Hemodynamic and Angiographic Evaluation of Aortic Regurgitation 8 and 27 Months After Aortic Valve Replacement

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SUMMARY **Eighteen patients with chronic aortic insufficiency were evaluated hemodynamically and angiographically 8 months after aortic valve replacement. Both the pulmonary artery diastolic pressure and the left ventricular end-diastolic volume decreased significantly ($p < 0.001$), but the mean ejection fraction and the cardiac output remained identically lowered, though some individual cases showed improvement. The relative reduction in end-diastolic volume correlated only with the preoperative ejection ($p < 0.05$) and regurgitation fractions ($p < 0.02$).**

In the 10 patients whose left ventricular volume remained high or ejection fraction low, a second evaluation was performed 27 months after surgery. The left ventricular end-diastolic volume was significantly lowered (from 151 to 120 ml/m^2, $p < 0.05$) back to normal in five cases. The systolic and diastolic ventricular shape returned to normal. Cardiac index and ejection fraction were unchanged.

These results show a marked improvement a few months after aortic valve replacement, with a further improvement several months later, as shown mainly by the decrease of left ventricular end-diastolic volume and the return to normal of left ventricular cavity shape. However, in most cases, the ejection fraction remained at its preoperative value, suggesting that surgery should be performed early, before myocardial deterioration appears.

AORTIC REGURGITATION produces no clinical symptoms at first[1, 2] because the left ventricle is initially the only cardiac chamber involved and can compensate for the regurgitation. During this time, the total cardiac volume increases slowly, pulmonary pressures remain normal, and left ventricular function shows no evidence of change. The alteration in left ventricular function is, however, a major factor in the postoperative prognosis.[3-7]

The best time for valve replacement is difficult to determine, despite precise clinical, hemodynamic and angiographic data, because the relative risks involved in the consequences of prolonged aortic regurgitation, and those inherent in surgery and prosthetic valves, are not easy to determine.

Evaluation of the results of valve replacement in relation to the pre- and postoperative hemodynamic and angiographic findings has only been undertaken in a few studies that, for the most part, involved few patients.[8-15] The aim of the present study was to determine which preoperative factors have a prognostic value, to assess the reversibility of the left ventricular changes and to ascertain the optimal time for valve replacement.

Patients and Methods

The study comprised 18 consecutive patients (one woman and 17 men), mean age 47.5 years (range 18–65 years), suffering from an isolated, marked, long-standing aortic regurgitation. Its etiology was rheumatic in 10 cases, infective endocarditis in six and unknown in the other two. No patient had associated coronary disease and coronary arteriography, systematically performed in the 15 patients over 40 years old, was normal. Eleven patients were in functional class I or II of the New York Heart Association and seven were in class III or IV. Seventeen showed an increase in heart size on a standard chest x-ray (mean cardiothoracic ratio for the 17 cases, 0.58 ± 0.04) and one had a heart of normal size.

All patients gave informed consent. Preoperative hemodynamic investigation included a right-heart catheterization with recordings of the right atrial, ventricular pulmonary arterial and wedge pressures, and a left-heart catheterization with recordings of the aortic and left ventricular pressures, except in two patients in whom the left ventricle could not be entered. The arteriovenous oxygen difference and (except in one case) cardiac index were also measured. The pressures were recorded by external manometers (Statham P23Db). The cardiac output was measured by Fick's method. Left ventricular angiography was performed in the right oblique position with the contrast medium (meglumine diatrizoate 66%) injected at a mean speed of 20 ml/sec through a pigtail #8F catheter. The angiographic films were taken at 50 frames/sec. The ventricular volumes were calculated by the multiple-slice method based on Simpson's rule, the validity of which has been confirmed by others,[16] the correction factor being obtained by filming a reference of known size (grid or ball). The specific regression equation for each angiographic equipment[17] was established from plaster casts of the left ventricle (Philips equipment in one room: $Vr = 0.84 \times Vc - 7$ ml; Siemens equipment in the other room: $Vr = 0.85 \times Vc - 10$ ml, where Vr = the real volume and Vc the

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calculated volume; the standard errors of the estimates were 10 and 12 ml, respectively). The calculated end-diastolic volume was indexed to the body surface area.

