

An Experimental Functional Evaluation of End
to Side Anastomosis Related to Operative
Procedures of Tracheobronchial Reconstructiottn

Masao TOMITA, Yasunori KOGA, Koichiro SHIBATA,
Kazuhiisa MATSUMOTO, Toshio ONIZUKA,
Koichiro SAKODA, Takami MAEDA,
Shigehito HAMASUNA, Hiroshi HASEGAWA

The Second Department of Surgery,
Miyazaki Medical College

Received for publication, June 28, 1979

End to side anastomosis between the trachea and the bronchus was widely employed as one of bronchial reconstructed method.

However, functional evaluation undergone bronchial reconstruction did not completely display its superiority functionally.

This study was undertaken to determine whether end to side anastomosis was far superior in regard to reserved pulmonary function by means of observation on changes in size of anastomotic area on xp film delineated during inspiration and expiration simultaneously and also by intrabronchial pressure tracing.

The results were as follows.

- 1) The creation of window defect on the tracheal wall prior to anastomosis was necessary to maintain an adequate anastomotic area.
 - 2) The end to side anastomosis obliquely results in an excellent ventilation functionally.
- In contrast, the ill effects were disclosed by moderate angulation as far as exceeded 45 degree against tracheal wall owing to loss of rigidity in bronchial wall. From the present study, we concluded that end to side anastomosis obliquely with moderate degree should be avoided because of bronchial stenosis produced by bronchial collapse due to loss of supporting ability of bronchial cartilage.

富田 正雄, 古賀 保範, 柴田紘一郎, 松本 和久, 鬼塚 敏男, 迫田耕一郎, 前田 隆美,
浜砂 重仁, 長谷川 宏

INTRODUCTION

Bronchial plastic surgery was widely accepted for relief of bronchial stenosis resulting from traumatic injury¹⁾ or postinflammatory scar constriction²⁾ and for reconstruction after resection of benign³⁾⁴⁾⁵⁾ or malignant tumor⁶⁾⁷⁾ arising from the bronchus.

The various kinds of bronchial plastic procedures were advocated to achieve a more extensive resection as well as enlarge the operative indication.

As a corollary to wide acceptance of bronchial plastic procedures, it has encountered in some complications which has been due in part to operative technique. Many investigators have explored the preventive steps of complication and the technical improvement, including anesthesia to support respiration during operation, developing an appropriate methods to deal with a major complication such as anastomotic leakage or stenosis which might attribute to operative death.

Nevertheless, there is relatively little information with special reference to an evaluation of ventilatory function in bronchial reconstructed lung.

This study was to certify the reliability of end to side anastomosis as one of bronchial reconstructive procedures experimentally.

MATERIAL AND METHOD

Mongorel dogs, weighing from 12kg to 17kg, were anesthetized with 25 to 30mg/kg of pentobarbital sodium and left thoracotomy was performed through fifth intercostal space. Bilateral lung preparation with the trachea was prepared by excision and the heart was isolated from the lung, remaining the left atrial wall connected to bilateral pulmonary veins. This lung preparation was inflated with aid of Havard respirator adjusted intrabronchial pressure to as high as 20cm H₂O by a control of ventilatory volume.

The dogs used in this study were divided into three groups as indicated Fig 1. Group I. The group consisted of six dogs undergoing end to side anastomosis between

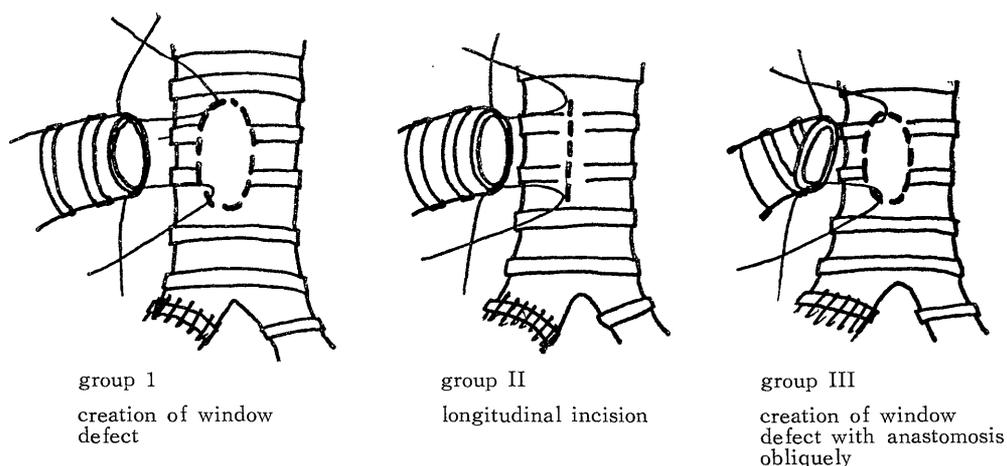


Fig. 1 Operative schema of end to side anastomosis between the trachea and right main bronchus

the trachea and the right main bronchus, in which window defect was created in lateral wall of the trachea to anastomose the right main bronchus.

