Aortic Aneurysm
Report of 101 Cases

By BROOKE ROBERTS, M.D., GORDON DANIELSON, M.D., AND WILLIAM S. BLAKEMORE, M.D.

An evaluation of the management of patients with aneurysm of the aorta seems timely because of new and promising methods of treatment. The risks of nonoperative and operative treatment are presented from the experiences with 101 patients admitted to the Hospital of the University of Pennsylvania during the years 1950 through 1955. Follow-up data indicate that the mortality of nonoperative treatment is considerably greater than that of excision of the lesion, in spite of the poor operative risk of many patients in this group. The nonoperative mortality within 1 year of diagnosis was approximately 50 per cent. Many of these patients died of rupture of the aneurysm.

RECENT developments in vascular surgery have focused attention on many lesions previously refractory to treatment. Among such conditions aneurysms of the aorta rank high. Sporadic attempts to correct these lesions by wrapping, ligation, wiring, and other methods had been reported; but, with few exceptions, the end results had not been encouraging. Since the introduction of grafts for replacement of major vessels, however, renewed interest has been given to aneurysms generally. To render rational judgments with regard to the problem presented by these patients, it is essential to know the natural history of these conditions, the prognosis both with and without treatment, and the prognosis for the various forms of treatment. For this reason the cases seen during the period from January 1950 to January 1956 at the Hospital of the University of Pennsylvania have been reviewed.

MATERIAL

During the 6 years from 1950 through 1955, 101 patients were admitted to the Hospital of the University of Pennsylvania in whom a diagnosis of aortic aneurysm was established. We have been able to follow all of these patients. During this period our approach to these lesions underwent a radical change. At first only symptomatic treatment was offered. The first excision of an aortic aneurysm in this hospital was in 1951 when a ruptured saccular abdominal aneurysm was successfully removed. In 1953 such an operation was again attempted, and since that time it has been done with increasing frequency. The operated patients have been followed for relatively short periods of time, inasmuch as they are concentrated in the later years of the study. Since the mortality has been high in the unoperated group and has usually occurred within a short time after the diagnosis was established, it appears that some valid comparison can be made between those who were subjected to surgery and those who were not.

The entire group of patients with aortic aneurysms has been divided into those with thoracic and those with abdominal aneurysms. Each group in turn has been subdivided into those who have been operated upon and those not subjected to surgery. The operative procedures were carried out by 6 surgeons.

RESULTS

Aneurysms of the Abdominal Aorta

Between January 1950 and January 1956, 65 patients with abdominal aortic aneurysms were admitted to the Hospital of the University of Pennsylvania. Only 3 of them had a positive serologic test for syphilis. In an additional 10 cases the test was not recorded, and the rest had negative tests. These figures strongly confirm the views of many authors that today the great majority of abdominal aneurysms arise on the basis of arteriosclerosis and not syphilis.

Of the 65 patients, 30 were subjected to operation. The reasons for not operating varied, and included refusal of operation by the patient. The usual reason, however, was the judgment of the physician that the risk of the
operation was too great or that the presence of other diseases made the operation unwarranted. During the last 3 years a much higher percentage of patients have been subjected to operation than during the first 3 years of the study.

Age and Mortality. Table 1 shows the ages of the patients with abdominal aneurysms and the mortality for the various age groups, both among the operated and nonoperated patients. The surgical mortality includes any patient who died within 30 days of operation. Of the patients who survived this period, all but 3 are still living. One patient whose aneurysm was wrapped with cellophane died 6 months later. The first patient whose aneurysm was excised died 44 months later of rupture of a new thoracic aneurysm, and the third patient died of a cerebrovascular accident 23 months after resection of the aneurysm.

Of the 15 nonoperated patients first seen in the year 1955, and therefore not followed for 1 year at the time of this writing, 8 have already died, 5 of them from rupture of the aneurysm.

