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## ANEURYSM FOLLOWING SURGICAL PROCEDURES*

### Report of Five Cases

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IT IS GENERALLY RECOGNIZED that trauma is the *usual* causal agent in the production of an arteriovenous fistula, and the *most frequent* etiologic factor in the production of an aneurysm. However, it is not generally recognized that the trauma incurred in the performance of a surgical procedure or operation is an additional factor in the production of these lesions. Operative procedures have become so commonplace that safety factors which prevent serious complications are occasionally overlooked. The purpose of this report is to call attention to the possibility of arterial injury accidentally produced in the course of an operation, eventuating in an aneurysm or a fistula.

Accounts of injuries to blood vessels have been recorded since the beginning of medical history, and among the writings of Galen in the first century of the Christian Era we find descriptions of aneurysms produced accidentally in the course of bloodletting.† Although bloodletting has long passed into

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† "One of the earliest and most interesting references in literature is to an instance of this kind. Galen was called in consultation by a young and inexperienced surgeon who had opened the artery at the bend of the elbow instead of the vein, and the blood spurted out 'clarus, rubens, lucidus et caid'. (*See footnote continued on next page.*)

oblivion, the re-introduction on a large scale of both venous and arterial puncture as a diagnostic and therapeutic measure will probably be followed by an increased number of aneurysms and fistulas.

The early medical history of blood vessel injury, although primarily concerned with the arrest of hemorrhage and the use of ligatures, makes frequent mention of aneurysms. It was not until 1757, however, that William Hunter accurately described an arteriovenous shunt and its effect upon the local circulation. Hunter's two cases were both produced accidentally by bloodletting, it being supposed that the lancet puncturing the basilic vein pierced too deeply and injured the underlying radial or brachial artery at the same time.*

A survey of the literature reveals numerous reports of arteriovenous fistulas following surgical procedures. This lesion has been produced between the inferior vena cava and the right iliac artery during operation for ruptured intervertebral disk;[1] it has been seen in amputation stumps,[2] and in the uterine vessels following hysterectomy.[3] Instances have been reported of intercostal arteriovenous fistula following thoracentesis,[4] of the facial vessels, caused by application of a Roger Anderson splint,[5] of the anterior tibial vessels following introduction of a Steinmann pin,[6] and of the superior thyroid artery following thyroidectomy.[7] I have seen it in the posterior tibial vessels following introduction of a Steinmann pin, and in the genicular vessels following an operation for the removal of a semilunar cartilage; but as these two patients refused operation, they are not included in this report.

It is thus evident that an arteriovenous communication may be produced in any operation. It is most likely that the lesion is produced when vessels are transfixed and ligated, an artery and vein being injured simultaneously by the needle, and an opening made through which the communication is subsequently established. Although transfixion and ligation of a vessel are standard procedures, it should be remembered that mass ligation of arteries and veins may well give rise to this lesion (see Case 5). Particular care should be taken to avoid the inclusion of more than one vessel in a transfixion suture. In addition,

* Hunter's first case was published in *Medical Observations and Inquiries by a Society of Physicians in London,* in 1757 (Volume 1, page 323). His second case was reported in the same journal in 1762 (Volume 2, page 390). The exact time of his observation of these patients is unknown but is supposed to have occurred several years before the publication of the reports.

(*Footnote continued from p. 769*) 'I took in the situation at once; there happened to be an elderly physician with me, so we prepared a medicine, viscid, conglutmable, and obstructive, and placing it strongly against the lips of the wound bound over it a soft sponge. The surgeon who had opened the artery wondered, but said nothing. When we went out [note the professional touch!] I said to the surgeon that he had opened the pulsating vessel, and charged him not to dress the wound before the fourth day, and not without me.'

"The cure was complete, and Galen remarks that this was his only successful case of the kind, as in all others aneurysm had followed." Sir William Osler, Remarks on Arterio-Venous Aneurysm. Lancet, Lond., 1, 949, 1915.

traction pins, wires, and fixation devices for immobilization of bones should not be inserted near the known anatomic course of blood vessels.

In a personal series of approximately 650 operations for aneurysm and arteriovenous fistula, six definitely followed operation or some surgical procedure, and it may be presumed, therefore, that approximately one per cent of these lesions follows operative trauma. One of these cases has been previously reported,[3] and this communication is concerned primarily with five additional instances of this lesion.

