J Forensic Sci, July 2009, Vol. 54, No. 4
doi: 10.1111/j.1556-4029.2009.01051.x
Available online at: www.blackwell-synergy.com

CASE REPORT

Pauline Saint-Martin,[1] M.D.; Christopher Rogers,[2] M.D.; Eugene Carpenter,[2] M.D.; Michael C. Fishbein,[3] M.D., Ph.D.; Stanley Lau,[4] M.D.; and Lakshmanan Sathyavagiswaran,[1] M.D., F.R.C.P.(C), F.C.A.P., F.A.C.P.

Subaortic Pseudoaneurysm of the Left Ventricle Complicating Staphyloccal Endocarditis*

ABSTRACT: Subaortic pseudoaneurysms are rare but can be a cause of sudden death in young individuals. This case report involves a 20-year-old Vietnamese male who died suddenly from rupture of a subaortic pseudoaneurysm with resultant hemopericardium with tamponade. He had a history of bicuspid aortic valve with recent but healed Staphylococcal endocarditis. A review of the literature reveals few similar cases and enlightens the association between aortic bicuspid valve, endocarditis, and subvalvular aortic aneurysm. The pathogenesis as well as recent studies that identified aneurysm predisposing genes in patients with bicuspid aortic valve will be discussed.

KEYWORDS: forensic science, forensic pathology, pseudoaneurysm, endocarditis, aortic valve, mycotic aneurysm

Subvalvular aortic aneurysms are located under the intermediate portion of the left leaflet of the aortic valve (1). They may occur as a complication of aortic valve endocarditis. A review of the literature reveals an association between aortic bicuspid valve, infective endocarditis, and subaortic aneurysm. We are reporting this case because of its rarity and to make forensic pathologists aware of the possible occurrence of this condition among the relatives of individuals with aortic aneurysms.

Case Report

A 20-year-old Vietnamese male who worked as a machinist presented to the Emergency Room of a local hospital with a 4–6 days history of fever, chills, and headache. A cardiology evaluation was requested due to a systolic murmur on examination. Trans-esophageal echocardiography revealed vegetations on the aortic valve and mild aortic, tricuspid, and mitral regurgitation. Blood cultures drawn at the time of the admission grew *Staphylococcus aureus*. The patient was treated for *Staphylococcus aureus* endocarditis with gentamycin for 14 days, and nafcillin for 7 weeks.

Nine days after the onset of the first episode, he returned to the Emergency Room complaining of tachycardia, headache, and profuse sweating, without fever. Laboratory results showed no leukocytosis. Trans-esophageal echocardiography at that time showed severe aortic regurgitation but no vegetations were seen on the aortic valve. After this episode, the patient was followed by a cardiologist for 8 months. He refused aortic valve replacement surgery.

Ten months after the onset of the first episode the patient was found collapsed at home with shortness of breath and an altered level of consciousness. He was transported to the hospital but suffered cardiac arrest and was pronounced dead in the Emergency Room.

At autopsy, the patient weighed 149 lbs and measured 67 inches in length. The pericardial cavity was filled with 200 mL of clotted blood. The heart weighed 430 g. There was a distended cystic mass 3.0 cm in diameter at the base of heart in the region of the aortic root between the aorta and the left atrium. The source of the hemopericardium was a ruptured 1.0 cm blister-like region located on the superior aspect of the mass (Fig. 1). The aortic valve was bicuspid (Fig. 2). The cystic mass communicated with the left ventricle just below and between the attachments of the aortic valve leaflets through a large triangular defect measuring 1.5 × 1.0 cm (Fig. 3). The mouth had a fibrous border without vegetations. The wall of the mass measured 1 mm in thickness. There was no communication between the interior of the mass and either the left atrium or the coronary sinuses. None of the cardiac valves was the site of active infection. The coronary sinuses were unremarkable. There was no compression of coronary arteries by the mass.

Histologic examination revealed the site of rupture to consist of a thin fibrous wall covered by fibrin (Fig. 4). Trichrome stain of the wall of the cystic lesion showed two layers of tissue, a pseudo-neointima and a dense fibrous layer with no smooth muscle present (Fig. 5). Elastic tissue stain showed scant elastic fibers in the pseudo-neointima but none in the dense collagenous tissues (Fig. 6). These findings were indicative of a ruptured pseudoaneurysm. Toxicological analysis was negative for alcohol, barbiturates, cocaine, methamphetamine, opiates, and phencyclidine. Hair testing was not performed. Death was attributed to cardiac tamponade from spontaneous rupture of a subaortic pseudoaneurysm.

[1]Service de Médecine Légale, Hôpital Trousseau, Centre Hospitalier Régional Universitaire de Tours, 37 044 Tours Cedex 1, France.
[2]Department of Coroner, Los Angeles County, 1104 North Mission Road, Los Angeles, CA 90033.
[3]Department of Pathology and Laboratory Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA 90095.
[4]Southern California Heart Center, 506 West Valley Boulevard, Suite 100, San Gabriel, CA 91776.

