

PULMONARY EMBOLECTOMY
IN A PATIENT WITH RECENT
RENAL HOMOTRANSPLANTATION

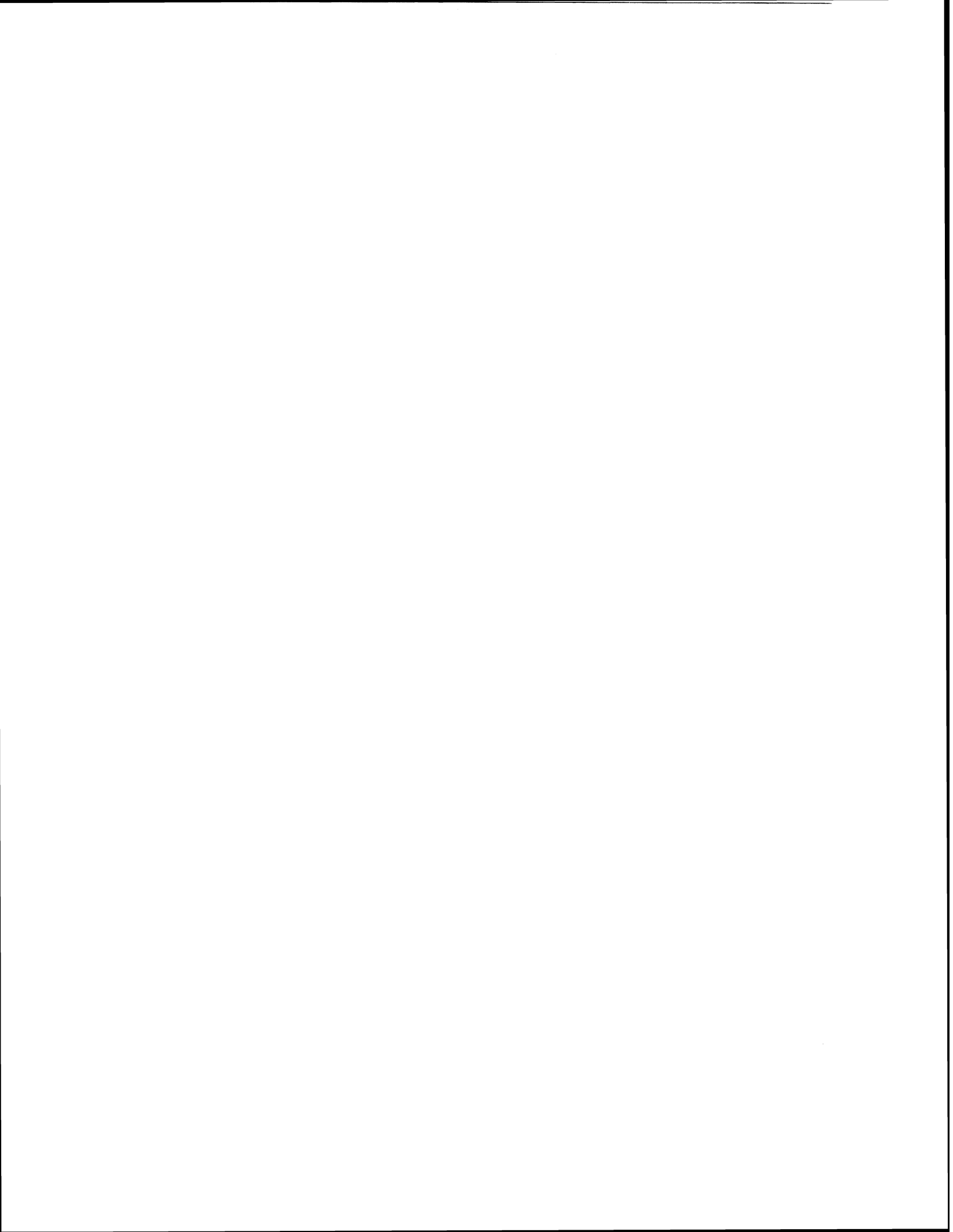
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Pulmonary embolectomy in a patient with recent renal homotransplantation

