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Usefulness of systolic time intervals in differential diagnosis of constrictive pericarditis and restrictive cardiomyopathy[1]

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Systolic time intervals in 15 patients with constrictive pericarditis and seven patients with restrictive cardiomyopathy were compared in order to assess their value in the differential diagnosis of the two disorders. Clinical examination had failed to make the distinction. Right heart catheterization was helpful in diagnosing restriction but failed to differentiate patients with constrictive pericarditis from those with restrictive cardiomyopathy. The systolic time intervals clearly separated the two groups. The PEP/LVET was normal in all patients with constrictive pericarditis ($0{\cdot}34 \pm 0{\cdot}01$) and abnormal in all patients with restrictive cardiomyopathy ($0{\cdot}70 \pm 0{\cdot}09$, $P < 0{\cdot}001$). In 13 patients (five with restrictive cardiomyopathy and eight with constrictive pericarditis) the results of quantitative left ventricular angiocardiography were available. A high correlation ($r = -0{\cdot}90$, $P < 0{\cdot}01$) between the PEP/LVET and the ejection fraction confirmed the validity of the PEP/LVET as a measure of left ventricular performance in these patients. Thus the systolic time intervals clearly distinguished between constrictive pericarditis and restrictive cardiomyopathy and are a reliable non-invasive technique for making the difficult differential diagnosis.

Restrictive cardiomyopathy may simulate constrictive pericarditis both clinically and haemodynamically (Hetzel, Wood, and Burchell, 1953; Gunner *et al.*, 1955; Clark, Valentine, and Blount, 1956; Goodwin *et al.*, 1961; Wasserman *et al.*, 1962; Burch and Phillips, 1962; Parry and Abrahams, 1963; Shabetai, Fowler, and Fenton, 1965; Ramsey *et al.*, 1970). Whereas diastolic filling of the ventricle is severely impaired in both diseases probably the systolic performance differs. The systolic time intervals are usually normal in constrictive pericarditis (Armstrong, Lewis, and Gotsman, 1973; Lewis and Gotsman, 1973), but they are a sensitive indicator of abnormal left ventricular performance in cardiomyopathy (Weissler, Harris, and Schoenfeld, 1968, 1969; Lewis *et al.*, 1973). Therefore we have reviewed our cases of these two disorders to see whether systolic intervals might provide a reliable non-invasive method of distinguishing one from the other.

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Patients and methods

Fifteen patients with constrictive pericarditis and seven with restrictive cardiomyopathy were selected for study. All the patients were symptomatic. At the time of study they were receiving no medication. All underwent right heart catheterization, and left heart catheterization with left ventriculography was performed in 13. The systolic time intervals were routinely obtained the day before catheterization.

The clinical profile of the 15 constrictive pericarditis patients was typical. All underwent successful pericardectomy. None had visible pericardial calcification. The seven patients with restrictive cardiomyopathy were clinically indistinguishable from those with constrictive pericarditis. All presented the strict criteria of restrictive physiology (Fowler, 1971). None had obstructive or purely congestive cardiomyopathy, in which the restrictive features may develop late in the course of the disease. In four of the seven patients the diagnosis was confirmed by finding a normal pericardium at thoracotomy. Another patient had endomyocardial fibroelastosis, confirmed at necropsy, and another had haemochromatosis. The aetiology of the restrictive cardiomyopathy in the remaining patient was not established but his subsequent clinical course was highly suggestive of cardiomyopathy.

Systolic time intervals were determined by our usual methods (Lewis *et al.*, 1974). In the 13 patients who underwent left heart catheterization and cineventriculography left ventricular volumes were determined from the RAO projection by the area-length method (Sandler and Dodge, 1968; Kasser and Kennedy, 1969). All statistical evaluations were made using standard statistical methods.

Results

The results of right heart catheterization in the two groups of patients are shown in Table 1. All pressures were raised in both groups and the pressure pulses were typical of restriction. There were no significant differences between the pressures for each group except for the pulmonary artery diastolic pressure, which was slightly higher in the cases of restrictive cardiomyopathy. Notably the mean pulmonary wedge pressure was not significantly different from the mean right atrial pressure in either group. The respiratory variation of peak arterial pressure was slightly greater than normal in each group but did not differ between the groups. The cardiac index was normal in the patients with constrictive pericarditis but was below normal and significantly different in the restrictive cardiomyopathy group.