**Case 1**—*S.H., Hosp. No. 10123, soldier, age 30: False aneurysm, right brachial artery, lower third, following diagnostic venepuncture August 1944. Treatment by Matas endo-aneurysmorrhaphy, September 19, 1944. Recovery.*

This 30-year-old soldier was transferred to the Army vascular center at Ashford General Hospital with a diagnosis of mycotic aneurysum of the right brachial artery. The patient had had bacterial endocarditis, and at the time of his transfer had mitral stenosis. The aneurysm had developed at least six week after his blood cultures were negative. Shortly before the aneurysm developed, blood was drawn from the patient's arm in this region on numerous occasions. He complained of swelling of the right forearm of seventeen days duration, numbness of the first and second fingers, congestion of the hand on dependency, excessive sweating and loss of complete motion of the elbow.

Examination revealed a fusiform swelling of the upper right forearm on the anterior aspect. It was approximately 8 cm. in diameter, and over it a faint thrill could be felt. The mass pulsated, and on auscultation a systolic bruit, not transmitted to the hand or the axilla, could be heard over it. There was congestion of the right hand and cyanosis of the nail beds on both sides. Both hands were mildly sweaty. Oscillometric readings at the wrists were normal, slightly higher on the left than on the right. Skin temperatures were excessively high on both sides. The Kahn test was negative. A diagnosis of false, traumatic aneurysm of the right brachial artery was made.

Endo-aneurysmorrhaphy (Matas) was performed September 19, 1944 under nitrous oxide, oxygen and pentothal sodium. Under a tourniquet, an incision was made just over the aneurysmal swelling, beginning at the crease of the elbow and extending down about 10 cm. The aneurysm was found to ramify deep in the muscles and between the ulna and radius. It was opened and a large clot evacuated. The appearance of the sac was that of a false aneurysm as seen following trauma. The lining was smooth; there was no evidence of infection, or of vegetations. An upper and lower opening in the wall of the artery could easily be seen, and these were closed with interrupted sutures of silk. After closure of the wound, an ace bandage was applied from the wrist to the midarm. The hand was warm, and there was good return of circulation after pressure on the fingers. The postoperative course was uneventful.

**Case 2**—*Mrs. M.P., E.U. 1178, age 57: False aneurysm, left brachial artery, lower third, produced by incision of abscess forty years previously. Treatment by excision, April 9, 1947. Recovery.*

This patient had an abscess of the left arm and forearm when she was 18 years old, which was incised and drained. During a period of hospitalization in 1938, it was noticed that she had a mass in the left forearm near the elbow. The condition was entirely asymptomatic until the summer of 1946 when her left arm became weak and stiff after a period of carrying groceries. During the succeeding few months she had pain in her left arm, extending into the left shoulder region. This became more severe, and in January 1947 she noticed swelling of the left hand with occasional numbness and tingling.

Examination revealed an old operative incision on the anteromedial aspect of the left arm near the elbow, and a larger incision on the anterior surface of the arm at a slightly higher level. A firm, expansile mass was present, extending from just above the

antecubital fossa for a short distance inferiorly. A bruit, present only in systole, was heard over the mass. On palpation of the incision a defect in the underlying muscle and fascia was noted, and the pulsation of the brachial artery was readily detected. Slight pressure in this region obliterated the expansile pulsation. Oscillometric readings and skin surface temperatures were normal. There was no color change of the extremities on positional changes. Radial and brachial pulsations were normal. The Kahn test was negative. A diagnosis of arterial aneurysm, left brachial artery, lower third, was made (Fig. 1).

