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Hazards of Radial-artery Catheterization

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Indwelling arterial catheters are frequently placed to facilitate monitoring blood pressure and the sampling of blood of patients who need intensive care. Ischemic damage to extremities is the most commonly reported complication of long-term arterial catheterization.[1] Recently, however, Lowenstein *et al.*[2] presented evidence suggesting that cerebral embolization could result from the irrigation of radial-artery catheters. To our knowledge, a prospective analysis of the hazards of radial-artery cannulation has not been reported. This study was undertaken to assess the relative incidences of arterial occlusion, thrombus formation, emboli, and clinical dysfunction that occur with intra-arterial catheters of various sizes and shapes.

METHODS AND MATERIALS

Thirty-two patients (23 male and nine female), 5 to 74 years of age, had 35 Teflon catheters placed percutaneously in their radial arteries. The catheters inserted were 11 20-gauge Longdwels § (Group I), 14 18-gauge Longdwels § (Group II), and ten 18-gauge Medicuts ¶ (Group III) (fig. 1, table 1). Catheter sizes were randomized regardless of age or size of patient. All catheters were irrigated hourly with 1 to 3 ml of a solution (either D_5W or 0.9 per cent NaCl) containing two units of USP heparin per ml. One hundred and four portable arteriograms were made with injections of 1 to 3 ml of a radi-

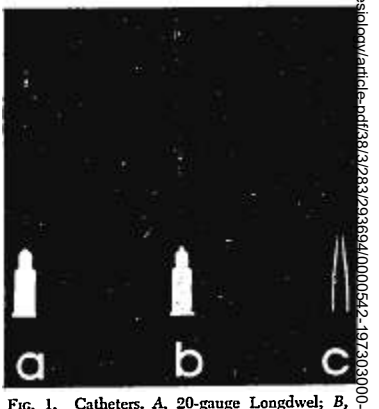

FIG. 1. Catheters. *A*, 20-gauge Longdwel; *B*, 18-gauge Longdwel; *C*, 18-gauge Medicut.

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§ Becton, Dickinson & Co., Rutherford, N. J.
¶ Aloe Medical, St. Louis, Mo.

opaque solution** through the catheters shortly after catheter insertion and daily thereafter until the catheters were removed. Care was taken to ensure that air was excluded from all of the lines prior to performing the arteriograms.

Thrombus formation was rated according to the following scale:

0 = no thrombus visible
1 = minimal thrombus visible around the catheter
2 = artery nearly occluded by thrombus
3 = artery totally occluded by thrombus

Clinical function was based on the free flow of blood from the catheter. In 29 instances, Allen's test[3] was performed by two of the investigators 5 minutes after, and one day after, removal of the catheter to determine whether the artery was patent. The test results were equivocal for three patients and not obtained for three patients who died prior to removal of the catheters.

** Renografin-60, E. R. Squibb & Sons, Inc., New York, N. Y.

Results

There were no significant differences among the patients in the three groups with respect to age, height, weight, arterial blood pressure, or duration of arterial catheterization (table 1).

Arterial occlusion during or after catheterization did not occur with the 20-gauge catheters (fig. 2). With 18-gauge catheters, the incidence of occlusion was significantly less in Group II than in Group III (fig. 3). All arteriograms taken within two hours after insertion of the catheters showed that thrombus formation occurred regardless of the catheter employed. The extent of thrombus formation was greatest with the 18-gauge tapered catheters (Group III) and least with the 20-gauge nontapered catheters ($P < 0.05$). Only in the latter group was the degree of thrombus related to the length of time the catheter was in place. The 18-gauge tapered catheter (Group

TABLE 1. Studies Performed on Tapered and Nontapered Catheters

	Group I 20-gauge, Nontapered	Group II 18-gauge, Nontapered	Group III 18-gauge, Tapered	P		
				I vs. II	I vs. III	II vs. III
Number of arteries catheterized*	11	14	10	NS	NS	NS
Duration of arterial catheterization (hours)	59 (±18)†	77 (±74)	42 (±32)	NS	NS	NS
Thrombus formation (0 to 3)	1.32 (±0.70)	1.76 (±0.90)	2.63 (±0.88)	<0.05	< 0.001	< 0.001
Number of arteries occluded with catheter in place	0 of 11	4 of 14	9 of 10	NS	< 0.01	< 0.01
Number of arteries occluded following catheter removal‡	0 of 11	3 of 10	6 of 8	NS	< 0.01	< 0.5
Number of arteriograms showing emboli	5 of 31	12 of 46	7 of 27	NS	NS	NS
Number of catheters functioning just prior to removal	10 of 11	11 of 14	4 of 10	NS	NS	NS

* Three patients had two catheters each.
† Numbers in parentheses are ± 1 SD.
‡ As assessed by Allen's test.

