Surgery of Large Inaccessible Arteriovenous Fistulas *

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OF THE MANY OPERATIONS performed in surgical practice, none is fraught with greater difficulty than that for large arteriovenous fistulas located in areas other than the extremities. These operations entail excessive operative blood loss. Even when blood replacement is carefully equated with loss, there are hazards of massive transfusion.[2]

Extensive operative hemorrhage is partially caused by high venous pressure in the area of the fistula. This is relatively unaffected by position of the patient. Pulsatile bleeding of oxygenated blood is encountered even when transecting small ordinarily bloodless venules. Extensive collaterals have developed if the fistula has been present for any length of time.

Tourniquets can be effectively employed to control bleeding in the extremities. After the fistula has been disconnected, venous pressure falls; and, although bleeding may be considerable after removal of the tourniquet, it is easily controlled. In this type of operation, it is important not to rely on automatic tourniquets of the inflatable type and to be sure that the tourniquet is well away from the operative field. In obese patients, slippage of the tourniquet on the thigh is a serious problem. Although blood loss is usually controllable in extremity fistulas, it may become as severe as in other areas if tourniquet failure occurs.

Recently, two massive arteriovenous fistulas were operated upon. One was a longstanding communication between the common iliac artery and vein in a patient in heart failure. This patient expired on the operating table after massive bleeding climaxed by cardiac arrest. This case stimulated an investigation into methods of management of large inaccessible arteriovenous communications and led to a method successfully used in the second case.

In the first unsuccessful instance, operative occlusion of the common iliac artery proximal to the fistula did not obliterate pulsation below the occluded artery. Holman recommended double occlusion of the vessel above the fistula.[1] This was done with tapes to form a tourniquet rather than

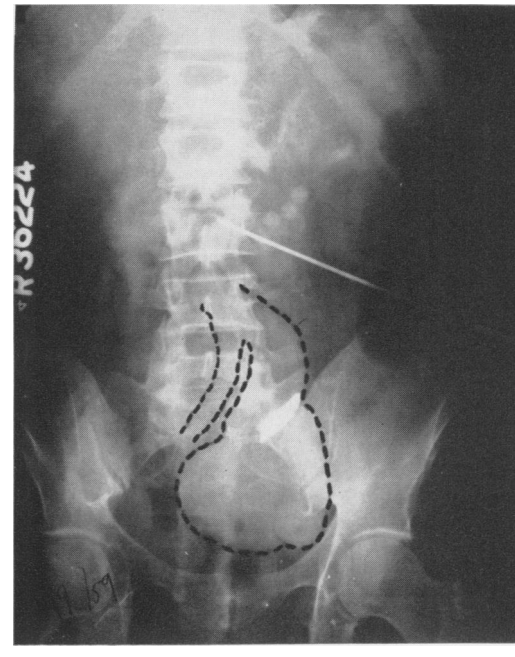

FIG. 1. Aortogram showing dilatation of left common iliac artery and aneurysmal dilatation of vein beneath a large piece of shrapnel. Opacification of the vessels is scanty even with concentrated dye because of rapidity of flow through the fistula.

