Introduction

The current standard-of-care treatment of malignant pleural mesothelioma (MPM) is generally accepted as systemic therapy alone. Surgery could be part of a multimodal treatment plan since it is the only modality that could render a patient without the disease. Selecting patients fit for surgery, determining the optimal operation and the additional treatments have not yet been established due to the severe variability of neoplasm itself related to the surgical techniques' variability. Even though there is an MPM staging system, the results of surgery remain to be strongly affected by other prognosticators (e.g., subtype of histology, not taken by the contemporary staging systems). Consequentially, there is not a common denominator that permits careful evaluation between surgical cohorts and the definitive creation of beneficial operational approach.

Technical definition

The confusion of MPM surgical terminology was standardised by the International Association for Study of Lung Cancer (IASLC) in 2011. EPP was well-defined as en bloc resection of the parietal and visceral pleura with the ipsilateral lung.
pericardium, and diaphragm. Extended pleurectomy/decortication (P/D) was defined as parietal and visceral pleurectomy to eliminate all overall tumour as well as the resection of the pericardium and/or diaphragm (Table 1) (3).

Whilst surgery scarifying the lung has been unambiguously characterized and extremely standardised as EPP, attempts to standardise the procedure for lung-sparing have been restricted by the paucity of randomised trials. In the lack of data, various patterns of extensive surgery completed by P/D have in recent times emerged. At this time, there is no consensus on the ideal multimodality approach to resectable MPM. Various intraoperative treatments under investigation include hyperthermic povidone-iodine lavage, hyperthermic chemotherapy lavage, fibrin associated cisplatin, and photodynamic therapy (4).

### Objectives of surgical treatment
Surgery [open or video-assisted thoracoscopic surgery (VATS) pleural biopsies] could help to achieve an MPM correct diagnosis or to palliate (VATS pleurectomy, VATS talc pleurodesis, indwelling pleural drainage placement) symptoms caused by malignant pleural effusions. Every time aggressive surgery is scheduled, it aims to remove all visible disease, increasing survival by decreasing the intrathoracic tumour burden to microscopic levels. Ideally, all MPM patients should be operated by thoracic surgeons with recognised broad experience in MPM management, regularly related to radiation and medical oncology involved in MPM clinical trials (5).

### Prognostic factors and patient selection
This risk factors substantially impact on survival in MPM undertaking surgery:

- Tumour status (most evident in curative intent surgery);
- Nodal status;
- Tumour histology (epithelial with better outcomes);
- Gender and age;
- Curative intent.

Since the impact of surgery as an extension of overall survival is needed but lacking, the overall survival without substantial morbidity negative influence on the quality-of-life. Institutional and practice bias will have a considerable impact on surgical approaches. Therefore, the selection in the accrual and recording of small multimodality trials makes it challenging to include neoadjuvant/adjuvant treatments (6).

### Preoperative evaluation
MPM patients judged for EPP are staged with positron emission tomography/computed tomography (PET/CT) to evaluate lymph nodes or metastases to other organs. The avidity of PET of the pleural tumour correlates with survival, with higher avidity correlated with reduced survival. Enlarged and/or PET-positive mediastinal lymph nodes are assessed with cervical mediastinoscopy or endobronchial ultrasonography. Even though some centres perform in all patients routine staging mediastinoscopy, others have abandoned since the inconstant pleural nodal drainage with a random pattern of lymph nodes metastases and the absence of sensitivity of cervical mediastinoscopy for discovering extrapleural nodal spread. Chest magnetic resonance is frequently accomplished to assess for thin transdiaphragmatic, chest wall, or transmediastinal invasion of the tumour. The presence of a transdiaphragmatic extension of the tumour and/or ascites deserves additional evaluation (e.g., laparoscopy for staging since intraabdominal tumour precludes surgery). The residual preoperative evaluation should determine the capability to tolerate EPP. Spirometry and diffusion lung capacity should be completed. Quantitative ventilation/perfusion scan is usually performed to evaluate perfusion to the affected lung. The product of

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**Table 1** Definitions of surgical procedures for the malignant pleural mesothelioma. Adapted from IASLC (2)

