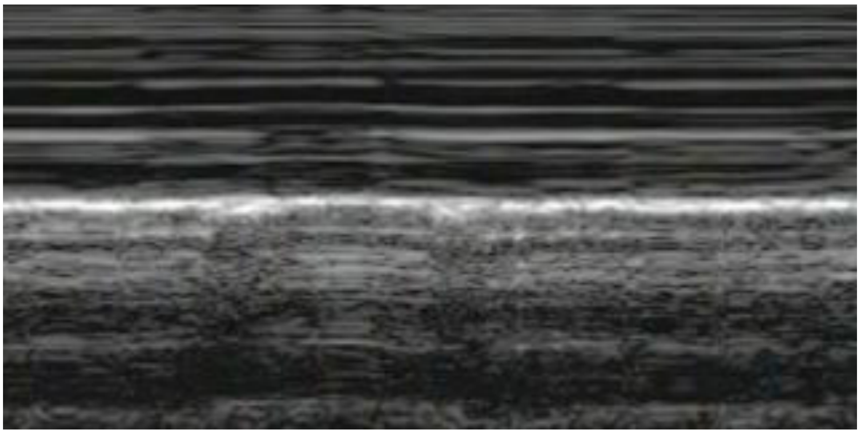
(3) The absence of a lung pulse; and

(4) The presence of one or more lung points. The so-called lung point is a somewhat recently described sign that, although difficult to identify, is pathognomonic for a pneumothorax and can be used to measure the size of the pneumothorax.

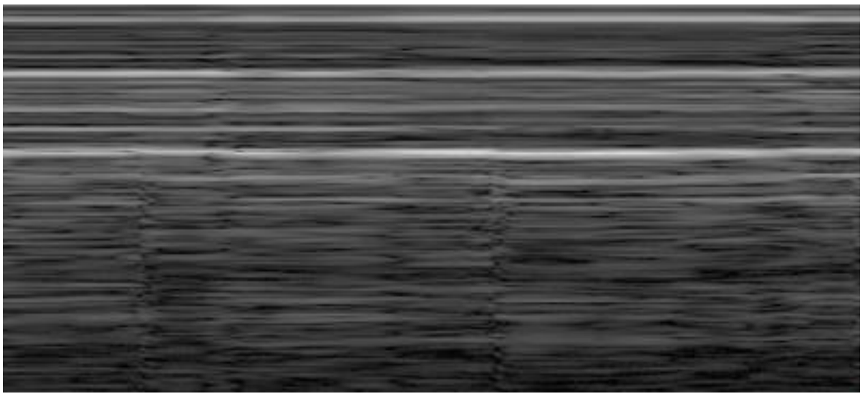
Absence of pleural sliding and lung pulse

In normal patients, the pleural line represents both the parietal and visceral layers of the pleura, and back-and-forth sliding of that line is easily visualized during the respiratory cycle. The lung pulse refers to the subtle movement of the visceral upon the parietal pleural along with cardiac beats. In the presence of a pneumothorax, air accumulates between the 2 layers and blocks transmission of sound waves, so that the sliding is not visualized. This phenomenon can be seen in real time in the 2-D mode but is more easily visualized by viewing a still image in M-mode.

The appearance of normal lung has been described as the seashore sign (see the first image below). This term refers to the change in appearance between soft tissue and lung, divided by the pleural line, a change resembling that between sand and sea waves. In the presence of a pneumothorax, this demarcation is lost, and the appearance on M-mode imaging is described as the stratosphere sign (see the second image below).



SEASHORE SIGN



STRATOSPHERE SIGN/BAR CODE SIGN

Absence of comet tails

Comet tails are artifacts that are thought to be created when ultrasound waves bounce off the interface between the apposing visceral and parietal layers of the pleura. They appear as hypoechoic vertical ray-like projections off the pleural line and are parallel to the rib shadows previously noted.

The presence of air in the pleural space inhibits the propagation of sound waves, preventing the appearance of comet tails. Comet-tail artifacts may be hard to visualize, requiring considerable patience; the transducer should be kept in a fixed location on the chest as the dynamic lung is observed sliding throughout the expiratory cycle. The presence of comet tails is 60% specific for the absence of pneumothorax. Combined with the absence of lung sliding, the absence of comet tails has a negative predictive value of 100% and a specificity of 96.5%.

