



Cardiopulmonary bypass for advanced thoracic surgery

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The review article by Fuentes-Gago *et al.* (1) describes in detail two cases of extended thoracic tumor resections with the help of cardio-pulmonary bypass. The authors nicely explain application and handling of the cardiopulmonary bypass.

Extracorporeal circulation may allow for extended resections and complete resections of locally advanced thoracic tumors in contact to or invading the heart or the great vessels. Without the possibility of resecting the affected cardiac or vascular structures *en bloc* the tumor remains not resectable or the resection is incomplete leaving tumor in place. In this respect, cardiopulmonary bypass is a very valuable tool for thoracic surgeons, because the circulatory support helps to realize complete and extended resections. For the vast majority of the malignancies encountered, a complete resection is the most important factor for the outcome of patients undergoing surgery.

Furthermore, cardio-pulmonary bypass is not only required for the resection of tumors infiltrating cardiac structures or the great vessels, but also helps to control severe bleeding and is a back-up tool for intraoperative bleeding complications and circulatory failure. It feels much safer to approach advanced tumors, when a cardiopulmonary bypass is in stand-by. If things get more complicated than expected, or in case of an intraoperative crisis, the device can be life-saving (2,3).

Advanced tumors requiring extracorporeal circulation for resection are rare malignancies. It had been estimated, that less than 0.1% of all resections for lung cancer are done with cardiopulmonary bypass (3). In addition to T4 non-small cell lung carcinomas, sarcomas and a variety of locally advanced mediastinal and pleural tumors can be resected

successfully with the help of this technique.

However, a word of caution is appropriate as cardiopulmonary bypass is associated with adverse effects and risks that have to be managed with great care to guarantee for a safe procedure. The surgical resection of a locally advanced thoracic tumor with cardiopulmonary bypass is indicated only in a minority of cases, because oncological principles for the treatment of the individual malignancy have to be respected (4-6). For advanced non-small cell lung cancer, satisfactory long-term survival has been demonstrated for pT4 and pN0/pN1 classifications. In case of advanced mediastinal lymph node disease or even distant metastasis (oligo-metastatic state), a radical surgical approach should be critically evaluated. For these advanced cancers, multimodal treatment regimens are generally accepted. Neo-adjuvant strategies should be considered, if appropriate. These may reduce the tumor mass, making the procedure easier in some of the cases. Further a neo-adjuvant therapy may reduce the risk for the development of subsequent metastases, and help to select the potential candidates for a radical surgical approach at restaging after therapy. Selection of candidates is the key for long-term success.

The article by Fuentes-Gago *et al.* (1) stresses the requirement of an extensive and careful planning of the multidisciplinary procedure. This includes additional preoperative evaluation including trans-esophageal echocardiography, cardiac MRT and in some cases cardiac catheterisation. The intraoperative approach and strategy should be discussed and planned in detail with alternatives. The tumor should be approached from a side allowing expose and control of the central cardiac and vascular structures. Excellent exposure by extended incisions is important

for the resection of large tumor masses. The time on cardiopulmonary bypass should be kept as short as possible to avoid adverse effects. If possible, all preparations to isolate the tumor should be made prior to cardiopulmonary bypass to spare time on the device. Special attention has to be addressed to avoid postoperative bleeding complications under the anticoagulation regime. Peripheral cannulation requires experience to avoid complications. Cardiac arrest, cardioplegia and de-aerating maneuvers have to be safe. Adverse effects and complications by cardio-pulmonary bypass further include an inflammatory reaction, capillary leak syndrome and lung injuries.

Currently a lot of emphasis is put into exploring minimal invasive procedures. Extended high-risk procedures are discussed more controversially and do not share the same popularity. Although cardio-pulmonary bypass has been a standard technique in cardiac surgery for more than 3 decades, only some patient series and some case reports were published in the literature during that time span. An extended resection with cardiopulmonary bypass remains a challenging and high-risk operation. However, several single case series demonstrated a low perioperative mortality and a long-term survival, not different from extended resections without cardiopulmonary bypass (5-8). For T4 non-small cell lung cancer a 5-year survival of more than 40% has been reported by several authors (5-8). The review by Rosskopfova *et al.* (7) summarizes relevant case series. In addition the recent experience by Darteville *et al.* (8) supports the favorable outcome and the acceptable long-term survival that has been achieved.

In addition to cardiopulmonary bypass, less invasive extracorporeal circulation techniques like extracorporeal membrane oxygenation (ECMO) have been used in recent years to help the thoracic surgeon to achieve advanced resections. ECMO-systems have different components and properties (7). They require only minimal anticoagulation, have less systemic adverse effects and can be used for much longer periods. However, they miss a reservoir for recollecting blood from the operating field. Over the last years, there has been a rapidly rising number of applied extracorporeal support devices for thoracic surgical procedures (9). For some indications the ECMO support in a veno-venous or veno-arterial setting is sufficient for an extended resection. The ECMO device is associated with less complication compared to a cardiopulmonary bypass. This has been shown for lung transplantation. The recent review by Rosskopfova *et al.* (7) gives a good overview on the indications and techniques of ECMO support and

cardiopulmonary bypass for thoracic tumor resections.

The description of the two cases in the review (1) offers a lot of information on techniques and strategies in this situation. Because the application of cardiopulmonary bypass is not offered in all thoracic surgical units, but only in a minority of institutions, thoracic surgeons should be aware of the potential, indication and risks of this technique. Depending on the national education and training systems thoracic surgeons are more or less familiar with cardiopulmonary bypass techniques. The possibility of an extended resection for advanced thoracic malignancies should be evaluated by an experienced surgeon or in a specialized center. An intense interaction and cooperation with cardiac surgery is required to accomplish the best strategy for these patients. All thoracic surgeons should have at least a basic knowledge of extracorporeal circulation techniques and consider the application of the devices for a complete *en bloc* resection.

In conclusion, thoracic surgeons should be encouraged to use extracorporeal circulation support for advanced resections more frequently. Indeed, in the future a significant increase of thoracic tumor resections with circulatory support has to be expected. This implies improved interaction of thoracic and cardiac surgery as well as advanced training for thoracic surgeons. In many countries thoracic and cardiac surgeons have complete separate training programs. Therefore, it seems time to think about incorporation of cardio-pulmonary bypass and ECMO techniques into the training programs for thoracic surgeons.

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Footnote

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aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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