

ularly in the upper airway by use of conduction anesthesia.

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## Removal of Radial-artery Thrombi Following Percutaneous Cannulation for Monitoring

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Thrombotic occlusion of the radial artery frequently occurs following percutaneous cannulation of this vessel for monitoring purposes.<sup>1</sup> Ordinarily the thrombi are asymptomatic, since there is usually adequate collateral blood flow to the hand via the ulnar artery. Occasionally, however, when ulnar arterial flow is compromised or the palmar arterial arches are incomplete, occlusion of the radial artery can cause ischemia or even frank gangrene of the hand and wrist.<sup>2</sup> Cannula-induced thrombi may also occlude cutaneous branches of the radial artery, resulting in necrosis of the skin over the cannula tip.<sup>3</sup> In an effort to remove such thrombi, a technique that is a modification of that described by Snyder and Amplatz<sup>4</sup> for removing clot from the femoral artery following arteriography has been developed.

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### METHODS

The subjects of this study were 70 consecutive patients scheduled for major elective operative procedures. During the preoperative interview, both the risks and the benefits of radial arterial cannulation, and the nature of this study, were explained in detail to each patient, and informed consent was obtained. Allen's test<sup>5</sup> invariably showed brisk radial and ulnar arterial circulation to the hand, and Doppler examination revealed a patent radial artery prior to cannulation. Teflon 18-gauge catheters† were placed percutaneously in the radial arterial lumen just prior to induction of general anesthesia. They were flushed with a continuous infusion of heparinized 0.9 per cent saline solution (2 units/ml) via an Intraflow system‡ at a rate of 3 ml/hr.

Arteriography was performed on the morning after operation by injecting 5 ml of contrast solution§ while an x-ray of the wrist and hand was taken. The films were interpreted independently by two radiologists, and the amount of thrombus visible in the

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§ 25 per cent sodium diatrizoate, USP. Winthrop Laboratories, New York, N.Y.

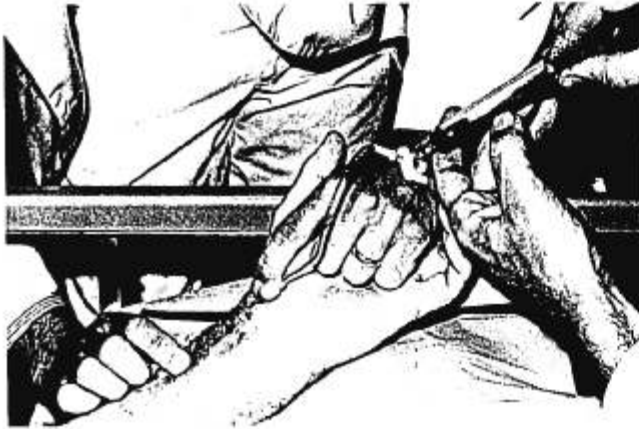


FIG. 1. Technique of applying suction to hub of radial-artery cannula while it is being withdrawn from vessel. Note assistant occluding vessel both proximal and distal to cannulation site.

artery was graded on the following scale: 0 = no thrombus visible; 1+ = small amount of thrombus; 2+ = moderate thrombus; 3+ = vessel occluded by thrombus.

Decannulation was performed before the arteriograms were developed. In the control group (the first 35 patients) the artery was decannulated in the usual fashion, using direct digital pressure applied over the arterial puncture site while the catheter was withdrawn. Pressure was maintained on the vessel for 5 minutes, or until there was no evidence of bleeding from the puncture site.

In the study group (the subsequent 35 patients), the artery was decannulated as shown in figure 1. The radial artery was occluded by digital pressure both proximal and distal to the catheter, and continuous suction was applied to the hub of the catheter with a 10-ml Luerlok<sup>†</sup> syringe while the catheter was being withdrawn from the vessel. Digital pressure was applied until hemostasis was assured. Using the Doppler flow probe and Allen's

† Trademark, Becton-Dickinson Co.

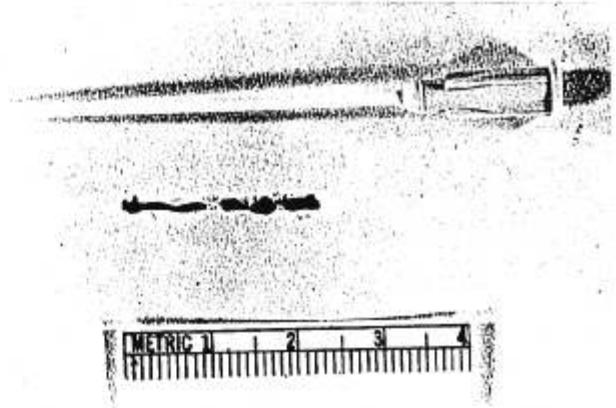


FIG. 2. Specimen of thrombotic material successfully aspirated from a radial artery during decannulation. Arteriography demonstrated complete occlusion of the lumen by thrombus and catheter, yet vessel function was normal after decannulation.

test, radial arterial patency was then examined daily until the patients were discharged from the hospital (mean follow-up period 14.8 days). Statistical comparisons were performed using Fisher's exact probability test.

