

skeletal muscle protects the cardiac muscle from fibrillation. Energy is required to maintain its length, for when there is lack of oxygen or glucose, or in the presence of metabolic inhibitors, the action potential is shortened and fibrillation is facilitated.

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The International Atomic Energy Agency will send 20 nuclear experts in 1960 to Afghanistan, Austria, Brazil, Iran, Iraq, Korea, Philippines, Turkey, Venezuela, and Yugoslavia. One biochemist will work at the Austrian Cancer Research Institute in Vienna to advise on the use of radioisotopes in cancer research and on the establishment of a radioisotope laboratory. He will train Austrian scientists in the techniques of determining the distribution of labelled tumour cells in experimental animals. I.A.E.A. will also provide some nuclear equipment for this project. (International Atomic Energy Agency, Vienna.)

## DISSECTING ANEURYSMS

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[WITH SPECIAL PLATE]

A dissecting aneurysm is a lesion produced by degeneration or disease of the tunica media of an artery. A split forms in the tunica intima and inner layers of the media with extravasation of blood within the tunica media of the vessel; the dissection produced by this extravasation extends in both centripetal and centrifugal directions from the original intimal split. The thoracic aorta is frequently involved, and death usually results from rupture of the aorta, cardiac tamponade, or ischaemia of essential organs.

Maunoir (1802) first described this lesion, and Laennec (1826) used the term "anévrisme disséquant." Pennock (1839) demonstrated that dissection occurred between the layers of the media, and Swaine *et al.* (1856) recorded the first clinical diagnosis. No attempt at surgical treatment was made until Gurin *et al.* (1935) operated on a patient who subsequently died of renal failure. Shennan (1934), in a comprehensive review of 297 cases of dissecting aneurysm of the aorta, concluded that the ascending aorta was the origin of the dissection in 69%, and death due to rupture occurred in 94.6%. Spontaneous cure by formation of a re-entry ostium and resultant double-barrelled aorta was described by Shekelton (1822). The frequency of this has been variously quoted as between 5% and 15%.

During the past few years an increasing number of successful surgical operations have been recorded. Creech *et al.* (1956) reported ten successful cases treated either by resection and grafting or by the formation of a re-entry ostium, Warren *et al.* (1956), four patients operated on with one survivor; and Shumacker and Harris (1956), one patient with recovery. More recently DeBakey (1958) has quoted a 27% mortality among 36 patients, and Beckwith *et al.* (1959) four successful results in 11 patients. In Great Britain, Martin and Muir (1958) and Birt (1959) have each reported a case with recovery.

We present our experience with seven patients who have undergone operation for dissecting aneurysms, with recovery in six.

## Case Reports

## Case 1

A railway porter aged 47 had been in good health until, three months before admission, he began to experience tiredness on exertion. He had previously had uncomplicated rheumatic fever at the age of 16. At 7.30 p.m. on the day of admission he experienced severe left upper abdominal pain, which radiated to the epigastrium and a few minutes later to the left leg, which became numb and white. Later the abdominal pain radiated to the right side of the chest posteriorly. Shortly before the onset of pain he had carried several heavy parcels without discomfort. On admission to hospital the patient, a heavily built, obese man, was rolling about in severe pain. There was no evidence of shock, pallor, or sweating. The pulse rate was 74 per minute and regular, the blood-pressure 160/95 mm. Hg, and the

apex beat was displaced to 5 in. (12.7 cm.) from the midline; apical systolic murmurs were heard over the whole praecordium. No abnormality was found on abdominal examination, and no murmurs were heard over the abdominal aorta. The left leg was white and cold, and the femoral pulse was absent. Sensation was diminished over the dorsum of the foot, and motor power of the leg was reduced. Examination of the chest gave normal results apart from reduced respiratory excursion at both bases. An electrocardiogram showed signs of left ventricular strain, but no evidence of coronary infarction. Blood examination: Hb 14.83 g. per 100 ml.; W.B.C. 10,000 per c.mm.; E.S.R. 3 mm. in 1 hour. Plasma electrolytes normal, and blood urea 37 mg. per 100 ml.

Morphine  $\frac{1}{4}$  gr. (16 mg.) was given, with relief of the pain and improvement in the circulation of the leg; there was no return of arterial pulsation. A further attack of epigastric pain occurred 12 hours later, and an aortogram was performed through a catheter introduced into the right femoral artery. This showed a dissection extending from the thoracic aorta to the abdominal aorta and occluding the left common iliac artery (Special Plate, Fig. 1). During the period of observation the urine output had been 240 ml.

