

ATLAS OF
SURGERY
IN THE FIRST SIX
MONTHS OF LIFE

S. FRANK REDO

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PREFACE

This atlas was conceived as a companion work to the volume *Principles of Surgery in the First Six Months of Life*, which discussed the problems commonly encountered during this period of life but did not specifically illustrate the techniques of the surgical procedures designed and employed to treat them.

Although the book is written so that even those with only a limited exposure to pediatric surgery can understand the steps of the various operations, it is designed for surgeons at all levels of training and experience and for nurses, students, residents and pediatricians who, by knowing what is done at surgery, are better able to manage patients postoperatively and can discuss, orient and advise parents more adequately regarding the contemplated surgery. The operations used to manage the more commonly encountered problems are illustrated. Procedures which are required infrequently in the first six months of life have been omitted intentionally. The surgery for neuroblastoma, intraabdominal tumors, cystic hygroma and extrahepatic biliary tract atresia has not been included since these problems manifest themselves in such a variety of ways that description of a standardized surgical approach is not practical. The operations discussed are those I have used personally. They are, obviously, extensions, variations or modifications of classical techniques based on sound surgical principles. As I have said so often to my residents, "you may not find this the best way to do it, but at least know a way by which it can be done."

This atlas has been planned to include a description of the operation or the condition for which the surgery is to be performed, and in some cases, the methods for making the diagnosis; the preoperative considerations, the surgical technique, suggestions for postoperative management, comments that include complications that may ensue, and remarks (based on personal experience) concerning some of the pitfalls to anticipate and avoid.

The drawings have been chosen to illustrate salient features of the surgical technique which is described in step-by-step fashion.

A surgeon is the product of reading, training and exposure to other surgeons. Largely, however, technique is developed over the years from helping others, learning basic principles and applying this knowledge to both the common and uncommon problems with which one may be confronted. Sometimes much can be learned from those with lesser training and experience, whose very lack in these areas may make for innovative (and often helpful) suggestions in management.

Thus, I wish to give thanks to those residents who have been on my service over the years for the many contributions they have made. In addition to ex-

pressing my appreciation to Dr. Frank Glenn who taught me the principles of surgery, I would like to express my deep and warm respect to Dr. William A. Barnes, with whom I have worked for more than two decades on various surgical research endeavors. He contributed much to my interest and development in surgery.

I wish also to thank most sincerely Mr. Peter Ng, the artist, who made the concept of this atlas a reality. He was willing at all times to come without warning to the operating room, sketch book in hand; then, balanced precariously on a ladder, he would make note of the operation being performed. His cooperation, reliability and affableness made the development of this atlas a pleasant undertaking.

Last, but not least, I want to take this means of expressing to my wife, Maria, my deepest and warmest feelings for her patience and understanding during the preparation of this book. Relegated, for quite a while, to the periphery of my interests, she took it in stride and waited for tomorrow and the end of deadlines. This is tomorrow, Maria. Thanks.

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VENOUS CUTDOWN PROCEDURES

9. A small incision is made through the skin and subcutaneous tissues about 2 cm distal to the main incision, and a curved mosquito clamp is inserted through this incision and directed upward until the end of the clamp enters the main wound. The tip of the polyethylene tube is grasped and pulled through the subcutaneous tunnel so that the catheter will exit from the small distal wound (Fig. 1-14).

10. An alternate method that may be used to lead the catheter out through a more distal site is to make a short incision 2 cm below the main wound and to direct a lamp distally from the wound into the short incision, grasping the end of the catheter and drawing it into the main operative field (Fig. 1-15).

11. The vein is then opened as described earlier, and the catheter is introduced and secured as has been described (Fig. 1-16).

12. The main wound is closed with interrupted sutures of 3-0 silk or polyethylene, and the catheter is sutured to the skin with the same type of suture material (Fig. 1-17).

13. Povidone-iodine (Betadine) ointment is applied over the wounds, which are then covered with a small sterile dressing.

Fig. 1-14. In most instances the operation is done under local anesthesia (0.5-1.0% lidocaine).

PERIPHERAL VENOUS CUTDOWN

The important operative steps are the same regardless of the vein that is chosen for the cutdown. Preferably the greater saphenous vein at the ankle is chosen for peripheral cutdown. However, in infants weighing 1000 g or less, this vein is usually so small that it is impossible to cannulate. In such patients the greater saphenous vein in the femoral region may have to be used, or the femoral vein itself. Not infrequently, the saphenous vein is the ankle or groin may have been used already, often on both sides, and in such cases the cutdown may have to be done using a vein in the antecubital region or the lateral jugular vein (Fig. 1-18).

SURGICAL TECHNIQUE

1. The skin over the vein chosen for the cutdown is washed, prepared with povidone-iodine solution, and suitably draped.

Venous cutdown procedures are of two major types: 1) peripheral—primarily for the introduction of fluids or blood and occasionally for certain types of solutions for hyperalimentation; and 2) central—performed expressly for the purpose of providing a route for total parenteral nutrition.

