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Simplified Delivery of Volatile Anesthetics for Bronchoscopy

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The Sanders bronchoscopic attachment is a safe and simple means of ventilation with oxygen-enriched air when general anesthesia for bronchoscopy is provided with intravenous agents. If it had an ability to deliver volatile anesthetics, this attachment would be more valuable. Thus, bronchoscopies in which volatile agents seem preferable or advantageous could easily be performed. This paper describes the use of a standard Sanders attachment to deliver volatile anesthetic agents by the same Venturi principle on which it was founded.

METHODS

A standard Sanders bronchoscopic ventilating attachment was placed on an 8 × 40-mm Pilling ventilating bronchoscope. The ventilating sidearm of the bronchoscope was then attached directly to the gas outflow tubing of a Foregger model E anesthesia machine as shown in figure 1. Utilizing a Finnigan mass spectrometer, the concentrations of halothane vapor were measured within the gas outflow tubing of the anesthesia machine, and at the distal end of the bronchoscope while air was being entrained with the Sanders apparatus. Oxygen pressures from 20 to 50 psi were used for entrainment of room air into the bronchoscope. A 5-l/min flow from the anesthesia machine was used.

Measurements were made proceeding from low to higher concentrations of halothane to alleviate any problem of background or room accumulation of vapor. The anesthesia machine and bronchoscope were flushed with 100 per cent oxygen preceding each new determination. Data were analyzed and a line constructed using a least-squares regression.[1]

A direct relationship was established between the concentration delivered and that entrained (see table 1 and figure 2). Admixture of entrained air through the proximal opening of the bronchoscope and of halothane vapor via the sidearm resulted in a marked dilution of the delivered halothane concentration, as expected. The relationship between concentration delivered and that entrained was not affected by varying oxygen pressures delivered to the Venturi aperture. Therefore, all data from all pressure measurements were pooled. Furthermore, prolonged entrainment did not progressively deplete or dilute the concentration being emitted from the end of the bronchoscope.

DISCUSSION

Examination of the tracheobronchial tree during general anesthesia has long been

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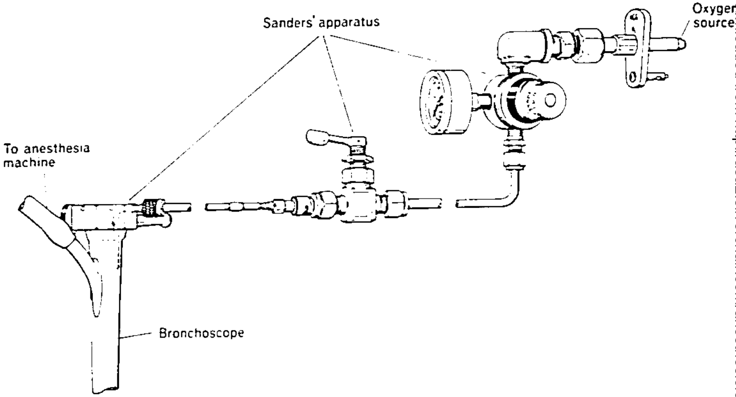

FIG. 1. Sanders ventilating attachment connected directly to the proximal end of a ventilating bronchoscope with the fresh gas tubing from an anesthesia machine connected to the sidearm.

fraught with the problem of adequately ventilating the patient while at the same time providing a reasonable depth of anesthesia. Ventilating bronchoscopes have simplified the problem by providing a means of periodic lung inflation. Their major disadvantage is that the proximal end of the bronchoscope must be closed during ventilation, thereby interrupting endobronchial manipulations and making it difficult to maintain ventilation or administer any form of inhalational anesthesia. The introduction of the Venturi principle of air entrainment, using a Sanders attachment, has now made possible adequate alveolar ventilation and uninterrupted manipulations during any phase of the respiratory cycle.

