[Original Research]

CHEST

A Systematic Review and Meta-Analysis Comparing Pigtail Catheter and Chest Tube as the Initial Treatment for Pneumothorax

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BACKGROUND: The optimal initial treatment approach for pneumothorax remains controversial. This systemic review and meta-analysis investigated the effectiveness of small-bore pigtail catheter (PC) drainage compared with that of large-bore chest tube (LBCT) drainage as the initial treatment approach for all subtypes of pneumothorax.

METHODS: PubMed and Embase were systematically searched for observational studies and randomized controlled trials published up to October 9, 2017, that compared PC and LBCT as the initial treatment for pneumothorax. The investigative outcomes included success rates, recurrence rates, complication rates, drainage duration, and hospital stay.

RESULTS: Of the 11 included studies (875 patients), the success rate was similar in the PC (79.84%) and LBCT (82.87%) groups, with a risk ratio of 0.99 (95% CI, 0.93 to 1.05; $I^2 = 0\%$). Specifically, PC drainage was associated with a significantly lower complication rate following spontaneous pneumothorax than LBCT drainage (Peto odds ratio: 0.49 [95% CI, 0.28 to 0.85]; $I^2 = 29\%$). In the spontaneous subgroup, PC drainage was associated with a significantly shorter drainage duration (mean difference, −1.51 [95% CI, −2.93 to −0.09]) and hospital stay (mean difference: −2.54 [95% CI, −3.16 to −1.92]; $P < .001$) than the LBCT group.

CONCLUSIONS: Collectively, results of the meta-analysis suggest PC drainage may be considered as the initial treatment option for patients with primary or secondary spontaneous pneumothorax. Ideally, randomized controlled trials are needed to compare PC vs LBCT among different subgroups of patients with pneumothorax, which may ultimately improve clinical care and management for these patients.

TRIAL REGISTRY: PROSPERO; No.: CRD42017078481; URL: https://www.crd.york.ac.uk/prospero/.

CHEST 2018; ■(■):■-■

KEY WORDS: chest tube; pneumothorax; pigtail; thoracostomy; thoracentesis

ABBREVIATIONS: LBCT = large-bore chest tube; PC = pigtail catheter; RCT = randomized controlled trial; RR = risk ratio

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DOI: https://doi.org/10.1016/j.chest.2018.01.048

FLA 5.5.0 DTD ■ CHEST1563_proof ■ 22 March 2018 ■ 12:04 pm ■ EO: CHEST-17-2988

Pneumothorax, a potentially lethal respiratory disease, is a common presentation to the emergency department worldwide, and it affects > 20,000 patients per year in the United States. Pneumothorax can be categorized according to its etiology as primary spontaneous pneumothorax, secondary spontaneous pneumothorax, and iatrogenic or traumatic pneumothorax. Although a small spontaneous pneumothorax may resolve without treatment, for patients who are symptomatic (ie, significant dyspnea defined as deterioration in usual exercise tolerance[2]) and exhibit a larger pneumothorax (rim of air > 2 cm), simple aspiration or tube thoracostomy is necessary.[1] However, whether a small-bore pigtail catheter (PC) or a large-bore chest tube (LBCT) should be used as the initial treatment for pneumothorax remains controversial. For example, according to the American College of Chest Physicians Delphi consensus statement,[2] an LBCT (16F-28F) should be used for treating larger and unstable primary and secondary spontaneous pneumothorax; by contrast, the British Thoracic Society no longer recommends the use of the LBCT for primary and secondary spontaneous pneumothorax.[1] In addition, clinical guidelines are unclear regarding the management strategies for pneumothorax subtypes other than primary and secondary spontaneous pneumothorax. Due to the inconsistency and the paucity of evidence, substantial variations exist in the approaches used for the initial management of pneumothorax in clinical practice.[3] We therefore conducted a systematic review and meta-analysis to investigate the effectiveness of small-bore PC drainage compared with that of LBCT drainage as the initial treatment for different subtypes of pneumothorax.

