

Acute Ascending Aortic Dissection

WALTER G. WOLFE, M.D.

Thirty of 33 patients (ages 18–67) with acute dissection of the ascending aorta underwent surgical intervention. There were four deaths. There were eight male and five female patients and 15 patients were known to be hypertensive. Severe chest pain, widened mediastinum (demonstrated radiographically), and varying degrees of aortic insufficiency were present in each patient. Heart failure was present in 13 patients, numbness and coolness of an extremity in seven patients, and central nervous system changes were present in three patients. The diagnosis in each instance was confirmed by aortography. Three patients treated nonoperatively died during hospitalization following aortic rupture into the mediastinum and pericardium. The remaining 30 patients were managed by insertion of a woven Dacron® graft sutured distal to the coronary arteries and proximal to the origin of the great vessels. This was accompanied with resuspension of the aortic valve in 24 patients and valve replacement in six patients. Each of the latter six patients had a history of aortic valve disease. The goals of the operation were: 1) correction of the accompanying aortic insufficiency, either by valve replacement or resuspension of the valve and 2) placement of a prosthetic graft into the ascending aorta, thereby obliterating the false lumen and preventing involvement of the coronary arteries or rupture into the mediastinum or the pericardium. Hypertensive patients were managed pre- and postoperatively with nitroprusside and then with propranolol HCl, methyl-dopa, or hydralazine HCl and hydrochlorothiazide. One late death occurred six months after myocardial infarction and a second late death occurred from a presumed cardiac arrhythmia. One patient had a femorofemoral graft two months after the initial operation and another patient has mild aortic insufficiency. It is concluded that prompt surgical management is mandatory in acute ascending aortic dissection, and in most patients aortic valve competency can be re-established with resuspension of the valve preventing the added morbidity associated with a prosthetic valve. Four patients have been followed for five years and additional follow-up data will better define long-term survival.

IN 1761 MORGAGNI was the first to describe the clinical course and pathologic findings of fatal aortic dissection in detail, and since then the grave prognosis of this disease has been well established.⁹ The high mortality rate of aortic dissection was well documented by Hirst before definitive therapy for this condition was available. A total of 505 aortic dissections were reviewed covering a period of 21 years. In

From the Department of Surgery, Duke University Medical Center, Durham, North Carolina

his series, the mortality rate was 50% at four days, 75% at two weeks, and 90% at three months.⁷ This review also emphasized the protein manifestations of acute aortic dissection and the unfortunate fact that a diagnosis is frequently not made before death.

The surgical treatment of dissecting aneurysms was pioneered by DeBakey, Cooley, and Creech, and, on the basis of an extensive experience, these lesions were classified into types I, II, and III. Immediate surgical intervention was recommended as the treatment of choice for most patients with this disorder.^{4,5} Recently, it has become more apparent that from a therapeutic point of view dissecting aortic aneurysms may be classified into two primary groups, those involving the ascending aorta (types I and II) and those originating in the descending aorta (type III).

In the past five years our experience has grown through the treatment of 33 consecutive patients with dissecting aneurysm of the ascending aorta at the Duke University Medical Center. As a result of this study, it is now felt that immediate surgery is the treatment of choice.

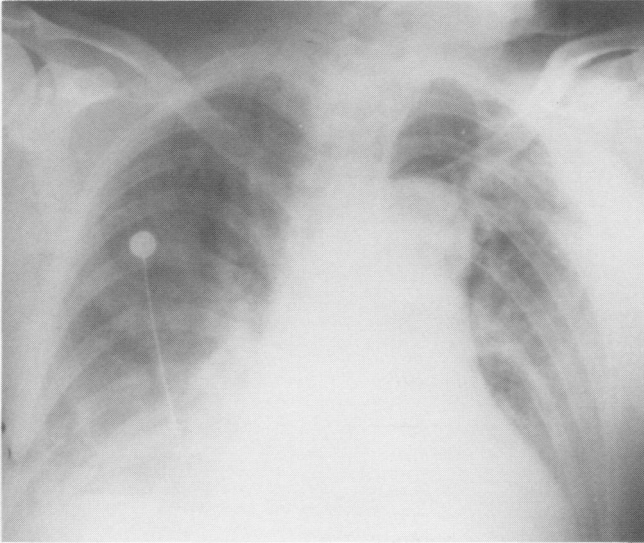
Clinical Data

This group of patients with dissecting aneurysms of the aorta is comprised of 28 males and five females, ranging in age from 18 to 67. Fifteen patients were known to be hypertensive prior to the onset of the aortic dissection. Severe chest pain and varying degrees of aortic insufficiency were present in all patients (Figs. 1 and 2). Three patients had symptoms associated with central nervous system disorders, including transient stroke and lethargy. Thirteen patients had heart failure and seven had numbness and coolness of the extremities. Two patients had motor loss of a lower extremity. The diagnosis in the 30 patients managed surgically was confirmed by aortography in each instance. Most of the patients were first seen at outlying hospitals and then referred to the Emergency Clinic at the Duke University

Reprint requests: Walter G. Wolfe, M.D., Box 3507, Duke University Medical Center, Durham, North Carolina 27710.

Submitted for publication: May 5, 1980.

0003-4932/80/1100/0658 \$00.95 © J. B. Lippincott Company



FIGS. 1A-C. (A) This 27-year-old man was admitted with a history of chest pain, pulmonary edema, and renal failure. Referring diagnosis was Goodpasture's syndrome, but on arrival in our emergency room it was apparent that aortic dissection was the most likely diagnosis. The chest radiograph shows a widened mediastinum and pulmonary edema. (B) The aortogram demonstrates ascending aortic dissection with aortic insufficiency. (C) The distal abdominal aorta did not opacify through true lumen and only the celiac axis opacified on the injection.

