How-to-do-it
A new technique of diaphragmatic patch fixation in extrapleural pneumonectomy

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Abstract
Extrapleural pneumonectomy (EPP) is an established surgical treatment for malignant mesothelioma; this operation is, however, burdened by a high rate of perioperative morbidity, mostly related to the surgical procedure. Diaphragmatic patch dehiscence is a potentially serious complication often related to the difficulty in placement of the fixing stitches, especially in the costo-phrenic angle. We present our experience with the use of titanium-plate support for an easy and safe positioning of the diaphragmatic patch.

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1. Introduction
Extrapleural pneumonectomy (EPP) is an established surgical treatment frequently used as part of a multimodality therapy for malignant mesothelioma [1]. This intervention provides en bloc removal of the lung with the parietal pleura envelope, hemi-pericardium and hemi-diaphragm with their prosthetic replacement.

This operation is, however, burdened by a high rate of perioperative morbidity, mostly related to the surgical procedure [2]. Diaphragmatic patch dehiscence is a potentially serious complication, often related to the difficulty in placement of the fixing stitches, especially in the costo-phrenic corner and in proximity of the oesophageal hiatus on the left side. Therefore, research of new technical solutions is encouraged. We present our experience with the use of titanium-plate support for an easy and safe positioning of the diaphragmatic patch in the costo-phrenic angle.

2. Technique
EPP is performed with the technique described by Sugarbaker et al. [3]; in this article, we will only focus on the steps regarding diaphragmatic replacement.

The diaphragm is reconstructed using a 2.0-mm-thick Gore-Tex® DualMesh (WL Gore and Associates, Inc., Flagstaff, AZ, USA). The diaphragmatic patch is secured anteriorly and laterally to the chest wall using interrupted 1/0 polyester sutures (Ticron, Tyco, Waltham, Massachusetts, USA) first placed through the patch, then brought through the intercostal space and tied. Medially, the patch is sewn to the diaphragmatic edge of the resected pericardium and to the fibres of the crus.

At the level of the costo-diaphragmatic angle, between the vertebral column and the posterior arch of the ribs, where it is difficult to fix the patch, we use a Titanium Fixation System (Synthes™, Solothurn, Switzerland). Usually, the 9th and 10th vertebra represent the fixing points of the bar; the accurate identification of the body and site of screws insertion is fundamental to avoid the potentially dangerous positioning into the intervertebral disc.

Then the procedure carries on as follows (Figs. 1—2): the first step provides a simulation by adapting an easy-flexible L-shaped plate model for fixation on two vertebral bodies and along the rib arch below. The second step is the shaping of the final plate, by using a dedicated instrument, resembling the model. The bone of the vertebral bodies is then exposed removing the overlying tissue and the plate is fixed with two screws (length, 14 mm) on the two adjacent vertebral bodies and with one or two screws (length, 12 mm) on the corresponding rib.

Finally, the patch is fixed to the plate with single stitches that are passed through the plate loops. The whole procedure takes about 15 min.
3. Results

From December 2008 to January 2010, 15 patients (11 males and four females, median age 61 years) underwent EPP using the new technique. In nine cases, the procedure was performed on the left side and in six, on the right side. The application of the plate resulted easy for both sides and we did not report any case of patch dehiscence, nor the presence of complications related to the procedure.

4. Discussion

EPP is a technically challenging operation with peculiar complications [4] such as diaphragmatic patch dehiscence that is reported in the literature having an incidence of 5–6% [2], most frequently observed on the left side. In our experience, on a total of 92 EPP, we recorded seven (7.6%) diaphragmatic patch dehiscences (six on the left side and one on the right side).

The diaphragmatic reconstruction technique underwent evolution over the years in response to oncologic and technical issues. The risk of dehiscence derives from the positive abdominal pressure, especially on the left side, and from absence of diaphragmatic tissue that can be used to fix the patch. In particular, on the left side, the oesophageal hiatus represents an anatomical 'hot point' in reconstruction due to the risk of dehiscence caused by the difficulties in fixing the stitches.

For these reasons, some authors proposed variants in technical reconstruction: Sugarbaker et al. described the use of a double patch to avoid the excessive tension and to recreate the dome shape of the diaphragm [2]; Kobayashi et al. employed the autologous latissimus dorsi muscle [5].

In recent years, we experienced the use of titanium plates in chest wall reconstruction [6,7].
Titanium plates have characteristics of both endurance and flexibility, thus resulting in a valid and physiologic replacement for resected anatomic structures [8]. Moreover, the plates provide a good support for patch fixing, thanks to the presence of multiple holes in its structure. These reasons led us to apply this system for diaphragmatic reconstruction in the EPP procedure.

We would like to underline the importance of using a preliminary plate model to shape a definite bar that can adapt to the different anatomical situations. This also eases identification of precise fixing points, specifically on the vertebral sites, to avoid involvement of the intervertebral disc.

In our experience, this new technique did not significantly prolong surgical time, allowing an easy fixing of the posterior edge of the diaphragmatic patch.

In conclusion, the use of a titanium plate bar to fix the diaphragmatic patch appears to be a promising surgical technique, being easy, devoid of complications and able to prevent patch dehiscence. It is anyway important to avoid exceeding tension of the prosthesis, which is probably the major cause of this surgical complication.

References