

Aortic valve regurgitation caused by blunt chest injury

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Abstract

Aortic valve regurgitation is an uncommon consequence of closed chest injury. It is caused by damage to the valve apparatus (ruptured cusp) or when subadventitial rupture of the ascending aorta causes prolapse of a subjacent valve cusp. Aortic valve regurgitation was detected in 4 patients (2 men and 2 women, 30 to 65 years old) who had sustained multiple injuries in road accidents 1 week to 30 years before. Three had subadventitial rupture of the ascending aorta and one had isolated rupture of the non-coronary cusp of the aortic valve. The mechanism responsible for the damage was believed to be a consequence of multiple chest lesions (right costal flap, sternal fracture, pulmonary contusion). It is difficult to diagnose and treat aortic regurgitation in patients with multiple injuries. Three patients had repair operations and the remaining patient needed valve replacement. If aortic regurgitation is haemodynamically well tolerated, the operation should be postponed until the patients have recovered from their other injuries. The results in these 4 patients and in other reported cases indicate that operations can be performed soon after the acute phase.

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Aortic valve regurgitation is a rare consequence of chest injury. Regurgitation is caused by damage to the aortic valve (rupture of a cusp) or to the ascending aorta (subadventitial rupture) with prolapse of the subjacent cusp.

Patients and methods

From 1973 to 1989 four patients underwent an operation for aortic valve regurgitation that developed after chest injury. At the time of the accident the two women and two men were 30 to 65 years old and in all of them the operation to treat regurgitation was performed some time (1 week to 30 years) after the accident. This lesion is rare: in the same period we operated on one patient with rupture of the descending thoracic aorta and 57 with ruptures of the aortic isthmus, of which 40 were new ruptures requiring emergency opera-

tions and 17 were post-traumatic aneurysms treated electively (fig 1).

Case 1

A 65 year old man suffered skull and thoracic injuries (anterior flail chest and fractured sternum) in a car accident and required prolonged ventilation. Aortic regurgitation was diagnosed only after dyspnoea and acute pulmonary oedema developed. Examination showed aortic valve regurgitation (grade IV) with dilatation of the ascending aorta. During operation, a subadventitial rupture was found above the sinus of Valsalva. It required a simple suture.

Case 2

A 28 year old man suffered a fractured femur, skull injury, and a fracture of the sternum with serious pulmonary contusion in a road accident. An aortic murmur was noted but an operation was not proposed because initially the regurgitation was well tolerated and the patient had other severe lesions, principally cerebral. An echocardiographic examination, performed after he left the intensive care unit, showed grade II to III aortic regurgitation. The echocardiographic examination suggested rupture of a non-coronary cusp. Eighteen months after the accident the patient presented with dyspnoea (NYHA III). At operation a tear was found at the bottom of the non-coronary cusp. The free edge of the cusp and the other two cusps were not

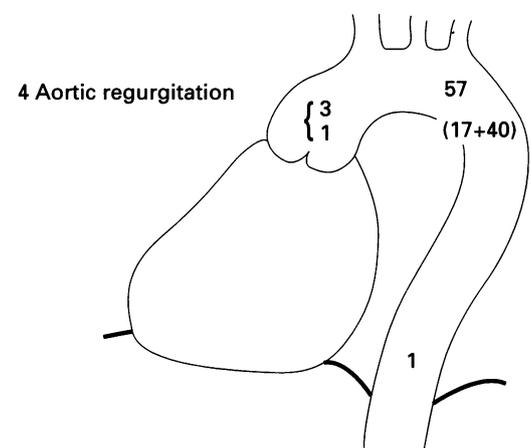


Figure 1 Distribution of post-traumatic aortic lesions seen during the same period in our institution (4 cases of aortic regurgitation, 57 lesions of the isthmus, and one rupture of the thoracic aorta).

