

A Functional Evaluation of Bronchial Reconstructed Lung with Special Reference to Denervation

Masao TOMITA, Yasunori KOGA, Koichiro SHIBATA,
Kazuhisa MATSUMOTO, Toshio ONIZUKA,
Koichiro SAKODA, Takami MAEDA,
Shigehito HAMASUNA, Norio WAKE, Yukito ICHINOSE

*The Second Department of Surgery
Miyazaki Medical College*

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Bronchoplastic procedures for lung cancer were suitable operative method to reserve pulmonary function and to enlarge the resected area. However, functional evaluation is not necessarily achieved in bronchial reconstructed lung, especially with reference to denervation. In this study the influence of denervation was investigated experimentally by pulmonary perfused wedge method in which vascular tonus was directly illustrated and by measurement of oxygen saturation (Sao₂) of pulmonary venous blood in which the ability of oxygen uptake was elucidated. When comparing the results of denervation with regard to operative procedures of bronchoplasty, bronchoplasty with sleeve anastomosis of pulmonary artery and autotransplantation respectively, the deteriorate effects related to bronchoplasty were not observed as compared to autotransplantation.

INTRODUCTION

The operative treatment for lung cancer has been accepted widely and its prognosis has been satisfactory compared with that of other treatments.

It has been due in part to improvement in operative technique and to detection in the early stage.

However, there are a large amount of the factors influenced on its prognosis after surgical treatment. The presentation of an adequate cardiopulmonary function after pulmonary resection was indispensable to expect an excellent results.

It was considered that sufficient cardiopulmonary function has been proposed to

富田 正雄, 古賀 保範, 柴田紘一郎, 松本 和久, 鬼塚 敏男, 迫田耕一朗, 前田 隆美,
浜砂 重仁, 和気 典雄, 一瀬 幸人

prevent the occurrence of cor pulmonale which might play a role of ill effects with the elapse of time following surgery.

According to subsequent follow up, it has been noted that the improvement of its prognosis consists in prevention of postoperative recurrence and preservation of cardiopulmonary function.

The prognosis in patients with a slight or moderate cardiopulmonary dysfunction after surgery was not necessarily fair despite of no occurrence of recurrence.

As a consequence, it is obvious that the reliability of surgical treatment for lung cancer consist in an adequate reserved cardiopulmonary function following surgery and in sufficient extended resection against affected bronchus.

For the purpose of obtaining an excellent results after surgery, bronchoplastic procedures is one of the most ideal operative maneuver for preservation of postoperative pulmonary function, especially in whom are elderly.

This report, therefore, analyze the functional influence of denervation in bronchial reconstructed lung with sleeve anastomosis of the bronchus alone or both the bronchus and pulmonary artery.

METHOD

Mongorel dogs, weighing 10 to 15 kilograms were anesthetized with pentobarbital (30mg. per kilogram) and ventilated with a Harvard pump apparatus.

All dogs recieved left thoracotomy through the fifth intercostal space.

Silicon catheter (IVH300 Fuji) which applied to hyperalimentation clinically was inserted into peripheral pulmonary arterial wedge of left lower lobe through pulmonary branch of upper lobe retrogradely.

Thereafter, catheter filled by saline with heparin was connected to infusion pump (Harvard) and the perfused wedge pressure was adjusted with a range of 12 to 13 mmHg by means of regulation of influsion flow. The successive changes in perfused wedge pressure thereby created were observed according to different operative techniques with regard to bronchoplasty. bronchoplasty with sleeve anastomosis of pulmonary artery and unilateral reimplantation which reflected complete denervation.

A silicon catheter utilized to measure the perfused wedge pressure as previously described was inserted through left atrium into the opening site of pulmonary vein which was drained from bronchial reconstructed lung to collect blood sample of pulmonary vein.

Immediately after taking a blood sample through catheter, O₂ saturation in blood drained from pulmonary vein was measured using O₂ saturation meter (Amer. Optical co. type 2).

