Title: RELATIVE PERFORATING POTENTIAL OF CENTRAL VENOUS CATHETERS: EFFECT OF NUMBER OF LUMENS

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Introduction. A well-described complication of central venous catheters (CVCs) is perforation of the superior vena cava or the right atrium or ventricle, which results in cardiac tamponade or hydro- or hemotorax. 1 Angle of incidence and material of construction have been shown to play key roles in perforating potential of catheters. 2, 3 To date there exists no data regarding the potential for perforation in relation to the number of lumens a catheter has. This becomes an important question in view of the increased use of multi-lumen catheters. Therefore, in an in-vitro model of a simulated pulsating vessel wall, we studied the relative effect of number of lumens on perforating potential of 5-Fr polyurethane CVCs.

Materials and Methods. A catheter testing chamber consisting of a 37°C water bath and a water-filled cylinder separated from a main chamber by a 12.7-micron polyethylene membrane (simulated vessel) was used (Fig.). A 12-mm Hg pulsation pressure created in the water-filled cylinder caused the polyethylene membrane to bulge 3 mm into the main chamber. Five each of 5-Fr polyurethane (Cook) catheters with 1, 2, or 3 lumens were tested five times (25 runs/catheter type). Each catheter was fixed 15 cm from its tip within a 1-cm-ID support tube; the CVC tip extended 1 cm beyond the end of the support tube and was approximated to within 1 mm of the simulated vessel. Pulsations of 80/min with a duty cycle of 30% were created in the water-filled cylinder, which caused the simulated vessel to pulse (bulge) against the tip of the catheter. The catheter was placed at an incident angle of 90° to the membrane. Perforation of the simulated vessel by the catheter was recorded on a strip chart record as a pressure drop in the water-filled cylinder. Some catheters did not perforate the simulated vessel in 33,600 pulsations (7 h), which was used as an arbitrary endpoint. After each run, a new polyethylene membrane was used. Data were analyzed by ANOVA, P < 0.05 being considered significant.

Results. Perforation of the simulated vessel resulted from significantly fewer pulsations with the triple-lumen catheter than with the single- or double-lumen ones (Table).

Discussion. Although a CVC would never purposely be positioned at a 90° angle to a vessel wall, we specifically used this angle to obtain the worst-case estimate of the relative number of pulsations required to perforate a simulated pulsating vessel wall and to identify differences between catheter types. The clinical implication of our data is that, in choosing a CVC to minimize relative perforating potential, there is a measurable benefit in using a single-lumen catheter compared with multiple-lumen ones when it is clinically acceptable. Our findings probably reflect both the manufacturing process, which requires a firmer plastic in order to extrude a multi-lumen catheter, and the septation required to create multiple lumens, both factors increase stiffness of the catheter.

References

![Diagram](http://example.com/diagram.png)

**FIG.** Test chamber used to study the effect of number of lumens of a catheter on its potential to perforate a pulsating vessel wall, simulated by a polyethylene membrane.

**TABLE.** Effect of Number of Catheter Lumens on Perforating Potential of 5-Fr Polyurethane Central Venous Catheters

<table>
<thead>
<tr>
<th>Pulsations to Perforation (n)</th>
<th>Single</th>
<th>Double</th>
<th>Triple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumen</td>
<td>Lumen</td>
<td>Lumen</td>
<td>Lumen</td>
</tr>
<tr>
<td>Mean</td>
<td>31,587*</td>
<td>1,149</td>
<td>4.0</td>
</tr>
<tr>
<td>SD</td>
<td>± 7,254</td>
<td>± 2,034</td>
<td>± 4.5</td>
</tr>
<tr>
<td>Range</td>
<td>1,440-33,600</td>
<td>32-9,007</td>
<td>1-24</td>
</tr>
</tbody>
</table>

*P < 0.001 compared with double- and triple-lumen catheters.