Management of Acute Aortic Dissections

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Acute dissecting aneurysm of the aorta continues to be associated with an excessively high mortality. Consequently, both surgical and nonsurgical therapeutic approaches have evolved. The superiority of one method over the other has not been clearly demonstrated. At most institutions the tendency has been to use one method to the exclusion of the other.

In reviewing the literature [13, 14, 16–18] and the experience at Stanford University Hospital, it has become apparent that there is a very significant and distinct difference in the clinical course and prognosis in patients in whom the ascending aorta is involved with dissection as opposed to those in whom disease does not extend proximal to the left subclavian artery. Aortography makes it possible in nearly all cases to determine the site of the initial intimal tear [12, 22] or at least to determine if the ascending aorta is involved. A therapeutic approach has evolved which utilizes both surgical and medical methods of management, depending upon the origin of the dissection. The present report describes this method of management and relates the experience at the Stanford University Hospital.

CLINICAL SERIES AND RESULTS

From April, 1964, to June, 1969, 35 patients with dissecting aortic aneurysm were treated by the Cardiovascular Surgery Service at Stanford University Hospital. There has been 100% follow-up on these patients as of June, 1969.

The average age in this group of patients was 58 years, with a range from 34 to 72. Approximately one-third were women. In 30 patients the dissection was acute, of less than two weeks' duration. In the remaining 5 patients the dissection had been present more than two weeks and was considered to be chronic.

Initially, surgical or medical therapy was generally selected after consideration of the patient's condition and evaluation of complications from dissection, such as renal artery involvement, mesenteric ischemia, or aortic insufficiency. These complications placed the patient into the surgical group. Later in the series, patients found to have ascending aorta involvement were operated upon immediately, whereas the others were evaluated for surgical or medical treatment as outlined above.

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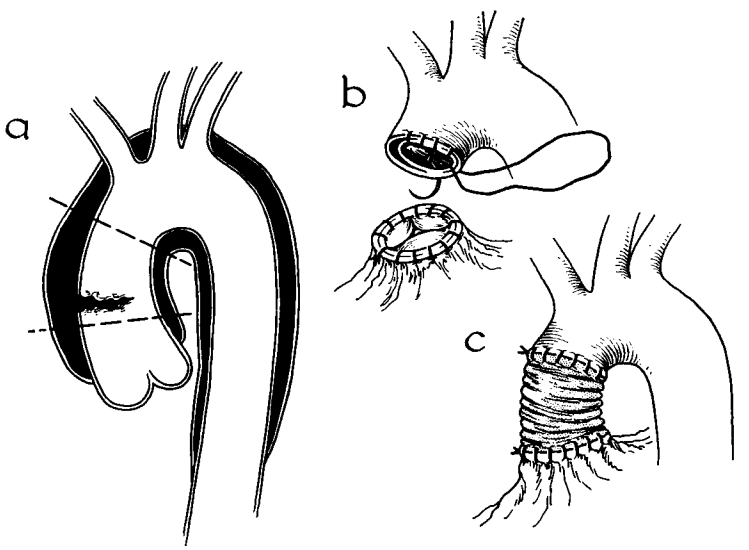

FIG. 1. Method of repair of dissection of the ascending aorta (type A dissection). The portion of aorta containing the intimal tear is resected (a), and the dissected ends are then oversewn to reapproximate the dissected aortic wall (b). Finally, a woven Teflon graft is interposed to reestablish aortic continuity (c).

The method of medical treatment was that initially described by Wheat and his associates [28]. Only 2 patients had been treated at our center prior to the publication date of that paper, one surgically and one with guanethidine, and both survived.