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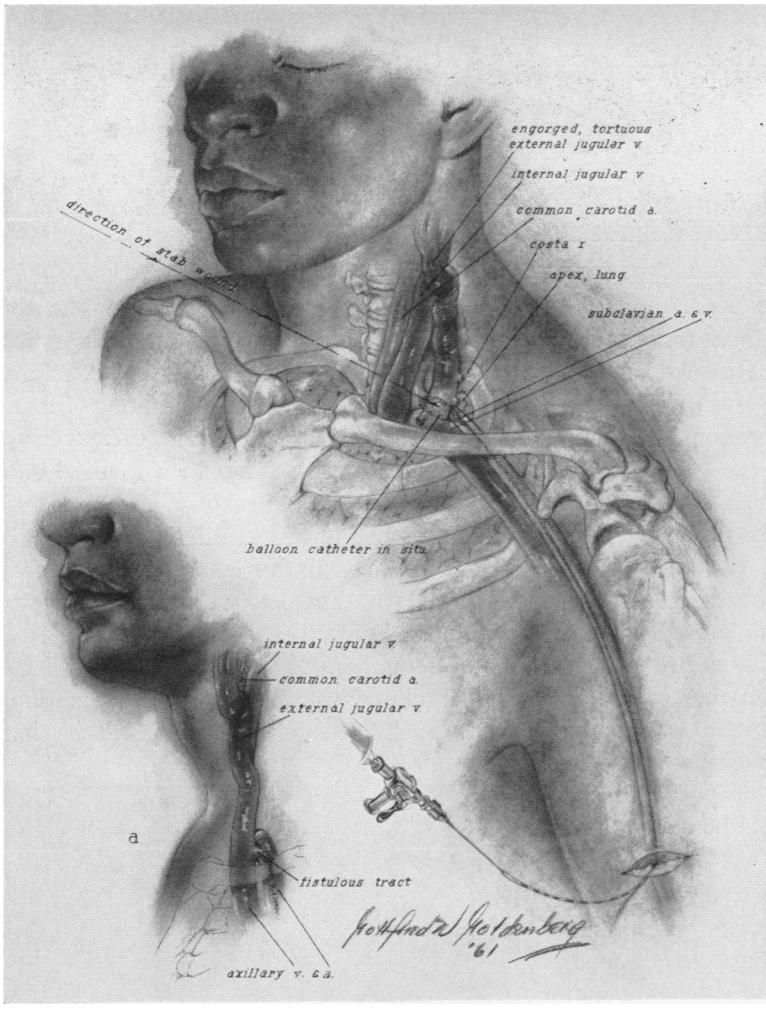

FIG. 2. A Woodruff catheter is inserted through the open brachial artery and the balloon inflated at the region of the fistula. a. Dilated vessels anterior to the fistula are shown.

tapes tied over rubber tubing as suggested by Holman. In other words, collaterals were so extensive that flow around the main vessel was sufficient to maintain pulsatile flow. The arteriovenous communication in the first patient was posterior and it was impossible to expose the area. A large piece of shrapnel was protruding through the vein into the artery. The common iliac artery was dilated to more than twice normal size. Its wall was so thinned it resembled a vein rather than an artery. This situation has been observed in other cases of long duration in the extremities. The iliac veins in this patient were so dilated that they filled the entire right half of the pelvis with what appeared to be a large blue tumor. The size of the emerging dilated vein can be seen in the preoperative arteriogram (Fig. 1). Bleeding during the operation was profuse and even though blood loss was being properly monitored, replacement was so massive that cardiac arrest occurred during replacement.

After this first experience, a method was devised for occlusion of the fistulous tract by a balloon introduced into the distal vessel. The fistula in the second patient was inaccessible for application of a proximal tourniquet and in addition was of considerable size. The communication lay between subclavian artery and internal jugular vein

and measured 6.0 mm. in diameter. The brachial artery was opened and a Woodruff urethral catheter * was inserted and passed retrograde to the subclavian artery as is shown in Figure 2. When the balloon was inflated, the bruit immediately disappeared and there was slowing of the pulse rate. A radiograph of the catheter *in situ,* with the balloon filled with radiopaque material is shown in Figure 3. The fistula was exposed through a U-shaped incision and a reflected flap from the chest wall as is shown in Figure 4a. The middle half of the clavicle was excised subperiosteally. The dilated external jugular vein and subclavian

* Special catheter has been devised and is manufactured by U. S. Catheter Co., Glen Falls, N. Y.

