RESULTS

A total of 44 patients in the unflexed group and 44 patients in the flexed group were included in this study. Four patients in each of the two groups had a headache which met the diagnostic criteria. There was no significant difference in incidence between the two groups ($P > 0.05$). The average age in the flexed group was 57.1 and in the unflexed group it was 53. No significant difference was found between the two groups in a comparison of age ($P > 0.05$). The average number of introductions of the needle was 2.8 in the flexed group and 2.6 in the unflexed group, a nonsignificant difference ($P > 0.05$).

DISCUSSION

Rosser and Schneider reported a study of spinal anesthesia using a 22 gauge needle in which they found a low incidence of severe headache if the back were unflexed at the time of lumbar puncture. However, there was no control group with the back flexed. Furthermore, the data for the incidence of headache were obtained by reviewing the doctors' and nurses' notes in the patient's chart rather than by direct questioning.

In the present study it was found that performance of lumbar puncture with the back flexed or extended did not influence the frequency of postspinal headache. The incidence of headache was 9.1 per cent in both groups, results that are in good agreement with those of Vandam and Dripps. Since only male patients whose average age was greater than fifty years were studied the small number of headaches was not unexpected. It is possible that a difference in incidence could be detected in a population with an expected higher incidence of postspinal headaches, such as young women receiving spinal anesthesia for obstetrical delivery.

SUMMARY AND CONCLUSIONS

Patients were given spinal anesthesia with the back flexed and unflexed in an alternating distribution and the incidence of postspinal headache in each group determined. No significant difference in the incidence of postspinal headache could be found between the two groups.

The authors wish to acknowledge the assistance of Theodore Colton, Sc.D., who performed the statistical calculations.

REFERENCES


GADGETS

Modified Moerch Piston Respirator

PETER SAFAR, M.D., GILBERT DAVIS, R.I.T.*

Experience with prolonged intermittent positive pressure ventilation in the Intensive Care Units of Baltimore City Hospitals (1957–1961) and the University of Pittsburgh Health Center Hospitals (1962–1963) in over 200 patients included approximately 75 patients (ages 1–71 years) in whom the Moerch Piston Respirator was used. These patients were ventilated for continuous periods ranging from one day to 4½ months. The piston respirator proved simple and reliable. The electrical motor performed continuously without failure for several months. Piston stroke volumes between 0 and 3,000 ml. and rates between 0 and 40 per minute were possible.

A satisfactory respirator should provide: (1) adequate ventilation even in greatly reduced compliance and increased airway resistance;
(2) registration of tidal volumes and airway pressures; (3) an airway pressure curve with an expiratory pause at atmospheric pressure at least as long as the inflation phase; (4) function without compressed gases; (5) simplicity and reliability; and (6) air and air-oxygen mixtures with warm, high humidity.

Since the original commercial model of the Moerch (Mueller) piston respirator did not fulfill all these requirements, it was modified in several ways. One modification is described here (fig. 1).

Non-leaking System. The use of the leaking system (uncuffed tracheotomy tube), as originally recommended by Moerch, made constant volume ventilation impossible and adequate humidification difficult. Therefore, cuffed tracheotomy tubes were used since 1958, which provided fairly constant tidal volumes in spite of changes in pulmonary resistance (fig. 1-1). In children, relatively large bore uncuffed tubes were sufficient to minimize leakage.

After clinical trial of various types of cuffed tubes, the Moerch modification of the Jackson silver cannula (with swivel adaptor), equipped with a latex, double-walled slip-on cuff, was used.

When there was a risk of inhalation of gastric contents or other material, the cuff was inflated to the point of abolishing all air leakage, but not beyond, to prevent pressure necrosis of the trachea. Brief deflation every few hours seemed advisable. In conscious patients a minimal leak was provided to permit the patient to talk with the air leaking through the larynx during positive pressure inflation. Tracheal necrosis from cuff pressure was seen at autopsy only when the recommended meticulous cuff inflation technique was not observed; when the detailed sterile and atraumatic tracheotomy technique was not used; or when humidification was inadequate.

Heated Midstream Humidifier. Various humidifiers were tested during piston strokes of 2 liters at a rate of 20 per minute. The unheated draw-over humidifier of the original model delivered air with a relative humidity of 30–45 per cent and a temperature of 20°C. Particularly in conjunction with the uncuffed tube, this led to lethal crusting and drying of the tracheobronchial mucosa in several patients. When the output of a Walton humidifier (not heated) was directed into the piston intake, the air delivered by the respirator had a relative humidity of 50–60 per cent and a temperature of 20°C.