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Although successful pulmonary embolectomy was described in the European literature as early as 1924,⁵ the first successful case in the United States was not documented until 5 years ago.⁹ Since this first success, seven additional cases have been reported in the American literature, all having been performed with the aid of cardiopulmonary bypass.^{1-3, 6, 7}

The present report describes an additional case of pulmonary embolectomy, which occurred under unusual circumstances. The patient had received a renal homograft to the left iliac fossa 5 weeks and 3 days before the occurrence of the embolus. His problem, therefore, was not only the operative and postoperative management of the pulmonary embolus, but the preservation of the renal homograft as well. In order to prevent recurrent embolization, it was necessary to perform a vena caval plication above the level of the renal vein anastomosis. Studies of renal function were obtained at frequent intervals after the pulmonary embolectomy.

CASE REPORT

B. S., a 34-year-old man, was admitted to the Denver Veterans Administration Hospital on Feb. 6, 1963, with terminal renal failure due to chronic glomerulonephritis.

Clinical course prior to pulmonary embolectomy. On Feb. 12, 1963, thymectomy, splenectomy, and bilateral nephrectomy were performed in preparation for a renal homograft. Azathioprine (BW 57-322, Imuran) therapy was begun 3 days later, and prednisone, 100 mg. daily, was started on February 22 (Fig. 1). A renal homograft from the patient's 30-year-old wife was placed in his left iliac fossa on February 25 (Fig. 2), after which renal function returned to normal (Fig. 1). The immediate postoperative course was uneventful except for clinical evidence of an acute peptic ulcer, which responded to vigorous antacid therapy. On the twenty-first posttransplant day, a rise in the blood urea nitrogen (BUN) level occurred. Treatment with actinomycin C intravenously in a dose of 4 mcg. per kilogram of body weight, given on the twenty-second and twenty-third postoperative days, resulted in a prompt return of the BUN level to normal. Imuran and prednisone therapy was continued essentially unchanged (Fig. 1).

During the early postoperative period, platelets were reported to be normal in number. On the twelfth posttransplant day, the patient complained of tenderness in the right calf. There was no other evidence of phlebitis. Concomitant with the calf tenderness, an abnormal increase in platelets was noted, the numbers consistently exceeding 1,000,000 for the remainder of his course in the hospital. The electrophoretic pattern of serum protein on March 14 revealed total protein of 4.6 Gm., with 51 percent albumin, 8 percent alpha₁ globulin, 14 percent alpha₂ globulin, 12 percent beta globulin,

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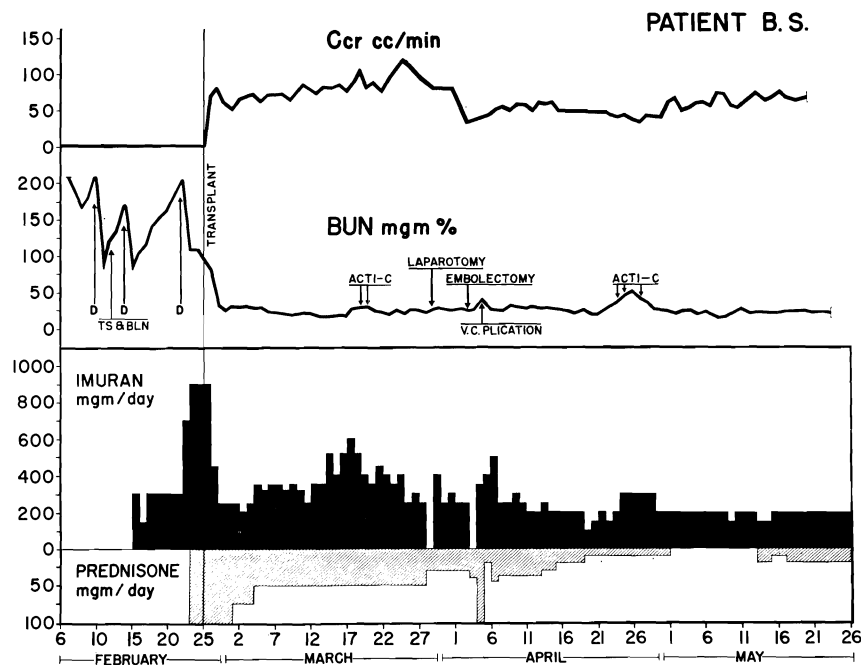


