Combined axillary plexus block and basal sedation for cardiac catheterization in young children

D. M. Ross¹ and D. O. Williams²

From the Departments of Anaesthesia and Cardiology, North Staffordshire Hospital Centre

A technique for the management of cardiac catheterization in children is described which combines axillary plexus block with basal sedation. The technique offers a quiet still arm with pronounced vasodilatation, permitting the use of larger catheters than usual, making sampling easier, and giving undamped pressure records.

These factors, together with the absence of venospasm, make catheterization of an arm vein in young children a feasible proposition; in addition arterial sampling via the brachial artery may be performed without further inconvenience to the child.

Cardiac catheterization in infants and young children presents problems in anaesthetic management which are not encountered in adults.

Numerous methods have been recommended for conducting this procedure in younger children. These may be broadly classified as:

- (1) Basal sedation. A wide variety of drug combinations have been used (Smith, 1950; Rees and Hay, 1959; Fieldman *et al.*, 1955; Keown *et al.*, 1957; Smith, Rowe, and Vlad, 1958; Carnegie, 1953; Feldman, Robbie, and Monro, 1961; Ordish and Mair, 1961).
- (2) General anaesthesia (Kepes, Livingston, and Escher, 1955; Keats *et al.*, 1958; Eggers, Stoeckle, and Allen, 1959; Norton and Kubota, 1960; Adams and Parkhouse, 1960).
- (3) Basal sedation and nerve block (Inglis, 1954; Eather, 1958; Eggers, Metzgar, and Plumlee, 1967).

Lee and Atkinson (1964) have stressed that cardiac catheterization, which is often performed in near darkness, requires that the child remain still for a prolonged period, that blood gases, especially O₂, should not be interfered with, nor the haemodynamics significantly disturbed. Moreover, they advised that non-explosive anaesthetics should be used in the presence of x-ray equipment. It is the purpose of this paper to describe a technique combining basal sedation with axillary plexus block, which fulfils the above

criteria, and to indicate some other advantages which this method offers.

Method

The children were sedated for one and a half hours before axillary plexus block. Any one of several drugs were used, e.g. Pamergan S.P.100 0.05 ml./kg., Omnopon 0.7 mg./kg., and promethazine 1.5 mg./kg., or the ataractic mixture used by Smith *et al.* in 1958, but we have found the most satisfactory form of sedation to be a combination of droperidol (0.3–0.6 mg./kg.) and Omnopon (0.7 mg./kg.) which we have used for the last 23 cases.

Some authorities have suggested reduced dosage for cyanotic children, whereas others (Lucas, 1958) comment on how refractory some cyanotic children are to basal sedation. It has been our experience that cyanotic children are extremely difficult to sedate satisfactorily, and we have therefore given a full dosage of premedicants.

Axillary plexus block was first described in 1911 by Hirschel. Various authorities (Pitkin, 1946; Burnham, 1959; De Jong, 1961) since then have modified his technique and we use Eriksson's method (1965). This involves the use of a venous tourniquet to prevent distal spread of the analgesic solution. Only one needle puncture is required.

The axillary artery is palpated at its highest point in the axilla, and a 25G needle, length 1.6 cm., is inserted as adjacent to the artery as is possible. Often a click is felt as the needle pierces the neurovascular bundle. The needle is correctly placed when it is pulsating with the artery. (The Fig. illustrates the position of the needle with relation to the contents of the axilla.)

After first aspirating to exclude blood, the analgesic solution is injected.

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¹ Present address: Coventry Group of Hospitals.

² Present address: The Department of Cardiology, Queen Elizabeth Hospital for Children, London E.2.

FIG. Schematic section of axilla as viewed distally.

The agent used in all cases was 0.25 per cent bupivacaine with adrenaline 1/400,000 in a dosage of 1.25 mg.-1.5 mg./kg.

If the patient was still awake and restless before the cut down, a sleep dose of thiopentone was given. No further sedation was needed during the procedure, which often included selective angiocardiology.

The children often made involuntary sucking movements or smacked their lips. This was taken to indicate that a satisfactory plane of hypnosis had been achieved. Feldman *et al.* (1961) have suggested that these movements indicate that protective reflex activity and muscle tone remain intact; thus, the patient would be able to maintain his own airway. In practice we have found that oropharyngeal airways have not been required.

