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# Optimal surgical technique in spontaneous pneumothorax: a systematic review and meta-analysis

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## ABSTRACT

**Background:** Numerous thoracoscopic techniques have been used in the management of primary spontaneous pneumothorax (PSP), including wedge resection, pleurectomy, pleural abrasion, chemical pleurodesis, and staple line covering. The purpose of this systematic review was to compare outcomes for the most commonly reported techniques.

**Materials and methods:** A systematic literature search looking at pneumothorax recurrence rate, length of stay, and chest tube duration after surgery was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines using the PubMed database.

**Results:** Fifty-one unique studies comprised of 6907 patients published between January 1988 and June 2015 were identified. Heterogeneity among effect sizes was significant for all outcomes. The lowest recurrence rates were observed in the wedge resection + chemical pleurodesis (1.7%; 95% confidence interval [CI], 1.0%-2.7%) and the wedge resection + pleural abrasion + chemical pleurodesis (2.8%; 95% CI, 1.7%-4.7%) groups. The shortest chest tube duration and length of stay were observed in the wedge resection + staple line covering ± other group (2.1 d; 95% CI, 1.4-2.9 and 3.3 d; 95% CI, 2.6-4.0, respectively).

**Conclusions:** The variability in reported outcomes and the lack of published multicenter randomized controlled trials highlights a need for more robust investigations into the optimal surgical technique in the management of PSP. Based on the limited quality studies available, this systematic review favors wedge resection + chemical pleurodesis and wedge resection + pleural abrasion + chemical pleurodesis in terms of recurrence rate after surgery for PSP.

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## Introduction

Pneumothorax refers to a collection of air in the pleural space. A pneumothorax can be either primary or secondary. Primary pneumothorax occurs in patients without underlying lung disease, whereas secondary pneumothorax occurs in patients with diseased lung. Furthermore, a pneumothorax can be either spontaneous or traumatic. The age-adjusted annual incidence of primary spontaneous pneumothorax (PSP) in the United States is best estimated as 7.4 per 100,000 for men and 1.2 per 100,000 for women.<sup>1</sup> As originally cited by Baumann and Strange, applying Swedish cost analysis data to these numbers, the economic burden of spontaneous pneumothorax in the United States approximates \$130 million per year.<sup>2,3</sup> The risk of recurrence after an initial case of PSP approximates 50%.<sup>4</sup> Surgery is often offered as a treatment option to reduce this risk.

There are numerous surgical options available to treat PSP and, over time, minimally invasive approaches through thoracoscopy have gained popularity. Because the rupture of blebs is considered to be the underlying pathologic source of PSP, wedge resection of diseased lung is commonly performed. Blebectomy, or wedge resection, may be performed alone or in conjunction with additional interventions such as pleurectomy, pleural abrasion, chemical pleurodesis, and/or staple line covering. The optimal technique or combination of techniques for recurrence prevention is unknown.<sup>5-7</sup>

Many authors have described outcomes using the aforementioned techniques predominantly through small series reports or single-center experiences, but a comprehensive literature review has not been published. The purpose of this systematic review was to compare outcomes after thoracoscopic surgery for PSP.

## Methods

### Study selection

This review was designed, performed, and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.<sup>8</sup> We conducted a PubMed search for studies published between January 1988 (based on the emergence of thoracoscopic surgery in patients with pneumothorax) and June 31, 2015, applying “English language” and “humans” filters. The search strategy used the following Medical Subject Headings term: “pneumothorax/surgery.” Furthermore, the reference lists of retrieved studies were reviewed for inclusion.

### Inclusion and exclusion criteria

The primary outcome of interest was recurrences of ipsilateral pneumothorax after surgical intervention. We included all studies on thoracoscopic management of pneumothorax that reported recurrence. We included prospective randomized trials, prospective cohort studies, retrospective cohort studies, and case series. We elected to include cohort studies and case series because of the paucity of prospective randomized trials

available in the literature. We recognize that this potentially introduces selection bias into our meta-analysis.<sup>9</sup>

Our review was comprised of two tiers of exclusion criteria: study exclusion criteria and treatment arm exclusion criteria. First, we excluded studies if the study population was exclusively comprised of secondary spontaneous pneumothorax, traumatic pneumothorax, hemopneumothorax, bilateral pneumothorax, pneumothorax in pregnancy, or catamenial pneumothorax (pneumothorax related to menstruation in young women). We also excluded studies if they exclusively focused on nonoperative management, nonthoracoscopic procedures, or were performed using a less common approach: needlescopic approaches or single-incision approaches.

Second, included studies were analyzed by individual treatment arms. Treatment arms were then excluded if the treatment arm sample size was <10, the treatment arm intervention was unique (i.e., the specific treatment arm intervention type was not used in any other study), duplicate data were present, or if the authors were not explicit about the specific surgical technique used.

### Outcomes of interest

As noted, the primary outcome of interest was ipsilateral recurrence rate. Recurrence was defined as subjectively experiencing symptoms associated with pneumothorax (e.g., acute onset shortness of breath and chest pain) in the postoperative period. The secondary outcomes were chest tube duration (CTD) and length of stay (LOS). We defined CTD as the length of time between intraoperative chest tube placement and postoperative removal. We defined LOS as the length of time between hospital admission and discharge.

### Data extraction

Data from individual studies were extracted, checked for accuracy, and entered into an electronic data collection form. Two authors (C.S. and J.S.) independently reviewed the studies and treatment arms. If disagreement existed on whether a study met inclusion criteria, the article was reviewed in detail and discussed with other authors until reaching a consensus (C.S., J.S., and M.V.R.).

### Treatment groups

The precise intraoperative intervention reported by the authors was recorded in the electronic data collection form. If the same intervention was reported in at least two different articles and published results using that intervention met all our inclusion criteria, then that intervention was identified as a treatment group.

### Quality of reporting

All studies were assessed for their quality of reporting using previously published Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.<sup>10</sup> These guidelines include more than 20 recommended reporting items to be included in reports of observational studies. The

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