The ejection fraction (EF) was obtained from the ratio of the corrected values of the systolic ejection volume (SEV) and the end-diastolic volume (EDV), i.e., EF = SEV/EDV. The regurgitation fraction (RF) was calculated from the formula

$$\frac{\text{SEV} - (\text{cardiac index/heart rate})}{\text{SEV}}.$$

A shape index (ShI) was calculated in systole (S) and in diastole (D): ShI S = Dm S/dm S and ShI D = Dm D/ dm D, where Dm represents the larger diameter of the left ventricle, i.e. the long axis, and dm the small equatorial diameter.

The normal values (± SEM) for the measurements assessed in this study were obtained from nine healthy subjects and were: end-diastolic volume 79 ± 7 ml/m^2; ejection fraction 69 ± 0.5%; diastolic shape index 1.7 ± 0.1; systolic shape index 2.2 ± 0.15.

Isolated aortic valve replacement was performed using either a Starr-Edwards valve (five cases) or a Smeloff-Cutter valve (13 cases). Recovery was uneventful in all cases, with no infarction. Clinical examination, confirmed when necessary by phonocardiography and carotid pulse tracings, excluded any postoperative regurgitation.

The first postoperative hemodynamic investigations on these patients were performed a mean of 9.7 months after operation. They were limited to a right-heart catheterization and recording of the same variables as preoperative and to the insertion of a plastic cannula into the femoral artery to measure cardiac output by the Fick method. The pulmonary artery end-diastolic pressure was taken as the left ventricular filling pressure. Opacification of the left ventricle was obtained indirectly by injection of the contrast medium into the pulmonary artery. The correlation between the left ventricular volumes by selective angiography and the injection of contrast medium into the pulmonary artery in 16 patients in whom end-diastolic volume was as high as 156 ml/m^2 was excellent and confirmed the validity of the comparison between the pre- and postoperative volumes (EDV 106 ± 26 ml/m^2 vs 107 ± 30 ml/m^2, r = 0.97; ESV 49 ± 20 ml/m^2 vs 48 ± 20 ml/m^2, r = 0.96; EF 0.54 ± 0.12% vs 0.55 ± 0.12%, r = 0.95). Because left ventricular wall thickness cannot be measured accurately by this type of angiography, the myocardial mass was not calculated. No assessment was made of the indexes involved in the ejection time (mean velocity of circumferential fiber shortening and the normalized ejection fraction) because the postoperative aortic pressure was not recorded and because the angiographic determination of ejection time is very inaccurate on angiograms obtained by injecting the contrast medium in the pulmonary artery.

The postoperative findings were compared with those obtained preoperatively. The relative reduction of the end-diastolic volume (ΔV/V) after surgery was expressed by the formula: preoperative EDV − postoperative EDV/preoperative EDV. This ratio was correlated with a number of preoperative measurements (functional class, pulmonary artery, aortic and left ventricular pressures, arteriovenous oxygen difference, cardiac index, left ventricular volumes, systolic and diastolic shape index and ejection fraction) as well as with age and the delay between operation and examination.

Among those who still had an increased end-diastolic volume or decreased ejection fraction, 10 underwent a second hemodynamic study a mean of 27 months (range 21–35 months) after operation. This study included the same variables as the first and the results of these 10 patients could therefore be compared.

Statistical analysis was performed by the comparison of matched pairs by the t test and by seeking a linear correlation between the different measurements. Values are given as mean ± SEM.

Results

First Investigation (table 1)

There was a considerable overall clinical improvement after operation, with 13 of the 18 patients now in functional class I and four in class II. One patient remained in class III (fig. 1).