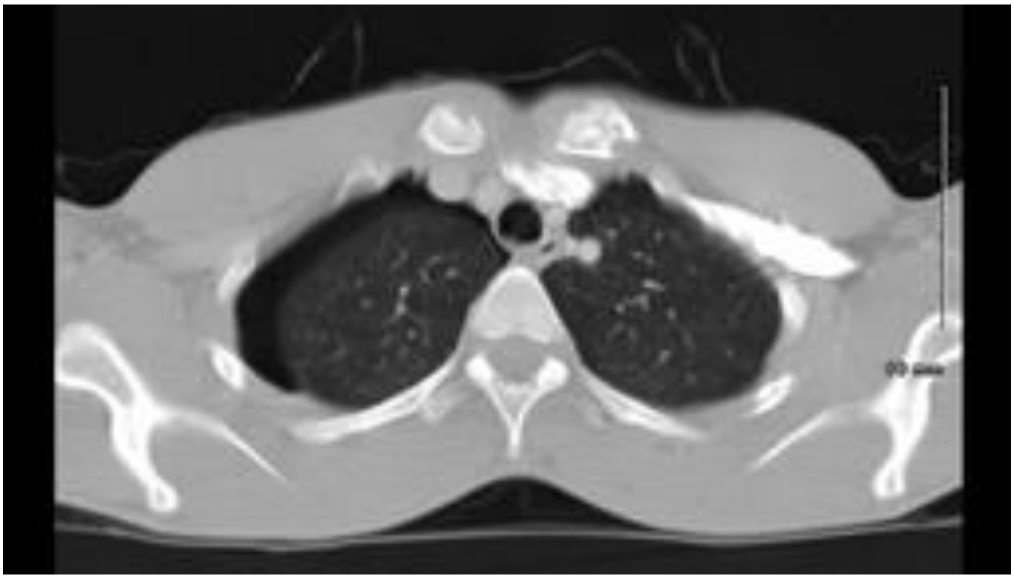
Lung point

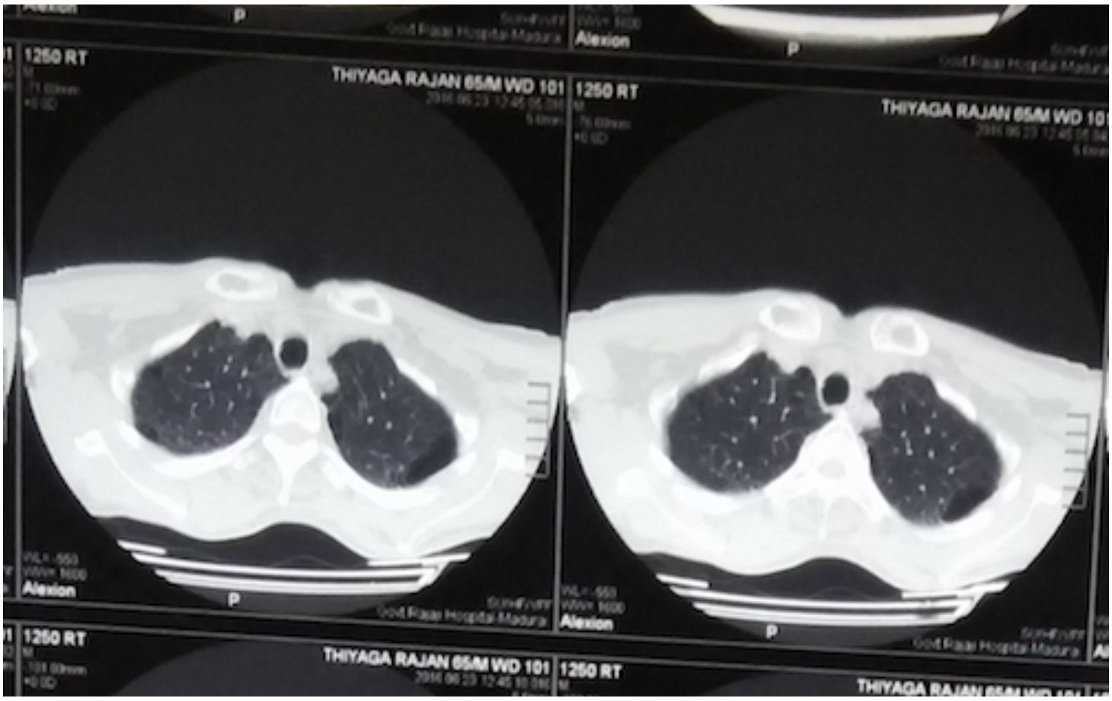
The lung point is a more recently described sign that is pathognomonic for the presence of a pneumothorax. The lung point is the actual point at which the normal lung pattern (ie, lung sliding and comet-tail artifacts) is replaced by a pattern consistent with a pneumothorax (ie, no lung sliding and no comet-tail artifacts).

The lung point is a dynamic sign and, like the comet tails, can be visualized only by keeping the transducer in a fixed position and watching the pleura throughout the respiratory cycle. This point should be sought by longitudinally scanning the anterior, lateral, and posterior positions of the chest wall. Although it is the most specific sign of pneumothorax, it is also the hardest to visualize and may require an experienced operator to locate. Finding both transition zones (from normal lung to pneumothorax and then back again) allows calculation of pneumothorax size.

CT Chest Findings:

CT Scanning is more sensitive for the presence of pneumothorax than plain chest X-ray. However the significance of these small pneumothoraces is unknown. A small anterior pneumothorax is not visible on the plain radiograph but visible on CT. Many of these 'occult pneumothoraces' may be managed without chest tubes, even in the presence of positive pressure ventilation.





METHODOLOGY

Patient's with history of blunt injury chest attending Govt Rajaji Trauma Care Centre for the period of 1 year were included in this study.

A verbal consent was taken from the conscious patients and attender's of unconscious patients in this study.

Sample size was 140 patients with blunt injury chest who fulfills the inclusion criteria. Inclusion and exclusion criteria of the patients were defined and applied.

DESIGN OF STUDY :

Prospective study

PERIOD OF STUDY :

1 year

COLLABORATING DEPARTMENT :

Radiology

SELECTION OF STUDY SUBJECTS :

All patients satisfying inclusion criteria admitted in Govt. Rajaji hospital for the period of 1 year

INCLUSION CRITERIA:

All blunt chest trauma patients admitted in Govt Rajaji Trauma Care Centre who requires CT-chest evaluation

EXCLUSION CRITERIA:

- Hemodynamically unstable patients
- Pregnant mothers
- Patients in whom chest tube inserted before CT-chest examination
- Penetrating chest trauma

DATA COLLECTION:

- Data regarding ultra sonographic findings of pneumothorax,
- clinical signs of pneumothorax,
- chest x-ray findings of pneumothorax and
- finally compared with computed tomography chest findings of pneumothorax

METHODS : Study of comparision

In our study we performed EFAST examination in 140 consecutive patients with blunt chest trauma. Fig. shown below is the ultrasound machine situated in Govt Rajaji trauma care centre with which EFAST scans were performed for patients with blunt chest injuries.

All patients with history of blunt chest injuries were screened by EFAST examination for evidence of pneumothorax. EFAST didn’t interfered with the management of the patient.

Patients with blunt chest trauma after clinical examination, EFAST, chest x-ray, CT-chest- type of injury and presence of pneumothorax, hemopneumothorax, lung contusions confirmed and managed appropriately. In doubtful cases cardiothoracic surgeon opinion obtained and managed accordingly.

ULTRASOUND MACHINE SITUATED IN TRAUMA CARE CENTRE

OBSERVATION AND RESULTS

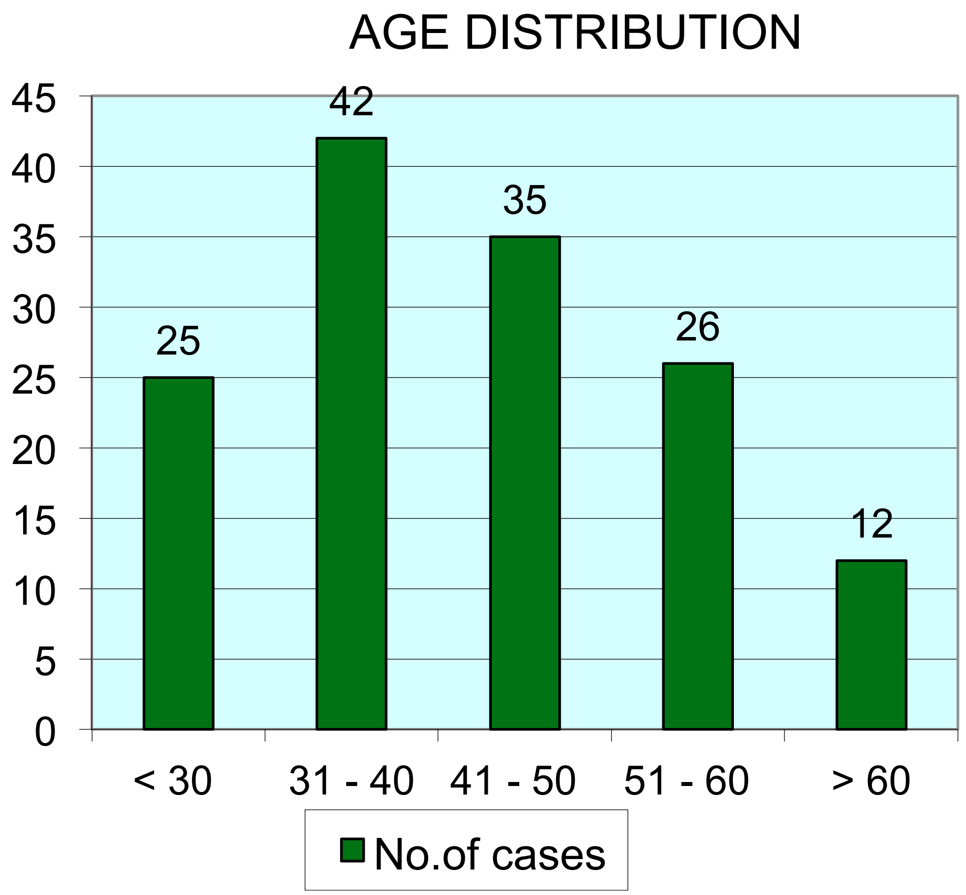
We conducted study on one hundred and forty patients who had a history of blunt chest trauma admitted in govt. Rajaji Hospital trauma care centre fron the period of December 2015 to august 2016.

