Treatment of Pneumothorax with Intrapleural Tetracycline

The enthusiasm for using sclerosing agents to treat spontaneous pneumothorax has waxed and waned over the years. This is at least in part because various sclerosing agents have been associated with undesirable side effects. For example, talc poudrage has been condemned by some because of talc cerebral embolism in both experimental animals and man. Quinacrine has been associated with CNS side effects. In one series of patients treated with kaolin for pneumothorax, virtually all developed pleural effusion, fever and chest pain afterwards.

Tetracycline, however, has not been associated with significant side-effects and has been found to be highly effective in both animals and man. Thorsrud demonstrated that tetracycline in acidic solution causes destruction of mesothelial cells when injected into the pleural space of laboratory animals. He also studied other sclerosing agents in animals and found that tetracycline was the most reliable for causing pleurodesis. Rubinson and Bolooki were the first to report the success of using tetracycline as a pleural sclerosing agent in humans with malignant effusion. Austin and Flyre reviewed more than a dozen different techniques for controlling pleural effusions and concluded that, on the basis of effectiveness, morbidity and convenience, tetracycline was the method of choice to obtain pleurodesis with malignant effusions. Sahn came to a similar conclusion after testing numerous agents. Goldszer used tetracycline in two patients with spontaneous pneumothorax and active air leak which had been present for several days. Within 24 hours of tetracycline installation, the air leaks subsided in both patients and there was no evidence of recurrent pneumothorax.

In general, however, there has been a reluctance to use sclerosing agents in patients with active pulmonary-pleural air leaks, possibly because of the fear of reflux of the sclerosing agent through the fistula into the pulmonary parenchyma, which might result in pneumonitis and lung damage. Because of this possible complication, we tested the effects of tetracycline pleurodesis in experimental animals with active pulmonary-pleural air leaks, since this is the usual clinical setting in which patients present with recurrent pneumothorax. We found that concentrated tetracycline solution was effective in causing pleurodesis even when active air leak was present, and we failed to detect any evidence of pneumonitis.

As a result of this study, we began to use tetracycline pleurodesis in selected high-risk patients with pneumothorax and active pulmonary-pleural air leaks, including patients requiring mechanical ventilation and severely cachectic children with cystic fibrosis, pneumonia and pneumothorax. In our initial patients, all had active pulmonary-pleural air leak and in none would the lung remain expanded when the chest tube was clamped. We were able to cause pleurodesis in all of the early cases, although some required more than one installation of tetracycline. We were unsuccessful, however, in patients whose lung could not be expanded even with multiple chest tubes and high negative suction. This was because the lung and chest wall were not in contact and, therefore, the symphysis between the parietal and visceral pleura could not occur.

Subsequently, we widened our indications for tetracycline pleurodesis and offered it to patients presenting to the hospital with recurrent pneumothorax. In contrast to the effect in patients with malignant pleural effusion, tetracycline frequently caused quite severe chest pain in patients with simple pneumothorax. The pain was often described by the patients as if scalding water had been injected through the chest tube. Various techniques to alleviate the chest pain were tried including intramuscular and intravenous analgesics and sedatives before administering the tetracycline. The tetracycline was also mixed with lidocaine or bupivacaine hydrochloride. In some patients, lidocaine or bupivacaine hydrochloride was instilled first. None of these methods was successful. Eventually it was discovered that intravenous ketamine in analgesic doses (0.2-0.75 mg/kg) was effective. Ketamine is presently administered by the anesthesiologist either...
in the intensive care unit or in the operating room. After the ketamine is given, tetracycline is instilled. In this dose range, patients breathe spontaneously, their cough reflex is maintained, and they are able to follow simple verbal commands within 10 to 20 min.16 Very few patients have complained of any pain when this technique is used.

Many patients have received tetracycline for pneumothorax at the Hospital of the University of Pennsylvania and the Children's Hospital of Philadelphia. Since 1980, we have had only one recurrent pneumothorax among these patients. This was in a young woman who had received one dose of tetracycline. She returned about one month later with complete collapse of the same lung. Surgical pleural abrasion was performed. At operation, there were almost no adhesions. Because of this incident, we now instill tetracycline three days in a row (normally with administration of ketamine each time). We use 2 g of powdered tetracycline mixed in 50 ml of saline solution for adult patients. If active air leak is present, the chest tube is only clamped for a brief time, usually less than a minute. The patients are not necessarily placed in different positions. The patients are forewarned that there is usually a significant amount of pain associated with the instillation of tetracycline. Of those who choose to undergo tetracycline pleurodesis, most prefer to go to the operating room, where the tetracycline is instilled after the administration of intravenous ketamine.

We recently treated a patient with persistent pulmonary-pleural air leak whose right middle and lower lobe would not remain expanded after right upper lobectomy. When the second dose of tetracycline was instilled into the pleural cavity while the patient was awake in his room, he began to cough up a substance that looked and smelled like tetracycline. Treatment with tetracycline, which is always instilled slowly, was immediately discontinued. Subsequent chest x-ray examination showed no evidence of pneumonitis. The patient had no apparent sequelae and was discharged a few days later after the pulmonary-pleural air leak had ceased. We have not observed any other acute complications with tetracycline or long-term complications such as fibrothorax. We have seen patients from elsewhere who had been treated with tetracycline pleural installation and had continued or recurrent pneumothoraces during that same hospitalization. These failures may have occurred because the tetracycline was instilled when the lung was not fully expanded. As previously mentioned, tetracycline pleurodesis is doomed to failure if the lung and chest wall are not in contact.

In summary, tetracycline is effective in causing pleurodesis. It can be used in patients with pneumothorax and active pulmonary-pleural air leak provided the lung is expanded. At this point, the exact clinical indications for tetracycline pleurodesis in the treatment of pneumothorax are not as yet clearly defined. It does seem especially useful, however, in patients who are considered high surgical risks and in the occasional thoracotomy patient whose remaining ipsilateral lung will not remain expanded without water seal or suction because of persistent air leak.

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Ablation by Transcatheter Shock Current Status

Over the last three years, electrode-catheter delivery of direct-current shocks has emerged as a means of closed-chest ablation of cardiac tissue in man and has now been applied to arrhythmogenic substrates in the atrium, atrioventricular node-His bundle, accessory pathways of conduction, and ventricles. The technique is still largely investigative and much remains to be learned about its long-term sequelae. In this issue of Chest (see page 883) Bharati and co-

804