

Penetrating Wounds of the Thoracic Aorta

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Two factors usually associated with penetrating wounds of the aorta, massive blood loss and inability to totally and safely occlude the aorta, continue to make successful treatment of such injuries rare and challenging. This conclusion is supported by the fact that from 1922,¹² when the first successful repair of such a wound was accomplished, until 1969, only 43 successfully treated cases have been reported (Tables 1-5). This communication reports 4 years' experience with diagnosis and treatment of penetrating wounds of the thoracic aorta and problems of management.

Clinical Material

During the 4-year period, January 1965 to January 1969, six patients with penetrating wounds (five knife stab, one bullet) of the thoracic aorta were surgically treated at Grady Memorial Hospital (Table 6). Two patients had aorticopulmonary fistulas due to stab wounds and one had a bullet wound of the descending thoracic aorta just distal to the insertion of the ligamentum arteriosum and an arteriovenous fistula between the aortic arch and left innominate vein. Two patients had single stab wounds, one in the ascending and one in the descending thoracic aorta; and one patient had a through-and-through stab wound of the descending thoracic aorta.

The patients' ages ranged from 20 to 37 years. The three stab wounds and the bullet wound of the aorta were repaired shortly after admission to the hospital. The three fistulae, two between aorta and main pulmonary artery and one between aorta and left innominate vein, were corrected eight, 21 and 22 days after the injury, respectively. The diagnosis in the four patients operated upon shortly after admission was made at the time of operation. In the two patients with aorticopulmonary and in one with aortic arch to left innominate vein fistula, the diagnoses were suspected when continuous murmurs were first heard immediately, 8 and 13 days after the injuries, respectively; and was confirmed with aortography prior to surgical correction. All three patients with arteriovenous fistulas developed signs of congestive heart failure (after the detection of the murmur) and were digitalized.

The bullet wound and one of the stab wounds of the aorta were repaired after the aorta was tangentially clamped, partially occluding the aortic lumen. The through-and-through stab wound of the descending thoracic aorta was repaired after the aorta was temporarily cross clamped proximal and distal to the wound. One stab wound of the descending aorta was repaired after a similar cross clamping of the aorta and by employing a temporary local bypass to the occluded aortic segment (Fig. 1) with a 1/4" plastic tube connected to two 7.5 mm. in diameter Mayo arterial cannulae (Fig. 2). While the bleeding was controlled with digital pressure, a 3.0 arterial pursestring stitch was placed proximal and distal to the selected

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TABLE 1. *Successfully Treated Penetrating Wounds of the Thoracic Aorta without Coexisting Fistulae*

| Author | No. of Cases | Mode of Injury | Site of Lesion | Time Interval Between Injury and Definitive Treatment |
|--|--------------|-----------------|----------------------------------|---|
| Dshanelidze, I. I. ¹² | 1 | Stab | Intrapericardial ascending aorta | Not stated |
| Blalock, A. ⁷ | 1 | Stab | Intrapericardial ascending aorta | Shortly after admission |
| Elkin, D. C. ^{14,15} | 2 | Stab | Intrapericardial ascending aorta | Shortly after admission, 60 minutes |
| Beattie <i>et al.</i> ⁶ | 1 | Stab | Intrapericardial ascending aorta | 48 hours |
| Beall, A. C. ⁴ | 2 | Stab | Intrapericardial ascending aorta | Immediate |
| Overbeck, W. <i>et al.</i> ³¹ | 1 | Metal splinter | Intrapericardial ascending aorta | Not stated |
| Stelzner, F. <i>et al.</i> ³⁷ | 1 | GSW | Extrapericardial ascending aorta | Shortly after admission (30 minutes) |
| Perkins, R. <i>et al.</i> ³³ | 1 | Stab | Extrapericardial ascending aorta | 2 hours |
| Diveley, W. L. <i>et al.</i> ¹¹ | 1 | Pierced by wire | Extrapericardial ascending aorta | 56 hours |
| Kleinert, H. E. ²¹ | 1 | GSW | Descending thoracic aorta | Not stated |
| Baret, A. C. <i>et al.</i> ² | 1 | Stab | Descending thoracic aorta | 29 hours |
| Beall, A. C. ⁴ | 1 | GSW | Descending thoracic aorta | Immediate |

GSW = Gunshot wound.