Materials and Methods

The study protocol was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[4] This research was exempted from institutional review board approval because it used only existing, publicly available data. The protocol of the present systematic review was registered online with PROSPERO, the international prospective register of systematic reviews (CRD42017078481).

Search Strategy and Selection Criteria

We systematically searched PubMed and Embase for randomized controlled trials (RCTs) and cohort studies published up to October 9, 2017. Natural language terminology, Embase Subject Headings (Emtree) and Medical Subject Headings (MeSH) (pneumothorax, pneumothoraces, thoracentesis, drainage catheter, pigtail catheter, chest tube, and thoracostomy) with Boolean algebra were used to identify articles comparing PC drainage with chest tube drainage in the databases of PubMed, Embase, and Cochrane Library. The search was not limited to articles published in English.

The abstracts and full text of articles were screened for pertinent information. The inclusion criteria were defined a priori and were as follows: (1) RCTs or cohort studies (prospective or retrospective); (2) articles that reported outcomes (success rates, recurrence rates, complication rates, hospital stay, or prognosis) of primary and secondary spontaneous pneumothorax (or both), traumatic pneumothorax, or iatrogenic pneumothorax; and (3) articles that compared PC drainage vs LBCT drainage for the initial treatment of pneumothorax. We excluded studies on the newborn population and studies if they reported the outcomes for PC drainage or LBCT drainage only.

Size Definitions of PC and Chest Tubes

Chest tubes are available in various sizes based on the external diameter, ranging from 6F to 40F. Typically, chest tubes may be straight or coiled at the end ("pigtail"). A small-bore chest tube is typically ≤ 14F, whereas an LBCT is typically > 14F in diameter. However, in the included studies, only one patient aged 17 years was treated with an LBCT sized 16F and was categorized into the chest tube group.[5]

Data Extraction and Quality Assessment

Two reviewers (Y. N. K. and S. H. C.) independently extracted the data on the study design, setting, population descriptors, and outcomes. In the case of disagreement, other reviewers (H. Y. C. and Y. H. C.) served as the arbitrators. The Newcastle-Ottawa Scale was used to assess the methodologic quality and risk of bias of the included cohort studies, and the Cochrane Risk of Bias Tool was used for the included RCTs, as recommended in the Cochrane Handbook.[6,7] The appraisal tools are described in detail in e-Figure 1 and e-Table 1. The Cochrane Risk of Bias Tool comprises seven methodologic domains: (1) random sequence generation; (2) allocation concealment; (3) blinding of participants and personnel; (4) blinding of assessment; (5) incomplete outcome data; (6) selective reporting; and (7) other sources of bias. The Newcastle-Ottawa Quality Assessment Form comprises eight methodologic domains associated with a risk of bias that are categorized into three groups: (1) representativeness of the exposed cohort; (2) selection of the nonexposed cohort; (3) ascertainment of exposure; (4) demonstration that the outcome of interest was not present at the start of the study; (5) comparability of cohorts on the basis of the design or analysis controlled for confounders; (6) assessment of the outcome; (7) whether the follow-up was long enough for the outcomes to occur; and (8) and adequacy of follow-up of cohorts (e-Fig 1, e-Table 1).

Two reviewers (H. Y. C. and S. H. C.) independently evaluated the quality of the included studies by using the appraisal tools. A high-quality study was defined as one that met the criteria for ≥ 5 domains. In the case of disagreement, a third reviewer (Y. N. K.) served as the arbitrator. Potential publication bias was detected by using Egger's test, which was applied to measure the significance of asymmetry among the included studies. A funnel plot was generated to demonstrate publication bias and effectiveness (log-OR) against the standard error of log-OR (precision).

Statistical Analysis

The primary outcomes were success rates and recurrence rates for PC and LBCT drainage performed for all types of pneumothorax. The secondary outcomes were complication rates, drainage duration, and hospital stay for these two types of chest drains. Subgroup analyses were also performed according to regions (United States, Asia, and Egypt), study design (RCTs and cohort studies), and types of

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