The operative mortality (table 1) is based on all operations for abdominal aneurysms during the 6-year period, including 2 patients who were simply explored without execution of any definitive procedure. Both these patients died shortly after surgery. Their explorations were performed because of symptoms of "an acute abdomen" due to rupture of the aneurysm before grafts were available in our hospital. In 2 patients early in the series the aneurysms were wrapped with cellophane, and in the remaining 26 patients the aneurysms were excised. In 2 of these 26 patients, grafts were not required, 1 of the aneurysms being sacular, though not syphilitic, with a small neck that was closed directly. The second patient had such tortuous iliac vessels that after excision of the aneurysm an end-to-end anastomosis was accomplished when the iliac vessels were straightened out. Among the 26 patients in whom the lesion was excised, there were 8 operative deaths, or a mortality of 31 per cent. Four of these 8 deaths occurred in patients with ruptured aneurysms. If they were excluded, the operative mortality would be 18 per cent (4 of 22 patients). These residual 4 deaths were due to rupture of the graft at 28 days, pulmonary embolus, thrombosis of the graft, and cerebral hemorrhage 4 weeks postoperatively.

It is worth pointing out that the very high operative mortality of 80 per cent in the 70 to 79 age group is affected by the fact that 3 of the 4 patients who died had suffered rupture of the aneurysm prior to operation. In all, 8 cases of ruptured abdominal aneurysms were operated upon, and 6 of them died.

Of the entire group of patients, 16 had had a rupture of the aneurysm when first seen. Eight of these were subjected to operation, 8 were not. All the latter patients died, whereas 2 of the 8 subjected to surgery were saved. It is worth emphasizing that among the last 16 patients with unruptured aneurysms only 1 operative death occurred. The early cases therefore have greatly affected our mortality figures.

Approximately 40 per cent (11 of 27) of the patients who were not operated upon and who had not had a rupture of their lesion when

<table>
<thead>
<tr>
<th>Age</th>
<th>Total patients</th>
<th>Operative deaths</th>
<th>Total deaths within 1 year</th>
<th>Surviving At end of 1 year</th>
<th>Followed less than 1 year</th>
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* Parentheses signify aneurysm ruptured or dissecting when first seen.
first seen died within 1 year. Six of these 11 patients died of ruptured aneurysm, and 5 of other causes. Of the 9 patients who survived 1 year, 5 have since died, 2 of them from rupture of the aneurysm. Two of these 5 patients died in the second year, 1 in the third, and 2 in the fourth year after the diagnosis was made. Of the 4 patients who are still living, 1 is in the third year, and in another 58 months have elapsed following the diagnosis.

Of the entire 35 nonoperated patients, 16 have died as a direct result of the aneurysm, 8 others from other causes. The short survivals of patients who were not treated by operation, even excluding those patients who had a ruptured or a dissecting lesion when first seen, indicate a grave prognosis (table 2).

Thus, the dismal picture reported in other series is again apparent in our group. There was, however, a certain amount of selection in this group, particularly in the last few years: as a rule, the better risk patients were subjected to operation.

Aneurysms of Thoracic Aorta

During the same time 36 patients were seen with aneurysms of the thoracic aorta. In contrast to those with abdominal aneurysms, a test for syphilis was positive in 18 of the 36, negative in 12, and not recorded in 6 cases. That a higher proportion of thoracic aneurysms than abdominal aneurysms arise from syphilitic infection has long been recognized and is confirmed in our series.

Age and Mortality. Table 3 gives the ages and mortality of these patients and, as before, they are divided into those operated and not operated upon. Twenty of the 26 nonoperated patients were first seen more than a year before the end of this study, and 10 survived 1 year or more. Of the remaining 6 unoperated patients followed less than a year, 4 have died, 2 and possibly 3 of their aneurysm. Of the 10 patients who survived 1 or more years without operation, 6 are still alive; 4 are living in their second year, 1 is in his third, and the last patient is in his fourth year after the diagnosis was established. Of the remaining 4 that died, 3 died of ruptured aneurysm, and 1 of coronary occlusion. In contrast to these short survivals, aneurysms were present in 2 patients for 6 and 9 years respectively before their eventual death from rupture. Thus, of this group of 26 patients, a total of 18 have died, of which 9 and possibly 10 died of rupture or dissection.