AGE DISTRIBUTION:

Most common age group falls under 31 to 40 years next followed by 41-50 years. Extremes of ages were seems to be the minimal. This might be due to the fact that middle aged men were the once who uses the motor vehicles more often than others.

Table shown below represents the age distribution in blunt injury chest patients

Age Distribution	No.of cases	Percentage
< 30	25	17.86
31 - 40	42	30.00
41 - 50	35	25.00
51 - 60	26	18.57
> 60	12	8.57
Total	140	100.00



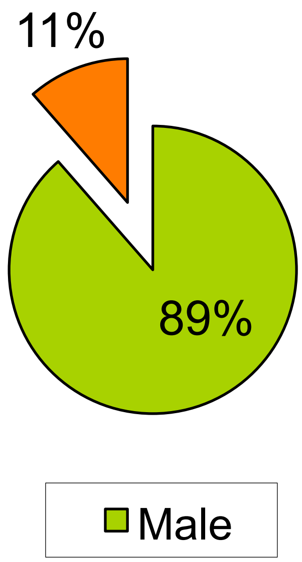
SEX DISTRIBUTION:

Among the 140 patients 124 patients were male and only 16 patients were females.

Sex Distribution	No.of cases	Percentage
Male	124	88.57
Female	16	11.43

Chart given below represents the sex distribution for incidence of blunt injury chest

SEX DISTRIBUTION



sex distribution for those who were positive for pneumothorax among blunt injury chest patients were given below

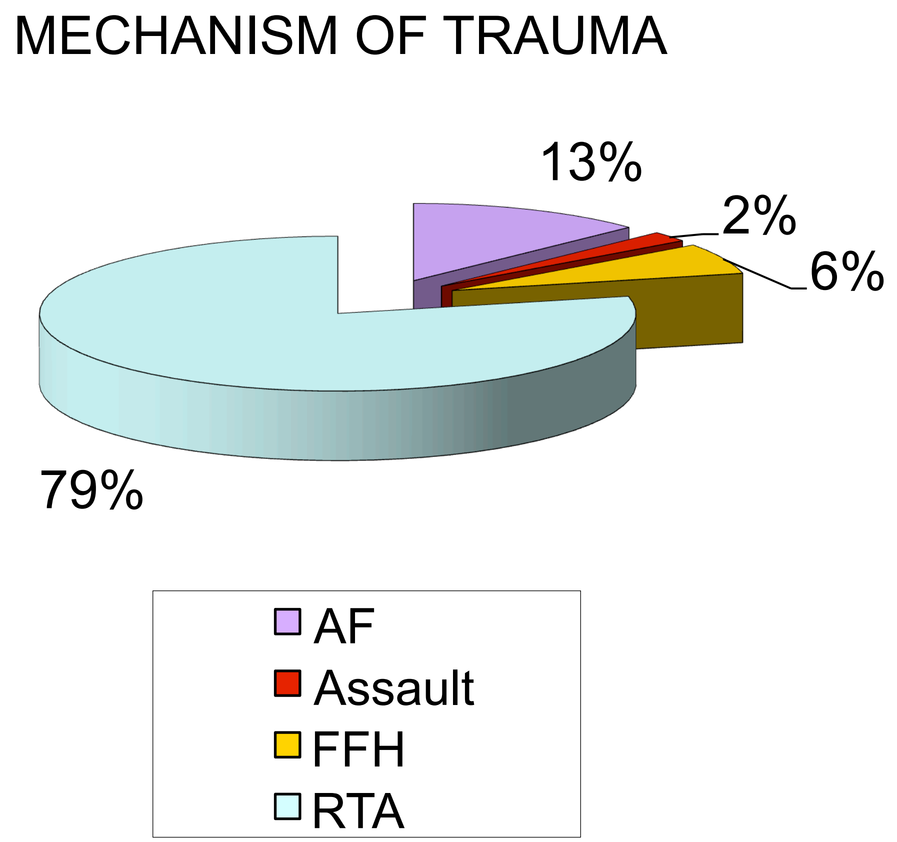
Sex vs Findings	USG	CF	Chest X	CT
Male (124)	41	35	9	55
Female (16)	1	1	1	3

MECHANISM OF INJURY:

On observation the most common incidence of blunt injury chest comes under RTA (road traffic accident) which accounts for 78.57% of the cases followed by AF (accidental fall) which accounts for 12.86%

Mechanism of Trauma	No.of cases	Percentage
AF	18	12.86
Assault	3	2.14
FFH	9	6.43
RTA	110	78.57
Total	140	100.00

Pie chart representing the distribution for mechanism of blunt chest injury



RESULTS:

Out of 140 patients who were presented with blunt injury chest (only those who met the inclusion criteria of our study) were examined thoroughly and based on the clinical findings 36 patients were diagnosed of having pneumothorax.

