Radionuclide study of mid-term left ventricular function after endoventricular circular patch plasty

Hiromichi Fujii*, Hirokazu Ohashi, Yasushi Tsutsumi, Takahiro Kawai, Kenji Iino, Masateru Onaka

Department of Cardiovascular Surgery, Fukui Cardiovascular Center, Shinbo 2-228, Fukui city 910-0833, Japan

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Abstract

Objective: Although the early result of endoventricular circular patch plasty (EVCPP) has been reported, few are seen about the long-term results. We studied left ventricular (LV) function in the early and mid-term periods after EVCPP with electrocardiographic-gated single photon emission computed tomography (Gated SPECT).

Methods: Consecutive 14 patients with LV asynmetry after myocardial infarction, who had the EVCPP procedure, were studied by Gated SPECT. Mean age of patients was 67 ± 10 years. Gated SPECT images were obtained and LV end-diastolic volume index (EDVI), LV end-systolic volume index (ESVI) and ejection fraction (EF) were studied with QGS(+) program. Gated SPECT study was performed before surgery, early (23 days) and mid-term periods (32 months) after surgery.

Results: EDVI changed significantly from preoperative value to early postoperative value (107 ± 39 to 72 ± 37 ml/m², \(P < 0.01\)). There was no significant difference between early and mid-term postoperative values. ESVI also changed significantly from preoperative value to early postoperative value, and from early value to mid-term postoperative value (78 ± 37 to 51 ± 34 to 47 ± 35 ml/m², \(P < 0.05\), respectively). EF increased significantly from preoperative value to early postoperative value, and from early value to mid-term postoperative value (30 ± 10 to 35 ± 13 to 45 ± 18%, \(P < 0.05\), respectively). Conclusions: Direct influence of EVCPP brought significant improvement of LV function in early period. Further decrease of ESVI and increase of EF were noticed from early period to mid-term period. This result suggest that the effect of EVCPP sustains long and yields reverse LV remodeling.

Keywords: Gated single photon emission computed tomography; Endoventricular circular patch plasty; Mid-term

1. Introduction

Surgical treatment for left ventricular (LV) aneurysm was first performed in 1955 [1], and linear closure after simple LV aneurysmectomy was performed under cardiopulmonary bypass in 1958 [2]. Furthermore, an innovative surgical repair of LV aneurysm was reported [3–5] in the 1980s. Dor and co-workers performed endoventricular circular patch plasty (EVCPP) for postinfarction dyskinetic and akinetic scar, and indicated improving LV ejection fraction (EF) and low mortality after EVCPP in the early postoperative period [6–9]. The precise LV volume studies early and 1 year after EVCPP were reported [10,11]. Although long-term survival after repair of LV aneurysm was reported by Lundbald et al. [12], the precise LV volume study in the long-term period has not been reported yet.

Automatic quantification from electrocardiographic-gated myocardial single photon emission computed tomography (Gated SPECT) with \(^{99m}\text{Tc}\)-labeled radiopharmaceuticals was developed by Germano and co-workers [13] for non-invasive assessment of LV volume study and function. Its quality is high in reproducibility and repeatability. Furthermore there is a report which proved an excellent linear correlation between Gated SPECT and left ventriculography in LV end-diastolic volume, LV end-systolic volume and EF [14]. Recently, it is also reported that there is a good correlation in LV volumes and EF between Gated SPECT and magnetic resonance imaging [15]. The aim of present study was to evaluate LV volumes and EF in the early and mid-term periods after EVCPP using Gated SPECT method.

* Corresponding author. Tel.: +81-766-54-5660; fax: +81-766-53-2132.
E-mail address: h_fujii@bellland.or.jp (H. Fujii).
2. Materials and methods

2.1. Patients

Fourteen patients (11 men and 3 women) were performed EVCPP and studied by Gated SPECT before and after operation. Patient age was 67 ± 10 years (mean ± standard deviation, range 46–79 years). All patients were diagnosed heart failure with LV dyskinesia or akinesia. Preoperatively, 14 cases were on nitrate and/or nicorandil dependent state. Digitalis was given for four cases, and diuretics was given for five cases. Neither postoperative complications such as cerebral infarction nor fatal arrhythmia were found after operation. Their hospital course was uneventful and all patients have not returned to hospital admission.