When the mortality is tabulated with regard to the years followed, a relatively short survival
Table 4.—Survival of Twenty-six Patients with Untreated Thoracic Aortic Aneurysms

<table>
<thead>
<tr>
<th>Year first seen</th>
<th>Patients seen in year</th>
<th>Patients living in January 1956</th>
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</tr>
<tr>
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<td>10 (2)</td>
<td>3 (0)</td>
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<tr>
<td>1955</td>
<td>6 (1)</td>
<td>2 (0)</td>
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* Parentheses signify aneurysm ruptured or dissecting when first seen.

is again seen (table 4). The high operative mortality among the thoracic cases is apparent in table 3. Among the youngest group, 2 of the 3 patients had aneurysms associated with coarctation of the aorta. Such aneurysms are more favorable for resection. These patients have done well with resection and grafts. In 2 patients early in the study the lesions were wrapped with cellophane. One died 3 days later and the other 11 months later, both of rupture of the aneurysms. Attempts to excise 2 aneurysms of the arch were unsuccessful, and in several cases the surgeon believed that the lesion was too extensive to be resected after it was exposed. Of the 5 who survived operation 3 are living more than a year, and the other 2 died of rupture of the lesions. With the recent development of hypothermia and vascular shunts, it is reasonable to predict that more favorable results will be obtained in this group of patients.

Signs and Symptoms of Aortic Aneurysms

Sex. The sex incidence of the 101 cases showed 20 women and 81 men in the series. Fifty-two men and 13 women had abdominal aneurysms, while 29 men and 7 women had thoracic lesions. It is interesting that the women were usually considerably older than the men. The average of the women with abdominal aneurysms was 73 and the median age was 74; men on an average were 8 years younger, the median and average age both being 65 years. Among patients with thoracic lesions the ages were more nearly equal. The average for women was 58 years, with a median of 55 years; the average age of men was 56 years with a median of 61 years. Of the women with thoracic lesions 5 of the 7 had syphilitic aneurysms, thus accounting for the younger age.

Hypertension. It is recognized that hypertension is often found with arteriosclerotic aneurysms. If pressures over 150 systolic or 100 diastolic are regarded as hypertensive, 38 of the 65 patients with abdominal aneurysms, or 58 per cent, were hypertensive. This percentage is lower than that usually reported. Among the patients with thoracic aneurysms, 22 (61 per cent) showed pressures above 150/100.

Symptoms. The symptoms of the patients with abdominal aneurysms are given in table 5. Ten of the 13 patients with ruptured abdominal aneurysms had symptoms less than 1 month prior to rupture. Most of these apparently did not have any premonitory symptoms. Pain, of course, was uniformly present at the time of rupture, but the absence of pain cannot be taken to mean that the lesion is “safe.”

Pain, when present, was clearly the dominant symptom and was usually felt in the back or epigastric area, but occasionally was experienced in the region of the hip, or even the leg. Among the patients with thoracic aneurysms, pain was again the dominant symptom (table 5). Here, however, additional symptoms arising...
from the compression of structures lying within the thorax were noted. At times, it was difficult to be certain that the symptoms were directly related to the presence of the aneurysm, rather than to an accompanying disease. Among these patients were 3 with ruptured aneurysm and prior symptoms for less than 1 month.

A study of table 5 indicates that thoracic aneurysms are apt to give rise to symptoms earlier than abdominal lesions.

**Discussion**

During the last half century a profound change in the relative incidence of thoracic and abdominal aortic aneurysms has apparently occurred. It has long been recognized that syphilis is a much more frequent etiologic factor in thoracic than in abdominal aneurysms; the reverse is true of arteriosclerosis. As the incidence of syphilis has decreased, one would expect a relative decrease in thoracic aneurysms. It would appear, however, that there also has been an absolute increase in aneurysms of the abdominal aorta, which may well be related, in part, to the increasing number of elderly people in our population. When Osler wrote of abdominal aneurysms in 1905, he reported only 16 cases in as many years at the Johns Hopkins Hospital, and referred to the reported autopsy series in Vienna in which only 3 of 222 aortic aneurysms involved the abdominal aorta. Kampmeier in 1936 reported that thoracic aneurysms were approximately 8 times more frequent than abdominal lesions at Charity Hospital in New Orleans; subsequent reports have shown that the ratio has gradually been reversed. In 1952 Maniglia and Gregory in Philadelphia, reported abdominal aneurysms to be more than twice as frequent as thoracic aneurysms. The increase in vascular disease generally is being reflected in an increasing incidence of abdominal aneurysms. Today, these lesions are not rare, and the sex incidence in this series, namely, 4 males to 1 female, is not surprising in vascular disease.