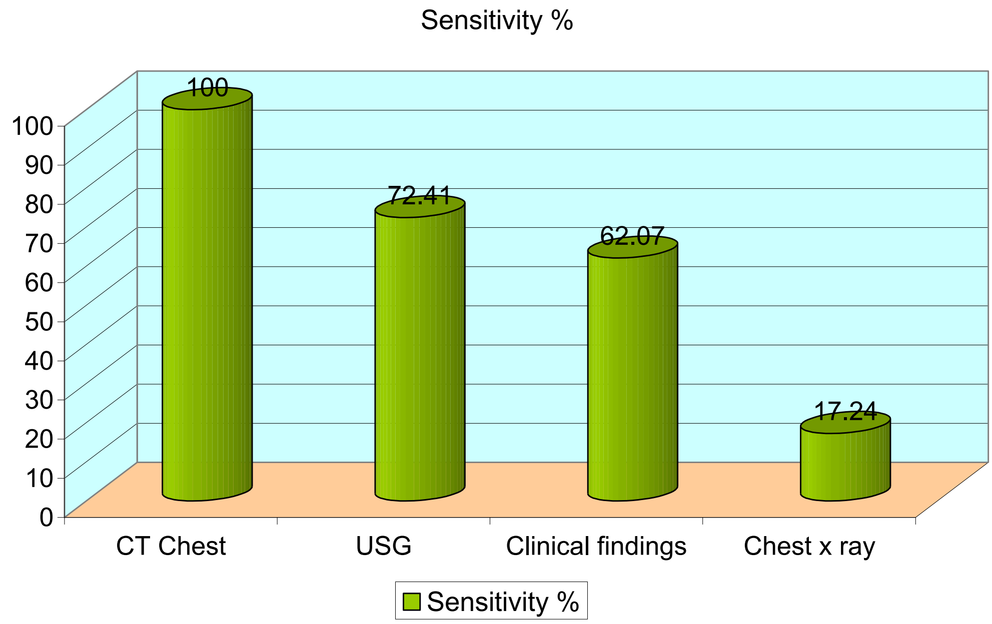
All the 140 patients were after initial treatment measures (except tube thoracostomy) were subjected to chest x-ray, EFAST, CT chest one by one. CT finidings were interpreted finally after all other investigation.

By chest x-ray of 140 patients only 10 patients shows positive findings for pneumothorax. on ultrasound thorax on both hemithorax for all the patients showed positive pneumothorax signs in 42 patients.

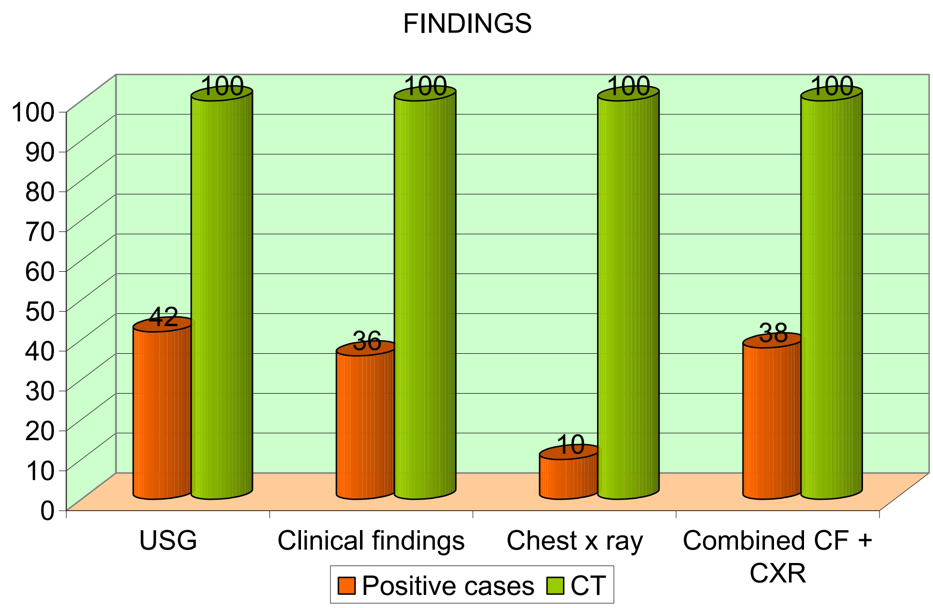
After diagnosis pneumothorax by all other means CT chest results were obtained. Out of 140 patients under observation 58 patients were found to have pneumothorax. Since CT chest is considered as gold standard investigation, diagnosis of pneumothorax by all other means is compaed with CT and sensitivity of each tests were predicted.

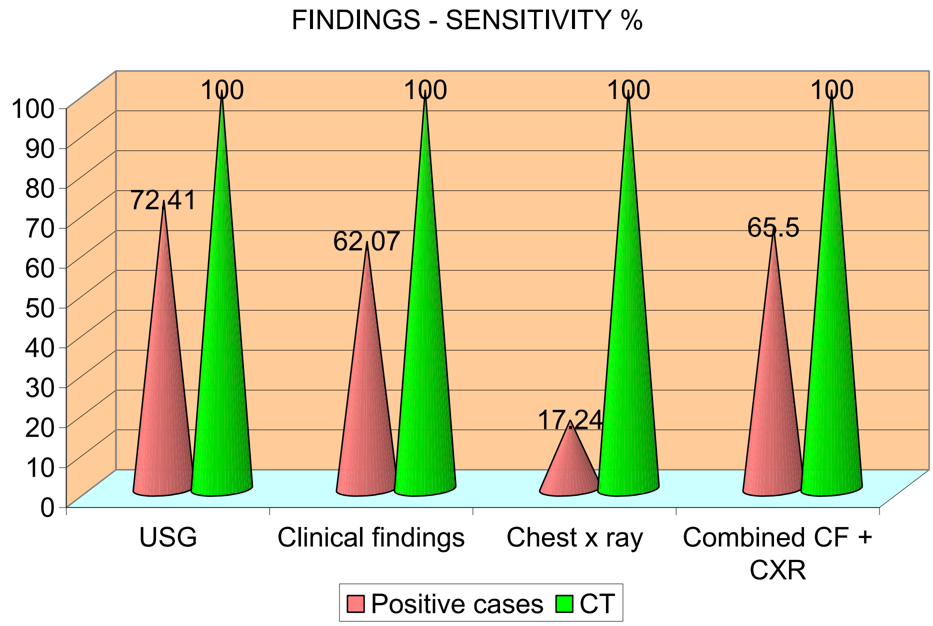
Findings	No.of cases
CT Chest	58
USG	42
Clinical findings	36
Chest x ray	10
Combined CF + CXR	38

Findings	Sensitivity %
CT Chest	100
USG	72.41
Clinical findings	62.07
Chest x ray	17.24
Combined CF + CXR	65.5



The sensitivity of chest x-ray seems to be the least with a sensitivity of only 17.24%, USG has a very good sensitivity of 72.41%. Sensitivity of EFAST, CXR, CF compared with the CT chest is given below



