Femoral Catheters *

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IN the management of burns, particularly those of any extent, it is mandatory that one be assured a venous pathway through which large volumes of fluids can be administered rapidly and under conditions that frequently would prevent the routine methods of intravenous infusion. If the superficial venous system has been thrombosed as a result of thermal injury or repeated cut-downs or intravenous infusions, only the deep venous system remains. The most easily accessible portion of this deep venous system is the femoral vein just below the inguinal ligament, as it can be entered without difficulty and without the necessity of a cut-down. This article presents the experience gained through the use of a large number of femoral catheters in a group of critically ill patients suffering either from extensive thermal injury or renal insufficiency.

The equipment necessary and the technic used in inserting a femoral catheter is a relatively simple one. The following equipment is needed:

1. A measured length of polyethylene tubing with an inside diameter of .047 inches and an outside diameter of .067 is ideal. This size allows a No. 18 gauge needle to fit on one end; and it will also allow the tubing to pass readily through a No. 14 gauge needle. It is extremely important to use a definite length of tubing and to record its length prior to insertion into the femoral vein. When the polyethylene tubing is removed from the femoral vein, it is equally important that the tubing be measured and this length be compared with the length when it was inserted into the vein. Obviously, any discrepancy in the two measurements should be investigated.

2. A No. 14, short-beveled needle is used and it contains a snug, smooth-fitting obturator. It is important that the bevel of this needle be short in order to minimize the possibility of producing a long tear in the femoral vein or transfixing the vein with the distal point. It is also important not to have the bevel excessively sharp because of the polyethylene tubing can be sheared off easily by the beveled edge.

3. A No. 18, blunt needle that can be inserted into the end of the polyethylene tubing serves as an adapter to connect with the intravenous fluids.

The sizes of the various parts of this equipment may be changed to suit the clinical needs; and in infants and small children it is wise to use a catheter of smaller diameter.

The polyethylene tubing may be purchased in bulk lots, cut to desired lengths, and sterilized in Zephiran with little difficulty. This is a much more economical and practical means of utilizing the tubing than to purchase pre-cut lengths in individually packaged, sterile containers.

When inserting the polyethylene catheter into the femoral vein, a few important precautions must be taken. The femoral vein is located indirectly by palpating the pulsation of the femoral artery just below the inguinal ligament and then moving approx-

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imately 1 to 1.5 cm. medially. If necessary, a small skin wheal is made with procaine and, using a No. 11 Bard-Parker blade, a small incision is made through the skin to facilitate the passage of the large bore, No. 14 gauge needle (Fig. 1a). Continuing to palpate the pulsations of the femoral artery, the No. 14 gauge needle is directed cephalad and slightly medial to the pulsations of the femoral artery until the operator can feel it penetrating the wall of the femoral vein. To assure placement of the tip of the needle within the lumen of the femoral vein, the obturator is removed and a rapid flow of venous blood through the needle establishes the location of its tip. The hub of the needle is then depressed towards the skin in order to point the needle in an even more cephalad position. This position facilitates the threading of the polyethylene catheter through the lumen of the No. 14 gauge needle into the femoral vein and, it is hoped, up through the iliac veins into the vena cava. The 14 gauge needle is then removed from around the polyethylene tubing. After pressure has been maintained for a few moments, during which time the No. 18 gauge needle is being attached to the polyethylene catheter and to the intravenous solution, a dressing is placed over the area.

If any difficulty is encountered in inserting the polyethylene tubing through the large bore needle, it is extremely important that the needle and the polyethylene tubing be removed at the same time. If an attempt is made to withdraw the polyethylene tubing through the large bore needle, there is great danger that the bevel of the needle will shear off the plastic tubing and leave it within the lumen of the vein. It is equally important for the femoral catheter to be well anchored to the skin and for all individuals concerned with the care of the patient to be oriented as to its location.

Since early 1954, polyethylene femoral catheters were used in 135 instances in 91 patients at the Surgical Research Unit,

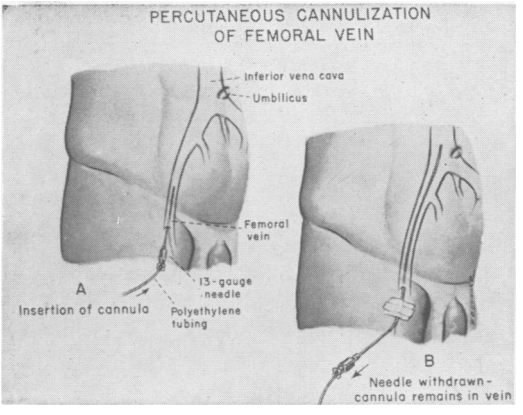

FIG. 1 a & b.

