Diagnosis of Thrombosis by Catheter Phlebography after Prolonged Central Venous Catheterization

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Sixty central venous catheterizations in 53 patients were prospectively studied with respect to phlebographic findings after prolonged parenteral nutrition. Phlebography was performed by a special technique on completion of the intravenous therapy. Under fluoroscopic control, the central venous catheter was slowly removed, while simultaneously contrast medium was continuously injected through it. Two types of thrombosis were demonstrated—sleeve thrombosis, on 25 occasions (42%), and mural veno-occlusive thrombosis, on five occasions (8%). On removal of the catheter the sleeve thrombosis peeled off the catheter and in several cases it was noticed that parts of the sleeve thrombus or the entire sleeve became detached and were carried away with the blood flow. Although the sleeve thrombus seldom gave rise to any symptoms, this type of thrombosis is of great importance in view of the risk of pulmonary embolism, especially in connection with removal of the catheter. With use of the described phlebographic technique thrombi of this type can be visualized.

CENTRAL VENOUS CATHETERIZATION for measurement of the central venous pressure, for rapid infusions in states of shock or for prolonged parenteral nutrition is a well established procedure. The risk of complications on insertion of a central venous catheter, especially in percutaneous subclavian catheterization, is well documented,[6] and the possibility of catheter sepsis has also been pointed out by several authors.[5,10] Less well studied is the risk of thrombosis in the superior vena cava and the subclavian vein as a complication of central venous catheterization.[2] This is probably due partly to the fact that the thrombosis only seldom gives rise to distinct clinical symptoms but it is also likely that with previously used phlebographic techniques the thrombi have to a large extent escaped detection.

This paper describes a prospective study of central venous catheterizations in which phlebography by a new technique was performed on removal of the catheter in order to investigate the occurrence of thrombosis. Preliminary results have recently been presented.[3]

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Materials and Methods

The study comprised 60 catheter periods in 53 consecutive patients (28 males, 25 females) aged 17–84 years (mean: 54 years). A catheter period was defined as the length of time for which a central venous catheter was *in situ*. All the patients were given parenteral nutrition via the catheter. Forty-seven patients were catheterized once, five twice and one three times. Fifteen patients had carcinoma of the colon, rectum or pancreas, 13 Crohn's disease, seven gastric or duodenal ulcer, five pancreatitis, two ulcerative colitis and 11 various other benign gastrointestinal diseases.

The catheterization was achieved by percutaneous infraclavicular puncture of the subclavian vein on 24 occasions and by a cut-down technique exposing the external jugular vein on 36 occasions. The catheter was advanced under fluoroscopic control until its tip lay in the superior vena cava, its location being confirmed by chest x-ray.

The duration of the catheter period varied from 3–111 days (mean: 27 days). Five catheter materials were used (Table 1). The catheters were removed because of discontinued intravenous therapy on 40 occasions, technical problems such as catheter occlusion on 15 occasions and suspicion of catheter sepsis on five occasions.

The infusion solutions included amino acids, glucose, fructose, fat emulsion (Intralipid 10% and 20%, Vitrum, Sweden), electrolytes, trace elements and vitamins. Drugs, blood and blood products were also administered through the intravenous catheter when indicated. The infusions were administered by gravity drip, usually for a period of 12 hours per 24 hours. During intermission of administration of the intravenous fluids, the catheter

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TABLE 1. *Catheter Materials and Duration of Catheterization*

Catheter Material	Catheter Periods		
	Number	Mean in Days	Range in Days
Teflon	19	13	3-29
Polyvinyl chloride (PVC)	19	19	7-47
Silicone	14	45	8-111
Ethylene vinyl acetate (EVA), heparin coated	6	44	18-97
Polyethylene, heparin coated	2	46	12-79

was flushed and filled with 5-10 ml of a solution of 1 ml of heparin (5000 IU/ml) in 100 ml of sodium chloride, 0.9%.