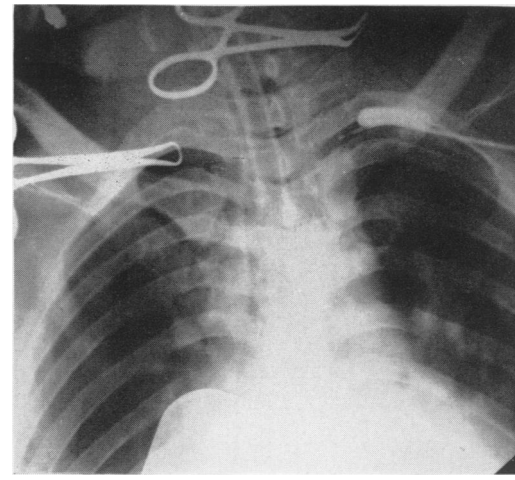

FIG. 3. Inflated Woodruff catheter is shown in the radiogram *in situ.* The bruit and thrill disappeared immediately upon inflation of the catheter.

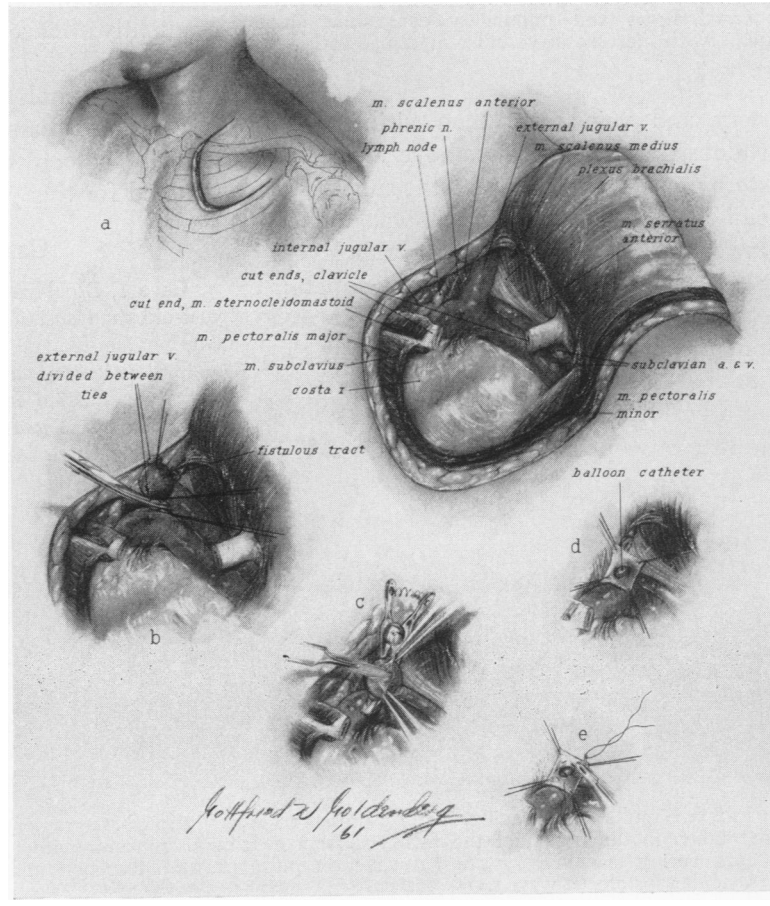

FIG. 4a. A "U" shape flap was raised from chest wall. b. Fistula is exposed after resection of mid-part of clavicle. Veins around fistula are ligated until segment of vein over fistula dressings as a small aneurysm. c. Isolated venous segment above fistulous tract is opened. d. Fistulous tract is visualized with inflated balloon in depths of opening. e. Fistulous tract is closed with a modified end aneurysmorrhaphy.

