Clamping thoracostomy tubes: a heretical notion?

Geoffrey A. Funk, MD, Laura B. Petrey, MD, and Michael L. Foreman, MD

To determine the safety and complications of chest tube clamping, a retrospective chart review was conducted at Baylor University Medical Center's level I trauma center. The records of 243 patients with pneumothoraces, hemothoraces, or a combination were identified and analyzed; 134 patients underwent clamping according to the care path, and 109 did not. The demographic characteristics of age, gender, and mechanism of injury were similar in both groups, as was the frequency of pneumothoraces, hemothoraces, and combined hemo/pneumothoraces. Subsequent radiographs showing recurrence or patient symptoms were noted in 13 patients (9.7%), requiring unclamping. Nine patients (6.7%) who had passed the clamping trial prior to removal required reinsertion of a chest tube due to recurrent pneumothoraces. One clamped patient required urgent insertion of a second thoracostomy tube due to occlusive thrombus within the residing chest tube. No deaths were documented as a result of the care path or of clamping. Overall, the clamped chest tube allows for more definitive assessment of persistent occult air leaks based on a 6-hour chest radiograph and avoidance of premature removal and did not appear to have any adverse effects on patient safety. Further refinements of the clamping procedure may be needed, as some patients still required reinsertion despite an absence of pneumothorax after a 6-hour clamping trial. Given these data, a prospective study with clamping is warranted to evaluate whether or not such a system can increase the speed with which chest tubes are removed and decrease the length of stay while maintaining patient safety.

Both pneumothoraces and hemothoraces are well-recognized injuries resulting from a variety of traumatic events, quite often requiring placement of one or more thoracostomy tubes. For the treatment of pneumo- and hemothoraces, a prospective care path was designed with the goal of increasing the rapidity of chest tube removal and decreasing patient length of stay. As a result of this effort to standardize the care path and the progression of chest tube care, a clamping trial was added to allow for additional certainty that the patient was ready for removal of the chest tube. This trial was developed under the premise that, should a recurrent pneumothorax or tension pneumothorax develop in the scheduled 6-hour window, it was possible to simply unclamp the tube rather than place a new thoracostomy tube.

There is significant debate regarding clamping of thoracostomy tubes. Anecdotally, sentiment at this institution outside

of the trauma service largely falls against the practice due to concern that patients may develop tension pneumothoraces. A recent consensus statement from the American College of Chest Physicians (ACCP), however, noted that while 41% of its panel would not clamp a chest tube under any circumstances, the remaining 59% would consider a clamping trial and radiograph prior to removing a chest tube (1). Given the existence of this debate and the potential to minimize the need for replacing chest tubes should recurrent pneumo- or hemothoraces develop, we felt that a review of our own data was warranted.

MATERIALS AND METHODS

Between January 2000 and May 2006, 243 patients sustaining a pneumothorax, hemothorax, or a combination of the two and requiring thoracostomy tube placement were admitted to Baylor University Medical Center at Dallas. A retrospective chart review was performed to determine various demographic factors regarding the involved patients, as well as to classify the injury by mechanism and nature (i.e., pneumothorax, hemothorax, or combined) and to determine whether or not the chest tube care path—and, specifically, the clamping trial—was followed appropriately.

The care path is presented in the *Figure*. After thoracostomy tube insertion, wall suction was maintained until the pneumothorax resolved and no air leak was present for 6 hours. Once the chest tube output dropped to an acceptable level—<30 mL over 6 hours—and a radiograph confirmed the continued reexpansion of the lung, the tube was clamped. Clamping of the thoracostomy tube was performed only after all of the above conditions were met, and a follow-up radiograph was again obtained to confirm the absence of a recurrent pneumothorax, with allowance for unclamping should the patient develop any signs or symptoms of respiratory distress. Radiographs throughout the process were interpreted either by the facility's radiology or surgery housestaff.

From the Department of Surgery (Funk) and Division of Surgical Critical Care (Petrey, Foreman), Baylor University Medical Center, Dallas, Texas.

Corresponding author: Geoffrey Funk, MD, Resident, Department of Surgery, Baylor University Medical Center, 3500 Gaston Avenue, Dallas, Texas 75246 (e-mail: Geoff@thefunks.net).

Figure. Chest tube care path.

Patients with spontaneous pneumothoraces, as well as patients requiring mechanical ventilation, were excluded from this study. It was not possible in this study to obtain data retrospectively to demonstrate whether or not the care path had any effect on decreasing length of duration of chest tube insertion or duration of hospitalization.

RESULTS

The study population included 189 men (77.8%) and 54 women (22.2%), with an age range of 11 to 100 and an average age of 46 years. Of this population, 40% were Caucasian, 36% were African American, and 23% were Hispanic.