The usual sites for a peripheral venous cutdown are the greater saphenous vein at the ankle or in the femoral region; the antecubital, cephalic, or basilic vein in the antecubital area; or, less often, the external jugular vein or the femoral vein itself. Sites for a central venous cutdown are the external jugular, internal jugular, greater saphenous in the groin, or femoral vein.

For peripheral venous cutdown a polyethylene tube is employed usually; for central venous cutdown a radiopaque polymeric silicone (Silastic) catheter is used.

PREOPERATIVE CONSIDERATIONS

No special preoperative measures are required. Special instruments of fine proportions are important (Fig. 1-2). In most infants the operation is done under local anesthesia (0.5–1.0% lidocaine).

PERIPHERAL VENOUS CUTDOWN

The important operative steps are the same regardless of the vein that is chosen for the cutdown. Preferably the greater saphenous vein at the ankle is chosen for peripheral cutdown. However, in infants weighing 1000 g or less, this vein is usually so small that it is impossible to cannulate. In such patients, the greater saphenous vein in the femoral region may have to be used, or the femoral vein itself. Not infrequently, the saphenous vein in the ankle or groin may have been used already, often on both sides, and in such cases the cutdown may have to be done using a vein in the antecubital region or the external jugular vein (Fig. 1-1A).

SURGICAL TECHNIQUE

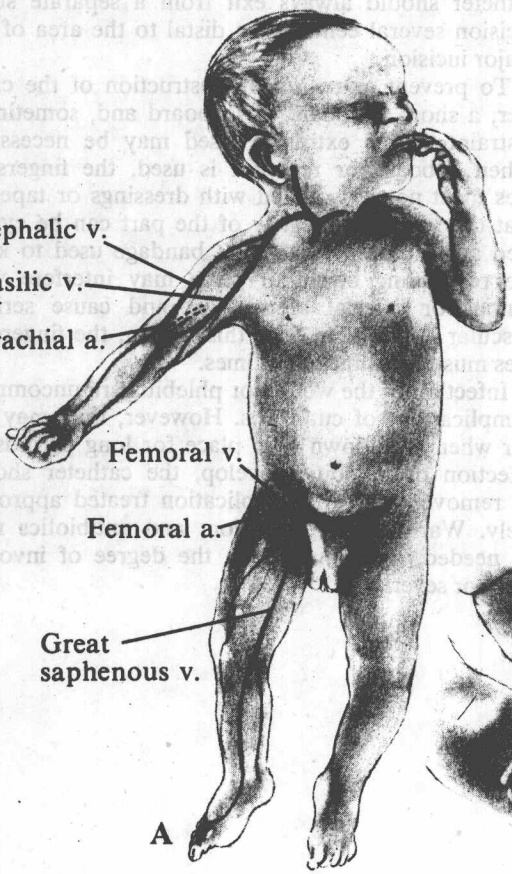
1. The skin over the vein chosen for the cutdown is washed, prepared with povidone-iodine solution, and suitably draped.

2. Lidocaine (0.5–1.0%) is injected into the skin and subcutaneous tissues for local anesthesia.
3. An incision is made through the skin and subcutaneous tissues overlying the vein (Fig. 1-1B).
4. By blunt dissection, the vein is identified and dissected free of surrounding adventitia.
5. The vein is mobilized and ligatures of 3-0 or 5-0 silk are placed proximal and distal, isolating a 0.5- to 1-cm portion of vein (Fig. 1-1C,D).
6. The ligature on the distal segment is tied down, a clamp is placed beneath the vein to steady it, and with a fine scalpel, a small transverse incision is made in the vein (Fig. 1-1E). (I have found that a 59-G Beaver eye blade is better for this than a number 11 blade in the tiny infant.)
7. Traction is made on the proximal ligature, and a fine forceps is used to elevate the portion of vein that has been incised, and a suitable size of polyethylene tube is threaded into the vein in a cephalad direction (Fig. 1-1F).
8. After the tube has been inserted a distance of 6–10 cm, the proximal ligature is tied down, securing the polyethylene catheter (Fig. 1-1G).
9. A small incision is made through the skin and subcutaneous tissues about 2 cm distal to the main incision, and a curved mosquito clamp is inserted through this incision and directed upward until the end of the clamp enters the main wound. The tip of the polyethylene tube is grasped and pulled through the subcutaneous tunnel so that the catheter will exit from the small, distal wound (Fig. 1-1H).
10. An alternate method that may be used to lead the catheter out through a more distal site is to make a short incision 2 cm below the main wound and to direct a clamp distally from the wound into the short incision, grasping the end of the catheter and drawing it into the main operative field (Fig. 1-1F¹).
11. The vein is then opened, as described earlier, and the catheter is introduced and secured as has been described (Fig. 1-1G¹).
12. The main wound is closed with interrupted sutures of 5-0 silk or polyethylene, and the catheter is fixed to the skin with the same type of suture material (Fig. 1-1I).
13. Povidone-iodine (Betadine) ointment is applied over the wounds, which are then covered with a small sterile dressing.

My practice has been never to bring the catheter out the main wound used to create the cutdown. The catheter should always exit from a separate small incision several centimeters distal to the site of the main incision.