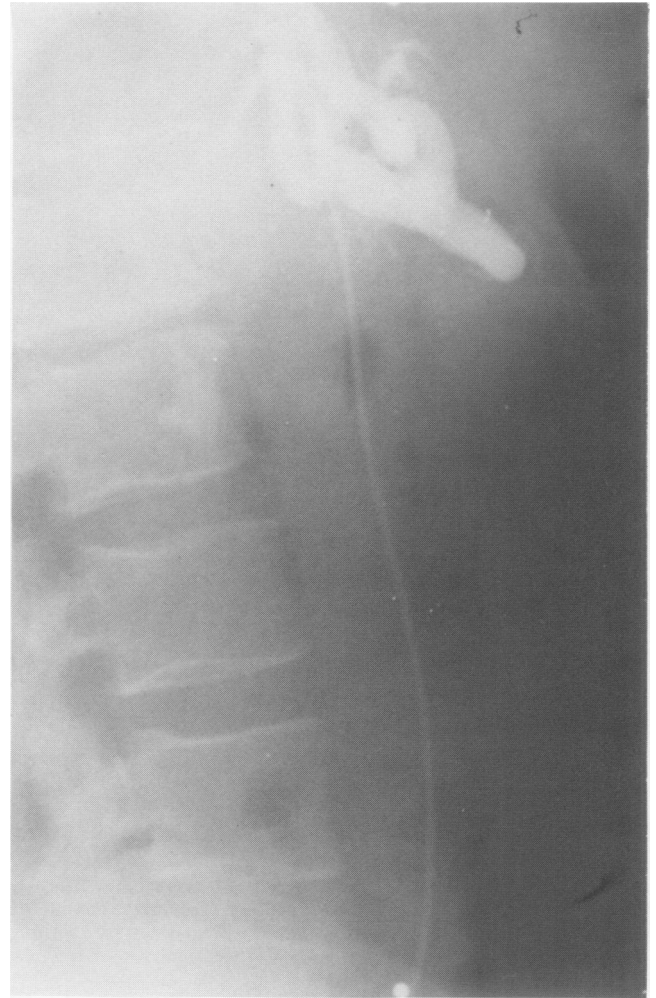
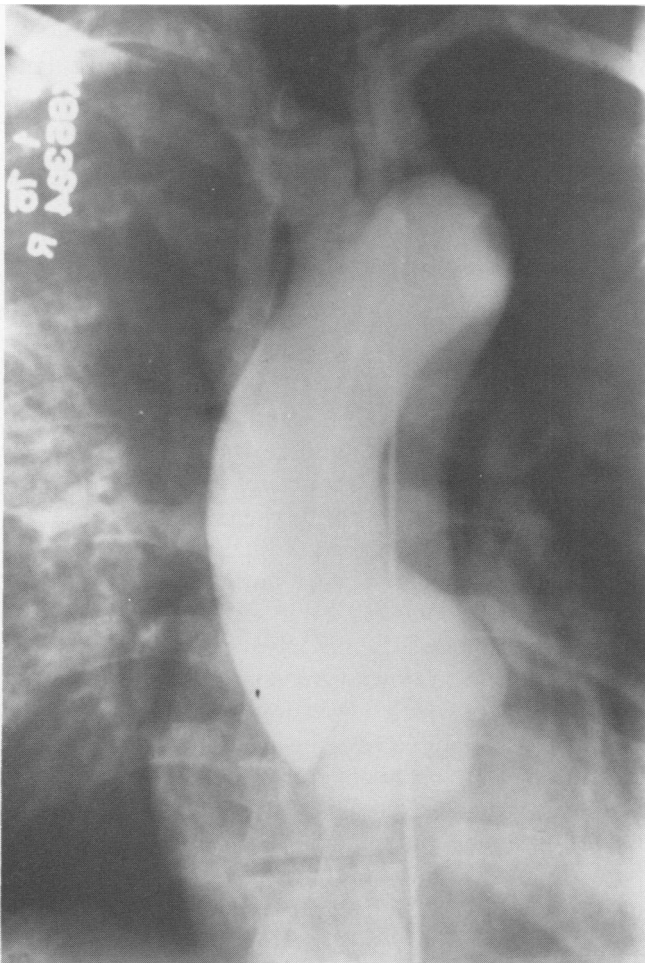
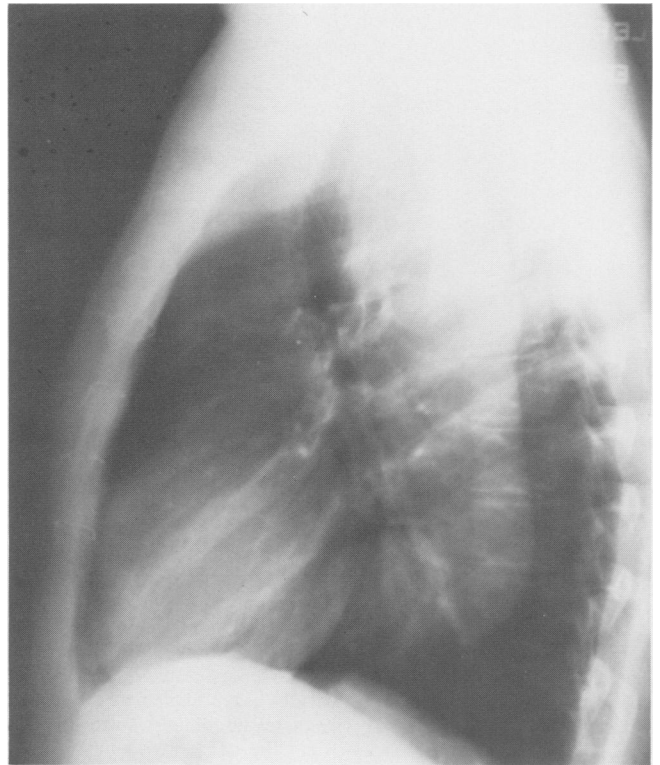
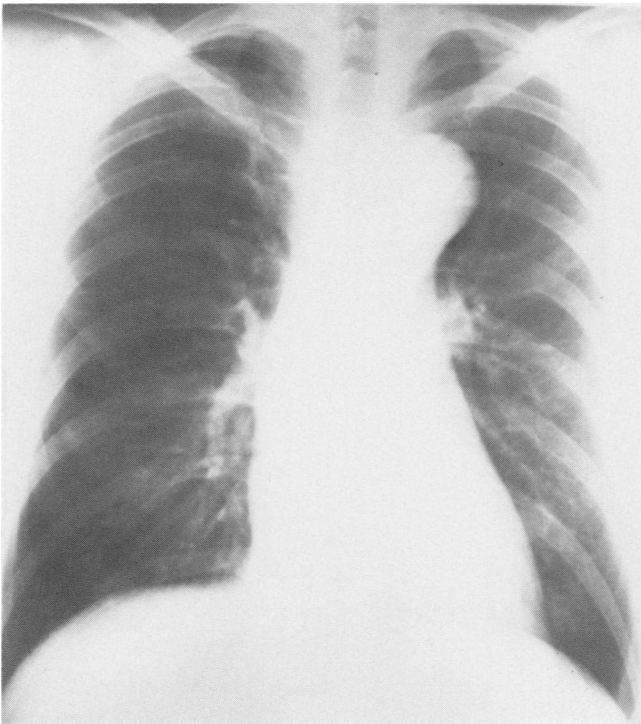


FIG. 1C.