Operation was performed 18 hours after admission. The abdominal aorta was approached through a left paramedian incision, and on exposing the bifurcation the dissection was apparent and the surging blood-flow was visible through the thin, almost transparent adventitia. The dissection involved the antero-lateral aspect of the aorta and had occluded the left common iliac artery, but spared the coeliac axis, renal artery, and superior and inferior mesenteric arteries. Tapes were passed round the aorta at the bifurcation and 5 cm. above, and an attempt was made to place a lateral clamp. This failed owing to the inner layer of the dissection slipping out of the clamp jaws, and the aorta was therefore cross-clamped. An area of 3 square cm. of the inner layer was excised, and the distal portion sutured to the adventitia to prevent further dissection. The adventitia was then sutured and the clamps removed. The iliac pulse returned, and there was surprisingly little haemorrhage from the suture line on the tenuous adventitia. The abdomen was close in layers. A total of 1,560 ml. of blood was transfused during operation. Apart from a moderate degree of paralytic ileus over the first three days, the patient made an uneventful recovery. He was allowed up on the 12th post-operative day, and discharged to convalescence on the 27th day. During this period the blood-pressure remained in the region of 150/90 mm. Hg. He returned to light work after three months, and when last reviewed 18 months after operation was in good health.

#### Case 2

A farmer, aged 54, while performing heavy manual labour, was seized with intense substernal pain, radiating within a few minutes to the back and upper abdomen. He collapsed and soon was severely shocked; the blood-pressure was, however, 160/90 mm. Hg. Morphine partially relieved the pain, and an electrocardiogram was normal. The pain persisted for two days, but was of diminished intensity. Blood-pressure was then 230/115 mm. Hg; electrocardiogram and serum transaminase were normal. W.B.C. 14,900 per c.mm. The patient experienced periodic attacks of abdominal discomfort during this period, and was subsequently admitted to Northampton General Hospital, where a chest radiograph showed some broadening of the upper mediastinum. Hb 95%; W.B.C. 12,000 per c.mm.; E.S.R. 43 mm. in 1 hour; serum amylase 80 mg. and serum cholesterol 200 mg. per 100 ml. At 5.30 p.m. on the eighth day he suddenly collapsed with severe retrosternal pain radiating to the left sterno-clavicular joint and left shoulder. Blood-pressure was 50/30 mm. Hg, and there was reduced respiratory movement in the left chest. A systolic pulsation was noted in the third left interspace in the midclavicular line. A chest radiograph showed broadening of the mediastinal shadow. He improved, and was transferred to St. Mary's Hospital.

On arrival he was pale and sweating, with cold extremities. Pulse rate was 90 per minute and blood-pressure 210/100 mm. Hg, with no significant difference in either arms or legs. All peripheral pulses were present, and urine output had been normal. Examination of the chest showed a sternal heave and visible pulsation in the second, third, and fourth interspaces on each side. Cardiac dullness was increased 2 in. (5 cm.) to the right, and a diffuse apex beat was palpable in the fifth and sixth spaces  $5\frac{1}{2}$  in. (14 cm.) from the midline. There was an accentuated aortic second sound, with non-conducted systolic murmurs in all areas. The left chest was dull to percussion, with only slight respiratory excursion in the upper lobe. A soft systolic murmur was heard in the midline over the liver for 2 in. (5 cm.) below the xiphisternum. Other systems were normal, and there was no evidence of spinal-cord ischaemia. A chest radiograph showed almost complete opacity of the left pleural cavity with mediastinal displacement. An aortogram, performed via a left femoral retrograde catheter, confirmed the diagnosis of dissecting aneurysm and showed the lower limit of the dissection to lie immediately above the coeliac axis (Special Plate, Fig. 2).