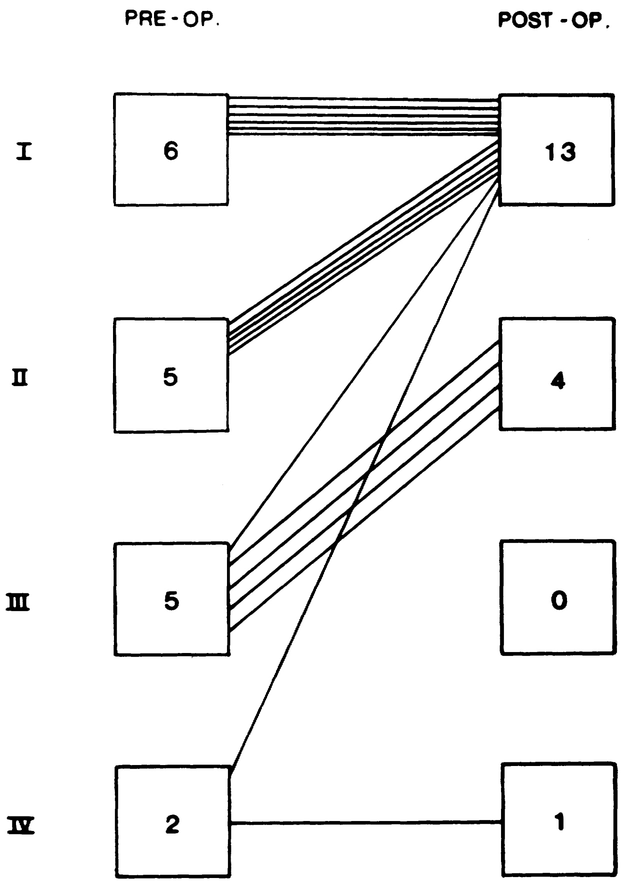

FIGURE 1. *New York Heart Association functional class pre- and postoperatively in 18 patients with aortic insufficiency.*

The pulmonary artery systolic pressure did not change significantly (27.1 ± 0.2 mm Hg before and 23.8 ± 1.6 mm Hg after), but the pulmonary artery diastolic pressure decreased significantly after operation (12.4 ± 1.5 to 7.9 ± 0.9 mm Hg; $p < 0.01$). The cardiac index remained unchanged (2.6 ± 0.2 ml/m² compared with 2.7 ± 0.1 ml/m² after operation; NS).

The shape index in diastole, which was very low before operation (1.58 ± 0.04), was not significantly altered (1.63 ± 0.04), but the shape index in systole, which was abnormally low before operation, increased significantly after (1.80 ± 0.06 to 1.95 ± 0.09; $p < 0.05$). The end-diastolic volumes, which were considerably increased before operation, were markedly reduced after operation (217 ± 12 ml/m² to 148 ± 12 ml/m²; $p < 0.001$). In four cases, end-diastolic volume had diminished little or not at all postoperatively, and returned to normal (≤ 100 ml/m²) in five cases. The end-systolic volumes were also significantly lower (124 ± 13 ml/m² to 77 ± 16 ml/m²; $p < 0.01$). The ejection fraction, which was significantly decreased before operation (average 45.2 ± 2.6%), and above 50% in only six patients, did not increase significantly after operation (49.3 ± 3.5%) (fig. 2). An attempt to separate the patients in two groups according to the preoperative value of ejection fraction (greater or less than 45%) failed to show any difference in the pattern of response of this index after surgery.

The data were examined to see if there was any correlation between the relative reduction in end-diastolic volume ($\Delta V/V$) and the clinical and other hemodynamic measurements. No correlation was found with the age of the patient, the preoperative functional class or the interval between operation and examination. In addition, no correlation was found with right- and left-sided pressures, arteriovenous oxygen difference, cardiac index, left ventricular volumes and systolic and diastolic shape index. However, there was a significant linear correlation between $\Delta V/V$ and the preoperative ejection fraction ($r = 0.48, p < 0.05$) and $\Delta V/V$ and the regurgitant fraction ($r = 0.60, p < 0.02$) (fig. 3).

Second Examination (table 2)

The findings of the first and second examination were compared in the 10 patients who were investigated twice. The pulmonary artery diastolic pressure, which had almost returned to normal at the first examination (7.4 ± 0.9 mm Hg), remained unchanged at the second (8.0 ± 0.5 mm Hg). The cardiac index was 2.8 ± 0.2 l/min/m² before and 2.9 ± 0.2 l/min/m² after. Left ventricular volumes decreased significantly between the two examinations, the mean end-diastolic volume from 153 ± 19 ml/m² to 120 ± 20 ml/m²; $p < 0.05$) (fig.2). In five cases, the end-diastolic volume was still increased at the first examination, but had returned to normal at the second (< 100 ml/m²). The end-systolic volume was also further decreased, but not significantly (from 77 ± 16 to 69 ± 18 ml/m²; NS).

