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Simultaneous cardiac surgery with pulmonary resection

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ABSTRACT

Introduction: Combined heart surgery and lung resection remain a controversial issue. This method facilitates the treatment of two major problems with one intervention, reducing hospitalization cost with acceptable outcomes. On the other hand, skepticism exists related to the effects of cardiopulmonary bypass on malignancy, proper extent of lung resection from non-standard approach and to a possible greater risk of perioperative bleeding.

Methods: Between November 2010 and April 2014 ten patients (male 9, female 1) underwent simultaneous cardiac surgery and pulmonary resection (mean age 69 ± 7 years). Pathological findings were as follows: primary carcinoma 4, benign lesion 4, metastasis 1, and carcinoid 1. Surgery at right lung was done in five cases and on left lung in five cases (lobectomy 5, extraanatomical resection 1, enucleation 3). In one case, because of the extent of malignant process, exploration only was done via sternotomy and pneumonectomy was performed later through thoracotomy. Cardiac procedures were as follows: coronary artery bypass grafting 5, aortic valve replacement 3, mitral valve replacement 1, ascending aorta replacement 1, and MAZE procedure 3. Sternotomy was performed in eight patients; in two of them left lateral thoracotomy was used and coronary artery revascularization was performed with MIDCAB principle. Off-pump surgery was used four times.

Results: There was no hospital mortality. There was no reexploration because of bleeding. Cardiac part of procedures was in all cases without complications. Prolonged air-leak was found in one case. All patients with benign pathology are alive. In the malignant group, one patient with staged approach died in terminal phase of disease and the second patient deceased because of disease-non-related reasons one year after surgery. The rest of them are followed up regularly by pneumo-oncology outpatient department.

Conclusion: Combined heart surgery and lung resection can be performed without increased mortality and/or morbidity. The synchronous treatment avoids the necessity of a second intervention with good results and economic benefits.

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Introduction

Combined heart surgery and lung resection remain a controversial issue. This method facilitates the treatment of two major problems in one intervention with acceptable outcomes and overall cost reduction. With increasing age and frailty of the patient population, it is sometimes very difficult to perform two major surgeries during short time interval. Even, because of primary heart surgery complications, planned lung tumor resection can be delayed into the already inoperable condition due to malignancy spread. Psychological factor can also play an important factor, and few patients wish to have second extensive surgery.

The combined heart revascularization with lung resection was first reported by Dalton [1] in 1977 and Girardet [2] in 1981. In 1985, Piehler [3], on his 41 patients, concluded that it is possible to perform both procedures from sternotomy safely at the same time. On the other hand, skepticism exists related to the effects of cardiopulmonary bypass on malignancy and to a possible greater risk for perioperative bleeding. There are also concerns about completeness of pulmonary resection and staging from non-standard sternotomy approach. The purpose of this report is to present our experience with the combined surgical approach and evaluate its benefits and safety.

Patients and methods

We present a series of ten patients who underwent combined surgical treatment for heart and lung disease in a one-step procedure between November 2010 and April 2014. There were nine males and one female. Their mean age was 69 (range: 59–79) years. Five patients were presented with a documented lung tumor and a concomitant heart disease. These were as follows: aortic stenosis; combined aorto-mitral disease with paroxysmal atrial fibrillation; aortic stenosis with dilatation of ascending aorta; ischemic heart disease and acute non-transmural myocardial infarction. In the other group in five of the patients, pulmonary tumor was accidentally discovered on preoperative chest X-ray when cardiac procedure was planned.

The standard preoperative assessment included chest X-rays, computer tomography, lung function testing, echocardiography and coronary angiography. All patients were operated on the basis of an absence of mediastinal lymphadenopathy and metastatic disease according to the results of their preoperative evaluation.

After induction of general anesthesia, all the patients had a double lumen endotracheal tube positioned in order to achieve one-lung ventilation. Standard middle sternotomy was used in eight patients. Access to the chest cavity was gained through widely opened pleura on the affected side. Pulmonary surgery was carried out and a frozen chest pathological analysis was performed immediately. According to histopathology result the extent of resection was carried out. Left upper lobe was affected in three cases and left lower lobe in three cases. Right upper lobe was affected in one case, right middle lobe in two cases and right lower lobe in one case. Pulmonary lobectomy was performed in five cases, extraanatomical resection in one case and simple lesion enucleation in three cases respectively.