To prevent infection of the catheter, a small dressing or cap should be used and, sometimes, a small dressing or cap may be necessary. When a catheter is used, the fingers or forceps should be used with dressings or tape, so that the catheter is not touched by the hands. It is important to keep the catheter dry. If the catheter is to be used for a long period, it should be changed at intervals. The degree of infection may be determined by the degree of infection.

Cephalic v.
Basilic v.
Brachial a.
Femoral v.
Femoral a.
Great saphenous v.



POSTOPERATIVE CONSIDERATIONS
The dressing is changed when necessary. Sutures are removed in 7-10 days. Care must be exercised to prevent accidental or careless removal of the catheter at the time of dressing changes or in the routine care of the infant.

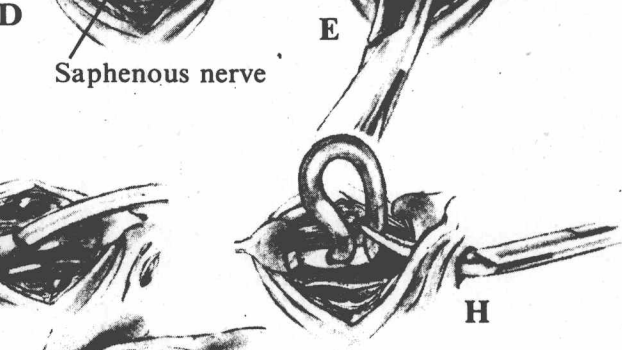
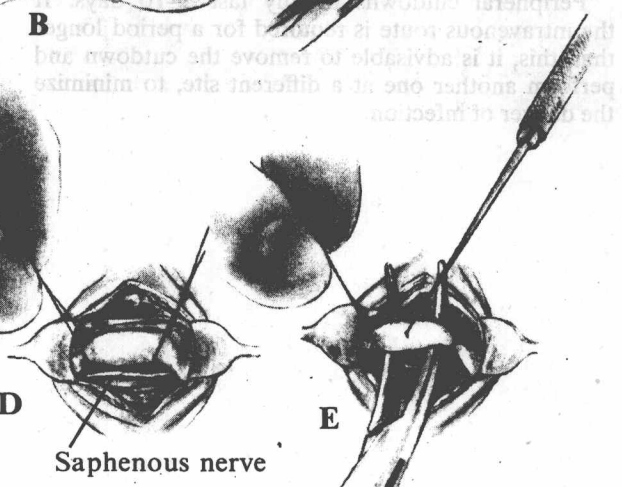
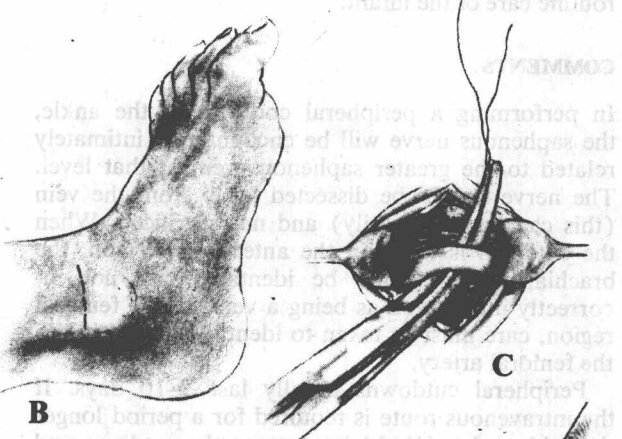


FIG. 1-1

POSTOPERATIVE CONSIDERATIONS

The dressing is changed when necessary. Sutures are removed in 7-10 days. Care must be exercised to prevent accidental or careless removal of the catheter at the time of dressing changes or in the routine care of the infant.

COMMENTS

In performing a peripheral cutdown at the ankle, the saphenous nerve will be encountered, intimately related to the greater saphenous vein at that level. The nerve should be dissected away from the vein (this can be done easily) and not sacrificed. When the cutdown is made in the antecubital region, the brachial artery should be identified and not incorrectly interpreted as being a vein. In the femoral region, care must be taken to identify and not injure the femoral artery.

Peripheral cutdowns usually last 7-10 days. If the intravenous route is required for a period longer than this, it is advisable to remove the cutdown and perform another one at a different site, to minimize the danger of infection.

My practice has been never to bring the catheter out the main wound used to create the cutdown. The catheter should always exit from a separate small incision several centimeters distal to the area of the major incision.

To prevent extrusion or obstruction of the catheter, a short armboard or legboard and, sometimes, restraint of the extremity used may be necessary. When a board or restraint is used, the fingers or toes must not be covered with dressings or tape, so that the vascular integrity of the part can be evaluated at all times. A too-tight bandage used to keep the restraining board in place may interfere with venous or arterial blood flow and cause serious vascular impairment. For this reason, the fingers or toes must be visible at all times.

Infection of the wound or phlebitis are uncommon complications of cutdowns. However, they may occur when a cutdown is in place for long periods. If infection or phlebitis develop, the catheter should be removed and the complication treated appropriately. Warm soaks, elevation, and antibiotics may be needed, depending upon the degree of involvement or severity.

