Initial single-port thoracoscopy to reduce surgical trauma during open *en bloc* chest wall and pulmonary resection for locally invasive cancer

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Abstract

OBJECTIVES: *En bloc* pulmonary and chest wall resection is the preferred method of treatment for locally invasive lung carcinoma. However, it carries major trauma to the chest wall, especially in cases with chest wall involvement distant to the potential location of 'traditional' thoracotomies. We describe an alternative method of estimating the boundaries of chest wall resection employing video assisted thoracoscopic surgery (VATS) and hypodermic needles.

METHODS: VATS delineation of boundaries of chest wall involvement by lung cancer has been performed in six patients who gave written consent. In one case the single-port thoracoscopic examination revealed unexpected distant pleural metastases thus preventing from resection. The other 5 patients, three males and two females [median age of 60.5 (range 39 to 75) years] underwent *en bloc* anatomical lung resection in addition to chest wall excision and reconstruction for T3N0 lung cancer.

RESULTS: In these five cases the chest wall opening was restricted to the extent of the rib excision, and the pulmonary resection was performed via the existing chest wall opening without requiring extension of the thoracotomy or any rib spreading.

DISCUSSION: Minimally invasive techniques aid to delineate the boundaries of chest wall involvement of lung cancer and intraoperative staging. This helped tailoring the surgical approach and location of the thoracotomy, and prevented rib-spreading or additional thoracotomies in our cases.

Keywords: Minimally invasive surgery • Lung cancer • Thoracoscopy

INTRODUCTION

Approximately 5% to 8% of patients presenting with a diagnosis of lung cancer have chest wall invasion either limited to the parietal pleura or extending into the soft tissues and bony structures of the chest wall [1]. For patients with locally advanced disease clearly involving beyond the parietal pleura, complete *en bloc* pulmonary and chest wall resection remains the best chance of long-term survival. Reports show that with *en bloc* resection of bronchogenic carcinoma invading chest wall, a 5 year survival of up to 40–50% can be achieved with complete resection and no nodal involvement [2].

There is some controversy over how tumours just invading the parietal pleura should be resected with authors stating that extrapleural mobilization may be sufficient for clearance and will reduce surgical trauma [3]. However, more authors would also advocate *en bloc* excision of the chest wall due to higher incidence of histological evidence of tumour at the margins of the resection as well as local recurrence in such cases of extrapleural 'stripping' [4, 5]. It is therefore generally advisable that the entire tumour-bearing area should be resected *en bloc* [1].

The traditional approach of these cases is to perform a thoracotomy, starting by doing the chest wall resection before proceeding with the appropriate anatomical pulmonary resection *en bloc*. As it stands, to define the extent of the chest wall invasion without cutting through the tumour an exploratory thoracotomy is normally employed for this purpose. Visual and finger palpation is then used to define the extent of chest wall invasion. The amount of chest wall excision is then roughly planned.

Clinicians are always in the look to minimize surgical trauma, especially in the high-risk cases. We identified in the past age over 70, limited respiratory function and poor nutritional status as predictors for worse outcomes after *en bloc* lung and chest wall resection [6].

As the role of minimally invasive techniques increases, more indications are found for the use of VATS. We have applied the use of a single-port VATS incision to confirm chest wall invasion when suspected on CT scan, and to determine the boundaries and location of the chest wall involvement. In that manner, we have been able to place the incision over the involved area, proceed with accurate excision of the chest wall without the need of extensive thoracotomies, and to proceed with the

Figure 1: (A) CT scan of a case with T3 non-small cell lung cancer involving ribs anteriorly and pericardium. (B) Intrapericardial right pneumonectomy performed through the chest wall defect without additional rib spreading. (C) Placement of the marking needles with the help of single-port thoracoscopy to delineate rib involvement and aid the placement of the incision. (D) Chest wall defect reconstructed with a bioprosthesis (Permacol™).

Figure 2: Placement of the hypodermic needles as markers under single-port VATS control (A and B). Once all the needles are placed, the thoracotomy is performed at the exact location (C). The correct intercostal space is entered avoiding cutting through the tumour, and minimizing surgical trauma (D).

pulmonary resection *en bloc* only through the space available after the rib excision without rib spreading or extending the thoracotomy.

OPERATIVE TECHNIQUES

Patients under general anaesthesia undergo double lumen intubation. The routine care in our services for these cases is to insert an epidural catheter for postoperative pain control. The patients

are monitored with arterial and central venous lines, capnography and pulse oxymetry.