Knowledge of the prognosis of these lesions is of the greatest importance in formulating a rational decision with regard to their treatment. It has generally been recognized that an aortic aneurysm constitutes a distinct threat to life. The type and location of the lesion have some effect on its prognosis. Syphilitic aneurysms lie more proximal and generally have a poorer prognosis than arteriosclerotic lesions. Syphilitic abdominal aneurysms are more apt to extend above the renal arteries than the more common arteriosclerotic aneurysms and thus have a poorer operative as well as non-operative prognosis. In our experience with arteriosclerotic aneurysms, the aorta has nearly always been of increased diameter throughout, even though the aneurysm itself starts below the level of the renal artery.

Whether or not symptoms arise from the aneurysm, does not permit one to predict the period remaining before rupture may occur. This has been pointed out by deTakats and Marshall and others and is confirmed in our series. One must not, therefore, think that the patient can be watched with safety if the lesion is asymptomatic.

Pain and erosion of the vertebrae are usually more prominent in syphilitic aneurysms. Today many asymptomatic abdominal aneurysms are being diagnosed, and the prognosis is better than previously when no therapy was of avail. In his study Crane found a rather close correlation between the likelihood of rupture and the size of abdominal aneurysms. Lesions that were at least 7 cm. wide had a far higher incidence of rupture than the smaller ones. This is apparently due to the fact that the distending force increases as the diameter of the lesion increases, and the wall becomes relatively weaker as it becomes progressively larger. It follows that an aneurysm will usually distend to more than 7 cm. in diameter before rupturing. It is surprising that once these lesions begin to enlarge, they do not all go on to rupture in a brief time.

The prognosis of patients with abdominal aneurysms stated by Estes from the Mayo Clinic is borne out by most smaller series. Roughly one third of his patients died within a year after the diagnosis was made and four fifths were dead within 5 years. Of those who died, approximately two-thirds died of rupture of the aneurysm. In Kampmeier's series of abdominal aneurysms, in which 57 per cent of the patients had syphilis, 2 out of 3 died in the
hospital during the admission in which the
diagnosis was made. In the present series, more
than 50 per cent of the unoperated patients
with abdominal aneurysms were dead within a
year; a little less than half of these deaths were
the result of rupture of the lesion.

With excision of abdominal aneurysms the
prognosis appears distinctly improved. It is
our present belief that unless there is some
strong contraindication to surgery, an abdom-
inal aneurysm should be excised and replaced
by a graft or prosthesis. Although the operative
mortality from this procedure is still consider-
able, it is rapidly declining, and the risk is
reasonable when weighed against the alterna-
tive of “letting nature take its course.” We
think that other surgical methods are not so
satisfactory as excision; they have not been
employed in preference to resection in this
hospital in the last 3 years. As more experience
is gained in the operative procedure, it is rea-
sone to anticipate further decreases in
mortality.

The problems of thoracic aneurysms are
more difficult than those in the lower aorta. The
incidence of syphilitic lesions is distinctly
higher, the general prognosis appears worse,
and the operative treatment more difficult be-
cause temporary occlusion of the aorta in this
region cannot be tolerated so well as below the
level of the renal arteries. Neither the viscera
nor central nervous system can withstand long
periods of anoxia, whereas the extremities can.
Various methods are being used to solve this
problem, such as hypothermia and the use of
vascular shunts. At present, the danger atten-
dant on operating upon a thoracic aneurysm
is considerably greater than upon an abdominal
aneurysm, provided the latter lies below the
renal arteries. Removal of the upper abdominal
aorta has been accomplished,24 but remains a
hazardous undertaking. Total removal of the
aortic arch has also been carried out,25 but is
even more hazardous.

