Axillary artery cannulation for blood pressure monitoring

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This article examines the value of cannulating the axillary artery for continuous blood pressure monitoring. Special emphasis is placed on emergency situations that preclude the use of other more peripheral arteries for this role. Risks and benefits associated with this procedure are presented, as well as a technique for arterial puncture.

Percutaneous cannulation of the axillary artery is a safe and appropriate means of intervention for invasive blood pressure monitoring, particularly in the absence of radial or other peripheral pulses. On five separate occasions the author was called upon to place an indwelling cannula for continuous blood pressure monitoring for patients in whom no distal peripheral pulses were palpable. In each of these cases, the axillary artery was palpable and was cannulated on the first attempt, thus enabling the anesthetist to obtain accurate pressure values.

Anatomical considerations and cannula location

The axillary artery is a continuation of the subclavian artery. The pectoralis minor crosses the vessel and divides it into three parts: the first is proximal, the second is posterior, and the third is distal to the muscle. Two primary collaterals exist in the second segment, the subscapular and the thoracoacromial. The third segment contains no major collateral vessels and is the part which will be cannulated.

To approximate where the tip of the 2-inch cannula would lie once inserted, a collection of films was obtained from the radiology department which involved angiography studies of the shoulder. (Figure 1.) The cannula was to be inserted at the most palpable area below the belly of the bicep. (Figure 2.) From this point the above length cannula was measured to scale (Figure 3) and the results were that the tip of the cannula

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Figure 1
Angiography study of the shoulder.
should remain within the third segment in most adults. (Figure 4.)

The location of the cannula is significant in that the indwelling cannula alters the flow characteristics within the vessel. Turbulence of flow causes the formation of thrombus deposits which may dislodge and occlude smaller collateral vessels in the first or second segments. If the axillary artery is occluded, then the limb is dependent on its collateral vessels for vascularity to the limb.²

A major safety factor to consider is that complete occlusion of the axillary artery is reported possible, but unlikely, given the large size of the vessel relative to the size of the recommended cannula.³,⁴

Since the axillary artery is second in size only to the femoral, the axillary lumen is capable of receiving a cannula as large as an 18-gauge, while still maintaining a favorable ratio of intraluminal size to outer diameter of the cannula. The more vessel lumen that is occupied, the greater the likelihood of thrombosis and spasm predisposing the area distal to the occlusion to ischemia.

**Indications**

Emergency situations or severe clinical dis-

**Figure 2**
The cannula is inserted at the most palpable area below the belly of the bicep.

**Figure 3**
The cannula is measured to scale.

orders preclude the use of other more distal arteries. A few examples of these (though there can be others) are:

1. Severe hypotensive states.
2. Severe peripheral vascular disease.
3. Localized burns, infection or fractures to the site of cannulation.
4. Hypothermia.

**Benefits**

*Close proximity to central artery pressures.* Since the axillary artery is a continuation of the subclavian, accurate waveform values should be present in the absence of any pre-existing vessel anomalies.⁵ This is a key point in considering this vessel over others such as the radial, femoral, or dorsalis pedis in an emergency setting, when the other peripheral arteries are not palpable or are ruled out for other reasons.

*Reduced probability of contamination and blood loss.* The axillary artery site is preferred over the groin area because it is far removed from the sources of fecal and urine contamination. The femoral site also requires a longer cannula in order to reduce the possibility of dislodgement. Also, the femoral site is technically more difficult to cannulate, and because most patients have their groin area covered by towels or bed linen, there is risk for massive blood loss from undetected decannulation.

*Convenient and easy access to cannula.* The axilla is readily accessible to the anesthetist during the operative procedure. Convenient and rapid access to "lines" has proven to be a desirable feature during emergency situations. The axilla should also require the least amount of conductive tubing

**Figure 4**
The tip of the cannula, based on previous measurements, should remain within the third segment in most adults.
when compared to femoral or dorsalis pedis sites, thus improving waveform accuracy.

**Complications**

In 1969, Gaan reported cerebral damage following irrigation of a Scribner shunt. Two years later, Lowenstein reported cerebral embolization following irrigation of an indwelling radial arterial cannula. These reports highlighted the potential risk of retrograde movement of emboli when “flushing” an indwelling cannula.

Table I lists the complications involved in the cannulation of the axillary artery and their frequency. This data is compiled from two of the more recently published studies. The sample size is relatively small when compared to similar studies involving the radial artery.

As one can see, the complication rate is very low with no reported loss of digit, limb, or neurological deficit stemming from retrograde movement of emboli from irrigating “flush” solution.