Operation was performed immediately, the aorta being exposed through a left eighth interspace thoraco-abdominal incision with radial splitting of the diaphragm. The left chest contained 1,050 ml. of heavily blood-stained fluid and a few clots. The aorta was dissected free from the crura and tapes were placed 7.5 cm. apart. Owing to the danger of retrograde dissection with consequent rupture into the pericardium an attempt was made to place a lateral clamp on the aorta to partially occlude the lumen. This manoeuvre was unsuccessful, the dissection slipping from the jaws of the clamp. The systolic blood-pressure was therefore reduced to 70 mm. Hg by purposely bleeding 1,000 ml. from the aorta, and the lower limit of the dissection isolated over 8 cm. by two transversely placed clamps. The aorta was then incised longitudinally for 7 cm. and the dissection exposed. An area of 6 square cm. of intima was excised to form a re-entry ostium, and the distal intima sutured to the aortic wall to prevent further dissection distally. The arteriotomy was then closed with a 0000 continuous silk suture. The clamps were removed after a period of occlusion of  $17\frac{1}{2}$  minutes. The chest was closed in layers with drainage to an underwater seal. A total of 2,160 ml. of blood was transfused during operation, which included the 1,000 ml. removed from the aorta. The post-operative condition was satisfactory, a blood-pressure of 120/80 mm. Hg being maintained. This rose to 200/100 mm. Hg on the second day, and was then controlled by "ansolysen" (pentolinium tartrate) in a dose of 0.5-1 mg. to maintain a pressure in the region of 150/90 mm. Hg. Two pints (1.1 litres) of packed cells was transfused on the third and fourth days after blood-pressure had been controlled. The precordial pulsation gradually subsided over the immediate post-operative period, and was imperceptible by the sixth day. There was some evidence of impaired renal and hepatic function; urine output for the first 24 hours was 1,470 ml., the urine containing protein and granular casts, and on the fourth day the blood urea reached a peak level of 148 mg. per 100 ml. The patient became jaundiced and the serum bilirubin rose to 3.9 mg. per 100 ml. The chest drain was removed after 48 hours, and a small residual effusion required aspiration on the fourth post-operative day. Thereafter the patient's recovery was uneventful. When last reviewed eight months after operation he was in good health and the blood-pressure was 150/90 mm. Hg.

#### Case 3

The patient, a man aged 70, had been in good health until the evening of admission to hospital, when he was seized by severe retrosternal pain radiating to both nipples and shoulders. He collapsed and was transferred to hospital, when he was noted to be pale and sweating, with some cyanosis of the lips. Pulse rate was 50 per minute, and blood-pressure 220/130 mm. Hg, and on auscultation of the heart there was a short systolic-diastolic murmur in the

aortic area; an electrocardiogram was normal. Morphine did not completely relieve the pain. On the second day the patient became oliguric, and only a few ml. of blood-stained urine was obtained by catheter. Screening of the chest showed a pulsatile enlargement of the aortic arch with diminished distal pulsation. W.B.C. 13,900 per c.mm.; blood urea 138 mg. per 100 ml.; serum electrolytes normal. He became anuric and was transferred to St. Mary's Hospital on the fourth day of his illness.

On arrival the patient was still experiencing precordial pain, the pulse rate was 100 per minute and blood-pressure 160/110 mm. Hg. There was some evidence of peripheral circulatory failure, and on abdominal examination a pulsatile mass was found extending from umbilicus to costal margin. Blood urea had risen to 280 mg. per 100 ml. An immediate laparotomy was performed, and on inspection of major vessels a complete absence of pulsation in the superior mesenteric and both renal arteries was noted. The aorta was therefore exposed and the lower extent of the dissection defined at the bifurcation. Tapes were passed round the aorta, and it was possible to include the inner lumen with a laterally placed clamp without occlusion of the main channel. A re-entry ostium 4 square cm. in area was made, the distal portion obliterated, and the outer wall sutured longitudinally. When the clamp was released there was return of pulsation to the renal and superior mesenteric arteries. The wound was closed in layers and the patient made a satisfactory immediate recovery. He remained anuric, and died in uraemic coma on the seventh day of his illness.

At necropsy there was advanced atheroma of the aortic arch and a 2-cm. split in the intima immediately above the aortic valves, with a dissection extending to the bifurcation of the abdominal aorta. The operative ostium near the terminal portion of the dissection and the lumen of the dissection were patent. The renal arteries were patent, as also were the other main branches. The kidneys showed extensive bilateral cortical necrosis. There was no evidence of ischaemic changes in the small intestine.