point of cross clamping of the aorta. After the tube was filled with heparinized normal saline, a stab wound was made in the center of the pursestring stitches, and the arterial cannulas were inserted into the aorta and the pursestrings were tied. After the clamps from the plastic tube were removed, the aorta was cross clamped and the wound was repaired while the aorta distal to the occlusion was perfused via the bypass (Fig. 1). The ascending aorta to pulmonary artery fistulas were closed with the use of the cardiopulmonary by-

pass unit, and the aortic arch to innominate vein fistula was closed using a temporary local bypass between the ascending aorta and innominate artery and partial tangential occlusion of the aorta (Fig. 3). Five patients did well following repairs and are fully employed with no residual disability. One patient with the through-and-through stab wound of the descending aorta developed paraplegia following operation and died from massive pulmonary embolus on the 26th postoperative day.

Pertinent information of the clinical

TABLE 2. *Successfully Treated Penetrating Wounds with Aorta to Cardiac Chamber Fistulae*

| Author | No. of Cases | Mode of Injury | Fistulae | Time Interval Between Injury and Definitive Treatment |
|--|--------------|----------------|-----------------|---|
| King, H. <i>et al.</i> ²⁰ | 1 | GSW | Ao-RV | 6½ months |
| Morris, G. C., Jr. <i>et al.</i> ²⁷ | 2 | Stab | Ao-RV | 76 days, 38 days |
| Smyth, N. P. D. <i>et al.</i> ³⁶ | 1 | Stab | Ao-RV | 2 months |
| Swanepoel, A. <i>et al.</i> ³⁹ | 1 | Stab | Ao-RV | 2 months |
| Nowlan, J. A., Jr. <i>et al.</i> ³⁰ | 1 | Stab | Ao-RV | Not stated |
| Mulder, D. G. ²⁸ | 1 | Stab | Ao-RV with AI | 6 weeks |
| Beall, A. C., Jr. <i>et al.</i> | 3 | Stab | Ao-RV | 67 days, 38 days, 89 days |
| Summerall, C. P. <i>et al.</i> ³⁸ | 1 | Stab | Ao-RV and Ao-RA | 2 months |
| McNalley, M. C. <i>et al.</i> ²⁴ | 1 | GSW | Ao-RA-LA | 5 days |
| Cleveland, R. J. <i>et al.</i> ⁹ | 1 | GSW | Ao-RV with AI | 3 days |
| Villareal, R. <i>et al.</i> ⁴⁴ | 1 | Stab | Ao-RV | 53 days |

GSW = Gunshot Wound.

Ao = Aorta.

RV = Right Ventricle

RA = Right Atrium.

LA = Left Atrium.

AI = Aortic Insufficiency.

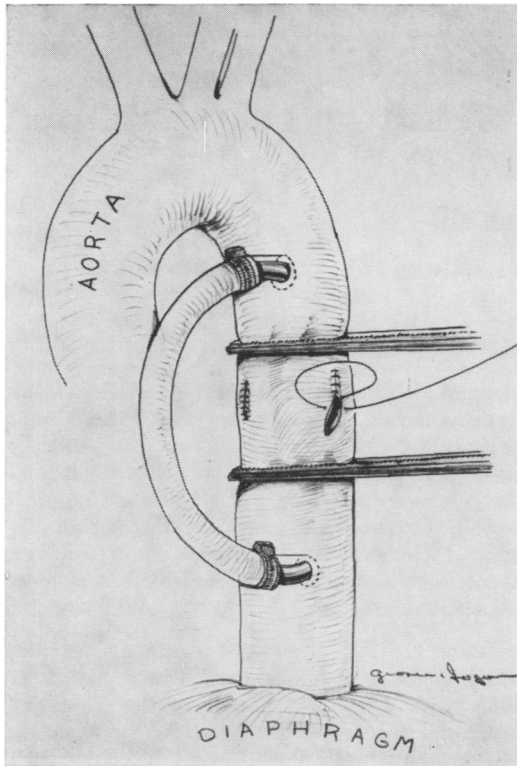


FIG. 1. Diagrammatic illustration of the temporary bypass in use.

courses in three patients are summarized in the following reports.