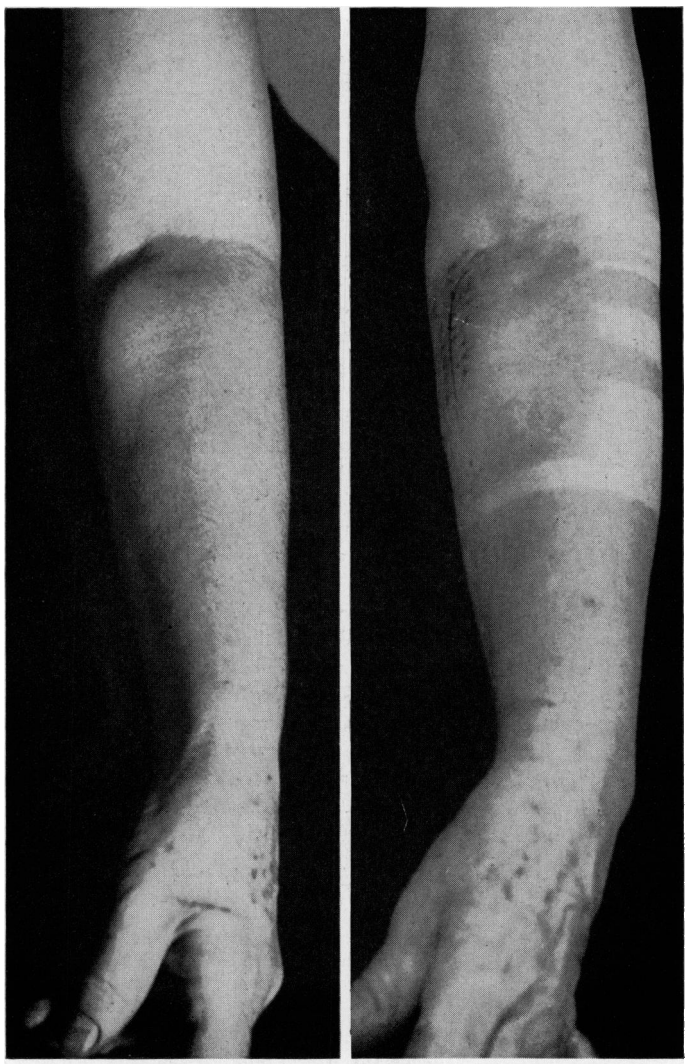

FIG. 1 FIG. 2

FIG. 1.—Case 2: Preoperative photograph. False aneurysm of the brachial artery following incision of abscess.

FIG. 2.—Case 2: Postoperative photograph showing incision curved transversely across the antecubital fossa.

On April 8, 1947, excision of the aneurysm was performed under pentothal sodium, nitrous oxide and ether. A pneumatic tourniquet was applied to the upper arm. An incision was made longitudinally over the mass for about two inches and curved transversely across the elbow in line with the skin fold (Fig. 2). A large number of superficial veins were divided and ligated. The mass was oblong, about 2 by 4 cm.; its capsule was tough and could easily be dissected from surrounding structures. The proximal and distal arteries were ligated and divided, and the mass completely enucleated. The vessels were soft and showed no evidence of arteriosclerosis. The aneurysm was

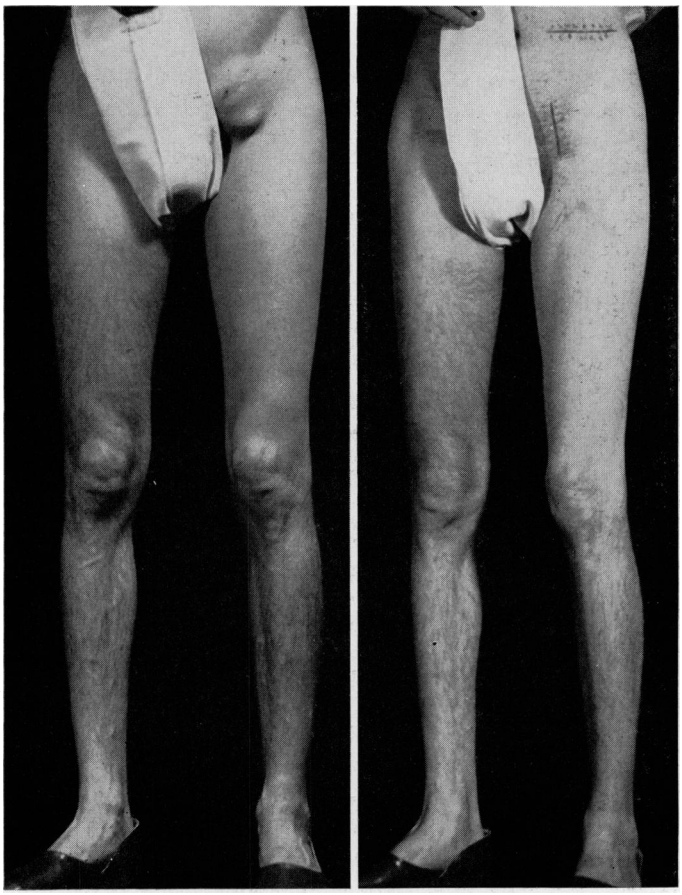

FIG. 3.—Case 3: Preoperative photograph. False aneurysm of the external iliac artery following repair of hernia.