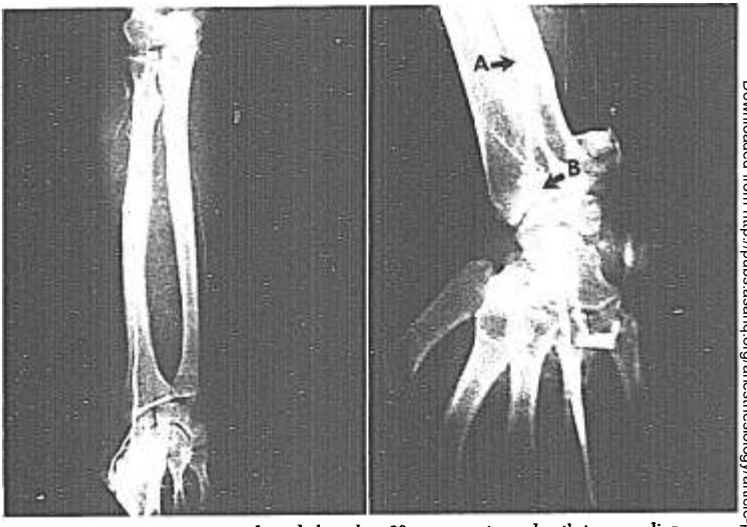

FIG. 2. An arteriogram performed through a 20-gauge nontapered catheter, revealing no intra-arterial complications.

FIG. 3. Tapered catheter with total occlusion (*A*) and extravasation of contrast solution from the arterial puncture site (*B*).

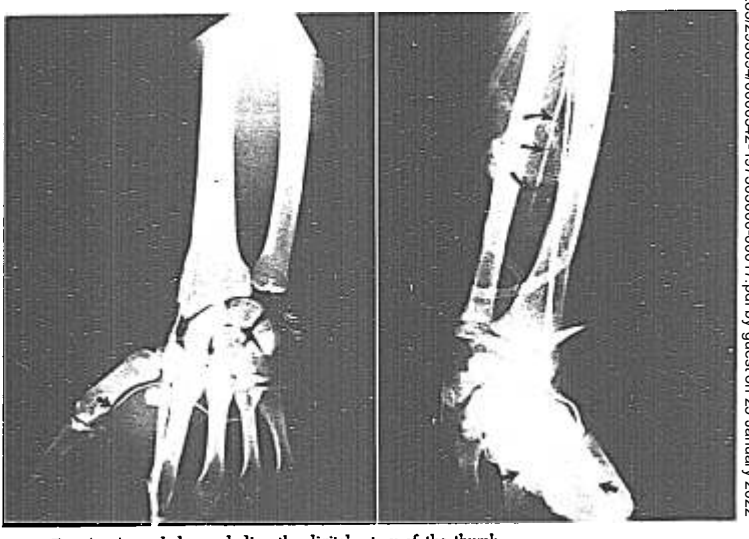

FIG. 4. An embolus occluding the digital artery of the thumb.

FIG. 5. Numerous small emboli in the forearm and hand.

FIG. 6. Contrast solution in the axillary artery after a 3-ml injection.

III) also stopped functioning earlier than the nontapered catheters (table 1).

The incidence of thrombotic embolization in the three groups was 23 per cent. Incidences were not significantly different among the groups and did not appear to be related to patient age. In only one instance did a proven embolus produce symptoms (fig. 4). Emboli were seen in the brachial, interosseous, ulnar and digital arteries, and were frequently numerous (fig. 5). A 15-year-old patient had an arteriogram made with an injection of 3 ml of contrast solution. The solution was observed at the subclavian–axillary artery junction (fig. 6).

DISCUSSION

Three types of catheters commonly used for continuous arterial cannulation were studied. Longdwel catheters have a tapered tip, but the shaft is not tapered. The Medicut catheter has a tapered tip and a tapered shaft. Therefore, catheter diameter relative to internal diameter of the artery is greater for a Medicut catheter than for a Longdwel catheter of equal gauge. Our results show that the catheter which has the largest external diameter relative to the size of the vessel is associated with the highest rates of vascular occlusion (both during and after catheterization) and thrombus formation. Since catheter dysfunction occurred less often with 20-gauge nontapered catheters, successful long-term arterial catheterization is more likely to occur with catheters of small diameter. Thrombotic emboli were seen in 24 of 104 arteriograms and were observed in all major arteries of the arm, forearm, and hand. Yet, only two patients had clinical signs of vascular insufficiency of the digits. One of these patients had embolic occlusion of the digital artery to the thumb shown by the arteriogram. In each patient, the catheter was removed and the symptoms disappeared within two hours of their onset. One arteriogram showed retrograde flow to the subclavian artery with injection of only 3 ml of contrast solution, suggesting that cerebral embolization could result from rapid, large-volume, arterial catheter irrigation.

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