SINGLE PLANE CINEANGIOGRAPHIC STUDY OF NORMAL LEFT VENTRICULA VOLUMES IN HUMAN SUBJECTS

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Summary : Single plane cine angiographic estimation of left ventricular volumes in 10 Indian subjects with no evidence of left ventricular disease was carried out. The figures obtained were end diastolic volume 72.43±10.27 *ml*/M², endsystolic volume 26.82±7.46 *ml*/M², stroke volume 45.61± 12.23 *ml*/M², ejection faction 62.30±10.90%. These values compare well with those already reported in literature from Western countries. No study in Indian subjects was available for comparison so far.

Key words : Cineangiography

End-diastolic volume —EDV
End-systolic volume —ESV
Stroke volume —SV
Ejection fraction —EF

INTRODUCTION

Advances in cineangiography have made possible the estimation of volume or size of ca diac chambers with reasonable amount of accuracy. These volume estimates in the vario phases of cardiac cycle and the amount of blood pumped per beat have been used to describe t functional mechanics of left ventricle both in health and disease. Reports of normal figures f these volumes have been scanty and only from the Western countries (1, 4, 7, 9, 10) and m not be representative for Indian population. The absence of corresponding Indian data prompt the present study which is concerned with the measurement of left ventricular volumes in 10 Indi subjects with no evidence of left ventricular dysfunction.

MATERIALS AND METHODS

Ten patients with no evidence of left ventricular involvement were selected from among those admitted in the Cardiology Department of L.L.R. Hospital, Kanpur. Six of these patien had a systolic bruit alone and no other physical sign. In the remaining four subjects, three ha atrial septal defect and one had pulmonary stenosis. The cases of atrial septal defect were simp uncomplicated septum secundum defects without evidence of any other associated anatom malformation. In all these subjects no evidence of left ventricular involvement was detected clin

cally, radiologically, electrocardiographically and on cardiac catheterisation, as well as on cineangiography.

Right heart catheterisation was performed through right antecubital vein and left heart catheterisation was performed through brachial arteriotomy in the right upper limb using a Lehman or a multiple hole pig tail angiography catheter. The cathter tip was positioned as near the left ventricular apex as possible. Intravascular and intracardiac pressures were measured with Statham P 23 DB strain-gauge transducers coupled with Electronics for Medicine Inc. DR 12 Simultrace Recorder with model SGM pressure amplifier with meter readout for systolic pressure and electronic mean pressure using midthoracic position as the zero reference. Heart rate and ECG were monitored during the procedure. Cases showing premature ventricular etopics were excluded.

Sodium iodothalamate (Conray 420) was used as the contrast medium. Precautions were taken to test individual sensitivity to it and an amount of 5 *ml* was injected in the left ventricle to check the production of arhythmias as a result of dye injection. Cineangiograms in R.A.O. projections were taken at 48 frame/sec., using Philips 9" image intensifier and 35 mm arriflex movie camera complex, as 40 *ml.* of the contrast medium was injected, using a remotely controlled Elema-Scholander high pressure injector at a pressure of 6-8 KP/cm^2. and at a temperature of 37°C. The entire process was monitored on Philips 19" television monitor. A metal grid of 1 cm^2 placed at the level of left ventricle was routinely photographed for correction of magnification and distortion of diameters.

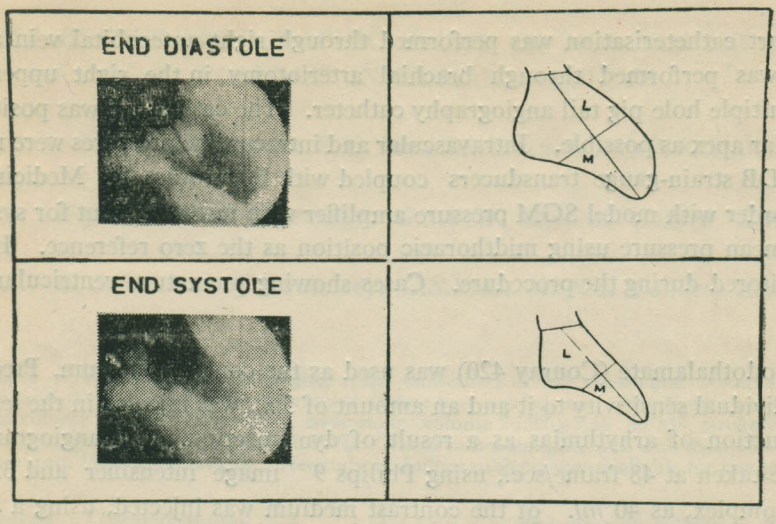
The left ventricular volumes were calculated from the single plane cine pictures using the ellipsoid type model developed by Arvidson (1) in which the following formula is applicable :

$$V = II/6\ LM^2$$ where,

V = Left ventricular volume
L = Long axis of the ellipse
M = Short axis of the ellipse

For the measurement of these diameters from the cine film, the image of the opacified left ventricle was viewed under standard conditions, on Tagarno 35 mm projector, model DTF 685, five initial cycles were selected from the sequence of contractions and relaxations and suitably marked. The outline of the left ventricle and adjacent atrial boarder was traced on a sheet of paper with identifying frame number as shown in Fig. 1. The long axis of the ventricular cavity 'L' was measured from its apex to the intersection of its left anterior margin with the corresponding margin of the left atrium. This point is approximately as far from the apex as the centre of the aortic valve which is obscured. The long axis 'L' was bisected and the transverse diameter 'M' of the ventricle at the mid point of its long axis was measured. These figures are corrected for magnification and pincushion distortion using a factor which was calculated using the photographs of the metal grid.