2.2. Operative procedure

Cardiopulmonary bypass was used in all cases, and 12 cases were operated under cardiac arrest using cold blood cardioplegia. LV incision and reconstruction were performed under ventricular fibrillation in 13 cases, and under heart-beating state in 1 case. EVCPP was performed following Dor’s methods. Circumferential purse-string suturing in the endomyocardium was performed at the borderline between the scarred and normal myocardium. Secondly, a glutaraldehyde-treated or bovine pericardial patch was inserted and fixed, and then the ventriculotomy was closed.

Revascularization was added for all patients with coronary artery bypass grafting (CABG). Left internal mammary artery was implanted on the left anterior descending artery in 12 cases and on the diagonal branch or the circumflex coronary artery in 2 cases. Mean number of bypass graft was 2.6 ± 0.7 per patient.

2.3. LV volume study procedure by Gated SPECT

One hour after injection of 740 MBq 99mTc-tetrofosmin, Gated SPECT rest images were obtained with a two-head rotating gamma camera (VERTEX-PLUS, ADAC, CA, USA). Image was obtained by the rate of eight-frames per single R–R interval. The data were analyzed with QGS(+) program produced by Germano and co-workers. LV end-diastolic volume index (EDVI), LV end-systolic volume index (ESVI), and EF were calculated and evaluated. Gated SPECT study was performed before surgery, early postoperatively (23 ± 8 days after surgery) and mid-term postoperatively (32 ± 11 months after surgery).

2.4. Statistical analysis

Statistical analysis was carried out using special software of Stat View 5.0 for Macintosh (SAS Institute Inc., CA, USA). All results are reported as mean ± standard deviation. The paired t-test was used for the comparison of between preoperative and early-postoperative values, and between early and mid-term postoperative values. A P value of less than 0.05 was considered statistically significant.

3. Results

3.1. LV volumes and ejection fraction

3.1.1. EDVI

EDVI (Fig. 1) decreased significantly from preoperative value to early postoperative value (107 ± 39 to 72 ± 37 ml/m², P < 0.01). There was no significant difference between early and mid-term postoperative values (72 ± 37 to 76 ± 36 ml/m², P = 0.18).

3.1.2. ESVI

ESVI (Fig. 2) also changed significantly from preoperative value to early postoperative value (78 ± 37 to
Fig. 3. Changes of left ventricular ejection fraction (EF, mean ± standard deviation). Abbreviations are the same as in Fig. 1. EF increased significantly from preoperative value to early postoperative value, and from early value to mid-term postoperative value.

51 ± 34 ml/m², P < 0.01). Furthermore, ESVI decreased from early value to mid-term postoperative value (51 ± 34 to 47 ± 35 ml/m², P < 0.05). EF (Fig. 3) increased significantly from preoperative value to early postoperative value (30 ± 10 to 35 ± 13%, P < 0.05). Furthermore, EF also increased significantly from early value to mid-term postoperative value (35 ± 13 to 45 ± 18%, P < 0.01).

4. Comment

The present study showed that EVCPP induced a dramatic early improvement in EDVI, ESVI and EF as other reports [8,10,11,16]. There was no significant difference between the early and mid-term periods in EDVI, those indicated that direct effect of EVCPP had been kept until the mid-term period after operation. Furthermore, the dramatic improvement in ESVI and EF was confirmed at the mid-term period after operation. The fact that the systolic function can further improve long after the operation is quite interesting. Two possible mechanisms can be raised about those facts. Remote myocardial function apart from infarcted area may improve gradually or direct effect of complete myocardial revascularization may keep improving myocardial function.

First, according to Di Donato and co-workers [16], indirect effects of reduction of the aneurysm can play a role in improvement of LV function. Namely, the surgical repair for LV aneurysm leads to improvement of the remote regional wall motion due to reducing local wall stress, according to Laplace’s law [16,17]. In this study, the remote regional wall motion may improve further in the mid-term period. So further improvement of regional wall motion may bring decrease of ESVI and increase of EF.

Secondly, the complete revascularization was indicated to be necessary for increase of oxygen supply to contractile myocardium [10,11]. The importance of bypass on the left anterior descending artery [11,18–20] was described. We also try to implant left internal mammary artery on the left anterior descending artery for preservation flow into septal branches or diagonal branches. Di Donato and co-authors [10] reported that postoperative functional improvement is mainly related to the increase in inferior LV wall motion, and the importance of revascularization of the left circumflex or the right coronary artery [10,19] was described, too. After all, those suggest that complete revascularization can bring good results.

5. Conclusions

The present study demonstrates that the LV dimension and systolic function are maintained not only at the early but also at the mid-term period after EVCPP.

References


