POSITIONING CENTRAL VENOUS CATHETERS THROUGH THE BASILIC VEIN
A Comparison of Catheters

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SUMMARY

The frequency of reliable central venous pressure measurements from the percutaneous cannulation of a central vein through the basilic vein was 52.8% using a Bardic I-catheter and 77.7% using an Abbott Drum-Cartridge catheter. For catheterization of the superior vena cava or the right atrium, 85.7% of catheters inserted through the subclavian vein could be positioned satisfactorily compared with 39.6% of I-catheters and 70.3% of Drum-Cartridge catheters passed through the basilic vein.

Percutaneous catheterization of central veins is widely practised. Measurements of central venous pressure require that the catheter tip lies in a large intrathoracic vein, preferably the superior vena cava. The estimation of central venous oxygen saturation or tension requires that blood samples be drawn from the superior vena cava or right atrium (Theye and Tuohy, 1965; Goldman, 1968), and for the aspiration of air emboli the catheter tip should lie in the right atrium (Michenfelder et al., 1966).

Most commonly the basilic or cephalic vein or one of their tributaries near the antecubital fossa is cannulated. This is an easy technique without risk of major complication. However, because cannulation through an arm vein is not a sufficiently reliable method for positioning a central venous catheter, more complex, and potentially more hazardous, methods have been developed.

At the time of this study the subclavian vein approach has been advocated because of its higher success rate in the cannulation of central veins (Yoffa, 1965; Defalque, 1968). This study compares the effectiveness in “blind” placement of two types of central venous catheter through a vein in the antecubital fossa with that through a subclavian vein.

METHOD

Patients were distributed randomly between catheterization through an antecubital fossa vein or a subclavian vein. The majority of the patients were undergoing cardiac surgery, the remainder were undergoing neurosurgery, general surgery or intensive care.

Bardic I-catheters and Abbott Drum-Cartridge catheters were used for cannulation through the antecubital fossa veins. A medially placed vein, either the basilic or one of its tributaries, was punctured.

Figure 1 shows the two types of catheter used. The Bardic I-catheter is of the “catheter-through-needle” type with a 14-gauge steel needle. The catheter is a straight 24-in. length of plastic tubing with a polypropylene stilette. The Abbott Drum-Cartridge is also of the “catheter-through-needle” variety with a 14-gauge steel needle. The catheter is 28 in. long, is made of polyvinyl chloride and is wound tightly on a drum which gives the catheter a natural curvature; the stilette is of stainless steel and only extends to within 2.5 cm of the catheter tip.

For subclavian vein cannulation the supraclavicular approach was employed (Defalque, 1968). Only the Bardic I-catheter was used at this site.

The catheter was inserted until an appropriate length of catheter had been passed or until the catheter was held up. Those catheters in which insufficient length had been passed to enter the thoracic cavity were deemed unsatisfactory and removed. The catheter was judged to be satisfactorily placed if the following criteria obtained: the passage of an appropriate length of catheter to enter the chest cavity; easy injection; easy aspiration of blood; free oscillations with respiratory movements. The ability to aspirate blood freely was considered essential. If this did not occur the catheter was slowly withdrawn until blood flowed freely on aspiration. Some catheters had to be withdrawn up to 15 cm
in order to obtain a free flow of blood on aspiration. This was probably due to kinking or curling of the catheter or passage of the catheter to a peripheral vein in the contralateral arm. In these instances the catheter was re-advanced and aspiration repeated. Occasionally a free flow of blood could be obtained only when the length of catheter was just within the chest cavity.

The majority of catheterizations were performed by the authors, but a few were carried out by registrars supervised by one of the authors.

After insertion of the catheter an antero-posterior radiograph was taken with the patient in the recumbent position. The position of the catheter tip was ascertained from the chest radiograph. Each radiograph was scrutinized by one of the authors (W.S.N.) and, in difficult cases, by a consultant radiologist. The catheter tip positions were then classified (table I).

RESULTS

189 patients had 249 catheterizations. Table I shows the final position of the catheter tip in relation to the site of introduction and the type of catheter.

Basilic vein route.

(a) I-catheters. The introduction of the catheter from the right or left arm made no difference to the overall distribution of sites in which the catheter tip ended. However, in the case of the tip ending in the innominate vein, of those introduced through the left arm 10.4% ended in the left innominate vein, whilst of those introduced through the right arm only 2.8% ended in an innominate vein. Sixteen (15.1%) catheters ended in veins remote from the central veins; eleven ended in the axillary vein including one catheter which passed through to the contralateral axillary vein; four in the brachial and superficial neck veins and one in the azygos vein.
TABLE I.  Position of catheter tips.

<table>
<thead>
<tr>
<th>Final position of catheter tip</th>
<th>I-catheter (Right)</th>
<th>I-catheter (Left)</th>
<th>Subclavian vein, I-catheter (Right)</th>
<th>Subclavian vein, I-catheter (Left)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary vein</td>
<td>7</td>
<td>2</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Subclavian vein</td>
<td>11</td>
<td>11</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Internal jugular vein</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Innominate vein</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Superior vena cava</td>
<td>15</td>
<td>12</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Right atrium</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Right ventricle</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other veins</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>48</td>
<td>58</td>
<td>106</td>
<td>100%</td>
</tr>
</tbody>
</table>

The differences between the results of the I-catheter through the basilic vein, the Drum-Cartridge catheter through the basilic vein and the I-catheter through the subclavian vein are all significant (P <0.001) except between the Drum-Cartridge catheter through the basilic vein and the I-catheter through the subclavian vein in groups B and D.