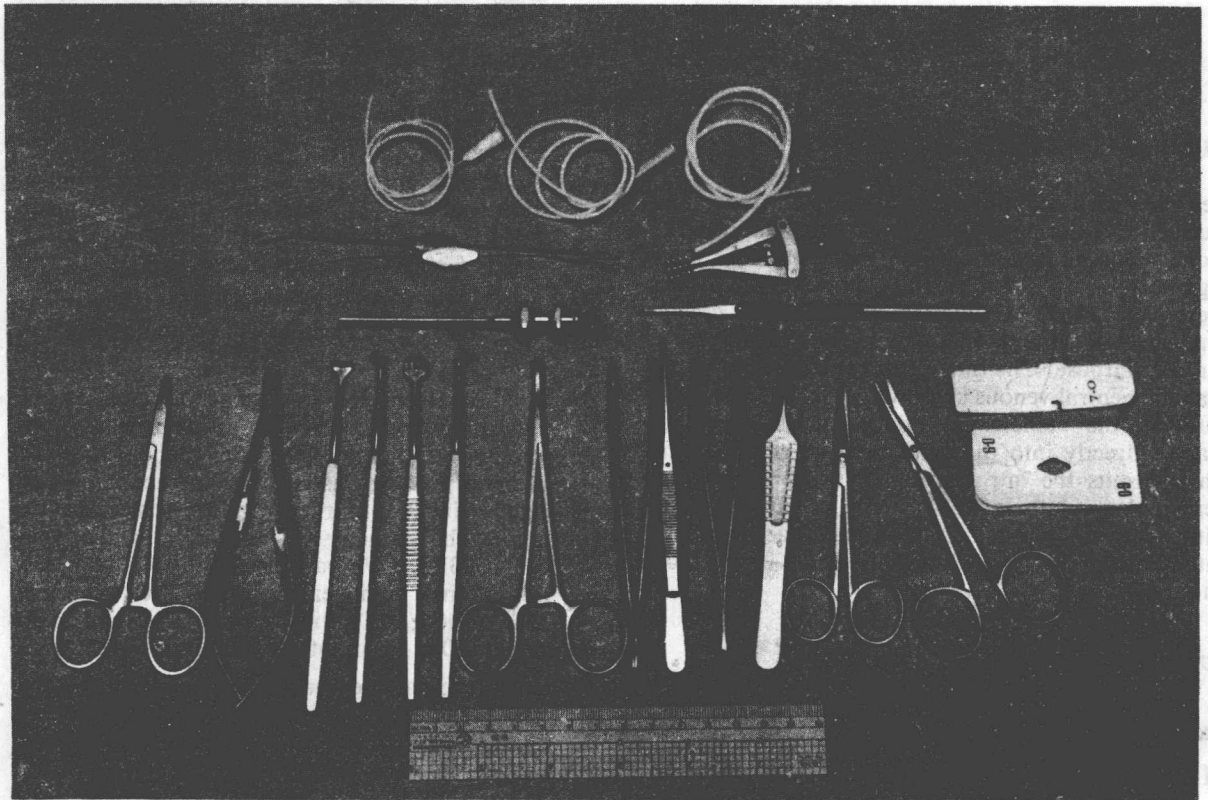


FIG. 1-2. Some of the fine instruments used for creating central venous cutdown. *At top*, Silastic catheters with hubs attached (0.025, 0.035, 0.045 in. internal diameter). *Second row, at left*, two fine lacrimal probes, used to dilate the vein; *at right*, a small self-retaining retractor. *Third row, at left*, large-bore (number 12) needle with stylet, used to make subcutaneous tunnel; *at right*, Beaver (59G) eye-knife. *At bottom*, fine needle holders, retractors, clamps, forceps, and scissors. *At far right*, 6-0 and 7-0 nonabsorbable sutures used for purse-string suturing when internal jugular vein is site of cutdown.

Many of the same instruments are useful, but not essential, in doing a peripheral venous cutdown.