#### Case 4

On January 16, 1959, a woman aged 57, having spent the morning doing housework, was preparing for a walk when she experienced sudden severe pain on both sides of the jaw. She collapsed, but did not lose consciousness, and in three hours the pain became retrosternal and persisted for 24 hours. She appeared shocked during this period, but blood-pressure was recorded as 175/95 mm. Hg. A third attack of pain now started in the left shoulder and radiated to the back, and she was transferred to hospital. No further attacks of pain occurred after this time. Examination showed a raised blood-pressure and E.S.R., and an electrocardiogram was normal. Wassermann and Kahn reactions were negative. A chest radiograph showed broadening of the aortic shadow when compared with a miniature film taken three years previously. She had an intermittent fever, which gradually subsided, and she was discharged one month later. She was then referred to St. Mary's Hospital. During this period she was easily tired and lost 18 lb. (8.164 kg.) in weight, but had no further symptoms. Previous to the onset of symptoms the patient had been in good health and had had no serious illness.

On examination she appeared somewhat pale, but no other abnormality was noted. Pulse rate was 84 per minute, blood-pressure 120/80 mm. Hg with no significant variation in arms or legs, and all peripheral pulses were normal. An aortogram by retrograde catheterization via a femoral artery showed a typical dissection extending from the arch to the region of the diaphragm (Special Plate, Fig. 3). An electrocardiogram was normal. Hb 12.6 g. per 100 ml.; W.B.C. 10,000 per c.mm.; E.S.R. 14 mm. in 1 hour; serum cholesterol 240 mg. per 100 ml.; Wassermann and Harris tests negative.

The chest was opened through a fifth interspace incision, and the enlarged aorta was exposed and found to measure 7 cm. in transverse diameter. The dissection started in the

region of the arch and extended to the diaphragm. The lower portion was isolated between tapes placed 10 cm. apart, and before cross-clamping was performed 500 ml. of blood was removed to lower the blood-pressure to 60-70 mm. Hg. The aorta was clamped and the dissection opened to expose the flattened inner lumen, which measured 2.3 cm. at the widest point. Removal of the upper clamp resulted in a profuse blood-flow from the lumen of the dissection, but there was no back-flow from the distal portion indicating the absence of a spontaneous re-entry ostium. The lower limit of the dissection was visualized at this time 5 cm. distal to the lower clamp. A re-entry ostium 6 × 2 cm. was formed in the aortic lumen and the distal portion of the dissection obliterated with a continuous 0000 silk suture. The aorta was then closed with a continuous silk suture. After removal of the clamps the 500 ml. of blood previously removed was then transfused. The total period of aortic occlusion was 17 minutes. The chest was closed with drainage. During the first four post-operative days a mild depression of renal and hepatic function was evident, manifest by red blood cells and a few tubular casts in the urine and a rise in blood urea level to 61 mg. per 100 ml. There was no diuresis during this period. The serum bilirubin level was raised to 1.1 mg. per 100 ml. on the third day. All returned to within normal limits by the fifth post-operative day. The patient had an uneventful recovery, and was discharged to convalescence on the 20th post-operative day. She was readmitted two months later for a post-operative aortogram. This showed some dilatation of the thoracic and abdominal aorta, but no evidence of the dissection. When last reviewed six months after operation the patient was in good health.

#### Case 5

The patient, a male Jamaican aged 53, experienced severe lumbar pain 12 months before admission to hospital; the pain radiated to the abdomen and left hip, and persisted for 24 hours. He rested for one day, then returned to work. He had a second similar attack six months later, and he was observed in hospital for 18 days. The third attack of pain occurred five months later, and now radiated to both loins and persisted for three days. He was investigated at the Central Middlesex Hospital, and subsequently transferred to St. Mary's Hospital with a diagnosis of dissecting aortic aneurysm.

Clinical examination showed the patient to be a well-built man. The pulse rate was 72 per minute and the blood-pressure 140/95 mm. Hg. A pulsatile swelling in the region of the aortic bifurcation was found on abdominal examination. Peripheral pulses and other systems were normal. The Wassermann reaction was negative, electrocardiogram normal, and serum cholesterol 188 mg. per 100 ml. An aortogram performed at the Central Middlesex Hospital showed aneurysmal dilatation of the aorta with dissection and dilatation of both iliac arteries.

