



# Role of chest tube drainage in physical function after thoracoscopic lung resection

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A chest tube is traditionally placed to drain pleural effusions in order to maintain the pressure balance of the thorax after pneumectomy and at the same time observe possible hemorrhage, air or lymphatic leakage (1-3). Even though the rapid progress of the chest tube management along with the advances in surgical technologies and ideas in lung surgery, much controversy still exists on size and type of chest tube, criteria for chest tube removal after surgery over these years (1,4,5). What's more, chest tube placement postoperatively increases chest pain and analgesic dosage and even extends the length of hospital stay, and most importantly affects patients' early motivation and postoperative rehabilitation. Over the past two decades, thoracic surgeons raised the concept of early removal of chest tube and no drain strategy after pneumectomy for carefully selected patients receiving wedge resection and even patients receiving major lung resection. Published studies demonstrated that the early removal of chest tube or the no drain strategy showed comparable and even superior perioperative outcomes compared to the traditional chest tube placement strategy (6,7).

In recent years, thoracic surgeons tend to use one single chest tube after pulmonary resection, which allows for well drain and the complete re-expansion of residual lung likewise compared to the two chest tubes method (8-11). In Deng's systematic review and meta-analysis (12), the authors found that using one chest tube was effective for drainage and could shorten the length of hospital stay and meanwhile lowered the risk of transcutaneous infection compared to

two chest tube. Moreover, patients with one chest tube placement experienced reduced postoperative pain (8-10). Yet, as soon as there remains chest tube placed, patients experienced more chest pain and the chest tube constrained patients from pulmonary function recovery as well. Dr. Refai and colleagues (13) compared postoperative static and dynamic pain and forced expiratory volume in 1s (FEV1) before and 1h after the chest tube removed, results of which revealed reduced static and dynamic pain and improved FEV1 after the chest tube removal in 56, 78% and 67% of the patients respectively. Russo *et al.* (14) compared patients who met their criteria for early chest tube removal within 90 minutes after surgery to those did not, and found that patients in the early chest tube removal group experienced reduced chest pain in postoperative day 5, 8 and 30 and patients required less total narcotic ( $P=0.005$ ) in the early removal group. A recent propensity score matching analysis study elevated the feasibility and outcome of omission chest tubes in thoracoscopic mediastinal tumor resection (15), the results of which revealed less postoperative day 2 pain in the omission chest tube group than the drain group regardless of whether or not the objects were matched. These results from above high-quality studies seemed to prove that less chest tube was significantly associated with less chest pain.

As one of the main factors influencing patients' well-being after thoracic surgery, postoperative chest pain prevents patients from early postoperative rehabilitation. To our knowledge, chest pain also restricts patients from cough effectively, which plays a significant role in the

remnant lung re-expansion and the recovery of pulmonary function. Physicians came up with mounts of methods to relieve postoperative pain for patients undergoing thoracic surgery. Intercostal nerve blocks and epidural analgesia has been well studied in controlling post-thoracotomy pain, and satisfactory results were observed (16). Nonetheless, this kind of adding medical intervention did not satisfy us for that the ultimate of our objective was applying as little medical intervention as possible and not vice versa. On the other hand, patients would never consider themselves appropriate for early ambulation and rehabilitation exercise with a chest tube placed, not only for physical concerns but for mental concerns. Now that we've been aware of the knowledge of less chest tube meaning less pain, why not omitting the chest tube if it is not always imperative?

In Ueda's recent study (17), the authors reviewed 116 patients who underwent thoracoscopic radical segmentectomy (n=18) or lobectomy (n=98), and in 53 patients the chest tube was omitted after surgery according to their reported criteria (18,19). Ueda and colleagues measured vital capacity (VC), 6-minute walking distance (6-MW), visual analog scale and the number of analgesics used until postoperative day 7 between groups with chest tube placement and with chest tube omitted, and proved that omitting chest tube after thoracoscopic major lung resection was associated with a significant reduction in both the postoperative pain and the number of analgesics using on postoperative day 0 and 1, and the preservation of VC and the 6-MW capacity on postoperative day 1. Besides, the VC, 6-MW distance and pain scale measured on postoperative day 1 were significantly correlated with each other.