TABLE 1 *Right heart catheterization results (means±SEM)*

	Constrictive pericarditis (n=15)	*Restrictive myocardopathy (n=7)*	*P*
RA mean (mm Hg)	13±1	16±2	NS
RVEDP (mm Hg)	13±1	17±2	NS
PADP (mm Hg)	15±1	20±2	<0·05
PCW (mm Hg)	16±2	20±2	NS
Arterial pulse pressure (mm Hg)	17±5	16±4	NS
Cardiac index (l/min per m²)	3·2±0·3	2·3±0·2	<0·05

RA=right atrium; RVEDP=right ventricular end-diastolic pressure; PADP=pulmonary artery end-diastolic pressure; PCW=pulmonary capillary wedge pressure.
Conversion from Traditional to SI Units: 1mm Hg≈0·133 kPa.

The systolic time intervals are shown in Table 2. The mean values for the QS_2I, LVETI, PEPI, and PEP/LVET of the two groups were all significantly different. The PEP/LVET was normal in the constrictive pericarditis cases but highly abnormal in those of restrictive cardiomyopathy. The QS_2I was normal in the restrictive cardiomyopathy group but significantly short in the cases of constrictive pericarditis.

The Fig. shows the relation between the left ventricular ejection fraction and the PEP/LVET in five patients with restrictive cardiomyopathy and eight with constrictive pericarditis. A high correlation was present ($r=-0·90$, $P<0·01$). It is also clear that all constrictive pericarditis patients had a normal ejection fraction ($0·68\pm0·02$) while the ejection fraction was abnormal in all patients with restrictive cardiomyopathy ($0·42\pm0·08$, $P<0·005$).

Discussion

The similarity of the clinical and haemodynamic data in the two groups of patients was expected. The characteristic intracardiac pressures and pulse configurations first described by Bloomfield *et al.* (1946) and further defined by others later (Hansen, Eskildsen, and Götzsche, 1951; McKusick, 1952; Yu *et al.*, 1953; Wilson *et al.*, 1954) are now known not to be pathognomonic of constrictive pericarditis (Wilson *et al.*, 1954; Lyons, Zuhdi, and Kelly, 1955; Burwell and Robin, 1954; Balchum, McCord, and Blount, 1956). That was so in our series. While the total clinical picture may permit the proper diagnosis, many cases have been reported in which primary myocardial disease masqueraded as constrictive pericarditis (Hetzel *et al.*, 1953; Gunner *et al.*, 1955; Clark *et al.*, 1956; Wasserman *et al.*, 1962; Burch and Phillips, 1962; Parry and Abrahams, 1963; Burwell and Robin, 1954). Among these so-called restrictive cardiomyopathies are endocardial fibroelastosis (Clark *et al.*, 1956; Parry and Abrahams, 1963), cardiac amyloidosis (Hetzel *et al.*, 1953; Gunner *et al.*, 1955), cardiac haemochromatosis (Wasserman *et al.*, 1962), and idiopathic myocardial fibrosis (Hetzel *et al.*, 1953; Burch and Phillips, 1962; Burwell and Robin, 1954).

Certain radiographic and angiographic techniques have been used to discriminate between these two conditions (Figley and Bagshaw, 1957; Steinberg, von Gall, and Finby, 1958; Preger *et al.*, 1965; Desilets, Grollman, and MacAlpin, 1966). The cineangiographic demonstration of a diastolic ventricular snap has not proved specific for constriction (Ramsey *et al.*, 1970; Desilets *et al.*, 1966). Angiographic measurement of cardiac wall thickness as an indication of pericardial thickening is unreliable since it does not clearly distinguish between chamber wall hypertrophy, pericardial effusion, and pericardial thickening (Figley and Bagshaw, 1957). The presence of pericardial calcification alone

TABLE 2 *Systolic time interval results (means±SEM)*

Group	*No.*	*Age*	*QS_2I*	*LVETI*	*PEPI*	*PEP/LVET*
Constrictive pericarditis	15	40±4	520±6	401±4	122±3	0·34±0·01
Restrictive cardiomyopathy	7	39±5	545±11	379±5	171±11	0·70±0·09
P		NS	<0·05	<0·005	<0·001	<0·001

QS^2I=total electromechanical systole corrected for heart rate; LVETI=left ventricular ejection time corrected or heart rate; PEPI=pre-ejection period.