FIG. 4.—Case 3: Postoperative photograph showing incisions.

lying directly on the median nerve, but this structure was not disturbed. After the wound was closed, an elastic bandage was applied from the finger tips to the midarm. There was no pulsation of the radial artery at the wrist following operation, but the hand was warm and the circulation in the fingers good. Recovery was uneventful. Examination of the specimen showed a typical false aneurysm with a smooth-walled, fibrous sac.

**Case 3**—*C.M., E.U. 1166-936, male, age 38: False aneurysm, left external iliac artery, following herniorrhaphy performed May 1946. Treatment by Matas endoaneurysmorrhaphy, January 23, 1947. Recovery.*

This man had a left inguinal hernia repaired on May 13, 1946. He was told after the operation that a blood vessel had been injured. His surgeon stated that he "encountered some bleeding when a stitch was placed to unite the conjoined tendon to the inguinal ligament, but the bleeding was easily controlled by a ligature". Two months following operation, the patient noticed in the left inguinal region a small, firm mass which gradually increased in size over a period of about four months, and then suddenly enlarged causing severe pain in this region. Two months prior to admission to the hospital in January 1947, a smaller mass developed at the inferior limit of the first one. There was no further progression in the size of either. The patient complained of pain in the left inguinal region on exercise. There was no weakness, claudication, or swelling of the extremity.

Examination revealed a lobulated, pulsating mass, approximately 12 cm. in diameter, under a left inguinal incision (Fig. 3). At the inferior limit of this mass was a smaller mass measuring 2.5 cm. in diameter. A systolic bruit with a slight pause and a diastolic murmur were audible. The murmur was not continuous, nor was it transmitted beyond the confines of the mass. The veins of the extremities were not enlarged. The lower extremities were equal in size and without abnormal color changes, ulceration or pigmentation. There were no color changes on positional maneuver. There was moderate sweating of both feet. Skin surface temperatures of the toes of both feet were moderately reduced but equal bilaterally. The right dorsalis pedis pulsation was faint; the left was absent. Oscillometric readings were bilaterally equal, symmetrical and normal. The Kahn test was negative. A diagnosis of arterial aneurysm of the left external iliac artery was made.

On January 23, 1947, under continuous spinal anesthesia, a sympathectomy was performed prior to the operative repair. A low abdominal incision was made, the peritoneum was reflected medially without opening it, and the common iliac artery was exposed. The lumbar sympathetic chain was exposed and the third ganglion removed. A clamp was placed on the common iliac artery temporarily to occlude it.

A longitudinal incision was then made directly over the aneurysm which pointed under Poupart's ligament (Fig. 4). The sac was opened and a large clot removed. Bleeding was brisk but the opening was found and could be controlled by occlusion with a finger. The opening itself was closed with four interrupted sutures of silk. There was considerable oozing from the wound which probably indicated a good collateral circulation. At the end of operation, the patient's foot was warm and pink, and the color returned rapidly after pressure. Recovery was uneventful.

**Case 4**—*Mrs. E.B., GR.A132223, age 44: Arteriovenous fistula, right facial vessels, following injection of procaine thirty years previously. Treatment by quadruple ligation and excision of fistula, October 15, 1946. Recovery.*

This patient reported September 27, 1946 because of a tumor on the right side of her jaw. Her dentist had refused to pull a tooth until the tumor was removed, for fear of hemorrhage. The patient gave a history of having had a right lower molar extracted when she was twelve years old. Procaine was injected prior to extraction of the tooth. The tumor, which was about the size of an acorn and of bluish color, was first noticed when the swelling following extraction subsided. Since that time it had slowly grown to about 3 cm. in diameter.

Examination revealed a bluish streak, 3 cm. wide, extending from the right corner of the mouth down across the angle of the jaw and terminating over the bifurcation of the cartoid artery. Slightly above the streak where the facial artery crossed the mandible, there was a soft, nontender mass about 3 by 4 cm. in diameter. This could be collapsed on pressure, but refilled rapidly. There was continuous thrill and bruit, accentuated in systole, over the entire mass. The pulse rate was 88, and the heart sounds were of good

quality with no irregularities or murmurs. A diagnosis was made of arteriovenous fistula, right facial artery and vein at angle of the mandible (Fig. 5).

On October 15, 1946, under intratracheal nitrous oxide, oxygen and ether anesthesia, operation was performed. A linear incision about 5 cm. long was made transversely below the lower border of the mandible on the right side, beginning just anterior to the angle and extending forward. As it was impossible to isolate the main proximal and distal vessels to the fistula, the mass was enucleated. The proximal and distal arteries and veins, together with the collateral vessels, were ligated and divided. The wound was closed and a pressure dressing applied. Recovery was uneventful (Fig. 6).

