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PLACEMENT OF DOUBLE-LUMEN ENDOBRONCHIAL TUBES

Correlation Between Clinical Impressions and Bronchoscopic Findings

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SUMMARY

Double-lumen endobronchial tubes were placed "blindly" in 23 patients undergoing thoracotomy. Clinical criteria suggested satisfactory positioning in all cases; however, subsequent fibreoptic bronchoscopy revealed malposition in 48%. Bronchoscopic findings included the inability to view the bronchial cuff, narrowing of the bronchial lumen of the tube at the level of the cuff and herniation of the cuff over the carina. The potential hazards associated with these findings are discussed.

Accurate placement of double-lumen endobronchial tubes is essential for optimal gas exchange during one-lung anaesthesia. Until the availability of suitable fibreoptic endoscopes, confirmation of the correct positioning of these tubes was achieved by observing the expansion of the chest and by auscultation. Since then, several reports have advocated the use of the fibreoptic endoscope as an "introducer" over which the double-lumen tube is advanced under direct vision (Shinnick and Freedman, 1982; Ovassapian, Braunschweig and Joshi, 1983). The fibreoptic endoscope has also been used to verify the position of tubes placed "blindly" (Benumof, 1984). In the present study, we have examined the correlation between the clinical signs commonly used to verify the position of double-lumen tubes and the subsequent findings at bronchoscopy.

PATIENTS AND METHODS

Twenty-three consecutive patients undergoing elective thoracotomy which required the use of double-lumen endobronchial tubes were studied. Anaesthesia was induced with thiopentone 4–6 mg kg^{-1} and neuromuscular blockade produced with suxamethonium 1 mg kg^{-1}. Following laryngoscopy, an appropriately sized double-lumen tube (Bronchocath, National Catheter Company, U.S.A.) was inserted in a "blind" fashion. The tracheal and bronchial cuffs were inflated using one of two techniques, the choice being dictated by the clinical practice of the anaesthetist concerned.

Technique 1. Following inflation of the tracheal cuff, bilateral lung expansion was confirmed by inspection of the movement of the chest wall and by auscultation. The tracheal limb of the catheter mount was then clamped and the tracheal lumen opened to air. Ventilation continued through the bronchial limb of the endobronchial tube and air was introduced to the endobronchial cuff until the reflux of gas from the tracheal limb ceased. The tracheal catheter mount was then unclamped, the tracheal limb reconnected and the ability to inflate both lungs was reconfirmed.

Technique 2. Following intubation both cuffs were inflated with air using the technique described by Brodsky and Mark (1983). No attempt was made to listen for leaks from around the endobronchial limb. Between 1 and 3 ml of air was introduced to the bronchial cuff.

The ability to isolate each lung was then assessed before and after positioning the patient by alternately clamping the tracheal and bronchial limbs and noting the presence or absence of chest

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TABLE I. *Characteristics (mean ± SD) of 23 patients (12 male) studied*

Age (yr)	55.3 ± 15.6
Weight (kg)	71.0 ± 15.2
Height (cm)	172.9 ± 12.2

movement in three areas of each hemithorax: apical, anterior and axilla. Auscultation was performed over these areas. Finally, the presence of moistened exhaled breath in the transparent catheter mount of each limb of the tube was noted.

With the patient in the lateral position, fibreoptic bronchoscopy was performed to determine whether the bronchoscopic findings confirmed the clinical impressions of successful placement of the tube. The fibreoptic endoscope (Machida ENT 4L-50) was first introduced to the tracheal lumen of the tube. The tube was considered to be placed accurately when all of the following were observed:

(1) Unobstructed view of the tracheal carina and the absence of herniation of the bronchial cuff over the carinal surface.

(2) Unobstructed view down the non-intubated bronchus.

(3) Visualization of the bronchial cuff, immediately below the carina.

The fibreoptic endoscope was then introduced to the bronchial lumen of the tube and the following sought:

(1) The absence of constriction of the bronchial limb of the tube at the level of the bronchial cuff.

(2) Unobstructed view of the distal bronchial tree.

RESULTS

The demographic data concerning the 23 patients studied are presented in table I. Nine patients underwent right thoracotomy and 14 a left thoracotomy. In all but one patient, a left-sided Bronchocath was inserted, the exception being a patient with a vascular tumour in the left main bronchus. Eight of the men studied received a 39-French gauge tube and the remainder, a 37-French gauge tube. Of the women, eight were intubated with a 37-French gauge tube and the rest with a 35-French guage. The cuffs of 15 tubes were inflated using technique 1 and eight using technique 2.

In all cases studied, selective isolation of each lung was possible. In all 23 patients, chest expansion was considered satisfactory and equal in the three areas of the chest previously described. Similarly, breath sounds in these areas suggested that ventilation to all lobes of the lungs was adequate. Moisture from exhaled breath was noted in the bronchial and tracheal lumen of the tubes in all cases.

TABLE II. *Bronchoscopic findings*

	No.	%
Observations through tracheal lumen		
Carina visible	19	82.6
Clear view of non-intubated bronchus	19	82.6
Visualization of upper surface of bronchial cuff, immediately below carinal surface	17	73.9
Observations through bronchial lumen		
Constriction of bronchial tube lumen at level of bronchial cuff	1	4.3
View of distal bronchial tree	23	100

Bronchoscopic findings are described in table II. In 11 of the patients (48%), bronchoscopy revealed the double-lumen tube to be in a less than satisfactory position. In four patients (17%), herniation of the bronchial cuff over the carina had occurred. In six patients (26%) the bronchial cuff could not be visualized and in one patient (4%) narrowing of the bronchial lumen of the double-lumen tube was observed.