At operation the abdominal aorta was found to be dilated, measuring 8 cm. at the widest point, and to extend from below the renal arteries to the iliac bifurcation on each side. The aorta and iliac arteries were clamped and the aneurysm was isolated and excised. The aortic stump had a double lumen, the outer portion of which extended to the thoracic aorta. The common iliac arteries also showed a double lumen extending to the bifurcation on the right and a short distance down the external iliac on the left. A bifurcated homologous transplant was inserted, the upper part being sutured to the outer lumen of the dissection, and the lower limits to include all layers of the dissection of the remaining short portion of iliac arteries. The patient had an uneventful post-operative recovery, and when reviewed three months later was in good health. Histological examination of the resected aorta showed atheromatous degeneration.

#### Case 6

The patient, a man aged 43, experienced an aching pain extending from behind the right knee to the buttock at 1 p.m. on the day of admission. An hour and a half later

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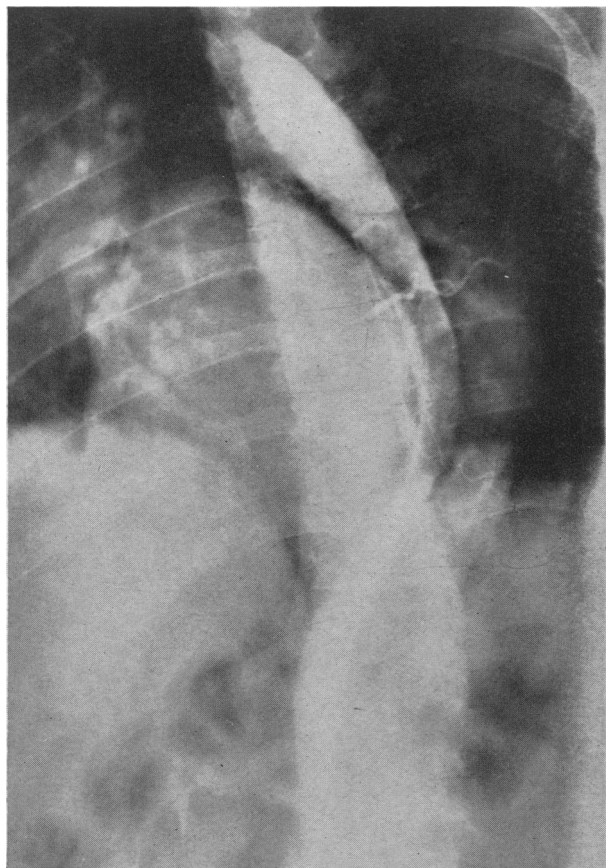


FIG. 1.—Case 1. Aortogram by retrograde femoral catheterization, showing dissecting aneurysm involving lower thoraco-abdominal aorta.

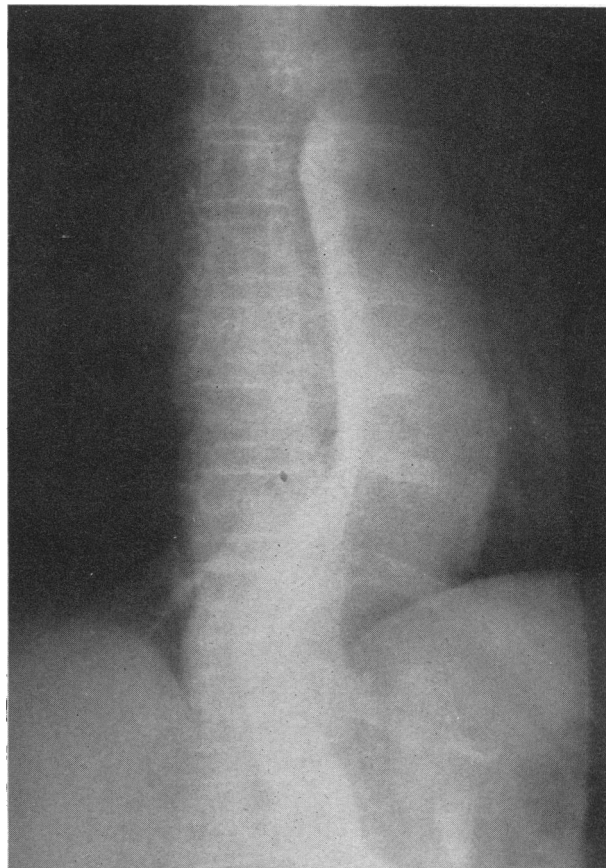


FIG. 3.—Case 4. Aortogram showing dissection extending to lower thoracic aorta.

