Advancing an endotracheal tube into a main bronchus for such procedures essentially may allow one-lung ventilation.

The use of cardiopulmonary bypass for tracheal resection and reconstruction was popular in the 1960s [3]. Systemic anticoagulation therapy associated with cardiopulmonary bypass risks lung hemorrhage with dissection. Improvements in surgical management at specialized centers subsequently decreased the need for bypass.

The need for cardiopulmonary bypass was anticipated well in advance of the procedure, and confirmed when the degree of tracheal and mainstem involvement was noted on computed tomography scan and preoperative bronchoscopy. Standard single-lumen endotracheal intubation of the right mainstem bronchus would have potentially ventilated only the right middle and lower lobes during resection and reconstruction. Manipulation of the tumor because of its size combined with possible lack of ventilation of right upper lobe would have resulted in inadequate gas exchange for the patient and fetus. Concern in the past existed about full heparinization, manipulation of lung, and risk of pulmonary hemorrhage. Lung transplant on cardiopulmonary bypass has proved this can be done safely if care is taken. There was no pulmonary hemorrhage in this case, despite wedge resections of two lung nodules.

There are two primary aims in the anesthetic management of patients undergoing cardiopulmonary bypass: avoidance of teratogenic agents and minimizing effects of cardiopulmonary bypass that may induce premature labor.

The safety of most drugs in the perioperative period is unclear. The most critical time for teratogenic effects is in early gestation. Diazepam is associated with the development of cleft palate, etomidate is embryocidal, and coumadin is associated with congenital malformations. The use of ketamine is not recommended in the first trimester. Neuromuscular-blocking agents and heparin do not cross the blood-brain barrier and are considered safe. The effects of vasoressors such as epinephrine and dopamine are unknown. The use of phenylephrine and ephedrine is considered acceptable for treatment of hypotension. Recent evidence suggests phenylephrine is associated with higher fetal pH [4]. Propofol is considered a safe induction agent, although hypotension may compromise uterine perfusion.

Premature onset of labor is the major concern with the conduction of cardiopulmonary bypass. Uteroplacental blood flow may be compromised by nonpulsatile blood flow, hypotension, hypothermia, and the inflammatory state associated with bypass [5]. Low uteroplacental blood flow, hypothermia, hemodilution, embolization, prolonged bypass, and obstruction of vena cava blood return may induce fetal asphyxia [5]. Chandrasekhar and associates [5] recommend several strategies for the safe management of cardiopulmonary bypass in the parturient, including 15 degrees of lateral tilt, perfusion pressure greater than 70 mm Hg, higher bypass flow rates (>2.5 L \cdot \min^{-1} \cdot \text{m}^{-2}) , minimization of bypass times, normothermia, and maintenance of arterial oxygenation. The team may consider tocolytic therapy for procedures performed later in pregnancy, α-stat blood gas management, and pulsatile perfusion during bypass.

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References

Preoperative Computed Tomography-Guided Localization of Ground-Glass Opacities With Metallic Clip

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Intraoperative localization of ground-glass opacities is difficult because they are not easy to palpate and may be invisible at radioscopy. Therefore, various techniques have been developed to improve intraoperative localization of these lesions, allowing an adequate surgical resection. The aim of this study is to report two cases of preoperative localization of ground-glass opacities through computed tomography–guided placement of a metallic clip inside the lesion and to discuss this new technique in comparison with those previously described.

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Ground-glass opacities (GGO) are a nonspecific radiologic finding, which may be associated with various benign and malignant diseases. In patients with lung cancer or other malignancies, these lesions are known to exhibit high malignancy potential and therefore require tissue confirmation for proper treatment planning [1].

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Computed tomography (CT)-guided percutaneous biopsy is one accurate option to establish the diagnosis of pulmonary lesions [2]. However, the histologic confirmation may remain unclear in some cases, especially for GGO. One alternative approach is open lung biopsy or video-assisted thoracoscopic surgery (VATS). However, it is difficult to localize the accurate position of these lesions during surgical procedures because they are not easy to palpate, even at thoracotomy. Furthermore, these lesions are invisible at radioscopy. Therefore, various techniques have been developed to improve intraoperative localization of nonpalpable lesions, allowing an adequate surgical resection while trying to keep morbidity as low as possible [3–8].

All of the described preoperative localization techniques have their own advantages and disadvantages, and none of them has been widely adopted. The aim of this study is to report two cases of preoperative localization of GGO through CT-guided placement of a metallic clip inside the lesion and to discuss this new technique in comparison with those previously described.