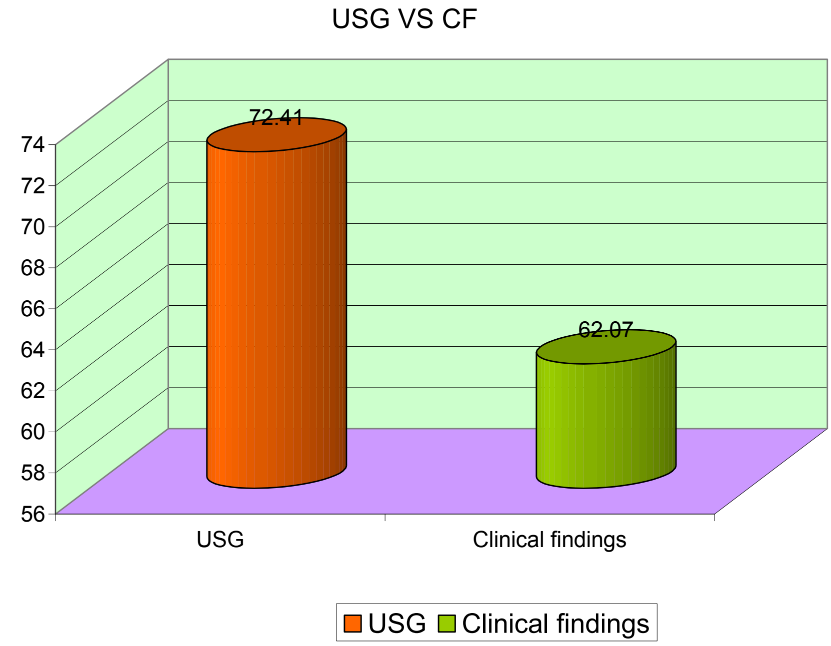


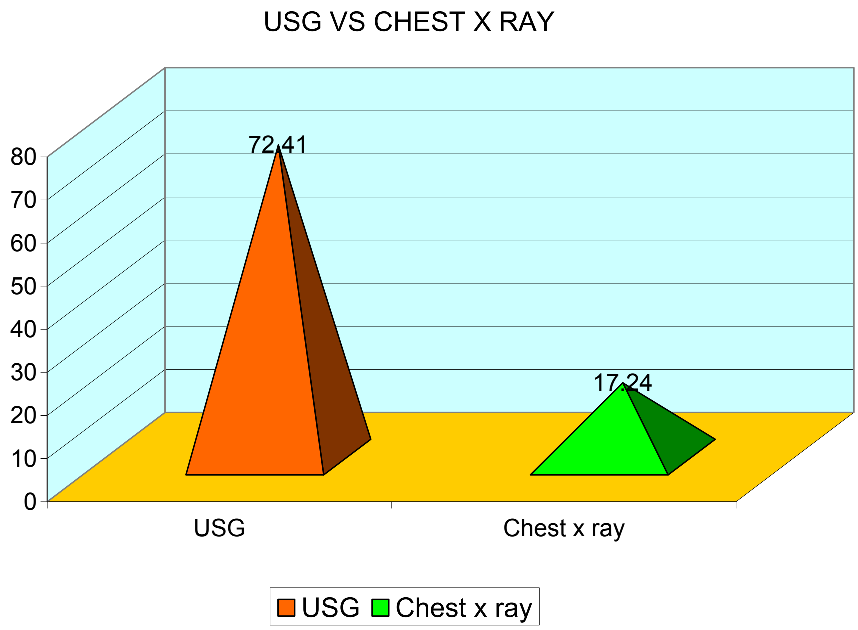
Comparison of USG thorax with clinical finding, chest x-ray and combined chest x-ray with clinical findings in diagnosis of pneumothorax is shown below

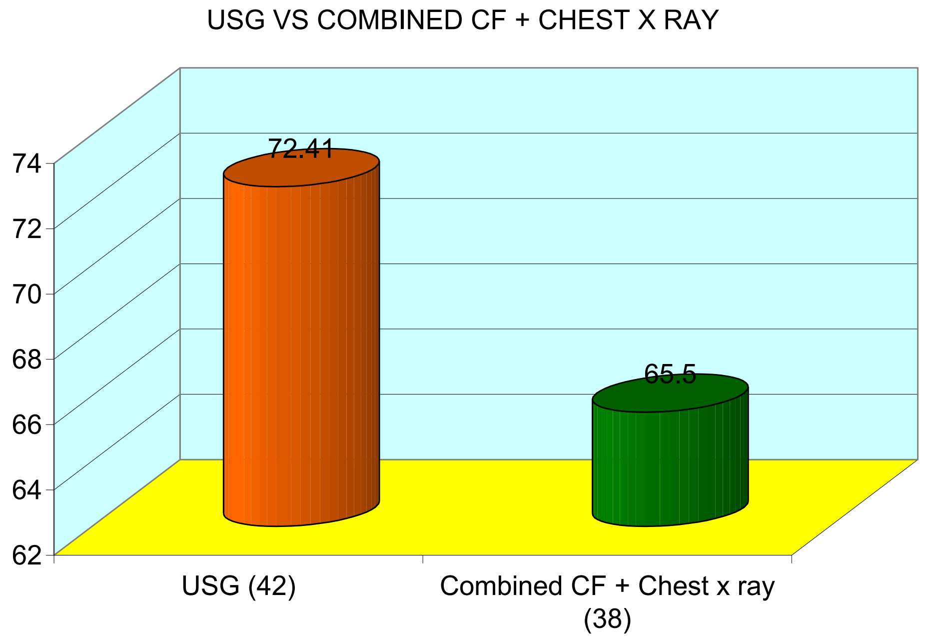
USG	72.41
Chest x ray	17.24

USG	72.41
Chest x ray	17.24

USG (42)	72.41
Combined CF + Chest x ray (38)	65.5







These observation clearly shows that USG thorax has greater performance than the combined modality of clinical diagnosis and chest x-ray.

The specificity of both ultrasound thorax and chest x ray found to be 100% in our study. No false positive cases were recorded in both the modalities.

Pneumothorax/ USG	True positive	False positive
Yes	42	0
	False negative	True negative
No	16	82

SENSITIVITY	72.41%
SPECIFICITY	100.00%

Similarly sensitivity and specificity of chest x-ray in diagnosis pneumothorax is given below