The function of bronchial reconstructed lung, thereby, were evaluated with the elapse of time postoperatively, at least up to 7th day after surgery in which catheter was occluded by thrombus formation intra- or extraluminally.

RESULTS

To evaluate the function of bronchial reconstructed lung, an influence on denervation following bronchoplastic procedures has been estimated according to perfused pulmonary artery wedge method as shown in Fig 1. In 5 dogs of control group, there was no changes of perfused pulmonary wedge pressure under simple left thoracotomy.

In 7 dogs with bronchoplasty as operative procedure perfused pulmonary wedge pressure increased apparently averaging 5.4 mmHg of increasing pressure compared with that of control group.

In 7 dogs with sleeve anastomosis of both the bronchus and the pulmonary artery, the level of perfused wedge pressure was maintained at approximately 20mmHg of wedge pressure. In 7 dogs with left autotransplantation, the perfused wedge pressure was remarkably increased at the level of 26mmHg which was reflecting induced vasoconstriction by complete denervation.

Furthermore, a comparison of oxygen saturation level in pulmonary venous blood were made between different operative procedures of bronchoplasty and bronchoplasty with sleeve anastomosis of pulmonary artery.

As shown in Fig 2, the level of oxygen saturation in the pulmonary vein were different from control group received thoracotomy only at the time of 3 hours after surgery. The average oxygen saturation in control group showed 98.3%. In contrast, in group with bronchoplasty the level of oxygen saturation was low range compared with control group.

However, remarkable changes were observed in group with sleeve anastomosis both the bronchus and the pulmonary artery in which mean value of oxygen saturation in the pulmonary vein showed 93.5%.

Furthermore, changes of oxygen saturation level were observed according to elapse of time after surgery. In control group a low level of oxygen saturation in blood of the pulmonary vein was observed on first day after surgery but after third days of surgery

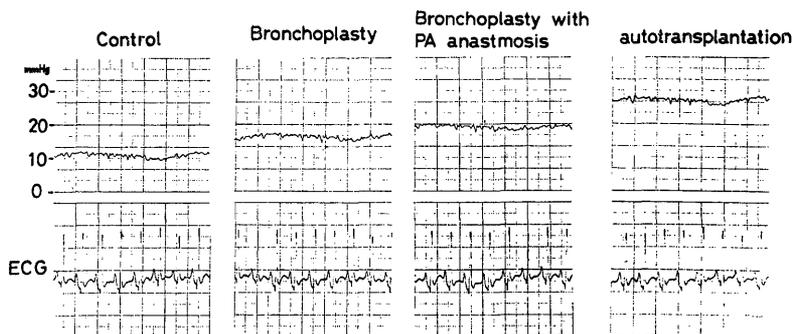


Fig 1. The changes of perfused pulmonary artery wedge pressure has been observed according to operative methods submitted to bronchoplasty with resection of segmental pulmonary artery and autotransplantation respectively.

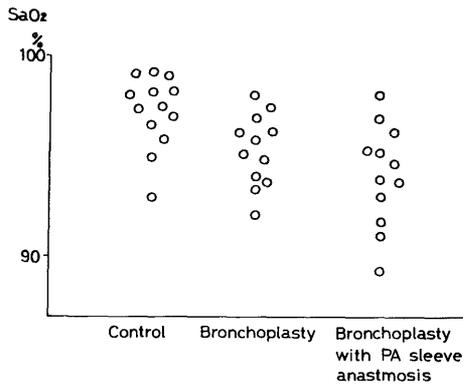


Fig 2. The levels of SaO_2 in pulmonary venous blood have been presented after 3 hours of bronchoplasty or bronchoplasty with resection of segmental pulmonary artery.