Radiology

In patients who had been catheterized previously, phlebography was performed at the time of insertion of the catheter to exclude the presence of thrombosis. Phlebography was then performed on completion of the intravenous therapy in all patients. A standardized technique was used: the patient was placed in a supine position on the x-ray table in a room for angiographic procedures. Before removal of the central venous catheter 15-20 ml of contrast medium, Isopaque cerebral (Nyegaard & Company, Norway), was manually injected through the catheter to allow visualization of any thrombotic masses at the catheter tip. In patients with a history of allergic reactions, Amipaque, 280 mg iodine/ml (Nyegaard & Company), was used. The catheter was then slowly removed under fluoroscopic control, while at the same time 20-40 ml of contrast medium was manually injected. The fluoroscopic findings were recorded by a video tape technique with electronic magnification in most cases. In a few cases full-size films in a cut film changer and 35 mm cine film were used for the documentation.

Statistical Methods

The statistical methods used were Student's paired and unpaired t-tests. Differences were considered significant at the level $p < 0.05$.

Results

Two types of thrombosis were demonstrated, namely sleeve thrombosis on 25 occasions (42%) and mural veno-occlusive thrombosis on five occasions (8%). A sleeve thrombus was only visualized upon injection of contrast medium during removal of the catheter. It had the configuration of a sleeve, as a rule coating the entire length of the catheter from the point of insertion of the catheter into the vein to its tip (Figs. 1A and B). On a few occasions the sleeve thrombus continued beyond the tip of the catheter, floating from the tip as a freely suspended tail in the superior vena cava and sometimes entering the right atrium (Fig. 2). On removal of the catheter, the sleeve thrombus successively peeled off. Generally it was adherent to the vessel wall only at the site of entry of the catheter into the vessel (Fig. 3). On several occasions it was noticed on removal of the catheter that parts of the sleeve thrombus or the entire sleeve became detached and were carried away with the blood flow. In connection with removal of the catheter chest pain, anxiety and respiratory changes were noticed in three patients. Lung scintigraphy was performed in these patients and the findings were compatible with pulmonary embolism.

In five patients phlebography revealed total occlusion of the subclavian vein (Fig. 4). One of them had prom-

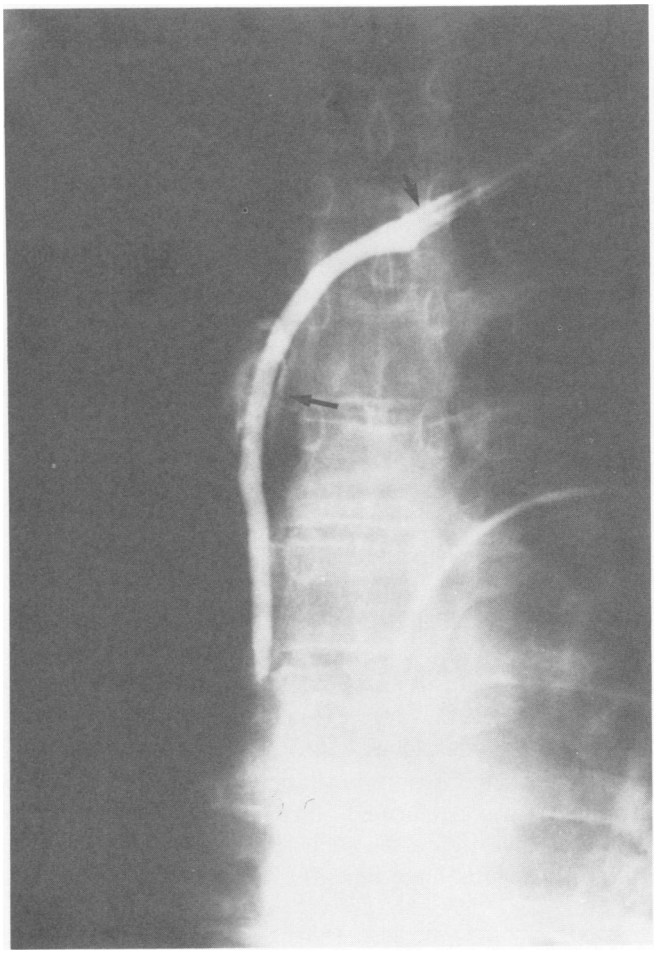

FIG. 1A. The catheter is partially withdrawn. Short arrow indicates the catheter tip and long arrow contrast medium leaking from defects in the sleeve thrombus into the superior vena cava.

inent veins over the thorax and swelling of the arm on the catheterized side. In four of these five patients the catheter had been inserted into the subclavian vein percutaneously. In the fifth patient, in whom the catheter had been introduced through the external jugular vein, the catheter tip had become displaced in a peripheral direction to the axillary vein on the homolateral side.