Fig. 1. Measure of renal function, as influenced by renal homograft, and subsequent pulmonary embolectomy. The antirejection drug therapy is indicated.

and 14 percent gamma globulin. Right calf tenderness persisted and 4 days later left calf tenderness also developed. Intramuscular heparin therapy was begun on March 15, 18 days after homotransplantation. It was necessary to stop the heparin after 5 days because of significant gastrointestinal bleeding. At this time, signs of phlebitis had regressed. His further course was uncomplicated until March 29, at which time small bowel obstruction occurred. This responded satisfactorily to laparotomy and lysis of adhesions. Recovery was rapid.

At 2:30 P.M., April 3, 5 days following adhesiolysis, the patient had a sudden onset of dyspnea and cyanosis while at stool. He promptly collapsed. Ten minutes later, while being examined by a resident surgeon, cardiac arrest occurred. Prompt external massage coupled with endotracheal intubation resulted in a spontaneous heartbeat with a blood pressure of 90/60. At this time, the pump team and operating room were alerted. Fifteen minutes later the extracorporeal apparatus (employing a disposable glucose-primed bubble oxygenator) was ready. During this interval, 3 additional episodes of cardiac arrest occurred, all responding to external massage. The patient was removed to the operating room, while blood pressure was being maintained with a continuous infusion of norepinephrine. Operation was begun at 3:15 P.M., 45 minutes following onset of symptoms.

Operative technique of pulmonary embolectomy. Simultaneous incisions were made in the right groin and in the third interspace bilaterally. Heparin, 3 mg. per kilogram, was given intravenously, and the right atrium and right common femoral artery were cannulated (Fig. 2). Bypass was begun and a vascular clamp was placed across the base of the pulmonary artery. The main pulmonary artery, opened through a longitudinal incision (Fig. 2), showed a large clot occupying the distal portion, and extending into the right main pulmonary artery (Fig. 2). The embolus, which measured 8 inches in length (Fig. 3) was gently extracted. Compression of the right lung and aspiration of the right main pulmonary artery produced 4 more emboli of varying sizes. Similar manipulations on the left retrieved a single smaller fragment (Figs. 2 and 3). The incision in the pulmonary artery was closed and bypass terminated. Total perfusion time was 21 minutes. Cannulas were removed and the wounds closed, after which the norepinephrine drip was discontinued.

Clinical course after pulmonary embolectomy. After 36 hours, the patient was returned to the operating room for a vena caval plication,⁸ which was performed uneventfully. Recovery was prompt. Imuran and steroid therapy had been maintained throughout this time (Fig. 1), and 3 days after vena caval plication intramuscular heparin therapy was resumed.