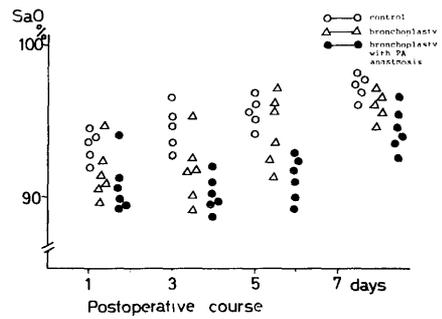


Fig 3. Postoperative changes of SaO_2 of pulmonary venous blood have been observed up to 7 days after surgery according to bronchoplasty and bronchoplasty with resection of segmental pulmonary artery.

normal level of oxygen saturation was observed. No ill effects has been noted from the view of functional oxygen uptake capacity of lung undergone thoracotomy alone.

However, there were observed a low level of oxygen saturation in the pulmonary vein of groups undergone bronchoplasty with sleeve anastomosis of pulmonary artery and there were unable to find out improvement of oxygen uptake resumed with the elapse of time after surgery compared with groups undergone thoracoplasty alone as shown in Fig 3.

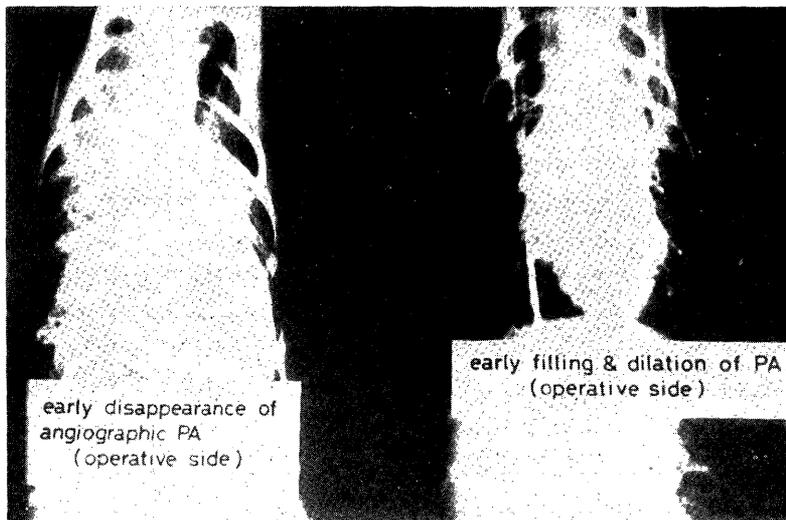


Fig 4. The angiogram after bronchoplasty with resection of segmental pulmonary artery has been presented.

In left lung of operative side, early filling of contrast material was revealed and marked dilatation of pulmonary artery was observed.

On a consequent observation, early disappearance of contrast material was recognized with intact lung in right side.

From the results of these studies it was certified that capacity of oxygen uptake of bronchial reconstructed lung was impaired in groups with bronchoplasty and sleeve anastomosis of pulmonary artery and slow return to normal level of oxygen saturation was shown according to postoperative course reflecting that restoration of oxygen uptake capacity was achieved incompletely.

Furthermore, hemodynamics of bronchial reconstructed lung with sleeve anastomosis of pulmonary artery was studied by pulmonary angiography. The demonstrable pulmonary angiogram was presented in Fig 4.

From the finding of pulmonary angiography, the results of hemodynamic changes tended to show early filling and dilatation of pulmonary arterial tree on operative side undergone bronchoplasty combined sleeve anastomosis of pulmonary artery in initial phase.

In late phase early disappearance of contrast material was recognized from pulmonary artery on operative side.

As a finding of pulmonary angiography, shunt effect on operative side has been suggested by early disappearance following early filling on pulmonary angiogram. It is, therefore, apparent that decreased capacity of oxygen uptake attributed to shunt effects which might be induced by vasoconstriction.