Surgical management has consisted solely of prosthetic graft interposition

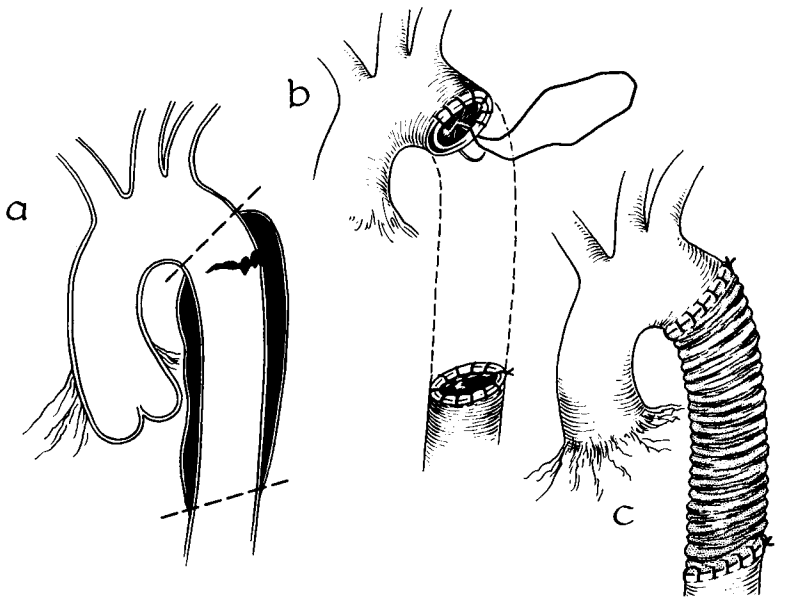

FIG. 2. Method of repair of dissection of the descending aorta (type B dissection). The steps in repair are identical to those of type A dissection.

after oversewing the dissected ends of the aorta [11]. Fenestration [2, 10], aortorrhaphy [15], and primary anastomosis [11] have not been used. If the ascending aorta was involved, it was excised and replaced with a graft; otherwise, the proximal descending aorta was excised and replaced. When possible the portion of aorta containing the intimal tear was excised. Both types of repair are illustrated in Figures 1 and 2.

For replacement of the ascending aorta, total cardiopulmonary bypass was employed. A Kay-Cross disc oxygenator was primed with fresh heparinized whole blood or Ringer's lactate solution. During the period of cardiac anoxia, the myocardium was protected by local hypothermia using cooled saline solution [23]. The descending aorta was replaced after implementing partial bypass from the femoral vein to the femoral artery. During the period of bypass, blood volume was regulated by monitoring the left atrial and systemic pressures.

In 23 patients the ascending aorta was found to be involved, while in the remaining 12 the dissection was limited to the descending aorta. The hospital mortality, based upon this classification, is listed in the table. The hospital mortality for dissection of the ascending aorta treated medically was 67%; treated surgically, it was 28%. The mortality for dissection limited to the descending aorta was 20% for medical treatment and 28% for surgical treatment, which are not significantly different results. The overall mortality for patients treated medically was 50%, while for surgical treatment it was 28%. For ascending dissection the combined medical and surgical mortality was 44%, and for descending dissection, 25%.

Four of 14 patients died after excision and replacement of the ascending aorta. In 2 of these patients the heart could not be resuscitated after operation; 1 had suffered cardiac arrest during induction of anesthesia, and in the other the dissection had severed the left coronary artery. A third patient with preoperative bowel infarction and renal failure died from hemorrhage into the lungs five days postoperatively; and the fourth patient, who had preoperative renal failure and a postoperative cardiovascular accident, died from hemorrhage into the lungs ten days postoperatively.

Six patients with ascending dissection died after being treated medically. Rupture into the pericardium accounted for death in 4 patients and was probably the cause of death in 1 other patient; the sixth patient was a paraplegic who died of renal failure.

Only 3 of 12 patients with descending dissection died. One patient treated medically died after the dissection ruptured into the left pleural space. Of the surgically treated patients with descending dissection, 1 died of cardiac arrest when the aorta was cross-clamped and 1 died of renal failure and respiratory insufficiency.

STANFORD UNIVERSITY HOSPITAL EXPERIENCE WITH DISSECTING AORTIC ANEURYSM IN 35 CONSECUTIVE PATIENTS

	Site of Dissection		
Hospital Mortality	Ascending Aorta	Descending Aorta	Total
Medically treated patients			
Survived	3 (33%)	4 (80%)	7
Died	6 (67%)	1 (20%)	7
Surgically treated patients			
Survived	10 (72%)	5 (72%)	15
Died	4 (28%)	2 (28%)	6
Total	23	12	35

Twenty-two patients survived beyond the period of hospitalization. At the time of follow-up, 18 patients were alive. Two patients, both with ascending dissection treated medically, were operated upon elsewhere and did not survive operation. Two patients with ascending aorta replacement have also died after hospitalization. The periods of follow-up ranged from one month to five years.