Group II. This group consisted of six dogs undergoing the same as above procedures except window defect of lateral tracheal wall, in which only the longitudinal incision was placed to anastomose the right main bronchus.

Group III. This group consisted of six dogs undergoing the same manner as group I except that the edge of right main bronchus was cut off obliquely.

In each group, anastomotic orifices against the tracheal wall were observed by xp film during inspiration and expiration. The changes of its size and contours in anastomotic area were defined as shown in Fig. 2 on xp film in which a gain of the same position was substantiated during inspiration and expiration.

The variety in regard to its size and shape of the orifice of right main bronchus anastomosed into lateral tracheal wall were measured as a changes of the area planimetrically and the changes of anastomotic area were calculated according to the phase of inspiration and expiration respectively in three groups.

And also the changes in length and width of the trachea were estimated in resected lung preparation during inspiration and expiration. The length of longitudinal axis of the trachea was measured with distance of tracheal wall composed of five cartilage rings.

The intrabronchial pressures during inspiration and expiration were sequentially measured by transducer connected with the needle of 21 G in size through bronchial wall, compared with that of contralateral bronchus in each group respectively.

The patterns of intrabronchial pressure tracing were analyzed from the view of ventilatory function, which enabled to verify as to whether stenosis in anastomotic site or some degree of air flow resistance existed or not.



Fig 2 The changes in size of anastomotic area between the trachea and the bronchus during the phase of either inspiration or expiration, which showed a reduced size of anastomotic area at the time of expiration

RESULT

During inspiration and expiration, the tracheal sizes in length and width were apparently changed as shown in Fig.3 from observation of xp film according to respiratory cycle. Especially, the degree of transverse changes in diameter of the trachea were prominent. It was shown as an average of 23.5% with range of 18% to 31% in Fig. 3. Meanwhile, the ratio of the longitudinal changes in tracheal length were less than that of transverse change during inspiration and expiration, which changed in 13% of average ranging from 9.5% to 16%.

These differences between longitudinal and transverse changes in length during inspiration and expiration were considered to play an important role for a maintenance of the best ventilation physiologically.

From above results it has been assumed that the important role of membranous portion of the trachea has become apparent that tracheal size had changed according to respiratory cycle which was capable of being expanded widely in diameter during inspiration in order to enhance ventilatory effects.

The changes in size of sleeve anastomotic site were measured by planimetry on xp film. As indicated in Fig.1, the area of sleeve anastomosis with creation of window defect on tracheal wall (group I) had shown more broad and extend rather than that with longitudinal incision alone (group II) during inspiration and expiration.