1. The patient is placed in the supine position with the head of the bed elevated 30 degrees.
2. The patient's arm is extended to the side, and the arm is supported by a sandbag.
3. The skin is cleaned with 70% alcohol.
4. A 1-cm incision is made in the skin over the internal jugular vein.
5. The incision is deepened to the level of the vein.
6. The vein is dilated with a lacrimal probe.
7. A small self-retaining retractor is placed over the incision.
8. A large-bore needle with stylet is used to make a subcutaneous tunnel.
9. The needle is removed, and the stylet is left in place.
10. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
11. The incision is deepened to the level of the vein.
12. The vein is dilated with a lacrimal probe.
13. A small self-retaining retractor is placed over the incision.
14. A large-bore needle with stylet is used to make a subcutaneous tunnel.
15. The needle is removed, and the stylet is left in place.
16. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
17. The incision is deepened to the level of the vein.
18. The vein is dilated with a lacrimal probe.
19. A small self-retaining retractor is placed over the incision.
20. A large-bore needle with stylet is used to make a subcutaneous tunnel.
21. The needle is removed, and the stylet is left in place.
22. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
23. The incision is deepened to the level of the vein.
24. The vein is dilated with a lacrimal probe.
25. A small self-retaining retractor is placed over the incision.
26. A large-bore needle with stylet is used to make a subcutaneous tunnel.
27. The needle is removed, and the stylet is left in place.
28. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
29. The incision is deepened to the level of the vein.
30. The vein is dilated with a lacrimal probe.
31. A small self-retaining retractor is placed over the incision.
32. A large-bore needle with stylet is used to make a subcutaneous tunnel.
33. The needle is removed, and the stylet is left in place.
34. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
35. The incision is deepened to the level of the vein.
36. The vein is dilated with a lacrimal probe.
37. A small self-retaining retractor is placed over the incision.
38. A large-bore needle with stylet is used to make a subcutaneous tunnel.
39. The needle is removed, and the stylet is left in place.
40. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
41. The incision is deepened to the level of the vein.
42. The vein is dilated with a lacrimal probe.
43. A small self-retaining retractor is placed over the incision.
44. A large-bore needle with stylet is used to make a subcutaneous tunnel.
45. The needle is removed, and the stylet is left in place.
46. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
47. The incision is deepened to the level of the vein.
48. The vein is dilated with a lacrimal probe.
49. A small self-retaining retractor is placed over the incision.
50. A large-bore needle with stylet is used to make a subcutaneous tunnel.
51. The needle is removed, and the stylet is left in place.
52. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
53. The incision is deepened to the level of the vein.
54. The vein is dilated with a lacrimal probe.
55. A small self-retaining retractor is placed over the incision.
56. A large-bore needle with stylet is used to make a subcutaneous tunnel.
57. The needle is removed, and the stylet is left in place.
58. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
59. The incision is deepened to the level of the vein.
60. The vein is dilated with a lacrimal probe.
61. A small self-retaining retractor is placed over the incision.
62. A large-bore needle with stylet is used to make a subcutaneous tunnel.
63. The needle is removed, and the stylet is left in place.
64. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
65. The incision is deepened to the level of the vein.
66. The vein is dilated with a lacrimal probe.
67. A small self-retaining retractor is placed over the incision.
68. A large-bore needle with stylet is used to make a subcutaneous tunnel.
69. The needle is removed, and the stylet is left in place.
70. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
71. The incision is deepened to the level of the vein.
72. The vein is dilated with a lacrimal probe.
73. A small self-retaining retractor is placed over the incision.
74. A large-bore needle with stylet is used to make a subcutaneous tunnel.
75. The needle is removed, and the stylet is left in place.
76. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
77. The incision is deepened to the level of the vein.
78. The vein is dilated with a lacrimal probe.
79. A small self-retaining retractor is placed over the incision.
80. A large-bore needle with stylet is used to make a subcutaneous tunnel.
81. The needle is removed, and the stylet is left in place.
82. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
83. The incision is deepened to the level of the vein.
84. The vein is dilated with a lacrimal probe.
85. A small self-retaining retractor is placed over the incision.
86. A large-bore needle with stylet is used to make a subcutaneous tunnel.
87. The needle is removed, and the stylet is left in place.
88. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
89. The incision is deepened to the level of the vein.
90. The vein is dilated with a lacrimal probe.
91. A small self-retaining retractor is placed over the incision.
92. A large-bore needle with stylet is used to make a subcutaneous tunnel.
93. The needle is removed, and the stylet is left in place.
94. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.
95. The incision is deepened to the level of the vein.
96. The vein is dilated with a lacrimal probe.
97. A small self-retaining retractor is placed over the incision.
98. A large-bore needle with stylet is used to make a subcutaneous tunnel.
99. The needle is removed, and the stylet is left in place.
100. A Beaver (59G) eye-knife is used to make a 1-cm incision over the tunnel.

CENTRAL VENOUS CUTDOWN

Central venous cutdowns are performed almost exclusively for the purpose of hyperalimentation. The most common routes are the external or internal jugular vein. In some patients, however, in whom these veins have been used already, the greater saphenous or femoral vein may have to be employed for this purpose. The difference between the peripheral and central venous cutdown is that in the central cutdown the catheter introduced via the vein is placed directly into the vena cava or right atrium. This permits the introduction of concentrated, hyperosmolar solutions into a vein of large caliber, with great volume and flow. A radiopaque Silastic catheter is used. The operation is done under local anesthesia.