Medical Center, usually with a diagnosis of dissecting aortic aneurysm, myocardial infarction, or occlusive or embolic disease of the extremities. On evaluation and examination in the Emergency Clinic, the diagnosis of aortic dissection was strongly suspected in each patient although myocardial infarction nearly always had to be considered in the differential diagnosis. Documentation of myocardial infarction was not present on electrocardiogram tapes in any of these patients.

The single most important feature in the presentation of these patients was severe chest pain. The pain which these patients experienced was of sufficient magnitude to need the assistance of a physician. The chest radiograph was abnormal in all patients and revealed widening of the mediastinum. Another helpful physical sign was the presence of differential pressures in the arms or differential pulses in the lower extremities in many of these patients, leading one to confirm the

FIG. 1B.



FIGS. 2A-C. Postoperative chest radiograph (A) in the same patient five years ago compared with his recent chest radiographs (B and C) which shows continued enlargement of the descending thoracic aorta. Ultrasonography has shown comparable increases in the size of the abdominal aorta. Currently, the patient is pain-free and asymptomatic except for hoarseness secondary to left vocal cord dysfunction.

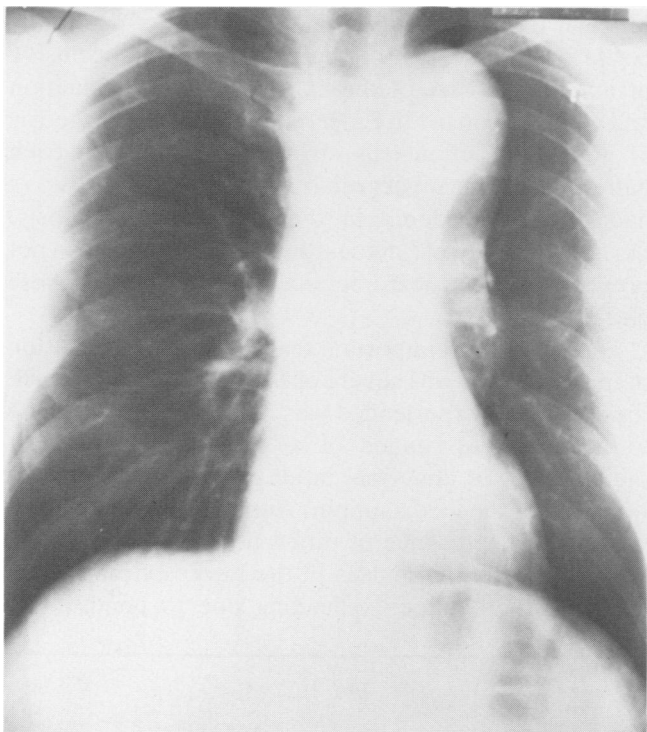


FIG. 2C.

suspected clinical diagnosis (Fig. 3). From these data, the firm view was established that aortography is indicated in the patient with acute chest pain and widened mediastinum as evidenced on radiographic evaluation.

Pathogenesis

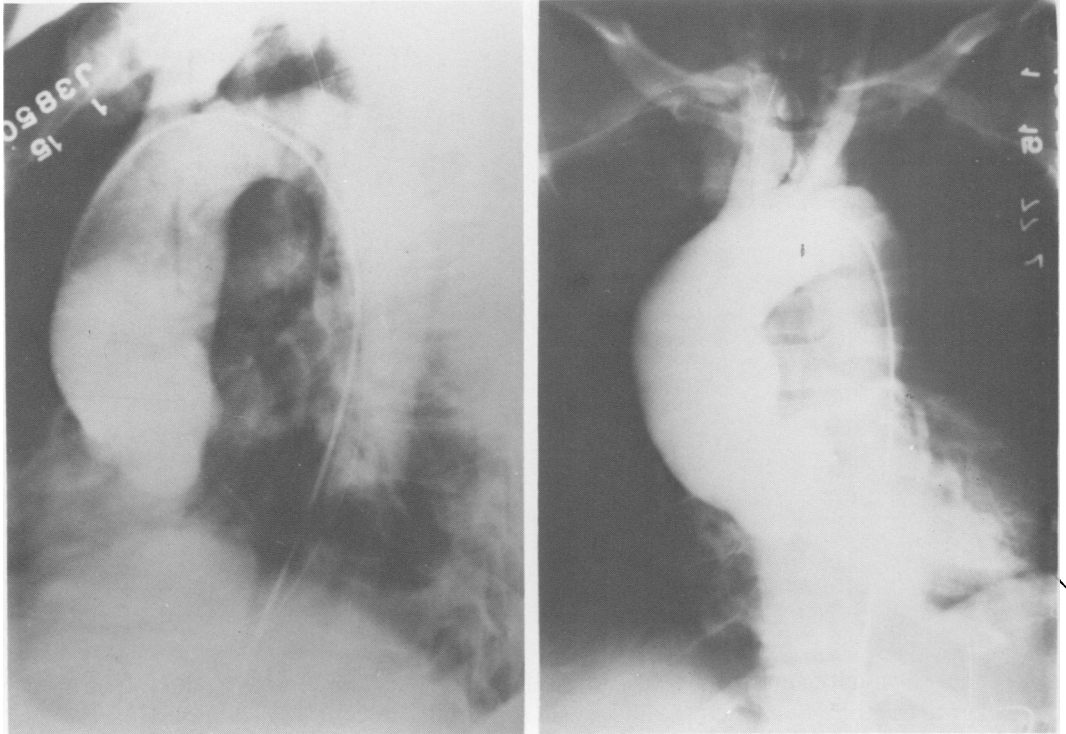
Acute dissection of the ascending aorta usually involves the transverse and ascending aorta. In the present series, all but one patient had involvement of the entire aorta with the dissection beginning low in the ascending aorta and continuing distally to the iliac arteries (Fig. 4). The visceral vessels were involved to varying degrees as were the head vessels.