Case Reports

Case 1. L. H., C268128, a 22-year-old man, was admitted to the Emergency Clinic on Sept. 10, 1967, with a stab wound (sword) in the third intercostal space at the left anterior axillary line. Pulse was 120/min., regular, low in volume with no demonstrable paradox; respiration 16–20/min and blood pressure 70/30 mm. Hg. There was dullness on percussion and diminished breath sounds over the left hemithorax and the heart sounds were distant.

Chest x-ray showed complete opacification of the left chest. After a chest tube was inserted, approximately 600 ml. of blood were evacuated from the left pleural space and was rapidly autotransfused. The patient continued to bleed approximately 350 ml./hour, and while being transfused and autotransfused, left anterolateral thoracotomy was performed. A laceration of the lingular branch of the left pulmonary artery was found and lingolectomy was performed. Following this vital

signs returned to normal and drainage from the thoracostomy tube was minimal until approximately 12 hours later when he became hypotensive with a simultaneous marked increase of blood drainage from the chest tube. At emergency operation through the same incision a ruptured pseudoaneurysm of the descending thoracic aorta was found. While bleeding was controlled with digital pressure, the thoracotomy incision was extended posteriorly as far as possible, tilting the table to the right. Through somewhat limited exposure, the mediastinal pleura was opened and a through-and-through wound of the aorta was found. The aorta was freed without ligation of any intercostal artery and cross clamped proximal and distal to the injury during closure of the wounds for two interrupted periods of 10 and 15 minutes. Immediately after the repair, the patient became hypotensive, although it was thought that blood volume had been adequately replaced. Following hypotension, he had two transient episodes of cardiac arrest and ventricular fibrillation, but was successfully resuscitated. At the conclusion of the procedure, the patient had good urinary output with no demonstrable cerebral damage. During operation, he received a total of 2,100 ml. of autologous and 9,000 ml. of homologous blood and 1,500 ml. of fluids.

Immediately postoperatively, paraplegia with motor and sensory loss at T₈ level appeared. During the third postoperative week, he developed thrombophlebitis of his left lower extremity which was treated with elevation and heparin. On the 26th hospital day, he suddenly had severe chest pain with a blood pressure of 75/0 mm. Hg, respirations of 50/min. and pulse rate of 140/min. Oral temperature was 102° F. A S₃ gallop was present and there were nonspecific ST-T changes

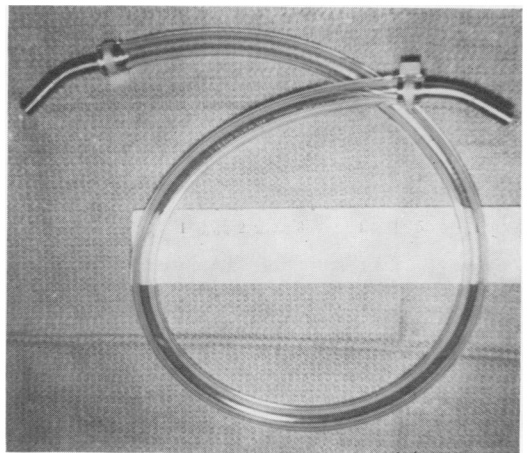


FIG. 2. Photograph of the local bypass.

TABLE 3. Successfully Treated Penetrating Wounds with Aortic Arch to Innominate Vein Fistulae

| Author | No. of Cases | Mode of Injury | Time Interval Between Injury and Definitive Treatment |
|--|--------------|--------------------|---|
| Proctor, W. H., Jr. ²⁴ | 1 | Flying glass piece | 3 years |
| McCook, W. W. ²³ | 1 | Stab | 11 months |
| Conrad, J. K. <i>et al.</i> ¹⁰ | 1 | Stab | 12 years |
| Beall, A. C., Jr. <i>et al.</i> ³ | 1 | Stab | 6 hours |
| Sealy, W. C. <i>et al.</i> ³⁵ | 1 | Stab | 6 years |
| Borst, H. <i>et al.</i> ⁸ | 1 | Shrapnel | 20 years |
| Giraud, R. M. ¹⁶ | 1 | Stab | 2 years |
| Tarlov, E. <i>et al.</i> ⁴³ | 1 | Stab | 14 years |

and late forces to the right in the electrocardiogram. Pulmonary embolism or gram negative sepsis were suspected and he was treated with sodium cephalothin (Keflin*), kanamycin (Kantrex**), steroids and isoproterenol hydrochloride

(Isuprel †), in addition to the heparin he was already receiving. He improved slightly and right heart catheterization and pulmonary angiography were performed. These showed delayed filling of the pulmonary artery on the left side but no gross emboli; however, the same day the patient developed another episode of severe chest pain with hypotension and tachycardia and died in spite of resuscitative attempts.