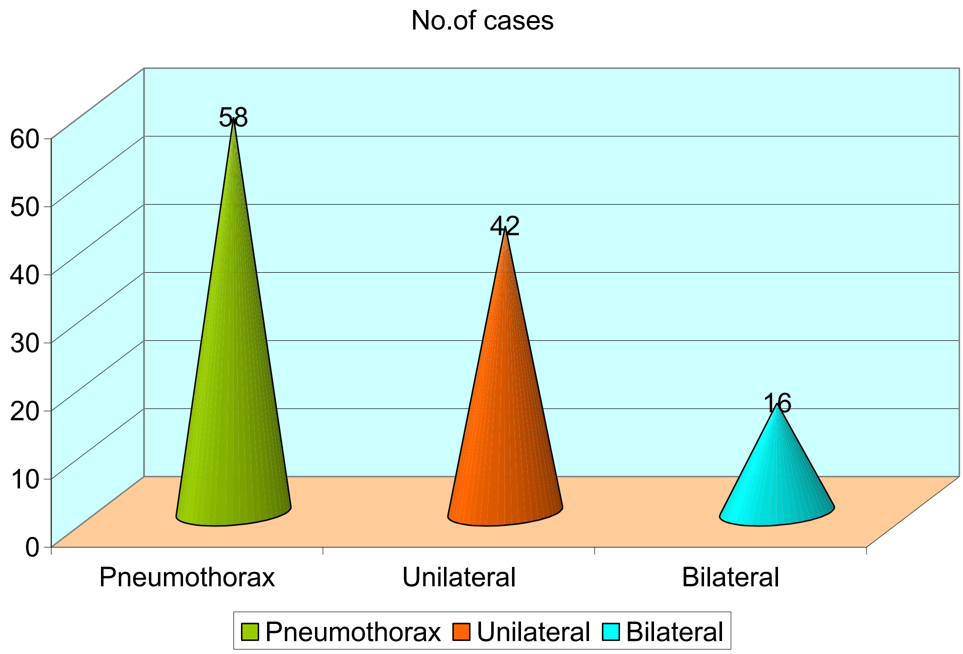
chest X RAY	True positive	False positive
Yes	10	0
	False negaive	True negative
No	48	82

SENSITIVITY	17.24%
SPECIFICITY	100.00%

BILATERAL INCIDENCE:

58 cases out of 140 blunt chest chest injury patients were considered as positive for pneumothorax (CT as confirmation). Among the 58 cases number of bilateral cases were 16.

Pneumothorax	58
Unilateral	42
Bilateral	16



No.of cases
58
42
16
60
50
40
30
20
10
0
Pneumothorax
Unilateral
Bilateral
Pneumothorax
Unilateral
Bilateral

CONCLUSION

From the observation we came to a conclusion that ultrasonography chest is the better investigation test for diagnosing pneumothorax in a blunt injury chest patient compared to chest x-ray or clinical investigation or even with combined chest radiography and clinical findings. Chest x-ray missed 48 cases out of 58 cases detected in CT chest. In view of

- availability in small centers,
- cost,
- radiation exposure,
- portability of equipment to bedside,
- to evaluate hemodynamically unstable patients
- and finally sensitivity in diagnosis

makes ultrasound chest to be the better investigation modality for blunt injury chest and can be combined with FAST as an “EXTENDED FAST” which can prevent the morbidity and mortality due to difficulty in diagnosis of pneumothorax in time and prompt intervention.

ANNEXURE 1

STUDY PROFORMA

1) NAME :

2) AGE/SEX :

3) ADDRESS :

4) PHONE NO :

5) COMPLAINTS :

6) HISTORY OF CHEST PAIN :

7) SITE :

8) HISTORY OF BREATHLESSNESS / SWELLING / COUGH / HEMOPTYSIS :

9) HISTORY OF TREATMENT FOR PRESENT CONDITION (If any) :

10) PAST HISTORY OF ANY SIMILAR ILLNESS AND TREATMENT :

11) PAST HISTORY OF ANY CO-MORBIDITY AND DRUG INTAKE :

12)GENERAL EXAMINATION :

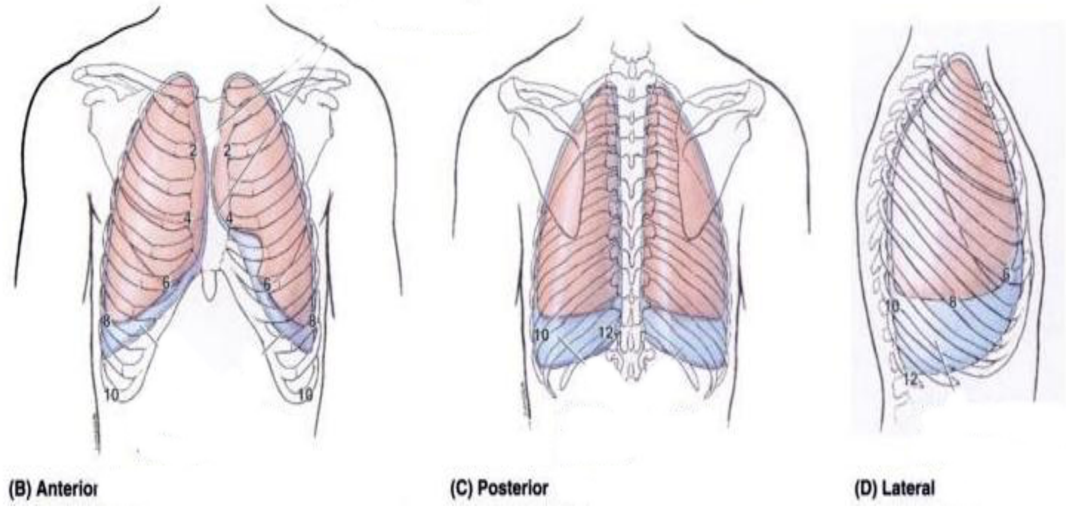
13) SYSTEMIC EXAMINATION :

INSPECTION :

PALPATION :

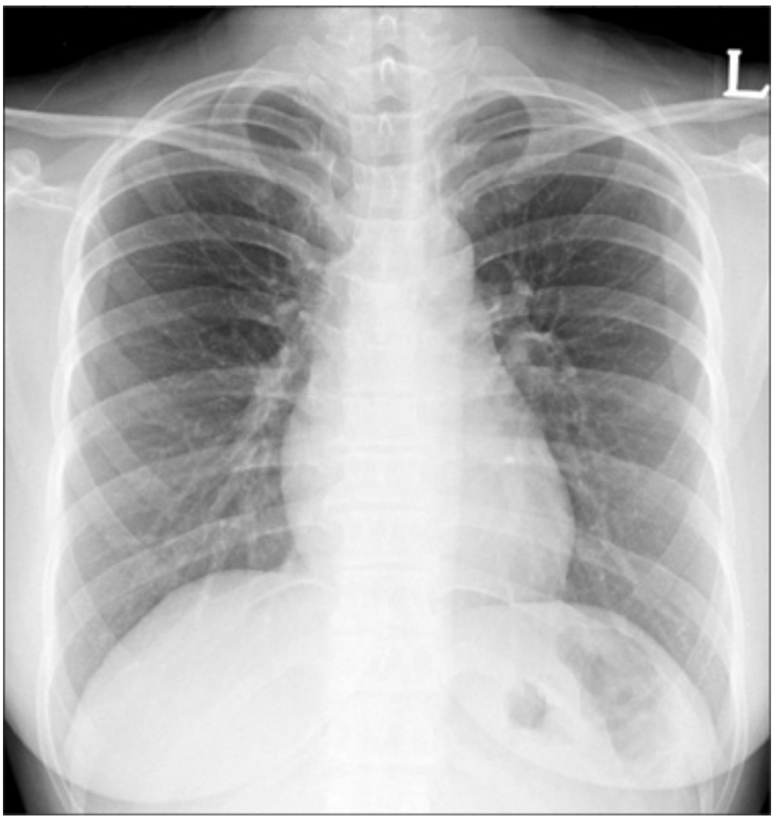
PERCUSSION :

