

ARTERIOVENOUS ANEURYSM*

EXPOSURE OF THE TIBIAL AND PERONEAL VESSELS BY RESECTION OF THE FIBULA

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A NEAR DISASTER from hemorrhage of the posterior tibial vessels in the course of the excision of an arteriovenous aneurysm has prompted the approach to these vessels by the removal of the upper portion of the fibula, including the resection of the head of that bone where necessary. The rich collateral anastomosis which develops as the result of an arteriovenous communication, together with dilatation of the vessels including those which perforate the interosseous membrane, demands direct visualization of these vessels and their careful ligation and division. Otherwise the retraction of vascular channels through the interosseous membrane may result in serious or even uncontrollable hemorrhage and necessitate a second incision along the front of the leg, or the removal of the fibula in the presence of hemorrhage and at an inopportune time during the course of the operation.

While this operation has been performed primarily as an approach to arteriovenous fistulae and aneurysms of the posterior tibial vessels, it is of equal importance to realize that the same approach is necessary to reach the anterior tibial and peroneal vessels in the upper part of their course. It is often impossible to differentiate by clinical measures which of these three vessels is involved because of their close proximity to each other. No matter which vessels are involved, difficulties in exposure are similar. In fact, resection of the upper end of the fibula is probably of more importance in fistulae involving the anterior tibial and peroneal vessels near their point of origin than it is of the posterior tibial. Moreover, more than one fistula may be encountered, as was found in Case 13.

The exposure of the fibula and the method of its removal have been described by Henry,¹ and it is but a modification of the procedure used by him which we have followed successfully in 15 instances. The fibula is removed subperiosteally, thus, insuring continued stability of the knee joint. Moreover, the peroneal nerve which may be concomitantly injured along with the vessels is at the same time exposed and may be explored or repaired without further operative incision.

It should be stressed, however, that resection of the fibula for exposure of these vessels is necessary only in their course in the upper portion of the leg. In the lower third they are more easily reached by direct approach along the posterior surface of the tibia on the medial side of the leg.

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TECHNIC OF OPERATIVE PROCEDURE

Continuous spinal is the anesthetic of choice. A pneumatic tourniquet is applied to the thigh but is not inflated unless severe hemorrhage is encountered. The patient is placed upon the unaffected side, with the knee slightly flexed. Incision is carried directly over the fibula beginning about two inches above the head and extending distally for a length required by the position of the aneurysm (Fig. 1B). After the skin and superficial fascia are divided at the upper end of the incision, the deep fascia is opened at the medial edge of the biceps tendon. The common peroneal nerve is exposed, and a rubber strip passed around it for aid in mobilization (Fig. 1). The division of the deep fascia is carried downward along the course of the nerve along the posterior margin of the biceps tendon. The fascial origin of the peroneus longus muscle lies directly over the groove in which the nerve passes forward across the neck of the fibula. This fascia is divided. A definite plane, the lateral intermuscular septum, between the soleus muscle posteriorly and the peroneus longus muscle anteriorly, is easily developed and, when the muscles are separated, the lateral border of the fibula is immediately exposed. By the use of sharp dissection and a periosteal elevator the periosteum can be readily stripped from the fibula and its division accomplished by means of a Gigli saw (Fig. 2A). The subperiosteal removal of the head is more difficult and is best carried out by sharp knife dissection, keeping the blade of the knife *directly* against the bone and retracting the peroneal nerve completely out of the field of incision (Fig. 1A). With removal of the head and upper portion of the fibula, the lower end of the popliteal artery with its terminal branches, namely, posterior tibial, anterior tibial, and peroneal vessels, are exposed. With the retraction of the soleus muscle posteriorly and the peroneus longus muscle anteriorly, the vessels are easily seen (Figs. 3 and 4). The resected portion of the bone is not replaced.

In excision of the fistula, the artery proximal to it is secured as the first step in the procedure. A ligature is passed around it (for safety should severe bleeding be encountered) but not tied at this time. The vessels distal to the fistula are then isolated, ligated, and divided. The proximal artery is then ligated and divided. The fistula is then removed from below upward, ligating and dividing all communicating vessels. The proximal vein is divided as the last step in the operation. *It is of utmost importance that the region of the fistula be avoided until its principal blood supply is completely controlled.*

Following removal of the insertion of the fibular collateral ligament, the question of stability of the knee joint naturally arises. Subjectively, no patient has had complaint referable to the knee joint on the operated side. Examination has failed to reveal any loss of stability. Comparison of the fibular collateral ligaments by palpation, with the ligament under stress, usually discloses as tense a ligament as on the unoperated side.

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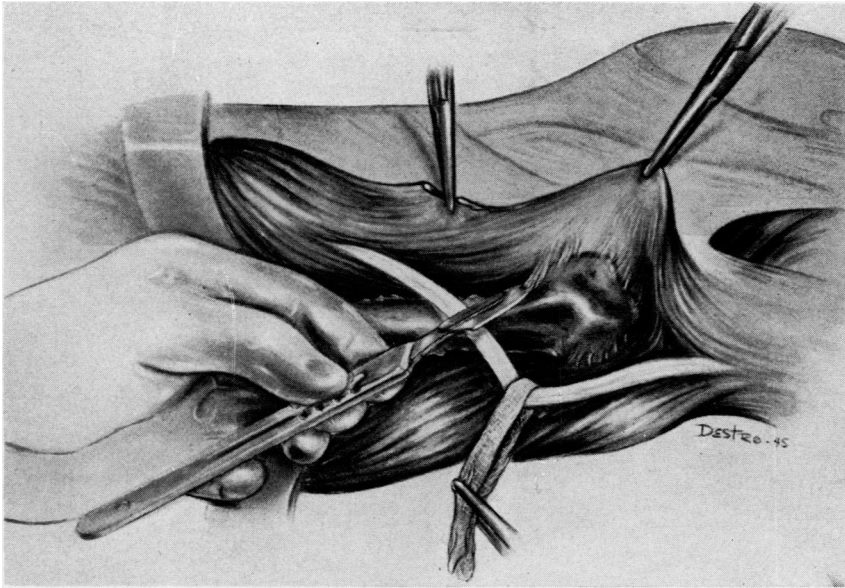


FIG. 1A.—Showing mobilization of peroneal nerve and sharp dissection of the periosteum covering head of fibula.

