Anesthesiology
72:55–58, 1990

# *Central Venous Cannulation Using the Infraclavicular Axillary Vein*

*Bruce L. Taylor, B.S., F.F.A.R.C.S.,* Ian Yellowlees, B.A., M.B.Ch.B.†*

**A new percutaneous approach to central venous catheterization was recently described which seemed to offer advantages over others commonly used. To evaluate the technique, it was successfully used in 102 consecutive patients for monitoring, drug infusion, pulmonary arterial catheterization, and parenteral nutrition. There was a low incidence of complications, the most frequent being arterial puncture. The results confirm that this is an effective and relatively safe technique that deserves consideration in patients who require central venous catheterization. (Key words: Veins: axillary; cannulation.)**

THE NUMEROUS METHODS of central venous catheterization and their associated complications have been well summarized.[1] Nickalls[2] described a technique using the infraclavicular axillary vein, which, despite being tried in only a small number of patients, seemed to offer advantages over other routes. In this report we describe our experience with a modified version of the original technique.

## Methods

The technique was used in 102 consecutive patients in whom central venous catheterization was clinically indicated. Patients were placed supine with head-down tilt, and the arm was abducted to 45 degrees. In this position the axillary vein follows a straight course from the arm to the subclavian vein. The lateral landmark (A) was located by measuring a distance of three finger's breadths or 5 cm (in the adult) below the lower margin of the coracoid process (C) and the medial landmark (B) by the junction of the medial one-fourth and lateral three-fourths of the clavicle. The approximate position of pectoralis minor (D) was outlined from its origin, the third to fifth ribs anteriorly, to its insertion, the coracoid process (fig. 1). This muscle divides the underlying axillary vein into its three anatomical parts.

With the usual sterile preparations, and after infiltration with local anesthetic, the skin was entered at point A with the needle directed medially and posteriorly in the direction of the line A, B to pierce and traverse the pectoralis minor muscle, and to enter the axillary vein in its anatomical first part medial to the muscle border (fig. 2). Because the structures most vulnerable to damage are located superior to the vein, the advancing needle was aimed "low" initially, progressing further cephalad in a fanwise manner. In thin individuals the pulsation of the infraclavicular axillary artery was sometimes palpable, offering a useful guide to the position of the vascular bundle. When continuous aspiration of the syringe plunger was applied, the point of entry into the vein was usually clear. Cannulation was facilitated if the arm was placed on a support to prevent traction on the pectoral muscles and clavipectoral fascia, which presumably tended to flatten the vein. A Seldinger wire method was used in all cases.

It should be emphasized that the point of entry to the axillary vein is, by definition, lateral to its continuation as the subclavian vein at the outer border of the first rib; for practical purposes, this means that the tip of the needle must not be advanced beneath the clavicle. If this occurs, subclavian vein catheterization is being attempted, and the advantages of the axillary approach will be lost. However, once the vein is located, the subsequent insertion method is essentially the same as for subclavian catheterization. The catheters were secured by suturing, and their position was confirmed radiologically.

## Results

Cannulation was attempted in 102 patients, and was successful in 98. The left side was used in 85 patients. The majority of the catheters were inserted for either monitoring or iv nutrition in intensive care (46 patients), but a number were also used for perioperative fluid management, chemotherapy, and long-term total parenteral nutrition. In eight patients a pulmonary artery catheter was inserted, and in 39 patients triple-lumen catheters were used, the remainder being single-lumen. Sixty-eight cannulations were performed in patients under general anesthesia, usually during controlled ventilation. Although the majority of the patients were adults with a wide range of weight and build, two 25-kg children were also included, one of whom required a multiple-lumen catheter for monitoring and iv feeding.

In four cases the vein could not be cannulated (table 1). Two of these occurred early in the series before the importance of having the arm supported was appreciated. The other failures were in a morbidly obese patient weighing 140 kg and in a patient with severe preeclampsia

* Senior Registrar.

† Senior House Officer.