AUSCULTATION :



14) INVESTIGATIONS :

CHEST X-RAY:



ULTRASOUND CHEST :

CT CHEST :

OTHERS :

Hb%: BLOOG GROUP:

RBS:

BLOOD UREA:

S.CREATININE:

15) PROVISIONAL DIAGNOSIS :

16) REMARKS :

17) MANAGEMENT:

ABBREVIATIONS

AF	-	ACCIDENTAL FALL
CT	-	COMPUTED TOMOGRAPHY
FFH	-	FALL FROM HEIGHT
RTA	-	ROAD TRAFFIC ACCIDENT
EFAST	-	EXTENDED FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA
USG	-	ULTRASONOGRAPHY
CXR	-	CHEST X-RAY

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MASTER CHART

S. No.	NAME	AGE	SEX	IP No.	MECHANISM OF TRAUMA	USG FINDING	CLINICAL FINDING	CHEST X-RAY	CT CHEST	BILATERAL
1	SUNDARAMOORTHI	21	M	1315	AF	-	-	-	+	-
2	SHEIK SAYYED ABHUDHAHIR	39	M	1413	RTA	-	-	-	-	-
3	AMMAVASAI	51	M	1410	RTA	-	-	-	-	-
4	PANDIARAJAN	47	M	2138	FFH	+	+	-	+	-
5	SERMADURAI	50	M	8116	RTA	+	+	+	+	+
6	MARUDHU	65	M	9589	RTA	-	-	-	-	-
7	MUNIANDI	58	M	9592	RTA	-	-	-	-	-
8	MARUDHAI	58	M	9202	RTA	+	-	-	+	-
9	CHINNAIYAN	60	M	9140	AF	-	-	-	-	-
10	JOTHILAKSHMI	28	F	9230	RTA	+	+	+	+	+
11	VALLI	50	F	9545	RTA	-	-	-	-	-
12	MURUGAN	45	M	9430	AF	-	-	-	-	-
13	SENTHIL	43	M	9661	RTA	-	-	-	+	-
14	THYAGARAJAN	65	M	9556	RTA	-	-	-	-	-
15	KRISHNAMOORTHY	45	M	9236	FFH	+	+	-	+	-
16	AYYAMMAL	60	F	9456	RTA	-	-	-	-	-
17	SUBBURAJ	45	M	9551	RTA	-	-	-	-	-
18	KULANDHAIVELU	38	M	9602	RTA	-	-	-	-	-
19	VEERASAMY	55	M	9660	RTA	+	+	+	+	+

20	MARIMUTHU	40	M	9711	AF	+	+	-	+	-
21	KANNAN	33	M	9823	RTA	-	-	-	-	-
22	VIMAL KUMAR	28	M	9891	RTA	-	-	-	+	-
23	PAULRAJ	47	M	9946	RTA	-	-	-	-	-
24	NAGARAJAN	52	M	9985	RTA	-	-	-	-	-
25	MUTHAYYAH	62	M	10017	AF	+	+	-	+	-
26	MANI	50	M	10211	AF	+	-	+	+	-
27	RAJENDIRAN	44	M	10301	RTA	-	-	-	-	-
28	MURUGESAN	40	M	10410	RTA	-	-	-	+	-
29	PICHAI	65	M	10741	RTA	-	-	-	-	-
30	ABDUL HAMEED	37	M	10983	RTA	+	+	-	+	+
31	IRUDHAYARAJ	45	M	11329	FFH	-	-	-	-	-
32	KARPAGAM	42	F	11564	RTA	-	-	-	-	-
33	RAVI	30	M	11732	RTA	+	+	-	+	-
34	VELAYUDHAM	39	M	11756	RTA	-	-	-	-	-
35	AMMASI	68	M	11834	RTA	-	-	-	-	-
36	ARULMURUGAN	42	M	12004	ASSAULT	+	+	-	+	-
37	SUSILA	35	F	12367	RTA	-	-	-	+	-
38	AVINASI	55	M	12598	RTA	+	+	-	+	+
39	GURUSAMY	62	M	12812	RTA	-	-	-	-	-
40	AROKIYAMARY	52	F	12987	RTA	-	-	-	-	-
41	PANDI	36	M	13213	RTA	-	-	-	-	-
42	PRAKASH	24	M	13732	FFH	-	-	-	+	-
43	MARUDHUPANDI	29	M	13756	RTA	-	-	-	-	-
44	VEERANNAN	70	M	13821	RTA	+	-	+	+	-

45	ARAVIND	21	M	13992	ASSAULT	-	-	-	-	-
46	BOSE	35	M	14121	RTA	-	-	-	-	-
47	BILAL	40	M	14176	RTA	+	+	-	+	+
48	KARUPAYAMMAL	64	F	14298	AF	-	-	-	-	-
49	JOSEPH	56	M	14423	RTA	+	+	-	+	-
50	KARUPPASAMY	55	M	14498	RTA	-	-	-	-	-
51	VARUNKUMAR	26	M	14574	RTA	-	-	-	-	-
52	FAYAZ GHANI	35	M	14732	RTA	-	-	-	+	-
53	VILLAMMAL	63	F	14921	FFH	-	-	-	-	-
54	SENTHIL KUMAR	30	M	15213	RTA	-	-	-	-	-
55	CHINNASAMY	57	M	15245	RTA	+	+	-	+	-
56	ALAGARSAMY	49	M	15365	RTA	+	+	-	+	-
57	SARAVANAN	32	M	15552	AF	-	-	-	-	-
58	PERIAKANNU	51	M	15632	AF	-	-	-	-	-
59	MAHESHWARAN	37	M	15803	RTA	-	-	-	-	-
60	CHINNATHAMBI	48	M	15845	RTA	-	-	-	+	-
61	KARTHI	26	M	15947	RTA	-	-	-	-	-
62	KUMAR	36	M	16012	RTA	+	+	-	+	+
63	SURESHBABU	34	M	16078	RTA	-	-	-	-	-
64	BHARATHI	32	M	16113	RTA	-	-	-	-	-
65	RUKUMANI	33	F	16126	RTA	-	-	-	+	-
66	SIVANESAN	36	M	16287	RTA	+	+	+	+	+
67	PERIAKARUPPU	54	M	16421	RTA	-	-	-	-	-
68	MEENA	38	F	16493	RTA	-	-	-	-	-
69	DURAIPANDI	56	M	16573	RTA	-	-	-	+	-

