Case Report

Ultrasonography and X-Ray guided drain placement to evacuate a pneumopericardium/pneumomediastinum in a 1-day-old infant

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Abstract

Ultrasonographic (US) guided procedures have wide range of application in the abdomen and pelvis, however their role is somewhat limited in the chest due to complete reflection of the ultrasound beam by the air in the lungs, preventing the direct imaging of the tissues deep to the air-sound interface. Most of the chest procedures, other than the exception of thoracentesis, rely on the use of CT (computed tomography) scan. The disadvantages of using CT scan is the cost, lack of portability, and most importantly the radiation involved, particularly in case of infants and children, whose tissues are more radiosensitive than the adults. Identification of air by Ultrasonography can help direct needles and wires, to accomplish procedures which may otherwise need CT. A 1-day-old infant with respiratory distress syndrome (RDS) on a ventilator, developed an expanding symptomatic pneumopericardium/pneumomediastinum. The patient was too unstable to leave the neonatal intensive care unit (NICU), so a pericardial/mediastinal drain was placed under ultrasonographic and radiographic guidance. This case, highlights a method for bedside treatment of pneumopericardium/pneumomediastinum in an unstable neonate. This procedure may be equally effective in older children and adults.

Key words: Cardiac tamponade; pneumomediastinum; pneumopericardium; respiratory distress syndrome; ultrasound guided drain of pneumopericardium

Introduction

Ultrasonographic guided procedures have a wide range of application in the abdomen and pelvis, however their role is somewhat limited in the chest due to complete reflection of the ultrasound beam, preventing the direct imaging of the tissues deep to the air-sound interface.[1] Most of the chest procedures, other than thoracentesis, rely on the use of computerized tomography (CT) scan. The disadvantages of using CT scan are the cost, lack of portability, and most importantly, the radiation involved, particularly in case of infants and children, whose tissues are more radiosensitive than adults. Identification of air by ultrasonography can

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Case Report

A 36-year-old [Gravida 5 and Living 3] mother, gave birth to a 35-36 week baby boy. This was a high risk pregnancy associated with advanced maternal age, chronic hypertension and superimposed pre-eclampsia. The new born experienced excessive grunting and severe retractions which prompted endotracheal intubation shortly after birth. The baby received surfactant and was monitored by serial chest radiographs. Initial radiograph showed bilateral diffuse hazy granular opacities suggesting respiratory distress syndrome (RDS) [Figure 1]. Due to increasing FiO2 demands and hypercapnia, the ventilator was adjusted several times. Subsequently the serial radiographs showed enlarging pneumopericardium/pneumomediastinum [Figure 2A and B]. The patient also developed hypotension, suggesting some component of cardiac tamponade. An echocardiogram was performed, which confirmed presence of pneumopericardium/pneumomediastinum. [Figure 3A and B]. Since the baby was not responding to conservative management, interventional radiology was consulted to aspirate the air and place a drain in the pneumopericardium/pneumomediastinum. A drain placement was preferred over simple aspiration to prevent re-accumulation of air. At our institution, procedures to drain pneumothorax and pneumomediastinum are typically performed under CT guidance, and hence, we asked the team to move the patient to CT. However, the patient was very unstable at that time and after discussion with the pediatric surgeon and neonatologist, we decided to perform the procedure at the patient's bedside using ultrasound imaging and radiography.

Ultrasonographic guided drain placement for pneumopericardium/pneumomediastinum was performed as follows; with the patient in the supine position, a hockey stick transducer (15 MHz) was placed on the right anterior chest wall along the long axis of the ribs in the expected location of the pneumopericardium/pneumomediastinum [Figure 4], as correlated with the radiograph. The right side was chosen as the pocket of pneumomediastinum was wider on that side and also to stay away from the heart. A micro puncture needle was then advanced under ultrasonographic guidance, using an in-plane approach along the long axis of the ribs, making sure the needle approached the air pocket. Once the needle was seated in the air pocket, the ability to visualize the tip was lost and at this point, no further advancement was made. After this, a 0.018'' microwire was advanced through the needle without resistance. Once enough wire purchase was achieved, the 5F micro puncture sheath was advanced over the wire into the pericardial/mediastinal space. A 0.035'' Benston wire was advanced through the micro puncture sheath. At this point portable anteroposterior and lateral radiographs were obtained at the patient's bed side to confirm wire localization [Figure 5A and B]. Once we were satisfied with the wire localization, we advanced a 6.5 French drain into the mediastinum and aspirated the air. Another radiograph was obtained to confirm the position [Figure 6]. Near complete resolution of the pneumopericardium/pneumomediastinum was seen.

