Cine Radiology in Subvalvular Left Ventricular Aneurysm*


SUMMARY

Left ventriculography was used to make a definitive diagnosis of subvalvular aneurysm in 4 Bantu patients. Three aneurysms were in the submitral position, and 1 was subaortic. A clinical diagnosis was made in only 2 patients. Direct injection of contrast medium into the aneurysm and coronary arteriography are useful additional diagnostic procedures.


Subvalvular annular aneurysms occur in the South African Bantu and also in the Negro races of Central and West Africa and the USA.

The pathological anatomy has been well described. The orifice of the aneurysm is related to the aortic or mitral annulus and its wall consists of dense fibrous tissue with few muscle cells; occasionally there is an endothelial lining which is continuous with thickened endothelium at the neck of the aneurysm. The orifice can distort either the mitral or aortic valve or both, and the body of the aneurysm compresses the ventricular or atrial wall and often displaces the coronary arteries. The aneurysmal recess contains free or organized thrombus and this may become calcified. Adhesions between the fibrous wall of the aneurysm and the pericardium are frequent. Aneurysms may be single or multiple and may have one communication or more with the left ventricular cavity.

Physiologically the aneurysm may produce a serious haemodynamic abnormality: large aneurysms fill with a regurgitant flow during systole, the distorted and displaced aortic and mitral valves become incompetent, or if the coronary arteries are compressed, coronary blood flow may be impaired. Recurrent ventricular tachycardia has been reported. Emboli are uncommon, possibly because of the small diameter of the neck of the aneurysm.

The clinical presentation is variable. The patients may present with severe congestive cardiac failure or the lesion simulates cardiomyopathy, rheumatic mitral or aortic incompetence. Occasionally the electrocardiogram shows signs of diaphragmatic infarction. The chest X-ray film is most helpful: it may show a localized bulge immobile on screening, or which pulsates paradoxically, or there may be a rounded or linear calcified intracardiac shadow. None of these features is specific and a definite diagnosis can be made only after careful left ventriculography.

This article describes the diagnostic angiographic features in 4 patients who were studied by cardiac catheterization and cine angiography. The diagnosis was confirmed at operation in 1 patient in whom the aneurysm was successfully repaired. Three of the aneurysms were in a submitral position and 1 in a subaortic position.

This study emphasizes 3 aspects of diagnosis: (i) a correct clinical diagnosis can be made from certain characteristic changes on the chest X-ray film, but these are not present in all cases; (ii) left ventricular angiography can show the aneurysm; (iii) complete anatomical diagnostic information is needed if surgical therapy is contemplated: this should include the site and the number of aneurysms, the number, size, and site of communi-

Fig. 1a. Patient 1. Postero-anterior chest radiograph. This shows great enlargement of all the cardiac chambers (cardio-thoracic ratio = 0.70), a prominent pulmonary conus, distension of the upper zone pulmonary veins, and interstitial oedema.
cations with the chambers of the heart, and the degree of displacement and compression of surrounding cardiac structures.

Fig. 1b. Left ventriculogram—right anterior oblique position. The left ventricle is enlarged and contracts well (ejection fraction = 65%). Contrast medium regurgitates into the left atrium and into the large posterior submitral aneurysm.

PATIENTS

The clinical, electrocardiographic, radiological data, and the findings on catheterization in the 4 patients are shown in Table I.

Fig. 2a. Patient 2. Postero-anterior chest radiograph. The heart is enlarged and a double contour is obvious at the left cardiac border.

Fig. 2b. Diagram to show a bilocular subvalvular aneurysm. N1 = neck of aneurysm 1; N2 = neck of aneurysm 2.

