

Asynchronous Independent Lung Ventilation in the Management of Bronchopleural Fistula

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Ventilation of lungs with parenchymal injury which can be caused by either disease or trauma has always been a difficult task for both respiratory therapists and physicians. There have been great many advances made in mechanical ventilators and ventilator modes over last decade. This has included the introduction of modes such as High Frequency Oscillator Ventilation (HFOV) [1] and Airway Pressure Release Ventilation (APRV). Coupled with these new modes has also been a better understanding of how to best recruit and stabilize the lungs [2] and how to best use therapist driven protocols which may help to decrease the percentage of Acute Lung Injury (ALI) that we see

today. Sometimes as respiratory care practitioners, we are exposed to trauma patients, which may present with massive amounts of parenchymal damage to the lungs, which we may have to modify on how to ventilate and oxygenate these patients. Some patients may have such severe unilateral lung pathology, that it will be difficult to oxygenation and ventilate, we should make a better effort to avoid high peak pressures and thus decrease the risk of barotrauma to uninjured lung tissue. In such a case, we may wish to consider asynchronous independent lung ventilation with one of these new modes.

Key words: respiratory failure, gun shoot, mechanical ventilation, bronchopleural fistula, trauma.

Case summary

The case is a 49 WF who presented with a gunshot wound (GSW) to the left thorax. This patient was admitted to the ICU placed on a Drager XL (Pennsylvania, USA) on continuous mandatory ventilation (CMV) mode (with auto flow) RR 16, TV 350, FiO₂ 90% and PEEP of 14. There were two chest tubes that had been placed in the left chest. The patient was noted to have a left-sided bronchopleural fistula,

and a left sided hemothorax. The bullet had lodged near her spine at T4, T5 which resulted in T6 paraplegia. A small amount of subcutaneous (sub Q) emphysema was also noted on the left side of the chest, due to the large air leak from the chest tubes. The first chest x-ray (CXR) showed relatively normal aeration, with patchy infiltrates in both lungs (**Figure 1**). After 48 hours the patient developed increased hypoxia and increased peak inspiratory pressures of 45-50 cmH₂O, the subsequent arterial blood gas (ABG) was (7.41/47/61/+1/92%). A repeat CXR still showed patchy infiltrates; with infiltrates on the left lung fields greater than the right. The patient was then taken down for a MRI of her chest which showed severe atelectasis and bronchopleural fistula (**Figure 2**). A CT of the chest also showed over distention of the right lung with severe atelectasis of the left lung [3]. On the CT the atelectasis of the left lung was so severe. It displaced the heart with a mediasternal shift to the left side of the chest (**Figure 3**). The respiratory care practitioner, along with the

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ICU attendings decided to perform Independent Lung Ventilation (ILV) for the patient [4]. The only problem was that the atelectasis was so severe that normal ILV would be very difficult. Anesthesia attending then placed a Sheridan (San Francisco, California) 37 French left sided double lumen tube (**Figure 4**), under direct vision with a bronchoscope without any problems [4,5]. The patient was then placed on two separate Drager Evita XL ventilators using differential lung ventilation [3,4]. The right side (uninjured side), was placed on CMV mode (with auto flow) RR 15, TV 250, starting FiO_2 at 70% (was later decreased to 40%) and PEEP 16 cmH_2O . The left (injured) lung was placed on APRV mode PH 35, PL 5, TH 3.5 sec, TL 0.5 sec, 90% FiO_2 . Initially we could only achieve about 100-150 cc TV in the left lung during the first hour. After several hours TV's increased to 400 cc in the left lung. The repeat ABG performed at the time showed the following results: (7.37/43/150/-1/97%). The FiO_2 on the left lung was titrated to 55%. Using the results of this ABG, we were also able to titrate a TV of 300-400 cc on the left lung.

This differential lung ventilation was continued for 8 days. During that time the FiO_2 was titrated down to 40% to both lungs, with a marked decrease in the chest tube leak. We also noted an increased in compliance of the left lung, mechanics improved to such an extent that, and at one time the left lung was almost over distended compared to the right lung [6] (**Figure 5**). At this time the ETT was changed to a standard tube and we returned to normal ventilation, using the APRV mode [7]. Chest CT revealed re-expansion of bilateral lung fields (**Figure 6**). The patient later had to be trached due to the T6 paraplegia, and was changed to convention ventilation and transported to a long term care facility.

