fitting, was elevated to reduce kinking in the connector hose. At this time, breath sounds were noted to be markedly diminished and an audible leak noted as the ventilator bellows descended. With return of the reservoir bag to the anesthesia circuit, no significant leaks were detected and effective ventilation was easily reestablished. Thorough examination of the ventilator fittings revealed several fine, longitudinal cracks in the machine connector pipe (fig. 1). Raising the ventilator and applying the screw clamp caused displacement of the fatigued metal pipe. This appeared as a variable leak in the ventilator system, depending upon the pressure and location of clamp application.

In retrospect, we speculate that this problem may have been present in previous cases but with no obvious cause or a variable leak of any great magnitude. The ventilator had been in active use and had passed all routine equipment checks. In fact, the area of metal fatigue was not obvious unless the connector pipe was deformed by a clamp or other pressure over the precise area of vulnerability; but there were several such areas along the length of the pipe. We hope that this report will serve to reemphasize the need to carefully reexamine all metal fittings which are prone to fatigue. Furthermore, it represents a major design flaw when a part of the ventilator circuit is also used as a structural mount and thereby subjected to the recurrent stress of daily operating room usage.

Steven Wolf, M.D.
Assistant Professor of Anesthesiology

Charles B. Watson, M.D.
Assistant Professor of Anesthesiology

Phyllis Clark, DDS,
Resident, Oral Surgery
Department of Anesthesiology
School of Medicine
Department of Anesthesiology
The University of North Carolina
at Chapel Hill
Burnett-Womack Building
Chapel Hill, North Carolina 27514

Reference


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Factors Affecting Rebreathing in T-piece Circuits

To the Editor: — The article by Byrick and Janssen on the effect of respiratory waveforms on rebreathing in T-piece circuits1 provides useful and provocative information. But like many papers on the subject,1 the authors' interpretation of their own results is flawed. If a patient's respiratory waveform does affect rebreathing in a T-piece system—and it probably does2—this article fails to prove it. Unfortunately, the authors did not take into account a variable known to affect the amount of rebreathing in a Mapleson-D system:3,4 the ratio of fresh gas flowrate (Vf) to minute volume ventilation (Ve). For instance, in their table 1, they report (in the upper left hand cell) that when Vf was 100 ml·kg⁻¹·min⁻¹, mean Ve was 4.34 l/min in their enflurane group, and 8.83 l/min in their halothane group. Assuming that the patients' body weights were comparable between the two groups and averaged 70 kg (and therefore Vf averaged 100 ml·kg⁻¹·min⁻¹ × 70 kg = 7.0 l/min) then the ratio Vf/Ve was 1.6 in the enflurane group, but only 0.8 in the halothane group, a twofold difference. On this basis alone one would expect to see little rebreathing in the enflurane group, but quite a lot in the halothane group. This is just what was found.

One could argue, in support of the authors' hy-
Correspondence

Richard L. Keenan, M.D.
Department of Anesthesiology
Medical College of Virginia
Richmond, Virginia 23298

References


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In reply:—The aim of our study,1 as the title suggested, was to analyze and compare the respiratory waveform of anesthetized patients during halothane and enflurane anesthesia, and to relate these waveform differences to rebreathing in T-piece circuits. The key role of minute volume \( (V_e) \) and the \( V_p/V_e \) ratio has been experimentally verified as Dr. Keenan suggests. Indeed, our hypothesis assumed that this relationship would exist, although presenting data in this manner would seem to verify our technique of measuring the inspired CO\(_2\) load. The impact of respiratory waveform on rebreathing can only be analyzed when one considers the basic components of \( V_e \) which characterize a waveform, that is the inspiratory flow rate and the timing of each phase.

Milic-Emili et al.2 introduced the concept of analyzing a given minute volume \( (V_e) \) in terms of inspiratory drive \( (V_i/T_i) \) and the effective timing ratio. This relationship,

\[
V_e = V_i/T_i \times T_i/T_{tot} \times 60
\]

caracterizes the interdependence of \( V_e \) and the components of the respiratory waveform. By plotting the ratio \( V_p/V_e \), Dr. Keenan is including the waveform characteristics on the x-axis which he wishes to isolate for examination. There are many variables (including dead-space, end-tidal CO\(_2\) levels, and waveform) which will influence the relationship between inspired CO\(_2\) volume and the \( V_p/V_e \) ratio. The key finding of our study was that when halothane-anesthetized patients increased \( V_i/T_i \), the fraction of CO\(_2\) inspised increased. When enflurane was used, the exact opposite