Partial Air Replacement During Thoracentesis: 
Its Value in Diagnosis and Treatment

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Replacement of fluid removed from the pleural cavity, partially by air, is a most valuable procedure. Its use has been known for a great many years, but for various reasons, it has been used infrequently in this country. The advantages in diagnostic roentgen ray work are great, and its usefulness in making possible the removal of large quantities of fluid at one time, is important. If such considerations are true, why then has it not been universally used?

The chief reason if not the sole one, has been due to the misinterpretation of the report of the Empyema Commission following the great Influenza epidemic in 1918. At that time there were a great many cases of empyema. Most of them were due to the Streptococcus hemolyticus, and accordingly when the empyema developed it did so while the pneumatic process was still active. Also in this type of infection the inflammatory process remains generalized for a long time, and is really a suppurative pleurisy, for empyema literally means a localized collection of pus. Many of these patients, treated by open drainage, died. The induction of open pneumothorax in the presence of underlying pneumonia, and mobile mediastinum, inevitably is followed by death. However, in the pneumococcus empyemas, with walled off pus and a fixed mediastinum, and the pneumatic process resolved, open drainage does no harm but leads to recovery. The Empyema Commission pointed out the fallacy of using open drainage in cases of streptococcus empyema, and explained the reasons for it. Unfortunately, many doctors in this country interpreted this report as a condemnation of open drainage in general. Furthermore, they came to believe that the mere presence of air in the pleural cavity was bad, in spite of their knowledge of the pneumothorax treatment of tuberculosis. How they could come to such a conclusion is hard to understand, but having taught in three medical schools, and having had contact with graduates from many others, I know that what I have said is true.

So much for the apparent reasons why this simple, and innocuous procedure has not been used. What can be accomplished by its use? Its greatest value lies in the aid given in roentgen ray visualization of shadows obscured by fluid in the pleural cavity. When one aspirates this fluid, unless most of it is removed, the only change noted in the roentgen ray is in the position of the mediastinum. Any nodule on the surface of the lung or on the parietal pleura, will not be visualized. However, if the fluid is even partially replaced with air it will fall away from the surface of the lung to the bottom of the pleural cavity. Then, if the patient is put in various positions, with the air uppermost, the surfaces of the lung and the
parietal pleura will be plainly visualized. The accompanying reproductions of roentgen rays from a case of hemothorax of unknown etiology will illustrate what I have just said. The procedure demonstrated the presence of peripheral nodules after all other studies, including bronchoscopy, had failed to show anything except the bloody pleural fluid. The diagnosis of metastatic carcinoma of the lung and pleura was thus established. Figures 1, 2, and 3.

**FIGURE 1**

*Figure 1:* Roentgen ray of chest showing massive right pleural effusion.

**FIGURE 2**

*Figure 2:* Roentgen ray of chest showing residual fluid in lower part of right pleural cavity and return of mediastinal shadow to midline.

**FIGURE 3**

*Figure 3:* Roentgen ray examination of chest to show details in right lower chest. Note rounded shadows on lower parietal pleura and over diaphragm, and showing through lowermost part of the lung.
The first time I saw air replacement of pleural fluid for diagnostic purposes was in 1921, as an intern at the Presbyterian Hospital in New York. We had all been admonished never to allow any air to enter the pleural cavity during thoracentesis. Then, Dr. Hans Jacobaeus of Stockholm visited the hospital to demonstrate his use of the thoracoscope. He examined a patient with bloody pleural effusion on whom no diagnosis had been made. In the chief operating amphitheatre the patient was placed on an operating table. Dr. Jacobaeus injected a small amount of novocain and then inserted a rather large trocar and cannula. When the trocar was removed bloody fluid escaped under pressure. He rolled the patient on his back in order for the fluid to flow out more easily and then turned him back on his side so that air could flow into the pleural cavity. He repeated this maneuver until practically all the fluid had been removed and been replaced with air. The thoracoscope was then inserted and he could see carcinomatous nodules scattered over the surface of the lung and the parietal pleura. A diagnosis of carcinoma of the lung and pleura was thus made. In spite of this dramatic demonstration no one was apparently influenced to follow Dr. Jacobaeus' lead, and it was not until 1929, when in Dr. Graham's chest clinic in St. Louis that I saw Dr. Singer use air replacement of pleural fluid. He told me then that the technique had long been in use in Germany. Since that day I have used this procedure and have exhorted my students, interns, and associates to do the same, but without success.