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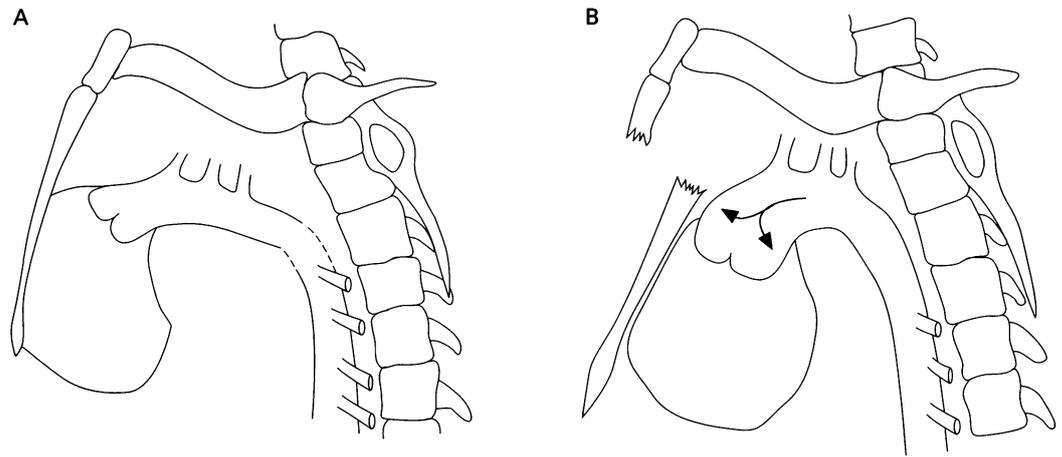
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Figure 2 (A) When the thoracic wall is intact, the heart is thrown forward and traction is exerted on the aortic isthmus. (B) When the thoracic wall is fractured, the movement of the heart is restricted and force is exerted on the ascending aorta rather than the isthmus.



affected. The tear was repaired with a simple running suture.

Case 3

A 61 year old woman presented with dyspnoea (NYHA III) associated with syncope. Seven years before, she had had a road accident which caused a fractured femur, bilateral patellar fractures, abdominal trauma, and a flail chest. She was found to have aortic regurgitation (grade IV), dilatation of the ascending aorta, and a lateral notch that suggested a post traumatic aneurysm. An old subadventitial rupture with a prolapse of the subjacent valve apparatus was found at operation. The competence of the valve was restored by suturing the lesion in the ascending aorta and adjusting the arrangement of the valve apparatus.

Case 4

When a 74 year old woman with angina was assessed before coronary artery bypass grafting angiography showed dilatation of the ascending aorta causing slight aortic valve regurgitation (class I). During operative exploration of the ascending aorta an old subadventitial rupture was found. This was repaired with a simple suture. She had had a serious road accident 30 years before when she had fractured her femur and several ribs. She had been in intensive care for a long time.

Two to eight years after operation, the four patients were symptom free and echocardiographic examination showed good aortic valve competence especially in the patients who had repair operations.

Discussion

Road accidents can cause complete or partial aortic ruptures and ruptures of the free wall, the septum, or the valve apparatus. The most serious ruptures are often fatal.^{1,2} Less severe ruptures such as subadventitial ruptures of the ascending aorta or isolated injury to the aortic valve cusps can cause acute aortic valve regurgitation, which is difficult to diagnose and treat in patients with multiple injuries. There are six other reported cases of rupture of the ascending aorta,³⁻⁹ of which two required emergency operations, and 23 cases of rup-

ture of one or more valve cusps.¹⁰⁻²² No cusp was preferentially affected. In static conditions the isthmus is the most fragile part of the aorta.²³ Deceleration during road accidents, however, seems to be an important factor that affects the pattern of injury.²⁴ Damage to the aortic isthmus is more common in patients with minor thoracic wall injuries⁷ whereas the post-traumatic aortic valve regurgitation (in our experience and in a review of reported cases²⁵) affects all ages and is often found with sternal or multiple rib fractures.²⁶ This finding may give a clue about why the aortic valve regurgitation develops in such patients. The impact of a hard surface on the chest wall could limit displacement of the heart during the accident (fig 2). This would avoid traction on the aortic isthmus but not displacement of the column of blood within the aorta, which can rupture the ascending aorta or a valve apparatus. Rupture of the valve is more likely during diastole when the left ventricular pressure is low, whereas during systole left ventricular counter-pressure may protect the aortic valves and make rupture of the ascending aorta more likely.

