THE ADVANTAGES OF A COMBINED T-PIECE AND NON-REBREATHING VALVE: A SIMPLE DEVICE

BY
SHAOTSU LEE
West Virginia University Medical Center, Morgantown, West Virginia, U.S.A.

SUMMARY
A combined device is described which is considered to utilize the advantages of both the T-piece and non-rebreathing valve, while eliminating the disadvantages. The device incorporates the reservoir bag and inhalation valve of the non-rebreathing system and the expiratory reservoir limb of the T-piece.

Ayre's T-piece.
The Ayre's T-piece (Ayre, 1937) has a very low resistance, is simple, and almost trouble-free. Intermittent positive pressure respiration (IPPR) can be induced by occluding the exhalation reservoir tube intermittently with one finger. However, the pressure, volume, and timing of lung inflation depends on the flow of gases from the anaesthetic machine and the duration of finger occlusion. This manoeuvre is also dangerous because the steep rise of intrapulmonary pressure cannot be estimated by the fingertip (Keuskamp, 1963). While controlled ventilation can be induced fairly well in infants or small children, satisfactory assisted respiration is often hard to attain, because there is no reservoir bag for transmitting respiratory information and for squeezing at an optimal time. Rees (1950) has advocated the addition of an open-ended reservoir bag to the expiratory limb to facilitate intermittent positive pressure respiration. The status of rebreathing is here obscure, because the expiratory gas may remain inside the expiratory limb or in the bag when there is no respiratory pause or if it is too short to enable sufficient fresh gas to accumulate for adequate ventilation. In order to have a properly functioning T-piece it would appear that the fresh gas flow and the expiratory reservoir limb volume should be adjusted to the patient's tidal volume, respiratory rate, duration of inspiration and expiration, and respiratory pause (Ayre, 1956; Collins, Bronner and Rovenstine, 1961; Harrison, 1964; Inkster, 1956; Keuskamp, 1963; Mapleson, 1954; Onchi, Hayashi, and Ueyama, 1957; Woolmer and Lind, 1954). A flow of two and a half to three times the patient's minute volume is often required to avoid rebreathing and dilution with room air by using a proper T-piece.

Non-rebreathing valve.
A non-rebreathing valve has two or more valves which create resistance, and is a relatively more complicated device than the T-piece. However, a reservoir bag is available and can be compressed intermittently. Movement of the bag can be perceived by hand. A gas flow equal to the patient's minute volume is just enough for adequate ventilation. No expiratory reservoir limb is necessary.

A new device.
In order to eliminate the disadvantages and to use the advantages of both the T-piece and non-rebreathing valve for an open non-rebreathing technique, a combination device is constructed (figs. 1 and 2) by using the proximal portion of a non-rebreathing valve (namely the reservoir bag and the inhalation valve) and the distal portion of the T-piece (namely the expiratory reservoir limb). There is no exhalation valve. By using a sufficient flow to keep the reservoir bag distended, fresh gases will flow into the expiratory limb in the same way as when a T-piece alone is used. The sustained gas inflow through a distended bag also eliminates the resistance of the inhalation valve. During spontaneous respiration, the device will function like a T-piece. The flow-reservoir limb volume relationship is applied...
FIG. 1
Diagram of a simple non-rebreathing device.
A. Fresh gas inlet.  
B. Reservoir bag (½ litre or 1 litre).  
C. Inhalation valve.  
D. Facepiece.  
E. Rigid, plastic body of the device (i.d. = 1 cm).  
F. Compressible exhalation tunnel.

FIG. 2
The non-rebreathing device in clinical use. Note the distended ½-litre reservoir bag. The angle-piece (body of the device) is rigid plastic. The exhalation tunnel is made of 0.5 by 6 inches of latex tube strengthened by waterproof adhesive tape. The patient is intubated with a Cole tube. The tube leading out of the right nostril is an oesophageal stethoscope.
to prevent inhalation of expired gas or room air, that is to say, the fresh gas flow should be the same as when a T-piece alone is used. The reservoir limb volume should be adjusted accordingly to avoid rebreathing and dilution of the anesthetic agents with room air. The expiratory reservoir limb should be made of compressible material. It should lie along the side of the reservoir bag so that it can be compressed and occluded simultaneously with manual compression of the bag during intermittent positive pressure respiration (Lee, 1964). The inhalation valve will prevent backflow of the expired air into the bag. The bag is a reservoir of fresh gases and can be used for assisted or controlled ventilation if desired; in this case only fresh gases are compressed out of the bag to inflate the lungs and a flow equal to the patient’s minute volume is required. Thus the device functions like a non-rebreathing valve with a safe automatic exit occlusion mechanism. With a reservoir bag between the anesthetic apparatus and the patient, it also minimizes the fatal danger of liquid anesthetic agent reaching the patient’s lungs, since the bag can entrap inadvertently spilled liquid. In the event of inadvertent occlusion of the distal end of the T-piece (Taylor and Stoelting, 1963) the bag is able to buffer the increased pressure.

REFERENCES