The largest and the smallest volumes in each cardiac cycle were presumed to be the end-diastolic volume (EDV) and the end-systolic volume (ESV) respectively. The difference of



the two yielded the stroke volume (SV) and the ejection fraction was calculated by taking stroke volume as the % of the end-diastolic volume. Based upon the height and weight of the subjects, the surface area was obtained from the normogram and the left ventricular volumes, were calculated as per square meter surface area.

OBSERVATIONS AND DISCUSSION

The biodata of the subjects on whom the study was undertaken is given in the Table I. It has already been mentioned that there was no clinical, radiographic or electrocardiographic

TABLE I : Showing biodata of individuals studied.

Case No.	*Name*	*Age in years*	*Sex*	*Height in inches*	*Weight in pounds*	*Diagnosis*
1.	M.N.	30	F	61	115	Systolic murmur of unknown origin
2.	S.	32	F	60	110	Systolic murmur of unknown origin
3.	O.P.	22	M	66	120	Atrial septal defect (uncomplicated septum secundum defect)
4.	K.	34	F	58	125	Mild Pulmonary Stenosis
5.	I.S.	28	F	62	115	Systolic murmur of unknown origin
6.	S.K.	26	M	67	140	Atrial septal defect (uncomplicated septam Secundum defect)
7.	A.P.	50	M	66	130	Systolic murmur of unknown origin
8.	M.S.	26	M	64	110	Atrial septal defect (uncomplicated septum secondum defect)
9.	A.G.	48	M	65	120	Systolic murmur of unknown origin
10.	R.	42	M	66	130	Systolic murmur of unknown origin

evidence of left ventricular involvement in these patients. Pulmonary wedge and left ventricular end-diastolic pressures were normal. No pressure gradient was observed across the aortic valve Cineangiography further excluded any mitral or aortic valve ragurgitation as well as dyskinesia of the left ventricular wall. Hence it is reasonable to presume that the values for left ventricular volumes obtained in these subjects should be representative of those in normal state of health. The values reported by various authors also belong to patients with no left ventricular disease but who were investigated for systolic murmur (5,10), cyanosis (12) or who had insignificant mitral stenosis (5, 12) or other lesions like atrial septal defect, pulmonary stenosis etc. (5,3).

Carleton (3) pointed out the variations in the volumes as determined by cineangiography due to inotropic effect of the contrast medium and suggested the calculation of left ventricular volumes in 3 to 5 cardiac cycles. In the present study five initial cycles were selected for the determination of volumes in each case.

Table No. II shows the figures for the end-diastolic volume, end-systolic volume, stroke volume and the ejection fraction as observed in the present study and Table III shows the comparative data already available in literature.

TABLE II : Showing values of end-diastolic volume (EDV), end-systolic volume (ESV), stroke volume (SV) in ml/M² and ejection fraction % (EF).

Case No.	*EDV*	*ESV*	*SV*	*EF*
1	83.91	39.35	44.56	53.10
2	85.15	24.73	60.42	70.95
3	81.29	16.81	64.42	79.32
4	60.72	36.21	30.51	45.72
5	59.02	24.41	34.61	50.64
6	72.96	21.99	50.97	69.86
7	76.48	16.77	59.72	78.07
8	79.50	33.85	45.65	57.42
9	65.76	31.61	34.15	51 .93
10	53.57	22.50	31.07	57.90
Mean	72.43	26.82	45.61	62.30
S.D.	±10.27	±07.46	±12.23	±10.92

The values of end-diastolic volume in each cycle and in each patient ranged from 53.57 to 85.15 *ml*/M², the average value being 72.43±10.27 *ml*/M². This compares well with the values reported by Chatterjee *et al* (4). Higher values have been reported by Arvidson (2), Miller and Swan (10). These authors had used biplane cineangiographic technique for determination. However, Kennedy *et al.* (9) reported values which they obtained using biplane technique similar to those in the present series.

TABLE III : Showing comparison of values available in the literature and in the present series.

Investigators	*Technique*	*EDV*	*ESV*	*SV*
Arvidson (2)	Biplane	85.00	28.00	—
Miller & Swan (10)	Biplane	85±11.6	28±8.7	56±8.9
Moore (11)	Single Plane			55±7
Kennedy *et al* (5)	Biplane	70±20		45±10
Chatterjee *et al* (4)	Single Plane	70±16	21±7	49±10
Present study	Single Plane	72.4±10.4	26.8±7.5	45.6±12.2

End-systolic volume ranged from 16.77 to 39.35 *ml*/M² with a mean figure of 26.82±07.4 *ml*/M². This compares well with the values reported by Arvidson (2), Miller and Swan (10) Chatterjee *et al* (4) have reported a lower figure.

Stroke volume was found to range from 30.50 to 64.48 *ml*/M² with a mean value of 45.6 ±12.23 *ml*/M². These observations are in line with figures reported by Kennedy *et al.* (9) an Chatterjee *et al* (4) . However, Moore (11), Miller and Swan (10) have reported slightl higher figures.

Ejection fraction values range from 45.72 to 79.32% with a mean value of 62.30±10.92%

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