When a Puritan “all purpose” heated nebulizer was connected midstream between piston and valve (fig. 1-2) and used with an oxygen

Fig. 1. Modification of Moerch-Mueller piston respirator: (1) cuffed tracheotomy tube; (2) heated midstream nebulizer; (3) oxygen; (4) location for aerosol attachment; (5) Beaver valve; (6) Wright ventilation meter and airway pressure gauge, and (7) magnetic safety exhaust valve.
TABLE 1. Performance of Nonbreathing Valves for Moerch Piston Respirator
Piston Stroke 1.5 Liters; Rate 20/Minute Cuffed Tube

<table>
<thead>
<tr>
<th>Valve</th>
<th>Entering Valve During Inflation</th>
<th>Leaving Expiratory Port of Valve During Inflation</th>
<th>Actual Tidal Volume of Patient's Lungs</th>
<th>Back-leak Through Valve into Piston During Exhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moerch (Test lung)</td>
<td>1250</td>
<td>100</td>
<td>1150</td>
<td>400</td>
</tr>
<tr>
<td>Moerch (Patient)</td>
<td>NS</td>
<td>NS</td>
<td>1000</td>
<td>300</td>
</tr>
<tr>
<td>Ruben (Test lung)</td>
<td>1250</td>
<td>0</td>
<td>1250</td>
<td>500</td>
</tr>
<tr>
<td>Ruben (Patient)</td>
<td>NS</td>
<td>0</td>
<td>1000</td>
<td>300</td>
</tr>
<tr>
<td>Rudolph (Test lung)</td>
<td>1300</td>
<td>300</td>
<td>1000</td>
<td>500</td>
</tr>
<tr>
<td>Emerson (Test lung)</td>
<td>1300</td>
<td>no expiratory port</td>
<td>1300</td>
<td>200</td>
</tr>
<tr>
<td>Beaver (BOC) (Test lung)</td>
<td>1300</td>
<td>0</td>
<td>1300</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Beaver (BOC) (Patient)</td>
<td>NS</td>
<td>0</td>
<td>1000</td>
<td>&lt;25</td>
</tr>
</tbody>
</table>

* Tested with Wright ventilation meters connected in both directions to all three ports simultaneously. Test lung: 5-liter rubber bag.
† With small piston strokes most expiratory valves close poorly, thus causing greater forward leak.

flow of 10 liters per minute (fig. 1-3), the gas delivered had a relative humidity of over 95 per cent, a temperature of 30-35°C, and an oxygen concentration of approximately 50 per cent. Equally satisfactory was the new Johns Hopkins midstream humidifier (not illustrated) which does not depend upon compressed oxygen.

Beaver Nonbreathing Valve (fig. 1-5). The original ball-valve was sturdy but leaked, had to be kept in the upright position, sometimes stuck in the inflation position (particularly when used with a non-leaking tube or with humidity), and did not allow collection of exhaled air. Therefore, several nonbreathing valves were tested (table 1). All but

TRACHEAL PRESSURE
MOERCH PISTON VENTILATOR
T. V. 500 mL.; R. 20/min.

![Ball Valve](Image1)

Mean P.
6.4 cmH₂O

![Beaver Valve](Image2)

Mean P.
6.3 cmH₂O

**Fig. 2.** Tracheal pressure curve with use of original ball-valve as compared to Beaver valve.
the Beaver valve (British Oxygen Company) caused back-leak into the piston tubing during exhalation, resulting in some rebreathing.

The Beaver valve, originally designed for the British Beaver respirator, is a disc-shaped, rubber leaflet valve. It showed essentially no forward or backward leak. It proved simple, easy to clean and sterilize, and reliable with continuous use of several days. After prolonged use, the rubber diaphragm must be replaced. It did not stick even in the presence of high humidity and it is not gravity dependent. It permits easy collection of exhaled air without leakage.

The airway pressure curve during the use of the Beaver valve is similar to that of the original ball-valve (fig. 2). The Beaver valve opens and closes easier and thus allows a slightly smoother inflation and a more rapid pressure drop during exhalation. For tidal volumes under 100 ml (small children) we recommend a “leaking” technique to permit a piston stroke large enough for closure of the expiratory valve. This is more critical with the ball-valve than with the Beaver valve.

Registration of Tidal Volumes and Airway Pressures. The original model of the respirator did not permit such monitoring, since the volume reading at the piston shaft did not reflect tidal volume because the piston housing and the ball-valve leaked. Therefore, the Beaver valve was substituted and a Wright ventilation meter connected to its expiratory port (fig. 1-6). The Wright ventilation meter should not remain attached for prolonged periods since it may become damaged by exhaled moisture.

Tidal volumes should be recorded during exhalation; when recorded during positive pressure inflation, air leaks at the tracheostomy tube introduce a greater error.

The aneroid pressure gauge (+60, −10 cm. of water) was connected to the tubing between the Beaver valve and the tracheostomy tube (fig. 1-6). Simultaneous registration of pressure and volume facilitated prompt recognition of increased pulmonary resistance, which usually could be corrected simply by suctioning.

Safety Exhaust Valve. A magnetic exhaust valve at the piston housing was substituted for the original exhaust valve which proved unsatisfactory (fig. 1-7). Before the respirator was connected to the patient, the exhaust valve was adjusted (during occlusion of the delivery tube) to prevent exceeding a peak pressure (e.g., 40–60 cm. of water). Changes of rate and volume required re-adjustment of the valve.

Summary. The use of the Moerch piston respirator was made more satisfactory with a non-leaking system (cuffed tracheotomy tube); a heated midstream nebulizer; a Beaver nonrebreathing valve with a Wright ventilation meter and an airway pressure gauge; and a safety exhaust valve.

Following the experiences described here the manufacturer introduced an improved model which includes a heated humidifier and some other modifications.

References