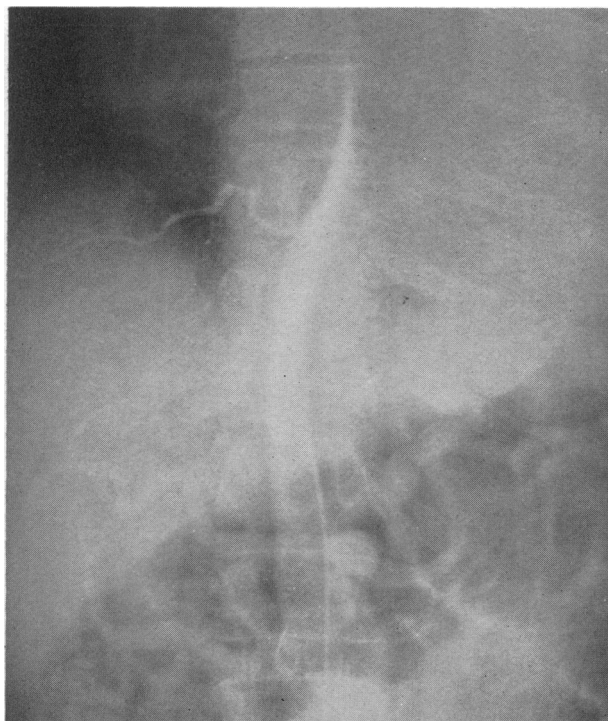


FIG. 2.—Case 2. Aortogram showing lower limit of dissection lying immediately above diaphragm.

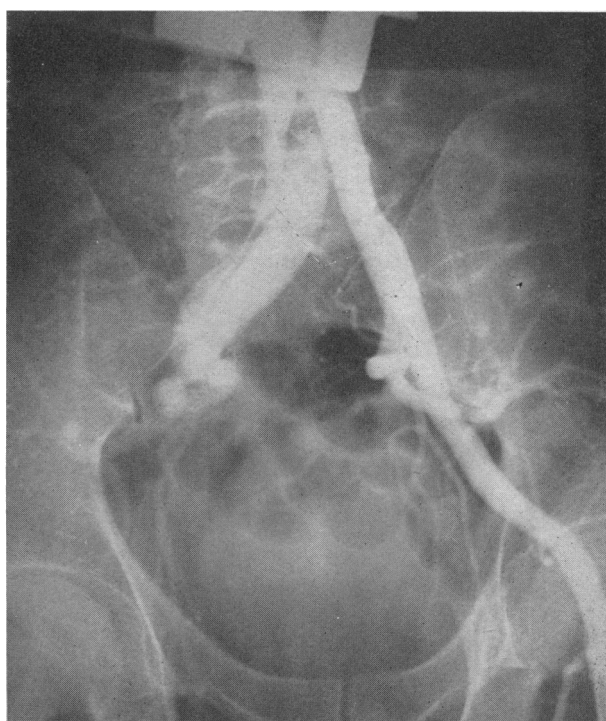


FIG. 4.—Case 6. Aortogram showing dissection involving right common iliac artery. External iliac artery is occluded.

a severe tearing pain occurred in the right groin and extended to the knee. The onset of pain was not associated with strenuous exertion. A swelling appeared in the affected groin and he experienced paraesthesiae in the right foot, which also became pale and cold. He had previously been in good health.

On admission there was no clinical evidence of shock or haemorrhage. The pulse rate was 84 per minute and the blood-pressure 130/80 mm. Hg. There was a small swelling and ecchymosis in the femoral triangle of the right thigh with pallor of the foot; the femoral and peripheral pulses were absent; the left leg was normal. Abdominal examination showed a normal aortic pulse, with some tenderness on deep palpation in the right iliac fossa. No bruit was heard over the major vessels. The remainder of the cardiovascular system and other systems were clinically normal. An aortogram by retrograde catheterization of the left femoral artery (Special Plate, Fig. 4) confirmed the provisional diagnosis of dissecting aneurysm of the iliac artery and showed the femoral artery to be patent. Hb 11.9 g. per 100 ml.; W.B.C. 7,000 per c.mm.; E.S.R. 25 ml. in 1 hour; serum cholesterol 180 mg. per 100 ml.