Rupture of the adventitia with extrusion of blood into the mediastinum or pericardium with resultant tamponade is recognized as an early cause of death. Aortic valvar insufficiency also becomes manifest, most often due to downward displacement of a non-coronary cusp which slips downward into the left ventricle beginning at the site of intimal fracture and separation. This produces aortic insufficiency and is usually poorly tolerated, causing left ventricular failure and subsequent pulmonary edema. In a spiraling dissection, the other valvar cusps are usually spared and the coronary arteries protect them from separation



FIG. 2B.

FIGS. 3A–C. This man was seen in the emergency room with chest pain and confusion. The clinical diagnosis of dissection was made and he was admitted and arteriograms done. Arteriogram shows ascending dissection with aortic insufficiency (A). He also has continuation of dissection into the abdominal aorta with visceral vessels being opacified from the false lumen with the exception of the superior mesenteric artery. Injection distal to the intimal flap reveals the sluggish, almost venogram effect of blood flow within the terminal aorta and iliac arteries (B). Postoperative chest radiograph following grafting of the ascending aorta and resuspension of the aortic valve is seen in Figure 3C.



in these areas. If the dissection does involve the coronary arteries, sudden death is likely to occur.

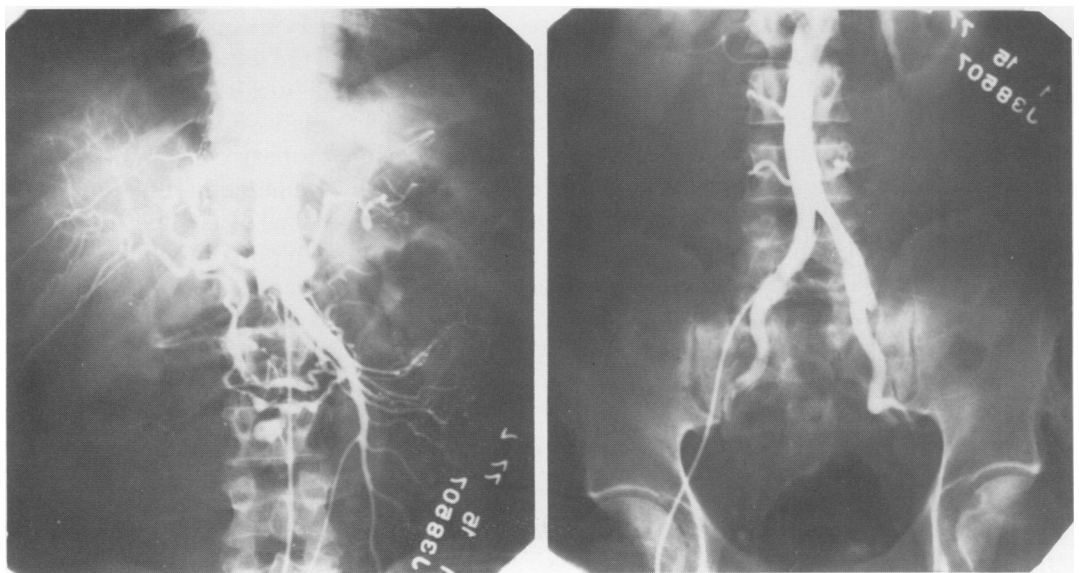
In the present series, all 27 patients had bloody fluid in the pericardium when it was opened. Although a number of patients are considered normotensive on initial examination following chest pain, the patient may actually be hypertensive and the normotensive reading the reflection of pericardial tamponade. It is quite likely that many of these patients have previous hypertensive cardiovascular disease even though it may not be possible to document this at the time of the dissection. The above combination of clinical

and pathologic features leads to a recommendation that operation be undertaken for replacement of the involved ascending aorta to prevent rupture and also to resuspend or replace the aortic valve to prevent aortic insufficiency.

Management and Results

Of the total 33 patients, three were not operated on. The first was an elderly woman whose family did not wish operative intervention due to her age, associated debilitating disease, and senility. Therefore, anti-hypertensive management was elected and the patient

FIG. 3B.



