

Minimally invasive procedures

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Abstract: Minimally invasive procedures, which include laparoscopic surgery, use state-of-the-art technology to reduce the damage to human tissue when performing surgery. Minimally invasive procedures require small "ports" from which the surgeon inserts thin tubes called trocars. Carbon dioxide gas may be used to inflate the area, creating a space between the internal organs and the skin. Then a miniature camera (usually a laparoscope or endoscope) is placed through one of the trocars so the surgical team can view the procedure as a magnified image on video monitors in the operating room. Specialized equipment is inserted through the trocars based on the type of surgery. There are some advanced minimally invasive surgical procedures that can be performed almost exclusively through a single point of entry—meaning only one small incision, like the "uniport" video-assisted thoracoscopic surgery (VATS). Not only do these procedures usually provide equivalent outcomes to traditional "open" surgery (which sometimes require a large incision), but minimally invasive procedures (using small incisions) may offer significant benefits as well: (I) faster recovery; (II) the patient remains for less days hospitalized; (III) less scarring and (IV) less pain. In our current mini review we will present the minimally invasive procedures for thoracic surgery.

Keywords: Pneumothorax; minimally invasive procedures; video-assisted thoracoscopic surgery (VATS)

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Introduction

Spontaneous pneumothorax is the presence of air in the pleural cavity. Pneumothorax is classified as primary and secondary. The secondary due to the underlying disease. The primary spontaneous pneumothorax, is a common disease amongst young people, with an incidence of 18-28/100,000 a year, in men and 1,2-6/100,000 in women (1).

The primary spontaneous pneumothorax needs hospitalization and frequent surgical therapy, mainly due to the increased possibility of relapse (16-52%) after the first incident (2,3). The primary spontaneous pneumothorax surgical therapy consists of excision of the cysts and pleurodesis, which is the most effective prevention method for possible relapses. Video-assisted thoracoscopic surgery (VATS) as well as axillary thoracotomy are considered to

be acceptable surgical approaches in handling primary spontaneous pneumothorax according to the instructions of the American College of Chest Physicians as well as the British Thoracic Society (4,5). Even though the VATS is preferred over open surgeries, because it reduces the hospitalization and is less painful, it has a bigger, by four times, relapse frequency (6,7). The open surgery with a small axillary thoracotomy is considered to be a safe and acceptable method of treating with spontaneous pneumothorax, with a satisfactory cosmetic result and a small relapse frequency.

Surgical technique

Patients with a relapsing spontaneous pneumothorax, are initially treated by placing a tube drainage of the half thorax rib cage, usually 24-French. They are then submitted to a high definition computed tomography in order to define the possible cause of pneumothorax. According to the indication, they prepare for surgical treatment.

During surgery, under general anesthesia, the patients are intubated with a double lumen endotracheal tube. They are then positioned for axillary thoracotomy extending the shoulder so that the axillary is fully revealed. The area is disinfected using an antiseptic solution and the area is covered with surgical settings. An approximately 6 cm skin incision is applied on the axillary area, between the posterior limit of the pectoralis major muscle and the anterior limit of the vastus dorsi muscle. The hemithorax is approached via the 3rd intercostal space. Entering the diseased hemithorax is assisted by using a special expander. The neurovascular bundle (intercostal vein, intercostal artery and intercostal nerve) is protected by placing gauze in between the speculum and the lower edge of the third side. The pneumothorax causes (usually cysts) are dissected using endo-GIA 45-mm by putting suture line reinforcement. Then it is carefully detached and the parietal pleura are dissected from the top of the lung, up to the fourth intercostal space. Then the lung is expanded, and using a normal saline that is infused in the hemithorax, it is checked for possible air leakage. A 24-French thoracostomy tube is inserted in the hemithorax at the midaxillary line and pushed to the top of the lung where it is stabilized by a No1 silk stitching. Three trapeze shaped 1-0 vicryl peripleural sutura are usually placed.

The trauma is then joined per layer with 2-0 vicryl while for the intradermal suturing, we use 3-0 vicryl rapide. The thoracostomy tube is connected with a negative suction



Figure 1 The operation is performed under general anaesthesia and single lung ventilation.



Figure 2 The patient is in the lateral decubitus position and the nondependent arm was suspended perpendicular to the chest wall.

system (-15 – -20 cmH₂O) and remains in that position for 48 more hours even if there is no air leakage. The tube is removed when there is no air leakage, when the lung is fully expanded at the chest X-ray and when the supply doesn't exceed 100 mL/24 h. The patients leave the hospital the day after the tube is removed (*Figures 1,2*).

Our experience on 124 patients with primary spontaneous pneumothorax

Within the last 8 years 124 consecutive patients with spontaneous pneumothorax were admitted to our department. There were 84 males and 40 females, ranging in age from 18 to 67 years. Primary indications for operation were recurrent spontaneous pneumothorax in 92 patients and persistent air leak in 32 patients. All patients underwent a limited axillary thoracotomy. Blebs or bullae were found in all patients and were ablated by stapling.