(b) **Drum-Cartridge catheter.** Introducing the catheter from the right or left arm made no difference to the final position of the catheter tip. Three (3.2%) catheters entered a remote vein. Two of these ended in the axillary vein, one passing through to the contralateral axillary vein, and one ended in the cephalic vein having turned back on itself.

**Subclavian vein route.**

(a) **I-catheter.** Following puncture of either the right or left subclavian vein the catheter tip consistently ended in either the superior vena cava or the right atrium except for one catheter which went outside the thoracic cavity into a superficial cervical vein. Pneumothorax was inadvertently produced in two cases (4.1%). In both these cases the pneumothorax resolved without serious sequelae.

**DISCUSSION**

The final catheter tip positions have been placed into groups A to D (table II) in order to compare the reliability of the two sites of introduction and the two types of catheter when central venous cannulation is needed for a specific purpose.

Catheters with their tips lying outside the thoracic cavity (D in table II) are unsuitable for any central venous measurements. In the case of the basilic vein route 15.1% of I-catheters fell into this category compared with 3.2% with the Drum-Cartridge catheter and 2% of I-catheters passed through the subclavian vein. Most of the catheter tips lying outside the thoracic cavity were in an ipsilateral axillary vein. The Drum-Cartridge catheter appeared more successful in negotiating the narrows of the axillary vein (2.1% in the axillary vein) than the I-catheter.
(10.4% in the axillary vein). This difference may be attributed to the Drum-Cartridge catheter possessing a more flexible catheter, no stilette in the terminal portion of the catheter and an intrinsic curvature imparted from being wound in a drum. McMahon (1973) has shown the first two factors to be important in helping the Drum-Cartridge catheter to negotiate acute angles.

Reliable central venous pressure measurements can be expected when the catheter tip lies in the innominate veins, the superior vena cava or the right atrium. Catheters ending in the right ventricle may also be included (A in table II) since this is easily recognized by the relatively high pressure or, if a record is available, the appearance of a ventricular trace. Withdrawing the catheter brings the tip into the right atrium or superior vena cava.

When the basilic vein route was used with the I-catheter 52.8% of catheters were in the innominate veins, superior vena cava or right atrium, compared with 77.7% with the Drum-Cartridge catheter and 93.9% when the subclavian route was used.

These results with the Bardic I-catheter passed through the basilic vein compare closely with those of Langston (1971) using a 24-in. Bardic I-catheter of smaller calibre (16-gauge) passed through an arm vein. He found that 65.4% of the catheter tips were in the superior vena cava, innominate veins or right atrium.

However, Johnston and Clark (1972) in a series of 73 cannulations also using a 14-gauge Bardic I-catheter reported the much higher incidence of 77.9% of catheters reaching these positions. This is very close to the figure achieved by us with the Drum-Cartridge catheter. No obvious explanation can be offered for the differences between their results and ours.

If the internal jugular and subclavian veins are also considered satisfactory for central venous pressure measurements, we achieved satisfactory placement of catheter tips at a rate of 84.9% with I-catheters, 96.8% with Drum-Cartridge catheters passed by the basilic vein and 98% with I-catheters passed through the subclavian vein (B in table II).

If it is essential to cannulate the superior vena cava, the right atrium or the right ventricle for estimations of central venous oxygen levels or for the aspiration of an air embolus, then the basilic vein approach is more certain (85.7%) than basilic vein cannulation with the I-catheter (39.6%) but not substantially better than the Drum-Cartridge catheter through the basilic vein (70.3%) (C in table II).

When choosing a technique of cannulation its inherent safety is an important consideration. Usually the basilic vein or its main tributaries are easily visible and palpable on the medial side of the antecubital fossa so that cannulation is easy. Furthermore, no vital structure lies in close relation to it. The subclavian vein is neither visible nor palpable and puncture of this vein is a blind procedure. Pneumothorax is a possible complication and an incidence of up to 5% is reported (Defalque, 1968; Walker and Sanders, 1969).

The results of this study suggest that the basilic vein approach is the method of choice for placing catheters for central venous pressure measurements. The subclavian vein and other routes should be considered only when catheterization through the arm veins is impossible or has failed. The Abbott Drum-Cartridge catheter is a significant improvement giving more “correct” placements than the Bardic I-catheter in this series.

This study also supports the view that clinical criteria of correct placement cannot be relied upon (Langston, 1971; Kellner and Smart, 1972; Johnston and Clark, 1972) and that radiological examination to locate the catheter tip is desirable.

**ACKNOWLEDGEMENTS**

Valuable advice and assistance were given by Professor W. W. Mushin, C.B.E., and Dr G. Tipton Davies, M.R.C.P., F.F.R.

**REFERENCES**


