Aortic Insufficiency Simulating Combined Aortic Stenosis and Insufficiency*

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The presence of an aortic ejection systolic murmur over the base of the heart, especially when associated with a systolic thrill, radiation of both murmur and thrill into the neck and an ejection sound, is pathognomonic of aortic stenosis. The additional presence of a regurgitant diastolic murmur, heard best at the aortic area, as well as at the left sternal border, is usually considered to be due to associated insufficiency, and the diagnosis of a "double aortic lesion" is made. In point of fact, this is not always true, and it is the purpose of this report to describe just such a situation, in which pure aortic insufficiency may simulate combined aortic stenosis and insufficiency, as demonstrated by hemodynamic techniques.

This very circumstance, i.e., pure aortic insufficiency simulating combined aortic stenosis and insufficiency, was first described by Corrigan,1 132 years ago. The authors thus wish to redemonstrate this old and valid clinical description with the assistance of modern hemodynamic techniques and graphic records.

Case Reports

Case 1

S. S., a 48-year-old man, was admitted to the Orange Memorial Hospital for the first time in

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Figure 1: Presence of ejection systolic murmur at base with radiation to apex. The diastolic murmur is not well shown (Case 1).
1959. At that time, he complained of exertional dyspnea, vertigo, occasional precordial distress on exertion and general fatigability. He gave a history of scarlet fever and rheumatic fever in childhood. The presence of a heart murmur was first noted in 1946, while he was in military service.

At the time he was first examined, the patient was a well-nourished, stocky man with a blood pressure of 150/50. The heart rate was 68 per minute, and the cardiac rhythm was regular. The heart was obviously enlarged, with the point of maximum impulse at the sixth intercostal space, 2 cm. to the left of the mid-clavicular line. The heart sounds were only faintly audible, and more particularly, the aortic component of the second sound was muffled. An ejection type systolic murmur was heard over the aortic area, and was transmitted toward the apex and into the carotid arteries. A long, blowing diastolic murmur was also heard at the aortic area and radiated down the right, as well as the left sternal border and to the apex (Fig. 1). An inconstant thrill was felt during systole at the right sternal border at the level of the second and third intercostal spaces. The peripheral pulses were normal in character, and the remainder of the physical examination was not remarkable.

The electrocardiogram revealed left axis deviation, with left ventricular preponderance and "strain." First degree heart block was present. Chest x-ray films showed enlargement of the cardiac silhouette, primarily of the left ventricle, with fusiform dilatation of the ascending aorta. The blood chemistries and blood count were normal and serologic test for syphilis was negative.

On April 4, 1959, left heart catheterization was performed using the posterior transhilaric approach. The left atrium was punctured with an 18-gauge thin-walled needle, and a polyethylene catheter was passed through it. The catheter was advanced through the mitral valve into the left ventricle, and then through the aortic valve into the aorta. Sequential pressure readings were made as the catheter was withdrawn from the aorta, through the valve, into the cavity of the left ventricle. Brachial artery pressures were recorded simultaneously by way of an indwelling catheter and showed good correspondence with the aortic pressure curves. The findings are illustrated in Fig. 2. The central aortic pressure was 130/45, the left ventricular pressure was 130/4, and the left atrial curve showed an A wave of 4, a C wave of 4, and a V wave of 5 mm Hg. The duration from onset of ventricular systole to the maximal pressure level in the aorta was prolonged to 0.26 second. In the absence of any systolic gradient across the aortic valve, it was apparent that there was no aortic stenosis. The degree of aortic insufficiency was not quantitated.

Approximately one year later, he was restudied at the National Heart Institute, at Bethesda,
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Maryland. Both right and left heart catheterization were performed, and the diagnosis of aortic insufficiency without aortic stenosis was confirmed.

CASE 2

G. E., a 43-year-old woman, was examined in February, 1964. She had recently been in severe congestive heart failure, which was one of many episodes which started in 1961. She gave a history of acute rheumatic fever at the age of 16 years. This was followed by a symptom-free period until the onset of cardiac failure at the age of 40 years. At that time, she was found to have a positive serologic test for syphilis and was treated with a course of benzathine penicillin. The congestive heart failure responded well to conventional therapy on each occasion, and between episodes her only symptoms were occasional exertional dyspnea and three pillow orthopnea.

When examined in 1964, she presented as an asthenic, chronically ill appearing woman who was not dyspneic and was able to lie flat in bed. The blood pressure in both arms was 140/40. The pulse rate was 86 per minute, and the heart rhythm was regular. The pertinent findings were related to the cardiovascular system. The heart was enlarged, with the point of maximum impulse in the sixth intercostal space to the left of the anterior axillary line. There was a pronounced systolic thrill at the first and second right intercostal spaces close to the sternal border.