DISCUSSION

When the Robertshaw double-lumen tube is used, misplacement occurs in approximately 25% of cases (Read, Friday and Eason, 1977). Burton and colleagues (1981) reported a much lower incidence (4%) when the newer p.v.c. double-lumen tubes were used. However, neither of these groups confirmed correct positioning with bronchoscopy.

In the present study, using chest expansion and auscultation as indicators of correct placement of the tube, we found that positioning was satisfactory in all 23 patients. However, using the criteria described, bronchoscopy revealed that in only 52% was the position optimal (fig. 1). In 26% of the patients, we were unable to visualize the bronchial cuff when looking down the tracheal lumen of tube. Using our criteria, the endobronchial limb had been advanced too far beyond the carina. In four out of six of those cases, no clinical sequelae occurred; however, in two, it became apparent at thoracotomy that the left upper lobe was not being ventilated. In each

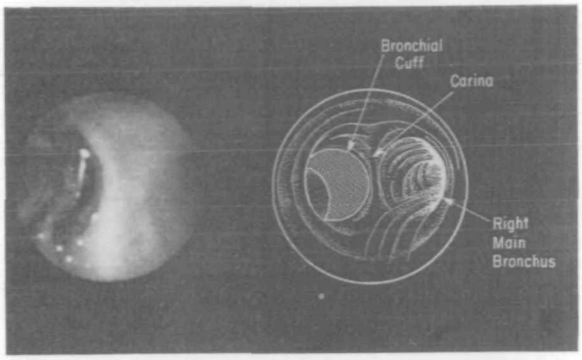

FIG. 1. Left: View through fibreoptic endoscope demonstrating correct position of bronchial cuff lying below the carina. Right: artist's impression of view.

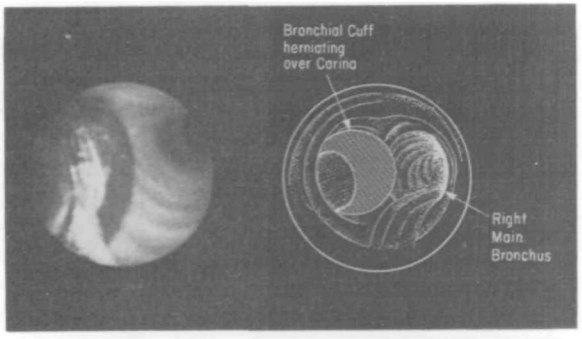

FIG. 2. Left: View through fibreoptic endoscope showing herniation of bronchial cuff over the carina. Right: artist's impression of view.

patient, withdrawing the tube by 1 cm under direct bronchoscopic control resulted in the immediate return of ventilation to that lobe and allowed visualization of the endobranchial cuff. It is interesting to note that, in both patients, breath sounds on the side concerned were considered satisfactory, even over the axilla where it is suggested one is less likely to hear transmitted breath sounds (Benumof, 1983). In the examples cited, the lack of ventilation to the left upper lobe was detected only at thoracotomy and detection would have been unlikely if a right thoracotomy had been performed. The only sign in this instance might have been hypoxia, for which there are many causes.

It is well known that right upper lobe obstruction may occur using a right-sided endobronchial tube, and this has resulted in the increased use of left-sided tubes (Alfrey and Benumof, 1981) even when a left thoracotomy is performed. The cases described illustrate that left upper lobe obstruction may occur with a left endobronchial tube, and this is supported by a recent publication (Brodsky, Shulman and Mark, 1985) which reported two similar cases. With a malpositioned left-sided endobronchial tube, there may be three clinical consequences: failure to ventilate the left upper lobe, failure of the left upper lobe to collapse, or continued ventilation of the left lung when right-sided, one-lung ventilation is planned.

In 17% of the patients studied, herniation of the bronchial cuff over the carina was found to be present (fig. 2). Once again, this complication was not detected using clinical signs. No untoward sequelae occurred, but such malplacement may, under certain circumstances, lead to a number of problems. First, the endobronchial limb may slip out of its bronchus, especially during the positioning of the patient (Saito, Dohi and Naito, 1985). Herniation may also result in obstruction of the unintubated bronchus, making it difficult or impossible to ventilate that lung. Finally, it may prevent the escape of air from the unintubated lung when one-lung anaesthesia is attempted.

The final abnormality that was detected at bronchoscopy was narrowing of the lumen of the endobronchial tube by the endobronchial cuff. Clearly, this is a complication of the introduction of an inappropriately large volume of air to the cuff. Narrowing occurred in only one patient (4%), and it is interesting to note that in this patient the tube was placed and the cuffs inflated using technique 2. This method involves the introduction of a relatively fixed amount of air to the bronchial cuff. We feel that, when using endobronchial tubes, only the minimum volume of air necessary to seal leaks around the tube should be introduced to the cuff. Not only will this prevent the narrowing of the bronchial limb and the consequent increase in resistance to gas flow, it will also minimize the risk of herniation of the cuff and rupture of the bronchus.

Although moist exhaled breath was visible in each limb of the catheter mount in all of the patients studied, it is obvious that this sign will merely indicate that each limb is unobstructed; it does not signify correct placement of the tube.

In conclusion, clinical observations are still used to determine the accurate placement of double-lumen tubes and will detect gross malposition. However, this study suggests that such

observations are unreliable signs of the exact position of the bronchial cuff, the presence of herniation of the cuff over the carina or overdistension of the cuff leading to narrowing of the lumen of the tube. We feel that fibreoptic bronchoscopy allows accurate confirmation of the position of double-lumen endobronchial tubes and facilitates repositioning of a malplaced tube. We recommend its use whenever double-lumen tubes are used.

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