Case 2. T. B., C256733, a 25-year-old man, was brought to the Emergency Clinic on Jan. 5, 1968, with a gunshot wound in the right first intercostal space just lateral to the sternum. He was in shock with unobtainable blood pressure and in acute respiratory distress. Breath sounds over the left hemithorax were absent and heart sounds were distant. The rest of the physical examination was not remarkable. Hematocrit was 25% and chest x-ray showed left hemothorax with widening of the mediastinum. A chest tube was inserted in the left pleural space and was connected to a chest bottle containing 400 ml. of sterile normal saline. Two thousand ml. of blood were evacuated and immediately autotransfused. He continued to have massive blood loss through the chest tube and was operated upon while being constantly autotransfused. A lateral thoracotomy incision through the fifth left intercostal space was rapidly performed and a large bleeding space was found and controlled with digital pressure. After the blood pressure was brought to a satisfactory level with autotransfusion and transfusion, the mediastinal pleura over the aorta was opened and a tangential wound of the aorta at the level just distal to the isthmus was found. The aorta was partially tangentially occluded and the wound was repaired. The laceration of the left upper lobe was also repaired and

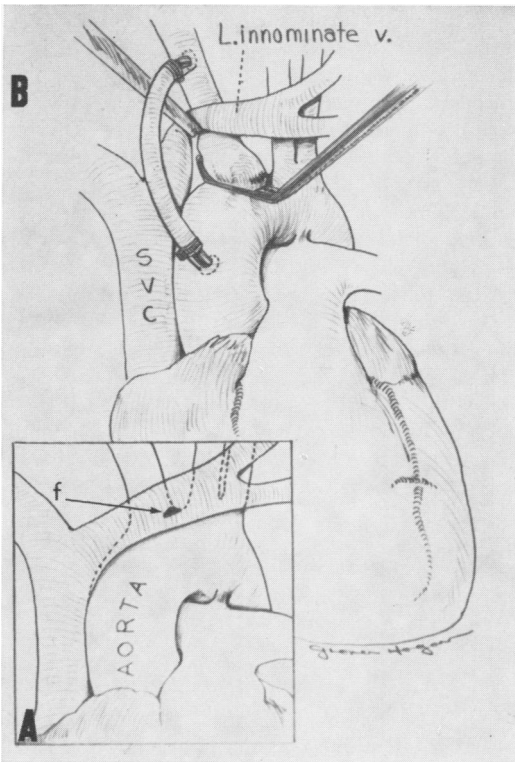


FIG. 3. Diagrammatic illustration: A. of the site of the aortic arch to left innominate vein fistula (f). B. of the technic used to close the fistula with a temporary ascending aorta to innominate artery bypass.

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TABLE 4. *Successfully Treated Penetrating Wounds with Aorta to Pulmonary Artery Fistulae*

| Author | No. of Cases | Mode of Injury | Fistulea | Time Interval Between Injury and Definitive Treatment |
|--|--------------|----------------|----------|---|
| Diveley, W. L. <i>et al.</i> ¹¹ | 1 | Stab | Ao-PA-RA | 5 months |
| | 1 | GSW | Ao-LPA | 6 months |
| La Fleche, L. R. <i>et al.</i> ²² | 1 | Stab | Ao-PA | Not stated |
| Hanolen, P. I. <i>et al.</i> ¹⁷ | 1 | GSW | Ao-PA | 2 months |
| Norman, J. C. <i>et al.</i> ²⁹ | 1 | Stab | Ao-RV-PA | 4½ months |
| Symbas, P. N. <i>et al.</i> ⁴⁰ | 1 | Stab | Ao-PA | 3 weeks |

Ao = Aorta.

PA = Main Pulmonary Artery.

RV = Right Ventricle.