SURGICAL TECHNIQUE

External Jugular Vein

1. The patient is supine with the head turned to a full lateral position. After washing, preparation with povidone-iodine, and suitable draping, 0.5% lidocaine is infiltrated into the skin and subcutaneous tissues overlying the junction of the middle and distal thirds of the sternocleidomastoid muscle.
2. After adequate anesthetization, an incision is made (Fig. 1-3A).
3. The incision is carried down to the external jugular vein. Ideally, the external jugular vein should be mobilized just distal to the level at which the posterior external jugular vein joins it (Fig. 1-3B). (I prefer this site since, where the tributary joins the more cephalad portion of the external jugular vein, the diameter of the vessel is larger, facilitating insertion of the catheter.)
4. By blunt dissection, the tributaries to the external jugular vein are mobilized and a 3-0 silk ligature is placed about each tributary and about the more distal external jugular vein proper (Fig. 1-3C). (If the external jugular is exposed distal to the junction of the tributaries, the external jugular vein proper is mobilized and a ligature is placed about the vein proximally and distally. Further steps in that procedure are the same as those that follow.)
5. The ligatures on the proximal (cephalad) tributaries of the external jugular vein (or the external jugular vein proper, if tributaries not used) are tied down.
6. Traction is applied to the distal ligature, and a short transverse or longitudinal incision is made through the anterior wall of the vein with a fine scalpel (Beaver eye blade) (Fig. 1-3D).
7. A lacrimal probe is inserted through the opening made into the vein, to dilate the lumen (Fig. 1-3E).
8. The vein is grasped with a fine vascular forceps and a radiopaque Silastic catheter is inserted into the venotomy. The estimated distance the catheter is to be passed (level of upper part of right atrium) is marked with a 5-0 silk ligature before the catheter is inserted into the vein (Fig. 1-3F). (We have used catheters of 0.025 in. internal diameter in infants weighing less than 1500 g, 0.035 in. in those less than 2500 g, and 0.045 in. in infants heavier than 2500 g.)
9. When the catheter has been introduced to the site previously marked on the catheter, the ligature on the vein is tied down to hold the catheter in place (Fig. 1-3G).
10. After instillation of 0.5% lidocaine into the skin and subcutaneous tissues in the pectoral region, at a level between the clavicle and the nipple, a short incision is made and a large-bore (number 12) needle with a stylet is introduced through the incision and passed subcutaneously above the clavicle into the neck wound (Fig. 1-3H).
11. The stylet is removed from the needle, the catheter is detached from its proximal hub and passed through the needle to draw it out through the subcutaneous tunnel created by passage of the large-bore needle (Fig. 1-3I).
12. The catheter exiting from the pectoral skin incision is formed into a loop and fixed to the skin with several sutures of 5-0 polyethylene (Fig. 1-3J).
13. The incision in the neck is closed with a few 4-0 polyglycolic acid sutures to approximate the subcutaneous tissues and 5-0 polyethylene to join the skin edges.
14. Povidone-iodine ointment is placed over the neck wound and the exit site of the catheter, and dry dressings are applied.

1-4B). (The carotid artery is medial to the vein and between the vagus nerve)

2. The external jugular vein is ligated and a transverse incision is made in the skin through the area circumscribed by the

scalp. (The external jugular vein is short and the incision is made in the skin through the area circumscribed by the

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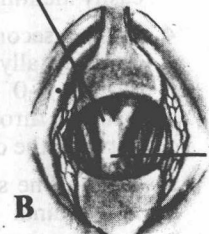
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scalp. (The external jugular vein is short and the incision is made in the skin through the area circumscribed by the



Posterior external jugular v.



External jugular v.

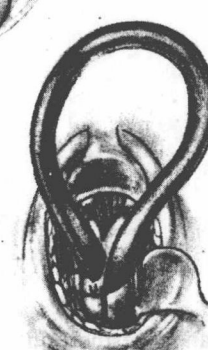
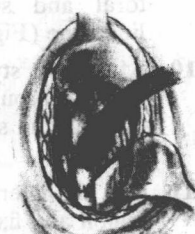
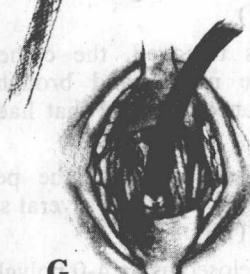
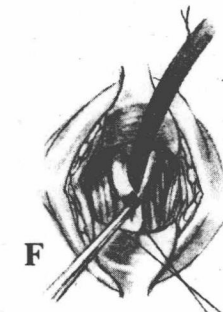
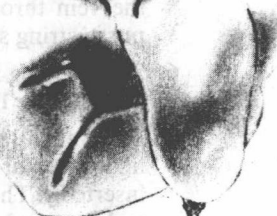
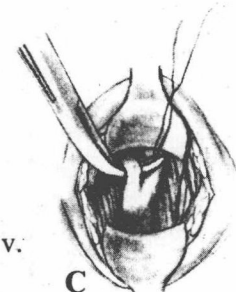


FIG. 1-3

Internal Jugular Vein

The infant is positioned, prepared, and anesthetized as described in the foregoing section on the external jugular vein.