Extended pleural abrasion was also performed.

The average operative time (measured from the time of the skin incision until leaving the operating theatre) was 54 mm. There were 12 postoperative complications including wound infection in four patients, fever in four, re-operation in two patients due to bleeding and shoulder arthritis in two patients (rate 9.6%). The duration of use of the thoracostomy tube after surgery for all 124 patients averaged 2.6 days, and postoperative hospitalization averaged 5.4 days. All showed good lung expansion postoperatively. Perioperative mortality was zero. No patient had a recurrence of a pneumothorax on the operated side at an average of 32 months following their axillary thoracotomy. There was universal satisfaction with the size and positioning of the scar, with patients finding it extremely acceptable cosmetically.

VATS versus thoracotomy in the surgical treatment of spontaneous pneumothorax

Surgical management of PSP is usually indicated in patients with recurrent ipsilateral pneumothorax, first episode with occupational risk or persistent air leakage. A first episode of a PSP is treated by observation if the area of pneumothorax is <20% or by simple aspiration if >20%, but recurrences are frequent. For recurrent or persisting pneumothorax, a more invasive surgical approach is indicated. There are two objectives in the surgical management of pneumothorax. The first widely accepted objective is resection of blebs or the suture of apical perforations to treat the underlying defect. The second objective is to create a pleural symphysis to prevent recurrence. The procedure can be approached through open thoracotomy or VATS (8) (Figures 3,4).

The classical posterolateral thoracotomy is now rarely used for the treatment of the primary spontaneous pneumothorax. This standard thoracotomy has been replaced by smaller incisions as axillary thoracotomy, anterior thoracotomy, muscle-sparing lateral thoracotomy, and a variety of posterior, lateral and axillary mini-thoracotomy procedures. The median sternotomy for simultaneous treatment of both lungs is performed only in, 1% of cases (9-13). There have been few prospective clinical trials comparing VATS and thoracotomy in the interventional treatment of spontaneous pneumothorax.

Waller *et al.*, compared the results on 30 patients underwent bullectomy and apical pleurectomy by VATS, performed through three 2-cm incisions and on 30 patients underwent a similar surgical procedure through

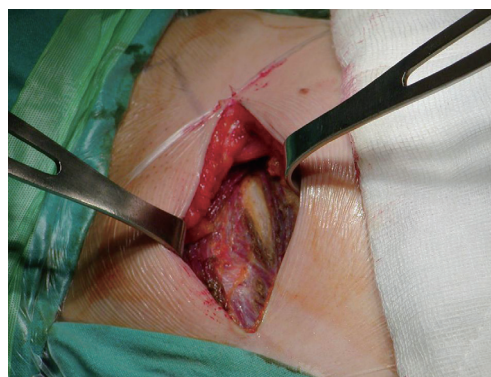


Figure 3 A horizontal skin incision was made in the superior aspect of the axilla posterior to the pectoralis major muscle and anterior to the latissimus dorsi muscle.



Figure 4 A rib spreader was used to expose the thoracic cavity.

a posterolateral thoracotomy and concluded that VATS is superior, (regard to the postoperative pain, hospital stay, and pulmonary dysfunction), to thoracotomy in the treatment of primary spontaneous pneumothorax (14). Crisci *et al.*, considered retrospectively the results obtained in a series of 30 consecutive patients with recurrent spontaneous pneumothorax treated with VATS between November 1991 and August 1994 in comparison with those obtained in a group of 30 patients previously treated with a traditional thoracotomy. The authors demonstrated that in VATS the total economic cost is lower about 22.7%, in comparison with traditional thoracotomy (15).

Kim and colleagues, on 66 patients with recurrent, persistent or contralateral spontaneous pneumothorax underwent surgical therapy (36 patients were treated by VATS and 30 by transaxillary minithoracotomy) conclude that there were no advantages of VATS over transaxillary