Received from the Department of Anaesthetics, Royal Devon & Exeter Hospital, Exeter, England. Accepted for publication August 25, 1989.

Address reprint requests to Dr. Taylor: Intensive Care Unit, Royal Children's Hospital, Flemington Road, Parkville 3052, Victoria, Australia.

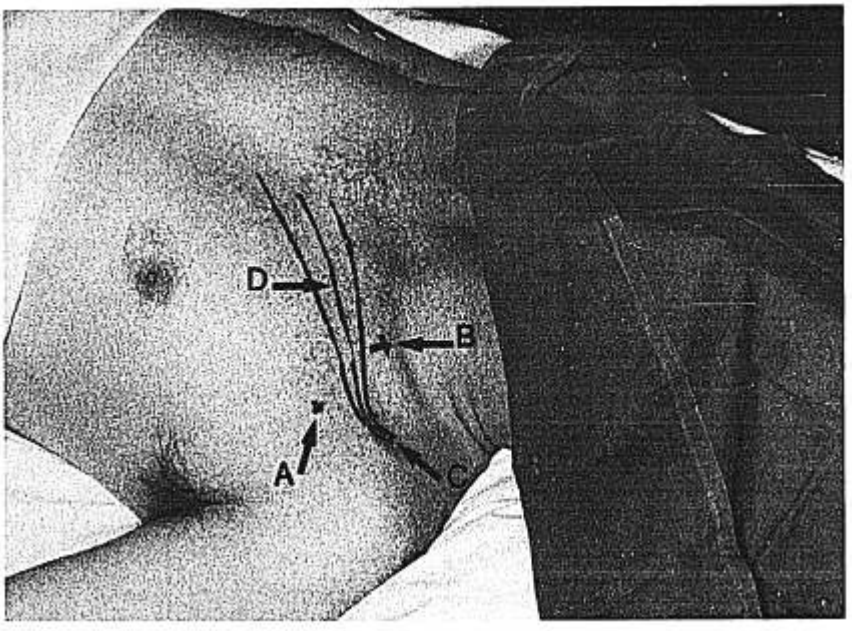


FIG. 1. Patient positioned for axillary venous catheterization. A = lateral landmark; B = medial landmark; C = coracoid process of scapula; and D = pectoralis minor muscle.

in whom the combination of breast tissue enlargement and edema made estimation of the depth of the vein impossible. Central venous access was achieved by alternative routes in all four cases. Two other cases required a second attempt on the opposite side. One of these was a woman with bilateral infraclavicular skin scarring and tethering secondary to childhood chronic infection; the vein was located approximately 1 cm higher than expected.

Arterial puncture occurred in five cases, three of these when performed by trainees under supervision (table 1). Two of these patients suffered transient paresthesia in the arm that resolved when the needle was withdrawn. In each case firm direct pressure was applied for 5 min, and there were no arterial sequelae or significant hematoma formation. In all but one of these the vein was subsequently catheterized easily. No pneumothoraxes were caused when the original technique was adhered to, but on one occasion when a trainee was unable to locate the vein in a small patient, an attempt at subclavian cannulation was made through the same entry point. During this procedure the patient began coughing, and a subsequent radiograph confirmed a pneumothorax. Extravas-