At operation the aortic bifurcation and right iliac vessels were exposed through a right lower paramedian incision, and the femoral vessels by oblique incision in the groin. The dissection was found to begin at the origin of the right common iliac artery, which was 4 cm. in diameter and actively pulsatile, and to extend to the bifurcation of the common femoral artery, which was pulsating feebly. The right ureter was adherent to the dissection and required mobilization. The external iliac artery had been spared from the dissection. The aortic bifurcation and the left common iliac, right internal iliac, and right femoral vessels were isolated and clamped, and a crimped terylene prosthesis was inserted from the left common iliac to the right femoral artery via the femoral canal, to lie deep to the right ureter. A re-entry foramen 1.5 cm. long was made at the lower limit of the dissection. On removing the clamps full pulsation was restored to the femoral artery and diminished pulsation was noted in the dissection. The wounds were closed in layers; 500 ml. of blood was transfused during operation.

Post-operatively all peripheral pulses were normal and the patient made an interrupted recovery. When last examined six months after operation he was in good health and able to do a normal day's work.

#### Case 7

This patient, a man aged 54, had a history similar in many ways to that recorded for Case 6. The dissection was in the left common iliac artery. Treatment was by excision of the whole zone of dissection and reconstruction with a homologous arterial transplant. The patient is fit and well four years later.

### Discussion

#### Indications for Operation

The medical management of dissecting aneurysms is usually without effect in the majority of patients, though a few recover, sometimes because a distal re-entry ostium forms spontaneously. Operation is therefore preferable whenever it appears that the patient has a reasonable chance of surviving the procedure. The high incidence of rupture of the dissection into the pericardium, with cardiac tamponade, or into the pleural or peritoneal cavities, with fatal haemorrhage, demands early relief of end-pressure in the blind lumen of the dissection. Occasionally the dissection may remain unchanged for several months, but this event cannot be predicted.

At the present moment there is no place for surgery in fulminating dissections or those with severe cardiac tamponade, or in those patients whose condition has not

stabilized, at least to some extent, after the initial onset. We believe surgery is contraindicated when there has been established anuria for more than a few hours, even when facilities for haemodialysis are available. The maximum time anuria may exist in such cases, with subsequent recovery of renal function, has yet to be determined.

Aortography by retrograde arterial catheterization is the most certain method of confirming the diagnosis and determining the lower limit of the dissection. It may also indicate whether or not the renal arteries are involved.

#### Operation

The procedure of forming a re-entry ostium in the lower limit of the dissection, with obliteration of the distal dehiscence of the arterial wall, has given satisfactory results in the cases described. It is essential that the ostium is of adequate size, a minimum area of 6 square cm. for the thoracic aorta and 4 square cm. for the abdominal aorta is suggested. When the lower-limb vessels are involved the double lumen may prove inadequate, with a tendency to subsequent thrombosis, and reconstruction of the vessel with a homograft or prosthesis is usually necessary.

There is considerable danger of rupture of the aorta or retrograde dissection with consequent haemopericardium on cross-clamping the aorta, particularly in the thorax. A laterally placed non-occlusive clamp is one solution. In practice this proved impossible in three cases owing to the discrepancy between the total aortic diameter and the true lumen. In two cases it was found preferable to produce a temporary reduction in the cardiac output by induced oligoemia. The removal of 500–1,000 ml. of blood directly from the aorta into a transfusion set effectively reduced the systolic blood-pressure to 60–70 mm. Hg and permitted aortic occlusion with safety. The blood was subsequently transfused after removal of the clamps. The period of occlusion of the thoracic aorta must also be limited, and it is considered that 20 minutes is approaching the upper limit of safety. In Cases 2 and 4 the periods of occlusion were 17½ and 17 minutes respectively, and both showed evidence of depressed renal function secondary to the reduction in blood-flow.

The fate of the dissection after the formation of the re-entry ostium is of particular interest. Clinical examination in Cases 2 and 4, and retrograde aortography in Case 4, suggests that the aortic lumen expands to obliterate the dissection, with resultant broadening of the aorta. An outflow ostium larger than the inflow tear is a prerequisite for this occurrence, otherwise a double-barrelled aorta may form.

Resection and grafting of the dissection is a more extensive procedure attended by a higher mortality. Resection of an aneurysmal dilatation of the false sac is necessary when this event occurs. It is doubtful whether the true aortic lumen could expand to obliterate such a dissection with decompression alone. This proved necessary in Case 5 when the distal abdominal aorta and bifurcation were involved. When the dissection extends to the vessels of the lower limb it is advisable to re-establish distal blood-flow with a prosthesis or homologous arterial transplant. It is also essential to decompress the blind lumen of the dissection in such cases.