COMMENT

The extremely high mortality of untreated dissecting aneurysm has been emphasized by Hirst, Johns, and Kime [14]. In their report 89% of 425 patients were dead within three months. Of significance from a therapeutic standpoint is the fact that only 3% died suddenly and 13% within 12 hours. Consequently, there is a period in the great majority of cases during which therapeutic measures might be instituted, as has been repeatedly emphasized [16, 28].

OPERATIVE INTERVENTION

The first successful surgical attack on dissecting aneurysm was reported by De Bakey, Cooley, and Creech [10] in 1955. Six cases were reported. Two dissections began in the ascending aorta and were treated by fenestration performed in the descending aorta. Treatment was successful in 1 patient. Four other dissections involved the descending aorta. Two were repaired primarily and the patients survived. The other two dissections were repaired by oversewing of the dissected ends and homograft interposition. One of these patients survived.

Fenestration has since been shown to be associated with a high mortality. Austen and DeSanctis [2] have reported only a 22% survival at one year following fenestration in 18 patients. Lindsay and Hurst [17] found that 8 patients undergoing fenestration for ascending dissecting aneurysm were all dead within three weeks. Necropsy was performed in 24 cases reported by McCloy, Spittell, and McGoon [18]. In 22 of these cases death occurred from rupture. In 11 of the 22 patients a spontaneous reentry was found, thus casting considerable doubt on the efficacy of the fenestration procedure. Pomerantz, Young, and Sealy [20], however, have continued to advocate fenestration.

Other authors have emphasized the effectiveness of direct surgical attack upon the dissected aorta [3, 11, 15, 21, 24], whether it is the ascending or descending portion. For the descending aorta, graft interposition has been used most frequently; however, for the ascending aorta the tendency has been to employ aortorrhaphy or to perform primary anastomosis after oversuturing the ends [11, 15]. De Bakey and associates [11], for example, used a graft in only 4 of their 20 type I dissections (see type definitions below). It has been our impression that graft interposition is preferable for several reasons. The tissues are extremely friable in the acute phase. If closed under even a small amount of tension, the additional forces exerted by the beating heart

might predispose to recurrence of the dissection or to aortic insufficiency. Aortic insufficiency has not occurred in any of our patients after graft replacement of the ascending aorta.

In De Bakey's report [11], 179 patients were operated upon with an overall mortality of 21%. De Bakey classified dissecting aneurysm into three basic types related to anatomical and pathological features. Types I and II involved the ascending aorta, whereas type III involved the descending aorta. The only factor differentiating type I from type II was that in type I the dissection extended beyond the arch, while in type II the dissection stopped proximal to the innominate artery. By classification according to the above types, 37 of his cases (21%) involved the ascending aorta and 142 cases (79%) originated in the descending aorta. These proportions are opposite to the natural occurrence of the disease, which occurs predominantly in the ascending aorta [14, 16]. Seventeen of the 37 ascending dissections were type II and characteristic of Marfan's disease, and all were in a chronic phase. Of the 20 patients with type I dissection, 6 underwent fenestration early in the series. Only 4 of the remaining 14 patients had graft replacement of the ascending aorta; the others had primary repair. In 10 of the patients with type I dissection the condition was acute and in 10 it was chronic. It is not possible to tell whether the 4 patients undergoing graft replacement were in an acute or chronic phase. The mortality in the 10 patients with acute type I dissection was 40%. Bosher has emphasized the higher mortality associated with repair of acute ascending aortic dissection as opposed to that associated with repair of dissection in a chronic phase [5]. In De Bakey's entire series, 58 (32%) of the patients were in an acute phase and 121 (68%) were in the chronic phase. The late survival was vastly improved, as contrasted with untreated dissections; 70% of the treated patients survived one year, whereas only 7% of Hirst's [14] untreated patients reported by De Bakey survived a similar period.

Comparable surgical results have been reported by Austen and DeSanctis [2]. Twelve patients underwent surgical repair in one year, and 9 survived. In this series, however, all but 2 of the patients had descending dissection. One of 2 patients with ascending dissection survived. By 1967 Austen and coauthors [1] had extended their surgical series to 31 patients, with a 38% hospital mortality in 8 patients with ascending dissection and a 22% mortality in 23 patients with descending dissection.