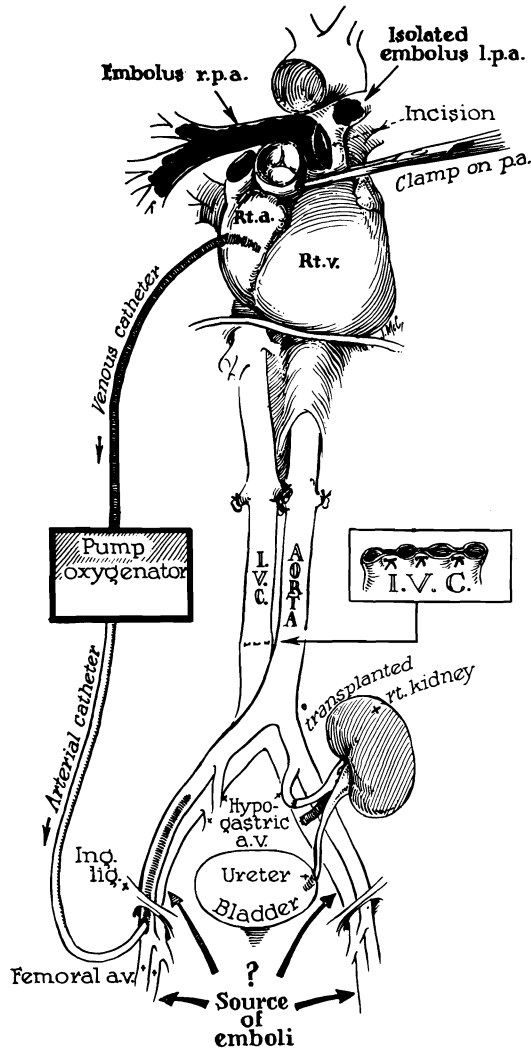


Fig. 2. Anatomic features of the cardiovascular system which were of importance in this case.

During the first 8 hours after pulmonary embolectomy, the patient was anuric. Subsequently, renal function was adequate, although there was transient depression of the creatinine clearance and temporary elevation of the BUN level (Fig. 1).

Oral moniliasis, complicated by a severe staphylococcal laryngotracheitis developed. Methicillin and nystatin therapy was begun. Despite these drugs, the infection failed to respond. The dosage of Imuran was reduced 16 days after embolectomy (Fig. 1), which resulted in a prompt rise in white blood cell count and improvement in the laryngotracheitis. Evidence of rejection of the transplant appeared shortly thereafter. This subsided after the dosage of Imuran was increased and actino-

mycin C was administered intravenously on the twenty-first, twenty-second, and twenty-fourth days after embolectomy (Fig. 1). Since then, renal function has remained normal. Heparin therapy again had to be discontinued on April 25 because of gastrointestinal bleeding. Coagulation studies on April 29 revealed that "formation of fibrinogen begins at the right time, but the formation proceeds with explosive speed. Recalcification time, thrombin generation, and thromboelastogram indicate hypercoagulability."* Electrophoresis of serum proteins on May 3 revealed a total protein level of 5.7 Gm., with 21 percent alpha₂ globulin as the only abnormality.

A superficial abscess in the original transplant incision was drained on May 2, 66 days after transplantation. The patient's subsequent course has been one of steady improvement.

DISCUSSION

Although pulmonary embolectomy has been performed with consistent success for only the past 2 or 3 years, the principles of evaluation, the indications for operative intervention, and the technical details of the operative procedure have already been firmly established. Particular attention has been focused on the need for prompt intervention when the embolus causes major hemodynamic alterations.^{1, 3, 6, 9} The chance of spontaneous recovery in the patient who develops

*Coagulation studies were performed by Dr. Kurt von Kaulla.

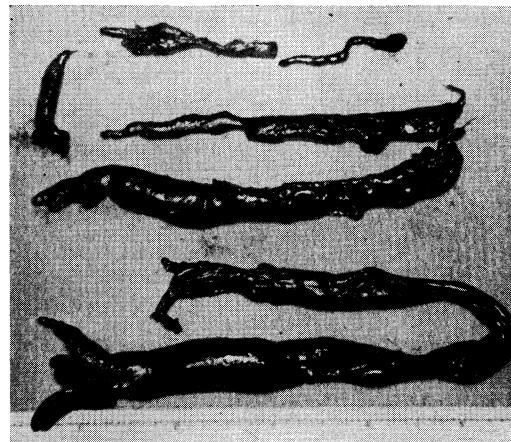


Fig. 3. Specimens removed at the time of embolectomy.

hypotension is slight, and the need for pulmonary embolectomy without delay is pressing.^{6, 9, 10} The operation should be performed with total cardiopulmonary bypass.^{1-3, 6, 7} The development of glucose-primed pump oxygenator systems^{1, 6} has meant that the operation can be undertaken in a matter of minutes, rather than after a relatively long delay to procure and cross-match blood donors. At the time of operation, thoroughness is a prerequisite for success, since many of the peripherally lodged fragments of clot can be retrieved only by milking the lung.¹ Finally, several authors have emphasized the need to perform an operative procedure, either vena caval ligation or plication, to prevent recurrences in the postoperative period.^{3, 7, 9, 10} Success with the presently reported case was due to strict observance of all these careful details.

