Effect of Patient Positioning on Distribution of Tetracycline in the Pleural Space during Pleurodesis*

Daniel G. Lorch, M.D.; Leonie Gordon, M.D.; Sally Wooten, M.D.;
J. F. Cooper, Pharm.D.; Charlie Strange, M.D.; and
Steven A. Sahn, M.D., F.C.C.P.

Thoracostomy tube drainage with tetracycline (TCN) instillation is an effective technique for management of recurrent, symptomatic, malignant pleural effusions. Although patient rotation through various positions after instillation of TCN has been advocated empirically, it has not been shown scientifically to be necessary and is often uncomfortable for the patient and time-consuming for personnel. Five patients with symptomatic, malignant pleural effusions were studied during pleurodesis using radiolabelled TCN. Scintigraphic imaging was done immediately after TCN instillation prior to patient rotation. Patients were rotated through six positions and multiple images were obtained at 30 and 120 minutes. Tetracycline dispersed throughout the pleural space within seconds. Patient positioning had no effect on the intrapleural distribution of TCN in four of the five patients. In one patient with loculated hydropneumothorax and trapped lung, rotation minimally improved distribution of TCN to the apex. Rotation during pleurodesis does not appear to be necessary in patients with a relatively normal pleural space. However, patient rotation enhances distribution of TCN when the lung is separated substantially from the chest wall, as with trapped lung. Possibly, in this situation the properties of fluid mechanics and capillary action no longer apply.

Thoracostomy tube drainage with instillation of tetracycline (TCN) is an effective technique for the treatment of symptomatic, malignant pleural effusions. After instillation of TCN, patient rotation has been advocated empirically to enhance contact between the sclerosing agent and the pleural surfaces. Patient rotation has been recommended because it was assumed that TCN did not disperse throughout the pleural space. However, the rotation sequence can be time-consuming for personnel and uncomfortable for the patient. Obviously, if TCN disperses throughout the pleural space without the aid of rotation, the patient would be spared added discomfort and utilization of personnel would be more effective. Therefore, we studied the distribution of TCN in the pleural space following intrapleural instillation to determine if rotation was necessary for dispersement of TCN throughout the pleural space.

MATERIAL AND METHODS

Five patients, 32 to 73 years of age, with recurrent, symptomatic, malignant pleural effusions consented to participate in the study. The pleural effusion was associated with carcinoma of the lung in three patients, non-Hodgkin's lymphoma in one, and adenocarcinoma of unknown origin in one patient. All patients had dyspnea relieved by thoracentesis, reasonable quality of life, and an expected survival of several months.

A chest tube was inserted into the involved hemithorax with drainage of the pleural effusion. When pleural fluid drainage was less than 150 ml/day and the chest radiograph showed minimal or no fluid, instillation of TCN was initiated.

Dispersion of TCN was determined by a radiolabelled TCN. The radiolabelled TCN complex was prepared by the nuclear pharmacy one hour prior to its use, utilizing the stannous chloride reduction technique. Technetium 99m pertechnetate ($^{99m}$Tc) was mixed with TCN in the presence of acidified stannous ion. Sodium bicarbonate was used to bring the solution to a pH of 5.5; under these conditions TCN forms a chelate with the $^{99m}$Tc. The solution was filtered

*From the Division of Pulmonary and Critical Care Medicine, Department of Medicine; Department of Radiology; and Department of Pharmacy, Medical University of South Carolina, Charleston.

Supported in part by Medical University of South Carolina Institutional Research Funds of 1985-86.

Manuscript received August 18, 1986; revision accepted August 11, 1987.

Reprint requests: Dr. Sahn, Pulmonary/Critical Care Medicine, Medical University of South Carolina, Charleston 29425

FIGURE 1. Dynamic imaging (4 s/frame) during the rapid distribution of TCN throughout the pleural space.
Tetracycline (20 mg/kg) was prepared in solution with 60 ml of D2O. One millicurie of 99mTc-TCN complex was added to the therapeutic dose immediately prior to the procedure. Fifteen ml of 1 percent lidocaine (150 mg) was instilled through the chest tube prior to the instillation of TCN.