The shape index in diastole, which was still below normal at the first examination (1.69 ± 0.06), had increased significantly and returned to normal at the second (1.82 ± 0.05; $p < 0.01$). The shape index in systole also returned to normal, increasing from 2.04 ± 0.12 to 2.21 ± 0.13 ($p < 0.05$). In contrast, the ejection fraction was essentially the same at both examinations (50 ± 4% and 50 ± 6%; NS).

Discussion

The remarkable improvement in function after valve replacement in cases of aortic regurgitation clearly illustrates the benefits of surgery. Seventeen of 18 cases showed improvement. The only patient who failed to show any clinical improvement (case 9) had a preoperative ejection fraction of 19%, the lowest in the group.

Hemodynamically, the only significant change was the return to normal of the pulmonary artery diastolic pressure, which is regarded as a reflection of the left ventricular filling pressure, although the cardiac index was unchanged. Angiographically, we found a decrease in the left ventricular end-diastolic volume. From a value that was almost three times normal before operation, it decreased to less than twice normal at the first examination and had decreased even more by the second examination. The decrease in end-systolic volume was just as striking. This decrease in the left ventricular volumes occurred simultaneously with the improvement in shape index, which had improved at the first examination and returned to normal at the second. This illustrates that the left ventricle works in better conditions when the extra strain imposed on it by aortic regurgitation is relieved by valve replacement. Postoperative progress varied widely. The difference between the four patients in whom the volume decreased little or not at all and the five patients in whom the volume returned to normal cannot be explained by the value of the original end-diastolic volume or variations in the period before the postoperative examination. Perhaps the duration of aortic regurgitation may be important, but this preoperative period is usually impossible to define accurately because the condition remains asymptomatic for a considerable time.

In four reports,[8, 10, 12, 18] the end-diastolic volume, although considerably reduced, remained above 120 ml/m², as in the present study. In three reports,[11, 13, 14] the end-diastolic volume returned almost to normal (i.e., ≤ 100 ml/m²). The discrepancies among the various studies cannot be explained by the differences in the initial end-diastolic volume values, or in the ejection fraction, or in the period before examination. There is also disagreement over the progress toward normalization of the shape of the left ventricle after operation. Herreman et al.[10] found that it returned to normal, but in the study of Thompson et al.,[19] an alteration in shape persisted.

The absence of significant improvement in ejection fraction must indicate that irreversible changes have taken place in the myocardium before operation, for it