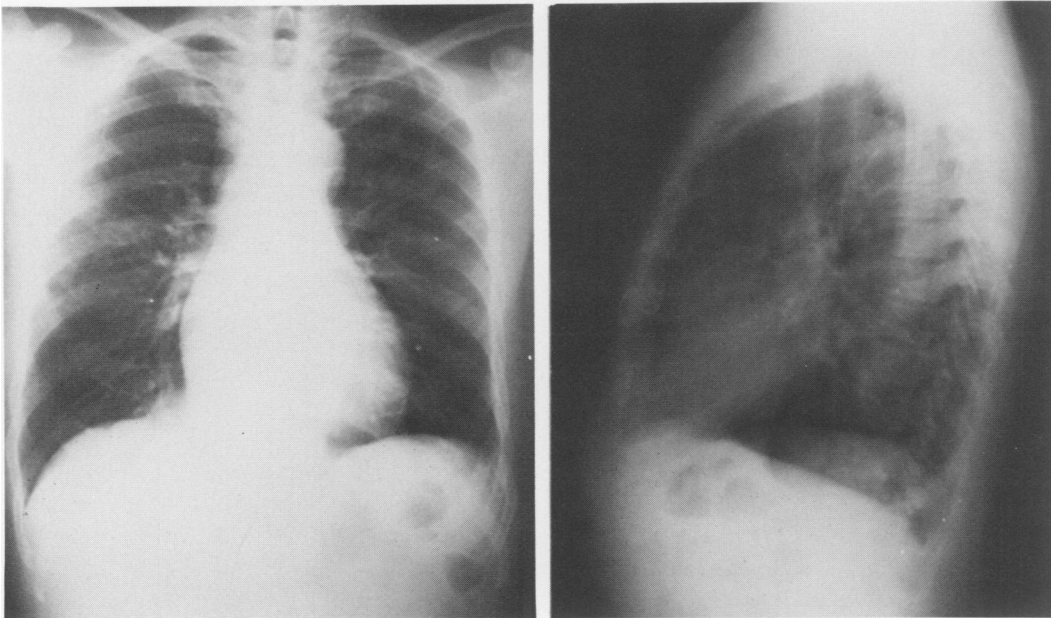


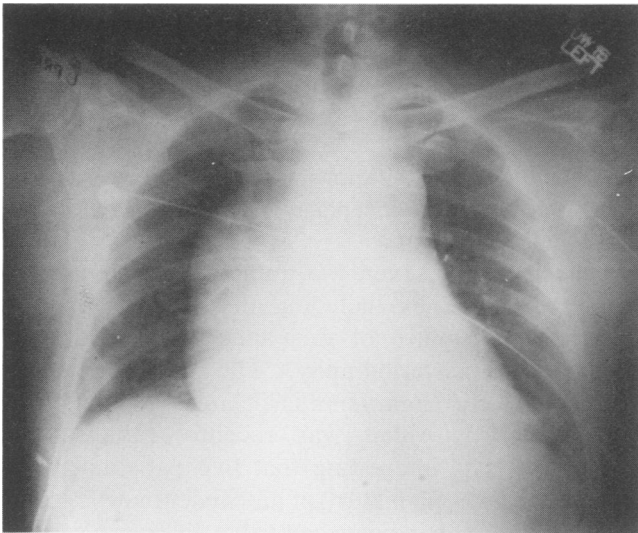
FIG. 3C.

was rendered pain free and remained under satisfactory control until the third day when the aneurysm ruptured, causing sudden death. The second patient was admitted with a suspected diagnosis of myocardial infarction, but acute aortic dissection was also considered in the differential diagnosis. The patient was normotensive and was admitted to the Cardiac Care Unit with aortography being planned for the following morning. However, before this could be done, cardiac arrest ensued and the patient died from rupture of the aneurysm and pericardial tamponade. In both of these patients, the diagnosis of acute ascending aortic dissection with rupture into the mediastinum and pericardium was confirmed by postmortem examination. A third patient, a 33-year-old man ruptured his aneurysm during radiographic evaluation and at autopsy had severe cystic medial necrosis and a bicuspid aortic valve. He had been in excellent health prior to his sudden onset of chest pain three hours before coming to the Duke Emergency Clinic (Table 1).

The remaining 30 patients had aortography followed by immediate operation. Again, we feel it is important to emphasize that operation should be done *as soon as possible* after the diagnosis is made, regardless of the time of day or night. During aortography and while the cardiovascular room and operating team are being assembled, we use nitroprusside to control hypertension if it is present to a significant degree.

After the diagnosis had been confirmed by aortography, 30 patients were subjected to median sternotomy and upon opening of the pericardium, 27 had blood-tinged fluid or gross blood clot within the pericardium. Half of these patients had an element of

tamponade from clotted blood which had accumulated there. Cardiopulmonary bypass was instituted via the femoral artery for arterial inflow and through the right atrial appendage for venous return. The body temperature was lowered to 28 C and ice saline slush was used to reduce the cardiac temperature. In the more recent patients, potassium cardioplegia as well as hypothermia was used. The aorta was then occluded just proximal to the innominate artery and opened longitudinally (Fig. 5). The intima was reattached to the adventitia with sutures. Twenty-four of the 30 patients had resuspension of the aortic valve (Fig. 5). Five patients had replacement of the aortic valve with a Starr-Edwards® ball valve and one with a porcine valve prosthesis. In this group of six patients, it was interesting that all had an antecedent history of aortic valvar disease. A woven Dacron® graft was then sutured beginning at the junction of the left and right coronary cusps. The graft was fashioned and sutured above the left coronary orifice around and down to the commissure of the left and noncoronary cusps (Fig. 6). The graft suture line was then extended along the noncoronary cusp and then around the right coronary artery completing the suture line (Fig. 7). The distal suture line was then completed using a running 3-0 suture of polypropylene (Fig. 8). Following rewarming, all patients were removed from cardiopulmonary bypass without difficulty except for the one patient previously mentioned who had a ruptured aneurysm en route to the operating room. Immediately following separation from cardiopulmonary bypass, the patients were maintained at a relatively hypotensive level. Protamine was administered for reversal of the heparin,



FIGS. 4A–C. This patient was known to have aortic stenosis and previous catheterization data revealed a gradient of 40 mmHg across the bicuspid aortic valve. Following the onset of sudden chest pain, he was admitted with the radiograph showing marked widening of the mediastinum (A). Arteriogram confirmed an ascending aortic dissection and the descending thoracic abdominal aorta was entirely normal (B). This patient underwent grafting of the ascending aorta with insertion of a Starr-Edwards prosthesis in the aortic position. Chest radiograph taken five years following his operation (C).

and nitroprusside was infused. Once clotting was apparent, the blood pressure was slowly increased by diminishing the level of anesthesia and decreasing the amount of nitroprusside infused. When adequate cardiac output was evident together with satisfactory hemostasis, the incision was closed and the patient taken to the Acute Care Unit. The endotracheal tube was removed within 24 to 48 hours in all patients, and those who were hypertensive postoperatively were managed with nitroprusside infusion. Postoperatively the patients were maintained on propranolol HCl,

methyldopa, or hydralazine HCl, and later some patients received hydrochlorothiazide.

There were 26 survivors and four patients died in the hospital (Table 1). One patient died on the second postoperative day of intestinal infarction due to an extensive dissection involving the mesenteric vessels. The second patient had rupture of the aneurysm en route to the operating room, and despite an attempt at operative correction the patient could not be separated from cardiopulmonary bypass at the completion of the procedure and died. The third patient had continued bleeding after operation that could not be controlled. A fourth patient had previous aortic valve replacement for aortic insufficiency three years prior to this admission. During the follow-up examination a perivalvular leak was documented but was not severe enough to require reoperation. He presented with a 24-hour history of severe chest and abdominal pain and a dissection of the ascending aorta extending to the iliac arteries by aortography. He underwent valve replacement and grafting of the ascending aorta but died from intestinal infarction.