Although successful pulmonary embolectomy is still uncommon enough to generate curiosity, the unique feature of this case was the occurrence and treatment of a massive pulmonary embolus in a patient who had recently received a renal transplant. The management of the patient, during and after embolectomy, was influenced by the presence of the renal homograft in the left iliac fossa.

The development of a pulmonary embolus in this type of case may have had a direct relation to the previous operations. In addition to the fact that the patient had been chronically ill and bedridden, he had undergone three major surgical procedures in the 2 months preceding the embolus. One of these involved the placement of a venous anastomosis of the left iliac vein (Fig. 2). Although thrombophlebitis has not been reported as a complication of renal homotransplantation, it is probable that this complication will be seen with increasing frequency.

Additional specific factors of unknown significance were present in this patient. His blood type was AB, Rh positive, but the kidney had been obtained from a patient with A, Rh positive blood type. Inasmuch as renal tissue contains blood group antigens,⁴ it was feared initially that agglutinative thrombosis might occur within the graft. This appre-

hension appeared to be unjustified in the early course, but it is possible that the mismatched tissues may have contributed to thrombosis. The peculiar thrombocytic response may have also predisposed to peripheral thrombosis. Beginning 13 days after surgery, the platelet count had increased alarmingly, usually being over 1,000,000, with the presence of many large and bizarre platelets. The cause for the thrombocytosis has not been determined, although the previous splenectomy may have been a contributory factor.

The appearance of a pulmonary embolus might be expected to have a catastrophic influence on the continued function of the renal homograft. At the time of the embolus, the patient had already been through one phase which was interpreted as rejection. This had occurred on the twenty-first postoperative day, at which time a small rise in the BUN level had been observed. This presumed rejection had been reversed by the addition of actinomycin C to the previous therapy with Imuran and prednisone. The pulmonary embolus initiated an additional chain of adverse events, with multiple cardiac arrests, hypotension, and the necessity for a cardiopulmonary bypass. Despite this trauma, the function of the graft was only temporarily impaired. After operation, anuria was present for 8 hours, but urinary function improved rapidly thereafter. Creatinine clearance, which had been 80 c.c. per minute, was depressed to a low of 33 c.c. per minute, with early recovery. The BUN level rose to 39 mg. percent, then rapidly fell to normal.

The details of operative care were influenced by the presence of the renal graft. The arterial catheter was placed in the femoral artery opposite the renal artery-hypogastric artery anastomosis in order to avoid impairment of perfusion of the homograft (Fig. 2). The decision for the type and location of operative procedure to prevent recurrent embolization was a troublesome one because of the location of the renal vein anastomosis. The ultimate decision was to perform a vena caval plication in preference to a vena caval ligation in order to minimize the risk of renal

venous hypertension. Proteinuria, hematuria, or other evidence of occlusion of the renal vein did not occur.

Perhaps the most difficult management problems occurred in the late period after pulmonary embolectomy, with the development of staphylococcal laryngotracheitis and a wound abscess. The response to antibiotic therapy was sluggish, probably due to the fact that the patient's immunologic defenses had been partially paralyzed by the cytotoxic drugs. Ultimately, it was necessary to allow partial escape from these drugs, in order to avoid fatal sepsis. The penalty for this was the development of a secondary rejection attempt which occurred on the fifty-seventh day after transplantation. At this time, recovery from the staphylococcal infection had started and it was possible to reverse the rejection once more with increased doses of Imuran and the addition of actinomycin C.