Blood levels and toxicity All local analgesic drugs are potentially toxic and bupivacaine is no exception. In man the toxic level has not been determined, though toxic symptoms do not appear at blood levels up to 4.0 µg./ml. (Jorfeldt *et al.*, 1964). Yoshikawa, Mima, and Egawa (1968), using dosages of 2 mg./kg. of 0.5 per cent bupivacaine with adrenaline 1/200,000 for axillary plexus block, found blood levels of 2 µg./ml. or less.

Children are more sensitive to local analgesics than are adults and have a lower threshold for convulsions. We therefore decided not only to use 0.25 per cent bupivacaine with adrenaline 1/400,000, but also to use a reduced dosage, viz. 1.25-1.5 mg./kg.

Using gas chromatography we have found a peak level of <1 µg./ml., thus showing that the blood levels are well within the toxicity range, as was to be expected.

Though 0.25 per cent bupivacaine is slightly less efficient than 0.5 per cent with regard to the intensity of the block (Hollmén, 1966), it offers a greater margin of safety in reducing the likelihood of convulsions.

Results

In all, 45 children 2-6 years old have been

satisfactorily managed by these methods. In 18 of these patients angiography was also performed without the need for additional anaesthesia. That there was no depression of ventilation has been confirmed by the O₂ saturation levels, which were normal in those patients who were not cyanosed and who had no shunts.

The details of weights and ages of the patients managed by this technique are shown in Table 1, and the catheter diagnosis in Table 2.

Discussion

To achieve conditions in which the child's arm is still, using either general anaesthesia or deep sedation, the possibility of respiratory depression with consequent arterial desaturation must exist. The use of intermittent positive pressure ventilation during this procedure will also affect the blood gas concentrations. Axillary block renders the arm both motionless and anaesthetic so a lighter plane of sedation can be safely achieved without adding to the difficulties of catheterization. We have confirmed that arterial desaturation does not occur with this technique. In addition, all our patients have recovered consciousness shortly after the procedure; we have not encountered the

TABLE 1 Patients' ages and weights

Age (yr.)	No. of patients	Range of weights (kg.)	Mean weight (kg.)
2-3	2	10-13	12
3-4	7	13-17	15
4-5	12	12-19	16
5-6	24	15-27	19
Total	45		

TABLE 2 Catheter diagnoses

Catheter diagnosis	No.
Pulmonary valve stenosis	12
Ventricular septal defect	7
Persistent ductus arteriosus	5
Atrial septal defect	4
Pulmonary branch stenosis + atrial septal defect	2
Tetralogy of Fallot	2
Endocardial cushion defect	2
Persistent ductus arteriosus + ventricular septal defect	1
Ventricular septal defect, persistent ductus arteriosus, and coarctation of aorta	1
Pulmonary atresia + pseudotruncus arteriosus	1
Transposition of great vessels	1
Corrected transposition of great vessels	1
Infundibular stenosis	1
No lesion shown	5
	45

prolonged awakening that was reported by Eggers *et al.* (1967).

The median basilic vein in young children is small and frequently difficult to catheterize. Following axillary block, the veins and arteries are released from vasomotor control and dilate. This has the following three advantages. First, the veins are easier to catheterize and allow the use of larger sized catheters. Blood samples are therefore easier to withdraw and the pressure recordings are undampened. Secondly, venous spasm has not been encountered. We have been impressed by the unimpeded manipulation of the catheter in difficult cases, particularly when it has been necessary to change the catheter during the procedure. Before the introduction of this technique, venous spasm had proved troublesome on many occasions. Keown *et al.* (1957) have also stressed the difficulties caused by venous spasm during catheterization. Thirdly, arterial sampling via the brachial artery is easier and may be performed without further inconvenience to the child.

When evaluating any procedure, it is essential to consider any possible long-term complications. The site of introduction of the local anaesthetic in axillary block avoids the well-known complications of brachial block which occur when the supraclavicular approach is used. All the children on whom we have used this technique have been subsequently followed up, and we have noted no adverse neurological sequelae. This confirms the work of Bosomworth, Egbert, and Hamelberg (1961) that this is a safe procedure and free from significant side-effects.

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