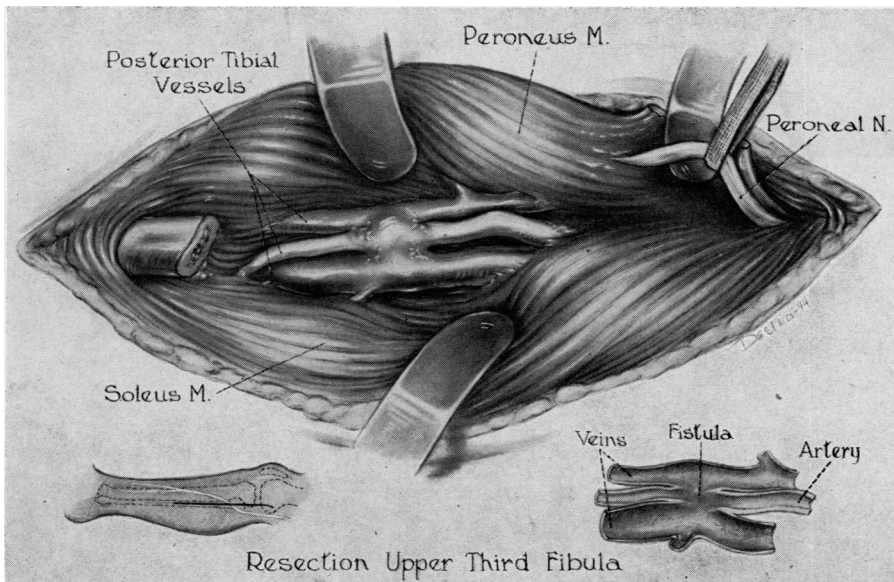


FIG. 1B.—The upper third of fibula removed, exposing fistula. Insert shows line of incision.

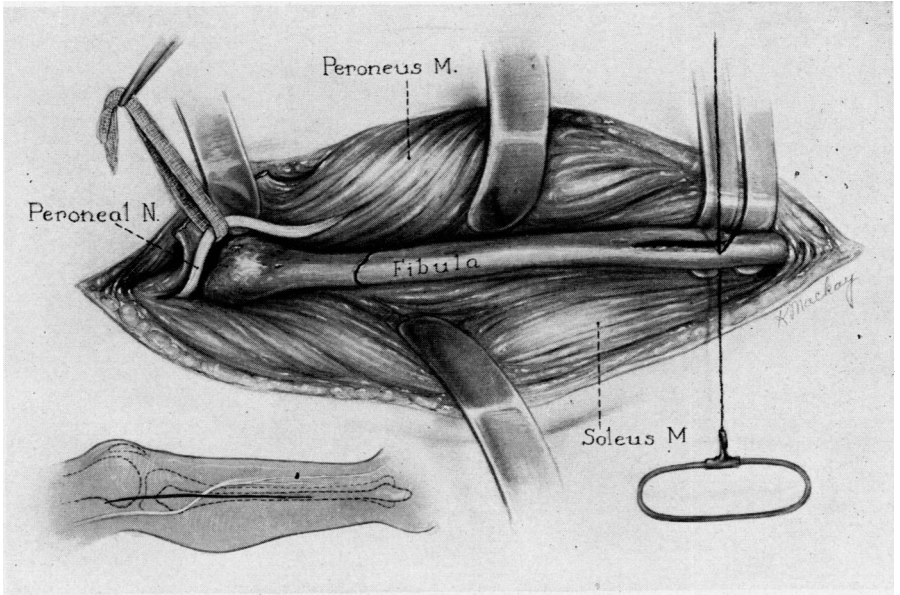


FIG. 2A.—Resection of fibula below the head.

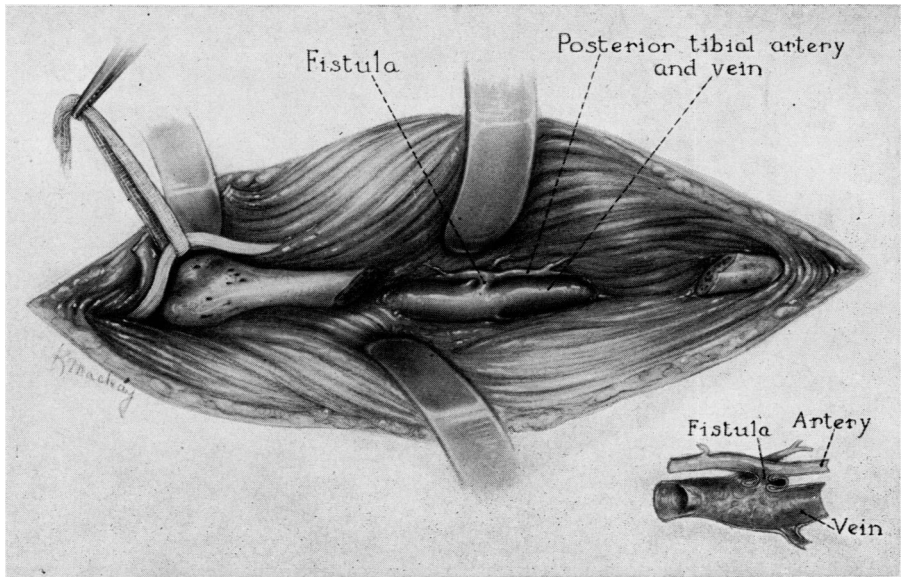


FIG. 2B.—Exposure of fistula between posterior tibial vessels.

CASE REPORTS

Case 1.—*A-V fistula, right posterior tibial vessels resulting from high explosive shell wound October 14, 1943. Resection of upper six inches of fibula not including the head. Quadruple ligation and excision of fistula, June 6, 1944. Recovery.*

On October 14, 1943, this 20-year-old soldier was wounded in the anterior middle portion of the right leg by high explosive shell fragment. There was little bleeding. On the same day the wound was débrided and immobilized by plaster. He was admitted to Ashford General Hospital February 14, 1944.

He complained of blueness and swelling of his right leg and foot on standing.

On examination, there was an infected wound on the anterior surface of the right leg. On elevation it became paler than the left. There was a well defined thrill and bruit, both anteriorly and posteriorly, at the junction of the upper and middle third of the leg. The bruit, which was continuous, was transmitted throughout the leg, into the foot, and upward to the middle of the thigh along the course of the vessels. Oscillations were markedly decreased at the right ankle and foot. On obliteration of the fistula by pressure the pulse rate dropped from 92 to 84 (Branham's sign). Radiography revealed no cardiac enlargement.

Drainage from the wound had ceased by May 1, 1944, and on June 6, 1944, operation was carried out. The six inches of fibula distal to the neck was resected and the fistula excised. The patient's recovery was uneventful, and there was no instability of the knee.

Case 2.—*A-V fistula, left posterior tibial vessels resulting from high explosive shell fragment September 17, 1943. Subperiosteal resection, upper half of fibula and excision of fistula June 28, 1944. Recovery.*

On September 17, 1944, this soldier sustained a shell fragment wound in the upper portion of the left leg, the missile entering anteriorly just below the knee. There was no wound of exit. Profuse bleeding necessitated control by tourniquet. Soon after the injury a drop foot was noted. The wound healed and the drop foot had disappeared by February 1, 1944. On March 9, 1944, at an overseas hospital, an attempted excision of the fistula was unsuccessful because the interosseous membrane interfered with proper ligation of the distal vessels. The operative note (Major John D. Martin, 43rd General Hospital) expressed the opinion that only by resection of the fibula could these vessels be secured. The proximal vessels were ligated at this time, but the bruit and thrill returned shortly thereafter, and the patient was evacuated to the Zone of Interior.