Six patients in this series sustained an acute aortic dissection, all of whom had previously documented antecedent aortic valvar disease. One of these, the only patient in this series with a class type II dissection, had had documented aortic stenosis with a gradient of 40 mmHg at the time of cardiac catheterization several months previously. A second patient had had an open aortic commissurotomy for congenital aortic stenosis four years previously. When dissection of the aorta occurred, the aneurysm ruptured into the mediastinum but due to the previous operation the hematoma was contained and it was possible to place the patient on cardiopulmonary bypass with replacement of the aortic valve and grafting of the ascending aorta. He was subsequently discharged from the hospital following

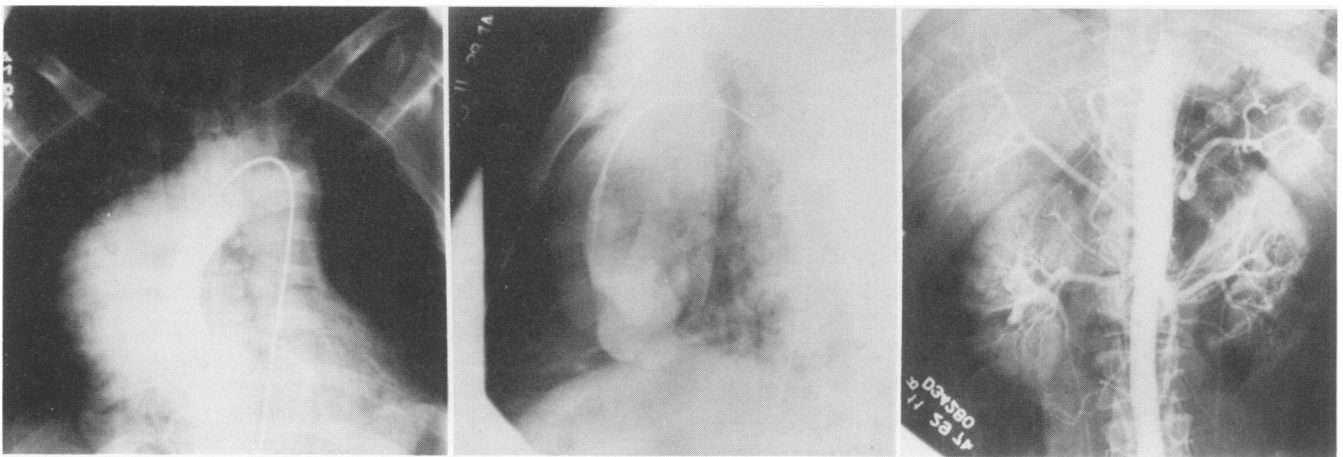


FIG. 4B.

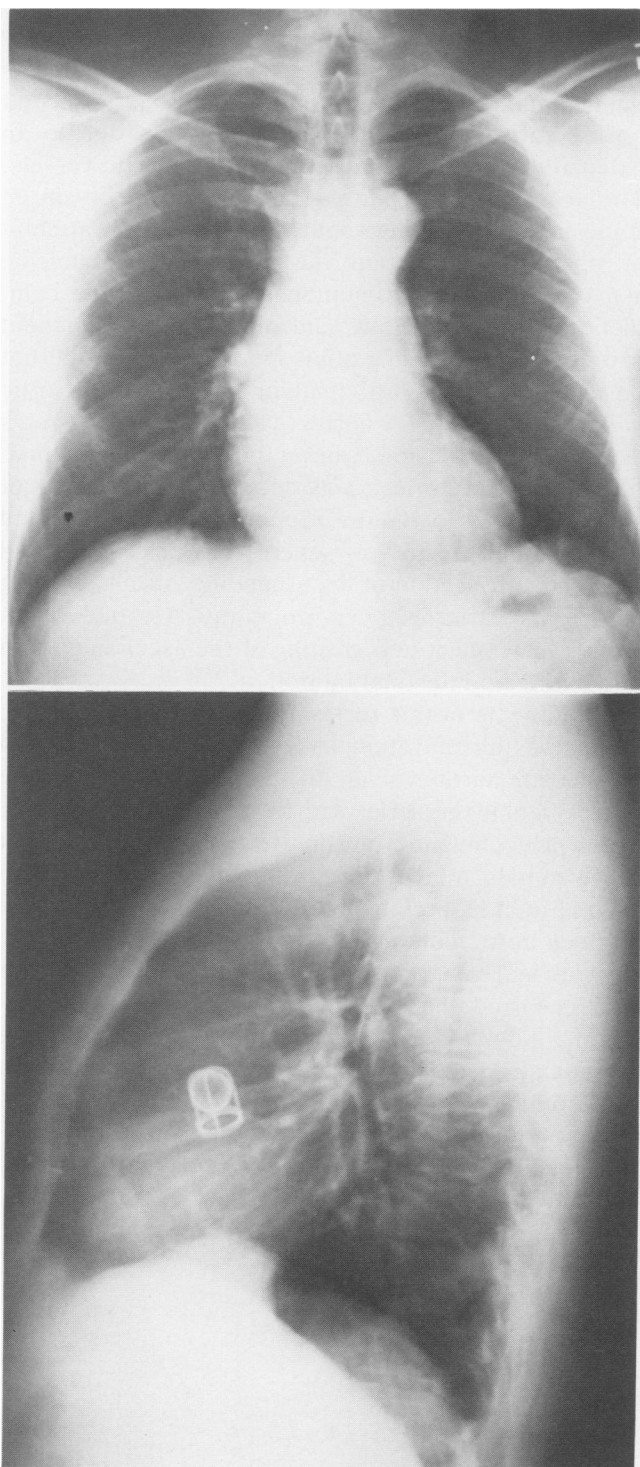


FIG. 4C.

an uncomplicated recovery. The third patient described earlier had replacement of his aortic valve three years prior to this dissection. The remaining three patients had a previous notation of an aortic murmur by the referring physicians. With this history and the operative findings in this particular group, it appeared that

the aortic valve disease had contributed to the pathogenesis of the dissection as a result of the abnormal flow characteristics across the aortic valve. It was also evident at operation that the valves were diseased and that resuspension of the aortic cusps in this situation would not have been appropriate. For these reasons, the aortic valve was replaced with a Starr-Edwards ball valve prosthesis.

This brings to seven the number of patients with valve abnormalities including the young man who had sudden rupture of this aneurysm while being prepared for arteriography. The phenomenon of dissecting aortic aneurysms associated with congenital bicuspid aortic valve was recently reviewed by Edwards.⁶ It is interesting that five patients in that report had a strong history of antecedent aortic valvar disease. This high incidence of valve disease in patients with dissecting aneurysms of the aorta lends further support to a causative relationship between the two conditions. This problem obviously raises the difficult question of appropriate management of patients with documented aortic valve disease, some with enlargement of the ascending aorta who at the time of investigation are not considered candidates for operation on either a clinical or hemodynamic basis.

