

TABLE 2. Cumulative Doses of Thiamylal during 72-h Period

	Birth Weight (kg)	24 h	48 h	72 h	Total Dose (g)
Patient 1	60	124 mg/kg	220 mg/kg	326 mg/kg	19.56
Patient 2	30	135	267	358	10.68
Patient 3	65	110	208	304	19.76
Patient 4	40	140	232	341	13.64
Patient 5	45	118	190	282	13.19
MEAN \pm SD		125.4 \pm 12.24	223.4 \pm 12.92	322.2 \pm 13.41	

In a clinical report of barbiturate intoxication, Brazier found that the duration of isoelectric periods is usually up to 10 s and these episodes are known to occur in cases of acute barbiturate coma with complete recovery.⁶ We regulated the doses of thiamylal to keep isoelectric periods in a burst-suppression pattern up to 10 s for 72 h while measuring total plasma thiamylal concentrations. With this EEG end point, the thiamylal concentrations gradually increased reaching two to four times their initial levels. We regard this phenomenon as "acute tolerance." However, tolerance to the hypnotic effects of barbiturates evidently does not significantly increase the lethal dose.⁷ Thus, there may be some risk to using a burst-suppression pattern as the sole guide in determining the barbiturate dose and perhaps there is a limitation to the duration of high-dose barbiturate therapy.

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A New Improved Double-Lumen Tube Adaptor

HENRIK W. ANDERSEN, M.D.,* GEORGE T. OZAKI,† JONATHAN L. BENUMOF, M.D.‡

Previous designs of double-lumen tube adaptors have permitted, with varying degrees of success and ease of use, the application of three major one-lung ventilation/anesthesia management functions/options (without the need for airway disconnection and/or external clamping maneuvers); one-lung ventilation, exposure of one lung to atmospheric pressure and suctioning of one lung at a time.¹⁻⁵ None of these double-lumen tube adaptors has the capability of providing the application of three recent

major advances in the management of one-lung ventilation/anesthesia; one-lung positive end-expiratory pressure (PEEP) with or without tidal ventilation,⁶⁻⁸ differential PEEP to both lungs,⁸ and one-lung fiberoptic bronchoscopy. This report describes a new, single unit, double-lumen tube adaptor which allows the easy application (no airway disconnection or clamping) of all six of the above one-lung ventilation/anesthesia characteristics by simply turning a dial to the desired setting.

* Fellow in Anesthesia.

† Developmental Engineer.

‡ Associate Professor of Anesthesia.

Received from the Department of Anesthesia, University of California at San Diego, Anesthesia Research Laboratory, La Jolla, California 92093. Accepted for publication July 13, 1981. Supported by UCSD Anesthesia Department.

Address reprint requests to Dr. Benumof: Anesthesia Research Laboratory, T-001, La Jolla, California 92093.

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DESCRIPTION

The double-lumen tube adaptor has two round three-way stopcocks placed in parallel inside a plastic-like block [(Delrin,[®] a heat and solvent resistant synthetic) (fig. 1)]. Each stopcock is fitted with an easily accessible handle. The three passage channels of each stopcock are located at 90° from each other. The anesthesia machine side of the adaptor has three entry ports which allow

access into the stopcock assembly area. Each entry port is fitted with a 15-mm male connector. The lateral (outer) entry ports can each enter only one stopcock, whereas the central (middle) entry port can potentially enter both stopcocks. The patient side of the adaptor has two exit ports, each of which can potentially connect with only one stopcock. Each exit port is fitted with a 15-mm female connector. Each of the entry and exit ports and stopcock channels are large enough (8-mm ID) to easily permit passage of a 5.6-mm OD fiberoptic bronchoscope. The entire adaptor (stopcocks, stopcock block, and male and female connectors) weighs 145 grams.

When an individual stopcock handle is in the horizontal position, the stopcock passage channel joins the central machine side entry port with the patient side exit port (fig. 2A, 0° position). When a stopcock is turned 90° into the vertical position, the stopcock passage channel joins the lateral machine side entry port with the corresponding patient side exit port (figs. 2B and 2C, 90° position). When a stopcock channel is in an intermediate position between machine side entry ports (45° position), passage through a stopcock channel from an entry to an exit port is not possible (fig. 2D, 45° position for left stopcock). A mechanical stop prevents each three-way stopcock from rotating to a position that would connect the central machine side entry port to a lateral machine side entry port.