On admission to Ashford General Hospital he complained of pain in the left leg and foot, particularly after walking, and of swelling in the left leg.

There was a healed wound on the anterolateral aspect of the left leg in the upper third and a healed operative scar over the popliteal space. The left leg was considerably larger in circumference than the right. On dependency, the right toes and foot were cyanotic and on elevation there was a pallor of the left foot. The pulsation of the left dorsalis pedis artery was faint and that of the posterior tibial was absent. There was a thrill over the lower popliteal space and the upper anterior aspect of the leg and a continuous bruit, accentuated in systole, was transmitted throughout the leg and thigh. Obliteration of the bruit by pressure resulted in a diminution of the pulse rate from 72 to 60. Oscillometric readings at both popliteal levels were normal and equal. Oscillations at the left ankle were diminished and were absent in the left foot. Skin temperatures were increased over the leg in the region of the fistula and decreased at the toes. The cardiac diameter was normal.

On June 28, 1944, the upper half of the fibula, including the head, was resected subperiosteally. The fistula was easily identified because of the presence of large dilated veins. After securing the proximal and distal arteries, three large veins distal to the fistula were ligated and divided, as were numerous small communicating vessels. The fistula was removed in its entirety by ligating the vessels proximal to it as the last step in the procedure. Recovery was uneventful, and there was no instability of the knee. The patient returned to full duty as a paratrooper.

Case 3.—*A-V fistula, right posterior tibial vessels, caused by high explosive shell fragment February 19, 1944. Paralysis of the right superficial peroneal nerve. Subperiosteal excision of five inches of fibula distal to the neck. Excision of fistula. Exploration of peroneal nerve July 28, 1944. Cure of fistula. No improvement in nerve function.*

Following multiple shell fragment wounds, five of which involved the right leg and thigh, sustained February 19, 1944, this soldier suffered shock for which he was treated with plasma. After evacuation to the Zone of Interior some two and a half months after injury, he discovered a "buzzing" sensation in the region of the right knee, and was admitted to Ashford General Hospital July 19, 1944.

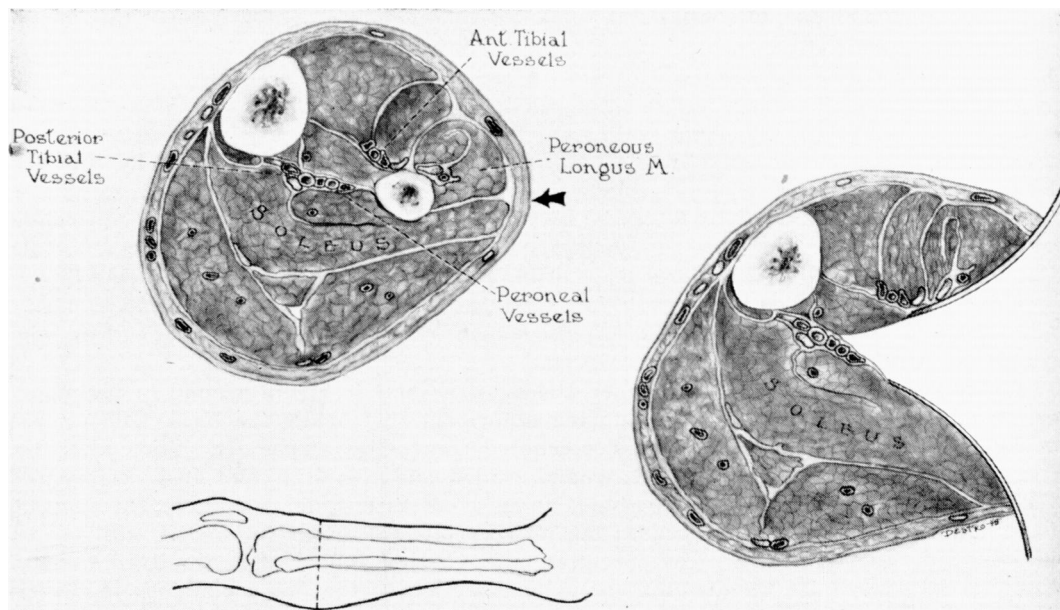


FIG. 3.—Cross-section through leg at level indicated in insert. Arrow shows point of incision through lateral intermuscular septum, with exposure of vessels after resection of fibula and retraction of muscles.

He complained of constant aching pain along the lateral aspect of the right leg and foot with alternating periods of cold and warmth in the right lower extremity and of right drop foot with anesthesia over the anterior portion of the right leg and dorsum of the right foot.

There was a considerable degree of atrophy of the right leg. Multiple wounds were present about the lateral aspect of the right lower thigh, knee, and upper leg. A large scar overlay the region just anterior to the head of the right fibula. Right drop foot was present. The right lower extremity was cyanotic. Oscillometric readings were increased at the right popliteal level and diminished at the right foot. Oscillations were normal on the left. Skin temperatures were diminished in all toes, more markedly on the right. There was a thrill over the lower popliteal space where a continuous bruit, accentuated in systole and transmitted both proximally and distally, could be heard. A striking finding was the intensity with which the bruit was transmitted along the anterior surface of the upper portion of the leg, indicating communication of the anterior vessels with the fistula. On obliteration of the fistula there was a drop in the pulse rate from 88 to 64.

At operation, July 28, 1944, five inches of the fibula distal to the neck was resected subperiosteally. The transverse fascial origin of the soleus muscle was divided, thus exposing the posterior tibial vessels in their upper portion. At this point the fistula was

located. The artery proximal to the fistula was dilated, as was the vein. The distal artery was small, but the veins were enlarged. After ligation and division of the proximal and distal arteries, a marked pulsation in the region of the fistula indicated other vessels of considerable size were entering this lesion. In the excision of the fistula several vessels, one of large size, were found to enter it through the interosseous membrane. All vessels were ligated and divided and the fistula removed in one mass.

The superficial peroneal nerve was explored and was found to be imbedded in scar tissue and to be the seat of considerable fibrosis. Recovery was uneventful, and there was considerable improvement in the nutrition of the leg, but there was no return of function in the muscles supplied by the superficial peroneal nerve. Although the heart was apparently not increased in size, there was a diminution of one centimeter in the transverse diameter following operation. He was fitted with a drop-foot brace and discharged from the service.

Case 4.—*A-V fistula, upper peroneal vessels, resulting from 25-caliber bullet June 21, 1944. Subperiosteal resection upper third of fibula and excision of fistula October 17, 1944. Recovery.*

On June 21, 1944, this soldier was struck in the left upper leg by 25-caliber bullet. He suffered a compound fracture of the upper third of the fibula. There was profuse bleeding, controlled by pressure. The wound was later débrided and the leg immobilized in plaster. On removal of the plaster six weeks later the presence of an arteriovenous fistula was discovered by a physiotherapist while giving massage. He was evacuated by air from the Pacific area and admitted to Ashford General Hospital September 15, 1944.