Various means of delivering inhalation agents by using a Venturi principle have been reported. Sanders had devised a special Venturi adapter capable of entraining volatile agents.[2] However, no description of the apparatus was presented, nor was the reader informed how it might be purchased. In addition, when using this special apparatus, the delivered concentration of halothane varied with wall pressure. In contrast, our system delivered a constant halothane concentration when wall pressures were varied from 20 to 50 pounds per square inch. Gillick[3] and Carden[4] have demonstrated ways of delivering N_2O by utilizing a N_2O-O_2 mixture to power the Venturi apparatus. The necessity for a premixed gas supply and the resultant diminution in $F_{I_{O_2}}$ make its use somewhat bothersome.

We have simplified the procedure by making use of the standard Sanders attachment to deliver volatile agents. The ventilating safety as well as flow, pressure, and oxygen-delivering characteristics have already been established for this type of Venturi attachment.[2-5] By attaching the gas outflow tubing from the anesthesia machine to the sidearm of a ventilating bronchoscope on which the Sanders attachment is fitted, it is possible to entrain anesthetic vapors. As shown in table 1, there is a large reduction in the concentration of halothane vapor emitted from the end of the bronchoscope compared with that delivered to the sidearm. Room air entrained via the main opening of the bronchoscope dilutes the anesthetic vapor. A slightly higher halothane concentration was measured at the end of the bronchoscope on initiation of air entrainment, possibly resulting from accumulation of vapors within the bronchoscope during non-ventilating periods. This concentration decreased sharply to a steady-state vapor concentration and could not be further diluted or depleted with continued oxygen delivery via the Venturi. One disadvantage of this technique is the inability to scavenge waste vapors.

A simple modification of this setup was to attach the circle system to the bronchoscope such that the Y piece connected directly to the sidearm using a suitable endotracheal tube adapter. This arrangement tended to be somewhat cumbersome and offered no advantage. Halothane concentrations were essentially identical to those measured when the gas delivery tube from the machine was connected directly to the sidearm.

We have successfully utilized this form of ventilation and delivery of volatile anesthetics to a number of patients. Anesthesia was induced with thiopental and succinylcholine administered intravenously after adequate preoxygenation. Patients' tracheas were then intubated with the 8 × 40-mm Pilling ventilating bronchoscope setup. Anesthesia was maintained with halothane (inspired concentration 0.4 per cent by vol) and O_2-enriched air, and muscle relaxation was provided by a succinylcholine drip. Uninterrupted ventilation was easily maintained irrespective of endobronchial manipulations. All patients were satisfactorily amnestic, maintained stable vital signs throughout, and awoke promptly at the end of the procedure. No complication ensued. Thus, with a simple extension of the Sanders bronchoscopic attachment, safe bronchoscopies using volatile anesthetic agents are possible.

TABLE 1. Halothane Delivered to Bronchoscope and after Air Entrainment

Wall Pressure (psi)	Halothane In (Per Cent)	Halothane Out (Per Cent)
20	1.3	.20
	2.3	.34
	4.0	.61
	5.2	.77
	6.2	.95
	8.4	1.25
	9.5	1.82
30	.9	.28
	1.6	.35
	2.1	.30
	3.8	.61
	5.6	.81
	6.4	.98
	8.4	1.17
	10.4	1.82
40	1.0	.18
	1.6	.35
	2.1	.38
	3.8	.64
	5.3	.73
	6.1	.93
	8.4	1.28
	10.0	1.53
50	1.1	.29
	1.6	.31
	2.4	.49
	3.6	.48
	4.9	.80
	6.4	.91
	8.1	1.19
	10.0	1.66

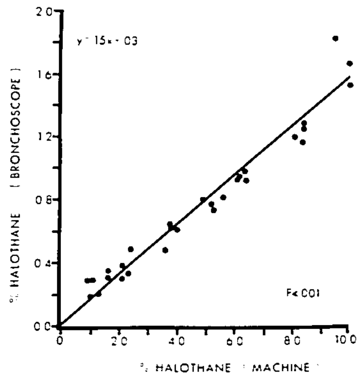

FIG. 2. Comparison of halothane concentrations delivered to bronchoscope and after air entrainment.

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