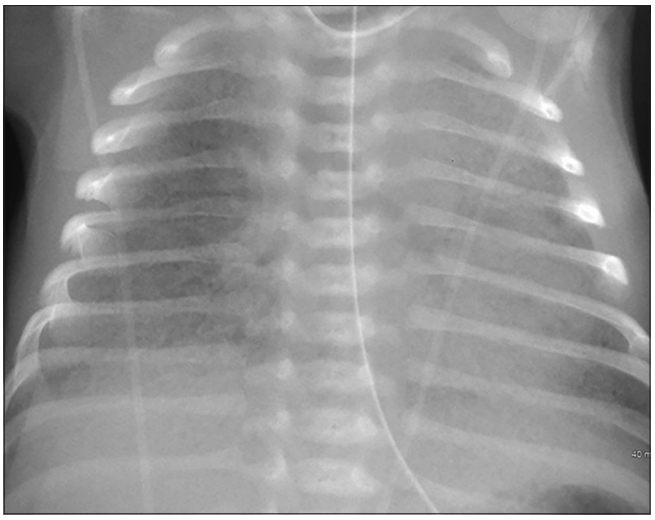

Figure 1: Anteroposterior radiograph of the chest showing granular opacities in both lungs consistent with Respiratory distress syndrome

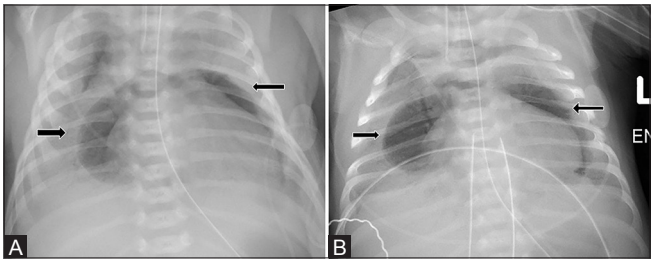

Figure 2 (A and B): (A) Anteroposterior radiograph of the chest, 2 hours after birth shows development of pneumopericardium/pneumomediastinum (black arrows). (B) Anteroposterior radiograph one hour following the radiograph in Figure 2A, shows enlargement of the pneumopericardium/pneumomediastinum

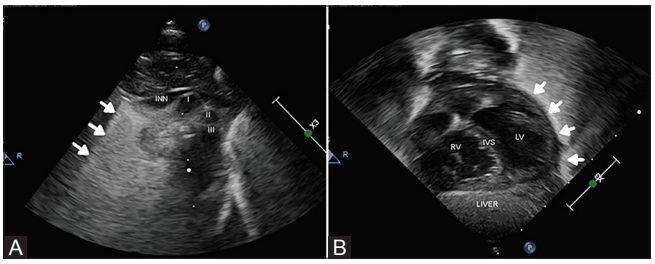

Figure 3 (A and B): (A) Suprasternal notch imaging plane. Echobright imaging artifact consistent with air in the superior mediastinum (arrows). INN; innominate vein, I; first branch of aortic arch, II; second branch of aortic arch and III; third branch of aortic arch. (B) Subcostal imaging plane demonstrating echobright artifact consistent with air along the left ventricular free wall (arrows). RV; right ventricle, IVS; interventricular septum, LV; left ventricle

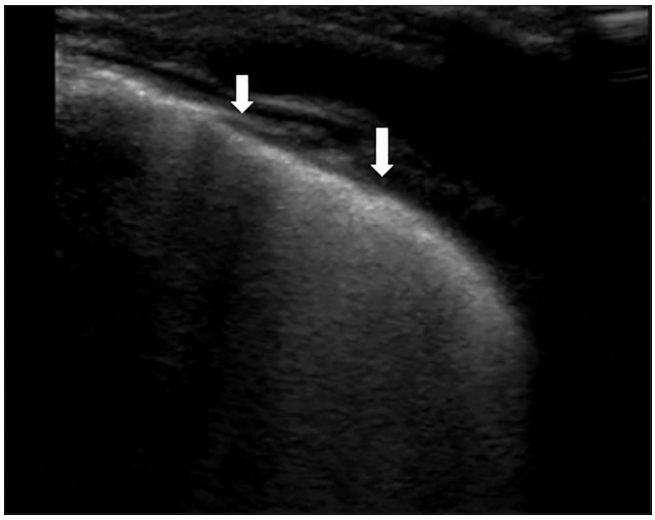

Figure 4: Sagittal ultrasound of the chest in the region of the right lower chest, showing dirty shadowing consistent with air echoes (white arrows)

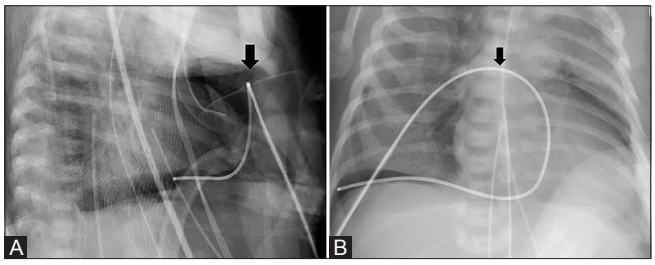

Figure 5 (A and B): Anteroposterior (A) and lateral (B) radiographs of the chest, after advancing a Bentson wire (black arrows), shows the wire in good position coursing through the pericardial/mediastinal space