Brooke Army Medical Center, Fort Sam Houston, Texas. These catheters were used on 15 patients suffering from renal insufficiency from various causes and on 76 patients sustaining extensive burns. The patients varied in age from four to 71 years, although the majority were males in the younger age groups, since this hospital is a military installation.

The femoral catheters were left in place from one to 51 days; but, in some instances, portions of the catheter were left in place for longer periods. Table 1 shows the number of femoral catheters left in place on the right side and the left side for varying specified periods. The majority of the catheters were left in place for ten days or less; however, a significant number remained in for a rather protracted period.

During the time these catheters were used as a therapeutic adjunct, an attempt was made to observe the patients for complications resulting from the use of the polyethylene tubing within the lumen of the femoral vein. Complications included edema of the lower extremities, either transient or persistent, localized evidence of femoral thrombophlebitis such as tenderness, heat, pain and swelling, obstruction of the plastic tubing by clots, and the complications proven at autopsy such as erosion of the vein wall and thrombosis. Complications were recorded when noted. However,

TABLE 1

Days in Use	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	30+
Left	15	12	13	10	4	2	3	2	1	1	7
Right	13	10	19	8	6	4	3	0	1	0	2

TABLE 2

Days in Use	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	30+	
Left	0	1	5	1	2	0	0	3	1	2	1	Comp.
	15	11	8	9	2	2	3	0	0	0	6	No comp.
Right	2	1	2	0	2	3	1	0	1	0	3	Comp.
	11	9	17	8	4	1	2	0	0	0	0	No comp.

TABLE 3. *Per Cent Incidence of Complications*

Days in Use	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	30+
Right	15	10	11	0	33	75	33	—	100	—	100
Left	0	9	62	10	100	0	0	100	100	100	14
Both	7	10	22	4	40	50	16	100	100	100	45

it is quite likely that many complications escaped the observation of the clinician and, therefore, any incidence of the frequency of complications must be considered a minimal incidence rather than an average.

Table 2 is a compilation of the observed frequency of complications in relation to the time period and the side involved. Although the observed frequency of complications appears to be greatest in the catheters that were left in for a period of 10 days or less, Table 3 shows a percentage wise calculation of the incidence of complications according to individual time periods. Table 3 indicates that the incidence of complications increases as the duration of use increases.

Table 4 shows the types of complications that were encountered in the use of femoral catheters and their frequency. Again, it is emphasized that the frequency of complications expressed here is not believed to reflect the actual incidence of complications

TABLE 4

Sequelae	Right	Left
Transient edema	3	3
Persistent edema	0	0
Clinical thrombophlebitis	1	1
Clotted tubing	2	3
Lost tubing	3	0
Proven thrombosis	9	9

but an incidence somewhat less than the average. The transient edema was not extensive and subsided rapidly after the removal of the intravenous catheters and the mobilization of the patient's extremities. Persistent edema did not occur in those patients who survived. It is not known whether the edema of the lower extremities in those patients suffering from septic thrombophlebitis would have subsided eventually if they had survived.

Table 5 tabulates the proven complications in relation to the duration of the femoral catheter *in situ*. A rather even dis-

TABLE 5

Days in Use	Sequelae 1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	30+
Proven thrombosis	2	1	4	1	2	1	1	1	1		4
Edema of extremity			1		1	1		1	1	1	
Clinical thrombosis			1							1	
Clotted tubing		1	1		1	1		1			

tribution occurs in the actual number of complications in relation to the duration of the use of the femoral catheter. However, this does not reflect the actual percentage of complications as expressed in Table 3 and in Figure 2.

Two cases of clinically suspected thrombophlebitis had localized pain, tenderness, heat and erythema in the femoral area. One of these patients responded to treatment when the femoral catheter was removed and local heat was applied conservatively. The other patient was treated with anticoagulant therapy but died from other complications of his burns and septic thrombophlebitis (FJL). In five patients, the polyethylene tubing became obstructed by blood clots. The tubing had to be removed and was then placed in the opposite side (Table 6). In three patients, portions of the polyethylene tubing were lost and these instances are discussed in some detail later (under thrombosis). Autopsy revealed 18

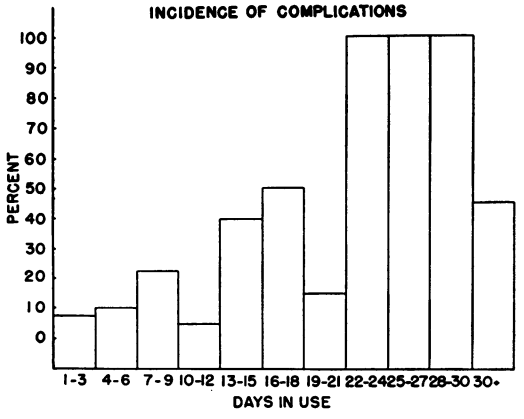

FIG. 2.

cases of throboses of varying extent and degrees of severity (Table 7).