## Summary

The case records of seven patients undergoing operation for dissecting aneurysm of the aorta are presented. Six patients recovered completely; one patient died in uraemic coma on the seventh day of illness.

The indications and contraindications for operation are discussed.

The surgical procedures are briefly described with particular reference to formation of a re-entry ostium, with apparent resolution of the dissection.

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## RUBELLA IN PREGNANCY

### A REPORT ON SIX EMBRYOS

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[WITH SPECIAL PLATE]

There have been comparatively few descriptions of foetal pathology in cases where pregnancy has been terminated because of maternal rubella. The present account is of six cases where rubella occurred from the second to the ninth week of pregnancy. The smallest foetus was 38 mm. crown-rump length, the largest 151 mm. In every case the size of the foetus confirmed the clinical dating of the pregnancy.

#### Material and Methods

Table I summarizes the main facts of the size of embryo, duration of pregnancy at the time of onset of the rubella, and methods of termination, fixation, and examination.

#### Results

Certain previous communications have reported "lesions" which now appear to be technical artifacts. It is freely conceded that the "lesions" in the present series may also turn out to be due to other causes than rubella; however, comparison has in all cases been

TABLE I.—Details of Cases

Case No.	Crown-Rump Length of Foetus (mm.)	Duration of Pregnancy at Time of Onset of Rubella	Method of Termination of Pregnancy	Fixation of Specimen	Method of Examination
1	53	37 days = 51 days after L.M.P.	Abdominal hysterotomy	Bouin's fluid 1 hour after termination	Complete serial sections
2	151	7 wks = 9 wks after L.M.P.	" "	Bouin's fluid	Serial sections both eyes, both ears. Naked-eye examination of remainder
3	134	9 wks = 11 wks after L.M.P.	" "	"	" "
4	69	6 wks = 8 wks after L.M.P.	" "	"	Complete serial sections
5	45	20 days = 34 days after L.M.P.	Vaginal hysterotomy	Formal saline followed by Bouin's fluid	" "
6	38	14 days = 28 days after L.M.P.	Hysterec-tomy	" "	" "

L.M.P. = Last menstrual period.

made with "normal" embryos of similar stages of development. The supply of material was too small to permit exact duplication of technical methods in the controls, nor was it possible to carry out planned variations in technique when human material was used, again because of the scarcity of the material.

#### Case 1: 53-mm. Foetus

Maternal rubella 51 days after last menstrual period = 37th day of pregnancy.

The pathology of the internal ear has already been described (Gray, 1959). There was an undoubted lesion affecting the organ of Corti on both sides. The basal and middle coils were affected, and the severity of the changes was greatest in the basal part of the cochlear duct. The lesion appeared to be a lysis of the cytoplasm of the epithelium of Corti's organ followed by complete disappearance of the cells. Special Plate, Fig. 1, shows the lower part of the basal coil, and Fig. 2 the middle coil; the sections are coronal. Both cochlear ducts were affected, but the vestibular apparatus was normal.

The eyes presented a difficult problem. The structure of the lens became less and less easy to make out as the centre of the lens was approached, until finally it was indiscernible (Special Plate, Fig. 3). There is a strong temptation to diagnose necrosis and subsequent autolysis of the primitive nucleus of the lens, especially because Swan (1954) has reported observing an amorphous appearance in the lenses of infants affected by foetal rubella. However, I have seen a similar appearance in embryos of about this size where no history of maternal rubella was given to me.

The posterior part of the dental lamina had not formed. If development had proceeded this might have resulted in the eventual absence of the lower permanent molars.

The left olfactory bulb was 380  $\mu$  shorter than the right. To ascribe any significance to this would be no better than guessing. No other abnormalities were found.

#### Case 2: 151-mm. Foetus

Maternal rubella 9 weeks after last menstrual period = 7th week of pregnancy.

In the heart the septum primum had completely absorbed; this must have caused a persistent foramen ovale had the embryo survived, because the septum primum forms the valve of the foramen ovale. A photograph was not taken. Histologically, there was no abnormality of the tissues adjacent to the defect. The remainder of the heart was normal.

Special Plate, Fig. 4, shows the appearance of the cochlear duct; the section is horizontal. The ducts show normal