In one case of previously known malignant tumor, more progressed disease with left hilus affection enforced us to indicate staged procedure – left lung resection with lymphadenectomy was carried out a month later from left thoracotomy. After lung resection, hemostasis was secured and heparinization instituted. Opened cardiac procedures were performed on CPB (cardio-pulmonary bypass) with antegrade cold blood cardioplegia. Off-pump approach for revascularization was used in two sternotomy cases. Prior to chest closure, chest drain was inserted into the pleural cavity. Mediastinum was drained with redon drains as ordered by department long-term experience.

In two patients with known left lung tumor and localized left anterior descending artery (LAD) stenosis (one with NSTEMI), left thoracotomy approach was used because of our experience with MIDCAB surgery. In these cases LIMA harvesting and heart revascularization were performed first.

Table 1 – List of patients, lung tumor localization, heart surgery and tumor histopathology.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age</th>
<th>Tumor localization</th>
<th>Lung surgery</th>
<th>Heart surgery</th>
<th>Tumor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>59</td>
<td>LUL</td>
<td>Enucleation</td>
<td>AVR, MAZE</td>
<td>Hamartoma</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>71</td>
<td>LLL</td>
<td>Exploration</td>
<td>AVR</td>
<td>Primary CA</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>66</td>
<td>RUL</td>
<td>Lobe resection</td>
<td>AVR, MVR, MAZE</td>
<td>Primary CA</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>67</td>
<td>RML</td>
<td>Lobe resection</td>
<td>CABG 2×</td>
<td>Metastasis</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>68</td>
<td>LUL</td>
<td>Lobe resection</td>
<td>CABG 4×</td>
<td>Carcinoid</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>74</td>
<td>LUL</td>
<td>Wedge resection</td>
<td>CABG 3×</td>
<td>Lung infarction</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>79</td>
<td>RML</td>
<td>Enucleation</td>
<td>AVR, asc. aorta replacement, MAZE, CABG 1×</td>
<td>Lung infarction</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>65</td>
<td>RLL</td>
<td>Enucleation</td>
<td>CABG 2×</td>
<td>Hamartoma</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>76</td>
<td>LLL</td>
<td>Lobe resection</td>
<td>MIDCAB (LAD)</td>
<td>Primary CA</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>65</td>
<td>LLL</td>
<td>Lobe resection</td>
<td>MIDCAB (LAD)</td>
<td>Primary CA</td>
</tr>
</tbody>
</table>

LUL, left upper lobe; LLL, left lower lobe; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; AVR, aortic valve replacement; MVR, mitral valve replacement; CABG, coronary artery bypass grafting; MIDCAB, minimally invasive direct coronary artery bypass; LAD, left anterior descending artery.
and lung resection was performed after protamine administration. All patients were transferred to the ICU in the immediate postoperative period and extubated after hemodynamic and ventilatory parameters stabilization.

**Results**

None of the patients required re-exploration for excessive bleeding. There was no hospital mortality. Cardiac part of the procedures was in all cases without major complications. Prolonged air-leak was found in one case. All surgical wounds were healed per primam. According to histopathology, four benign lesions were diagnosed (hamartoma 2, lung infarction 2). Six malignant tumors were confirmed (adenocarcinoma 3, spinocellular carcinoma 1, carcinoid 1, metastasis 1). All patients with benign pathology are alive. In the malignant group, the patient with staged approach died in terminal phase of disease (with prosthetic valve endocarditis as a complication) and the second patient died because of acute pancreatitis (one year after surgery). The others are followed up by pneumo-oncology outpatient department. Patients, lung tumor localization, type and surgical procedures are listed in Table 1.

**Discussion**

Concomitant surgical diseases of the heart and lungs are uncommon. The majority of these patients present with cardiac disease and are found incidentally to have an asymptomatic indeterminate pulmonary mass. Less frequently, patients present with pulmonary disease and are found to have significant cardiac disease that would increase the risk of pulmonary resection [4]. Options for therapy include either simultaneous or staged procedures for these disease processes. Some surgeons are reluctant to perform pulmonary resection for lung cancer at the time of a cardiac procedure that requires extracorporeal circulation because of potential increased bleeding from heparinization and extracorporeal circulation, compromised exposure for pulmonary resection via median sternotomy and possible alterations of the immune system leading to proliferation of lung cancer. In contrast, concomitant correction of both disease entities avoids the need for a second procedure and is advantageous if morbidity and mortality are not increased.