70	KRISHNAN	46	M	16601	RTA	-	-	-	-	-
71	MUTHUKUMAR	38	M	16659	RTA	+	+	-	+	-
72	VIJAYAKUMAR	32	M	16732	AF	+	+	-	+	-
73	BALAKRISHNAN	41	M	16786	RTA	-	-	-	-	-
74	MOHAN	30	M	16921	RTA	-	-	-	-	-
75	GNANAVEL	34	M	16994	RTA	+	+	-	+	-
76	THANIGAIVELU	43	M	17034	RTA	-	-	-	-	-
77	GOPIKUMAR	38	M	17098	RTA	-	-	-	-	-
78	MAYILATHAL	55	F	17117	RTA	-	-	-	-	-
79	ASHOKKUMAR	29	M	17189	RTA	-	-	-	+	-
80	MUTHUSAMY	35	M	17253	RTA	+	+	-	+	-
81	KAMALAKANNAN	40	M	17489	RTA	-	-	-	-	-
82	ARUNKUMAR	25	M	17642	FFH	-	-	-	-	-
83	VISHNUPRASAD	23	M	17674	RTA	-	-	-	-	-
84	ARULANAND	27	M	17712	RTA	+	+	+	+	+
85	IYYAPPAN	52	M	17748	RTA	-	-	-	-	-
86	PERIASAMY	57	M	17882	RTA	-	-	-	-	-
87	ANNADURAI	65	M	17923	AF	+	+	-	+	-
88	MARUDHAMMAL	59	F	17964	RTA	-	-	-	-	-
89	KADHIRVEL	30	M	18004	RTA	-	-	-	-	-
90	SUBBAN	48	M	18142	RTA	-	-	-	-	-
91	KARMEGAM	44	M	18204	AF	+	-	-	+	-
92	PODHUPONNU	36	F	18265	RTA	-	-	-	-	-
93	BALAJI	40	M	18287	RTA	-	-	-	-	-
94	MURUGAN	38	M	18332	RTA	+	+	-	+	-

95	MANI	43	M	18398	RTA	-	-	-	-	-
96	PANDI	48	M	18423	RTA	+	+	-	+	-
97	VINODH	27	M	18512	RTA	-	-	-	-	-
98	SARAVANAN	36	M	18634	RTA	-	-	-	-	-
99	MAARI	48	M	18687	RTA	-	-	-	-	-
100	JESUDAS	37	M	18754	RTA	+	+	-	+	-
101	RAMASAMY	54	M	18772	RTA	-	-	-	-	-
102	KALANIDHI	46	M	18802	FFH	+	+	+	+	+
103	KATTABOMMAN	64	M	18912	ASSAULT	-	-	-	+	-
104	PALANIVEL	50	M	18945	RTA	-	-	-	-	-
105	PRABHU	36	M	18998	RTA	+	+	-	+	-
106	DURAI	45	M	19034	RTA	-	-	-	-	-
107	MASILAMANI	52	M	19077	RTA	-	-	-	-	-
108	MANIKANDAN	30	M	19116	RTA	+	-	-	+	-
109	SIVAGAMI	40	F	19146	AF	-	-	-	-	-
110	CHINNAMMAL	67	F	19181	AF	-	-	-	-	-
111	SIVA	26	M	19243	RTA	+	+	-	+	+
112	FAROOQ	34	M	19276	RTA	-	-	-	-	-
113	KENNEDY	29	M	19328	RTA	-	-	-	-	-
114	LATHA	28	F	19376	AF	-	-	-	-	-
115	JAYARAJ	44	M	19390	RTA	+	+	-	+	-
116	XAVIER	53	M	19411	RTA	-	-	-	+	-
117	ARUL	28	M	19448	RTA	-	-	-	-	-
118	ELANGOVAN	40	M	19485	RTA	-	-	-	-	-
119	SIVALINGAM	55	M	19536	FFH	-	-	-	-	-

120	SAKTHIVEL	36	M	19573	AF	+	+	+	+	+
121	ASHWIN	22	M	19598	RTA	-	-	-	-	-
122	SIDDIQUE	31	M	19645	RTA	+	+	-	+	+
123	KARUPAIIAH	47	M	19712	RTA	-	-	-	-	-
124	PANDI	38	M	19734	RTA	-	-	-	+	-
125	UNNAMMAL	48	M	19745	RTA	-	-	-	-	-
126	MALAIAPPAN	57	M	19792	RTA	+	+	-	+	-
127	KIRUBAKARAN	47	M	19800	RTA	-	-	-	-	-
128	RANGASAMY	50	M	19821	AF	-	-	-	+	-
129	BASKARAN	36	M	19845	RTA	+	+	+	+	+
130	VIJAY	26	M	19862	RTA	-	-	-	-	-
131	RATHINAVEL	48	M	19890	AF	-	-	-	-	-
132	ANTONY	40	M	19913	RTA	-	-	-	-	-
133	GNANASEKARAN	53	M	19938	RTA	-	-	-	-	-
134	KITTU	55	M	19983	RTA	-	-	-	-	-
135	SETHURAMAN	45	M	20062	FFH	+	-	-	+	-
136	RAMESH	36	M	20134	RTA	-	-	-	-	-
137	ANANDH	30	M	20187	RTA	-	-	-	+	-
138	SABARIMUTHU	40	M	20211	RTA	+	+	-	+	+
139	THANGAPANDI	45	M	20254	RTA	-	-	-	-	-
140	RAGUNATHAN	42	M	20312	RTA	+	+	-	+	+

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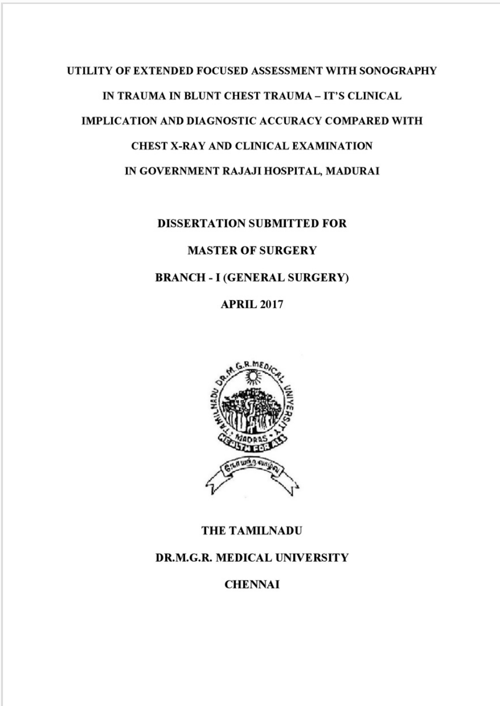

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