*Presented at the 60th Annual Meeting of the American Academy of Forensic Sciences in Washington, DC, February 18–23, 2008.

Received 23 May 2008; and in revised form 18 Aug. 2008; accepted 22 Aug. 2008.

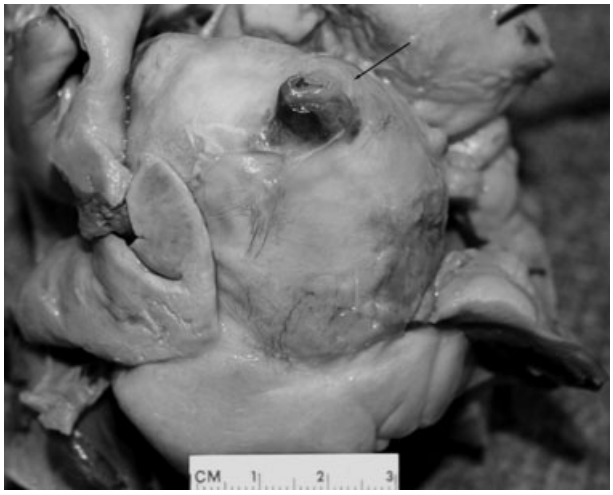

FIG. 1—*Epicardial surface of the base of the heart showing area of distention with rupture (arrow).*

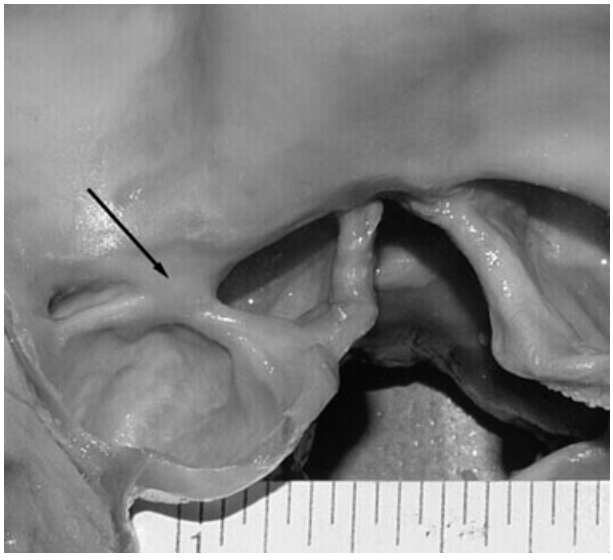

FIG. 2—*Opened bicuspid aortic valve with characteristic raphe (arrow).*

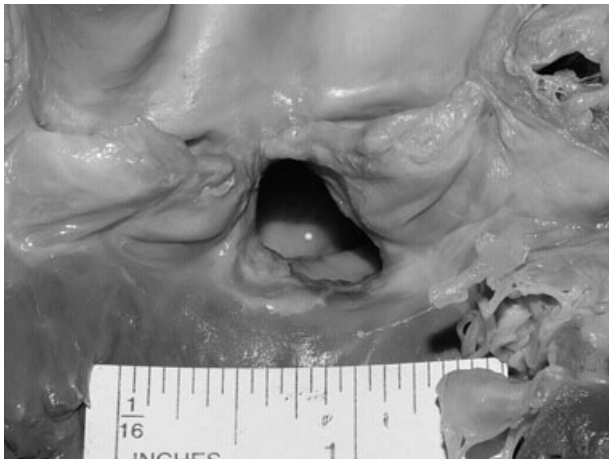

FIG. 3—*Triangular defect at base of left ventricle (asterisk) leading to the aneurysm.*