On admission, the patient complained of coldness and sweating of the left foot, tingling in the toes, stiffness of the left ankle and a "buzzing" sensation along the lateral aspect of the left leg.

There was a small healed wound of entry on the medial aspect of the left leg at the level of the tibial tubercle and a wound of exit on the lateral side of the leg at the junction of the middle and upper thirds. A thrill could be felt at the junction of the upper and middle thirds of the leg both anteriorly and posteriorly. A loud, harsh continuous bruit was most marked at this area and was transmitted along the course of the anterior and posterior tibial vessels and up the femoral vessels to the groin. On obliteration of the fistula the pulse rate fell from 84 to 74, and the blood pressure changed from 120/84 to 130/94. Transverse cardiac measurements were normal. The left foot was cyanotic on dependency and pallid on elevation. The oscillometric readings at the left popliteal level were higher than on the right. The skin temperature of the toes was two degrees lower on the right than on the left.

On October 17, 1944, operation was performed. The upper third of the left fibula including the head was subperiosteally resected. A fistula communicating with a false sac, one inch in diameter, was completely excised after ligating the major proximal and distal vessels and numerous communicating vessels (Fig. 5). The patient's recovery was uneventful.

Case 5.—*A-V fistula, left posterior tibial vessels resulting from shell fragments July 6, 1944. Subperiosteal resection, upper third of left fibula. Quadruple ligation and excision of fistula October 18, 1944. Recovery.*

On July 6, 1944, this 23-year-old soldier received multiple wounds of both lower extremities with a compound fracture of the upper third of the right fibula produced by shell fragments. The right leg at the site of the fracture bled profusely, and was controlled by a tourniquet. The following day débridement was carried out. A large wound of the left popliteal space was treated by skin graft. A month after the injury the presence of a thrill and bruit was noted along the upper outer aspect of the left leg, and he was evacuated to the Zone of Interior, and admitted to Ashford General Hospital October 2, 1944.

He complained of a "buzzing" sensation in the left leg, sweating of the left foot, and swelling on dependency.

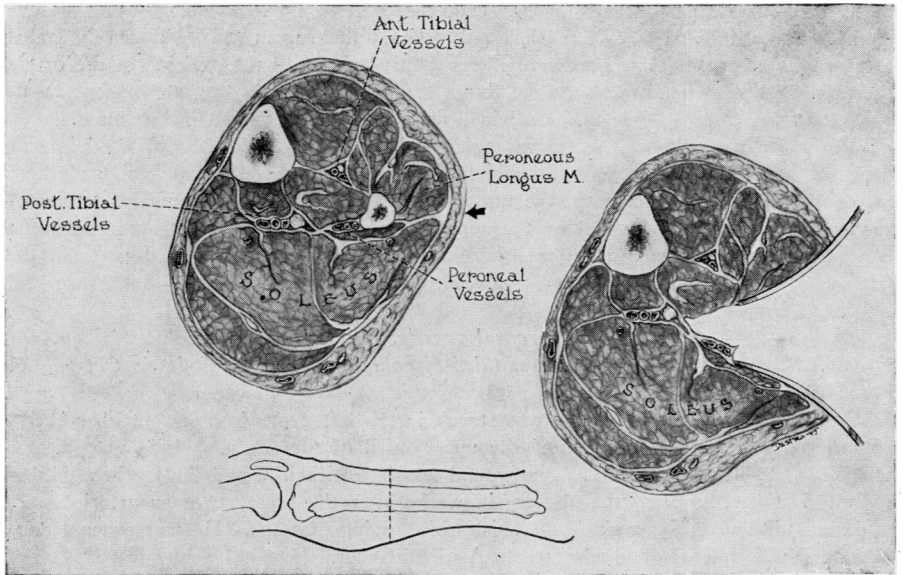


FIG. 4.—Cross-section of leg at level indicated in insert, showing exposure of vessels at this level after resection of fibula and retraction of muscles.

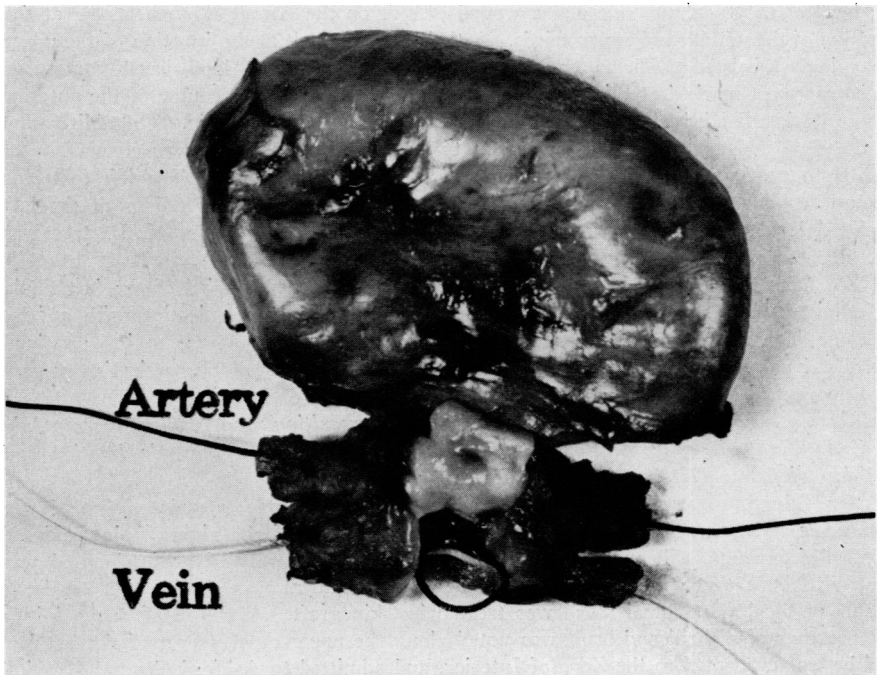


FIG. 5.—Case 4: Fistula with false sac. A window has been cut at the area of the fistula showing communication between artery and vein.

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There were multiple wounds of both lower extremities and a large healed scar on the lateral upper aspect of the left leg and a well-healed area of grafted skin in the left popliteal space. There was a thrill along the upper lateral aspect of this leg with a rough continuous bruit heard loudest in the upper third of the leg and transmitted down the calf and upward to the groin. On obliteration of the fistula the pulse rate fell from 100 to 80, and the blood pressure changed from 120/90 to 140/100. Cardiac measurements were normal.

On October 18, 1944, the upper-third of the left fibula was resected subperiosteally, and after ligating numerous vessels of entrance and exit, a fistula between the upper tibial vessels was excised. Its position required ligation and division not only of the tibial vessels but of the origin of the anterior tibial and peroneal vessels as well. It was believed that successful ligation of these vessels could not have been carried out without resection of the fibula and subsequent easy access to the arteries and veins perforating the interosseous membrane. Recovery was uneventful.