The thrill radiated to the neck and suprasternal notch. The first heart sound was diminished at the base of the heart, and the aortic component of the second heart sound was increased in intensity. An ejection type systolic murmur, grade V, VI (Fig. 3), was heard best at the right sternal border at the first and second interspace, but was transmitted over the entire precordium. A regurgitant type diastolic murmur, heard best at the aortic area was also transmitted over the entire precordium. The peripheral pulses were pounding in character, and there was pronounced pulsation at the suprasternal notch. The remainder of the physical examination was not remarkable.

The electrocardiogram showed left ventricular preponderance and "strain" and digitalis effect. Chest x-ray films showed marked enlargement of the heart, involving the left ventricle predominantly, with a transverse cardiac diameter of 17.5 cm. and a transthoracic diameter of 26.5 cm. The aortic shadow was prominent, but not significantly widened. The significant laboratory findings were a hemoglobin of 11.3 grams per cent, sedimentation rate of 30 mm. hr., and a positive serologic test for syphilis.

On February 22, 1964, the left heart was catheterized. The left ventricle was punctured directly using the posterior transthoracic approach. Through an 18T needle a polyethylene catheter was introduced into the left ventricle. The pres-

FIGURE 3: Showing systolic ejection murmur and diastolic murmur at the base of the heart. Phonocardiogram showing high, medium and low frequency recordings (top to bottom) (Case 2).
sure in the left ventricle was 140/35 mm Hg. Pressures taken simultaneously with a sphygmomanometer were 148/40 in the right arm and 140/42 in the left arm (Fig. 4). In the absence of a systolic gradient between the left ventricle and the brachial artery it was concluded that there was no aortic stenosis. The aortic insufficiency was not quantitated, but was felt to be of high degree. It is of particular interest that the diastolic pressure of 40 mm Hg in the brachial artery was in virtual equilibrium with the diastolic pressure in the left ventricle, indicating free aortic regurgitation.

We have thus presented two cases in which a significant degree of aortic insufficiency produced clinical findings which are characteristically associated with combined aortic stenosis and insufficiency. In both instances, cardiac catheterization demonstrated that aortic stenosis was, in fact, not present.

DISCUSSION

In his original description of aortic insufficiency, Corrigan described, as the principal findings, a systolic murmur over the base of the heart with radiation to the neck, and an associated systolic thrill in the same areas. He mentioned the diastolic murmur, which is now considered to be the hallmark of this lesion, but considered this to indicate only an advanced degree of regurgitation. To this combination of systolic and diastolic murmurs, he gave the name "double bruit de soufflet" or double bellows murmur.

Through the years, the diastolic murmur has received greater emphasis, and assumed greater significance. Indeed, today one would hesitate to make a diagnosis of aortic insufficiency in its absence. Despite the fact that most standard textbooks of cardiology make mention of the systolic murmur, its presence, particularly when associated with a systolic thrill, and radiating into the suprasternal notch and carotid arteries, usually leads to the diagnosis of combined aortic stenosis and insufficiency. For example, Friedberg states that in his experience "this murmur usually occurs in luetic cases, and is present in rheumatic aortic insufficiency only when there is considerable stenosis."

Very little is available in the literature regarding hemodynamic investigation of this particular issue. This is possibly because the presence of a combined lesion has always been assumed, and was therefore felt to be of only academic interest. With the advent of successful aortic valve replacement, however, delineation of the exact nature of the lesion becomes extremely important in a practical sense, especially since pure aortic insufficiency—if luetic—may suggest an abnormality of the aortic wall. This might present unique surgical considerations.

Battaglia and associates briefly reported 14 cases of isolated aortic insufficiency, associated with a loud systolic murmur, simulating aortic stenosis, and was able to demonstrate the absence of a systolic pressure gradient across the aortic valve in all. He

Figure 4: Left ventricular pressure. Note simultaneous blood pressure in left arm (Case 2).
performed external phonocardiography simultaneously with left heart catheterization, and clearly demonstrated the ejection systolic murmurs which could be heard over the precordium. Gordon, Kirschner, and Moscovitz studied four cases of aortic insufficiency by transbronchial catheterization of the left heart. Three of these with associated systolic murmurs were subsequently found to have minimal and probably insignificant aortic stenosis, and none of them had a systolic gradient across the aortic valve.

There are a number of explanations for the presence of the systolic murmur and thrill, all of which may, to some extent, be operative in the situation under discussion. In essence, the regurgitated aortic blood is added to the diastolic volume of the left ventricle and there is increased stretching of the myofibrils. As long as the myocardium is not in failure, i.e., on the up slope of Starling's curve, this will result in more forceful ejection of blood from the left ventricle during systole and produce greater turbulence as the blood passes through the aortic ring. The increase in stroke volume produced as a result of the valvular insufficiency actually creates a relative, or functional aortic stenosis, analogous to the ejection systolic murmur produced in the pulmonic valve by the increased flow in atrial septal defects. Finally, there may be eddy currents created by the dilated ascending aorta, or changes in the wall of the aorta itself may create turbulence in this area.