<table>
<thead>
<tr>
<th>Surgical procedure</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Extrapleural pneumonectomy</td>
<td>En bloc resection of the visceral and parietal pleura, lung, ipsilateral hemidiaphragm, and pericardium</td>
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<tr>
<td>Pleurectomy/decortication</td>
<td>Resection of the parietal and visceral pleura, to eliminate all gross tumours, without removing pericardium and diaphragm</td>
</tr>
<tr>
<td>Extended pleurectomy/decortication</td>
<td>Pleurectomy/decortication with the resection of ipsilateral pericardium and diaphragm</td>
</tr>
<tr>
<td>Partial pleurectomy</td>
<td>Limited removal of the parietal and/or visceral pleura for palliative or diagnostic intentions</td>
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</table>
the forced expiratory volume in 1-second and the proportion of perfusion to the contralateral lung is the predicted postoperative forced expiratory volume in 1-second. A stress test (detection of coronary artery disease with inducible myocardial ischemia) and an echocardiogram (Doppler of pulmonary artery pressure) should also be completed (7).

**Surgical technique**

**Extrapleural pneumonectomy**

EPP was continuously achieved through double lateral thoracotomy (first access through IV–V intercostal space, other access through VII–VIII intercostal space) with en bloc excision of the parietal pleura with the whole lung, ipsilateral pericardium and hemidiaphragm. The diaphragm was rebuilt with a synthetic dual mesh or with bovine pericardium placed on the resected diaphragm. The pericardium was recreated both on the left sides and on the right side to avoid cardiac torsion using a bovine pericardium or synthetic mesh. Lymph nodes dissection should always be done. Surgery was continually done within four weeks after the last cycle of induction chemotherapy (8).

**Pleurectomy/decortication**

P/D comprises two parts. The first half, from the thoracotomy to the end of the extrapleural dissection, is like EPP. Visceral pleurectomy is typically started at the lateral segment of the lower lobe (a broad flat plane). First, a 5 to 10 cm long incision in the visceral pleura using a blade or scissors was made. The visceral pleura is peeled off from the parenchyma. Sometimes, the parietal pleura is naturally dissected. Then, very soft blunt dissection using swabs or dry gauze is recommended. Dissection of the interlobar vessels is generally straightforward. Dissection at the apex and base is often tricky, requiring sharp dissection. In minimal resection of the pericardium and diaphragm, the direct suture is desirable. Else, the pericardium is reconstructed with a 0.1 mm Gore-Tex patch. The diaphragm is restored with a 2 mm Gore-Tex patch. Air leaks are unavoidable in P/D. Massive air leaks from detectable airways should be stitched (9).

**Comments**

The surgeon in the diagnosis and palliation of MPM have a prominent role. In properly carefully chosen patients with the appropriate risk profile, as part of a multimodality concept, surgical resection (P/D or EPP), should be offered only if performed in low mortality/high-volume centres (10). Nevertheless, current literature favours P/D to EPP since P/D is a procedure with smaller mortality and morbidity. Lung preservation should be achieved whenever possible. The Clinical Practice Guidelines of the European Society of Medical Oncology (ESMO) on MPM do not encourage a detailed procedure to implement a complete macroscopic resection (11). The National Comprehensive Cancer Network (NCCN) guidelines indicate P/D safer than EPP in early-stage disease with favourable histology but do not achieve on which procedure is oncologically enhanced because of the lack of adequately intended well-performed randomised controlled trials (12).

Nonetheless, the decision to do EPP or P/D should not be made until surgical exploration (13). Literature accounts yield evidence that the achievement of EPP in skilled referral centres, as a part of multimodality treatment, depends on a suitable patients selection with appropriate variables and technically favourable settings to decrease the typically high perioperative mortality and morbidity and recover the overall survival (14). Consequently, a P/D should be evaluated to undergo EPP if, during surgery, an extensive lung infiltration was discovered. The patient should be informed about EPP, not only during informed consent discussion, and preoperative functional assessments must be performed (15,16).

**Conclusions**

Progress in the surgical treatment of MPM has been
thwarted by:
  - Variability in the form of operations or the reportage of operations;
  - Variability in the surgical treatments;
  - Variability in the recurrence treatment;
  - Intrinsic variability of cancer.

Even though there is a brand new, improved MPM staging system, the results of surgery for MPM is strongly influenced by other prognosticators not taken by the current staging system (such as subtype of histology). Consequently, there is at this time no possibilities to determine a common denominator that permits laborious evaluation between surgical series and ultimate establishing which surgical approach and adjuvants are advantageous and in which sequences/circumstances used or combined.

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