Construction of hydraulic cuff occluders for blood vessels

ARTIN A. SHOUKAS
Department of Biomedical Engineering, School of Medicine, The Johns Hopkins University,
Baltimore, Maryland 21205


or Am. J. Physiol.: Heart Circ. Physiol. 1(1): H99-H100, 1977. —This report describes the construction technique for a simple and inexpensive cuff occluder for various size blood vessels. The occluder is made from polyvinyl chloride tubing and consists of two main parts, the balloon and catheter section, and the reinforcing back section. The occluders have functioned reliably in chronic dog preparations for up to 3 mo.

cuff occluder; blood vessels; polyvinyl chloride

WITH THE WIDESPREAD USE of chronic animal preparations in recent years it has become necessary to implant reliable occlusive devices to control blood pressures and flows. Most of the occluders previously described have a number of different materials in the same occluder and it takes a considerable amount of time and skill to manufacture them (2, 3). This communication describes the construction technique for a simple reliable cuff that can be made to fit any size blood vessel using ordinary laboratory-grade polyvinyl chloride tubing. The entire cuff consists of two main parts, a balloon catheter and a reinforcing backing, and can be made in less than 45 min without any particular skill.

The balloon-catheter section is made from a single piece of polyvinyl chloride tubing (Tygon, Norton Company, Plastics and Synthetics Div.). Table 1 shows the appropriate tubing size and the form size to be used for small-to-medium size vessels as well as for large size vessels. The method to make the balloon on the end of the tubing is modified from the technique used by Debley (1), in which the end of a piece of polyvinyl tubing is immersed in 90-95°C water and then the tube blown up until an appropriate size bubble forms. This method is not entirely satisfactory in that little control can be exerted over the final dimensions of the bubble that is formed. To circumvent this problem, a piece of glass tubing, which serves as a mold, is used to control the external diameter and length of the balloon, as shown in Fig. 1. As a simple criterion for the length, I use twice the flat width of the balloon. The backing section is then split and two holes that are equal to the outside diameter of the tube are bored on either side of the slit.

The balloon is then slipped through the two holes and cemented in place, as shown in Fig. 3. The cement can be easily made from equal parts by volume of cut pieces of polyvinyl tubing mixed with cyclohexanone (Fisher Scientific Co.). Adequate ventilation should be provided during the cementing because inhalation of cyclohexanone may be hazardous. Only a small drop of cement should be used at the two holes to join the two sections. In addition, a very thick coating of cement around the inner circumference of the backing holds the balloon in place. Care should be taken during the cementing pro-

---

TABLE 1. Dimension sizes for tubing and form

<table>
<thead>
<tr>
<th>Tube Size, in.</th>
<th>Form Diameter, in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-to-medium blood vessels</td>
<td>1/16 ID, 1/8 OD, 1/32 wall</td>
</tr>
<tr>
<td>Large blood vessels</td>
<td>3/16 ID, 3/16 OD, 1/32 wall</td>
</tr>
</tbody>
</table>
FIG. 1. Illustration of balloon form with plug and tube in place prior to expansion (bottom), and completed balloons (top).

FIG. 2. Various sizes of backing section and diagram of placement of holes for balloon and closure.

FIG. 3. Diagram of final cuff occluder showing attachment of balloon and backing and examples of two different size cuffs. The larger, partially inflated cuff has an internal diameter of 3/4-in. ID.

After the unit has dried completely, in approximately 24 h, an additional four holes are bored near the slit opening with a blunt 20-gauge needle, to allow for closure of the cuff around the vessel (see Fig. 2). In the larger cuffs two pieces of 1/8-in. umbilical tape, approximately 10 in. long, are coated near the center with the cement and allowed to dry. These two tapes are later cemented to the outer circumference of the cuff with additional cement. In the larger cuff this not only serves to keep the cuff closed but also serves as an additional backing support for the cuff when the cuff is used on large arteries or the aorta.

The unique feature of these cuffs is that they can be made cheaply and easily without specialized equipment. In addition, I have found these cuffs to be highly reliable in controlling blood pressures and flows in chronic dogs for periods exceeding 3 mo.

Received for publication 29 April 1976.

REFERENCES