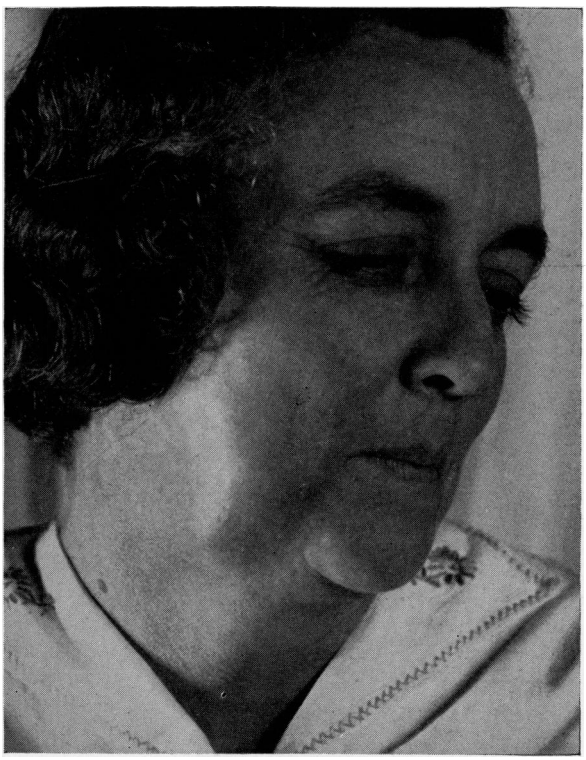

FIG. 5.—Case 4: Preoperative photograph. Arteriovenous aneurysm of the facial vessels following procaine injection.

**Case 5**—*S.V., E.U. 167-273, male, age 50: Arteriovenous aneurysm, right renal vessels, following nephrectomy for tuberculosis in 1926. Treatment by ligation of right renal artery, February 11, 1947. Recovery.*

A printer, age 50, had had his right kidney removed in 1926 because of tuberculosis. His surgeon stated later that the operation was performed in a routine manner and that no unusual difficulty was encountered. He further stated that it was possible that the artery and vein had been ligated en masse. His recovery was uneventful, and he left the hospital on the sixteenth postoperative day. For ten years he had suffered from shortness of breath, and in 1943 he began to have a feeling of oppression and constriction in his chest, which awakened him at night. This was diagnosed as pericarditis, and he was placed in a hospital for a week. His tolerance for activity decreased, and he became so short of breath that he had to sit up in bed to sleep comfortably. He

complained of increasing weakness, nervousness, and periodic headaches. In December 1945 he again was in the hospital for three days because of a friction rub over the left lower lobe of the lung which was treated with penicillin. He had recurrent bouts of pleuritic pain, and over a three-year-period on occasion coughed up bright red blood. In 1946 he became conscious of a thumping sensation in his arms and neck when he sat on a hard chair. During a physical examination in December 1946, his physician (Dr. Mason I. Lowance) noted a loud, rough murmur over the region of the flank wound. At this time moderate cardiac enlargement was noted.

He was admitted to the hospital January 29, 1947. Examination revealed a healed right flank wound over which a loud continuous bruit, accentuated on heart beat, could

FIG. 6.—Case 4: Postoperative photograph after excision of arteriovenous aneurysm.

be heard. The heart showed marked left ventricular enlargement; the sounds were loud, and a systolic murmur was heard at the apex. There was an increase in blood volume of approximately 450 cc. above the normal level. A diagnosis of arteriovenous aneurysm of the right renal vessels was made.

Operation was performed February 11, 1947 under nitrous oxide and ether anesthesia. A transverse incision was made, beginning at the costal border on the right, and carried directly across the abdomen, dividing both recti muscles (Fig. 7). The peritoneum was opened without difficulty. The liver was considerably enlarged. Just to the left of the vena cava, a distinct thrill could be felt. This region was exposed by opening the peritoneum along the right lateral border of the duodenum and reflecting the duodenum to the left, completely exposing the vena cava and the right kidney fossa (Fig. 8). The vena cava was greatly enlarged, perhaps three or four times its normal size, and was

covered with a network of greatly dilated veins thought to be the venae comites. Just to the right of the vena cava there was a soft knob-shaped protrusion, evidently the end of the renal vessels. This was the point of maximum thrill. The thrill could be obliterated by pressure on this point, and the opening between the artery and vein, about the size of the tip of the finger, could be felt. It was believed that the shunt of the blood from the stump of the renal artery into the stump of the renal vein was the cause of the great enlargement of the vena cava and of the dilated venae comites. An effort was made to dissect the stump of the renal artery free from the stump of the renal vein, but this was discontinued since it was evident that the accidental opening of the vein might lead to rapid and fatal hemorrhage. Therefore, the vena cava was separated from the aorta and the right renal artery was isolated as it passed behind the vena cava. This artery