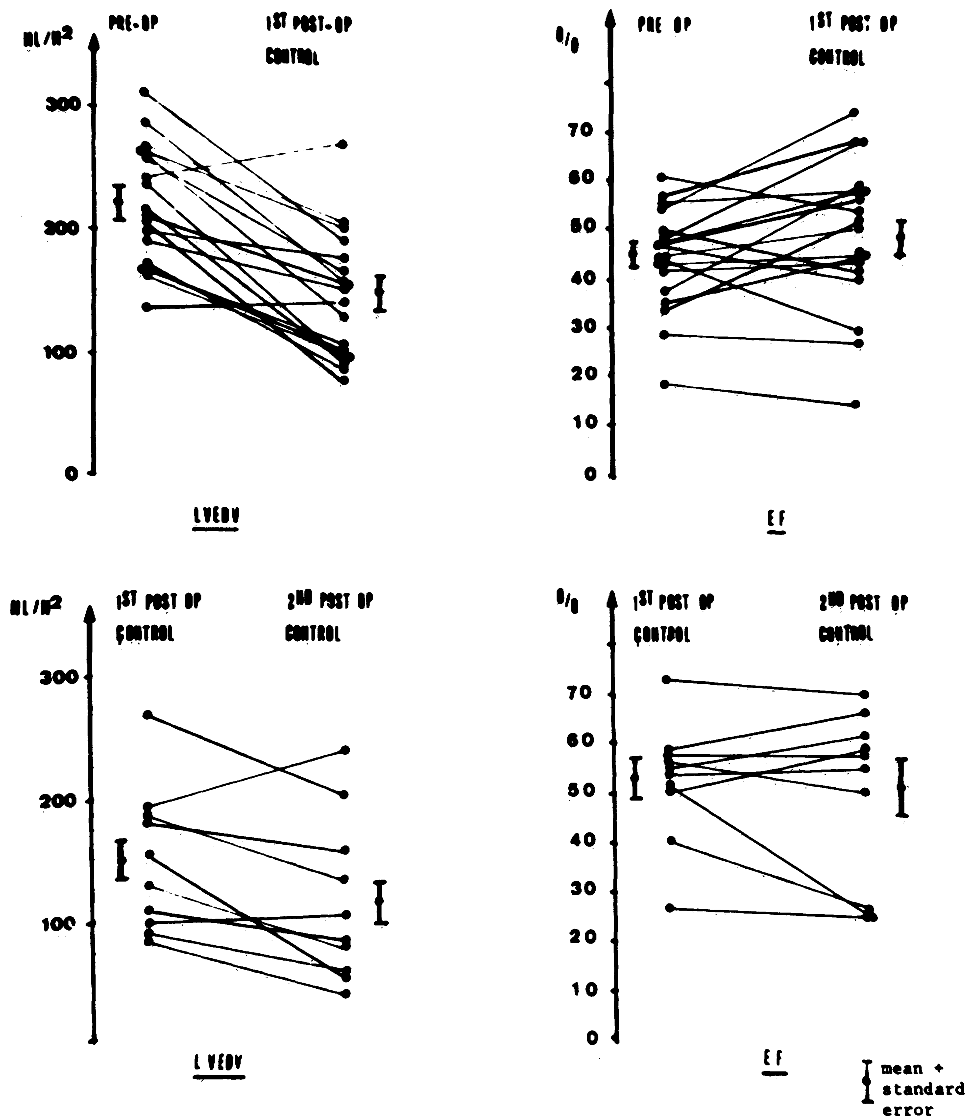

FIGURE 2. *Left ventricular end-diastolic volume (LVEDV) and ejection fraction (EF) pre- and postoperatively at first control (n = 18) and second control (n = 10).*

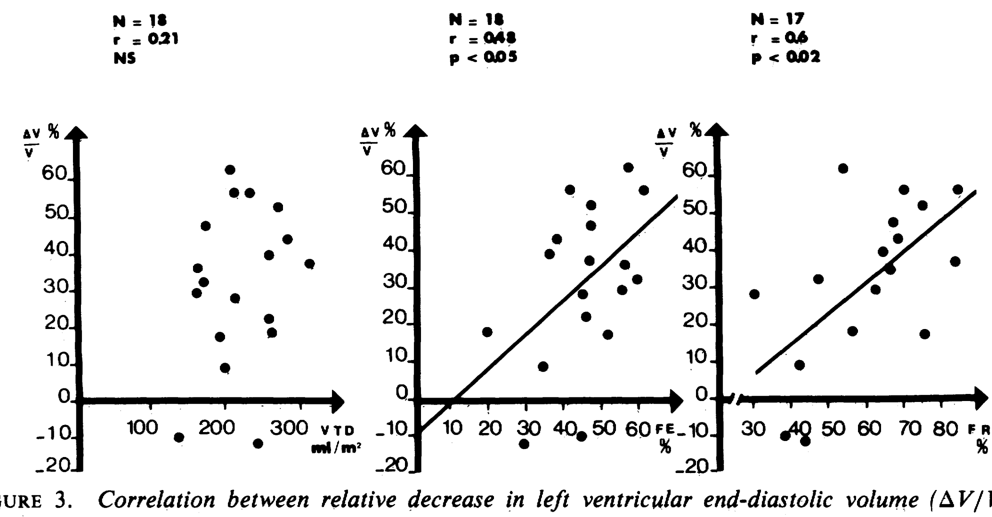

FIGURE 3. *Correlation between relative decrease in left ventricular end-diastolic volume (ΔV/V) and preoperative left ventricular end-diastolic volume (left), ejection fraction (middle) and regurgitant fraction (right).*