Fig. 2c. Left coronary arteriogram—left anterior oblique view. The circumflex branch of the left coronary artery is splayed over the large posterolateral submitral aneurysm. The coronary arteries are normal.
<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Clinical features</th>
<th>Disability</th>
<th>ECG</th>
<th>Chest radiograph</th>
<th>Haemodynamic</th>
<th>Site of aneurysm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19</td>
<td>M</td>
<td>Severe cardiac failure for 1 year. Severe MI with large LV, pansystolic murmur and 3rd heart sound. Pulmonary hypertension and TI. Previous acute rheumatic fever. Previous bacterial endocarditis. Recurrent cardiac failure over 9 months.</td>
<td>4</td>
<td>Sinus rhythm; LA ++; mild LVH</td>
<td>CTR 0.70; LV ++; LA +++; PA ++; RV ++; RA ++; interstitial oedema</td>
<td>CI 2.8, SI 32, LVEDP 14, PCWP 26, MPAP 32</td>
<td>Submitral</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>M</td>
<td>Severe MI with large LV, pansystolic murmur and 3rd heart sound.</td>
<td>3</td>
<td>Sinus rhythm; LA ++; severe LVH with intraventricular conduction defect</td>
<td>CTR 0.66; LV ++; LA +++; PA ++; enlarged upper zone PV; double edge LV; Pulmonary hypertension. Dull left-sided chest pain for 3 weeks. No cardiac failure. Mild MI with 3rd heart sound. Large LV.</td>
<td>CI 3.0, SI 30, LVEDP 24, PCWP 35, MPAP 55</td>
<td>Submitral</td>
</tr>
<tr>
<td>3</td>
<td>55</td>
<td>M</td>
<td>Dull left-sided chest pain for 3 weeks.</td>
<td>1</td>
<td>Sinus rhythm; LA +; mean frontal QRS axis = 0°; moderate LVH</td>
<td>CTR 0.46; bulge on lateral border of LV; Pulmonary hypertension. Previous acute rheumatic fever. Previous bacterial endocarditis. Recurrent cardiac failure over 9 months.</td>
<td>CI 2.8, SI 32, LVEDP 15, PCWP 12, MPAP 21</td>
<td>Submitral</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>M</td>
<td>Palpitations and effort dyspnoea for 4 months.</td>
<td>3</td>
<td>Atrial flutter; mild LVH</td>
<td>CTR 0.51; LV +; LA +; PA +</td>
<td>CI 3.6, SI 33, LVEDP 10, PCWP 9, MPAP 18</td>
<td>Subaortic</td>
</tr>
</tbody>
</table>

Disability = New York Heart Association grading; MI = mitral incompetence; TI = tricuspid incompetence; LVH = left ventricular hypertrophy; LA = left atrium; RA = right atrium; PV = pulmonary veins; RV = right ventricle; CI = cardiac index (1/min/m²); SI = stroke index (ml/beat/m²); LVEDP = left ventricular end-diastolic pressure; PCWP = pulmonary capillary wedge pressure (mmHg); MPAP = mean pulmonary artery pressure (mmHg); CTR = cardio-thoracic ratio.
have acute rheumatic carditis and was treated with steroids; later a presumptive diagnosis of subacute bacterial endocarditis was made. Catheterization provided the correct diagnosis of submitral left ventricular aneurysm, but it is possible that he might have had associated rheumatic heart disease to account for the chordal thickening and mitral incompetence (Figs 1a and 1b).

The second patient presented with cardiac failure, mitral incompetence and a suspicious chest X-ray film: the diagnosis was made at catheterization and angiography (Figs 2a-2d).

In the third patient the diagnosis was made on the plain radiograph of the chest (Figs 3a and 3b).

The fourth patient was thought to have congestive cardiomyopathy, but a fluoroscopic ring of calcification in the region of the aortic valve suggested the correct diagnosis of a subaortic left ventricular aneurysm (Figs 4a and 4b).

The findings at catheterization were not specific. The cardiac output was normal. The left ventricular end-diastolic pressure was elevated slightly. Two patients had pulmonary venous hypertension and elevation of left atrial pressure with a significant 'v' wave from mitral incompetence. Both patients had significant pulmonary arterial hypertension.

Angiocardiography

Left ventricular cine angiocardiography was diagnostic. The left ventricle was enlarged in all 4 patients, left

Fig. 4a. Patient 4. Postero-anterior chest radiograph. The heart is slightly enlarged. Fluoroscopy defined a ring of calcification below the left sinus of Valsalva.