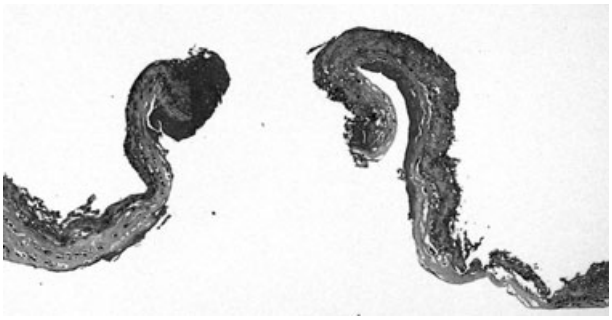

FIG. 4—*Site of rupture (trichrome stain).*

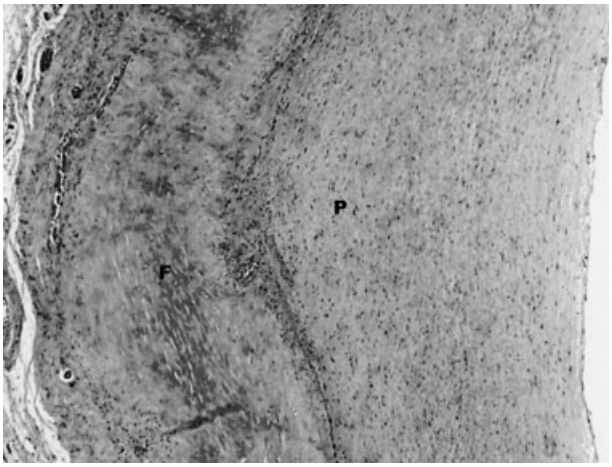

FIG. 5—*Trichrome stain of wall of cystic lesion showing pseudo-neointimata (P) and dense fibrous layer (F).*

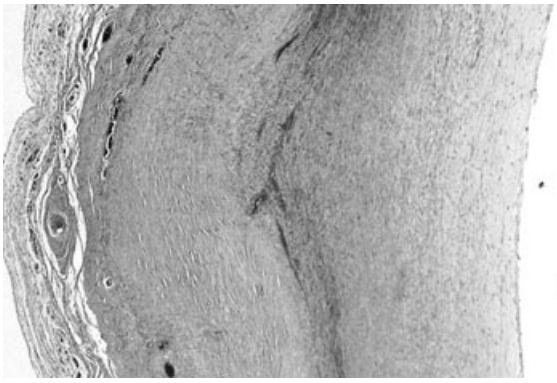

FIG. 6—*Elastic tissue stain of wall of cystic lesion showing scant elastic fibers in the pseudo-neointima but none in the dense fibrous layer.*

Discussion

Aneurysms may be classified as true aneurysms involving all layers of the aorta, dissecting aneurysms splitting the layers of the aorta (usually medial separation), or false aneurysms contained only by the adventitia and surrounding connective or fibrous tissue (2). In our case, histologic examination of the wall showed two layers but neither was the medial layer. This cystic mass is therefore a pseudoaneurysm.

The medical history of this patient and the autopsy and microscopic findings suggest a possible sequence of events. The patient

was diagnosed with staphylococcal endocarditis and treated. At that time trans-esophageal echocardiography revealed moderate to severe aortic regurgitation. During the 10-month period between the onset of the first symptoms and the death, a pseudoaneurysm developed at the base of the heart. Based on the size of the pseudoaneurysm, it is unlikely that it was present when the diagnosis of endocarditis was initially made because the echocardiography did not reveal a cystic mass at that time. We think that the initial event in the development of this pseudoaneurysm was probably a root abscess (ring abscess) secondary to the endocarditis.

In a study describing 95 postmortem examinations of acute infective endocarditis involving natural valves, Arnett et al. (3) showed that ring abscess was most common among the patients with endocarditis involving the aortic valve. The authors also stated that the presence of aortic regurgitation of recent origin is one clinical clue that suggests the presence of a valve ring abscess during life. In our case, the root abscess resulted in a cavity that communicated with the base of the heart, expanded with time as wall tension increased, and eventually ruptured. Smith et al. (4) reported a similar case but stated that the genesis of the pseudoaneurysm was not derived from infection.

The literature indicates that subvalvular aortic aneurysms are an uncommon but recognized complication of infective endocarditis that have been detected in up to 10% of patients undergoing valve replacement for aortic valve endocarditis (5). In a retrospective study of 19 subvalvular aneurysms seen in 16 autopsies, Deshpande et al. (6) reported that infection was the most common cause of subvalvular subaortic aneurysms. Among 12 cases with isolated subaortic aneurysms, seven had a recent past history of endocarditis, and the aortic valve was bicuspid in three cases. In each of the seven cases, the subaortic aneurysm was located just below aortic valve leaflets involved by endocarditis. In a study of 20 heart specimens with mycotic aneurysms of the aortic root, Feigl et al. (7) noted that mycotic aneurysm followed infection of the native aortic valve in 10 cases. In one case, mycotic aneurysm was due to infection of an aortic jet lesion. In nine patients the aneurysm was at the seat of a prosthetic aortic valve. In seven of the 11 cases with a natural aortic valve, the valve was either unicuspid or bicuspid. The most frequently isolated microorganism was *Staphylococcus aureus*. These aneurysms may (i) rupture into the pericardial sac as in the present case (4), (ii) become calcified (8), (iii) lead to fistulous communication between the aorta and the left atrium (9), or (iv) compress a coronary artery causing myocardial infarction (10).

Bhagwat et al. (11) are of opinion that the presence of subaortic aneurysm is an indication for early surgical intervention. Subvalvular aortic aneurysms can also be a result of a congenital defect at the valve annulus (1). When they are acquired, the first step in the natural history is probably a root abscess due to infection of a natural or a prosthetic aortic valve (7).