The location of the femoral polyethylene tubing, as determined by autopsy, revealed some rather interesting findings. The polyethylene tubing entered the common femoral vein near the junction of the superficial and deep femoral vein. Usually the catheter then passed along in a cephalad manner but, in some instances, distally; and in one case it described a 360° arc within the lumen of the common femoral vein, after which it continued to pass in a cephalad direction until its tip reached the inferior vena cava. Tips of other catheters were observed lying within the homolateral hypogastric, the contralateral hypogastric, the contralateral common iliac, and at varying points in the inferior vena cava as high as the hepatic vein.

One other complication noted in the insertion of a femoral catheter is depicted in Figure 3. This patient was suffering from renal insufficiency; and two attempts were made to place a femoral catheter into the right femoral vein, but without success, and a small hematoma was produced. On the first attempt it was felt that possibly the femoral artery had been entered, but this could not be definitely ascertained at the time. Two days later a definite bruit and thrill was noted over the right femoral area, but no pulsating mass or interference with the circulation of that extremity; and an increase in pulse rate could not be detected. The thrill and bruit continued for a period of 48 hours. Five days after the attempted insertion of the femoral catheter, at the

TABLE 6. *Fate of Retained Tubing*

Patient	Age	Site	Cause for Retention	Result
F. J. L.	24	Rt. Fem.	3 cm. length of catheter cut off by bevel of needle and remained in situ. on removal of the catheter.	Fatal. Septic (M. pyog.) thrombophlebitis.
C. B.	23	Rt. Fem.	Cut off flush with skin at time of dressing change.	Fatal. Septic (M. pyog.) thrombophlebitis.
C. H.	18	Rt. Fem.	13 inches cut off by Huber point needle and never found in spite of exploration.	No signs or symptoms have been retained since April, 1955.

TABLE 7. *Septic Thrombosis Due to Catheter and Contributing to or Actually Being Direct Cause of Death*

Patient	Age and Sex	Site	Duration	Remarks
F. J. L.	24—M	Rt	76 days	On removal of femoral catheter, tubing not measured. Persistent tenderness developed and remained in right femoral area. Pos. Bl. cultures for M. Pyogenes began 3 weeks later and persisted until death. Only 6% uncovered. Progressive swelling and tenderness of right extremity. At post had septic thrombus. 3 cm. length of retained tubing to right femoral.
C. B.	23—M	Rt	51 days	Apparently sheared off during dressing change after being in 14 days. Not measured. 4 days later began intermittently positive Bl. cult. (M. pyog.) in spite of eventually having 95% of burn area grafted. Never any swelling of extremities or femoral tenderness. At autopsy had septic thrombophlebitis secondary to retained catheter fragment in rt. femoral.
O. W.	23—M	Left and Rt	23 days	Catheter in place 23 days and then moved to opposite vein. Minimal tenderness in area, but with only 15% granulating surface remaining developed persistent Pos. Bl. Cult. (Pseudomonas) and granulations, grafts and subcutaneous tissue began disappearing. Died of septicemia. At autopsy had septic thrombus with extension around catheter.
F. S.	19—M	Left and Rt	10 days each	Catheters in place for total of 30 days. Two weeks later had edema of both lower extremities and rapidly developed collateral caput medusae and pos. bl. cult. (M. pyog.). At autopsy had septic thrombus.

time of autopsy, the suspected A-V fistula could not be demonstrated. There were small adherent clots in the area, but no actual passage was noted.

In three patients, portions of the polyethylene tubing were inadvertently left within the body. Table 6 shows one of the patients who is still alive and has no symptoms two years after insertion of the femoral catheter. The other two patients died as a result of a fatal septic thrombophlebitis directly attributable to the retention of the polyethylene tubing.

Thrombosis would appear to be the most frequent complication and, without doubt, the most serious (Table 4). Figure 4 shows the location and distribution of the thromboses encountered at autopsy in 18 cases. Several of these thromboses were quite extensive. Four of these patients developed an extensive septic thrombophlebitis that was undoubtedly the direct cause of death.