LPA = Left Pulmonary Artery.

the mediastinal pleura was left open for drainage. During and immediately after operation, the patient was autotransfused with 5,000 ml. blood and transfused 5,500 ml. blood. On the first post-operative day, he developed fever to 103° F. and was treated with sodium nafcillin (Unipen *) and other supportive means with improvement. On Jan. 18, 1968, he first complained of dyspnea on mild exertion. Blood pressure was then 140/35, although during the preceding days it ranged between 130/60 to 140/70 mm. Hg. His pulse was regular but large and bounding. There was no clubbing, edema or splinter hemorrhages. Neck veins were distended and a bilateral carotid bruit, more on the right side, with a loud bruit (purring) in the suprasternal notch were heard. Apex impulse was sustained in the fifth left intercostal space at the midclavicular line and a grade 4/6 continuous murmur was heard all over the precordium as well as the back. Hematocrit was 36% and electrocardiogram was normal. Chest x-ray showed normal heart size with some pulmonary congestion. Phonocardiogram confirmed the S₁ split into several components, S₂ normal and a continuous murmur over the first right intercostal space. Cardiac catheterization and aortography demonstrated a shunt between the aortic arch at the site of origin of the innominate artery and the left innominate vein (Fig. 4).

On Jan. 25, 1968, the patient was operated upon through a median-sternotomy incision. The left innominate vein was markedly distended and adherent to the aortic arch at the origin of the innominate artery. The innominate vein was isolated proximal and distal to the fistula and the aortic arch mobilized, as was the distal innominate

artery. A local bypass shunt between ascending aorta and distal innominate artery was established and a vascular clamp was applied tangentially, partially occluding the aortic arch and completely occluding the origin of the innominate artery (Fig. 3). The left innominate vein was detached from the aorta and an approximately 7 mm. fistulous stoma was disclosed on its posterior wall and on the anterior wall of the aortic arch just at the origin of the innominate artery. Both openings were closed with interrupted 4.0 arterial silk sutures, the local bypass was removed and a pericardial patch was interposed between the innominate vein and the aortic arch to prevent recurrence of the fistula.

Postoperative course was uneventful and the patient was discharged on Feb. 2, 1968, with blood pressure 120/70 mm. Hg. He was last seen 12 months after discharge doing well, fully employed and with no murmur or other abnormality.

Case 3. F. B., C64319, a 20-year-old man, was admitted to the Emergency Clinic on Dec. 24, 1968, with a stab wound in the left second intercostal space in the parasternal region. On admission his blood pressure was 110/80 mm. Hg and a soft systolic murmur was heard along the left sternal border with diminished breath sounds on the left. Chest x-ray on admission showed hemothorax on the left side. Hematocrit was 33%. A chest tube was inserted and approximately 300 ml. of blood immediately drained from the left pleural space. The patient was transfused 1,000 ml. of whole blood. The following day he became febrile, to 104° F. and bilateral inspiratory rales with diminished breath sounds were heard over the left base. The apex impulse was in the fifth left intercostal space at the midclavicular line, the S₁ and S₂ were normal and a S₃ was present along the left lower sternal border. A grade 4/6 continuous murmur in the second left intercostal space was

* Wyeth Laboratories, Division of American Home Products Corp., P. O. Box #8299, Philadelphia, Pa.

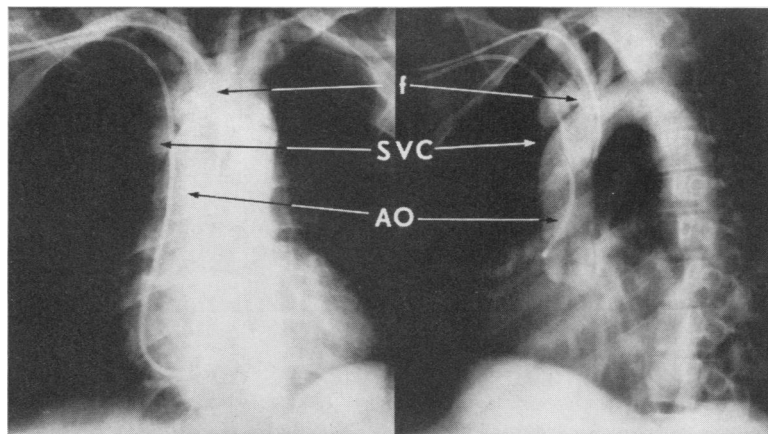


FIG. 4. Aortogram showing simultaneous opacification of the aorta (AO) and its branches and the superior vena cava (SVC) through a fistula (f) between aortic arch and left innominate vein.

heard. Blood cultures showed no growth and the patient was treated with sodium nafcillin with good response. On Dec. 27, 1968, a chest x-ray showed increased vascular markings in both lung fields and he was digitalized.