Fig. 4b. Left ventriculogram in the anteroposterior position. Contrast medium has opacified a subaortic aneurysm.
ventricular contractility was good in 3, and diminished in 1. Angiograms, made in different oblique projections, showed the neck, site of communication, size of the aneurysm and its relationship to surrounding cardiac structures. The aneurysm was a cul-de-sac so that it filled and emptied slowly. In 3 patients the aneurysm was submitral and all had significant associated mitral incompetence. In the fourth patient the aneurysm was located in a subaortic position.

The catheter was made to enter each submitral aneurysm, which was opacified with contrast medium. Injection was made into the neck and not into the body of the aneurysms to avoid displacing thrombus.

Selective coronary arteriograms, made in 3 of the patients, showed displacement and splaying of the coronary arteries around the aneurysm. The coronary arteriogram localized the aneurysm and defined its relationship to the coronary arteries. The coronary arteries were normal, but displaced (Figs 2c and 2d).

**Surgical Treatment**

One patient consented to operation, the other 3 elected to continue with medical therapy.

In the first patient who underwent surgery, the aneurysm communicated with the left ventricle through an orifice which was 2.5 cm long and 0.75 cm wide. The orifice lay immediately below the annulus of the mitral valve at the centre of the posterior leaflet; it was divided into 3 by 2 fibromuscular bands. The aneurysm burrowed beneath the coronary sinus. The leaflets of the mitral valve were thickened and the chordal mechanism abnormal. The orifice of the aneurysm was closed with a dacron patch and the mitral valve replaced with a 4M composite-seat Starr-Edwards valve. The postoperative course was complicated by a haemopericardium which needed aspiration. Postoperative cardiac catheterization showed moderate residual pulmonary hypertension (mean pulmonary artery pressure = 35 mmHg), a pulmonary capillary wedge pressure of 16 mmHg and a systemic index of 3.5 litres/min/m². A left ventriculogram showed normal left ventricular function, a competent prosthetic valve, and no aneurysm (Figs 5a and 5b).

**DISCUSSION**

**Aetiology**

The aetiology of subvalvular aneurysm is unknown. It is common in the Negro and rare in the White races. It is not hereditary. Associated rheumatic fever and cardiomyopathy have been described, but these are probably chance associations rather than causative factors.

Pathological studies suggest that there is a congenital weakness in the ventricular wall at its attachment to the fibrous skeleton of the heart: the high left ventricular pressure produces a sac which burrows into the fibrous skeleton or muscle, displacing the coronary arteries and

Fig. 5a. Patient 1. Postero-anterior chest radiograph 9 months after surgical repair of the aneurysm and replacement of the mitral valve with a Starr-Edwards prosthesis. Heart size has decreased and the cardio-thoracic ratio is 0.53. The lung fields are clear.

Fig. 5b. Left ventriculogram, right anterior oblique position, 9 months after operation. The ventricle is normal in size and contracts well (ejection fraction = 74%). The mitral prosthesis is competent and the aneurysm does not fill.
veins and compressing the ventricles and atria. The aneurysm imposes a severe haemodynamic burden on the ventricle and death is usually due to cardiac failure.

**Clinical Diagnostic Features**

Despite our high index of clinical suspicion of this disorder, the correct clinical diagnosis was made in only 2 patients. Unusual precordial pulsation, an electrocardiographic pattern of myocardial infarction in a Bantu patient, an unusual cardiac protrusion, or intracardiac calcification on X-ray examination, are also suggestive features, but are not always present. In a Bantu patient it is important to exclude an underlying ventricular aneurysm, if there is cardiomyopathy or severe mitral incompetence.

**Angiocardiology**

The left ventriculogram is diagnostic, but the aneurysm is a cul-de-sac, it fills slowly and may opacify poorly, so that the site of its neck, and its extension, may be difficult to define. Where possible, injection should be made into the aneurysm itself, care being taken to avoid embolism. Multiple oblique views are essential to define all the anatomical features of the aneurysm. If surgical therapy is planned, coronary angiography is useful, as it defines the extent to which the aneurysm has burrowed into the fibrous skeleton of the heart.

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**REFERENCES**