Late Results

Of the 30 patients managed surgically, 26 survived. Two late deaths have occurred, one at six months from a documented myocardial infarction and the second at two months from a presumed cardiac arrhythmia. One patient was readmitted to the hospital two months later and underwent a femorofemoral graft due to claudication of the extremity resulting from the dissection and presence of an intimal flap which occluded the iliac artery. One patient continues to show evidence of mild aortic insufficiency. The remaining patients have done well.

Two patients are compared for interest. The first, the only patient in this group who had an old type II dissection and antecedent bicuspid aortic stenosis,

TABLE 1. Results

Nonoperated Group (3 patients)	
Rupture and death while being studied	2
Rupture during planned antihypertensive therapy (1 bicuspid valve at autopsy)	1
Operated Group (30 patients)	
Grafting and Resuspension of Aortic Valve—24 Patients 3 deaths (3 ruptured prior to surgery with 2 survivors)	
Intestinal infarction	1
Myocardial failure (rupture prior to surgery)	1
Postoperative bleeding	1
Grafting and Valve Replacement—6 Patients 1 death	
Intestinal infarction (AVR 3 yrs prior to dissection)	1

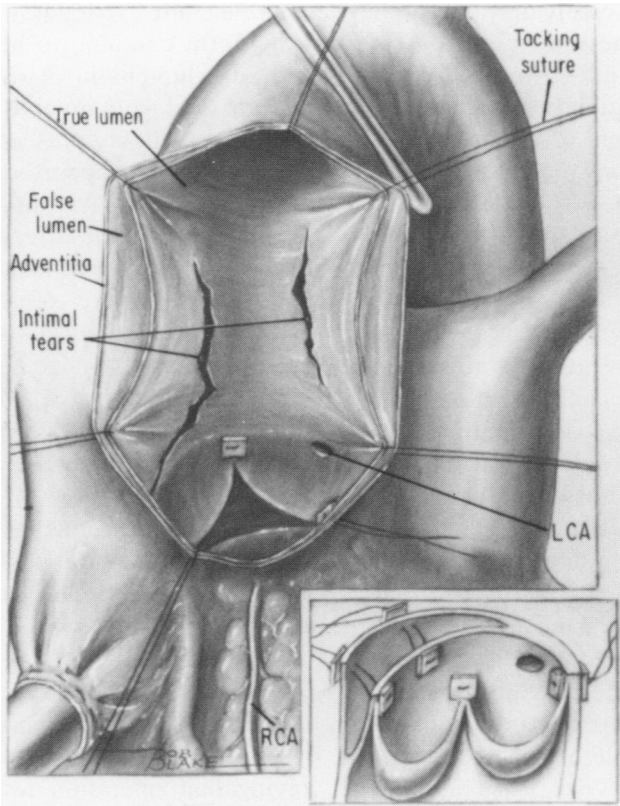


FIG. 5. Diagram of the open ascending aorta demonstrating initial tear and dissection as well as techniques of resuspension of the aortic valve.

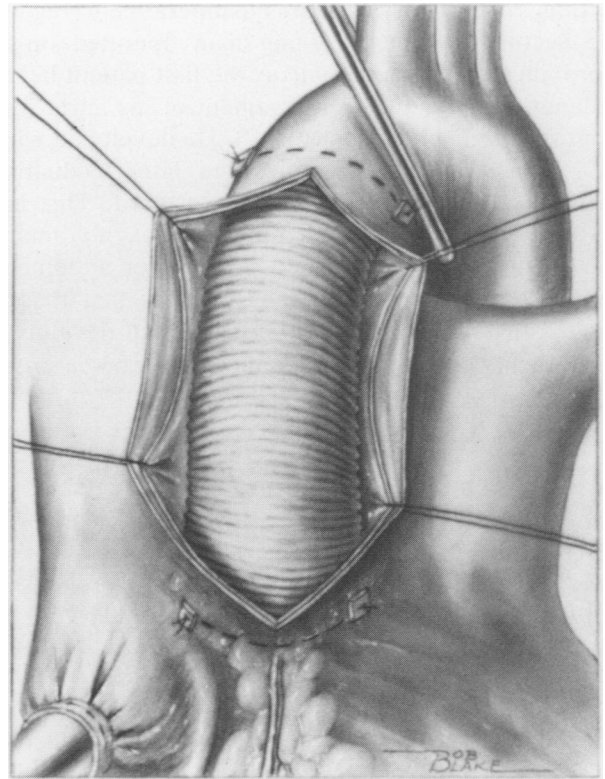


FIG. 7. The graft sutured within the ascending aorta.

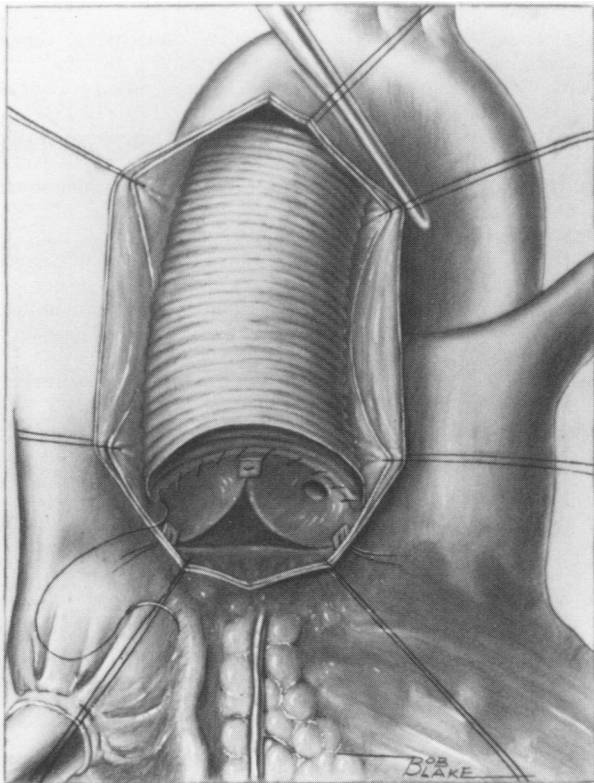


FIG. 6. Suturing of the woven Dacron graft inside the aorta.