Discussion

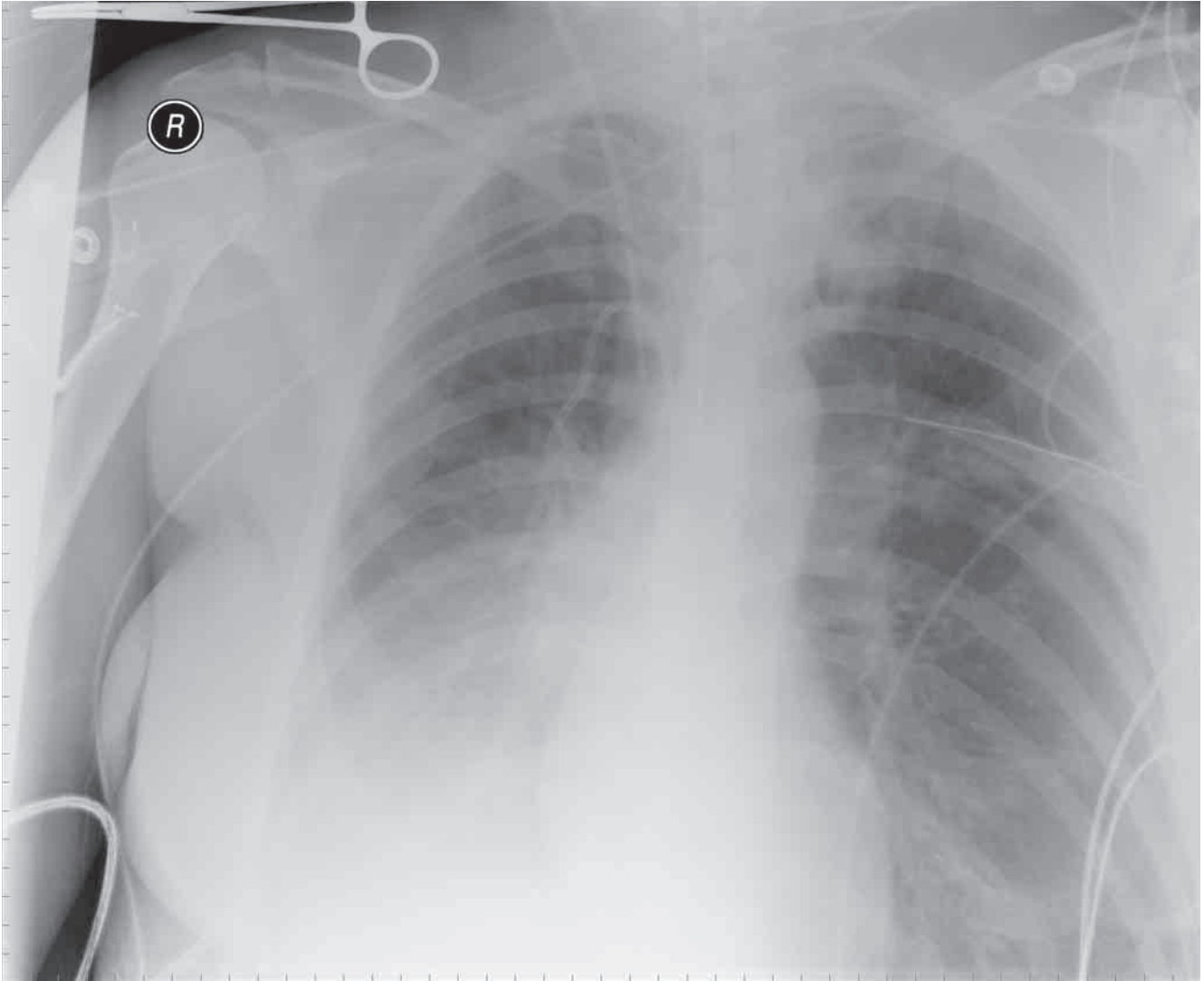
Respiratory care practitioners see many types of

bronchopleural fistulas, and when associated with ARDS, can have an increase in complications. Early detection and treatment are essential to reduce the morbidity and mortality. One of the options that we have is using ILV, where one lung can be ventilated using different pressures, with a use of a slave system between the two ventilators. This has been standard therapy in many traumas as well as surgeries (lung transplant, thoracic aortic repair (TAR), etc.). In some severe cases, where the damage is so great to one lung, each lung must be ventilated using completely different modes and pressures. Doing this lets the respiratory care practitioner ventilate and oxygenate the damage lung without having to over inflate the non-damaged lung. When setting up this way of ventilation, both the practitioner and the physician must find the right resting settings for the non-damaged lung to prevent over-distention or atelectasis. And once placing the patient on APRV, it may take several hours or even several days to see full results. Once homeostasis is achieved, both the respiratory practitioner and the physician may need to stay in this mode for several days or even up to a week, allowing the damage lung to heal. During this phase, education is very important for both the respiratory care department and the rest of the medical staff. It is also very important that both respiratory care and nursing work very closely in the management of this kind of patient. It takes a good working relation between the two to suction, roll, and provide adequate patient care.