### RESULTS

Table 1 summarizes the results. In the control group, the incidence of post-cannulation radial-artery occlusion was closely related to the amount of intravascular thrombus seen by arteriography immediately prior to decannulation. Of the 15 arteries with 2-3+ thrombus accumulation complete occlusion developed in 11 following decannulation. This was significantly different ( $P < .001$ ) from the single instance of vessel occlusion that occurred in the 20 control catheters with only 0-1+ thrombus.

In the study group, where suction was applied during decannulation, 16 patients had 0-1+ thrombus visible on arteriography. Only small amounts of thrombus were aspirated from these catheters, and none of the vessels became occluded after decannulation.

TABLE 1. Results of Removing Cannula-induced Radial-artery Thrombi

	Control Group		Study Group		
	0-1+ Thrombus on Arteriogram	2-3+ Thrombus on Arteriogram	0-1+ Thrombus on Arteriogram	2-3+ Thrombus on Arteriogram	
				Successful Clot Removal	Unsuccessful Clot Removal
Vessel Function Patent	19	4	16	7	1
Occluded	1	11	0	2	9
Significance	$P < .001^*$		$P < .01†$		$P < .02‡$

\* Control 0-1+ thrombus group vs. control 2-3+ thrombus group.

† Successfully aspirated group vs. control group with 2-3+ thrombus.

‡ Unsuccessfully aspirated group vs. successfully aspirated group with 2-3+ thrombus.

Of the 19 study group patients who had 2-3+ thrombus present at arteriography, large amounts of clot were successfully removed during decannulation in nine (fig. 2). The radial arteries of two of these patients went on to occlude following decannulation ( $P < .01$  versus control group, which had 2-3+ thrombus present). In contrast, there were ten patients who had 2-3+ thrombus formation and from whose arteries clot could not be extracted. Nine of these vessels went on to occlude ( $P < .02$  versus the 2-3+ thrombus group where clot was successfully removed).

### DISCUSSION

Once it was observed that intra-arterial clot could be removed as described above, patients expressed the desire not to be randomized into control and study groups. Accordingly, we utilized the results of previous radial arterial cannulations as the only available control group. We had just evaluated 35 consecutive radial arterial cannulations using the technique described for the control group and decided that the next 35 consecutive cannulations should be treated identically except at the time of decannulation.

These results do indicate that the intravascular thrombus caused by radial-artery cannulas can be extracted successfully from the vessel lumen during decannulation. As was demonstrated in the control group, such thrombotic material is capable of causing complete arterial occlusion, either while the cannula is in place or following decannulation. None of the occlusive lesions generated in this study resulted in distal ischemic complications, due to the collateral circulation to the hand, which was documented prior to radial-artery cannulation. In one of the patients in the control series, however, an area of cutaneous necrosis developed overlying her thrombosed radial artery, a complication that has been attributed to occlusion of cutaneous branches of this vessel.<sup>3</sup> With successful extraction of clot during decannulation, lesions such as this may be prevented. In addition, this procedure seems indicated in management of those patients whose radial arteries are cannulated on an emergency basis, where collateral circulation to the hand cannot be documented in advance.

Clot was successfully removed from only nine of the 19 study patients who had 2-3+ thrombus formation within their radial arteries prior to de-

cannulation. It may be that after 24 hours of cannulation many thrombi are so organized that they cannot be extracted easily. This technique has been used, however, in many patients whose radial arteries have been cannulated for several days, and large amounts of thrombus have been aspirated successfully despite the longer periods of cannulation.

Although 18-gauge cannulas were used in this study, radial-artery thrombi can be removed in the same fashion following the use of 20-gauge cannulas. There appears to be a lower overall incidence of successful clot extraction during decannulation of 20-gauge cannulas, perhaps because they are associated with a significantly lower incidence of thrombus formation compared with 18-gauge cannulas.<sup>6</sup> It remains to be determined whether this technique will be as successful following arterial monitoring with 20-gauge cannulas.

The results of this study are reported as preliminary findings. It appears that many radial-artery thrombi resulting from percutaneous cannulation can be removed during decannulation. Refinements in technique, however, will undoubtedly improve the rate of successful thrombus removal and, thereby, increase the safety of percutaneous radial arterial cannulation for cardiorespiratory monitoring.

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