In seven patients occlusion of the catheter rendered phlebography impossible. This was probably caused by a clot in the catheter lumen. Phlebography via a peripheral vein was not performed after removal of the catheter in these patients, as they had no symptoms.

The frequency of thrombosis increased significantly with the length of the catheter period (Table 2). On the other hand, no relation was found between the type of catheter used and the frequency of thrombosis. Neither was there any difference in the frequency of sleeve thrombosis between catheterization of the jugular and subclavian veins.

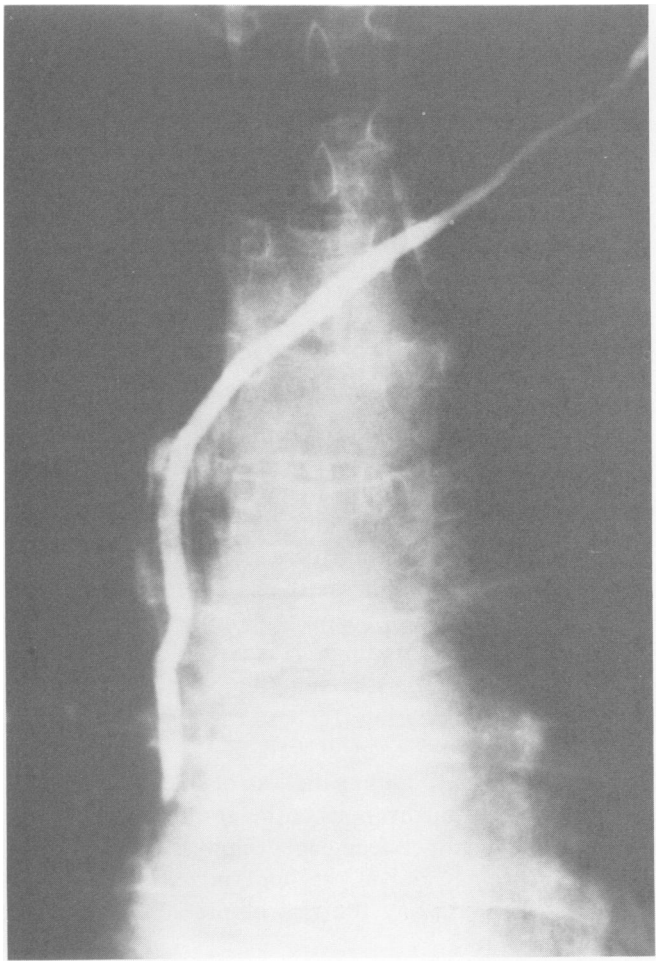

FIG. 1B. The catheter is completely withdrawn from the vessel. Contrast medium injected at the site of insertion fills the thrombus hanging from the wall of the subclavian vein. Note the change in position of the moving sleeve thrombus.

FIG. 2. A spherical thrombus hanging on the tip of the catheter, surrounded by contrast medium, at the level of the right atrium.

The risk of thrombosis was not influenced by the occurrence of operation trauma during the catheter period or by the patient's age or diagnosis.

On five occasions, the catheter was removed because of a suspicion of sepsis. On three of these occasions bacteriemia was found and in two of these sleeve thrombosis was also present.

Discussion

At phlebography in the patients studied, two types of thrombosis associated with central venous catheterization were observed—mural thrombosis with partial or total occlusion of the lumen of the vein, and sleeve thrombosis coating the catheter. When occlusion of the catheter rendered phlebography impossible, thrombosis around the catheter may also have been present. The two types of thrombosis probably have different mechanisms of origin.[9]

FIG. 3. Partial obliteration of the proximal left subclavian vein; contrast medium is passing only through the canal left by the catheter, which has been withdrawn to the site of puncture (arrow).