Conclusion

We conclude that using asynchronous independent lung ventilation with APRV may help improve ventilation and oxygenation in some cases of bronchopleural fistulas in some traumas that are associated with ARDS, who do not improve with standard mechanical ventilation. Further work with APRV in this type of support may be useful.

Figure 1.



Legend: This CXR shows patchy infiltrates throughout both lung fields, with chest tubes noted in the left lung.

Figure 2



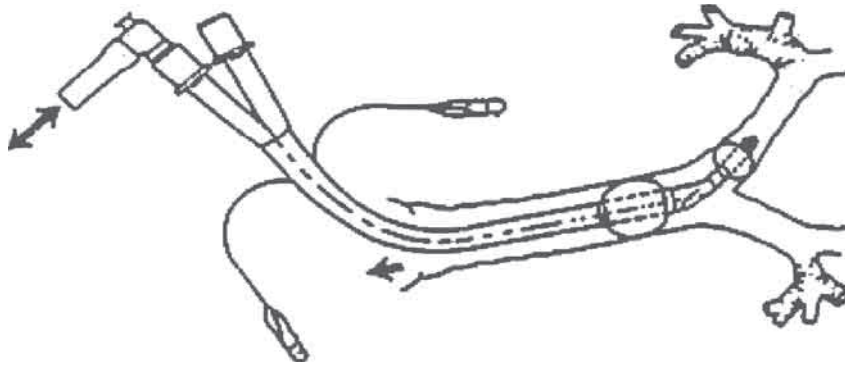
Legend: This MRI shows the almost total collapse of the left lung due to trauma. Some of the damage caused by the projectile (bullet) can be seen in the left upper lobe and to the extent of T4 and T5. The over distention of the right lung can also be seen.

Figure 3



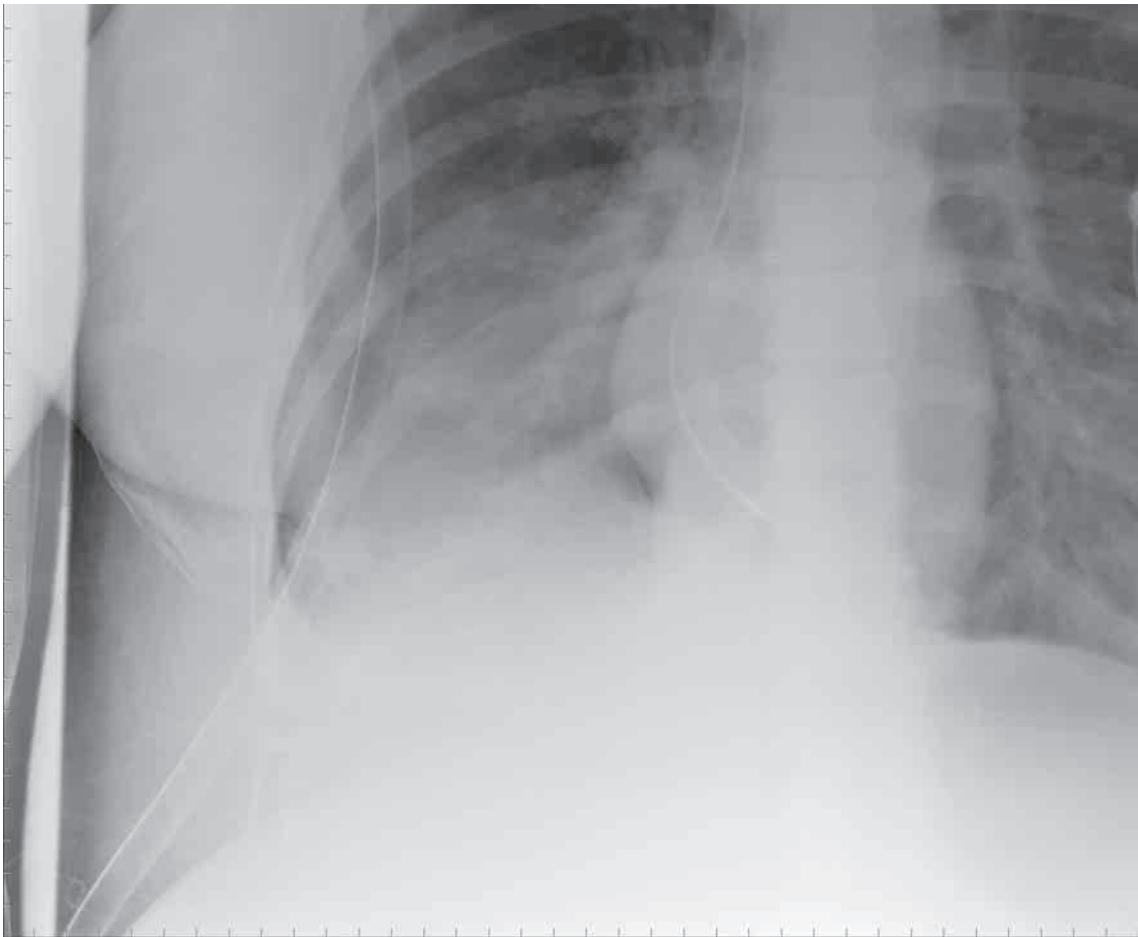
Legend: In this CT, you can see the collapse of the left lung, with it pulling the heart completely into the left side of the chest. Also the over distention of the right chest can be seen, with no damage seen.