MEDICAL TREATMENT

Not all authors have had success with surgical treatment comparable to that reported by De Bakey [11]. This prompted Wheat and his associates [28] to treat acute dissecting aneurysm with a medical regimen

aimed at preventing aortic rupture, which is the prevalent cause of death in the acute phase. They concluded that rupture results from continued dissection and not from previously dissected aorta. They emphasized that two forces were important in continued dissection. One force was related to mean blood pressure. The more significant force, however, was suggested to be "impulse," which is directly related to myocardial contractility. Based on this premise, trimethaphan was suggested as an ideal drug. The authors stated that trimethaphan lowered mean systemic pressure and reduced myocardial contractility, which implies a direct effect of trimethaphan on the myocardium. Hexamethonium, which has a direct, positive, inotropic effect on the myocardium, has been associated with an increased incidence of dissecting aneurysm in patients being treated for hypertension [4]. Cook, Schwartz, and Bass [8], however, have described a positive inotropic effect of trimethaphan on isolated heart muscle. They stated that reduced venous return caused the apparent decrease in myocardial contractility in the intact animal. The effects of trimethaphan on the myocardium could be reversed by volume loading of the vascular system.

Wheat and associates [28] also used reserpine, and guanethidine was started to control the blood pressure after trimethaphan tachyphylaxis developed. After 6 consecutive failures with surgical management, Wheat and his associates [28] had 6 consecutive survivors using the above regimen. Although it is not stated in the text of their paper, in the discussion it is mentioned that 2 of the 6 survivors had ascending dissection.

Palmer and Wheat [19] and Wheat and Palmer [27] presented in 1967 and 1968 a collection of 54 cases treated by the medical regimen with a 92% success rate. Fifteen of the 54 patients were from the University of Florida, and there was only 1 failure among those 15 patients. Of Wheat's original 6 patients reported in 1965, 4 still survived.

Daily and associates [9] have demonstrated aortographically that healing can occur if dissection is halted by the Wheat regimen; however, their patient eventually died of additional dissection months later when she abandoned the therapeutic regimen. The previously dissected areas were well healed. Healing of dissecting aneurysm has also been reported by Conston [7].

Wheat and Palmer [26] outlined their method of management of acute aortic dissection and extended their University of Florida series to 18 patients with 2 failures in 1968. Also, propranolol and alpha-methyldopa were suggested as useful additional or alternate drugs.

In 1969 Wheat and coauthors [25] reported the results of medical treatment of aortic dissection in a group of 50 patients. Seven patients died in the acute phase and 14 more in the follow-up period, giving a mortality of 42%. The results are not correlated with the type of dissection.

A similar mortality of 43% at one year was found in a group of 14 patients treated medically by Austen and associates [1]. In a group of 31 surgically treated patients, however, a 26% hospital mortality with no late deaths at one year was obtained.

BASING TREATMENT ON THE SITE OF DISSECTION

From experience gained early in the present series, it became apparent that there were distinct therapeutic and prognostic differences between patients with ascending dissection and those with descending dissection. The therapeutic significance of knowing the site of the initial intimal tear was predicted by Burchell in 1955 [6].

This point was further emphasized by Hume and Porter [16]. Twenty-four patients had tears in the ascending aorta. Twenty-three of these patients died from proximal dissection with rupture into the pericardium. In 17 patients with tears from the midarch to the midportion of the descending aorta, however, only 1 dissected proximally with rupture into the pericardium.

This difference was further substantiated by Lindsay and Hurst [17]. It was possible to determine the site of intimal tear in 59 of 63 consecutive cases. Forty patients had ascending dissection, and none survived more than three weeks. Eight of 19 patients with descending dissection survived 6 to 69 months.

In the present series, 6 of 9 patients died with ascending dissection treated medically. Two of the 3 surviving patients died during the follow-up period. Only 1 death occurred in 5 patients with descending dissection treated medically. Consequently, in this group of 14 patients the prognosis was greatly influenced by the location of the intimal tear.

Based upon this prognostic difference, it was decided to operate immediately upon patients with ascending dissection. Those with descending dissection were treated medically or operated upon if continued dissection, compromise of a vital arterial trunk, evidence of leaking, or some other indication for operation developed.