According to Kampmeier,18 in patients with
saccular thoracic aneurysms, “with few excep-
tions the duration of life after onset of symp-
toms is to be measured in months.” The “aver-
age patient”17 with an aneurysm of the ascending
aorta died in 8.0 months after the onset of
symptoms, in 6.4 months when the lesion arose
from the transverse portion of the arch, and in
6.3 months if the lesion was in the descending
aorta. Therefore, a considerable risk would
seem well justified in an attempt to remove
such a lethal condition; more and more suc-
cessful cases of removal of thoracic aneurysms
are being reported. Successes are particularly
frequent with lesions that are distal to the left
subclavian artery. Bahnson19 pointed out that
syphilitic aneurysms in the chest are apt to be
saccular and thus suitable for resection by
clamping across their base without occluding
the aorta. Aneurysms just distal to an area of
coarctation of the aorta seem particularly
favorable for resection because of the rich col-
ateral circulation. The pathogenesis of such
lesions is discussed by Holman.23 This col-
ateral circulation permits more prolonged
obstruction of the aorta. With newer methods
and more experience one can also anticipate
improved results with excision of thoracic
aortic aneurysms as a group.

Dissecting and ruptured aneurysms make up
a definite proportion of aortic aneurysms that
have not previously been diagnosed. Pre-
viously these lesions were nearly uniformly
fatal.26 The outlook today remains grave, but a
significant proportion of these patients may be
salvaged.27-29 Although the terms “dissec-
tion” and “rupture” have been used inter-
changeable by some authors, the term “dis-
secting aneurysm” should be used only for
those lesions in which the dissection involves
the aortic wall, separating the intima and
adventitia usually in the plane of the media.
Such lesions ordinarily start in the arch of the
aorta and then progress peripherally.30-32 In-
frequently they are self-limiting and may break
back into the lumen of the vessel producing the
so-called “double aorta.”33 Usually, however,
the result is death within 2 weeks. After rather
extensive work on this condition Gore34 believed
degeneration of the media to be the primary
defect. In younger patients, even in the twen-
ties, the elastic tissue is primarily involved in
the degenerative process, whereas in older pa-
tients the smooth muscle seems to be at fault.
In the intermediate age groups defects were
found in both muscular and elastic tissues.
Hemorrhage into the media apparently initiates the process, and not necessarily a tear in the intima, which may remain intact. Syphilitic aneurysms are seldom reported to dissect, presumably because of the scarring in their media. Of the 85 fatal cases of dissecting aneurysms reported by Gore and Seiwert, 19 were under the age of 30. Hypertension is common. Recently DeBakey’s group described a successful method of dealing with these lesions. No one in our series was treated by this method, and all died; 1 patient has since been treated successfully by this method.

Rupture of an aneurysm is the term used for the condition in which blood has broken out of the wall of the vessel into the surrounding tissue. Very rarely these, too, may be self-limiting, but they ordinarily result in death within a few days or hours. When this situation exists, operation again offers the only real chance of survival. Such patients are often in severe shock when first seen, and the risk of operation is correspondingly high. If there is a chance of salvage, operation should be undertaken. In abdominal aneurysms, the blood usually dissect out in the retroperitoneal space and then into the peritoneal cavity, but rupture into the bowel may occur with hematemesis or melena as the first sign. The retroperitoneal duodenum is the portion of gut most often involved, but ruptures into the stomach and other parts of the small bowel have been recorded. Only 2 patients in this series survived under these circumstances, but others have reported better results. If one can gain control of the aorta below the renal arteries before serious renal or other damage has occurred, there is a reasonable chance of saving the patient’s life.

Although it is still too early to know how well arterial homografts or prostheses will stand the test of time, it has been demonstrated that the elastic tissue in human grafts remains for at least a year by which time fibrous tissue has largely replaced the graft. Such grafts have now been used for 8 years and it is clearly apparent that they may greatly prolong the lives of patients who have aneurysmal aortas.