Instillation of TCN was performed in the nuclear medicine department. With the patient in the supine position, under the large-field-of-view (LFOW) gamma camera, the 99mTc-TCN plus TCN solution was injected through the chest tube over a period of 10 s. During drug administration, dynamic images (4 s/frame) were obtained. With the patient remaining immobile in the supine position, static images were obtained in the posterior, anterior, lateral and posterior oblique projections. Five minutes following instillation, the patient was rotated through the six standard positions. Static images were obtained in the posterior, anterior, lateral and posterior oblique projections at 30 minutes and 120 minutes post-TCN instillation and patient rotation.

**RESULTS**

The radiolabelled TCN dispersed rapidly throughout the pleural space, as visualized by the dynamic images in the supine, posterior view (Fig 1). Four of the five patients exhibited rapid dispersion of TCN throughout the pleural space illustrated by the representative scans of one patient in Figure 2. The left sided images in Figure 2 (a-c) represent the posterior, anterior, and posterior oblique views of the chest immediately following the instillation of the 99mTc-TCN and prior to patient rotation. As illustrated, the radiolabelled TCN dispersed throughout the pleural space without patient rotation. The right sided images in Figure 2 (a-c) represent the post-patient rotation images. Comparison of the immediate (left sided) images and the 30 minute post-patient rotation (right sided) images in Figure 2 confirm that patient rotation did not result in further dispersion of the radiolabelled TCN.

One patient had a hydropneumothorax and a trapped lung. Images obtained in all views following patient rotation revealed a slight increase in the 99mTc-TCN distribution in the apical portion of the hemithorax, suggesting that in markedly abnormal pleural spaces patient rotation may further the dispersion

**FIGURE 2.** Pleural scintigrams immediately after instillation of radiolabelled TCN (left image of pair) and 30 minutes after rotation through standard six positions (right image of pair); a, top, posterior view; b, center, anterior view; and c, bottom, left posterior oblique view. TCN distribution occurred throughout the pleural space without rotation. No further distribution occurred following rotation.

**FIGURE 3a, left.** Chest radiograph illustrating visceral pleural involvement with tumor, trapped lung, and hydropneumothorax. Pleural scintigrams immediately after instillation (left image of pair) and 2 hours after instillation and patient rotation (right image of pair); b, center: anterior view; c, right: lateral view. Minimal increase in TCN distribution occurred in the right apex following rotation in a patient with a trapped lung.
of TCN (Fig 3).

**Discussion**

In a previous study, Miserocchi et al. have shown rapid dispersion of injected fluid throughout the pleural space in dogs using 99mTc-labelled albumin. In the present study, dynamic and static scintigraphic imaging illustrate rapid distribution of TCN to all aspects of the pleural space during injection.

The mechanism of TCN dispersion throughout the pleural space is unknown. One can visualize the pleural space as a narrow channel between two parallel boundaries, each moving compared to the other. A property of liquid is to form to the configuration of its container. Perhaps TCN dispersion is, by the mechanism of capillary action, where the attraction between the boundary surface and the fluid is greater than the intermolecular attraction of the fluid, resulting in dispersion of the fluid. Perhaps TCN dispersion can be explained by fluid mechanics and the law of couette, where the velocity of a fluid in contact with a solid boundary is the same as that of the boundary.

Serial scans in the posterior, lateral, anterior and posterior oblique positions indicate that patient rotation does not promote the distribution of TCN in the pleural space. The exception to these findings was in the patient with a trapped lung in which TCN distribution was minimally enhanced by rotation. In situations where the pleural space is widened, as in pneumothorax, trapped lung or atelectasis, or is severely abnormal due to previous attempts at pleurodesis or prior inflammation, patient rotation may be useful to improve the distribution of TCN. Increasing the width of the pleural space may interfere with capillary action or fluid mechanics of the instilled liquid.

The present study has demonstrated that TCN disperses rapidly and completely throughout the pleural space following instillation through a chest tube and that patient rotation does not enhance distribution except minimally when the lung is not able to expand to the chest wall and the width of pleural space increases. A logical follow-up to this observation would be an efficacy study comparing rotation and no rotation.

**References**