Case 6.—*A-V fistula, left posterior tibial vessels resulting from shell fragments July 15, 1944. Complete paralysis peroneal nerve. Resection of upper third of fibula, excision of fistula, exploration of irreparable peroneal nerve injury, excision of scar, November 3, 1944. Mild secondary infection. Cure of A-V fistula. No improvement in nerve function.*

On July 1, 1944, this 22-year-old soldier was struck with shell fragments and suffered multiple wounds of the left lower extremity and hip. There was a severe wound overlying the upper half of the left fibula. None of the wounds bled excessively. The wounds were immediately débrided, shell fragments removed, and the wounds secondarily closed. Because of the peroneal nerve injury he was evacuated to the Zone of Interior and shortly thereafter evidence of an arteriovenous fistula of the left leg was noted. He was admitted to Ashford General Hospital October 18, 1944.

He complained of left drop foot, coldness, tingling, and numbness of the left leg and foot.

There were numerous healed sutured scars along the lateral and posterior aspects of the left lower extremity from the buttocks to the ankle. Just distal to the head of the left fibula there was a well defined thrill. A harsh continuous bruit, accentuated in systole, was best heard in this region and was transmitted upward to the groin and downward to the foot. Upon obliteration of the fistula by pressure the pulse rate fell from 80 to 60, and the blood pressure changed from 120/60 to 120/74. The cardiac measurements were normal. Oscillometric readings were increased at the left popliteal level and diminished in the left foot. The skin temperatures in the toes of both feet were below normal, and slightly lower in the left than on the right.

On November 3, 1944, the scar over the upper left fibula was excised, and the upper third of the fibula, including the head, was resected subperiosteally. A fistula between the posterior tibial vessels was found two centimeters distal to the origin of the peroneal artery. It was completely excised after ligating its major branches. A small false sac, lying on the lateral side of the fistula, was not removed. Following excision of the fistula exploration of the peroneal nerve was carried out. It was found to be divided at the point where it passed posterior to the head of the fibula. The distal portion was found in the substance of the peroneal muscles. Approximately four inches of this nerve had been shot away, and both ends were the seat of neuromas. After the removal of the neuromas the hiatus between the ends could not be breached, but the leg was flexed and a bridge of tantalum wire placed between the two ends in case further exploration was deemed advisable.

Following operation mild infection developed in the skin, probably the result of tension at the site of scar excision. The infection cleared rapidly without the necessity of secondary closure or skin graft. There has been some improvement in the nutrition of the leg following excision of the fistula. The extent of the nerve lesion probably precludes improvement in its function.

Case 7.—*A-V fistula, right anterior tibial vessels resulting from shell fragments, June 26, 1944. Resection of the upper third of the fibula, excision of the fistula November 25, 1944. Recovery.*

On June 22, 1944, this 25-year-old soldier received multiple shell wounds of both lower extremities, chest, eye, and nose. Although bleeding was profuse he was able to walk five miles to his own line. The wounds were débrided on June 25, 1944, and later were secondarily closed. About six weeks later a thrill in the upper right leg was discovered by a physiotherapist in the course of treatment. He was evacuated to the Zone of Interior, and admitted to Ashford General Hospital November 16, 1944.

He complained of pain in his right ankle, coldness, and excessive sweating of the right foot and a "buzzing" sensation along the upper anterior portion of the right leg.

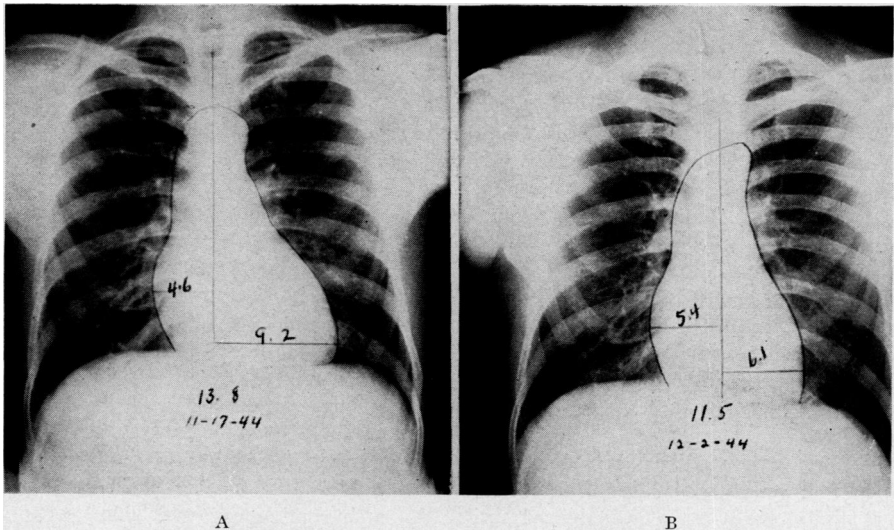


FIG. 6.—Case 7: A. Teleoroentgenogram of heart before operation. B. The heart shadow seven days after operation, showing reduction in cardiac diameter.

The right anterior thigh and leg were peppered with multiple wounds, well healed. There was a thrill over the anterolateral aspect of the upper portion of the right leg. It was also felt posteriorly in this region but not so marked as on the anterior surface. In this region a loud continuous bruit accentuated in systole was heard which was transmitted upward to the popliteal space and downward to the foot. On obliteration of the fistula the pulse rate fell from 72 to 52, and the blood pressure changed from 110/70 to 118/80.

On November 25, 1944, the upper third of the left fibula, including the head, was resected subperiosteally. The lower end of the popliteal artery was isolated and a suture, which was not tied, was passed around it. The fistula was found just distal to the origin of the anterior tibial artery, so near the popliteal artery that it was necessary to ligate that vessel in its removal. The anterior tibial artery and vein just distal to the fistula were ligated and divided and the fistula removed in its entirety. The transverse cardiac diameter was 13.8 cm. before operation. Two weeks after operation this had decreased to 11.5 cm. (Fig. 6). Recovery was uneventful.

Case 8.—*A-V fistula, right posterior tibial vessels, resulting from shell fragments, July 15, 1944. Resection upper third of fibula. Excision of fistula January 6, 1945. Recovery.*

On July 15, 1944, this 24-year-old soldier received multiple shell fragment wounds of the right leg, left foot, and both buttocks. Bleeding from the right leg was profuse,

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but no tourniquet was applied. The injury was behind enemy lines, and he did not receive aid for ten hours. He was evacuated to England the following day, the wounds were débrided, and closed secondarily. Shortly thereafter the presence of an arteriovenous fistula was noted. The patient was evacuated to the Zone of Interior, and admitted to Ashford General Hospital on November 29, 1944.

He complained of "buzzing" sensation in the right upper leg with coldness and blueness of both feet, most marked on the right.

