Tubes and bronchus blockers

© RWD Nickalls,
Department of Anaesthesia,
Nottingham University Hospitals,
City Hospital Campus,
Nottingham, UK.

dick@nickalls.org
www.nickalls.org

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Chapter 6

Tubes and bronchus blockers[1]

6.1 The Univent tube, 1984

The Univent tube is a combined blocker and ETT, and made in Japan. We do not have any just now, but we are trying to buy some in. The literature suggests that they are not as good as a well positioned double-lumen tube, but may well be useful in unusual situations.

- Campos JH, Reasoner DK and Moyers JR (1996). Comparison of a modified double-lumen endotracheal tube with a single-lumen tube with enclosed bronchial blocker [Univent tube]. *Anesthesia and Analgesia*; 83, 1268–1272. [conclusion:- DLT better than Univent tube (more malpositions with the Univent tube)]
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- Inoue M, Shohtsu A, Ogawa J *et al.* (1984). Endotracheal tube with movable blocker to prevent aspiration of intratracheal bleeding. *Annals of Thoracic Surgery*; 37, 497–499.
- Kamaya H and Krishna PR (1985). New endotracheal tube (Univent tube) for selective blockade of one lung. *Anesthesiology*; 63, 342–343.

6.2 The Hunsaker jet ventilation tube

- Robinson RJ (1997). One-lung ventilation for thoracotomy using a Hunsaker jet ventilation tube. *Anesthesiology*; 87, 1572–1574.

6.3 Bronchus blockers

Although Fogarty catheters have been used as bronchial blockers in adults (Ginsberg 1981) and in children (Tan and Tan-Kendrick 2002), special bronchus-blocker kits are now available. The one we use at the City Hospital is the **Arndt endobronchial blocker set** manufactured by Cook.[2] This consists of a 9 Fr-gauge bronchus blocker (78 cm) having a blue balloon at the end, together with a special tube-adaptor having three channels one each for anaesthesia gases, the bronchus blocker, and the fibrescope.

The Arndt bronchus blocker has a small loop at its tip, and is guided into position by first sliding it along the fibrescope, and then positioning it under direct vision. The art seems to be to

[1] `http://www.nickalls.org/dick/papers/thoracic/hand-tubes.pdf`

[2] William Cook Europe A/S, Sandet 6, DK-4632 Bjaeverskov, Denmark; `http://www.cookgroup.com`

place the tip of the fibrescope *just inside* the required main bronchus (i.e., not right down to the subcarina)[3] and then push the blocker down. Once the blocker falls off the end of the fibrescope it will be visible and can then be manipulated into position under direct vision. It is important to make sure that both the end loop and balloon remain within the main bronchus (i.e., do not migrate further down into a second-order bronchus where they might stray into surgical territory).

Note that two slightly different shaped balloons are supplied; one is long and thin (for the left main bronchus), and the other is fatter in the middle (for the right main bronchus). The length of each is about 2–2·5 cm (i.e., about half the length of the left main bronchus in an average adult man).

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- Culp WC and Kinsky MP (2004). Sequential one-lung isolation using a double Arndt bronchial blocker technique. *Anesthesia & Analgesia*; 99, 945–946.
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- Uzuki M, Kanaya N, Mizuguchi A *et al.* (2003). One-lung ventilation using a new bronchial blocker in a patient with tracheostomy stoma. *Anesthesia and Analgesia*; 96, 1538–1539.

6.4 Double-lumen tubes

Several modern well engineered versions are available (e.g., Mallinckrodt, Portex, Rüsch). While none is perfect—each has its own advantages and disadvantages—all are certainly far better than the old red-rubber versions. The Mallinckrodt *BronchoCath* would seem to be the best of those currently available in the UK as regards ease of placement, bronchoscopic access, and having good robust connectors. Both Portex and Rüsch also make double-lumen tracheostomy tubes (see Section 3.2).

6.4.1 History

Initial progress in thoracic anaesthesia seems to have been held up largely by trying to figure out how to overcome the problems associated with pneumothorax in a spontaneously breathing patient. Although physiologists have been ventilating the lungs of animals using bellows via a tube in the trachea for centuries,[4] there seems to have been a mental-block about this in the medical community until relatively recently.

The double-lumen tube was originally developed by the physiologist Henry Head (1889). He was interested in separating gas entering and leaving each of the two lungs in animals. His tube was widely used for determining differential lung function well before it was used in thoracic anaesthesia (Comroe 1977, p. 15).

In 1949 Carlens (1908–1990) designed a double-lumen endobronchial tube for use in bronchospirometry (Carlens 1949), and subsequently for one-lung anaesthesia (Björk and Carlens 1950).

[3] Described to me by Dr K Alagesan.

[4] Hooke (1666) showed that a dog could be kept alive indefinitely by IPPV via the trachea using a set of bellows. Importantly, he also indicated in this paper that after making numerous holes in the lungs, the dog could be maintained just as easily using a continuous through flow of air. Hence he proved that, contrary to contemporary thinking, the physical movement of the lungs did not of itself benefit an animal other than by simply ensuring the necessary movement of air in and out of the lungs, and that the lungs were simply a device for oxygenating the blood flowing through them. Note that the book *De Motu Cordis* by William Harvey (1578–1657) describing the circulation of the blood through the lungs was published in 1632.

A series of different modifications by Bryce-Smith[5] (1959), Bryce-Smith and Salt (1960), White (1960a) and Robertshaw (1962) followed. Note that the *routine* use of one-lung ventilation for lung resection was first advocated only in 1957 (see Slinger 1990).

