intraspinal pressure) certainly must be considered. Our patient had no further diagnostic work-up (i.e., magnetic resonance imaging, computed tomography–myelogram, cerebral-spine x-ray) because his symptoms never returned. We would concur with Vandam that if the patient's symptoms recurred, further diagnostic work-up would be indicated.

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**Airway Management with a Special Tube in an Infant with Bronchial Obstruction**

To the Editor.—In the case of increased pulmonary blood flow associated with congenital cardiac defects, dilation of pulmonary artery may compress the airway, causing airway stenosis.1–3 In such a case, positive pressure ventilation may lead to hyperinflation of the lung beyond the stenosis.1 We present a case of an infant in whom bronchial stenosis was successfully managed by use of a specially configured tube that served as a stent for a segment of collapsed bronchi.

Our male patient was delivered vaginally at 39 weeks gestational age, with a birth weight of 3,000 g. Immediately after delivery, he presented with severe respiratory distress and cyanosis, and his trachea was intubated. Echocardiography resulted in a diagnosis of corrected transposition of the great arteries, pulmonary atresia, ventricular septal defect, patent ductus arteriosus, and right aortic arch. Fiberoptic bronchoscopy (FB) indicated stenosis of the right main bronchus (RMB), with compression by the dilated aorta possibly contributing to the stenosis.

When the child was 8 days old, aortosternotomy and left modified Blalock-Taussig shunt were performed, but they failed to relieve stenosis of RMB and hyperinflation of the right lung. An endotracheal tube tried as a stent4 was unsatisfactory because it did not permit ventilation of the left lung and obstructed the orifice of the right upper lobe bronchus. We therefore created two elliptical openings in the lateral wall of a 3-mm tube. The orifice for ventilating the left lung was located 1.5–4 cm from the distal tip of the endotracheal tube. A second orifice for ventilation of the right upper lobe bronchus was created on the contralateral side of wall of the tube. It was at the distal tip of the tube with a long axis of 1 cm and short axis of 2 mm. This modified tube was positioned with the distal tip within the RMB. Correct positioning was confirmed with FB and chest x-ray.5 Hyperinflation of the right lung was reduced and PaCO2 could be maintained within normal range with lower inspiratory pressures than possible with tracheal intubation.

The risk of using a customized tube included the possibility of airway damage due to roughened surface of the tube where the added orifices were located. We smoothed the cut area using very fine sand paper and then tetrahydrofuran.

In conclusion, we treated a case of bronchial compression caused by a dilated aorta. The airway management was difficult and positive inspiratory pressure led to hyperinflation of the distal lung. Various therapies failed to improve the condition, and a customized tube, which could stent the compression, enabled us to manage ventilation successfully.

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**Spontaneous Ventilation Through Transtracheal Access**

To the Editor.—We read with interest the article by Dallen et al.4 We encountered a similar case more than 27 yr ago that was successfully treated by using two 14-G thin-wall intravenous needles. Subsequently we constructed two types of trocar (9- and 12-G) (fig. 1), which remain...
The Work of Breathing Through Large-bore Intravascular Catheters

To the Editor—We were fascinated by the case report of Dallen et al., illustrating that spontaneous ventilation is possible via a large-bore intravascular catheter. They point out that there are few studies of spontaneous ventilation through such small-diameter devices. We recently undertook a study assessing such devices measuring the impact to respiration in terms of the additional work of inspiration. The study involved a lung model with sinusoidal wave pattern, simulating spontaneous ventilation as described by Chan et al. Using simultaneous measurements of airway pressure and respiratory flow gas at the proximal end of the artificial airway, the additional work (W) was derived using the algorithm described by Engstrom and Norlander:

\[ W = \int P \cdot \dot{V} dt \]

where \( P \) = airway pressure monitored in the mouth (kPa) and \( \dot{V} = \) instantaneous respiratory flow rate (L/s).

Table 1 summarizes some of our findings. Assuming the normal work of inspiration of a resting adult is on the order of 400–500 mL/l, the results suggest that the patient ventilating through the 14- and 12-G catheters would need to sustain an additional inspiratory burden of 350–400% and 250–350% of the normal work of inspiration, respectively. The extra inspiratory workload may be more significant in acute rather than chronic obstruction. However, from the lung model must be extrapolated with caution to the clinical population, and must be interpreted in the context of the degree of upper airway obstruction, to its onset (acute or chronic) and change in pattern of ventilation as a consequence of adaptation. We agree with Dallen et al. that there are no studies looking at the flow characteristics or ventilatory parameters for adults breathing through such devices.

**Table 1. The Effect of Catheter Diameter on the Additional Work of Breathing**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>12-G</th>
<th>14-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_a )</td>
<td>316</td>
<td>1349</td>
</tr>
<tr>
<td>( T_e )</td>
<td>69</td>
<td>1658</td>
</tr>
<tr>
<td>( W ) (mL/l)</td>
<td>-0.03</td>
<td>-0.11</td>
</tr>
<tr>
<td>( \dot{P} ) (kPa)</td>
<td>-4.06</td>
<td>-1.72</td>
</tr>
</tbody>
</table>

Work (W) expressed as additional inspiratory work per breath per liter of total ventilation. Simulated spontaneous respiration at 16 breaths per min with a tidal volume of 530 mL. \( T_a \) = adult 8.0-mm internal diameter (ID) and \( T_e \) = 5.0- and 4.0-mm ID pediatric tracheostomy tubes, respectively. 14-G (Abbocath) and 12-G (Medicut) refer to the sizes of the intravascular catheter respectively. \( \dot{P} \) = the maximum pressure change attained during the inspiratory cycle.

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