**Summary**

A group of 101 patients having aortic aneurysm is presented. Sixty-five of these lesions involved the abdominal aorta, and 36 the thoracic aorta. Operative and nonoperative groups are compared.

The incidence of abdominal aneurysms is increasing. If untreated, approximately one half of the patients with aortic aneurysms died within a year, and, of these, approximately one-half died of rupture of their lesion. Rupture or dissection of the aneurysms often occurred without premonitory symptoms. Excision of aortic aneurysms with restitution of blood flow by grafting, if needed, has improved the prognosis, and presumably will become less hazardous as more experience is gained in the procedure.

**Acknowledgment**

We would like to acknowledge the assistance of Dr. S. I. Askovitz and Mr. C. George in arranging the tabular data.

**Summario in Interlingua**

Es presentate un gruppo de 101 patientes con aneurysma aortic. In 65 del casos, le lesiones concerneva le aorta abdominal; in 36, le aorta thoracic. Es presentate un comparation del gruppo de casos operate con le gruppo del casos non-operate.

Le incidentia del aneurysmas abdominal se trova in stato de crescentia. In le gruppo del casos non-tractate, circa un medietate del patientes con aneurysma aortic moriva intra un anno, e in circa un medietate del mortes, le causa letal esseva ruptura del lesion. Ruptura o dissection del aneurysma occurriva frequentemente sin symptomas premonitori. Le excision de aneurysmas aortic con restitution del fluxo sanguineo per medio de graffos in casos de necessitate ha meliorate le prognose e devenira sin dubita minus riscose in proportion al crescentia experientia in le manipulation technic.

**Addendum**

During the year 1956, 58 additional patients with aortic aneurysms were seen. Thirty-three had an abdominal aneurysm, 2 had abdominal and thoracic aneurysms, and 23 had thoracic aneurysms. Among
the latter group 7 patients had dissecting aneurysms and 3 had ruptured aneurysms. Among the abdominal aneurysms 7 were ruptured preoperatively.

In 11 patients with thoracic aneurysms an operation was performed. Of 3 patients with dissecting aneurysms who had a surgical procedure, 1 died of rupture of the aorta into the pericardium and 2 are living. Five patients had thoracic aneurysms successfully resected and 3 died during operation.

In the 27 patients with abdominal aneurysm, 5 had emergency procedures for ruptured aneurysms and these patients died; 5 patients were explored and their lesions were judged to be unsuitable for resection, 1 of these died from rupture of the lesion 2 weeks later; and 17 aneurysms were excised electively; 2 of these patients died, one because of renal failure and the other because of rupture of the graft.

This additional experience strengthens our belief that excision of aortic aneurysms is the treatment of choice.

REFERENCES


aneurysm: Review of 29 cases. Glasgow M. J. 
33: 320, 1952.

Medical Eponyms

By Robert W. Buck, M.D.

Ewart's Sign. This was described by William Ewart (1848–1929), Physician to St. George's Hospital, in an article “Practical Aids in the Diagnosis of Pericardial Effusion, in Connection with the Question as to Surgical Treatment” which appeared in the British Medical Journal 1896 pp. 717–721 (March 21), 1896.

"Whenever fluid is effused into the pericardium the normal resonance is modified at the left posterior base in a most definite way. A patch of marked dulness ... is found at the left inner base, extending from the spine for varying distances outwards, usually not quite so far as the scapular (angle) line, and ceasing abruptly with a vertical outer boundary. Above, its extension is also variable, according to the size of the effusion; commonly it does not extend higher than the level of the ninth or tenth rib, and here again its horizontal boundary is abrupt. Its shape then is that of a square, and it is quite unlike that of any dulness arising from pleuritic effusion....

"Immediately below or slightly to the left of the tip of the left scapula a patch about 2 inches in diameter presents well-marked tubular breathing and aegophony. ... This sign, although not so important as that of the patch of dulness, is very commonly, if not always, present in cases of considerable effusion, and gives valuable confirmation to other signs. It has been described by other observers. ... It also occurs in pleural effusions."
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