Several procedures have been used to inject opaque material for the purpose of visualizing the vertebrobasilar arterial system. These methods should enable one to visualize the entire course of the vertebral artery from its origin up to and including the basilar artery and its branches. The different techniques may be summarized as follows:

1. **Countercurrent injection of opaque material into the common carotid artery.** Introduced by Elvidge in 1938.

2. **Direct supraclavicular percutaneous puncture of the subclavian artery.** This method was introduced by Sliimidzu in 1937, Barbieri and Verdecchia in 1957, and Crawford et al. in 1958.

3. **Direct percutaneous infraclavicular puncture of the subclavian artery.** This technique was reported by Pouyanne et al. in 1960, and Amplatz and Harner mentioned it in a paper published in 1962.

4. **Direct percutaneous infraclavicular catheterization of the subclavian artery.** This method was introduced by Amplatz and Harner using a needle-catheter combination 6 inches in length. Their preliminary report was published in June 1962.

5. **Indirect percutaneous catheterization of the subclavian artery through the brachial artery.** This type of retrograde catheterization was reported by Pygott and Hutton in 1959, Begg in 1960, and Tatelman and Sheehan in 1962.

Other techniques have been described in the literature which we considered too complex and too time-consuming for our purpose.

One hundred twelve direct percutaneous supraclavicular punctures of the subclavian artery have been performed. It has not been difficult to enter the artery except in obese patients. The quality of the films has been satisfactory in most cases, and adequate filling of the entire course of the vertebral and basilar arteries and their branches has been obtained.

Unfortunately, this technique has several disadvantages. It does not permit study of the effect of turning of the head and neck on the circulation in the cervical portion of the vertebral artery. It is difficult to keep the needle in situ when turning the head, especially in patients having short necks. Pneumothorax has been reported in 10 to 20 per cent and mediastinal hemorrhage in 40 per cent of the cases with this technique. In our experience, pneumothorax occurred in 7 per cent and intramural injection and extravasation of contrast material in 15 per cent of the cases.

We have had very limited experience in the technique of retrograde catheterization of the subclavian artery through the brachial artery. Although it is a satisfactory procedure in many cases, spasm of the artery and tortuosity of the axillary artery may make it difficult. In addition, the presence of marked atherosclerosis may impede the passage of the catheter. Loss of pulsation of the radial artery because of thrombosis of the brachial artery has been reported by Amplatz and Harner and by Tatelman and Sheehan. This can be a very serious complication.

Unaware of the reports of Pouyanne et al. and Amplatz and Harner, we began to use the direct percutaneous infraclavicular puncture of the subclavian artery early in 1962. About 120 subclavian angiograms were per-
formed with this method using the Courmand needle (Fig. 1). The results were unsatisfactory in 20 to 25 per cent of the cases because of nonfilling or poor quality of visualization of the vertebral and basilar arteries. This was caused by faulty positioning of the tip of the needle in relation to the longitudinal axis of the artery. In obese patients it was difficult to keep the needle in situ, and intramural injection or extravasation of the opaque medium often resulted.

Present Technique

Because of the undesirable features of this procedure, as mentioned above, we decided to catheterize the subclavian artery directly following percutaneous infraclavicular puncture. Seldinger’s technique of percutaneous arterial catheterization was adapted to the subclavian artery in the following manner:

1. The patient was placed on the table in a supine position without hyperextension of the neck.
2. The skin was prepared with Merthiolate and both superficial and deep infiltration with 1 per cent procaine was performed in the infraclavicular region, approximately at the point of the junction of the internal and middle third of the clavicle.
3. The subclavian artery was palpated in the supraclavicular fossa with the fingers of one hand, and with the free hand the Seldinger needle was inserted beneath the clavicle and advanced upward, medially and posteriorly, toward the palpable subclavian artery.
4. Once the double needle was in the lumen of the artery, the inner needle was withdrawn and the outer needle was advanced into the artery until a satisfactory “back flow” was obtained. Then the flexible metallic guide was introduced through the outer needle.
5. After the metal catheter guide was in place, the outer needle was withdrawn. A polyethylene tube, PE-190 or PE-160 (Clay-Adams) in caliber, 20 to 25 cm. in length, previously prepared according to Solia’s technique,11 then was introduced over the metallic guide employing some rotatory movements. Once the catheter had entered 4–5 cm. into the vascular lumen, the guide was removed.
6. The “free” end of the polyethylene tube was fitted to a tubing adapter (Clay-Adams, A-1026), which was connected to the syringe through another long, flexible plastic tube. This latter tube was used to permit the operator to remain shielded from the field of radiation.
7. A small amount (3–10 ml.) of contrast material then was injected and the first film was taken in order to visualize the position of the tip of the catheter. The latter may be observed readily because of the very small amount of contrast material contained in the catheter itself.
8. Several films were taken at different levels, placing the tip of the catheter at the level of the vessel to be visualized. The amount of contrast material injected depended upon the vessel or vessels to be visualized with a single injection. At no time did the amount exceed 25 ml.
9. In order to avoid formation of clots in the tubing, small and repeated injections of a solution of normal saline containing 50 mg./100 ml. of sodium heparin were made.

Results

Direct percutaneous infraclavicular catheterization of the subclavian artery proved, in our hands, to be a much more satisfactory approach than the supraclavicular puncture with the needle since the possibility of pneumothorax was minimized markedly. The