Multiple injuries led to a delay in diagnosis of aortic valve regurgitation, which was diagnosed a week to several years after the initial accident. There are reports of valve replacement within 12 hours of a road accident⁹ as well as of cases that did not require operation.^{8,27} Indeed, in one of our patients (case 4) the lesion was discovered during bypass grafting and the grade of aortic regurgitation would not have prompted operation. It seems that there is a latent period^{28,29} during which regurgitation develops. This allows operation to be deferred until patients have recovered from their other injuries. Aortic regurgitation should be suspected if there is a diastolic murmur and a wide pulse pressure. A conventional chest x ray will show the usual signs of aortic isthmus rupture, in particular mediastinal enlargement.²⁷ Enlargement of the cardiac outline has also been reported; this is a more specific sign that confirms concomitant pericardial effusion.¹⁸

Transthoracic echocardiography sometimes shows the damaged cusp prolapsing into the left ventricular outflow tract or the exact site of the damage,³⁰ as in case 3. None the less, chest wall injuries and equipment for ventila-

tion or drainage make it difficult to obtain and interpret transthoracic echocardiograms. Perhaps transoesophageal echocardiography would be helpful in these cases. Before operation, patients must be examined angiographically to show the type of lesion and its functional consequence. Angiography may also show rupture of a sinus of Valsalva in the right atrium. These patients require surgical correction on cardiopulmonary bypass. Lastly, the diagnosis can be made angiographically when rupture of the aortic isthmus is suspected.¹⁸ Cross sectional echocardiography may show rupture of the ascending aorta in the absence of aortic valve regurgitation.¹⁹ There is no risk in postponing surgical correction of a defective valve, but where the ascending aorta is affected there is a risk of further rupture. This outcome has not been reported, however, and the risk of complete rupture must be weighed against the risks of surgical correction especially in patients with other severe injuries of the skull and brain. Thus it is advisable to defer operation until the patient has recovered from the other injuries. Only patients who show immediate poor haemodynamic tolerance of aortic regurgitation need an immediate operation.

Most patients do not need valve replacements, and valve replacement was no more common when the operation was performed some time after the injury. In case 3 repair was possible even though the valve apparatus had been affected for 7 years. The valve could be preserved because there was no fibrous degeneration or calcification on the cusps.

Conclusion

Aortic valve regurgitation is a rare consequence of chest injury. It generally follows severe multiple injuries to the thorax. The mechanisms that cause this type of lesion and rupture of the aortic isthmus are different. Although acute regurgitation develops, in most patients there is an initial period of good haemodynamic tolerance which allows operation to be deferred until the patient's condition is stable.

- 1 Loop FD, Hofmeier G, Groves LK. Traumatic disruption of the aortic valve. *Cleve Clin Q* 1971;38:187-94.
- 2 Beall AC, Shirkey AL. Successful surgical correction of