There were multiple small wounds over the anterior and posterior aspect of the right lower extremity. There was a long healed scar over the medial aspect of the right leg. There was a definite thrill over the anterolateral aspect in the right leg near the head of the fibula. A loud, harsh, continuous bruit could be heard over this region and was transmitted upward into the popliteal region and downward to the foot. Upon obliteration of the fistula the pulse rate fell from 72 to 64, and the blood pressure changed from 116/68 to 118/80.

On January 6, 1945, the upper third of the fibula, including the head, was resected subperiosteally and the posterior tibial vessels which were the seat of the fistula were exposed. The proximal artery and vein were identified and sutures passed around them which were not tied. The proximal vessels were greatly dilated. The veins distal to the fistula, which were dilated, were ligated and divided. The artery distal to the fistula, which was small, was ligated and divided. The proximal artery was then ligated and divided, and the fistula was removed from below upward after ligating numerous small vessels which entered it. The proximal vein was ligated as the last step in the procedure. The transverse diameter of the heart was 14.7 cm. before operation. Six weeks after operation this had decreased to 13 cm. Recovery was uneventful.

Case 9.—*A-V fistula, right posterior tibial vessels, resulting from shell fragments September 23, 1944. Resection of upper third of fibula. Excision of fistula January 12, 1945. Recovery.*

On September 23, 1944, due to mortar shell fragments, this 25-year-old soldier received multiple wounds of both lower extremities, chest, and right forearm. Bleeding was not profuse. Sixteen hours later the wounds were débrided, and at that time a compound fracture of the right tibia was found and the right leg was immobilized in plaster. Later, an arteriovenous fistula was found in the upper posterior surface of the right leg. He was evacuated to the Zone of Interior, and admitted to Ashford General Hospital December 19, 1944.

He complained of "buzzing" sensation in the upper part of the right leg, stiffness of the right knee, and coldness of the right leg.

There were numerous small, well-healed wounds over the leg, thigh, and body. On the upper posterior surface of the right leg there was a well-defined thrill and a continuous bruit transmitted upward to the popliteal vessels and downward to the foot. Upon obliteration of the fistula the pulse dropped from 96 to 80, and the blood pressure changed from 120/70 to 120/88.

On January 12, 1945, the upper third of the fibula, including the head, was removed. The fistula was located at the upper portion of the posterior tibial vessels. The proximal vein was dilated to twice its normal size. The artery, which was likewise dilated, was isolated and a suture passed around it, which was not tied. The tibial nerve was closely associated with the fistula and was dissected free from it. The distal veins were greatly dilated, and their ligation and division were accompanied with some difficulty because of hemorrhage resulting from the injury to one of them. This required mass ligation of the distal vessels. The proximal artery and vein were ligated and divided, and the aneurysmal mass was removed after ligating and dividing a number of communicating vessels. Prior to operation the transverse cardiac diameter was 14.4 cm. Two months after operation this had decreased to 12.2 cm. (Fig. 7). Recovery was uneventful.

Case 10.—*A-V fistula, right peroneal vessels secondary to machine gun wound September 4, 1944. Resection middle half of fibula. Quadruple ligation and excision of fistula, January 19, 1945. Recovery.*

This 32-year-old soldier was injured by machine gun fire on September 4, 1944, suffering a compound fracture of the right arm and wounds of both lower extremities. Shortly after the injuries the wounds were débrided and the right arm was placed in a plaster encasement. About a month after injury the patient discovered pulsation in the right calf and, because of this, he was evacuated to the Zone of Interior and eventually to Ashford General Hospital.

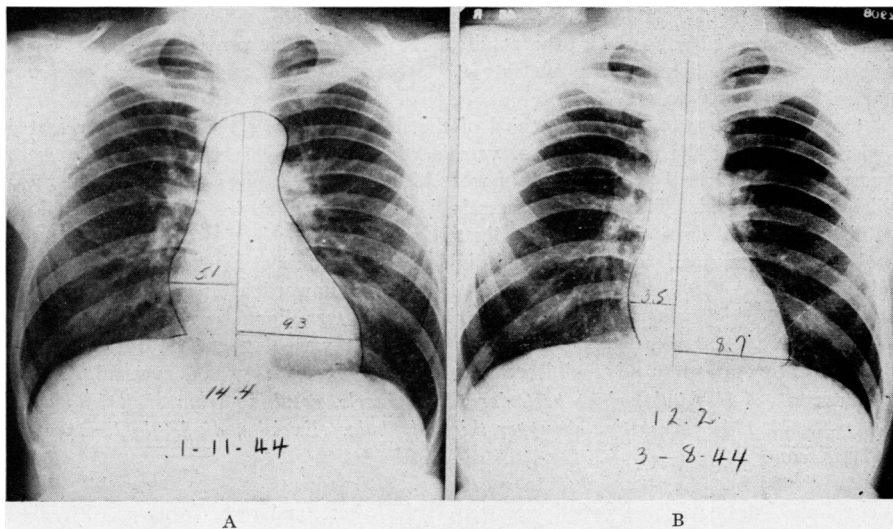


FIG. 7.—Case 9:— A. *Teleorcentgenogram of heart before operation. B. Reduction in cardiac diameter two months after operation.

Physical examination showed incomplete union of the right humerus. The right leg, particularly the calf region, was swollen, and in the upper portion of this leg there was a well-defined thrill and continuous bruit, accentuated in systole. On obliteration of the bruit there was no drop in the pulse rate. The cardiac diameter was not increased.

On January 19, 1945, under spinal anesthesia, incision was made along the lateral border of the fibula and the middle half of that bone was excised. In separating the peroneus longus and soleus muscles the fistula was found in the peroneal vessels at the junction of the upper and middle thirds of the leg. It was completely excised after ligating its main branches and all communicating vessels. The excised fibula was not replaced. Patient's recovery was uneventful. He was transferred to the Orthopedic Section for continuation of treatment for the ununited fracture of the humerus.

Case 11.—*A-V fistula, with false sac, left peroneal vessels, resulting from shell fragments June 3, 1944. Resection middle third of fibula; excision of fistula with false sac January 26, 1945. Complete recovery.*

On June 3, 1944, this 21-year-old soldier was injured by mortar shell fragments which produced wounds of both legs and the right forearm. Bleeding from the left leg required a tourniquet. He was rapidly taken to an Evacuation Hospital where the wounds were débrided, and where a compound comminuted fracture of the left tibia and fibula was discovered. This was treated by plaster immobilization. In spite of some infection the wounds healed and immobilization was discontinued on September 6, 1944, at which time the patient became conscious of a pulsating "buzzing" mass in the left calf. This was later brought to the attention of his medical officer, and he was later brought to Ashford General Hospital on January 11, 1945.

