**Traumatic Aortic Aneurysms**

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Aneurysm of the thoracic aorta may follow severe, nonpenetrating injuries of the thorax unaccompanied by rib fractures. The aneurysms characteristically appear in the first portion of the descending aorta or less commonly in the proximal ascending portion. A large aneurysm, progressive enlargement, or symptoms may necessitate excision or repair. Such repair is now feasible. Traumatic aortic aneurysm should be considered in the differential diagnosis of obscure lesions in the thorax when there is a history of severe antecedent trauma.

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may be produced by blunt trauma or by penetrating wounds. Only those produced by nonpenetrating injuries will be discussed.

Traumatic rupture of the thoracic aorta was formerly thought to be rare and to result generally in sudden death, the diagnosis being possible only at autopsy. With the development of angiocardiography and the popularization of exploratory thoracotomy, it is now possible to diagnose such injuries in the living patient. A few reports of such diagnoses have appeared in the recent literature and one survival for seven years has been reported. Recent advances in aortic surgery have demonstrated the feasibility of repairing traumatic aneurysms of the aorta and successful resections have been reported by Bahnson and by Johnston and associates.

Aneurysms of the thoracic aorta may be produced by compression injuries of the thorax and by blows with blunt objects which do not produce rib fracture or obvious bruising of the chest wall. The greatest number of these injuries result from automobile accidents in which the chest of the driver is violently crushed against the steering wheel or dashboard or in which pedestrians are struck by rapidly moving vehicles.

Traumatic aortic aneurysms are usually found at the top of the descending aorta just distal to the origin of the left subclavian artery at the site of the ligamentum arteriosum. The other frequent site is in the ascending aorta just distal to the aortic valve. These two points are relatively fixed. Haas has shown that whenever one part of the body is decelerated at a rate which is different from that of another part, the connection between these parts is placed under stress which is proportional to the rates of deceleration. Rice and Wittstruck postulated that the relatively free central portion of the aorta is snapped forward by the retarding force and decelerates at a different rate than the rigidly fixed portions, which decelerate at the same rate as the body as a whole. This difference constitutes a force which is concentrated at the point of maximum fixation. The tears produced are usually horizontal and may involve all layers or only the intima or the intima and media. Rupture of all layers results in sudden death; a tear of the two inner layers may result in a saccular aneurysm; rupture of only the intima may result in a dissecting aneurysm.

The sequence of events in the development of traumatic aortic aneurysm is easily understood and may be demonstrated graphically by serial chest roentgenograms. The initial tear usually results in a mediastinal hemorrhage which produces distortion, irregularity and obscuration of the outline of the aortic arch. The chest roentgenogram shows a "layering" effect around the aortic arch as if the outline of the arch is doubled or tripled by fluid. This finding is not pathognomonic of aortic rupture because such a finding may be present in mediastinitis, perforation of the
esophagus or mediastinal hemorrhage from any source. However, this finding should arouse the suspicion of traumatic aortic rupture when found following severe thoracic trauma, particularly in a patient with shock and evidence of blood loss without visible external bleeding to account for the state of shock. After the initial injury the mediastinal hemorrhage is rapidly absorbed and aneurysmal formation may ensue. Just how long it takes for the aneurysm to form is unknown, but it is probable that only a few weeks are enough. All cases of severe trauma with mediastinal widening and haziness should have repeat chest roentgenograms during the first 2 or 3 months. The aneurysm appears as a mass near the aortic arch and later examinations may show progressive increase in size. Physical examination reveals surprisingly few abnormal findings. Only one of our cases had any signs of cardiovascular abnormality. Fluoroscopy shows a mass that may or may not be pulsatile and cannot be separated from the aorta. The esophagus is displaced to the right and posteriorly. The detection of aneurysm formation indicates that operation should be performed as soon as the condition of the patient permits. The wall of the sac consists of adventitia and fibrous tissue; this should be resected and the laceration of the aortic wall sutured.

Cases seen months or years after their initial injury are usually detected by roentgenograms taken routinely or for some other purpose. All three of our cases were detected in this way. Whether or not surgical therapy is recommended might depend upon five factors: (1) the age of the aneurysm, (2) the size of the aneurysm, (3) evidence of increasing size, (4) the presence of symptoms, and (5) the age of the patient. Any large or increasing aneurysm in a young patient should be treated by resection of the sac and suture of the laceration if possible or by resection of the aneurysm and end-to-end anastomosis or insertion of a homologous aortic graft.

We have recently studied three soldiers who had aneurysms of the descending aorta which were considered to be of traumatic origin. All patients were in their early twenties and none showed evidence of syphilis, arteri-

sclerosis, coarctation, or arachnodactyly. All suffered severe, nonpenetrating, chest injuries without any evidence of fracture of the bony cage. Chest roentgenograms were considered normal on all prior to injury, whereas after injury all roentgenograms demonstrated shadows which were proven by exploration and/or angiocardiography to be aneurysms of the descending aorta.