- traumatic aortic valve regurgitation. *JAMA* 1964;187:507-10.
- 3 Lutes CA, Giverz B. Traumatic rupture of the normal aortic valve. *J Maine Med Ass* 1970;61:183-5.
- 4 Morrill GN, Taylor NC, Miller HC, et al. Traumatic aortic regurgitation. *J R Coll Surg Edinb* 1979;38:87-90.
- 5 Merchant F, Harris G, Long DM. Traumatic subluxation of an aortic cusp. *J Cardiovasc Surg* 1974;15:472-4.
- 6 Najafi H, Dye WS, Javid H, et al. Rupture of an otherwise normal aortic valve. *J Thorac Cardiovasc Surg* 1968;56:57-62.
- 7 O'Connor JB, Davis CC. Traumatic rupture of the ascending aorta and aortic valve. *Injury* 1980;12:34-6.
- 8 Desser KB, Benchimol A, Cornell WP, et al. Traumatic ventricular septal defect, aortic insufficiency and sinus aneurysm. *J Cardiovasc Surg* 1971;62:830-40.
- 9 Berger RL, Gibson H, Riemer RW, et al. Traumatic aortic regurgitation, ventricular septal defect and fistula of the sinus of Valsalva. *N Engl J Med* 1969;281:887-8.
- 10 Ehrenstein FL, Bahler RC, Ankeny J, et al. Untreated (combined) intracardiac and valvular trauma with long asymptomatic survival. *Am Heart J* 1971;81:685-7.
- 11 Staniforth P, Keen G. Closed traumatic rupture of a congenitally abnormal aortic valve. *Injury* 1981;13:61-2.
- 12 Leonard JJ, Harvey WP, Huftnagel CA. Rupture of the aortic valve: Therapeutic approach. *N Engl J Med* 1955;252:208-12.
- 13 Rittenhouse EA, Dillard DH, Winterscheid LC, et al. Traumatic rupture of the thoracic aorta: A review of the literature and a report of five cases with attention to special problems in early surgical management. *Ann Surg* 1969;170:87-9.
- 14 Sevitt S. The mechanisms of traumatic rupture of the thoracic aorta. *Br J Surg* 1977;64:166-9.
- 15 Beneke R, cited by Payne DD, De Weese JA, Mahoney EB, et al. Surgical treatment of traumatic rupture of the normal aortic valve. *Ann Thorac Surg* 1974;17:223-6.
- 16 Rowland TW. Traumatic aortic insufficiency in children: Case report and review of the literature. *Pediatrics* 1977;60:893-5.
- 17 Charles KP, Davidson KG, Miller H, Caves PK. Traumatic rupture of the ascending aorta and aortic valve following blunt chest trauma. *J Thorac Cardiovasc Surg* 1977;73:208-11.
- 18 Kirh MM, Orringer MB, Sloan H. Management of unusual traumatic ruptures of the aorta. *Surg Gynecol Obstet* 1978;146:365-8.
- 19 Holland D, Wareham E. Traumatic rupture of the ascending aorta: a case report. *Tex Heart Inst J* 1983;10:313-6.
- 20 Cleveland JC, Cleveland RJ. Successful repair of aortic root and aortic valve injury caused by blunt chest trauma in a patient with prior aortic dissection. *Chest* 1974;66:447-9.
- 21 Irving JB. Traumatic aortic incompetence following road traffic accident. *Postgrad Med J* 1974;50:725-7.
- 22 Kissane RW, Koons RA, Clark TE. Traumatic rupture of aortic valve. *Am J Med* 1948;4:606-9.
- 23 Levine RJ, Robertson WC, Morrow AG. Traumatic aortic regurgitation. *Am J Cardiol* 1962;10:752-3.
- 24 Payne DD, De Weese JA, Mahoney EB, Murphy GW. Surgical treatment of traumatic rupture of the normal aortic valve. *Ann Thorac Surg* 1974;17:233-5.
- 25 Proudfit WL, McCormack LJ. Rupture of the aortic valve. *Circulation* 1956;13:750-3.
- 26 Lundevall J. The mechanism of traumatic rupture of the aorta. *Acta Pathol Microbiol Scand* 1964;62:34-46.
- 27 Akins CW, Buckley MJ, Daggett W, et al. Acute traumatic disruption of the thoracic aorta: A ten year experience. *Ann Thorac Surg* 1981;31:305-9.
- 28 Schwaitzberg SD, Khalil KG. Isolated traumatic aortic valvular insufficiency with rapid pulmonary deterioration—report of two cases. *Arch Surg* 1985;120:971-3.
- 29 Jannelli G, Golino A, Di Lello F, et al. Rottura traumatica Osmata dell'aortoa ascendente. *G Ital Cardiol* 1985;15:649-51.
- 30 Amoudry C, Malergue MC, Gueveler C, et al. Rupture traumatique de la valve aortique. Aspect echographique. *Arch Mal Coeur* 1979;11:1274-7.