**Technique for inserting an indwelling cannula**

**Equipment.** The following equipment will be needed for the insertion of an indwelling cannula: (1) an intravenous cannula, consisting of a 2.5 ml syringe and a 2-inch Teflon® cannula (20 gauge) with an indwelling stylet (as illustrated in Figure 3); (2) a 2.5-ml syringe and a 25-gauge needle for use with 1% lidocaine; (3) povidone-iodine swabs or alcohol swabs; and (4) a continuous arterial infusion set-up, consisting of a 500 cc bag of NaCl with 500 units of heparin, a pressure bag, and a disposal pressure monitoring kit containing high pressure tubing and a flushing device/flow regulator.

**Continuous arterial keep-open technique.** First, add the heparin to the NaCl, attach and irrigate the pressure tubing with above solution. Care should be taken to avoid getting bubbles in the tubing. Next, attach the pneumatic pressure bag over the NaCl and connect the tubing that is now “flushed” to the transducer dome/and transducer. (Kits are now available that contain a complete set-up including transducer dome and stopcocks.) The use of a kit speeds along the set up process significantly. Again, it is very important that no air bubbles remain in the tubing or dome because they will cause inaccurate pressure values.

The pressure bag should be inflated to between 150 and 300 mmHg. Calibrate the transducer to the monitor by following the appropriate instructions included with the machine/monitor.

**Cannula insertion technique.** First, position the patient in a dorsal recumbent position. Abduct the patient’s arm so that it forms a 90-degree angle to the body. If the patient is cooperative, his arm may be flexed and externally rotated so that the dorsum of his hand is under his head. In emergency situations, the arm is positioned at 90 degrees to the body and held by an assistant. It is important that the arm be held stationary as best as possible, especially when cardiopulmonary resuscitation is ongoing, otherwise the anesthetist is faced with trying to “hit a moving target” while attempting insertion of the cannula.

Next, the middle medial aspect of the humerus is prepared with the antiseptic solution.

Figure 5 illustrates how a right-handed anesthetist would isolate the palpatting axillary artery

| Table I |
| Complications involved in the cannulation of the axillary artery |
| Study 1 (DeAngelis 1976) |
| Total number of insertion attempts | 86 |
| Successful insertions | 77 |
| Complications | |
| Hematoma | 9 |
| Loss of radial pulse | 1 |
| Other | 0 |
| Study 2 (Bryan-Brown 1979) |
| Total number of insertion attempts | 251 |
| Successful insertions | 245 |
| Complications | |
| Hematoma | 0 |
| Loss of radial pulse | 1 |
| Other | 1 (Mycotic aneurysm of the subclavian artery) |
between the index and middle finger of his left hand and stabilize the vessel against the humerus. After the above has been accomplished, the anesthetist may then inject 1 or 2 cc of local anesthetic into the subcutaneous tissue at the insertion site of the cannula; this is optional.

The cannula should then be irrigated with "flush" solution prior to inserting. This assures that the cannula is patent and may also reduce clotting during insertion.

The next step is to make a slight skin incision with an 18-gauge needle. This will facilitate smooth entry into the skin by the cannula, hopefully avoiding any sudden "give" or surge upon insertion. Insert the cannula along the axis of the vessel and towards the axilla at approximately a 30-45 degree angle to the skin. Once blood appears in the "hub" of the cannula, continue to advance it approximately 1 cm to insure that the cannula is within the vessel and not just the tip of the needle. (This can cause a problem, but one that is very easily corrected.) Then, advance the cannula over the needle. If the cannula is felt to be in place, remove the needle and attach the pre-irrigated pressure tubing. Visual inspection should reveal blood pulsating where the tubing is secured to the hub of the cannula. A good waveform should be present on the monitor and blood should be easily obtainable when aspiration is applied to one of the stopcocks.

Benzoin is then applied to the skin prior to taping.

Nursing care of the site is easily maintained since the site is not located at a joint such as the radial (wrist) or femoral (groin). This allows the patient to move the limb with few if any restrictions. Dressing changes are permitted as outlined by individual hospital policy.

Since the possibility exists of accidental disconnection and subsequent blood loss, it is recommended that all patients receiving an axillary arterial cannula be cared for by trained hospital personnel and kept under close observation.

**Conclusion**

Cannulation of the axillary artery should be considered for arterial monitoring whenever more distal arteries are not capable of being cannulated. The presence of collateral flow, a large lumen, and the close proximity to aortic arch pressures, makes this site especially well suited for effective and accurate arterial pressure monitoring in emergency situations.

**REFERENCES**


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