See also articles on the general history of endobronchial anaesthesia (White 1960b), and on the history of the various tubes (Pappin 1979) and instruments (Hillard and Thompson 1963). See also the cardiothoracic section in Rushman, Davies and Atkinson (1996) for various historical references.

The Robertshaw tube (1962)

A red-rubber tube with D-shaped lumina which has a lower resistance to gas flow than either the Carlens or White double-lumen tubes (Robertshaw 1962). Angular deviation of the endobronchial part from the midline is 20° on the right and 45° on the left. Three sizes only; large, medium, small.

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[5] Anaesthetist Roger Bryce-Smith (1918–2006) died in March 2006. See his obituary in *British Medical Journal* (2006); 332, 1277 (May 27).

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- White GMJ (1960b). Evolution of endotracheal and endobronchial intubation. *Br. J. Anaesth.*; 32, 325.

6.4.2 The *BronchoCath*

[Mallinckrodt Medical (UK) Ltd, 11 North Portway Close, Round Spinney, Northampton, NN3-8RQ, UK; TEL: 01604–646132.]

The *BronchoCath* (Mallinckrodt Medical, 1983) is a disposable polyvinylchloride (PVC) low resistance double-lumen endobronchial tube. Angular deviation of the endobronchial part from the midline is 15° on the right and 30° on the left. Five sizes for the left, four sizes for the right (see Table 6.1).

Table 6.1:

BronchoCath	Body of tube OD mm	L endobronchial OD mm
41 Fr	14–15	10·6
39 Fr	13–14	10·1
37 Fr	13–14	10·0
35 Fr	12–13	9·5
32 Fr	—	—
28 Fr	—	—

Table 6.2:

BronchoCath	Size	Length to teeth
Large	41 Fr (L/R)	30 ± 1 cm
Medium	39 Fr (L/R)	28 ± 1 cm
Intermediate	37 Fr (L/R)	27 ± 1 cm
Small	35 Fr (L/R)	26 ± 1 cm
V. Small	32 Fr (L only)	—
Child	28 Fr (L only)	—

Table 6.3:
This Table is from Brodsky *et al.* 1996

Measured tracheal width on chest x-ray	Predicted L bronchus width	Size
$\geq$ 18 mm	$\geq$ 12·2 mm	41 Fr
$\geq$ 16 mm	$\geq$ 10·9 mm	39 Fr
$\geq$ 15 mm	$\geq$ 10·2 mm	37 Fr
$\leq$ 14 mm	$\leq$ 9·5 mm	35 Fr

The Mallinckrodt bronchial cuff was originally clear and transparent (just like the tracheal cuff). It was subsequently changed to the current blue colour following complaints that the cuff was difficult to visualise during fibreoptic bronchoscopy.

Although Mallinckrodt recently made some improvements to their left-sided tube, in my view these tubes still have serious design faults; for example (a) the left endobronchial tip is bevelled medially (should be bevelled slightly laterally to face the subcarina), (b) the right endobronchial tube should have a much larger right upper-lobe orifice.

- Brodsky JB and Macario A (1995). Modified BronchoCath double-lumen tube. *J. Cardiothorac. Vasc. Anesth.*; 9, 784–785. [see also editorial pp. 117–118]

6.4.3 The tube database (TEPID)

Several studies have tried to correlate both tube size and depth of tube insertion with a *single* body parameter (e.g., height, weight or BMI), but none has proved particularly useful (see references below). This suggests that using only a single parameter is probably not a useful approach—not unexpected since tube distance from the teeth is markedly influenced by both diaphragm position (& hence with the degree of abdominal obesity) and height. Consequently my TEPID[6] database uses three parameters (height, weight and gender), and gives quite accurate predictions (560+ patients in the database).

The TEPID database of double-lumen tubes (DLT) can be useful for predicting both tube size and length for a given patient. For example, the predicted double-lumen tube lengths for an average supine male and female are given in Table 6.4.

The TEPID program also gives the position of the DLT's tracheal orifice, since this can be used to estimate the likely carina position (by adding approximately 1·5 cm, as the tracheal orifice of the double-lumen tube is typically 1–2 finger-breadths.[7] from the carina)

Table 6.4:
TEPID data for length of double-lumen tube and tracheal orifice position (cm) in an average supine male and female. In the UK the average male and female heights are approximately 5ft 9in (176 cms) and 5ft 4in (164 cms) respectively. The results are given as: `mean[range](n)`

	average male	average female
	wt 76 ± 7·5 kg	wt 67 ± 7·5 kg
	ht 176 ± 7·5 cm	ht 165 ± 7·5 cm
41L	30 [27·5–32] (n=56)	—
39L	29 (n=1)	28·1 [26–30] (n=15)
37L	—	27·3 [26–29] (n=10)
35L	—	27·1 [26·5–28] (n=8)
41R	29·1 [28–30] (n=6)	—
39R	28 [27·5–29·5] (n=4)	—
37R	—	26·6 [25–29] (n=4)
35R	—	25·7 [25–27] (n=4)
tracheal orifice	24·1 [21–26·5] (n=67)	21·5 [18·7–24] (n=41)

The TEPID database, together with a Perl program, is freely available on the thoracic anaesthesia CD. After entering the patient's height/weight/gender the program displays the relevant tube sizes and lengths (single and double-lumen).

[6]Tube and EPIdural Database (TEPID). This is a City Hospital collection of thoracic epidural and tube data over the past several years.

[7]Measured using a fibrescope.

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