SUMMARY

A successful case of pulmonary embolectomy is described. Diagnosis was made when the patient developed cardiac arrest in the hospital ward. The embolus was removed with the aid of cardiopulmonary bypass. The principal clot was discovered in the right pulmonary artery, with an additional small fragment in the left main pulmonary artery.

Several unique features of this case increased the problems of care during and after the embolectomy. The patient had received a renal homotransplant to the left iliac fossa from a patient of a different blood type 7 weeks earlier. The embolus was thought to have originated in the left leg distal to the renal vein anastomosis. Technical details of the cardiopulmonary bypass and the subsequent vena caval plication were planned with a view to protecting the function of the graft. The presence of the renal homograft may have contributed to the original formation of the peripheral thrombus. Finally, the postoperative care was complicated by the need to provide cytotoxic drug therapy for the continued protection of the homograft. This therapy, which weakens the immunologic response of the host, had to be modified when

septic complications occurred during the postoperative period. Eventual recovery was possible with minimal loss of renal function.

ADDENDUM

Seventy-six days following embolectomy, the patient died as a consequence of an unrecognized left subphrenic abscess, which had probably originated at the time of operation for intestinal obstruction. At autopsy there was a firmly adherent thrombus extending inferiorly from a level 3 cm. above the plication, completely occluding the lower portion of the inferior vena cava, both iliac systems, and the transplanted renal vein. Extensive renal venous collateral system had developed via capsular vessels, permitting satisfactory renal homograft function up to the time of death. No emboli were found in the lungs. The site of pulmonary arteriotomy was well healed.

REFERENCES

1. Cooley, D. A., and Beall, A. C., Jr.: Surgical treatment of acute massive pulmonary embolism using temporary cardiopulmonary bypass, *Dis. of Chest* 41: 102, 1962.
2. Couves, C. M., Sproule, B. J., and Fraser, R. S.: Acute pulmonary embolism: Successful embolectomy using cardiopulmonary bypass, *Canad. M. A. J.* 86: 1056, 1962.
3. Donaldson, G. A., Williams, C., Seannell, J. G., and Shaw, R. S.: A reappraisal of the application of the Trendelenburg operation to massive fatal embolism: Report of a successful pulmonary-artery thrombectomy using a cardiopulmonary bypass, *New England J. Med.* 268: 171, 1963.
4. Hogman, C. F.: Blood group antigen A and B determined by means of mixed agglutination on cultured cells of human fetal kidney, liver, spleen, lung, heart and skin, *Vox Sang.* 4: 12, 1959.
5. Kirschner, M.: Ein durch die Trendelenburgsche Operation geheilter Fall von Embolie der Art. pulmonalis, *Arch. klin. Chir.* 133: 312, 1924 (described in Alexander, John: Some dramatic thoracic operations, *J. Thoracic Surg.* 5: 1, 1935).
6. Rosenberg, D. M. L., Pearce, C., and McNulty, J. M.: Surgical treatment of pulmonary embolism. Presented at the 43rd annual meeting of the American Association for Thoracic Surgery, Houston, Texas, April 10, 1963, *J. Thoracic Surg.* 47: 1, 1964.
7. Sharp, E. H.: Pulmonary embolectomy: Successful removal of a massive pulmonary embolus with the support of cardiopulmonary bypass, Case report, *Ann. Surg.* 156: 1, 1962.

8. Spencer, F. C.: An experimental evaluation of partitioning of the inferior vena cava to prevent pulmonary embolism, *S. Forum* 10: 680, 1959.
9. Steenburg, R. W., Warren, R., Wilson, R. E., and Rudolf, L. E.: A new look at pulmonary embolectomy, *Surg. Gynec. & Obst.* 107: 214, 1958.
10. Stoney, L. I. S., Jacobs, J. K., and Collins, H. A.: Pulmonary embolism and embolectomy, *Surg. Gynec. & Obst.* 116: 292, 1963.