Median sternotomy is the preferred approach for combined heart and lung surgery. It is associated with less pain, reduced analgesic requirements, faster recovery of pulmonary function, and fewer pulmonary complications [5]. Lung resection through median sternotomy seems to be better tolerated even in patients with impaired pulmonary function and decreased pulmonary reserve [6]. Nevertheless, left lower lobectomy is believed technically to be the most difficult to perform with median sternotomy. In our group of patients, sternotomy approach was used in eight patients. Two left lower lobectomies were performed from left thoracotomy and heart revascularization was performed according to MIDCAB technique. In one patient with left lower lobe and hilus involvement, because of compromised exposure and local extent of the disease, the treatment was staged. Left lung resection was performed from thoracotomy approx. one month later.

Patients who undergo heart surgery with CPB are at substantial risk of postoperative bleeding [7]. Bleeding can result from excessive heparinization, inadequate heparin neutralization or protamine excess. More commonly it is the result of a transient impairment of platelet function mediated by platelet activation during passage through the extracorporeal circuit. In patients undergoing a concomitant procedure, bleeding may arise both from the area of the lung resection and mediastinal node dissection and accounts for a significant cause of postoperative morbidity [8]. In our group of patients, we did not observe greater than average blood loss and no re-exploration for bleeding was necessary.

Revascularization without CPB (off-pump) can significantly reduce postoperative bleeding and transfusion requirements. Pulmonary dysfunction sustained during CPB (fluid overload, activation of the inflammatory response) can also be prevented by off-pump approach. To reduce these risks in our group, patients with suitable coronary artery anatomy underwent revascularization without CPB. When CPB usage was necessary, lung resection was performed first prior to heparin institution.

There has been concern expressed regarding alterations in the immune system following cardiopulmonary bypass which can enhance malignant growth and decrease long term survival in patients with coexisting cancer. However, the specific effects of CPB on tumor growth and dissemination in patients with coexistent malignant disease remain largely unknown. A transient perioperative depression of immune function may provide window for malignant growth and dissemination in patients with coexisting disease. By performing simultaneous procedures and resecting the tumor prior to commencement of CPB or avoiding the use of CPB completely, these effects are minimized which may improve the long-term survival. Several authors demonstrated that in patients undergoing combined surgery, long-term survival is improved if the lung cancer is resected prior to CPB compared with during or after CPB [9,10]. However, there does not appear to be an increase in cancer recurrence in patients with previously treated malignant conditions who subsequently undergo cardiac surgery [11,12].

Long-term survival after combined treatment is mostly related to the predicted survival after lung resection. This depends on T stage and mostly on the patient’s nodal status. These parameters must be thoroughly evaluated preoperatively. Hilar and mediastinal lymph node sampling and dissection can be carried out through median sternotomy, although it is considered more difficult [13]. Inadequate lymph node evaluation and incomplete dissection are by some authors considered to be an important factor of poor long-term outcome in patients undergoing combined treatment [14]. Although radical mediastinal lymphadenectomy theoretically allows more accurate nodal staging, there are no data clearly promising survival benefits.

Still, majority of studies subscribing combined treatment include a small number of patients and there are no controlled randomized trials comparing the combined surgical treatment with two-stage procedure [15,16].
Conclusion

According to our very limited series of patients, combined treatment of cardiac disease and lung cancer is a feasible and safe method with good results. It can be carried out with accepted mortality and morbidity. It gives a good chance for definitive cure for patient and economic benefits. When indeterminate pulmonary mass at the time of cardiac operation is present, concomitant wedge excision should be performed if possible. If benign, the lesion will be appropriately managed and a second procedure will be avoided. If the lesion is malignant, the decision to proceed with a combined pulmonary resection should be individualized. In the attempt to minimize blood loss and theoretical CPB-induced tumor dissemination, off-pump revascularization techniques are preferred. In selected cases with suitable coronary anatomy, combined procedure can be performed from lateral thoracotomy using MIDCAB principles, especially in patients with left lower lobe affectation. In cases with open heart surgery and CPB installation, lung resection should be performed first. More advanced neoplasms that may require pneumonectomy, chest wall reconstruction, difficult nodal examination and those that have extensive pleural adhesions, should be resected at a later staged procedure.

Conflict of interest

The enlisted authors confirmed they do not have any potential conflict of interest.

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Ethical statement

Research was done according to ethical standards of University hospital, Olomouc, Czech Republic.

Informed consent

Informed consent was obtained from the patients for publication of this article and any accompanying tables.

REFERENCES