Case Reports

Patient 1

A 64-year-old woman, a nonsmoker, had an irregular lung nodule in the right lower lobe and a small GGO in the right upper lobe (Fig 1). The patient underwent open thoracotomy with anatomic segmentectomy of the upper segment of the right lower lobe, mediastinal lymphadenectomy, and wedge resection of the GGO in the right upper lobe. The GGO was marked before operation through CT-guided placement of a surgical clip, which was located intraoperatively by palpation (Fig 1). Histologic examination confirmed the diagnosis of multifocal adenocarcinoma, with clear margins and no lymph node metastatic involvement. The patient was referred for systemic therapy.

Patient 2

A 65-year-old woman, who smoked 100 packs per year, had an irregular lung mass in the right upper lobe. CT-guided percutaneous biopsy revealed a poorly differentiated adenocarcinoma. The patient’s staging CT also showed a GGO in the left upper lobe. In a multidisciplinary meeting, it was opted to perform surgical biopsy of the GGO to determine the therapeutic plan. Preoperative localization of the lesion was performed through CT-guided placement of a surgical clip. The surgical approach was performed through VATS with fluoroscopy to identify the location of the metallic clip, followed by lung biopsy. Histologic examination confirmed the diagnosis of metastatic adenocarcinoma in the contralateral lung, and the patient was referred for systemic therapy.

Comment

The lung lesion localization techniques previously described can be classified into three main types: image-guided surgical procedures, which include intraoperative ultrasound (US) and CT fluoroscopy; injection of liquid materials through fine needles, including dyes, contrast media, or radionuclides; and placement of percutaneous wires and microcoils with CT guidance.

Intraoperative US has been shown, in experienced hands, to be very sensitive for the localization of GGO [3, 4]. In addition, it is noninvasive, less expensive than other techniques, and allows studying the structures

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Fig 1. Computed tomography (CT) scan of a 64-year-old woman with (A) an irregular lung nodule in the right lower lobe and (B) a small ground-glass opacity (GGO) in the right upper lobe. The GGO was marked before operation. (C) After placement of a coaxial needle through CT guidance near the GGO, (D) a metallic surgical clip was left in the lesion, which was located intraoperatively by palpation. Histologic examination confirmed the diagnosis of multifocal adenocarcinoma.
surrounding the nodule. However, visualizing pulmonary lesions with US requires complete collapse of the lung, which may be impossible in patients with emphysema. It is also difficult to maintain single-lung ventilation in patients with pulmonary fibrosis or severe heart disease. Besides, US-guided operations are time-consuming and require experienced operators.

Guidance through the injection of liquid materials, including methylene blue dye, contrast medium, and radionuclides has been evaluated. However, the use of all these types of liquid is limited by their potential to diffuse in the lung and pleural cavity in the time interval between localization and operation, owing to the rich vascularization of the lung. Besides, when liquids that are not water soluble are injected, there is a potential risk of systemic embolization if the solutions are inadvertently injected into the pulmonary venous system. The localization of pulmonary lesions by the radio-guided technique has been shown to be reliable; however, it may be difficult to locate nodules with deep and posterior position because of the size and shape of the probe, which prevent free movements in the thorax [3, 5].

Percutaneous placement of hook wires is probably the oldest method of preoperative localization adapted for pulmonary lesions. Unfortunately, the needle-wire technique is associated with several complications. Wire dislocation can occur in 6% to 10% of the cases during movement of the patient or as a consequence of pulmonary collapse caused by the surgical maneuvers. The most frequent complication is pneumothorax, reported in 30% to 50% of cases. Other complications are pleuritic pain, lung hemorrhages or hematoma, and pleural bleeding [6]. Two recent reports have described the use of commercially available CT-guided dedicated lung-marker systems as a fast and effective method for localization of pulmonary nodules before thorascopy resection, but these systems are not yet widely available [7, 8].

Our technique involves the CT-guided placement of a coaxial needle in the center of the GGO, and then the insertion of a metallic clip through it. The metallic surgical clip provides a palpable marker that can also be located by fluoroscopic guidance. The surgeon can localize the metallic clip placed inside or near the lesion and determine with confidence how deep the surgical line should be. This technique does not interfere with frozen section or histologic examination.

In conclusion, preoperative localization with a metallic clip is a simple, useful, versatile, and cheap tool in the surgical diagnostic workup and treatment of patients with small pulmonary lesions. Our initial experience shows that this technique is safe, easy, and accurate for preoperative localization of GGO; however, further studies should be made to access its efficacy and possible complications.

References