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Thoracostomy tube function not trajectory dictates reintervention

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ABSTRACT

Background: Hemothorax and/or pneumothorax can be managed successfully managed with tube thoracostomy (TT) in the majority of cases. Improperly placed tubes are common with rates near 30%. This study aimed to determine whether TT trajectory affects the rate of secondary intervention.

Methods: A retrospective review of all adult trauma patients undergoing TT placement over a 4-y period was performed. TT trajectory was classified as ideal, nonideal, or kinked-based on anterior–posterior chest x-ray. TTs with sentinel port outside the thoracic cavity were excluded. The primary outcome was any secondary intervention.

Results: Four-hundred eighty-six patients and a total of 547 hemithoraces underwent placement and met inclusion criteria. The majority of patients were male (76%), with a median age of 41 y, and majority suffered blunt trauma ideal trajectory was identified in 429 (78.4%). Kinked TTs were noted in 33 (6%) hemothoraces with a 45.5% replacement rate. Review with staff demonstrates inherent bias to replace kinked TTs. The overall secondary intervention rate was 27.8%. Kinked TTs were removed from final analysis due to treatment bias. Subsequent analysis demonstrated no significant difference between ideal and nonideal trajectories (25.1% *versus* 34.1%, $P = 0.09$).

Conclusions: Intrathoracic trajectory of nonkinked TTs with the sentinel port within the thoracic cavity does not affect secondary intervention rates, including the rate of surgical intervention.

Introduction

The majority of thoracic trauma resulting in hemothorax (HTx), pneumothorax (PTx), or hemopneumothorax can be managed with thoracostomy tube (TT) placement. Indications for and technique of TT placement have been well described with the "ideal" TT coursing to the posterior apex originating from the fourth or fifth intercostal space between the mid-axillary and anterior axillary lines.[1,2] Although a seemingly simple procedure, TT malposition is common with rates approaching 30%.[1-5] There remains a paucity of data regarding the function of TTs in different intrathoracic positions. Several strategies have been used to manage TT malposition including observation, repositioning, replacement, additional

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TT placement, or early surgical intervention, but no technique is clearly superior.

The goal of this study was to determine whether the intrathoracic trajectory of a TT, as seen on anterior–posterior chest roentgenogram (AP CXR), influences successful resolution of traumatic HTx and/or PTx. We hypothesized that TT trajectory had no effect on clinical failure rate defined by the rate of secondary intervention.

Methods

Froedtert Memorial Lutheran Hospital is an American College of Surgeons' Committee on trauma-verified level I adult trauma center that serves the suburban and urban population of Milwaukee, Wisconsin. Using an administrative billing database and the trauma registry, we identified all patients who underwent TT placement between August 2009 and June 2013. Patients were excluded if less than 18 y of age, sentinel port of the TT was outside the thoracic cavity on initial imaging, death during index admission, or the initial TT placement was operative in nature. TTs were typically placed by a junior level surgical or emergency medicine resident under the supervision of an attending trauma surgeon. During the initial trauma evaluation, most patients underwent a portable AP CXR to diagnose HTx and/or PTx before TT placement. All TTs were placed using sterile technique. After insertion, AP CXR is obtained to evaluate TT intrathoracic trajectory. Patients underwent chest computed tomography (CT) scanning only when clinically indicated for evaluation of related injuries. Criteria for TT removal was based on the clinical judgment of the trauma physicians in accordance with internal policies but generally were removed after resolution of any air leak, and if the 24-h output was less than 150 mL after the TT had been placed to water seal.

This retrospective study was reviewed and approved by the Medical College of Wisconsin's Institutional Review Board. Demographics, mechanism of injury, Injury Severity Score, chest Abbreviated Injury Scale score, the presence of HTx/PTx, hospital and/or intensive care unit length of stay, discharge destination, and mortality were all included. Individual hemithoraces were evaluated due to an anticipated 10% rate of bilateral TT placement. Secondary intervention was defined as TT repositioning, replacement, additional TT placement, or surgical intervention for the management of an unresolved HTx and/or PTx. Of note, TT replacement for the management of postpull PTx was excluded.

An attending radiologist specializing in trauma retrospectively reviewed all postplacement CXRs to classify the trajectory of the initial TT. Two broad categories were used to define the initial TT trajectory, ideal, and nonideal. Ideal TT trajectory was further divided into two classes. Class I TT demonstrated an apicomedial course, whereas class II TT was apicolateral. Nonideal TT trajectory was grouped into three classes. Ideal TT were further stratified by location of the tip within 2 cm of the apex (Ia and IIa) and those in which it was greater than 2 cm from the apex (Ib and IIb). Class III TT were oriented medially and without apical deflection (as commonly seen with placement within the major fissure). Class IV TT was caudally oriented (supradiaphragmatic). Class V TT included any kinked TT, regardless of tip position. Figure shows representative CXR imaging of each class of TT.

The primary outcome was the need for secondary intervention, which was used as a surrogate for TT function. STATA (StataCorp LP, College Station, TX) version 11 was used for statistical analysis. Dichotomous variables were analyzed with chi-square tests using a P value less than 0.05 to determine significance. Continuous variables are reported as mean (standard error of the mean) if normally distributed and median (interquartile range) if not normally distributed. Continuous variables are analyzed using Student's t-test or Kruskal–Wallis where appropriate. Categorical variables are reported as counts and percentages.

Results

During the 4-y study period 554 trauma patients underwent percutaneous TT placement. Sixty-eight patients were excluded (53 mortalities and 15 with sentinel port out of the thoracic cavity) leaving a total of 486 patients and 547 individual hemithoraces for evaluation. Indications for placement were evenly distributed: hemopneumothorax (37%), HTx (29%), and PTx (34%). Most patients were male (76%) with a median age of 41 y (IQR, 26-55 y). The majority (67.9%) sustained blunt trauma. Please refer to Table 1 for complete patient demographics. Ideal TT positioning was identified in 429 (78.4%) hemithoraces. One hundred and eighteen (21.6%) were classified as nonideal including 33 (6.0%) class V TT. A total of 124 (25.5%) patients underwent CT evaluation of the chest within 24 h of TT placement. The overall rate of a secondary intervention was 27.8% including 109 (71.7%) requiring additional or replaced TT, 31 (20.4%) video-assisted thoracoscopic surgery (VATS), and 12 (7.9%) thoracotomies. Secondary intervention rates for ideal and nonideal TT trajectory were 25.1% and 37.3% ($P = 0.009$), respectively. Tables 2 and 3 outline anatomic TT distribution of tubes and reintervention statistics, respectively. Table 4 outlines statistical analysis of predictors of need for secondary intervention.

Kinked TTs were noted in 33 (6%) hemithoraces with 45.5% replaced or repositioned. No surgical interventions were noted in this group. When kinked class V TT's were excluded from analysis, the overall rate of secondary intervention was 26.7%, and there was no significant difference between ideal and nonideal trajectories (25.1% *versus* 34.1%, $P = 0.09$). Table 5 details risk factors for the need for secondary intervention. There was a significantly greater rate of secondary surgical intervention within hemothoraces in which an ideal TT trajectory was identified compared with those with a nonideal trajectory ($P < 0.001$). Table 6 summarizes additional outcome variables.

Of the 109 hemithoraces that required an additional TT, 25 (22.9%) required surgical management (19 VATS and six thoracotomies). Among patients who had an additional TT placed for management of retained HTx, 42.9% ultimately required surgical intervention for definitive management.