Bicuspid aortic valve is one of the commonest forms of congenital heart defect observed in adults, with an estimated prevalence in the general population of *c.* 1% (12). It is known to be a substrate for infective endocarditis, predominantly in children and young adults. Between 10% and 30% of patients with bicuspid aortic valve develop endocarditis (13). Individuals with bicuspid aortic valve are also at increased risk of developing thoracic aortic aneurysms and aortic dissections.

Familial occurrence of aortic aneurysms has been reported (14). Recently, McKellar et al. (15) have studied the relationship between mutations of NOTCH1, a gene reported to be associated with bicuspid aortic valve, and the phenotype of bicuspid aortic valve and thoracic aortic aneurysms. They stated that there could be aneurysm-predisposing susceptibility genes for individuals with bicuspid aortic valve. The mode of inheritance has not been defined yet; however, bicuspid aortic valve could be inherited as an autosomal dominant trait, with incomplete penetrance (15). Additionally, Loeys et al. (16) reported the association of mutations in the genes encoding transforming growth factor β-receptors 1 and 2 and aortic aneurysm syndrome as the Loeys–Dietz or Ehlers–Danlos syndrome. Although postmortem gene sequencing is not routinely performed as a part of medicolegal investigation of cause of death, individuals whose relative died because of an aortic or cardiac aneurysm should be advised by the forensic pathologist of this possible inheritance and should be evaluated by a cardiologist.

References

1. Chesler E, Mitha AS, Edwards JE. Congenital aneurysms adjacent to the anuli of the aortic and/or mitral valves. Chest 1982;82(3):334–7.
2. Ring WS. Congenital heart surgery nomenclature and database project: aortic aneurysm, sinus of Valsalva aneurysm, and aortic dissection. Ann Thorac Surg 2000;69(4 Suppl):S147–63.
3. Arnett EN, Roberts WC. Valve ring abscess in active infective endocarditis. Frequency, location, and clues to clinical diagnosis from the study of 95 necropsy patients.. Circulation 1976;54(1):140–5.
4. Smith TP, Crisera RV, Smisson DC, Edwards JE. Subaortic aneurysm of the left ventricle. Am J Cardiovasc Pathol 1988;1(3):405–10.
5. Griffiths BE, Petch MC, English TAH. Echocardiographic detection of subvalvular aortic root aneurysm extending to mitral valve annulus as complication of aortic valve endocarditis. Br Heart J 1982;47(4):392–6.
6. Deshpande J, Vaideeswar P, Sivaraman A. Subvalvular left ventricular aneurysms. Cardiovasc Pathol 2000;9(5):267–71.
7. Feigl D, Feigl A, Edwards JE. Mycotic aneurysms of the aortic root. A pathologic study of 20 cases. Chest 1986;90(4):553–7.
8. Gonzales-Lavin L, Scappatura E, Lise M, Ross DN. Mycotic aneurysm of the aortic root: a complication of aortic valve endocarditis. Ann Thorac Surg 1970;9(6):51–61.
9. Özerkan F, Duygu H, Nalbantgil S, Cinar CS. Mycotic aneurysms of aortic root and aorta-to-left atrial fistula complicating bicuspid aortic valve endocarditis. Cardiology 2006;105(2):110–2.
10. Normann SJ. Annular subaortic aneurysm resulting in sudden death. Clin Cardiol 1991;14(1):68–72.
11. Bhagwat AR, Patil RB, Loya YS, Sharma S. Subaortic aneurysm in infective endocarditis. Am Heart J 1991;122(2):588–9.
12. Clementi M, Notari L, Borghi A, Tenconi R. Familial congenital bicuspid aortic valve: a disorder of uncertain inheritance. Am J Med Genet 1996;62(4):336–8.
13. Ward C. Clinical significance of the bicuspid aortic valve. Heart 2000;83(1):81–5.
14. Prahlow JA, Barnard JJ, Milewicz DM. Familial thoracic aortic aneurysms and dissections. J Forensic Sci 1998;43(6):1244–9.
15. McKellar SH, Tester DJ, Yagubyan M, Majumdar R, Ackerman MJ, Sundt TM. Novel NOTCH1 mutations in patients with bicuspid aortic valve disease and thoracic aortic aneurysms. J Thorac Cardiovasc Surg 2007;134(2):290–6.
16. Loeys BL, Schwarze U, Holm T, Callewaert BL, Thomas GH, Pannu H, et al. Aneurysm syndromes caused by mutations in the TGF-beta receptor. N Engl J Med 2006;355(8):788–98.

Additional information — reprints not available from author:
Christopher Rogers, M.D.
Chief, Forensic Medicine
Department of Coroner
1104 North Mission Road
Los Angeles, CA 90033
E-mail: crogers@coroner.lacounty.gov