Using the above fundamental approach, the following method evolved. All patients suspected of having a dissecting aneurysm were admitted to the Intensive Care Unit, where their vital signs, venous pressure, urine output, and clinical condition were frequently monitored. If the patients were hypertensive, the Wheat regimen was instituted immediately to control the blood pressure near 100 mm. Hg systolic or to maintain adequate urine output. An emergency aortogram was then obtained to determine whether or not the ascending aorta was involved. Therapy then proceeded as described above.

This approach depends upon aortographic diagnosis of the disease with determination of the presence or lack of ascending aorta involvement. Hume and Porter [16] have suggested six types of dissection re-

lated to the origin and distal extent of the dissection. As mentioned, De Bakey and co-workers [11] have proposed three types of dissecting aneurysm, again in part associated with the distal extent of the dissection. The distal extent of the dissection has not been found to be of significance in determining the primary therapeutic approach.

From this therapeutic standpoint, it is suggested that aortic dissection classification be further simplified to designate whether the ascending aorta is involved. In this classification, type A indicates involvement of the ascending aorta from dissection originating there or from a proximal dissection. Type B dissections are limited to the descending aorta. These types are diagramed in Figure 3.

The tendency for type A dissection to rupture into the pericardium has been the main reason for the development of the above therapeutic approach. Another factor favoring early operation for type A dissection is that even though aortic insufficiency may occur, it may be corrected easily by reattaching the dissected media and intima to the outer aortic wall. If the ascending aorta is replaced during a chronic state of dissection, permanent distortion of the aortic root may necessitate aortic valve replacement, as occurred in 2 patients in this series. Although we did not encounter it, we believe that dissection arising proximal to the left subclavian artery and dissecting proximally to involve the ascending aorta would best be treated by ascending aorta replacement in order to obviate rupture into the pericardium. Also, there were no dissections which began beyond the left subclavian artery and dissected

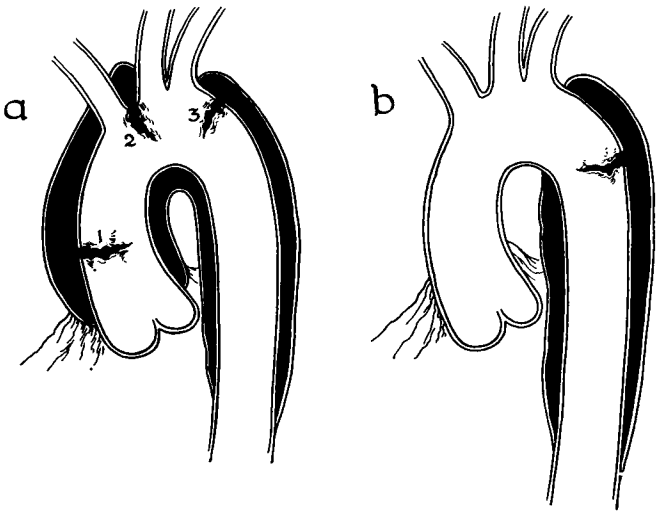

FIG. 3. Classification of aortic dissections. In type A the ascending aorta is dissected (a). *The intimal tear has always been at position* 1, *but it can occur at positions* 2 *or* 3 *(see text). In type B dissection the dissection is limited to the descending aorta* (b), *and the intimal tear is usually within 2 to 5 cm. of the left subclavian artery.*

proximally to the ascending aorta. It would seem, though, that initial resection of the ascending aorta followed by medical treatment could result in conversion to a chronic condition. If indicated, the descending aorta could then be treated surgically.

The number of patients with descending dissection is too small to allow definite conclusions regarding a difference in the efficacy of medical versus surgical treatment. Our results compare with those of Wheat and associates [28] and suggest that the two forms of treatment are about equally effective. Consequently, we have preferred to treat patients with type B dissection medically, reserving operation for development of complications such as those described by Wheat and co-workers [28].