It is of historic interest to recall the explanation presented by Corrigan in his original paper. After a discussion of the pulsatile change in the large arterial vessels (known to us today as the "Corrigan pulse"), with diastolic collapse, he wrote, "it may be remarked, that it is a property of fluid in motion, that, when discharging itself from the orifice of a tube into open space, or into a vessel of wider capacity not fully distended, its particles move in lines from the orifice, like so many radii tending to leave vacuums between them. When the flexible tube, artery, or intestine, therefore, is kept fully distended, the fluid moves forward as a mass, there is no tendency in its particles to separate from one another—they all press equally—there is no vibratory motion of the sides of the tube, and consequently no sound, and no fremitus (thril) or trembling. But if the tube be not kept fully distended, then the fluid propelled through it rushes along as a current; and its particles, tending to leave vacuums between them, throw the tube into vibrations, which can be very distinctly felt by the finger, and which give to the ear the peculiar sound 'bruit de soufflet' and to the touch 'fremissement.' These principles may be applied to the state of the ascending aorta and its branches in the instances before us."

It seems reasonable to add this explanation to the more modern ones cited above, and to suggest that, at least in part, the diastolic collapse and flaccidity of the aorta contribute to the formation of the eddy currents and therefore the murmurs.

Summary

An old concept has been reviewed and findings suggested 132 years ago have been confirmed by modern techniques.

It has been shown by left heart catheterization that the presence of a systolic murmur and thrill in aortic insufficiency does not necessarily indicate associated aortic stenosis, but may indeed be found in the pure lesion. The mechanisms which may be responsible for this phenomenon have been reviewed.

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Resumé

Une ancienne conception a été réévaluée, et les constatations suggérées il y a 132 ans ont été confirmées par les techniques modernes.

On a montré par le cathétérisme cardiaque gauche que la présence d'un souffle et d'un fremitus systolique dans l'insuffisance aortique, n'indique pas nécessairement qu'il y a une sténose aortique associée, mais ces signes peuvent être trouvés dans une lésion pure. Les mécanismes que peuvent être responsables de ce phénomène ont été étudiés.
ZUSAMMENFASSUNG
Eine alte Annahme wurde überprüft und Be-
funke, die vor 132 Jahren vermutet wurden war-
en durch moderne Technik bestätigt.
Es wurde mit Hilfe der Linksherzkatheterisier-
ung gezeigt, daß das Vorhandensein eines sys-
tolischen Geräusches und eines Schwirrens bei ein-
er Aorteninsuffizienz nicht unbedingt das Vorhan-
densein einer begleitenden Aortenstenose anzeigt,
sondern tatsächlich auch bei reiner Insuffizienz
gefunden werden kann. Die Mechanismen, die
für diese Erscheinung verantwortlich sein kön-
ten, werden besprochen.

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INFLUENCE OF CHEMOTHERAPY ON VENTILATORY FUNCTION TESTS
IN TUBERCULOSIS
The purpose of the study was to assess the in-
fluence of chemotherapy on the ventilatory function
tests (VC, MVV, FEV₁) in tuberculous patients, or-
iginal treatment cases. In 81 patients, the compara-
tive examinations were carried out after three months
of treatment, and in 50 patients, after six months
of treatment. The patients were divided into five groups
according to the extent of lesions radiologically. The
results showed the influence of chemotherapy on the
ventilatory values. A distinct increase in the values
of VC, MVV and FEV₁ was found in the patients
with moderately extensive and extensive pulmonary
lesions. In the patients with segmental lesions or
moderately extensive lesions, the values of ventila-
tory tests can return to normal. In cases of extensive
lesions, a considerable decrease of ventilatory re-
serves remains after treatment and long-term chem-
otherapy does not bring about any improvement. The
improvement observed occurred mainly within the
first three months of treatment.

OXYGENATED MAMMALIAN HEARTS
A method of isolation and storage of a normo-
thermic, oxygenated and contracting mammalian
heart is described. Perfusion rates of 13 ml./min. to
188 ml./min. were studied. A rate of approximately
100 ml./min. produced aortic pressures of from 43 to
125 mm.Hg and coronary venous PO₂ greater than 20
mm.Hg. These hearts continued to beat for as long
as 11 hours without significant change in the con-
centration of sodium, potassium, and calcium ions in
the perfusate.

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SIGNIFICANCE OF CHANGES IN PULMONARY DIFFUSING CAPACITY
IN MITRAL STENOSIS
The pulmonary diffusing capacity was measured in
79 patients with dominant mitral stenosis before mi-
tral valvotomy. Sixty-two lingual biopsies were ex-
amined and 30 right-heart catheterizations were per-
formed before surgery.
The results indicate that impairment of diffusion
usually parallels both the grade of functional in-
capacity and the severity of the pulmonary vascular
changes. If the diffusing capacity is less than 60 per
cent of the predicted normal, the pulmonary vascular
resistance is usually five units or higher and there is
considerable intimal thickening in the small periph-
eral branches of the pulmonary artery of the lingula.
However, there were important exceptions to this
relationship.