Figure 4



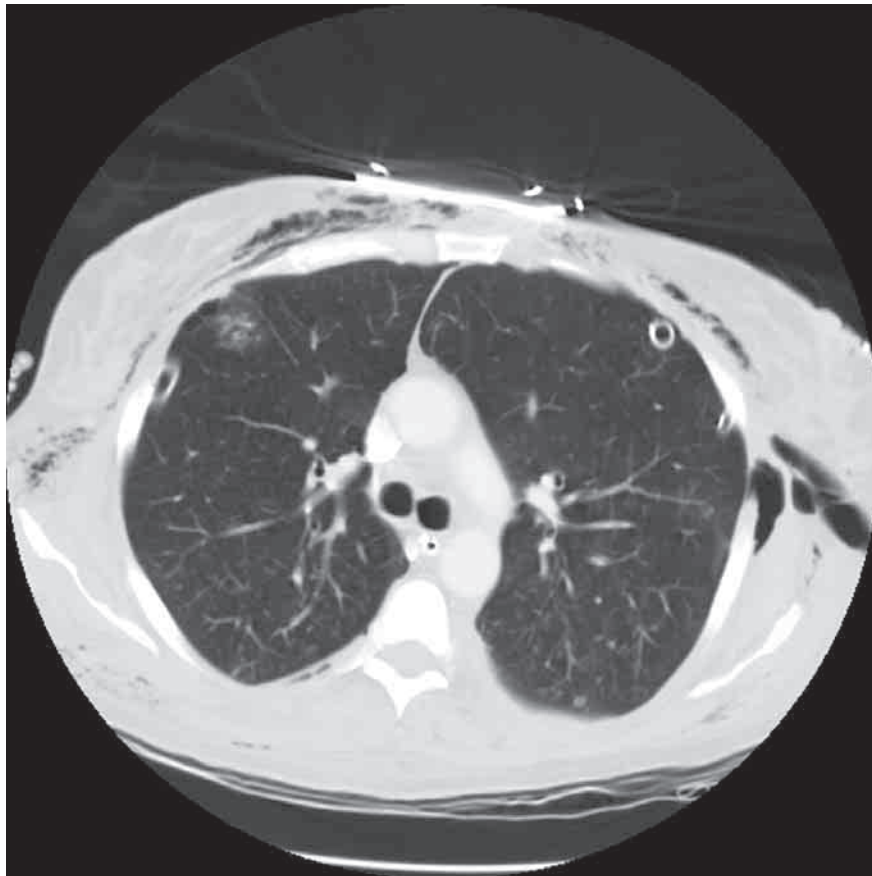
Legend: An illustration of a Sheridan (San Francisco, California) left sided double lumen endotracheal tube (ETT); showing inflated cuffs. It also demonstrates how the ETT is inserted into the left bronchus; therefore both lungs may be ventilated separately from each other.

Figure 5



Legend: Shows improvement in the CXR after 8 days in AILV, showing an increase in aeration, and decrease of patchy infiltrates throughout both lung fields. Also noted that there is almost an over distention of the left lung compared to the right lung.

Figure 6



Legend: A CT of the chest, after AILV was performed over a week. Both lungs can now be seen to be inflated properly. The heart is again located in its normal position. Slight Sub Q emphysema can be noted in the chest wall. The initial trauma of the entrance of the projectile can be seen on the lateral left side.

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