Cardiac catheterization demonstrated a left-to-right shunt at the main pulmonary artery level with a 2.2/1 pulmonary to systemic flow ratio. The cardiac output was 5.8 L./min. and the pulmonary flow 12.8 L./min. A percutaneous retrograde ascending aortogram showed an ascending aorta to pulmonary artery fistula (Fig. 5).

On Jan. 2, 1969, the patient was operated upon through a bilateral anterior thoracotomy incision. A small amount of bloody fluid was encountered in the pericardial cavity. A 5-7 mm. in diameter old, sealed stab wound in the outflow tract of the right ventricle was found and the pulmonary sinuses were markedly protruding and under considerable tension (Fig. 6). Total cardiopulmonary bypass was instituted and after the aorta was cross clamped, a longitudinal pulmonary arteriotomy just above the valve was performed. A 5-7 mm. in diameter hole was found in one of the pulmonary valve cusps and a fistulous opening of the same diameter was found between the aorta and the pulmonary artery just above the pulmonary valve. Culture from the fistula subse-

quently showed no growth, and its stoma was closed with interrupted 4.0 arterial silk suture (Fig. 7). The hole of the pulmonary valve cusp was not closed because it was considered to be hemodynamically insignificant. Postoperative course was not remarkable but a diastolic murmur at the pulmonary valve area has been present since immediately after operation.

On Feb. 3, 1969, catheterization was again performed and showed no residual shunt and mild pulmonary valve insufficiency.

The patient was discharged after 3 weeks, much improved. At his last visit on May 1, 1969, he was asymptomatic, had assumed his previous occupation and had the residual diastolic murmur at the pulmonary valve area as the only abnormal finding.

Discussion

In a review of the literature, we found reports of 43 successfully treated patients with penetrating wounds of the thoracic aorta (Tables 1-5). Thirty-three were due to stab wounds and ten to projectile wounds, mainly bullets. Fourteen patients, eight with injuries of the intrapericardial and six of extrapericardial segments of the aorta, did not have fistulas and wounds were repaired in eleven within a short time after injury and in three, 29, 48, 56 hours later, respectively. Twenty-nine patients developed fistulas between aorta (Ao) and cardiac chambers and between Ao and pulmonary arteries (PA) or systemic veins: Ao to right ventricle (RV) 9; Ao to RV and right atrium (RA) 1, Ao to

TABLE 5. *Successfully Treated Penetrating Wound with Ascending Aorta to Superior Vena Cava Fistula*

| Author | No. of Cases | Mode of Injury | Time Interval Between Injury and Definitive Treatment |
|---|--------------|----------------|---|
| Meredith, J. H. <i>et al.</i> ²⁶ | 1 | GSW | 3 days |

GSW = Gunshot Wound.

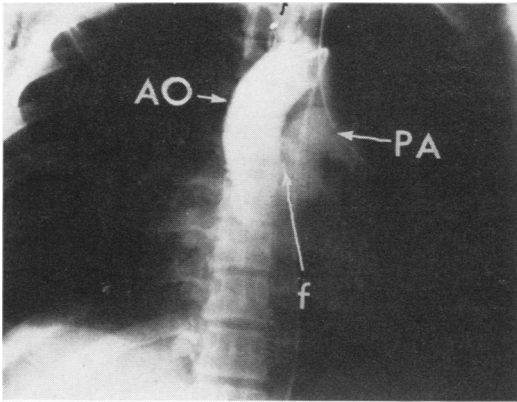


FIG. 5. Aortogram demonstrating the fistula (f) between aorta (AO) and main pulmonary artery (PA).

RV and aortic insufficiency AI) 2; Ao to PA 4; Ao to left PA 1; Ao to superior vena cava (SVC) 1; Ao to RV and PA 1; Ao to RA 1; Ao to RA and LA 1, and Ao to innominate vein 8.

This review suggests that other structures, pericardium, systemic vein, pulmonary artery, etc., play a great role in prevention of exsanguination (and thus survival is long enough to reach medical facilities) by tamponading the wound and by facilitating formation and maintenance of blood clot at the site of the wound.