minithoracotomy regard to the operating time, the amount of analgesics used on the first postoperative day, the duration of the indwelling chest tube, and the number of postoperative recurrences in patients with apical bullae (16). Atta *et al.* in their study in 1997, with small number of the patients, only 9, concluded that VAT is a safe and reasonably effective treatment of spontaneous pneumothorax (17). Horio *et al.*, in their important study, in 1998, on 97 patients with spontaneous pneumothorax underwent resection of pulmonary bullae by VATS (51 patients) or limited axillary thoracotomy (44 patients) argue strongly that the pneumothorax recurrence rate in VATS cases was double that in limited axillary thoracotomy cases and that the main reason for recurrence is the cysts and bullae that escape the attention of the surgeon (18). The retrospective study of Al-Qudah *et al.* was designed to compare the contribution of the VATS and open thoracotomy in the management of spontaneous pneumothorax. The authors recorded the results of surgical treatment in 100 patients and concluded that VATS have been shown to produce results comparable to those obtained following open thoracotomy with reduction of postoperative pain, respiratory dysfunction, catabolic response to trauma and decrease in wound related complications and VATS should be used with caution for the management of secondary pneumothorax (19). Freixinet *et al.* in their prospective randomized study on 90 patients with primary spontaneous pneumothorax underwent surgical treatment (46 patients by VATS and 44 patients by axillary thoracotomy) demonstrate that Video-assisted thoracoscopy and axillary thoracotomy offer similar results (20). Barker *et al.*, in their work reviewed the literature for studies on pneumothorax surgery (four randomised and 25 non-randomised) and the authors concluded that both randomised and non-randomised trials are consistent in recurrence of pneumothoraces and show a four-fold increase with a video-assisted approach compared with an open approach (21). Vohra and colleagues in their interesting study conclude that VATS pleurectomy has been shown to be comparable to open pleurectomy in the treatment of spontaneous pneumothorax, with a meta-analysis and several prospective randomised controlled trial showing reductions in length of hospital stay and analgesic requirements. Postoperative pulmonary dysfunction has also been shown to be reduced after VATS pleurectomy (22). Balduyck *et al.*, in an effort to evaluate quality of life (QoL) evolution after VATS and anterolateral thoracotomy for primary and secondary spontaneous pneumothorax studied prospectively 20 consecutive patients, using the

European Organization for Research and Treatment of Cancer (EORTC) QoL Questionnaire-C30 and the lung specific module LC-13. The researchers demonstrated that pneumothorax surgery is well tolerated by the majority of patients. In general, patients QoL subscales improved after surgery. After VATS, pain, dyspnoea and thoracic pain decreased significantly. After anterolateral thoracotomy, a significant increase was observed in general QoL, physical and emotional functioning. Dyspnoea and coughing decreased after anterolateral thoracotomy. Both techniques were comparable in QoL evolution. However, one month after surgery, physical, role, cognitive functioning and dyspnoea were significantly better in the VATS group. VATS also had a favourable thoracic pain evolution compared to anterolateral thoracotomy (23). Foroulis *et al.*, in the interesting prospective randomized study on 66 patients underwent surgical intervention for recurrent spontaneous pneumothorax through either a modified two-port VATS procedure (33 patients) or axillary minithoracotomy (33 patients) demonstrate that the recurrence rate, complication rate, postoperative chest tube drainage duration, postoperative hospital stay, and incidence of chronic pain did not differ between the two groups but VATS seems to offers to the patient more satisfaction (24). Fatimi *et al.* in their study on 39 patients presented with spontaneous pneumothorax and had undergone VATS, reported a recurrence rate of 7.6% (25). Joshi and colleagues in a recent publication on 163 patients underwent surgical intervention for pneumothorax (86 patients underwent VATS under a single surgeon with extensive VATS experience while 79 patients underwent an open procedure) noted that there was no statistically significant difference in the recurrence rate between the open and the VATS group (1% *vs.* 3.5%, $P=1.0$) and concluded that the VATS group was superior to the open group in terms of reduced postoperative bleeding (7.5% *vs.* 0%, $P=0.01$), reduced number of intensive care unit admissions (16% *vs.* 0%, $P<0.01$) and a reduced adjusted length of stay (3 *vs.* 5.5 days, $P<0.01$) (26-45). These data demonstrated that VATS offers a shorter postoperative hospital stay, less postoperative pain, improved pulmonary gas exchange postoperatively, lower total economic cost but has a higher recurrence rate of approximately 5% (46-65). In conclusion, open thoracotomy (with minimally invasive techniques) remains the procedure with lowest recurrence rate (approximately 1%) for simple cases and for difficult or recurrent pneumothoraces (59,66-75). Therefore the patients about to undergo surgery for pneumothorax should be informed



Figure 5 A single small-bore thoracostomy tube (usually 20French) was inserted and positioned in the apex of the chest cavity.

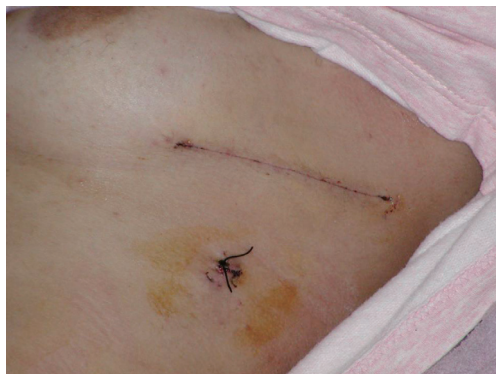


Figure 6 The limited axillary thoracotomy has excellent cosmetic result.

in detail about the pros and cons of interventions (*Figures 5,6*).

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