FUNCTION

The design of this double-lumen tube adaptor facilitates the performance of all six of the previously mentioned one-lung ventilation/anesthesia management functions. When the stopcock passage channels join the central entry port with an exit port(s) [horizontal (0°) position, fig. 2A], ventilation and/or PEEP of the corresponding lung(s) is possible. When the stopcock passage channels join a lateral entry port with the corresponding exit port (90° turn to vertical position, figs. 2B and 2C), six different single lung function/options become possible: exposure to atmospheric pressure, suctioning, fiberoptic bronchoscopy, one lung PEEP, differential lung PEEP, and independent lung ventilation. The six single lung functions/options also can be performed when the stopcock passage channels join both lateral entry ports with the corresponding exit ports (position C); this setting might be useful when more space is required by bulky external apparatus.^{6,8,10} The technically most complex maneuver, namely, differential lung PEEP, is easily achieved by using the adaptor settings shown in figure 2B and applying a different amount of PEEP to the lateral entry port compared with the PEEP applied to the central entry port (from a conventional PEEP valve in the anesthesia machine system).

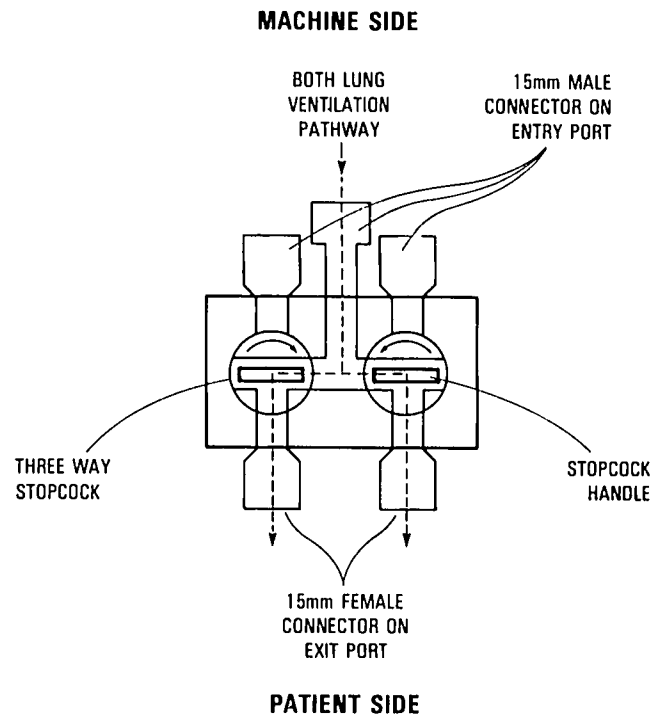


FIG. 1. Schematic drawing of double-lumen tube adaptor with the stopcocks (diagrammed as circles) turned into the horizontal position so that the central anesthesia machine side entry port connects with both patient side exit ports, thereby allowing conventional ventilation of both lungs. Connector characteristics and dimensions are labeled. The stopcocks are fitted with easily accessible handles (diagrammed as rectangles within the circles).

The application of all of these one-lung functions does not require interruption of ventilation of the other remaining lung or the application of any clamps to the airway tubing. When the stopcock passage channels are set in an intermediate position between a central and lateral machine side entry port (45° position, fig. 2D), the corresponding lung becomes a closed nonventilated space whose gas composition depends on the previous ventilatory history. This setting might be chosen when very brief periods of nonventilation are required either to check for air leaks (following inhalation or at high lung volumes) or to facilitate surgery (following exhalation or at low lung volumes). The following case report illustrates the versatility of the adaptor.