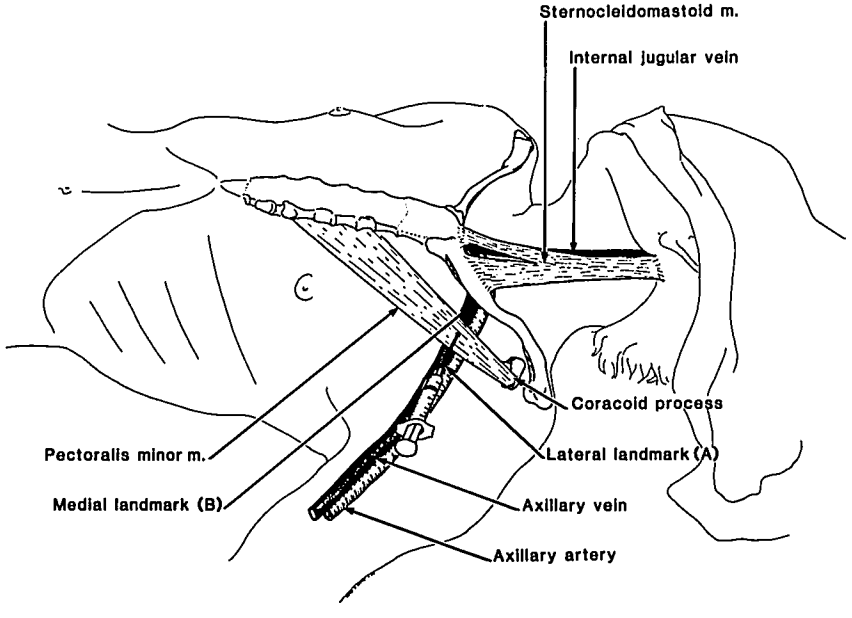


FIG. 2. Illustration of landmarks, anatomical features, and route of insertion of needle.

TABLE 1. Complications of Axillary Venous Catheterization

| Complication | N |
|---|---|
| Failed cannulation | 4 (3.9) |
| Catheter malposition | 6 (5.9) |
| Arterial puncture | 5 (4.9) |
| Transient paresthesia | 2 (2) |
| Pneumothorax | 1 (1) |
| Extravascular placement | 0 (0) |

The total number of cases was 102; values in parentheses are percentages.

cular placement did not occur. In six patients the catheter turned up into the internal jugular vein (table 1). Three of these were repositioned using a J-wire technique, and in the others the position was considered suitable for short-term iv nutrition. The site of the hub was acceptable to most conscious patients, and the nursing staff favored this position over the position of the hub following internal jugular vein cannulation because of the relative ease of fixation and dressing. Some ambulatory patients found that the hub caught on clothing and that the attachment of infusion tubing interfered with arm movement, but no catheters came out unintentionally. Specific records of sepsis were not kept.

## Discussion

The internal jugular vein and subclavian vein routes are those most commonly used for gaining central venous access, but both have their complications and disadvantages.[3-8] Fixation can be a problem with cannulas placed in the neck, particularly in males because of beard growth. The subclavian route allows more convenient and comfortable fixation, but its higher incidence of pneumothorax, notably in critically ill patients during intermittent positive pressure ventilation, is a deterrent for using it. Use of the infraclavicular axillary vein should, in theory, be a safer alternative. Axillary venous cannulation has been advocated previously[9-11] but these techniques have not been widely adopted. Nickalls[2] indicated that the infraclavicular technique was practicable and that the landmarks, although obtained from a single cadaver dissection, seemed reliable. Our experience confirms these observations, although to allow for variations in the size of the patient we modified the technique by using a distance below the coracoid process based on the patient's own anatomical characteristics, and we suggest the use of a distance equivalent to the breadth of three of the patient's (rather than the operator's) fingers. The overall success rate of 96% is similar to those for subclavian catheterization of 95.5% (Mogil *et al.*[12]), and 98.8% (Defalque[13]), and internal jugular catheterization of 94.8% (English *et al.*[14]), and 98% (Rao *et al.*[15]). The risk of pneumothorax is small if the correct technique is followed and if Nickalls' recommendation[2] that the needle tip is kept caudal to the clavicle is adhered to. The single pneumothorax in our series occurred after attempting to convert to a subclavian catheterization. Even if included, the incidence of this complication (1%) compares favorably with the rates of 1.7% (Ryan *et al.*[16]), 2.93% (James and Myers[17]) (infraclavicular approach), and 4.7% (Christensen *et al.*[18]) (supraclavicular approach) for subclavian catheterization, and it is similar to that seen when the internal jugular vein is cannulated via a relatively caudad position.[14,15] Lower rates have been achieved by some authors.[19-21]