DISCUSSION

It is widely accepted that surgical treatments for lung cancer is indispensable to expect an excellent results on follow up study.¹⁾²⁾³⁾⁴⁾⁵⁾

There is no doubt that no recurrence and no functional failure of cardiopulmonary are necessary to improve surgical results on postoperative course. It is emphasized that the bronchoplasty as operative procedures is potentially useful in the treatment for lung cancer.

The authors have emphasized that bronchoplastic procedures are the best suitable technique for management of hilar type of lung cancer because this operative procedures facilitate to reserve cardiopulmonary function and to extent the limitation of resected bronchial wall.

And also bronchoplastic procedures allows comfortable lifespan for patients with surgical treatment under less cardiopulmonary distress.

The aim of the present study was to certify the function of bronchial reconstructed lung. It has been considered that bronchial reconstructed lung had a interruption of vagal innervation through bronchial wall and denervation, thereby, might be provided functional demerit which was provoked bronchodilation and vasoconstriction.

Clinically bronchoplastic procedures for lung cancer are widely accepted and this procedures are enhancing the curability and enlarging the operative indication.

Recently, the therapeutic usefulness of bronchoplasty combined with sleeve anastomosis of pulmonary artery was appreciable⁶⁾ and 5 years survival rate after bronchoplastic procedures has been approximately shown the same as that after other resective procedures.

It was not necessarily documented as to whether an influence of denervation might

contribute to functional defect of bronchial reconstructed lung. Therefore this study was undertaken to determine the functional defect of reconstructed lung with regard to denervation following bronchoplastic procedures.

The influence of denervation upon pulmonary vasculature in this series was evaluated by increasing change of perfused wedge pressure.

However, bronchoplastic procedures only or combination with sleeve anastomosis of pulmonary artery did not produce marked vasospasm compared with autotransplantation.

Aside from autotransplantation, it was eventually noted that bronchoplastic procedures even though combined sleeve anastomosis of pulmonary artery had brought about no manifest functional defect arising from denervation and it was concluded that vagal denervation by this operative maneuver did not produce any functional deterioration and complete denervation for which nerve pathway through pulmonary vein was reserved.

However, there was observed vasospasm which demonstrated by increased perfused wedge pressure.

Furthermore, it was elucidated that pulmonary angiogram showed the finding of early filling and dilatation of pulmonary artery and early disappearance of contrast medium on operative side.

This finding of pulmonary angiography is suggesting that denervation by bronchoplastic procedures results in the dilation of pulmonary artery on operative side which was provoked by vasospasm of peripheral pulmonary artery.

In addition, shunt effect on operative side was suggested from angiographic finding in which contrast medium disappeared early compared with intact side contralaterally.

By study of evaluation with regard to oxygen uptake capacity, the level of SaO_2 of pulmonary venous blood was measured through catheter introduced into pulmonary vein from the left atrial wall.

At the time of 3 hours after surgery, the level of oxygen saturation showed the lowest value in the lung received bronchoplastic procedure with sleeve anastomosis of pulmonary artery but that level did not change significantly between thoracotomy alone and bronchoplastic procedure.

With elapse of the time after surgery subsequently the Sao_2 values of pulmonary venous blood showed the almost same level up to 3rd day after surgery and on 5th day after surgery the lung undergone bronchoplastic operation resumed the increased oxygen uptake capacity reflecting less capacity of the lung received bronchoplasty with sleeve anastomosis with pulmonary artery.

From above results, the lung undergone bronchoplasty has demonstrated less influence of denervation, meanwhile, even operative maneuver of bronchoplasty with sleeve anastomosis of pulmonary artery, the effect of complete denervation has not been evidenced.

It was emphasized from the view of innervation that denervated mode after bronchoplastic procedures have differed from that after autotransplantation provoked complete denervation, that is, innervation through pulmonary vein has played an important role

under an interruption of nerve pathway through the bronchus and the pulmonary artery, notably, comparative experiment with respect to innervation between bronchoplasty and autotransplantation has shown the variable capacity of oxygen uptake associated with pulmonary circulation due to provoked vasospasm.

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