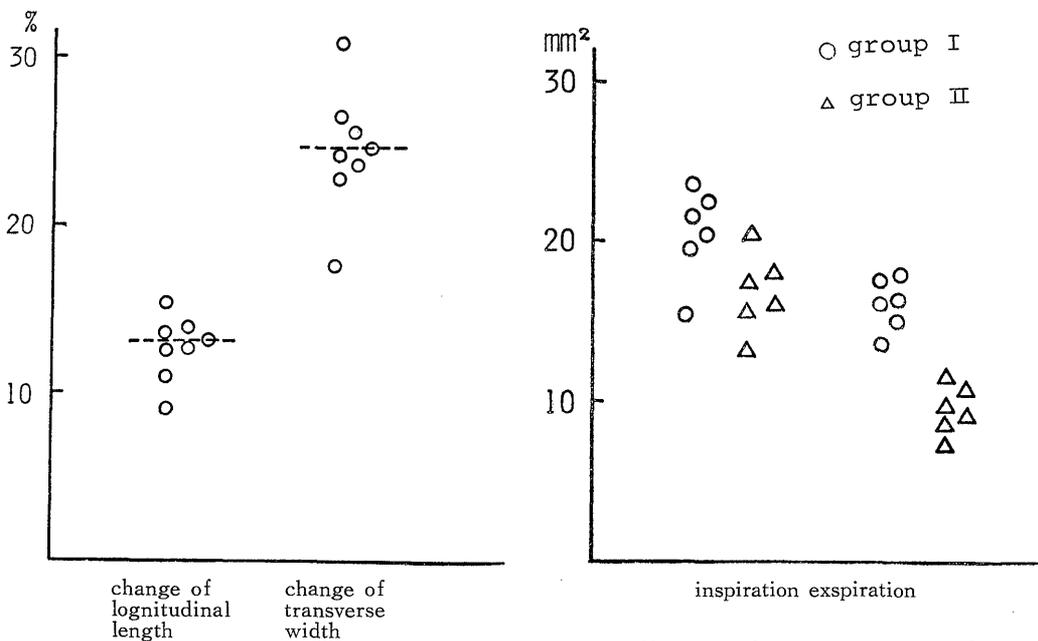


Fig. 3 Longitudinal and transverse changes in length of the trachea during the phase of inspiration and expiration

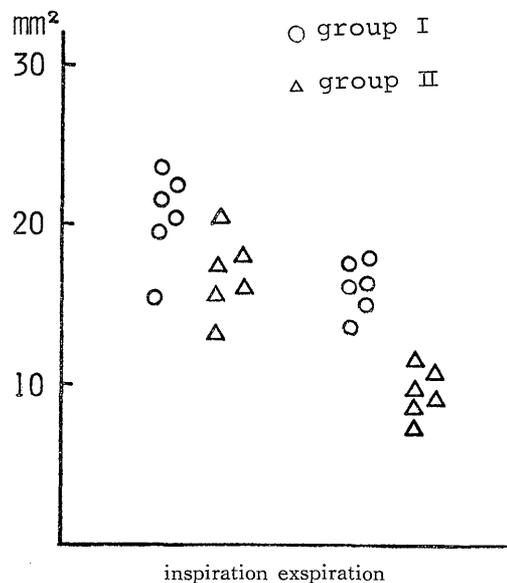


Fig. 4 Changes of anastomotic area between the trachea and the bronchus by operative procedure of end to side anastomosis in both group I and II

Furthermore, it was defined that the size of orifice in anastomotic site in group I showed less changes during inspiration and expiration rather than that in group II.

As a matter of fact, the orifice of anastomotic site reduced in size during expiration and also the ratio of changes in size was facilitated in accordance with longitudinal change in length of tracheal wall as shown Fig.4 in both group I and II.

Under further observation of the contour in anastomotic site, its shape of anastomotic area showed mainly longitudinal change, producing an ellipical form.

These changes of anastomotic area were evaluated among group I, II and III during inspiration and expiration in Fig.

5. In group II, the changes in sizes of anastomotic area had become manifest more significantly compared with other group.

By an accurate assessment in regard to the changes of contour in anastomotic area, the wall of the bronchus anastomosed into the trachea in group III showed frequently the deformity accompanied with collaps partially, reflecting the decrease or defect of support-

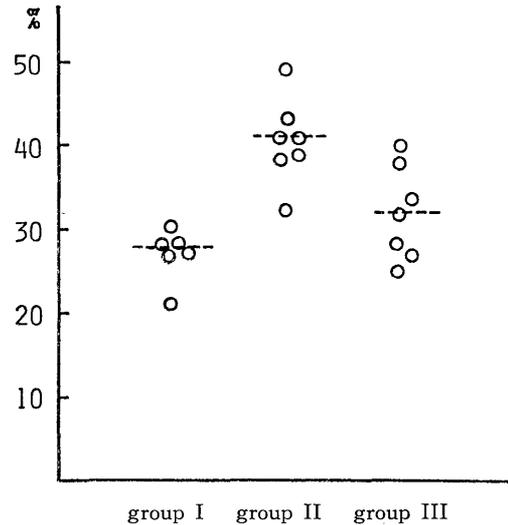


Fig. 5 The ratio of changes in size at anastomotic area during the phase of inspiration and expiration

