The Heart Surgery Forum #2005-1162
8 (6), 2005 [Epub November 2005]
doi:10.1532/HSF98.20051162

Online address: http://cardenjennings.metapress.com/link.asp?id=112496

Subnormalization of Left Ventricular Shape after Succesful Coronary Revascularization

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ABSTRACT

Background. It is asumed that the shape and size of the left ventricle could change after successful revascularization and that the shape and size reflect left ventricular function.

Methods. Echocardiography and Simpson's rule were used for evaluating the endocardial surface area of the left ventricle and elongation of the left ventricle as shape index in 13 patients before coronary arterio-venous bypass grafting (CABG) and 1 year after successful CABG.

Results. After succesful CABG, the left ventricle becomes bigger and less elongated than before CABG. Results show a change from concentric hypertrophy of the left ventricle before CABG to subnormalization after CABG.

Discussion. We suppose that the subnormalization of left ventricular size and shape is the result of successful CABG and successful rehabilitation. The change of left ventricular size and shape after CABG might depend more on the original state of the left ventricle before surgery.

INTRODUCTION

Earlier investigations showed the relation of left ventricle (LV) shape with the prognosis of cardiac patients [Krumholz 1995; Devereux 1995]. Echocardiograhy offers a traditional noninvasive possibility to visualize the shape of the LV in different pathophysiological situations [Feigenbaum 1986]. Many indices have been proposed to characterize LV function, including eccentricity [Rankin 1976], sphericity index [Tischler 1993], and elongation [Knap 2002]. Previous investigations showed that the shape of the LV intimately depends on its function [Juznic 1992; Knap 1996; Juznic 1998]. In the current study we sought to evaluate the shape of the left ventricle before coronary arterio-venous bypass grafting (CABG) and after successful rehabilitation. The aim of the study was to evaluate the shape of the LV in ischemic cardiomyopathy and the possibile change of this shape after succesful rehabilitation from standard CABG. We sought to evaluate the size and shape of the LV during ischemic cardiac disease.

From presentations at the International Symposium on Beating Heart Surgery, Belo Horizonte, Brazil, 2003 and 2004.

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MATERIALS AND METHODS

The patients were first asked for their cooperation in the investigation. Patients were selected on the basis of their anamnesis, clinical examination, their NYHA classification, and other clinical data (documentation of previous hospital treatment). All 13 patients needed revascularization treatment. They all had a positive anamnesis of the angina pectoris and positive test results from invasive angiography. All patients were on the waiting list for 6 to 20 months before CABG. The echocardiogram (M-mode, 2-D, color Doppler, pulsed, continuous Doppler from the outflow tract of the LV) and precardial electrocardiograms were recorded simultaneously in each of the 13 patients, 1 day before CABG and 1 year after CABG surgery. The noninvasive measure for shape and denoted elongation (ELO) [Knap 1996, 2002; Juznic 1998] was calculated from these recordings. Other basic cardiovascular measurements were made for the evaluation of the LV's function.

The ejection fraction was automatically calculated from the M-mode echocardiogram. The mass of the LV was obtained by measuring the interventricular septum and posterior wall thicknesses from the 2-D echocardiogram and automatically calculating the mass of the LV. Continuous Doppler measurements from the outflow tract of the LV were obtained manually (by measuring peak blood velocity) and automatically (from the absolute value of the average acceleration of blood flow and the velocity time integral) [Schmailzl 1994]. These measurements were taken according to the instructions for use that accompany the echo machine (Acuson Cardiac Patient Report). A basic statistical analysis (average values, standard deviation, *t* test) was made [Motulsky 1995].

RESULTS

The differences in the size (SLV) and shape (ELO) of the LV before and after CABG are statistically significant ($P < .01$) (Table), while the values of the ejection fraction are still normal after CABG. This finding indicates that the echo parameters, including the Doppler parameter from the outflow tract of the LV, are not sensitive enough to determine a change in heart function. The shape of the LV before

Average Values with Standard Deviation and *P* Values*

Parameter	Before CABG	After CABG	*P*
BSA, m^2	1.91 ± 0.19	1.91 ± 0.91	N.S.
EF, %	56.69 ± 10.13	53.43 ± 10.06	N.S.
VTI, m	0.28 ± 0.08	0.27 ± 0.06	N.S.
V-peak, m/s	1.10 ± 0.22	1.05 ± 0.16	N.S.
MLV, g	271.00 ± 47.16	307.46 ± 74.94	.05
SLV D, cm^2	121.42 ± 29.65	161.22 ± 64.24	.01
SLV S, cm^2	89.26 ± 22.16	122.24 ± 42.11	.01
ELO D	17.11 ± 2.48	15.07 ± 2.17	.01
ELO S	23.41 ± 4.23	19.68 ± 3.81	.01

*BSA indicates body surface area; EF, ejection fraction; VTI, velocity time integral Doppler measurements from outflow tract of the left ventricle; V-peak, blood velocity from the outflow tract of the left ventricle; MLV, mass of the left ventricle; SLV, endocardial surface area of the left ventricle; D, enddiastole; S, endsystole; ELO, shape index elongation.

CABG is less spherical and more elongated than in the previous study [Knap 1999]. After CABG the LV retains a more normal geometry. The mass of the LV increased significantly ($P < .05$) after successful CABG. Almost all patients with cardiac ischemia before CABG showed concentric hypertrophy. Cardiac ischemia was expected because 10 of the 13 patients had long-term arterial hypertension. The results show that the shape of the LV (ELO) is more elongated before coronary operation and that it becomes nearly normal 1 year after coronary surgery ($P < .01$). The table shows that the internal surface area (SLV) is smaller before CABG. After 1 year, subnormalization of the geometry of the left ventricle was found; this could indicate that after successful CABG the left ventricle becomes bigger and less elongated than before CABG. The results show a change from concentric hypertrophy of the LV before CABG to subnormalization after CABG.

DISCUSSION

In the present study, concentric hypertrophy was found in the group of patients wih ischemic cardiomyopathy, similar to the previous study of patients with only long-term hypertension [Knap 1999]. The reason could be the specific situation of the 13 patients of the current study; they had been on the waiting list for 6 to 20 months before cardiovascular surgery and suffered from hypokinesys and very often from long-term arterial hypertension. The lifestyle of patients with cardiac ischemia is typically sedentary and arterial hypertension is very common. After successful rehabilitation with regular exercising, the LV starts to adapt from being only a pressure pump to being a volume pump too, which is the key for the subnormalization of LV shape and size after CABG. The importance of LV size can be seen in patients with dilatative cardiomyopathy [Vanelli 1999], and diminshing the LV by surgery could be a successful treatment method [Tasdemir 1999; Cicek 1997; Green 1998]. After 1 year, subnormalization of the LV geometry was found. This change could be due to better oxygenation of the heart muscle and a change of the shape from being a pressure pump to a flow pump [Knap 2003]. The change of LV size and shape after CABG could depend on its original state before surgery and also reflects successful surgery and rehabilitation.

It was concluded that the clinical implication of the subnormalization of the LV's geometry could mean more efficient cardiac work with increased cardiac reserve and an increased quality of life. It is evident that not only the shape of the LV but also the change of the LV shape must be evaluated for better clinical and therapeutic evaluation of heart patients. Minimally invasive surgery offers a new possibility for the rehabilitation of cardiac patients, especially in the future [Gersak 2003].

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