TABLE 1. *Comparison of Pre- and Postoperative Studies*

Case	Age (years)	Sex	Interval (months)	NYHA class		PA pressures (mm Hg) Systolic		PA pressures (mm Hg) Diastolic		Cardiac index (l/m²)	
				Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	54	M	9	IV	I	30	18	17	6	—	2.3
2	38	M	10	I	I	24	26	14	12	2.4	3.2
3	54	M	8	III	II	18	17	10	4	1.9	3.3
4	65	M	6	I	I	22	13	8	2	4.2	2.8
5	54	M	7	III	I	70	33	30	12	2.0	—
6	54	M	15	III	II	30	20	10	6	2.1	2.6
7	34	M	7	I	I	20	28	8	8	2.7	3.4
8	18	F	11	II	I	22	18	9	4	2.5	2.1
9	57	M	10	IV	IV	50	40	20	18	1.7	2.0
10	48	M	10	I	I	18	24	7	8	4.7	—
11	41	M	10	I	I	26	22	12	8	3.7	2.3
12	50	M	13	II	I	26	20	12	6	2.6	—
13	49	M	7	III	II	28	28	16	8	1.7	2.4
14	56	M	12	II	I	20	14	10	4	2.2	3.3
15	37	M	8	II	I	15	25	7	8	3.2	—
16	65	M	10	III	II	22	26	11	8	2.2	2.4
17	34	M	10	II	I	35	27	20	12	1.5	3.6
18	48	M	11	I	I	12	30	2	8	3.0	2.4
Mean ± SEM	47.5 ± 2.8		9.7 ± 0.5			27.1 ± 3.2	23.8 ± 1.6	12.4 ± 1.5	7.9 ± 0.9	2.6 ± 0.2	2.7 ± 0.1
						NS		$p < 0.01$		NS	

Abbreviations: interval = interval between preoperative and postoperative investigations; NYHA class = New York Heart Association functional classification; Pre = preoperatively; Post = postoperatively; PA = pulmonary artery; HR = heart rate before angiography; LVEDV = left ventricular end-diastolic volume; LVESV = left ventricular end-systolic volume; EF = ejection fraction; RF = regurgitation fraction.

seems unlikely that this could be explained by myocardial alteration during operation as a result of an insufficient myocardial protection during the extracorporal circulation; no patient had a myocardial infarction after operation. The absence of an increase in the ejection fraction has also been recorded in most of the other studies.[8, 10, 11, 12, 20] though some report an increase after the relief of the regurgitation by surgery.[7, 8, 13-15, 18] These differences may be in part due to the fact that the number of patients studied was generally small, usually less than 15 cases.[9, 10, 12, 13, 18] However, in individual cases an improvement of ejection fraction has been noted in our series despite a preoperative value lower than 50%, as also recorded by Clark et al.[8] Five of 12 patients with such an impaired ventricular function had an average increase in ejection fraction of 34.4%.

The results should be interpreted with caution because several factors may be involved, notably the degree of regurgitation, its duration and its effects on the myocardium before operation. Technical factors may also be involved, especially when the results obtained by echocardiography are compared with those obtained by invasive methods. The only study that includes postoperative hemodynamic and angiographic investigations on a large number of cases (24 cases) is that of Thompson et al.,[15] but they did not calculate ventricular volumes. In this investigation, the improvement in myocardial function was assessed by the postoperative regression of areas of segmental hypocontractility and this regression was only observed in half the cases. Although in all published reports and in our cases left ventricular status improved markedly in most patients (reflected by the decrease in end-diastolic volume and the tendency of the shape of the cavity to return to normal), in some cases the ventricular status does not change after operation. The proportion of cases without change after surgery varies in different studies: 17% in our study, 33% in that of Herreman et al.[10] and 50% in that of Thompson et al.[19] In the present study, no correlation was found between the decrease in end-diastolic volume and the periods between operation and the first hemodynamic investigation, which varied from 6–15 months. The absence of any correlation with the preoperative end-diastolic volume suggests that even at an advanced stage of left ventricular dilatation (e.g., greater than 250 ml/m²) (patients 6, 14 and 15), end-diastolic volume may still decrease after operation. The significant correlation between the relative varia-

TABLE 1. (*Continued*)