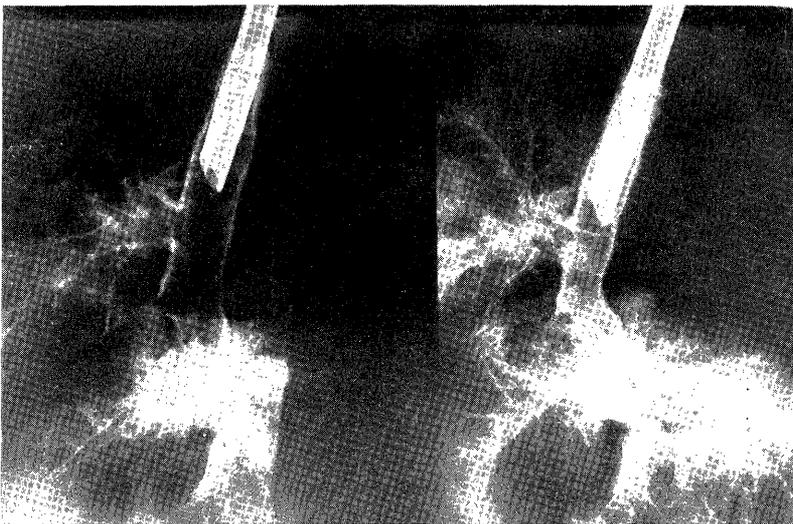


Fig. 6 This picture showed the deformity by collapse of the bronchial wall anastomosed into the trachea obliquely, which was seen during the phase of expiration (right figure) compared with during that of inspiration (left figure)

ing ability of the fragile bronchial wall to be trimmed obliquely in part as shown in Fig.6.

On intrabronchial pressure tracing, there was revealed the irregular slurr on the initial ascending slope of pressure curve in accordance with the phase of inspiration. It seems to be attribute to increase of flow resistance following that the anastomosed bronchus were reconstructed by being at right angle to the trachea in Fig. 7.

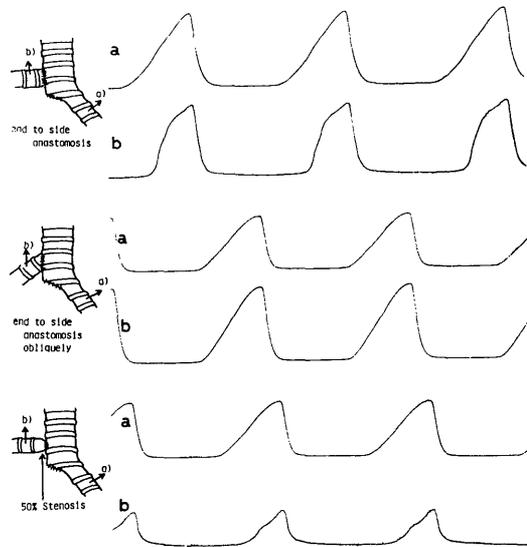


Fig. 7 Changes of intrabronchial pressure in each anastomosis utilized into the trachea, which demonstrate end to side anastomosis (upper), end to side anastomosis obliquely (middle) and end to side anastomosis with 50% of stenosis in anastomotic area (lower) respectively, compared with intrabronchial pressure of contralateral intact bronchus (a)

In end to side anastomosis obliquely between the trachea and the bronchus, an excellent ventilatory patterns were disclosed on pressure tracing curve within 30% of the changes of anastomotic area during inspiration and expiration, whereas the attitude of deteriorate ventilation was shown by the pattern of low amplitude of pressure curve with slow slope in Fig. 7, reaching a reduction of more than 50% in diameter of anastomotic area.

DISCUSSION

Bronchial plastic procedures were available to reserve the pulmonary function as well as to enhance the extent of resection against the diseases indicated for this operative procedures⁸⁾⁹⁾.

This study was mainly to certify some problems for end to side anastomosis as a bronchial reconstructive method.

It was emphasized with special reference to the operative method of end to side

anastomosis that anastomotic area had changed in size during inspiration and expiration.

The variety of size in anastomotic area has been ascertained in each group according to the different bronchial reconstructive methods experimentally.

Following bronchial reconstruction by a different operative maneuver as shown in group I, II and III, the changes in size of anastomotic area in each groups were compared with ratio of changes in size during inspiration and expiration.

Especially the sequential changes in size of anastomotic site was seen at the phase of inspiration as well as expiration. However, it was prominent in group II compared with in group I. In group II with longitudinal incision alone for tracheal wall, it results in easily collapse in anastomotic area during inspiration, whereas in group I there are seen preventive effect for collapse during inspiration by window defect on tracheal wall. It might be attribute to widely expansion of the trachea transversely rather than longitudinally according to respiratory cycle.

Therefore, it was concluded that an adequate ventilatory pattern was not necessarily anticipated after bronchial reconstruction by end to side anastomosis, unless window defect on tracheal wall, in which the bronchus was anastomosed, was created in accordance to the size of anastomosis.