As noted by Ueda and colleagues, the omission of a chest tube helped reduce postoperative pain directly, which was consistent with previous studies. And the significant correlation between pain scale and VC, 6-MW distance indicated that reduced postoperative pain resulted from the omission of a chest tube subsequently led to the preservation of the early postoperative VC and walking distance increasing (17). This could be pretty easy to understand. When a chest tube was placed, it was impossible for the patient to get out of bed on the day of surgery easily. The chest tube would stretch the wound, which aggravated wound pain whenever patient moved or exercised in the first postoperative days and then patients with chest tube placement were reluctant to walk or try to do any functional exercise. Hence these patients lost the chance to obtain a better recovery in the first a few postoperative days. While many patients with no chest tube placement

could walk about freely on the operation day, since most of these patients are free from many medical tubes (17). Typically, the first three to five days after operation plays a considerable role in patients' recovery when patients made their efforts for their recruitment of the residual lung through independent cough for that cough pressure reduced obviously than before surgery (20). However, postoperative chest pain exerted an important influence on patients' effective cough and breathing (20,21). Then pulmonary function especially the VC was significantly influenced (17,20). Besides, getting out of bed, walking and shoulder range movement on postoperative day one were essential in postoperative physiotherapy management and the recovery of physical conditions (22). While the pain resulted from the chest tube placement significantly confined patients from exercising those physiotherapies.

Another possible advantage of omitting chest tube was the lower incidence of postoperative complications. Patients without chest tube placement experienced significantly less postoperative complications (7.5%) than those with chest tube placement (25.4%) in Ueda's research. But this result should be explained carefully. On the one hand, as what we have mentioned above that effective cough was extremely important in the lung re-expansion after thoracic surgery which could be beneficial in reducing atelectasis risk and other complications. And the preservation of pulmonary function and the restoring the walking capacity may also helpful in this effect. On the other hand, however, only patients who did not have air leak before and after the removal of the endotracheal tube were considerable eligible for omitting chest tube. Whereas patients did not meet the above criteria were assigned to receive chest tube placement. What's more, patient with chest tube placement had poorer diffusing capacity of the lung carbon monoxide and other function parameter before surgery in their report even though it did not reach statistical significance (17). In this way whether patients with chest tube placement had poorer preoperative pulmonary function or these patients had more comorbidities such as chronic obstructive pulmonary disease might better be considered before we could draw a clear conclusion on this matter.

Even though published studies revealed encouraging perioperative results of omitting chest tube, only a small number of trails of limited number of patients have been conducted up to know. However, most of the published studies were retrospective observational studies and baseline characteristic of the two groups were inconsistent and it was difficult to perform randomized controlled studies on

this topic, which reduced the level of the evidence. Thus, the progress of no chest tube seems to go slowly. Another factor inhibiting the chest tube omission and early removal was not technology but the stereotype of the surgeons (23). So even though the great advantage of omitting chest tube after pulmonary resection, only a very limited number of patients were considered eligible for omitting chest tube. To break the inherent concepts, substantial steps must be taken to ensure the safety and integrity of the exploration. Thus, patients underwent strict examination generally before they were assigned to the no chest tube group according to the current studies. Based on the current available studies, we raised the following recommendation that could act as criteria for chest tube omission after pulmonary surgery: (I) thoracoscopic pulmonary resection, (II) absence of bullous or emphysematous disease, (III) absence of drainage required plural effusion, (IV) absence of coagulopathy, (V) absence of severe pleural adhesions, (VI) endotracheal tube be removed smoothly, (VII) no air leak on intraoperative air leakage test (usually a suction-induced air leakage test).

Considering the current situation of chest tube management, more reliable evidence is warrant to show its safety and efficacy of omitting chest tube after pulmonary resection, and there would be a long way for more patients to avoid the chest tube.

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### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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