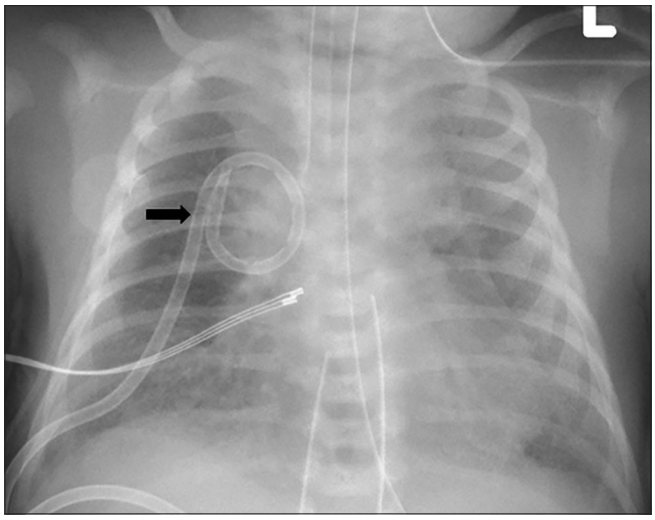

Figure 6: Anteroposterior radiograph with pericardial drain placement shows near complete evacuation of the pneumopericardium/pneumomediastinum. The drain is located in the right side of the heart/mediastinum (black arrow)

Following the procedure the patient's oxygen requirement decreased (improved) from 100% to 50%. The drain was clamped after 3 days of dwell time and removed 24 hours later, as serial X-rays showed no re-accumulation of air. The baby was discharged home in a stable condition 3 weeks after its birth.

Discussion

Pneumopericardium in the neonatal period is a rare clinical condition which is usually associated with other simultaneously-occurring air leaks. The majority of reported cases are in preterm newborns with RDS who had required active positive pressure during resuscitation and/or subsequent respiratory support.[2,3]

The chest radiograph is the standard diagnostic method. The classic finding in pneumopericardium is the "halo sign": Air completely surrounding and outlining the heart, but not extending beyond the reflection of the pericardium along the great vessels.[4] The exact pathophysiology of neonatal pneumopericardium is still unclear. Air is thought to dissect from ruptured alveoli along the perivascular sheaths to the hilum and mediastinum, with subsequent rupture into the thorax or mediastinum.[5] Rupture of this air into the pericardium has been postulated to occur in an area of weakness at the reflection of the parietal and visceral pericardium, near the pulmonary veins.[5]

There have been case reports of CT and fluoroscopic guided mediastinal drain placement in neonates[6,7] however, to our knowledge, there have been no case reports of sonographic guided and X-ray assisted drain placement for a tension pneumopericardium/pneumomediastinum.

Most cases of pneumopericardium/pneumomediastinum can be managed conservatively.[8] If there is continuous leakage of air in the pericardium, tension pneumopericardium may occur and result in compromised venous return to the heart, ultimately evolving into a life-threatening condition.[9,10]

Use of ultrasound for the detection and drainage of pleural and pericardial effusions in patients of all ages is well established. Despite many advantages of ultrasound in neonates, there is little information regarding the use of ultrasound for evaluation of abnormal air in the mediastinum/pericardium. The unique anatomy of the pediatric chest allows superior acoustic windows that can provide valuable information in children. The bony structures in the neonatal thorax are mostly cartilaginous, allowing sound beam transmission.[11,12]

One has to be cognizant of possible injury to the adjacent lung while trying to intervene in the mediastinum/pericardium. Several sonographic signs which help to identify the normal pleural space and the underlying lung have been described. Some of the useful signs include the "The Bat Sign"—where the periosteum of the ribs represents the wings and the bright hyperechoic

pleural line in between them represents the bat's body.[13] "Pleural Sliding Sign" is another important sign to identify the normal aerated lung. It relates to the to-and-fro movement of the visceral pleura on the parietal pleura, which occurs with respiration.[14]

The subtle movement of the pleura can also be identified by M-Mode ultrasound. It is beneficial in the elderly or patients with poor pulmonary reserve, who are not capable of taking large breaths. M-mode cursor placed over the presumed pleural line displays two different patterns on the screen: The motionless portion of the chest above the pleural line creates horizontal lines –"Waves", and the sliding below the pleural line creates a granular pattern, the "Sand". This is therefore called the "seashore sign" and is present in normal aerated lung.[15-17]

Conclusion

Ultrasound can be used to evaluate the lung, pleural space, and to guide chest/mediastinal procedures, as long as it is tailored to the clinical suspicion and the setting.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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