Our experience suggests that if a decision is made to proceed with subclavian catheterization, it should not be attempted by advancing the needle beneath the clavicle from the original skin entry site. A conventional method should be used after appropriate repositioning and preparation of the patient. Our incidence of arterial puncture was higher (5%) than the 3% reported when the internal jugular vein is approached from a position low in the neck but considerably less than the 11%[22] and 30%[23] reported using a high approach to the internal jugular vein. Although this caused us some concern, there were no complications related to it, and unlike the subclavian artery, direct pressure can be applied to the axillary artery. Any significant bleeding should be obvious and, if necessary, relatively accessible surgically. When arterial puncture did occur, retrospective assessment of the landmarks usually showed that the needle was initially directed too far cephalad, suggesting that the incidence might be reduced. Palpation of the axillary artery in the axilla can give some guide of the depth and height of the vascular bundle. The possibility of locating the vein accurately using Doppler ultrasound may be worth exploring.[24]

The 2% incidence of transient paresthesia compares favorably with the 20% occurrence of transient pain and paresthesia reported with proximal basilic or distal axillary vein cannulation.[9] The frequency with which paresthesia occurs during subclavian and internal jugular catheterization is uncertain, but in two series wherein the subclavian vein was cannulated, brachial plexus injury occurred (0.5% and 0.6%, respectively)[16,25]; presumably paresthesia uncomplicated by nerve damage occurs more frequently.

Catheter malposition occurred in 6% of catheterizations. Few authors give details of noncentral placement of catheters, but incidences of 6.2%[18] and 10%[26] have been quoted for infraclavicular subclavian insertion and 10%[11] for distal axillary insertion. In this context the right internal jugular and supraclavicular subclavian approaches are usually regarded as the most reliable, with malposition rates ranging from 0% to 6.5%.[15,27,28] It was encouraging that extravascular placement did not occur, but this may be attributable to the use of a Seldinger technique rather than to the approach itself.

One other possible advantage may be offered by the

necessity to traverse the pectoralis minor muscle obliquely, effectively "tunneling" the catheter. Although it remains controversial[29-31] that tunneling catheters reduces the incidence of infection, it does increase their longevity[29]; certainly, a number of ours were maintained for several weeks without complications.

Until familiar with the technique, the axillary vein was not located as easily or quickly as an experienced operator would expect to cannulate the internal jugular or subclavian vein. With experience, however, as with most practical procedures, a "feel" for the location is developed, and recently the method has been successfully used several times in resuscitation. As in the original series, our experience suggests that alternative approaches may be preferable in obese patients.

The authors wish to thank Dr. J. Searle, Professor C. Prys-Roberts, Dr. M. South, and Dr. J. Tibballs for their advice with the manuscript, and the Departments of Medical Photography of Bristol Royal Infirmary and the Royal Devon & Exeter Hospital for their assistance with illustrations and photographs.