Heart rate (beats/min)		LVEDV (ml/m²)		LVESV (ml/m²)		EF (%)		RF	Shape index			
									Diastolic		Systolic	
Pre	Post	Pre	Post	Pre	Post	Pre	Post	(%)	Pre	Post	Pre	Post
80	70	256	199	138	117	46	41	—	1.43	1.57	1.63	1.55
72	78	197	179	130	86	34	52	42	1.73	1.45	1.82	1.57
84	78	172	91	91	44	47	51	67	1.34	1.52	1.77	2.06
84	84	203	78	87	25	57	68	54	1.30	1.60	1.84	2.0
97	108	313	197	166	87	47	56	83	1.64	1.72	1.86	2.07
84	84	256	157	164	86	36	45	64	1.32	1.27	1.47	1.48
102	90	159	102	70	44	56	57	66	1.79	1.89	1.97	2.37
82	96	209	92	81	42	61	54	70	1.52	1.79	1.49	1.97
84	82	262	216	212	184	19	15	56	1.47	1.46	1.61	1.57
84	80	212	153	117	107	45	30	30	1.67	1.69	1.87	1.87
120	80	242	272	172	198	29	27	43	1.81	1.53	1.88	1.61
72	58	167	113	68	36	59	68	47	1.66	1.79	2.13	2.5
71	75	192	160	94	90	51	44	75	1.53	1.61	1.93	1.58
73	75	281	161	174	66	38	59	68	1.72	1.65	1.65	2.25
102	102	267	129	141	54	47	58	75	1.61	1.75	1.72	2.23
62	84	133	157	74	86	44	45	38	1.60	1.56	1.65	1.61
95	103	232	102	134	56	42	45	84	1.39	1.49	1.62	2.18
96	72	160	113	72	29	55	74	62	1.92	2.02	2.44	2.70
86 ± 3	83 ± 3	217 ± 12	148 ± 12	121 ± 10	80 ± 11.6	45.2 ± 2.6	49.3 ± 3.7	60 ± 3.8	1.58 ± 0.04	1.63 ± 0.04	1.80 ± 0.06	1.95 ± 0.07
NS		$p < 0.001$		$p < 0.01$		NS			NS		$p < 0.05$	

tion in the postoperative end-diastolic volume and the preoperative ejection fraction indicates that regardless of its initial value, the end-diastolic volume will decrease more when the ejection fraction is high, confirming that the preoperative ejection fraction is a good prognostic indicator.[20-23]

To our knowledge, no repetitive postoperative hemodynamic catheterization studies are available. The purpose of the second postoperative hemodynamic and angiographic examination in this study was to see if any delayed improvement could be observed in patients who still had an increased end-diastolic volume and decreased ejection fraction at the first examination. On the whole, at the second examination, which was performed at a mean time of 27 months after surgery or 17 months after the first examination, the ventricular end-diastolic volume had decreased and had reverted to near-normal values (120 ml/m²) and the shape of the cavity had returned to normal. Two cases had normal values despite very high preoperative values (207 and 201 ml/m²), which were still high at the first examination (161 and 129 ml/m²). However, in three cases the volume remained increased and did not change between the first and second examination; the preoperative ejection fraction had not always improved by the time of the second investigation and remained low in 50% of cases, suggesting that the extra load imposed by aortic regurgitation had caused irreversible myocardial changes. The results of the repeated hemodynamic investigation of this study may be compared with those of Schuler et al. obtained by echocardiography.[18] These investigators found a return to normal of the mean values at the end of 6 months and 18 months. Gaasch et al.,[24] in their echocardiographic study of 19 patients repeated at 10 days and then at the third, sixth, ninth, twelfth, eighteenth and twenty-fourth months, found a progressive improvement toward normal in the left ventricular dimensions in 12 cases up to the ninth month, but they were unchanged in four patients in whom the left ventricular dimensions were very markedly increased and the preoperative ejection fraction was very low.

In conclusion, after valve replacement for chronic aortic regurgitation, hemodynamic measurements show improvement in several aspects of cardiac function. The fact that the end-diastolic pulmonary pressure (considered as equivalent to the left ventricular filling pressure) was significantly decreased after the operation although the cardiac output remained unchanged indicates improved ventricular function. The left ventricular volume decreased significantly and, in some cases, may have returned to normal at the time of the first examination 10 months after surgery. A delayed return to normal was observed at the second examination 27 months after surgery in about

TABLE 2. *Comparative Study in 10 Cases with Two Hemodynamic Controls 9 and 27 Months After Surgery*