1. A transverse incision is made over the sternocleidomastoid muscle at the level of the junction of the muscle's middle and lower thirds. The incision is carried down through the platysma to expose a portion of the strap muscles as well as the medial margin of the sternocleidomastoid muscle (Fig. 1-4A).
2. The sternocleidomastoid muscle is retracted laterally. The carotid sheath is spread bluntly, and the internal jugular vein identified (Fig. 1-4B). (The carotid artery is medial to the vein and between the two lies the vagus nerve.)
3. The internal jugular vein is mobilized and a 3-0 silk ligature is placed about it (Fig. 1-4C). The carotid artery and vagus nerve can be easily identified and protected from injury.
4. After a second 3-0 silk ligature has been placed more distally, to provide control of the vein, a 6-0 or 7-0 suture is placed, in purse-string fashion, through the anterior wall of the vein between the control ligatures (Fig. 1-4D).
5. With a fine scalpel (Beaver eye blade), a short longitudinal or transverse incision is made in the vein through the area circumscribed by the purse-string suture (Fig. 1-4E).
6. The opening in the vein is dilated with a lacrimal probe (Fig. 1-4F).
7. The vein is grasped near the venotomy with a fine vascular forceps and the Silastic catheter inserted. (The estimated distance the catheter is to be passed—to the level of the upper part of the right atrium—is marked with a 5-0 silk ligature before the catheter is inserted into the vein) (Fig. 1-4G).
8. After the catheter has been introduced the desired distance, the purse-string suture is tied down and the ligatures placed for control of the vein are removed (Fig. 1-4H).
9. A large-bore (number 12) needle with stylet is introduced subcutaneously, after infiltration of the skin and subcutaneous tissue in the pectoral and subclavicular regions with 0.5% lidocaine (Fig. 1-4I).
10. After the stylet is removed, the catheter is placed through the needle and brought out through the subcutaneous tunnel that had been made.
11. The catheter is then looped in the pectoral region and fixed to the skin with several sutures of 5-0 polyethylene (Fig. 1-4J).
12. The neck wound is closed using 4-0 polyglycolic acid sutures to approximate subcutaneous tissue and 5-0 polyethylene sutures to approximate the skin.
13. A chest roentgenogram is obtained in the operating room to check the location of the catheter. The external appearance should approximate that illustrated in Figure 1-4K.
14. Povidone-iodine ointment is applied to the area of the incision and the exit site of the catheter; both sites are then covered with sterile dressings.