FIG. 8

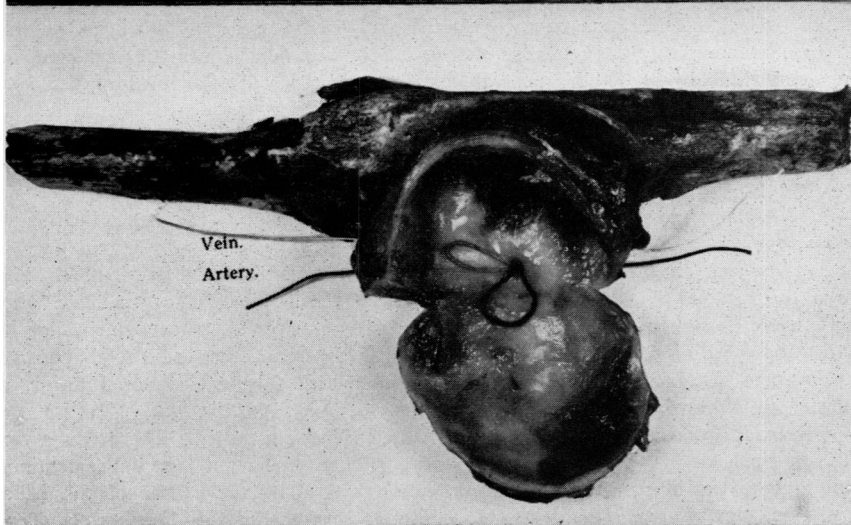


FIG. 9

FIG. 8.—Case 11: Roentgenogram showing pressure necrosis of fibula by aneurysm at site of fracture.

FIG. 9.—Case 11: The specimen, showing portion of fibula removed with false aneurysmal sac in eroded bone. The sac has been opened to show communication with artery and vein.

He complained of the pulsation in the left calf, aching of the left leg and ankle, with stiffness, swelling, and cyanosis of the foot. Radiography of the leg (Fig. 8) revealed a well-healed fracture of the left tibia and a healed fracture of the fibula, with considerable necrosis of the bone at the point of fracture, believed to be due to pressure necrosis of the aneurysm.

There were two wounds, six inches long, over the middle portion of the tibia and fibula which were well healed. In the midportion of the leg, just posterior to the fibula, there was a pulsating mass, about two inches in diameter, over which a continuous thrill could be felt. In this region there was a continuous bruit transmitted upward to the popliteal space and downward into the foot. Upon obliteration of the fistula the pulse rate dropped from 100 to 84; and the blood pressure changed from 130/70 to 120/82. The pulsation, which in this region was just posterior to the fibula at the point of fracture, was believed to be limited by the bone itself which formed a barrier to the aneurysm. A diagnosis of arteriovenous fistula of the posterior tibial vessels, with a communicating false sac eroding the posterior surface of the fibula and limited by that bone, was made. In view of these findings resection of the fibula as a preliminary to excision of the fistula and sac seemed imperative.

On January 26, 1945, the sac was partially emptied by elevation and application of a pressure bandage, and a pneumatic tourniquet about the thigh was inflated. The scar over the fibula was excised and approximately six inches of the middle third of the fibula was resected subperiosteally. Considerable difficulty was encountered because of the bizarre configuration of the fibula at this level resulting both from the healed fracture and from the erosive changes produced by the pressure of the false sac (Fig. 9). Following resection of the fibula the peroneal vessels were isolated, both proximal and distal to the sac. Although removal of the tourniquet had been contemplated at this point, some of the proximal veins, poorly demarcated in their collapsed condition, were torn. Because of the resultant venous bleeding, the source of which was difficult to determine, the remainder of the procedure was carried out with more than the usual difficulty because of lack of definition of the partially collapsed vessels. Following ligation of the main communicating vessels of the fistula and its excision, the tourniquet was removed and many small communicating vessels ligated. The removal of the fistula necessitated division of the neck of the false sac, which was removed separately. The transverse cardiac measurement before operation was 13.2 cm. Six weeks later this had decreased to 12.5 cm. Recovery was uneventful.

Case 12.—A-V fistula, right posterior tibial vessels, resulting from shell fragment wound November 18, 1944. Resection upper third of fibula. Quadruple ligation and excision of fistula. Recovery.

This 21-year-old soldier was wounded by shell fragment November 18, 1944. There was a through-and-through wound of the right upper leg just below the level of the tibial tubercle. Profuse bleeding was controlled by pressure. After a month of hospitalization swelling was noted along the medial aspect of the leg. A diagnosis of arteriovenous fistula was made, and he was evacuated to the Zone of Interior, and admitted to Ashford General Hospital February 7, 1945.

On examination, the wounds previously noted were well-healed. There was a thrill, both anteriorly and posteriorly in the upper portion of the right leg, and a continuous bruit accentuated in systole and transmitted upward along the course of the femoral vessels and downward to the foot. On obliteration of the fistula there was a drop in pulse rate from 80 to 64; and the blood pressure changed from 110/64 to 110/76. There was mild cyanosis on dependency of the right foot. The pulsations of the dorsalis pedis and posterior tibial vessels were diminished on the right side. Skin temperatures of the right toes were four degrees lower than on the left. The cardiac diameter was not increased.

On February 22, 1945, operation was performed and the upper half of the right fibula, including the head, was resected subperiosteally. The peroneal nerve was secured

and dissected free from surrounding tissues as a preliminary step in this operation. When the peroneal and soleus muscles were separated the posterior tibial vessels were brought into direct view. The fistula was found in the posterior tibial artery just proximal to the origin of the anterior tibial artery. It was completely excised by dividing the anterior tibial vessels as well as the posterior tibial vessels, both proximal and distal to the fistula. The fibula was not replaced. The deep fascia and skin were closed with interrupted sutures of silk. His recovery has been complete, and there is good stability of the knee joint.

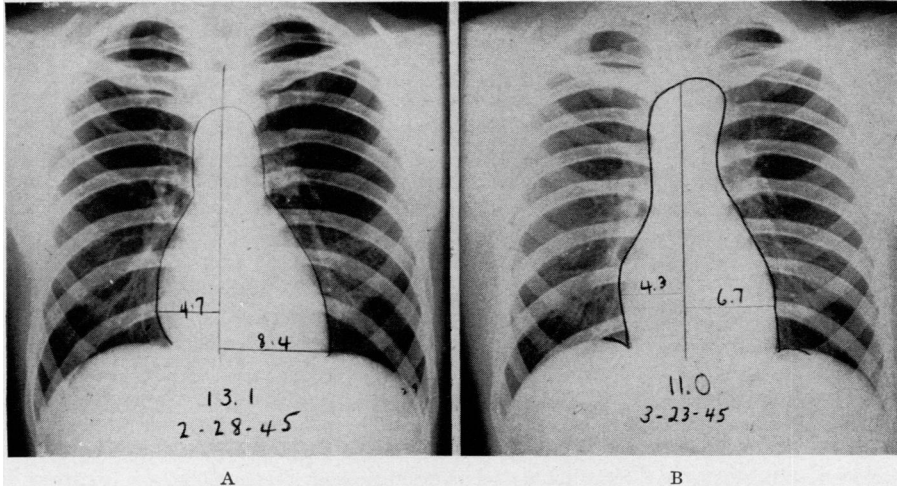


FIG. 10.—Case 14: A. Teleoroentgenogram of the heart before operation. B. The heart 15 days after operation, showing reduction in cardiac size.