## References

1. Rosen M, Latto IP, Ng WS: Handbook of Percutaneous Central Venous Catheterisation. London, WB Saunders, 1981, pp 35–129
2. Nickalls RWD: A new percutaneous infraclavicular approach to the axillary vein. Anaesthesia 42:151–154, 1987
3. Gamulin Z, Bruckner JC, Forster A, Simonet F, Rouge JC: Multiple complications after internal jugular catheterization. Anaesthesia 41:408–412, 1986
4. Morgan RNW, Morrell DF: Internal jugular catheterization: a review of a potentially lethal hazard. Anaesthesia 36:512–517, 1981
5. McGoon MD, Benedetto PW, Greene BM: Complications of central venous catheterization: A report of two cases and review of the literature. John Hopkins Med J 145:1–6, 1979
6. Defalque RJ: Fatal complication of a subclavian central venous catheter. Can Anaesth Soc J 18:681, 1971
7. Childs D, Wilkes RG: Puncture of the ascending aorta—a complication of subclavian venous cannulation. Anaesthesia 41:331–332, 1986
8. Hirsch NP, Robinson PN: Pulmonary artery puncture following subclavian venous cannulation. Anaesthesia 39:727–728, 1984
9. Spracklen FHN, Neische F, Lord PW, Beterman EMM: Percutaneous catheterisation of the axillary vein. Cardiovasc Res 1: 297–300, 1967
10. Ayim EN: Percutaneous catheterization of the axillary vein and the proximal basilic vein. Anaesthesia 32:753–759, 1977
11. Gouin F, Martin C, Saux P: Central venous and pulmonary artery catheterisation via the axillary vein. Acta Anaesthesiol Scand 81(suppl):27–29, 1985
12. Mogil RA, Delaurentis DA, Rosemond GP: The infraclavicular venepuncture. Arch Surg 95:320–324, 1967
13. Defalque RJ: Subclavian venipuncture: A review. Anesth Analg 47:677–679, 1968
14. English ICW, Frew RM, Piggot JF, Zaki M: Percutaneous catheterization of the internal jugular vein. Anaesthesia 24:521–531, 1969
15. Rao TLK, Wong AY, Salem MR: A new approach to percutaneous catheterization of the internal jugular vein. ANESTHESIOLOGY 46:362–364, 1977
16. Ryan JA, Abel RM, Abbott WM, Hopkins CC, Chesney TM, Colley R, Phillips K, Fischer J: Catheter complications in total parenteral nutrition. N Engl J Med 290:757–761, 1974
17. James PM, Myers RT: Central venous pressure monitoring: Complications and a new technic. Am Surg 39:75–81, 1973
18. Christensen KH, Nerstrom B, Baden H: Complications of percutaneous catheterization of the subclavian vein in 129 cases. Acta Chir Scand 133:615–620, 1967
19. Blackett RJ, Bakran A, Bradley JA, Halsall A, Hill GL, McMahon MJ: A prospective study of subclavian vein catheters used exclusively for the purpose of intravenous feeding. Br J Surg 65: 393–395, 1978
20. Yoffa D: Supraclavicular subclavian venepuncture and catheterization. Lancet 2:614–617, 1965
21. Jernigan WR, Gardner WC, Mahr MM, Milburn JL: Use of the internal jugular vein for placement of central venous catheters. Surg Gynecol Obstet 130:520–524, 1970
22. Vaughan RW, Weygandt GR: Reliable percutaneous central venous pressure measurement. Anesth Analg 52:709–716, 1973
23. Prince SR, Sullivan RL, Hackel A: Percutaneous catheterization of the internal jugular vein in infants and children. ANESTHESIOLOGY 44:170–174, 1976
24. Peters JL, Kenning BR, Garrett CPO, Kurzer M: Percutaneous central venous cannulation. Br Med J 281:618, 1980
25. Smith BE, Modell JH, Gaub ML, Moya F: Complications of subclavian vein catheterization. Arch Surg 90:228–229, 1965
26. Padberg FT, Ruggiero J, Blackburn GL, Bistrian BR: Central venous catheterization for parenteral nutrition. Ann Surg 193: 264–270, 1981
27. Fischer J, Lundstrom J, Ottander HG: Central venous cannulation: A radiological determination of catheter positions and immediate intrathoracic complications. Acta Anaesthesiol Scand 21: 45–49, 1977
28. Vazquez RM, Brodski EG: Primary and secondary malposition of silicone central venous catheters. Acta Anaesthesiol Scand 81(suppl):22–25, 1985
29. Moran KT, McEntee G, Jones B, Hone R, Duigan JP, M'Malley E: To tunnel or not to tunnel catheters for parenteral nutrition. Ann R Coll Surg Engl 69:235–236, 1987
30. Von Meyenfeldt M, Stapert J, De Jong P, Soeters PB, Wesdorp RIC, Greep JM: TPN catheter sepsis; lack of effect of subcutaneous tunneling of PVC catheters on sepsis rate. JPEN 5: 514–517, 1980
31. Royce C: To tunnel or not to tunnel catheters for parenteral nutrition (letter). Ann R Coll Surg Engl 70:59–60, 1988