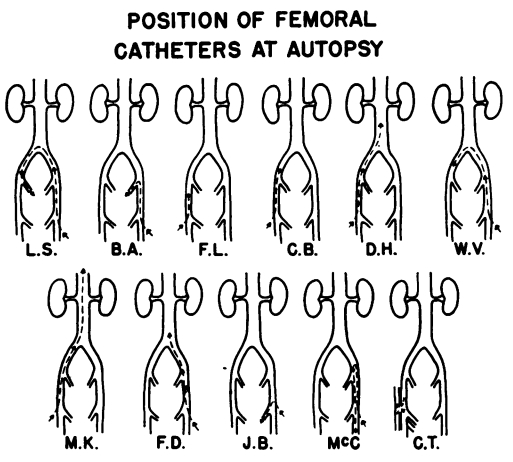

FIG. 3.

In all four patients, a persistent septicemia occurred as a result of septic thrombophlebitis during a period in the patient's convalescence when only a very small amount of body surface was not covered with skin (five to 15 per cent). Under the circumstances of such a small granulating surface, experience at this Unit confirms the belief that septicemia does not develop as a result of the burn alone. It would appear that these patients were combating their thermal injury without difficulty; and they probably would have recovered had it not been for the development of the fatal complication of a septic thrombophlebitis secondary to the use of intravenous femoral polyethylene tubing. This is adequately illustrated in Table 7.

During the period when the femoral catheters were in use, in some of the patients an attempt was made to prevent the appearance of the clots in the tubing by using a one-tenth per cent heparin solution injected intermittently through the lumen of the tubing. Table 8 indicates that this procedure was of no significance in the incidence of complications and it was not considered to be of any value. One would anticipate this since localized heparinization is of no value unless the concentration is raised to such levels that it produces systemic heparinization.

It is interesting to note that only one patient developed a thrombosis among the 15 patients suffering from renal insufficiency in whom 24 catheters were used in the femoral vein for periods from two to 21 days. Death due to septicemia occurred in ten of these 15 patients. It is therefore doubtful that the presence of septicemia from other causes would lead to an increased incidence of complications in the use of femoral catheters.

Summary

The complications encountered in the use of intravenous femoral polyethylene catheters at Surgical Research Unit have been presented. From this experience it is obvious that the routine use of this as a route of administration of intravenous fluids is to be avoided. Femoral catheters should be utilized only when all other methods of intravenous infusion have been exhausted and when in use should remain in a single femoral location for not more than seven to ten days.

The most serious complication encountered was that of septic thrombophlebitis. It is unlikely that this thrombus is septic

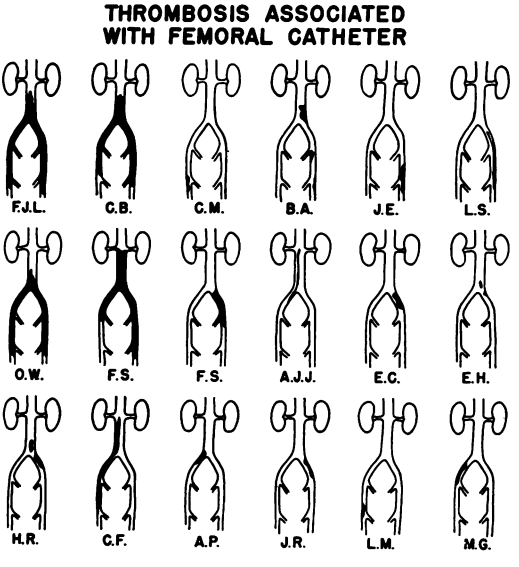

FIG. 4.

TABLE 8. *Effect of Heparin on Incidence Complications*

	Right	Left
Heparin used	7	4
Heparin not used	7	12

at its inception, but in the presence of infection in the blood stream becomes septic and remains so when the original source of blood stream contamination such as a burn wound has cleared. If septicemia occurs in a burned patient in whom there is only a small amount of granulating surface present and this patient has at that time or has had previously had a femoral catheter used, it is quite likely that the source of septicemia is a septic femoral thrombophlebitis resulting from the use of the femoral polyethylene tubing.

Acknowledgment

This article is drawn from the accumulated experience of the personnel of the U. S. Army Surgical Research Unit, Brooke Army Medical Center, Fort Sam Houston, Texas, from 1950 through January 1957. It represents the work of many fine doctors without whose efforts these pages would not have been possible, and to whom the author wishes to express his greatest appreciation.