On occlusion of the lumen of the vein the thrombus is adherent to the vessel wall to the greater part of its extent. Damage to the intima of the vessel wall occurring mechanically as in percutaneous catheterization or from pressure from within caused by stiff catheter material (*e.g.* Teflon®) can contribute to the clot formation. To reduce the risk of intimal damage due to the catheter, the use of catheters of softer material such as silicone has been recommended.[13] In the present study, no difference in the frequency of thrombosis was found between the different types of catheter. However, silicone catheters were used especially for prolonged nutrition, and the catheter periods with this material were therefore longer than with the use of Teflon catheters. As the risk of thrombosis increased with the length of the catheter period, no definite conclusion can be drawn from this study as to the importance of the catheter material for the development of thrombosis.

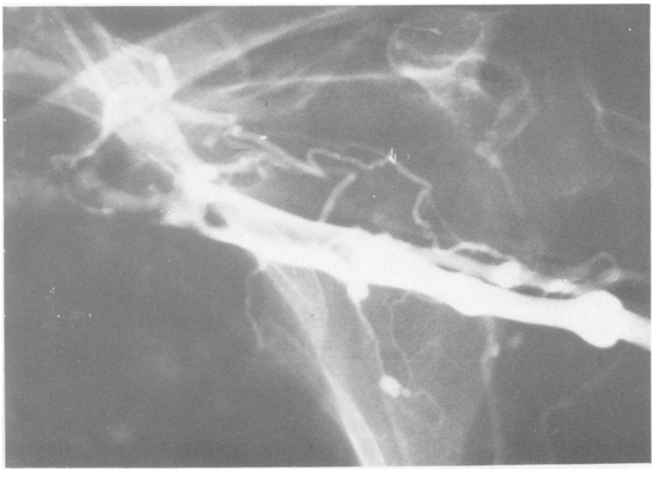

FIG. 4. Complete obliteration of the subclavian vein demonstrated by phlebography through a cubital vein.

TABLE 2. *Duration of Catheterization and Incidence of Thrombosis*

Duration of Catheterization in Days	Catheter Periods	Thrombosis
3-7	6	1 (17%)
8-14	24	14 (58%)
15-111	30	22 (73%)

By insertion of the catheter via the external jugular vein, the damage to the intima that may occur on percutaneous insertion into the subclavian vein is avoided. In no case in which the catheter was introduced via the external jugular vein and the central position of the catheter was maintained, did the subclavian vein become occluded in this series of patients.

A sleeve thrombus on the catheter is considerably more common than thrombotic occlusion of the lumen of the vein[1,8,11,12] and in this study was demonstrated with all the catheter materials used. Although a sleeve thrombus seldom gives rise to any symptoms, this type of thrombosis is of great clinical importance. This is on account of the risk of pulmonary embolism in connection with removal of the catheter, when parts of the sleeve thrombus or the whole sleeve may become detached from the site of adherence at the entry of the catheter into the vessel. With use of the described phlebography technique, with continuous injection of the contrast medium during removal of the catheter, this type of thrombosis can be very clearly visualized.

It can be difficult to distinguish between a sleeve thrombus and a totally occluding thrombus on isolated radiographs. By injecting the contrast medium continuously at the same time as the catheter is withdrawn, as in the present technique, with simultaneous recording of the fluoroscopic findings, it is possible to observe in the large vessels, *e.g.* the superior vena cava, whether the thrombus is floating freely in the lumen of the vein or is adherent to the vessel wall.

In an attempt to reduce the risk of sleeve thrombosis, heparin-coated intravenous catheters have been tried.[8] The results have not been encouraging, however, partly because the material of the heparinized catheters became stiff, increasing the risk of pressure damage to the vessel wall.[7]

Another possibility of diminishing the risk of catheter-related thrombosis in patients with central venous catheters is to give them anticoagulant therapy.[4] Preliminary results of an ongoing study of the use of pro-

phylactic intravenous heparinization of such patients indicate that this is a promising way of reducing the risk of clot formation on the catheters.

Even though the frequency of veno-occlusive thrombi after central venous catheterization is low, it would seem recommendable to perform catheter phlebography as a routine procedure on patients in whom further catheterization may be anticipated.[2]

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