With the patient placed in the lateral decubitus position, single-port VATS is performed [7]. This allows for macroscopic staging of the disease and also facilitates location and extension of the chest wall involvement. If the tumour is resectable, hypodermic needles are pinned into the chest wall from outside under VATS guidance to mark the extent of chest wall resection (Figs 1B and 2A and B). We normally include at least a 2-cm margin around the tumour to allow for histologic clearance. The

skin incision is then made in a location guided by the needles (Fig. 2C). The subcutaneous tissue is divided with electrocautery and we proceed to chest wall excision according to its extent (Fig. 2D). The intercostal muscles including the neurovascular bundle are ligated and divided using cautery while a costotome is used to divide the ribs. The procedure is repeated until the area marked with needles is completely resected with the tumour still attached onto the lung. The intraoperative view of the needles mapping the chest wall involvement is shown in Video 1. We then proceed to do the lung resection and the mediastinal lymphadenectomy through the defect created in the chest wall without the need of an additional thoracotomy and without rib spreading. When necessary, the chest wall defect can be reconstructed with a rigid (Prolene/methyl-meta acrylate sandwich) or soft (Gore-Tex™ or Permacol™) prosthesis.

A single intercostal drain is inserted via the single-port VATS incision and the wound is closed by layers. The patients are routinely extubated in theatre and transferred to the high dependency area of our thoracic ward or recovery.

RESULTS

This approach was used in six consecutive patients with presumed chest wall invasion on CT scan in two Units (three

Video 1: Intraoperative view via the single port thoracoscopy of the four hypodermic needles placed to delineate the chest wall involvement. These needles would mark the incision point and the lung resection will be performed solely via the chest wall defect after rib excision.

patients each). The demographics are described in Table 1. In one case the single-port VATS revealed unexpected pleural metastases confirmed by intraoperative frozen section analysis hence avoiding futile thoracotomy.

In the remainder 5 patients the operations performed were *en bloc* lobectomy and chest wall excision in 4 cases (one of them including a partial resection of diaphragm) and one *en bloc* intrapericardial pneumonectomy and chest wall excision [Fig. 1]. The materials employed to cover the defects were an expanded polytetrafluoroethylene mesh (Gore-Tex™) in 3 cases, and Prolene/methyl-meta acrylate sandwich and a porcine crosslink (Permacol™) in one case each. Patients recovered well and were discharged home after a median of 6 (5 to 11) days. Histopathological analysis of the specimens confirmed complete local excision in all cases.

DISCUSSION

Minimally invasive techniques have been proven of benefit for patients because of the reduction of surgical trauma while maintaining oncological principles. The initial description of uniportal thoracoscopy for intermediate procedures [7] has now developed into its use for major cases [8]. In our report, we used a single-port thoracoscopy not only for intraoperative staging, but more importantly to aid in delineating the boundaries of chest wall involvement of lung cancer in two different Units. This approach helped us to place the incision at the exact place of chest wall invasion thus preventing a more extensive thoracotomy (or even a 2-incision approach). It also allowed us to reduce surgical trauma by avoiding the use of rib spreading as the pulmonary resection was performed via the chest wall excision defect with its presumed benefits [9].

There have been reports of hybrid techniques in T3 chest wall non-small cell lung cancer resections combining VATS lung resection with an incision to complete the chest wall excision that also limits rib spreading [10, 11]. Our reported approach is similar, but by performing the lung resection via the chest wall defect, it could be used more universally in centers without experience in VATS lobectomies. This simple approach can be used for any case in which chest wall invasion is suspected, and adds to the indications of single-port thoracoscopy as it can be used by staging (pleural, chest wall and lymph node) as well as a guide to place the incision and avoidance of rib spreading. In our experience it has been successfully used in two centres simultaneously showing that it can be replicated.

Table 1: Patients who underwent *en bloc* pulmonary and chest wall resection for lung cancer using single-port VATS for placement of incision

Gender	Age	FEV ₁	Lung resection	Ribs excised	Histology	Staging
Male	51	69%	Left lower lobectomy	3	Squamous cell	T3N0M0
Female	39	91%	Right lower segmentectomy	2	Squamous cell	T3N0M0
Male	59	85%	Right lower lobectomy	3	Squamous cell	T3N0M0
Male	72	51%	Right pneumonectomy	2	Squamous cell	T3N1M0
Female	76	68%	Right lower lobectomy	2	Adenocarcinoma	T3N0M0
Female	54	79%	Palliative chemotherapy	–	Adenocarcinoma	T2bN0M1a

SUPPLEMENTARY MATERIAL

Supplementary material is available at *ICVTS* online.

Conflict of interest: none declared.

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