Case 13.—*A-V aneurysm, with false sac, left peroneal vessels; A-V fistula anterior tibial vessels, both resulting from shell fragment wounds November 14, 1944. Resection upper third of fibula; proximal and distal ligation of peroneal vessels and intrasacral suture (Matas). Excision of A-V fistula anterior tibial vessels, March 1, 1945. Recovery.*

This 27-year-old soldier was wounded in action on November 14, 1944. He suffered one through-and-through wound in the upper portion of the left leg. A tourniquet was applied to control the bleeding. The wounds were débrided three days later. Two months after the injury the presence of an arteriovenous fistula was discovered in the left leg just below the knee, and for this he was evacuated to the Zone of Interior, and admitted to Ashford General Hospital February 15, 1945.

On examination, there were two well-healed wounds on the lateral and medial side of his leg about four inches below the knee. In the upper part of the calf there was an expansile pulsation with a continuous thrill. The thrill was transmitted all over the leg and up the thigh along the course of the femoral vessels. It was particularly prominent over the pulsating mass and on the anterior surface of the leg just below the knee. A continuous bruit accentuated in systole was heard over the leg and transmitted upward to the groin. Obliteration of the fistula by pressure caused a drop in pulse rate from 72 to 60; and a change in blood pressure from 110/60 to 110/80. There was marked increase in oscillometry in the region of the fistula.

On March 1, 1945, the upper half of the fibula, including the head, was resected subperiosteally. During the resection of the fibula considerable bleeding was encountered because the false sac was entered in the stripping of the periosteum from the bone. A tourniquet previously placed about the thigh was inflated. The fistula was found to be in the peroneal vessels which entered a large false sac. The proximal and distal

vessels were ligated and divided and the sac opened and five openings were closed by intrasacular suture, after the method of Matas. The tourniquet was removed and all bleeding points were ligated. It was then found that another fistula existed between the anterior tibial vessels about two inches distal to the origin of this artery. This fistula was excised after ligating the proximal and distal vessels which entered it. The resection of the fibula gave excellent exposure to both fistulae, and it was felt that this exposure could not have been obtained without a preliminary resection of the bone. His recovery was uneventful.

Case 14.—*A-V fistula, with false sac, left peroneal vessels, due to bullet wound sustained November 24, 1944. Resection of upper third of fibula, excision of fistula and sac, scar excision, and secondary closure with skin graft, March 8, 1945. Superficial infection. Recovery.*

This 21-year-old soldier was wounded by a bullet on November 24, 1944, the missile entering the medial aspect of the leg about three inches below the knee. A tourniquet was necessary to control hemorrhage. Shortly thereafter a compound fracture of the middle third of the fibula was débrided and the leg immobilized in plaster. Upon removal of the plaster the presence of an arteriovenous fistula was discovered, and he was admitted to Ashford General Hospital February 22, 1945.

Upon examination, there was a well-defined thrill and bruit over the lower popliteal space which was transmitted up the course of the femoral vessels and down into the leg. There were two longitudinal scars on the posterior aspect of the left leg. Upon obliteration of the fistula the pulse rate dropped from 72 to 60; and the blood pressure changed from 130/70 to 130/90.

Operation was performed March 8, 1945, and a ten-inch scar on the lateral surface of the leg was excised, and incision was carried three inches above the knee. After isolating the peroneal nerve, the upper third of the fibula, including the head, was resected subperiosteally. The fibula had previously been fractured at the junction of the proximal and middle thirds, and approximately one inch of the distal fragment was likewise resected. After the posterior periosteum was opened the fistula was found to be between the peroneal artery and vein, about four inches below the knee. The proximal and distal vessels were identified and ligated, and the fistula, together with the false sac, was completely excised. Several communicating vessels of considerable size were divided at the point where they entered the fistula. It was necessary to make a relaxing incision on the medial aspect of the leg in order to close the wound, and this was covered with a split-thickness skin graft. Some superficial infection developed in the wound, probably due to tightness of the closure. This cleared up rapidly. Prior to operation the transverse cardiac diameter was 13.1 cm., which decreased to 11 cm. ten days after operation (Fig. 10). The grafted area of skin healed normally, and there is no evidence of recurrence of the fistula.

Case 15.—*A-V fistula with false sac, left anterior tibial vessels, due to land mine fragments, November 28, 1944. Resection upper third of fibula, quadruple ligation and division anterior tibial vessels; intrasacular suture of false sac (Matas) March 15, 1945. Recovery.*

This 26-year-old soldier was wounded by fragments of a land mine on November 28, 1944. He suffered multiple wounds of both lower extremities, and a through-and-through wound of the upper portion of the left leg. Bleeding was not profuse from any wound. Shortly thereafter the wounds were débrided. The patient was conscious of a throbbing in the upper portion of the left leg soon after the injury, but it was not until after evacuation to the Zone of Interior that presence of a fistula was noted. He was admitted to Ashford General Hospital on March 1, 1945.

On examination, there were numerous small healed wounds in both lower extremities. There was a larger wound of entry on the upper portion of the calf three inches below the knee. There was a large pulsating mass on the anterior portion of the leg just below the knee and, in addition, a continuous thrill and bruit, accentuated in systole, heard all

over the upper portion of the leg and transmitted to the foot and to the groin. On obliteration of the fistula the pulse rate dropped from 76 to 64. There was no change in the blood pressure, which was 110/70. Transverse cardiac diameter was normal.

Operation was performed March 15, 1945. The upper half of the fibula, including the head, was resected subperiosteally. In removing the fibula it was found that this bone formed a portion of the false sac, which was opened. Bleeding was controlled by the inflation of a pneumatic tourniquet which had been applied previously. The sac was opened and dissection revealed that the sac communicated with the anterior tibial artery and vein. These vessels were isolated both proximal and distal to the sac, and ligated and divided. The openings in the sac were closed with interrupted sutures. A portion of the sac was excised, and the remainder was infolded with a series of sutures. On removal of the tourniquet there was no bleeding, and the wound was closed in the usual manner in layers. Recovery was uneventful.

SUMMARY AND CONCLUSIONS

Careful exposure of the tibial and peroneal vessels in the upper part of their course is necessary in the operative treatment of arteriovenous fistulae in this region. This is facilitated by subperiosteal resection of the fibula, including the head of the bone if necessary. The resected portion of bone is not replaced. There has been no instability of the knee joint following this operation. Fifteen consecutive cases in which this procedure was carried out are presented in abstract.

We are indebted to Kathleen Mackay and T/5 V. Destro for the illustrative drawings, and to Captain Floyd B. Hall and T/5 Joseph Jackson for photographs.

REFERENCE

- ¹ Henry, Arnold K.: *Exposures of Long Bones and other Surgical Methods*, Bristol: John Wright & Sons, Ltd., 1927.