	Interval (months)	Interval (months)	PA diastolic pressure (mm Hg)			Cardiac index (l/m²)			LVEDV (ml/m²)		
Case	Pre/1 C	1 C/2 C	Pre	1 C	2 C	Pre	1 C	2 C	Pre	1 C	2 C
1	9	35	17	6	10	—	2.3	2.5	256	199	240
2	10	25	14	12	10	2.4	3.2	2.4	197	179	159
3	8	32	10	4	10	1.9	3.3	3.1	172	91	48
5	7	25	30	12	6	2.0	—	2.7	313	197	132
7	7	24	8	8	10	2.7	3.4	2.5	159	102	108
8	11	28	9	4	5	2.5	2.1	2.4	209	92	68
11	10	21	12	8	8	3.7	2.3	3.7	242	272	206
14	12	30	10	4	8	2.2	3.3	3.9	281	161	66
15	8	28	7	8	8	3.2	—	2.7	267	129	85
18	11	24	2	8	8	3.0	2.4	2.9	160	113	86
Mean	9.0	27.2	11.9	7.4	8.3	2.6	2.8	2.9	226	153	120
±	±	±	±	±	±	±	±	±	±	±	±
SEM	0.5	1.3	2.4	0.9	0.5	0.2	0.2	0.2	17	19	20
			NS (Pre vs 1 C)			NS (Pre vs 1 C)			$p < 0.01$ (Pre vs 1 C)		
			NS (Pre vs 2 C)			NS (Pre vs 2 C)			$p < 0.01$ (Pre vs 2 C)		
				NS (1 C vs 2 C)			NS (1 C vs 2 C)			$p < 0.05$ (1 C vs 2 C)	

Abbreviations: Pre = preoperative investigation; 1 C = first postoperative control; 2 C = second postoperative control; other abbreviations as in table 1.

half the number of patients who showed a raised end-diastolic volume at the first examination. However, the ejection fraction was not significantly improved at either examination. Nevertheless, ejection fraction was a good prognostic indicator: The higher its preoperative value, the greater the decrease in ventricular volume. Even a very large volume can decrease markedly if the ejection fraction remains normal.

These results suggest that valve replacement in aortic insufficiency should be performed before the stage of myocardial deterioration showed by a decrease in ejection fraction and confirm that the decision to operate should be based mainly on hemodynamic and angiographic data when the functional symptoms are slight or absent for a long time.

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TABLE 2. *(Continued)*

LVESV (ml/m^2)			EF (%)			Shape index					
						Systolic			Diastolic		
Pre	1 C	2 C	Pre	1 C	2 C	Pre	1 C	2 C	Pre	1 C	2 C
138	117	175	46	41	27	1.63	1.55	1.51	1.43	1.57	1.51
130	86	119	34	52	25	1.82	1.57	1.65	1.73	1.45	1.69
91	44	20	47	51	59	1.77	2.06	2.13	1.34	1.52	1.88
166	87	61	47	56	62	1.86	2.07	2.32	1.64	1.72	1.86
70	44	53	56	57	51	1.97	2.37	2.46	1.79	1.89	1.84
81	42	30	61	54	56	1.49	1.97	2.54	1.52	1.79	2.0
172	198	154	29	27	25	1.88	1.61	1.90	1.81	1.53	1.63
174	66	22	38	59	67	1.65	2.25	2.37	1.72	1.65	1.94
141	54	36	47	58	58	1.72	2.23	2.62	1.61	1.75	1.83
72	29	22	55	74	71	2.44	2.70	2.60	1.92	2.02	2.05
124 ± 13	77 ± 16	70 ± 18	46 ± 3	53 ± 4	50 ± 6	1.82 ± 0.08	2.04 ± 0.12	2.21 ± 0.13	1.65 ± 0.06	1.69 ± 0.06	1.82 ± 0.05
Pre vs 1 C: $p < 0.01$			Pre vs 1 C: NS			Pre vs 1 C: NS			Pre vs 1 C: NS		
Pre vs 2 C: $p < 0.02$			Pre vs 2 C: NS			Pre vs 2 C: $p < 0.02$			Pre vs 2 C: $p < 0.01$		
1 C vs 2 C: NS			1 C vs 2 C: NS			1 C vs 2 C: $p < 0.05$			1 C vs 2 C: $p < 0.02$		

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