The injury was caused by a variety of mechanisms, with the most common being motor vehicle collision, stabbing, gunshot

wounds, and falls (Table). Half of the patients had a pneumothorax ($n = 122$), 12% had a hemothorax ($n = 29$), and the remaining 38% had a hemo/pneumothorax ($n = 92$). There was no significant difference between the various mechanisms with respect to the presence of hemo- or pneumothorax.

Use of the care path was largely determined by staff preference. The characteristics of the patients undergoing clamping according to the care path (55.1%, $n = 134$) were similar to those who did not have the clamping portion of the care path (44.9%, $n = 109$), based on age, gender, and mechanism of injury. The frequency of pneumothoraces, hemothoraces, and combined hemo/pneumothoraces was also similar for the clamped and unclamped patients.

Subsequent radiographs showing recurrence or patient symptoms were noted in 13 patients (9.7%), requiring unclamping. Nine patients (6.7%) who had passed the clamping trial prior to removal required reinsertion of a chest tube due to recurrent pneumothoraces, versus 5 patients (4.6%) who did not have clamping as part of the care path. No specific patient population or mechanism was identified that had a higher likelihood of recurrence or need for unclamping. There was no significant difference between the need for reinsertion between the clamping and nonclamping arms of the care path.

One clamped patient required urgent insertion of a second thoracostomy tube due to occlusive thrombus within the residing chest tube. No deaths or other complications resulted from the care path.

DISCUSSION

Chest tube insertion has its own morbidity, with published rates of 9% to 25% (2–4). For example, incorrectly placed chest tubes can result in the need for repeated attempts at thoracostomy tube placement, as well as lung, vascular, and intraperitoneal injuries (5). Likewise, published rates of recurrent pneumothoraces after

removal of chest tubes range from 2% to 24%, with rates of reinsertion ranging from 1% to 6% (4).

The clamped chest tube allows for more definitive assessment of persistent occult air leaks based on a 6-hour chest radiograph and avoidance of premature removal. The 9.7% rate of premature removal in this study seems rather high, although, as noted

Table. Mechanism of injury

Mechanism	N (%)
Motor vehicle collision	84 (34.6%)
Stabbing	54 (22.2%)
Gunshot wounds	46 (18.9%)
Fall	21 (8.6%)
Motorcycle collision	13 (5.3%)
Assault	13 (5.3%)
Auto-pedestrian collision	6 (2.5%)
Animal attack	3 (1.2%)
Bicycle collision	1 (0.4%)
Other	2 (0.8%)

above, other sources in the literature quote similar rates (2% to 24%). In our series, a number of potential causes for this rate may be identified. The method of chest tube removal was not standardized in the study, nor was this information retrieved in our initial retrospective review. Premature removal of the clamp may have been related to reliance on newer housestaff without a specific protocol for actual removal of the thoracostomy tube; variations in technique, including simple occlusive dressings, suture closures, or combinations thereof, may account for some of these premature removals. Likewise, the preremoval radiograph was interpreted by the same housestaff rather than waiting on official radiologist interpretation. While this process may have resulted in some prematurely removed chest tubes, retrospective evaluation of the official radiologist evaluation of the nine chest radiographs that required reinsertion revealed that housestaff interpretations were correct in all of these cases. Current efforts are also directed towards streamlining the care path to allow for higher rates of compliance among all individuals involved, including nursing personnel, physicians, and respiratory therapists.

Other refinements of the clamping care path may be needed, since some patients still required reinsertion despite an absence of pneumothorax after a 6-hour clamping trial (6.7% in this study). Review of the data revealed no specific subset of the patient population that had a significantly higher risk of recurrence or need for reinsertion. This too can be further evaluated in a future prospective trial.

Insertion of a second chest tube for pneumothorax, as was required in one patient in this study, has been reported in the literature even in patients with patent thoracostomy tubes (6). In the case of this patient, our chest tube was determined to be

occluded by clot and had never been clamped. Careful monitoring of the patient with a thoracostomy tube identified the patient's shortness of breath and resulted in insertion of the second chest tube and resolution of his symptoms.

In our experience, thoracostomy tube clamping does not appear to have any adverse effects on patient safety when performed judiciously with appropriate supervision, just as is needed after removal of a chest tube completely. Use of clamping may allow identification of the same population of potential complications but with the ability to resolve the issue by simply unclamping the chest tube rather than reinserting it.

Given these data, we believe that a prospective study of clamping—with tight control of the algorithm, radiologist interpretation, and techniques of removal—is warranted to evaluate whether or not such a system can increase the speed with which chest tubes are removed and can reduce hospital length of stay while maintaining patient safety.

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