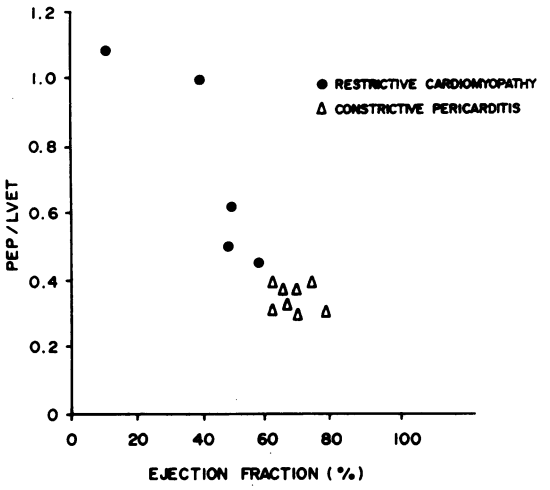

FIG. *Relation between the PEP/LVET and left ventricular ejection fraction in eight patients with constrictive pericarditis and five with restrictive cardiomyopathy. Correlation of −0·90 (P<0·01).*

is not in itself enough to warrant a diagnosis of constrictive pericarditis (Harvey *et al.*, 1953). Calcification cannot be detected radiographically in at least 40 per cent of patients with constrictive pericarditis (Shabetai *et al.*, 1965). Clearly it is often impossible to distinguish between constrictive pericarditis and restrictive cardiomyopathy by standard diagnostic methods and the diagnosis has been made only by exploratory thoracotomy. Indeed, this was the case in four of our seven patients with restrictive cardiomyopathy. In retrospect, the PEP/LVET was abnormal in all of them and could have aided in the proper diagnosis.

Left ventricular performance in cardiomyopathy is usually significantly abnormal, resulting in a low ejection fraction and an abnormal PEP/LVET (Weissler *et al.*, 1968, 1969; Lewis *et al.*, 1973, 1974). Seemingly systolic performance is nearly always preserved in constrictive pericarditis. This was so in our patients and also in others previously reported (Armstrong *et al.*, 1973; Lewis *et al.*, 1973), despite subepicardial fibrosis being reported in some patients with advanced constrictive pericarditis (Dines, Edwards, and Burchell, 1958; Levine, 1973). Indeed, in a recent large series studied by Lewis *et al.* (1973) all 30 patients with constrictive pericarditis had a normal ejection fraction and PEP/LVET despite reduced left ventricular volumes.

The reduced QS_2I characteristic of the constrictive pericarditis patients in this series is not seen in patients with other types of chronic myocardial disease who are not on drugs (Weissler *et al.*, 1968). It was not noted in our restrictive cardiomyopathy group of patients. A shortened QS_2I, reported in patients with acute myocardial infarction or patients in the first few weeks after cardiac surgery, has been shown to be related to excessive adrenergic activity (Lewis *et al.*, 1972; Boudoulas *et al.*, 1973). Possibly chronic adrenergic hyperactivity is present in patients with constrictive pericarditis. Unlike patients with cardiomyopathy, they have a relatively normal left ventricular myocardium. Consequently they seem to respond to such a stimulus (Nakhjavan and Goldberg, 1970). As a result a normal cardiac output and ejection fraction are maintained despite the impaired diastolic filling. For reasons that are not clear the chronically diseased left ventricle usually shows catecholamine depletion in spite of increased adrenergic activity (Chidsey, Braunwald, and Morrow, 1965). Perhaps this explains the lack of QS_2I shortening in chronic myocardial disease. This possibility requires further investigation.

Our study has not shown whether the sharp difference in the systolic time intervals in constrictive pericarditis and restrictive cardiomyopathy would exist in milder forms of these disorders. Very probably the systolic intervals would be normal in mild constrictive pericarditis, and also possibly in early cases of restrictive cardiomyopathy. Nevertheless, in patients with clinically severe systemic congestion measurement of the systolic time intervals seems a valuable, noninvasive way of differentiating between cases of constrictive pericarditis and restrictive cardiomyopathy.

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