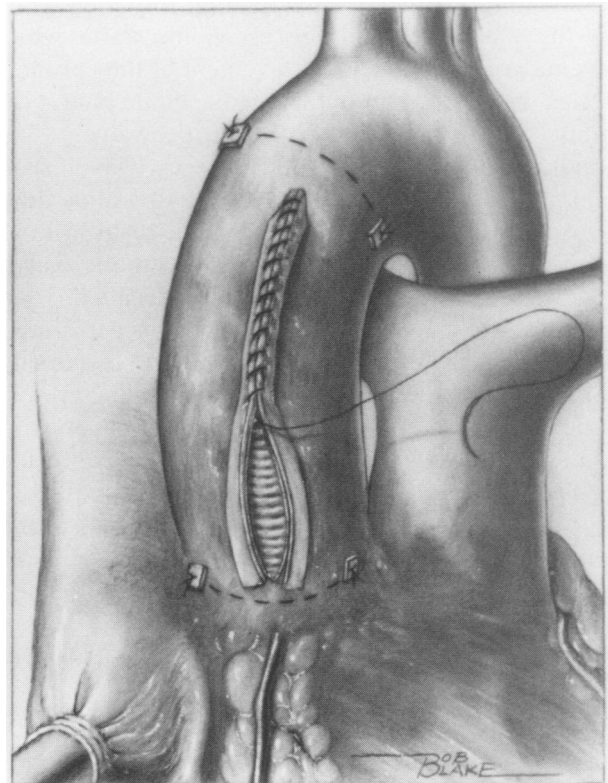


FIG. 8. Closure of the adventitia over the Dacron graft.

continues to do well five years postoperatively (Fig. 4). The second patient, a young man operated on at approximately the same time as the first patient began to demonstrate gradual enlargement of his aorta four years following operation (Fig. 2). He developed what was thought to be laryngitis, and later evaluation revealed a paralysis of his left vocal cord. This has continued, but he remains otherwise asymptomatic and specifically has had neither chest nor abdominal pain. Nevertheless, this emphasizes the fact that in some patients a residual aortic lesion can develop in the descending thoracic aorta and should be carefully followed.

Discussion

Earlier reports have indicated that acute ascending aortic dissection should be managed surgically,¹⁻³ and the group of patients reported here demonstrates that excellent results can be achieved with early operation. The results also emphasize the catastrophic course that may accompany medical management of this disease. Clearly, the antihypertensive regimen recommended by Wheat and associates¹⁰ may be effective in the management of these patients in the preoperative and in the postoperative period. However, the basic therapeutic approach should be a surgical one. The goals of the operation for this condition are correction of the aortic insufficiency and graft replacement of the ascending aorta, thereby obliterating the entry point into the false lumen in the ascending aorta which prevents progression and involvement of the coronary arteries or rupture into the mediastinum and pericardium. Resuspension of the aortic valve, when possible, is the procedure of choice as it avoids the use of a prosthetic valve, shortens the operative time, and provides an excellent hemodynamic result without adding the additional risks of a prosthetic valve. Nevertheless, in those patients with antecedent valve disease, aortic valve replacement should be performed. Valve replacement is usually necessary in patients with chronic dissection and aortic insufficiency.

The operative mortality has progressively decreased, and it is apparent that this procedure can be undertaken with an operative mortality rate of 10%. Also, the follow-up data and long-term results have been impressive. Long-term follow-up study demands careful control of the blood pressure in hypertensive patients who have undergone surgery and, as demonstrated by one patient in this series, the residual aortic

anomaly may play an important role in life expectancy. The remaining vessels from the aorta continue to be supplied by both the true and false lumens in many patients. Two patients in this group died from involvement of visceral vessels. This was most likely present from the event of the acute dissection and operative intervention did not contribute to the problem. Autopsy revealed disruption of the superior mesenteric artery without communication either through the true or false lumen. In the unusual patient with severe renal compromise or continued hypertension who survives operation, grafting of the renal arteries may need to be considered. However, this problem did not occur in any patient in this series, and those with hypertension have been easily controlled with propranolol HCl, methyl dopa, or hydralazine HCl.

It is concluded that prompt surgical management is mandatory in acute ascending aortic dissection, and in most patients aortic valve competency can be re-established with resuspension of the aortic valve preventing the added risk of a prosthetic valve complications. It is apparent by follow-up study of these patients and by an earlier report by Applebaum¹ as well as a recent review by Miller⁸ that long-term survival rates in patients having had operation for ascending dissection is clearly better than in that group managed by medical therapy alone.

References

1. Applebaum A, Karp RB, Kirklin JW. Ascending versus descending aortic dissections. *Ann Surg* 1976; 183:296.
2. Daily PO, Trueblood HW, Stinson EB, et al. Management of acute aortic dissections. *Ann Thorac Surg* 1970; 10:237.
3. Dalen JE, Alpert JS, Cohn LH, et al. Dissection of the thoracic aorta. *Am J Cardiol* 1974; 34:803.
4. DeBakey ME, Cooley DA, Creech O, Jr. Surgical considerations of dissecting aneurysm of the aorta. *Ann Surg* 1955; 142:587.
5. DeBakey ME, Henly WS, Cooley DA, et al. Surgical management of dissecting aneurysms of the aorta. *J Thorac Cardiovasc Surg* 1965; 49:130.
6. Edwards WD, Leaf DS, Edwards JE. Dissecting aortic aneurysm associated with congenital bicuspid aortic valve. *Circulation* 1978; 57:1022.
7. Hirst AE, Jr, Johns VL, Jr, Kime SW, Jr. Dissecting aneurysm of the aorta: a review of 505 cases. *Medicine* 1958; 37:217.
8. Miller DC, Stinson EB, Oyer PE, et al. The operative treatment of aortic dissections: Experience with 125 patients over a sixteen year period. *J Thorac Cardiovasc Surg*, in press.
9. Morgagni GB: *De Sedibus et Causis Morborum per Anatomen Indagitis*. (Venetiis, 1761); *The Seats and Causes of Diseases Investigated by Anatomy*, Vol. 1, translated by Alexander A, London, 1769. pp 802-808.
10. Wheat MW, Jr, Palmer RF, Bartley TD, Seelman RC. Treatment of dissecting aneurysm of the aorta without surgery. *J Thorac Cardiovasc Surg* 1965; 50:364.