Although the chief value of air replacement has to do with roentgen ray visualization, the procedure has real merit also in other respects. When one aspirates fluid from the pleural cavity the negative pressure in it is increased. If the patient is in the usual sitting position, and a large amount of fluid is withdrawn, he will usually faint as the result of the shift of the mediastinum, and the effect on the circulation. On the other hand, if air is allowed to flow back into the pleural cavity as the fluid is withdrawn, the change in pressure will be so slight that no symptom will develop. It is not necessary to measure the amount of air that is allowed to flow into the pleural cavity. All one need do is to disconnect the syringe from the needle from time to time and allow air to be sucked into the pleural cavity. Unless one is using a large cannula and leaves it open for a long time no harm can result. Using this technique one can completely evacuate the pleural cavity without disturbing the patient in any way. While it is the custom to have the patient sitting upright when thoracentesis is being done, apparently in order to remove all of the fluid, this is a bad practice. It is practically never necessary to remove all of the fluid from the chest, and about as much can be removed by having the patient lying on the side and rolling over backward, as by having him sit up straight. It is far more comfortable for the patient to lie on his side if he is sick and weak. The complete evacuation of the pleural fluid at one sitting makes it possible to do the aspirations at less frequent intervals.

Another advantage of partly replacing the fluid with air is that the negative pressure does not build up and therefore it is easier to withdraw the
fluid. Even the aspiration of blood and pus is aided, but in these cases it is important to remove the air at the end of the aspiration so that no pocket of pneumothorax remains which might lead to a localized pocket of empyema, or prevent full re-expansion of the lung.

SUMMARY

Partial replacement of fluid withdrawn on thoracentesis allows one to withdraw large amounts of fluid at one time without upsetting the patient, because changes in intrapleural pressure are so little. It also causes fluid covering the lung to fall from it, and thus allows the x-ray visualization of the surface of the lung and of the parietal pleura. This procedure should be used in all cases of pleural effusion, but where there is an empyema or hemothorax, it is important not to allow any air to remain in the pleural cavity. The air is allowed to enter the pleural cavity freely through the needle in the chest wall when the syringe is disconnected from it. If a needle of size 15 or smaller is used it is not necessary to measure the amount of air.

RESUMEN

La substitución por aire del líquido extraído por toracentesis, permite extraer grandes volúmenes de líquido de una vez sin molestar al enfermo porque los cambios en la presión intrapleural son pequeños.

También permite que el líquido que cubre el pulmón caiga y así permite observar la superficie del pulmón y de la pleura parietal por los rayos X. Este procedimiento debe usarse en todos los casos de derrame pleural, pero cuando hay empiema o hemothorax es importante que no se deje aire en la cavidad pleural.

El aire se deja libremente en la cavidad pleural entrando con sólo que se desconecte la aguja de la jeringa. Si la aguja es de calibre 15 o menos, no es necesario medir el volumen de aire.

RESUME

Le remplacement partiel du liquide ponctionné en cas de thoracenthèse par de l'air permet de retirer d'importantes quantités de liquide en une seule fois sans dommage pour le malade, car ainsi les modifications de la pression intra-pleurale restent assez faibles. Cela permet aussi de débarrasser le poumon du liquide qui le recouvre et assure la visibilité radiologique de la surface pulmonaire et de la plèvre pariétale. Ce procédé doit être utilisé dans tous les cas d'épanchement pleural, mais en cas d'empyème ou d'hémothorax, il est important de ne pas laisser la moindre quantité d'air dans la cavité pleurale. L'air peut entrer librement dans la cavité pleurale par l'aiguille dans la paroi thoracique, au moment où elle n'est plus emmanchée dans la seringue. Si une aiguille de taille 15 ou plus petite est utilisée, il n'est pas nécessaire de mesurer la quantité d'air.

ZUSAMMENFASSUNG

Partielle Verlagerung der bei der Thoraxpunktion abgesaugten Flüssigkeit macht es möglich, grosse Flüssigkeitsmengen auf einmal abzusaugen, ohne den Patienten aufzusetzen, weil die Veränderungen des intrapleu-
ralen Druckes so gering sind. Sie veranlasst auch die die Lunge überdeckende Flüssigkeit, sich zu senken, und ermöglicht so die röntgenologische Darstellung der Lungenoberfläche und der parietalen Pleura. Dieses Vorgehen sollte bei allen Fällen von pleuralem Erguss angewandt werden; liegt jedoch ein Empyem oder ein Haemothorax vor, so ist es wichtig, nicht zuzulassen, dass irgendwelche Luft in der Pleurahöhle zurückbleibt. Die Luft hat die Möglichkeit, in die Pleurahöhle frei durch die Nadel in der Brustwand zu gelangen, wenn die Spritze von ihr entfernt ist, Wird eine Nadel der Größe 15 oder weniger benutzt, ist es nicht nötig, die Luftmenge zu messen.

REFERENCE