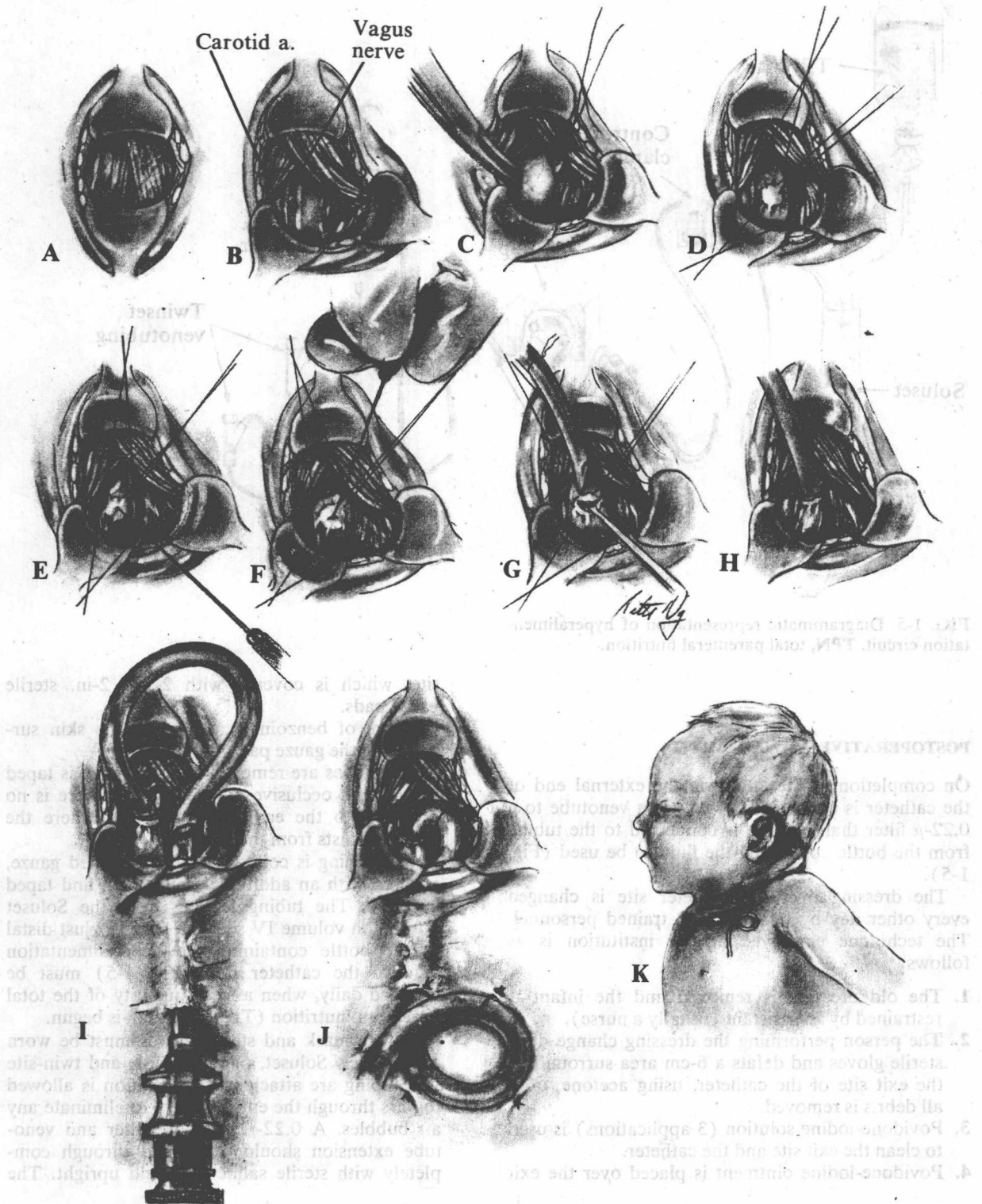


FIG. 1-4

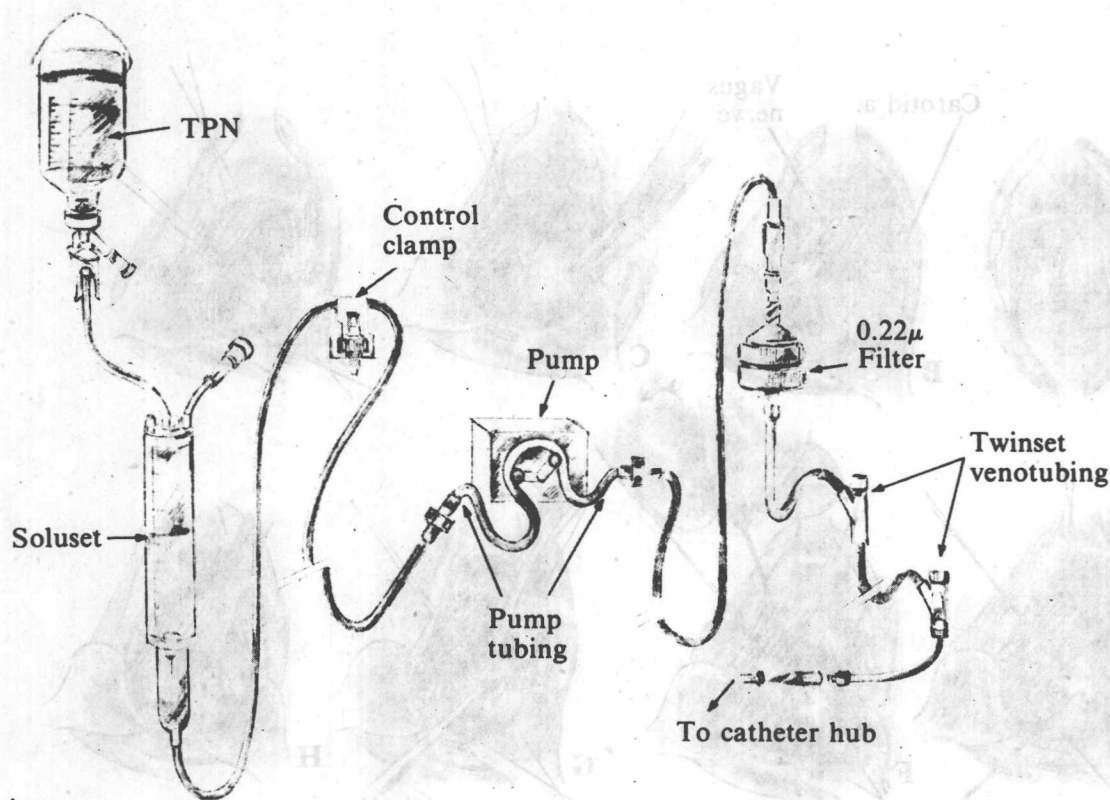


FIG. 1-5. Diagrammatic representation of hyperalimentation circuit. TPN, total parenteral nutrition.

POSTOPERATIVE MANAGEMENT

On completion of the cutdown, the external end of the catheter is connected by way of a venotube to a 0.22- μ filter that, in turn, is connected to the tubing from the bottle containing the fluid to be used (Fig. 1-5).

The dressing over the catheter site is changed every other day by qualified and trained personnel. The technique employed at our institution is as follows:

1. The old dressing is removed and the infant is restrained by an assistant (usually a nurse).
2. The person performing the dressing change dons sterile gloves and defats a 6-cm area surrounding the exit site of the catheter, using acetone, until all debris is removed.
3. Povidone-iodine solution (3 applications) is used to clean the exit site and the catheter.
4. Povidone-iodine ointment is placed over the exit

site, which is covered with 2- × 2-in. sterile gauze pads.

5. Tincture of benzoin is applied to the skin surrounding the gauze pad.
6. Sterile gloves are removed and the gauze is taped down in an occlusive manner so that there is no exposure to the environment except where the catheter exists from the gauze.
7. Excess tubing is coiled over the occluded gauze, covered with an additional gauze pad, and taped in place. The tubing leading from the Soluset (precision volume IV set with burette) just distal to the bottle containing the hyperalimentation fluid to the catheter hub (Fig. 1-5) must be changed daily, when a fresh quantity of the total parenteral nutrition (TPN) solution is begun.

A face mask and sterile gloves must be worn while a new Soluset, pump, tubing, and twin-site venotubing are attached. The solution is allowed to pass through the entire system to eliminate any air bubbles. A 0.22- μ millipore filter and venotube extension should be flushed through completely with sterile saline and held upright. The