In group III with anastomosis obliquely, the changes in anastomotic area was almost the same as in group I.

However, it was confirmed that the defined changes in size of anastomotic area was provoked by frailty of bronchial wall due to division obliquely against bronchial wall. Thereby, it was worthy to note that smooth angulation associated with anastomosis obliquely should avoid to maintain an adequate size of anastomotic area in spite of demonstration of an excellent air flow in anastomotic area without bronchial collapse.

From the view of ventilatory function, the end to side anastomosis as one of reconstruction surgery was evaluated by intrabronchial pressure tracing.

Pressure curve showed an almost fair ventilation either in group I or in group III, compared with that of contralateral bronchus. However, pressure curve in group I demonstrated the slurr irregularity at the initial phase of inspiration, which was suggesting to be slight degree of flow resistance in air way. This finding of pressure tracing study had indicated to be a pitfall of end to side anastomosis, by which respiration did not achieve laminal flow in anastomotic site due to an angulation produced by anastomosis.

Meanwhile, end to side anastomosis obliquely result in the pattern of an excellent ventilation on pressure tracing study, by which ventilation showed non-turbulent flow constantly at the site of anastomosis.

From these results of this study, it was defined experimentally that end to side anastomosis was one of an available methods of bronchial reconstruction. The angulation by end to side anastomosis infrequently yield air way resistance due to turbulence of air flow. The tendency of deteriorate ventilation after bronchial reconstruction by end to side anastomosis was facilitated by occurrence of anastomotic stenosis which was more than 50% in size.

On functional point of view, it was erroneous to assume that end to side anastomosis

was feasible as a operative method of bronchial reconstruction despite of having a pitfall compared with end to end anastomosis.

However, it was worthy to note that a reduction of air flow resistance achieved by the operative method of end to side anastomosis rather than end to end anastomosis, based on observation of ventilatory dynamics following bronchial reconstruction.

Meanwhile, there was defined, in this study, a pitfall of end to side anastomosis, which showed bronchial collapse in anastomotic site due to fragility of bronchial wall by oblique separation against bronchial wall.

As outlined above, end to end anastomosis afford promise of firm anastomosis without air leakage. However, an operative method of end to side anastomosis advocate routinely as a bronchial reconstructed method, unless end to end anastomosis enable to employ.

As a results of this study, we conclude that application of end to side anastomosis against the trachea is one of feasible operative procedure as bronchial reconstruction, whereas the creation of window defect against the trachea as shown in group I in this study is considered best suited for prevention from occurrence of postoperative stenosis in anastomotic site.

Furthermore, it seems worthwhile to document that end to side anastomosis obliquely provides an adequate ventilation with less increased resistance for air flow although it yields some degree of stenosis in anastomotic area during the phase of inspiration due to fragility of bronchial wall which is caused by separation of the bronchial cartilage obliquely.

REFERENCES

- 1) SANGER, P., W., : Evacuation hospital experiences with war wounds and injuries of the chest. *Ann, Surg.*, 122 : 147, 1945.
- 2) GEBAUER, P., W., Plastic reconstruction of tuberculous bronchostenosis with dermal grafts. *J Thorac Surg.*, 19 : 604, 1950.
- 3) GRILLO, H.C. et al : Ressection of the carina and lower trachea *Ann Surg.*, 158 : 889, 1963.
- 4) KITAMURA, S., MAEDA, M., KAWASHIMA, Y., et al : Leiomyoma of the intrathoracic trachea report of a case successfully treated by primary end to end anastomosis following circumferential resection of the trachea. *J Thorac Cardiovasc Surg.*, 57 : 126, 1969.
- 5) LE ROUX, B., T., et al : Squamous papillomatosis of the trachea and bronchi *Thorax* 24 : 673, 1969.
- 6) JENSIK, R., J., et al : Sleeve lobectomy for carcinoma a ten-year experience *J Thorac Cardiovasc Surg.*, 64 : 400, 1972.
- 7) PAULSON, D., L., and SHAW, R., R., : Bronchial anastomosis and broncho-plastic procedures in the interest of preservation of lung tissue. *J, Thorac Surg.*, 29 : 238, 1955.
- 8) WEISEL, W., et al : Long term follow-up study of patients with bronchial anastomosis or tracheal replacement *Chest* 61 : 141, 1972.
- 9) PAULSON, D., L., et al : Results of bronchoplastic procedures for bronchogenic carcinoma, *Ann, Surg.*, 151 : 729, 1960.