In reviewing the causes of death from type A dissection in this series, it is clear that operation prevents proximal rupture. In at least 4, and probably 5, of the 6 medically treated patients who died, rupture into the pericardium occurred. Twelve of 14 patients treated surgically survived operation. Two patients died in the hospital, both from hypoxia induced by massive bleeding into the trachea and bronchi. One of these patients died five days postoperatively and the other, ten days after operation. This complication has not been otherwise associated with dissecting aneurysm so far as we can determine. It is postulated that occlusion of the bronchial arteries by the dissection may predispose to bronchopulmonary hemorrhage.

SUMMARY

A series of 35 patients with dissecting aortic aneurysm is reported. It is emphasized that a marked difference exists both therapeutically and prognostically between dissections involving the ascending aorta and those limited to the descending aorta. Patients with ascending aorta involvement had a 28% hospital mortality when treated surgically, as contrasted to a 67% mortality when treated medically. In patients with descending dissection, however, the two forms of treatment do not differ significantly in terms of mortality; the hospital mortality is 20% with medical treatment and 28% with surgical treatment.

A plan for management is described which is based upon classification of dissecting aneurysms into two groups, depending on whether or not the ascending aorta is involved.

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DISCUSSION

DR. WILLIAM COOK (Bronx, N.Y.): Dr. Wheat, who was to discuss this paper, had to return to Gainesville and asked me to appear in his stead. The authors are to be complimented on a fine paper with a large series of patients and a thoughtful analysis of their medical and surgical results. These results are at variance with ours, with those of Wheat and his group, and with those of Harris and his group. There are now 75 patients known to all of us who have been treated initially with trimethaphan (Arfonad) for acute thoracic aortic dissection. Forty percent of these cases would fall into the authors' Group A. The current mortality of these patients is 10%, and a number of the patients have had long-term survival with no surgical procedures whatsoever.

One such patient previously reported by us presented with acute aortic insufficiency, electrocardiographic evidence of myocardial ischemia secondary to occlusion of the left coronary ostium, coma, paraplegia, and occlusion of both femoral arteries. That was one and one-half years ago. That man is working today as a laborer. His therapy has been entirely medical. His residual aortic insufficiency does not interfere with his activities, and he refuses to have it repaired.

In trying to reconcile the discrepancy between the authors' results and our own, Dr. Wheat and I both have been struck by the fact that in those Group A patients treated medically who died, death was caused by progression of the dissection, which of course is precisely what hypotensive therapy is designed to prevent.

We wonder if perhaps the difference in success of medical therapy might be related to the level of hypotension the authors are willing to create, or to problems with tachyphylaxis, or to uneven control of blood pressure, which we have pointed out can be difficult but is correctable.

DR. DONALD B. EFFLER *(Presiding):* I wanted to make two observations that possibly Dr. Daily and his coauthors might find of interest. In the acute dissection of the ascending aorta in which one actually has a double-barreled lumen, it has been acceptable practice in many centers simply to reconstruct the single lumen and then do a direct end-to-end anastomosis. Early in our experience in open-heart surgery we followed this procedure.

Recently, two women came back almost ten years after this procedure had been done, both with aneurysms of the ascending aorta and associated superior vena caval obstruction. Although it is very difficult to reoperate, we did succeed in implanting grafts.

It will now be our policy whenever possible to use primary graft replacement, as apparently Dr. Daily's group has done very frequently, rather than taking the simple approach of reconstructing the double-barreled transected aorta and putting it back together.

DR. DAILY: I would like to thank Dr. Cook and Dr. Effler for their comments. To answer Dr. Cook, accurate control of blood pressure is, of course, the primary goal of medical therapy. Therefore, effectiveness of medical therapy cannot be evaluated unless the primary goal is achieved. There is no question that it is absolutely necessary for the physician to sit at the patient's bedside and regulate the blood pressure on a minute-to-minute basis. We have tried to use systolic pressures in the range of 100 or whatever is necessary to provide adequate urine output. I feel certain that our control of blood pressure has been adequate.

Tachyphylaxis occurred rarely and was handled as described by Wheat. In some cases continuous epidural anesthesia has been used effectively.

I am glad that Dr. Effler mentioned the necessity for graft replacement of the aorta rather than primary repair, because that has been our approach also. Late formation of aneurysm may occur after primary repair. When aneurysm occurs, it makes the definitive repair much more difficult, and it may necessitate replacement of the aortic valve. I think valve replacement often can be obviated by early replacement of the ascending aorta with a graft.