FIG. 7.—Case 5: Postoperative photograph showing transverse incision.

was enlarged to about twice its normal size. It was doubly ligated with medium braided silk, the ligatures being placed about 1 cm. apart. The thrill immediately disappeared, and it was believed that this would cure the condition since there are no branches of the renal artery.

Observations were made during the course of the procedure. The blood pressure, which before operation was usually 180/70, fluctuated considerably, perhaps due to interference with the splanchnic nerves in this region. On compression of the fistula, there was a drop in pulse of twelve beats per minute, and the diastolic pressure rose to 100 mm. of mercury and remained at that level. He withstood the operation well, and his recovery was uneventful.

He has been examined on several occasions since the operation, but the enlargement of his heart has persisted and the symptoms of cardiac failure, as evidenced by dyspnea, have remained. It is believed that his cardiac failure resulted from the presence of this large arteriovenous shunt over a period of 21 years, so affecting his heart as to produce irreversible damage. There has been no return of the bruit.

## SUMMARY

In a series of approximately 650 operations for aneurysm and arteriovenous fistula, six have been encountered which were believed to be the direct result of accidental injury of a blood vessel during the course of an operative procedure. One of these was previously reported.

The history of five additional cases is reviewed with description of the location of the lesion, type of injury, and the treatment.

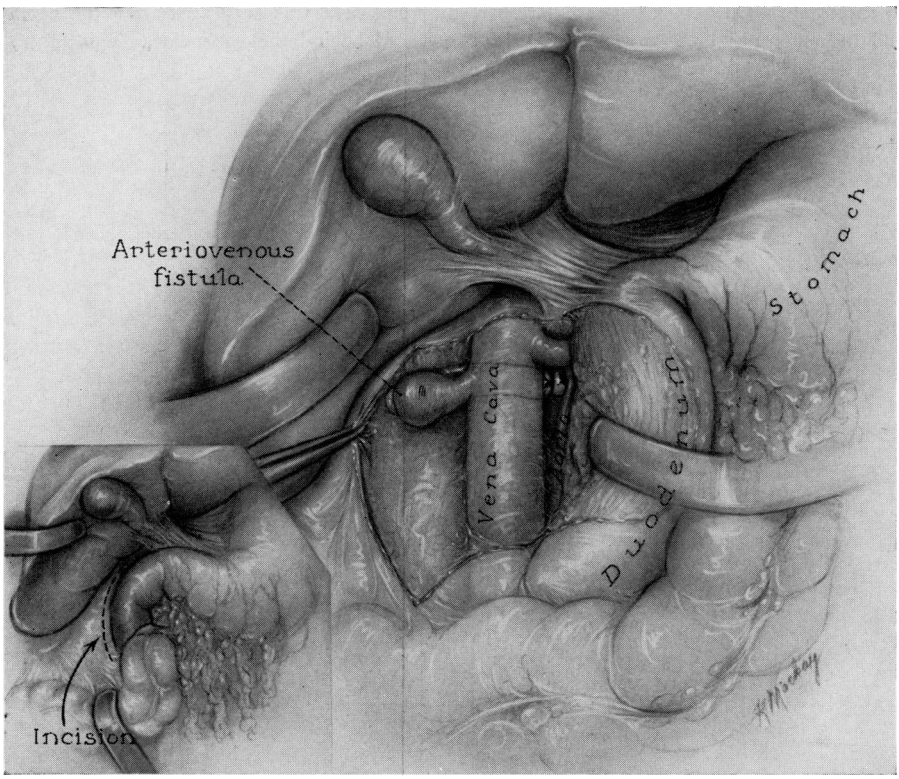


FIG. 8.—Case 5: Arteriovenous fistula in stump of renal vessels. Treatment by double ligation of the renal artery. Insert shows line of incision for mobilization of duodenum and exposure of renal fossa.

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