A penetrating wound of the aorta, even with rapid transportation, is seldom successfully managed. Massive and rapid blood loss from aortic wounds usually results in early death. Parmley *et al.*³² found in 456 autopsies of penetrating wounds of the heart and aorta that only 12% of patients survived more than one hour or long enough to reach medical facilities. The few patients who reach medical facilities either are transported rapidly before exsanguination or survive because bleeding temporarily or permanently ceases, in small wounds or seals with blood clot and adjacent tissues. Subsequently, clots may become dislodged with delayed massive bleeding or organized with good wound healing or with the formation of traumatic

aneurysms or fistulas between aorta and cardiac chambers (Table 2), pulmonary artery (Table 4), or systemic veins (Tables 3 and 5).

The diagnosis of penetrating wounds of the aorta is suspected when the bleeding is massive or continuous and is established at thoracotomy. When bleeding is not massive and is self-limited, the diagnosis of injury of the aorta is suspected when a new murmur is detected. The murmur may appear immediately or several days after injury. For this reason, frequent examination, particularly auscultation, should be performed in all patients with penetrating wounds of the thorax, especially those located in the region of the aorta and great vessels. The suspected diagnosis should be confirmed with angiography and cardiac catheterization to define the type and site of the lesion. In most instances, the most valuable procedure is aortography injecting the radiopaque material proximal to the suspected site of injury.

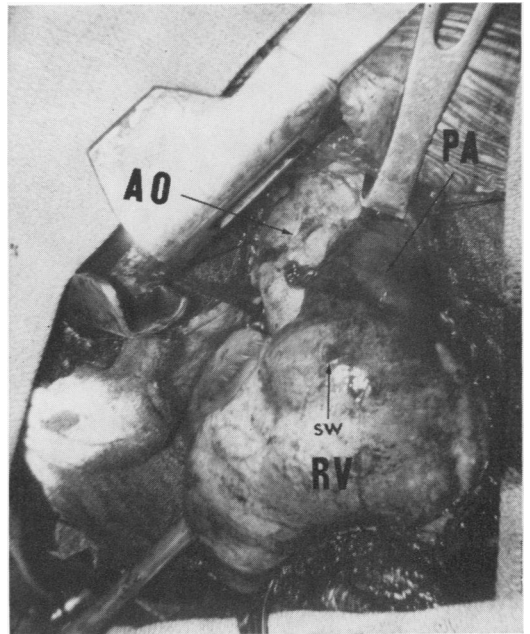


FIG. 6. Photograph taken at the time of surgery. Note the site of stab wound (sw) of right ventricle (RV) and the protruding pulmonary artery sinuses (PA).

TABLE 6. *Diagnosed and Treated Penetrating Wounds of the Thoracic Aorta*

| Case | Age | Type of Wound | Clinical Findings | Operative Findings | Treatment | Results |
|-------|-----|---------------|--|---|--|-----------|
| L. A. | 37 | Stab | Hemothorax, hemopericardium, continuous murmur | Aortopulmonary fistula | Closure of fistula | Recovered |
| F. B. | 20 | Stab | Hemothorax, continuous murmur | Aortopulmonary fistula | Closure of fistula | Recovered |
| T. B. | 25 | Bullet | Severe shock, hemothorax, continuous murmur | Laceration of the aorta at the isthmus and A-V fistula between aortic arch and left innominate vein | Repair of laceration Closure of fistula | Recovered |
| L. H. | 22 | Stab | Shock, hemothorax | Laceration of lingular artery and through-and-through laceration of descending aorta | Lingulectomy Repair of laceration | Deceased |
| H. F. | 32 | Stab | Hemothorax, severe shock | Laceration of descending aorta | Repair of laceration | Recovered |
| N. T. | 28 | Stab | Hemopericardium | Laceration of ascending aorta | Repair of laceration | Recovered |

The initial management of penetrating wounds of the aorta is rapid and vigorous resuscitation; adequate ventilation; relief of cardiac tamponade; massive and rapid administration of blood volume expanders; evacuation of blood and air from the pleu-