Case Reports

Case 1. A 22 year old soldier was injured in an automobile accident on Jan. 1, 1950, when the car he was driving collided head-on with another vehicle. He was hospitalized with the complaint of left chest pain. Physical examination revealed minor bruises of the chest wall, no fractures, and no evidence of shock. Chest roentgenograms showed a right hemothorax, fluid in the left costophrenic angle and no evidence of fracture of the bony thorax. He was discharged on the eighth day and remained well. A routine chest x-ray study two years later showed a left posterior-superior mediastinal mass which on fluoroscopy could not be separated from the aorta and which did not appear to pulsate (fig. 1). He was transferred to our hospital for diagnosis and treatment. Physical examination was normal and laboratory studies, including serologic tests were negative. He underwent exploratory thoracotomy with a preoperative diagnosis of posterior gutter tumor. Thoracotomy revealed an aneurysm of the aorta. The chest was closed without any definitive treatment. Subsequent follow-up films have not shown any detectable enlargement.
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Case 2. A 20 year old soldier was injured in Paris in May 1945, when his jeep collided with the back of a parked trailer truck; he was unconscious after injury for 72 hours. Physical examination showed only a fractured jaw. Chest x-ray films made at that time were considered negative but are not available. After regaining consciousness he complained of pain in the jaw and in the chest. Eight days after injury he felt dizzy, fainted and fell to the floor. No particular significance was attached to this episode at the time and the observations on the blood pressure and pulse during this period are lacking. He soon became asymptomatic and was discharged to duty. A routine roentgenogram eight months later showed mediastinal widening. In March 1953, another routine roentgenogram showed further slight enlargement of the mass with a layer of calcification in the lower lateral border (fig. 2). Physical examination was normal and routine laboratory studies, including serologic tests, were negative. Fluoroscopy showed a pulsating mass which could not be separated from the aorta. Angioangiography showed the mass to be an aneurysm of the descending aorta. Operative intervention was not recommended because of the age of the aneurysm and the presence of calcium in the wall which made repair hazardous.

Case 3. A 23 year old soldier was injured in an automobile accident on Dec. 11, 1952, in Okinawa. He was hospitalized within two hours at which time he was in moderate shock. The blood pressure was 70/20 and the pulse rate 120 per minute. The patient was slightly cyanotic. Physical examination was otherwise normal. A blood count showed 3.5 million erythrocytes per cubic milliliter, hematocrit of 31 per cent, and hemoglobin of 10 Gm. per 100cc. A chest roentgenogram was negative for rib fracture but showed a left hilar and superior mediastinal haziness (fig. 3). Two blood transfusions, each of 500cc., were given with alleviation of his shock and the unexplained anemia. He was discharged asymptomatic two weeks after injury. A routine chest roentgenogram three months later showed a large mass in the left mediastinum (fig. 4), for which he was transferred to our hospital in April 1953. Physical examination was normal except for the presence of a tracheal tug and a grade II systolic murmur audible over the base and in the interscapular area posteriorly. Routine laboratory studies, including serologic tests, were negative. Fluoroscopy showed a large pulsatile mass which could not be separated from the aorta and displaced the esophagus to the right and posteriorly. Angiography showed an 8 by 9 cm. aneurysm of the descending aorta (fig. 5).

On June 27, 1953, the chest was explored and the large aneurysm isolated. The aorta was occluded above and below the aneurysm and the sac opened. Instead of the usual narrow, slit-like opening, the entire anterior wall of the aorta had disappeared. Two rings of tissue marking the torn aortic ends had retracted and become everted so that both orifices faced anteriorly. Normal yellow colored intima stop-
tissue. Potts clamps were placed at the base of the sac, reducing the lumen of the aorta to normal size. Excision of the excess sac was followed by suture of the edges. Sclerosing polythene was placed about the aneurysmorrhaphy site. Later that day he developed signs of aortic block so he was operated upon again. The repaired aorta contained a firm clot which was evacuated and resutured and regional heparinization was instituted. This was followed by prolonged systemic anticoagulant therapy. Postoperatively he showed slow but progressive diminution of the femoral pulses. Postoperative angiocardiograms showed that the repaired aorta was tortuous, displaced forward and irregular. He was allowed to go on convalescent leave and while at home, on Sept. 2, 1953, he suffered a hemoptysis of 1,000 cc. He was hospitalized elsewhere and 10 days later he experienced a final fatal hemorrhage. Autopsy showed that the middle of the suture line had ruptured into a bronchus to the left upper lobe. We believe that our failure resulted from placing our sutures in the sac wall rather than in good aortic tissue.

SUMMARY

Aneurysm of the thoracic aorta may follow nonpenetrating injuries of the thorax unaccompanied by rib fractures or even obvious bruising of the chest wall. Long-term survivals thereafter are possible but not the rule. The aneurysms characteristically appear in the first portion of the descending aorta or less commonly in the proximal ascending aorta. At first there is only widening and obscuration of the aortic arch, but later definite aneurysm may ensue. A large aneurysm, progressive enlargement, or symptoms may necessitate excision or repair. Such repair is now feasible. If all the layers of the aortic wall cannot be sutured, excision of the sac with homologous graft should be performed. Traumatic aortic aneurysm should be considered in the differential diagnosis of obscure lesions in the thorax when there is a history of severe antecedent trauma.

SUMARIO ESPAÑOL

Aneurisma de la aorta torácica puede ser producido por traumatismo no penetrante del tórax sin acompañamiento de fracturas de costilla o aún de sencillas contusiones de la pared torácica. Supervivencia por largo tiempo luego es posible pero no la regla. Las aneurismas característicamente aparecen en la primera
porción de la aorta descendente o menos comúnmente en la porción proximal ascendente. Al principio solamente ocurre obscurecimiento del arco aórtico, pero más tarde un aneurisma puede aparecer. Un aneurisma grande, ensanchamiento progresivo, o los síntomas, pueden hacer necesario la excisión o corrección quirúrgica. Tal reparación es hoy posible. Si todas las capas de la pared aórtica no pueden ser suturadas, excisión del saco con un injerto homólogo puede intentarse. Aneurisma aórtico traumático debe ser considerado en el diagnóstico diferencial de lesiones obscuras en el tórax cuando hay un historial de trauma antecedente.

REFERENCES
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