Changes in Left Ventricular Volume and Predictors of Cardiac Events after Endoventricular Circular Patch Plasty

Objective: The aim of this study was to identify predictors of cardiac events after endoventricular circular patch plasty (Dor operation) by analyzing our experience with Dor operation. Methods: Thirty patients with left ventricular aneurysm and/or ischemic cardiomyopathy who underwent Dor operation were included in this study. Hemodynamic and clinical results were analyzed, and the predictors of cardiac events were examined. Results: Hospital mortality was 3.3%. Postoperative clinical status and left ventricular (LV) function in all survivors significantly improved. The survival rates at 1, 3, and 5 years after operation were 93%, 89% and 89%. The corresponding cardiac event-free rates were 75%, 67% and 49%. Pre- and postoperative LV function and volume did not differ significantly between patients with or without cardiac events. However, the proportion of reduced end-diastolic volume index (EDVI) (preoperative EDVI–postoperative EDVI) to preoperative EDVI was significantly higher in patients with cardiac events than in cardiac event-free patients. Postoperative LV volume re-increased in the cases with cardiac events during follow-up. Cox regression analysis confirmed that preoperative clinical premature ventricular contraction and end-systolic volume index (ESVI), postoperative EDVI, ESVI, and ejection fraction were independent predictors of late cardiac events. There was a significant positive correlation between preoperative ESVI and postoperative EDVI. Conclusion: Though LV function significantly improved after Dor operation, LV reconstruction with excessive reduction can cause restarting LV remodeling and increasing mortality and morbidity. Therefore, LV reconstruction of appropriate sizes and shapes, considering the function of residual myocardium, has a significant effect on prognosis. It is highly reasonable to expect that preoperative ESVI can predict the optimal size of reconstructed left ventricle. (Jpn J Thorac Cardiovasc Surg 2004; 52: 551–559)

Key words: endoventricular circular patch plasty, Dor operation, left ventricular end-systolic volume index, ischemic cardiomyopathy, left ventricular remodeling

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Endoventricular circular patch plasty was first performed as an effective surgical technique for left ventricular aneurysm (LVA) by Vincent Dor in 1984. He noted three advantages of this technique compared with classical linear suture of the left ventricle. They were exclusion of the septal akinetic segment, avoidance of the restraint caused by the linear suture of the left ventricle, and acquisition of the adequate left ventricular (LV) cavity size. Since endoventricular circular patch plasty (Dor operation) has been reported to result in superior postoperative improvement of LV performance, the indications have recently shown a tendency to extend. In addition, Dor operation is now performed to reduce LV volume for ischemic cardiomyopathy (ICM) with LV remodeling after myocardial infarction. The theoretical basis of the efficacy of volume reduction of the left ventricle is in Laplace’s equation, i.e., \( P = T/R \) (P: pressure, T: wall tension, R: radius). Since the left ventricle can be reconstructed to nearly a normal shape with exclusion of all akinetic and dyskinetic areas including the septum, both the radius of the left ventricle and
the wall tension reduce, leading to a decrease in myocardial oxygen consumption. Furthermore, the reduction of wall tension enhances contractile performance of the ventricle by increasing the extent and velocity of systolic fiber shortening. As a result, hemodynamic status improves. Recent advances in catheter intervention technique for the postinfarction acute phase have enabled preservation of epicardial myocardium, and segmental contraction after myocardial infarction results in akinetic rather than dyskinetic regions in many cases. If a large akinetic region exists, diffuse LV dilatation will gradually develop by LV remodeling and ICM will ensue. If standard Dor operation is performed in such a case, the more the preoperative left ventricle dilates, the more the postoperative left ventricle will assume a ball-like shape with a shorter axis. The reconstructed left ventricle will differ from the normal left ventricle: in the latter exhibits a spindle-like configuration. Furthermore, since residual myocardium of ICM functions less effectively than normal heart, the size of reconstructed left ventricle, which should be decided based on the quantity and quality of residual myocardium, significantly affects prognosis. This study examined the postoperative adequate LV size to optimize Dor operation, and assessed variables predicting late morbidity (cardiac event) by analyzing hemodynamic and clinical results for our series of Dor operations.

Subjects and Methods

Our indications for Dor operation are all types of dyskinetic and/or akinetic scars involving the anteroseptal region with symptoms. Between February 1996 and May 2003, we performed Dor operation in 30 cases for LVA and/or ICM after myocardial infarction. There were simple LVA in 8 and ICM in 22, which are included in this study. There were 22 males and 8 females with a mean age of 61 ± 11 years (range, 32 to 76 years) at the time of surgery. Preoperative LV function of all patients was evaluated by cardiac catheterization, and 28 of 29 surviving patients underwent cardiac catheterization again in the early postoperative period. The preoperative extent of asynergy (total dyskinetic and akinetic area) was calculated as the percent length of the diastolic LV perimeter revealed on left ventriculography (right anterior oblique 30° projection) using the centerline method. Wall motion abnormality more than 2 standard deviations below from normal mean values was defined as LV asynergy. Cardiac output was calculated with the thermodilution method. LV end-diastolic volume index (EDVI) and LV end-systolic volume index (ESVI) were measured from biplane (right anterior oblique 30° and left anterior oblique 60°) left ventriculography with the Chapman method. Patients were followed up by clinical examination and/or telephone interview. Heart failure, clinical arrhythmia, and angina were defined as cardiac events during the follow-up.

Surgical procedure. The basic technique resembles the one described by Dor. The procedure was performed during total cardiac arrest with cold crystalloid and/or blood cardioplegia and topical cooling. First, coronary artery bypass grafting (CABG) was performed. A left internal thoracic artery (LITA) was chosen for bypass graft to the left anterior descending artery (LAD) associated with additional arterial and/or venous grafting to the right coronary and/or circumflex arteries. Revascularization of the LAD was performed to the extent possible to increase blood supply to the infarcted margin and enhance postoperative LV function and survival in the early postoperative period. After bypass grafting, the left ventricle was opened between the LAD and the diagonal branch, in the middle of the anterior akinetic zone. The endocardial infarcted scar was mobilized and resected up to almost one-third to one-half of the long axis on the septal side and to the level of both papillary muscle roots on the free wall side with maximum range. If needed, cryotherapy would be added to the edge of resection, at the transitional zone between the scarred and normal tissue. Our indications for cryotherapy were those patients with previous clinical and/or inducible ventricular tachycardia (VT) or preoperative LV ejection fraction (EF) below 30%. As the endoventricular purse string suture was passed above the border between the scarred and normal tissue, the diameter of the neck of the contracting ventricle was reduced to about 20–35 mm. A Meadox Hemashield patch or mobilized and remodeled septal scar with a septal hinge (autologous patch) was fixed by 3-0 prolene continuous suture inside the LV cavity on the transitional zone marked by the purse string suture.

Statistical analysis. Values of continuous variables are expressed as means ± standard deviation. Univariate screening of preoperative characteristics among groups involved determining the significance of differences in means of continuous variables (unpaired t-test) or distribution of dichotomous variables (chi-square test or Fisher exact test). Repeated measures of differences within groups were analyzed by means of paired t-test, and differences among groups by means of unpaired t-test. Survival and cardiac event-free rates were calculated based on the Kaplan-Meier method with the logrank test. Cox regression analysis (backward stepwise Wald model) was used to assess the predictive