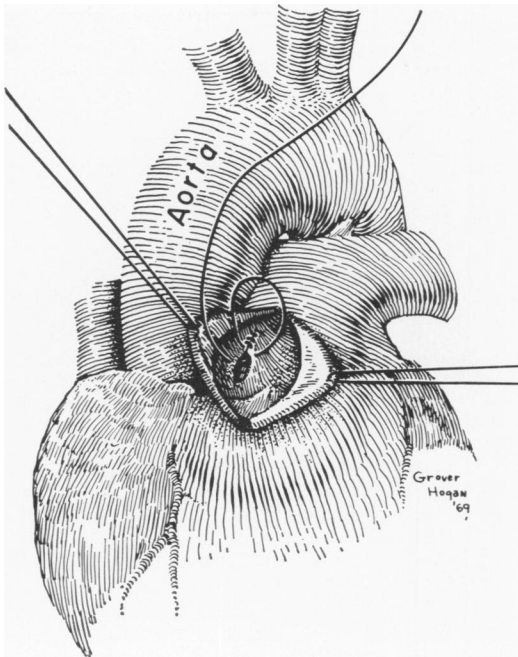


FIG. 7. Diagrammatic illustration of the technique used to close the aorta to pulmonary artery fistula.

ral space; and rapid determination of injuries to other organs. The procurement of blood is a frequent problem during the first minutes of treatment. Autotransfusion is technically applicable and has been used in more than 60 patients with thoracic wounds in our service.^{41, 42} Three patients reported here were autotransfused with 1,800, 2,100 and 5,000 ml. of blood, respectively. Autotransfusion contributed to the successful treatment of these patients.

When bleeding is massive thoracotomy is rapidly performed and bleeding controlled digitally.¹⁸ The incisions were chosen according to the sites of entrance and exit wounds or the location of the bullet.

Stab wounds of the side of the aorta can usually be repaired after partial tangential occlusion of the aorta. Through-and-through stab wounds, however, or bullet wounds frequently require occlusion of the aorta proximal and distal. When total occlusion of the ascending aorta is required, the cardiopulmonary bypass unit should be assembled while bleeding is controlled with digital pressure. Total occlusion of the descending thoracic aorta is said to be safe if less than 20 to 30 minutes' duration.^{1, 18} One patient developed paraplegia although

occlusion of the descending thoracic aorta was for two 10 and 15-minute periods. This patient was hypotensive for a long time which may have resulted in suboptimal perfusion of the spinal cord. Local bypass provides sufficient blood flow distal¹⁹ to the aortic occlusion and is protection when occlusion time is unpredictable.

High-velocity missile wounds of the arterial wall produce fragmentation of the intima and media for 3-5 mm. beyond the margin of external wounds²¹ and microscopic intimal changes extended 3 mm. beyond apparent external damage.²⁶ The need for resection of the damaged aortic wall before aortorrhaphy has been controversial.²⁶ In Case 2 repair of the bullet wound was performed without debridement and healed without aneurysm formation. This experience lends support to previous experimental observations that damaged media and intima, when accurately approximated, heal without complications.²¹

Traumatic fistulas between aorta and cardiac chamber or pulmonary artery were closed under total cardiopulmonary bypass. Closure of the fistula through a pulmonary arteriotomy and temporary occlusion of the aorta is easy and satisfactory. When the fistula is located low and close to the orifice of one of the coronary arteries, aortotomy should be performed to prevent accidental closure of the coronary ostia. After pulmonary arteriotomy air that might have entered through the fistulous opening into the ascending aorta must be evacuated before the aortic occlusion is released.

Most of the fistulas between aorta and systemic veins can be repaired by partial tangential occlusion of the aorta with or without local bypass.

Summary

Some patients with penetrating wounds of the thoracic aorta who arrive at medical facilities can be managed successfully if the wounds are treated rapidly.

Six instances of penetrating wounds of the thoracic aorta, diagnosed and treated, have been reported. All patients but one recovered without residual defects and are fully employed. One, who developed paraplegia following two 10 and 15 minutes' cross clamping of the descending aorta, died from pulmonary emboli 23 days after repair of the wound.

Three of the six patients were massively autotransfused before homologous blood was procured. Autotransfusion contributed to the successful management of these patients. It is a safe procedure in the management of aortic or other thoracic wounds.

Local bypass protects the spinal cord when emergency cross clamping of the descending aorta is required.

Late manifestations of aortic injury occur and should be diagnosed and treated before the patient is discharged.

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