REPORT OF A CASE

A 20-year-old woman, with angiographic-proven right main pulmonary artery thrombosis, underwent pulmonary thromboembolotomy under high-dose fentanyl (60 µg/kg) oxygen anesthesia. With a single-lumen endotracheal tube in place, fulminant hemorrhagic pulmonary edema occurred upon termination of cardiopulmonary bypass. Fiberoptic bronchoscopy revealed that the right lung was the sole source of the edematous fluid. Cardiopulmonary bypass was reinstated and a double-lumen endotracheal tube was inserted and connected to the anesthesia machine using our double-lumen tube adaptor. The lungs

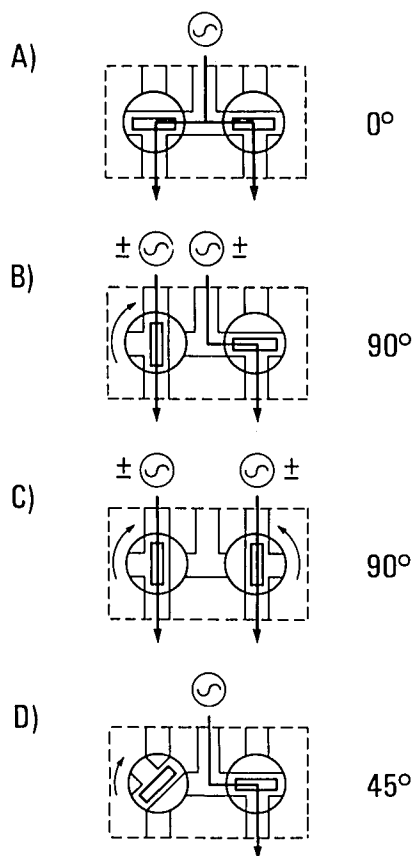


FIG. 2. Possible adaptor settings. \odot = external mechanical apparatus (*i.e.*, ventilator, PEEP system), \pm = presence or absence of external mechanical apparatus. In the absence of external mechanical apparatus, the setting would be used for suctioning, fiberoptic viewing, and exposure to atmospheric pressure. *A*) Stopcock (circles) handles (rectangle within circles) are in a horizontal position (0°). As in fig. 1, the central entry port connects to both exit ports. *B*) Left stopcock handle has been turned 90° into a vertical position so that left lateral entry port connects to left exit port while central entry port continues to connect to right exit port. *C*) Left and right stopcock handles have been turned 90° into vertical positions so that both lateral entry ports connect to their corresponding exit port. *D*) Left stopcock handle has been turned 45° so that no entry port connects to the left exit port.

were demonstrated to be functionally separated from one another by simple sequential turning of the adaptor stopcocks to the 45° position (fig. 2*D*) during positive pressure ventilation. Cardiopulmonary bypass was terminated again, while a sodium nitroprusside drip was initiated, but fulminant, exclusively right lung hemorrhagic pulmonary edema resulted again. By simple turning of the right stopcock between the central and lateral machine side ports [from the horizontal (fig. 2*A*) to the vertical (fig. 2*B*), position], the anesthesiologist could suction the patient every third or fourth uninterrupted positive pressure ventilation breath. In an attempt to decrease the rate of right lung edema formation, right lung PEEP (5–10 cmH₂O) was applied (fig. 2*B*), with and without tidal ventilation to the right lung by attachment of the appropriate external system to the right machine side entry port. The edema fluid

formation markedly abated over the ensuing hour and ventilation was controlled throughout the rest of the operative period with differential lung PEEP and differential lung volumes. The trachea was successfully extubated from the double-lumen tube one day postoperatively.

DISCUSSION

We have found that this adaptor greatly facilitates the application of all of the many varied one-lung ventilation/anesthesia functions. The separate external systems required for one-lung PEEP (without tidal ventilation) are simple and have been previously described.^{6,8,9} The further addition of a reservoir bag to these systems permits one-lung sigh or independent ventilation maneuvers. We have made the most use of the adaptor settings displayed in figs. 2*A* and 2*B*, but we have had occasion to utilize all of the possibilities listed in the previous section.

The double-lumen tube adaptor is not only helpful in managing one-lung ventilation, but it also avoids potentially harmful situations. Since the direct lateral entry port to exit port channels are straight, kinking or bending of bronchoscopes or suction tubes does not occur. The design of the stopcock ensures that, when set properly, occlusion of a stopcock channel is complete—a feature that external clamping cannot guarantee. Similarly, since no clamps are required, there is no possibility of damage to the endotracheal or connecting tubing by crush injury from an external clamp. In conclusion, the double-lumen tube adaptor enables the anesthesiologist to utilize all the maneuvers in one-lung ventilation/anesthesia that are demanded by modern anesthetic practice.

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