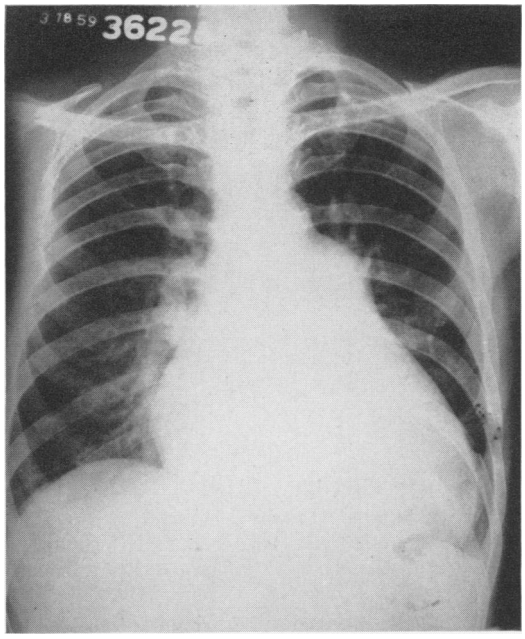

FIG. 5. Admission chest x-ray showing markedly enlarged heart and pulmonary congestion and edema with increase in vascular markings of lung.

artery and vein were then visible. The fistulous tract opened just above where the external jugular vein entered the subclavian vein. The external jugular vein was divided between ties to free it from the subclavian vein as shown in Figure 4b. The superior portion of the external jugular vein was similarly ligated. The vein overlying the fistulous tract was then completely freed and a bulldog clamp was placed just above the fistulous opening as in Figure 4c. The venous portion was entered into and the balloon catheter was seen to bulge into the vein as is shown in Figure 4d. The fistulous defect was closed as is shown in Figure 4e similar to the technic employed in endoaneurysmorrhaphy. After successful closure of the fistulous tract, the musculocutaneous flap was replaced and sutured. A suction catheter was placed under the flap. No attempt was made to splint the shoulder or to repair the defect in the clavicle. The patient made an uneventful recovery with perfect function of the extremity and shoulder.

Intra-artery balloon tamponade rendered the operative management of the second communication a simple matter. Blood loss was not excessive and hemostasis in the area was always perfect because the subclavian artery was occluded. Intra-arterial balloon tamponade should become a more frequently utilized procedure in arterial surgery since it is an excellent method of achieving complete hemostasis without the necessity for dissection of a large vessel. A special balloon catheter has been constructed for this purpose.

Case Reports

Case 1, Brooklyn VA Hosp., A-1323. This 49-year-old man sustained a shrapnel wound in the left inguinal-femoral region 15 years ago. Edema of the left lower extremity appeared eight months prior to admission followed by congestive failure with bilateral leg edema. He was admitted in severe congestive failure with generalized edema

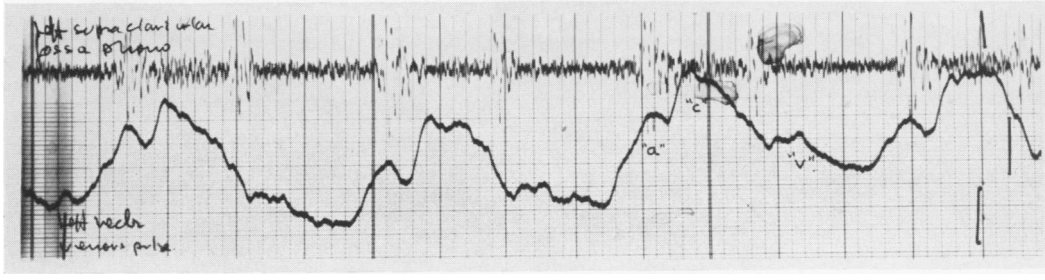

FIG. 6. Simultaneous tracing of pulse pressure (lower) and phonogram (upper) are shown. The tracings taken in the region of the fistula show a continuous murmur with two peaks in amplitude. One occurs during auricular systole (a wave on pulse pressure tracing); and the other occurs just after ventricular systole (c wave).

and bilateral pleural effusion. A continuous murmur was heard over both femoral arteries. Blood pressure rose from 140/40 to 140/80 after compression of the left external iliac artery. Simultaneously, the murmur disappeared and the pulse slowed. The EKG showed right ventricular hypertrophy. Chest x-rays revealed cardiac enlargement. An aortogram revealed an aneurysmatic mass filling the pelvis (Fig. 1) with a piece of shrapnel overlying the left external iliac artery and vein. There was practically no visualization of the aorta or the fistula itself. With medical therapy, the generalized edema disappeared, persisting in the left lower extremity.

At operation the left common iliac artery was thinned and dilated to the usual size of an abdominal aorta. The left common iliac vein was aneurysmally dilated and completely filled the left side of the pelvic cavity. The posterior wall of the left common iliac artery communicated with the anterior wall of the left common iliac vein through a 2.0 cm. defect which was partially obturated by a shiny pointed fragment of shrapnel. Severe hemorrhage started during the dissection of the aneurysm and was impossible to control in spite of the fact that the left common iliac artery had been previously isolated and secured with a tourniquet. Cardiac arrest occurred during massive blood replacement. Resuscitation was unsuccessful.

Case 2, Brooklyn VA Hosp. A-11227. Three months prior to admission, this 28-year-old man was stabbed in the left supraclavical fossa. He complained of pain, numbness and tingling in the fingers of his left hand. There was a constant buzzing noise over the left shoulder. His physical condition was excellent. Blood pressure was 106/70 and the pulse was 80 and regular. Veins in the left cervical region were distended even in upright position. The left supraclavicular fossa bulged slightly. A continuous thrill and a continuous machinery-like murmur radiated into the neck, chest and opposite supraclavicular region. The heart was normal. EKG indicated left ventricular enlargement. Chest x-rays were normal. A pulse tracing over the expanding mass showed a systolic thrust and a smaller lateral diastolic thrust (Fig. 6). High frequency systolic and diastolic continuous murmurs were seen on phonocardiograms. The venous pulse tracing exhibited a high sustained systolic thrust (C-wave). The venous pressure in the left arm was 170 mm. of water. Because of the rapid blood flow, arteriography failed to visualize the fistula.

At operation, a Woodruff catheter was inserted through the left brachial artery to the area of the fistula. When the balloon was inflated, the thrill disappeared (Fig. 3). A U-shaped incision was made with resection of the inner third of the clavicle (Fig. 4). The external jugular vein was communicating with the subclavian artery. The vein was ligated above and below the fistula. This converted the fistula to an aneurysm which was opened and treated by suturing of the arterial defect. The balloon could be seen in the defect. The wound was closed without attempt at reconstruction of the clavicle. Recovery was uneventful. The patient was well six months following surgery. A bony callus was visible at the site of the resected clavicle (Fig. 7).

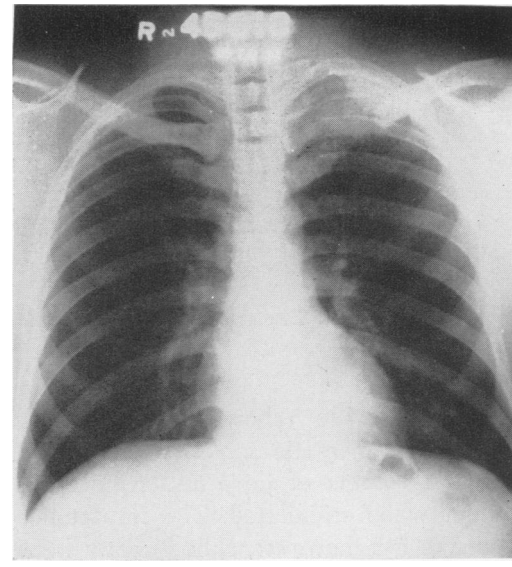

Fig. 7. New bone formation is seen in the region of the resected left clavicle.

Summary and Conclusions

A method is described for the intra-arterial balloon tamponage of blood vessels for use in vascular surgery. This is especially effective in surgical management of arteriovenous fistula.

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