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Treatment outcomes and therapeutic evaluations of patients with left ventricular aneurysm

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Abstract

Objective: This study was performed to analyze and compare the efficacy of three treatment methods for left ventricular aneurysm (LVA): coronary artery bypass grafting (CABG) combined with left ventricular resection, drug treatment, and percutaneous coronary intervention (PCI).

Methods: In total, 183 patients with LVA from Fuwai Hospital were divided into three groups according to the treatment method: 51 patients underwent left ventricular resection combined with CABG (CABG-resection group), 65 underwent drug treatment (drug group), and 67 underwent PCI (PCI group). The clinical characteristics and survival rates of the patients were compared among the three groups.

Results: The patients' basic data and medical history were analyzed. The postoperative left ventricular end-diastolic dimension (LVEDD) and left ventricular ejection fraction (LVEF) were significantly higher than those before surgery, indicating that the left ventricular function markedly improved after the operation.

Conclusion: Surgery is recommended as the first treatment option for LVA, and conservative therapy can be considered for selected patients. Although the difference was not statistically significant, CABG with left ventricular resection was associated with a better LVEF and LVEDD and higher survival and non-recurrence rates than PCI or drug treatment.

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Introduction

Left ventricular aneurysm (LVA) is a serious mechanical complication after coronary artery disease-induced penetrating myocardial infarction (MI) and often occurs in the left ventricle and apex wall. The reported incidence of LVA after MI is 10% to 35% and has declined, primarily due to treatment of MI with coronary angioplasty performed in the acute phase of the event.[1] However, if patients are not treated in a timely manner, LVA can cause many complications including cardiac failure, ventricular arrhythmia, systemic embolism, and ventricular rupture, all of which can be life-threatening.[2] A previous study showed that among patients with MI, the left ventricular ejection fraction (LVEF) was similar between those who developed LVA within 48 hours and those who did not develop LVA; however, the mortality rate of patients with LVA was more than six times higher than that of patients without LVA.[3,4] Therefore, LVA may be a high risk factor for death within 1 year in patients with MI.

Many treatment methods are currently available for LVA, including drug therapy, percutaneous coronary intervention (PCI), and coronary artery bypass grafting (CABG), and the treatment decision depends on the size of the LVA and degree of influence of the blood flow mechanics.[5] Intervention therapy with a series of drugs, such as β-blockers, angiotensin-converting enzyme inhibitors, and statin drugs, can effectively prevent or limit ventricular dilatation, improve clinical symptoms, prolong survival, and improve the quality of life.[6] However, drug therapy may have no effect on LVAs of larger size. PCI is a common therapeutic method in clinical treatment and has the advantages of minimal surgical trauma, a good curative effect, and a short postoperative recovery time. Several studies have shown that after PCI, the 5-year survival rate was 47% and the 10-year survival rate was 18%.[7–9] Treatment of LVA by resection with concurrent CABG is effective and reasonable for selected patients.[10] One study showed that such treatment may improve patients' long-term survival and was regarded as the main interventional treatment modality for LVA with concurrent old MI (OMI).[11] However, CABG was performed by thoracotomy under general anesthesia, which may result in more severe surgical trauma, higher surgical risk, and a longer recovery time.

The present study was performed to retrospectively evaluate patients with LVA from Fuwai Hospital and compare the efficacy and follow-up results of drug therapy, PCI, and CABG with left ventricular resection.

Methods

Patients

Patients with LVA from Fuwai Hospital (Beijing, China) treated from 2011 to 2013 were retrospectively studied. This study was approved by the Ethics Committee of Fuwai Hospital and conducted in accordance with the Helsinki Declaration of 1975. Written informed consent was obtained from all patients. The inclusion criteria were integration of patient data, the presence of a secondary LVA, and an imaging diagnosis of LVA. The exclusion criteria were coronary heart disease, myocarditis, aortoarteritis, or angiodysplasia; severe hepatic insufficiency (alanine transaminase concentration of >2.0 times the upper limit of normal); severe renal insufficiency (creatine kinase concentration of $\geq$2.0 times the upper limit of normal, serum creatinine concentration of $\geq$1.2 times the upper limit of normal, and treatment with hemodialysis); chronic inflammatory diseases, tumors, mental disorders, or drug or alcohol abuse; and congenital LVA.

Clinical data and treatment

All patients with a discharge diagnosis of LVA were identified by a search of the electronic medical records system of Fuwai Hospital. The following clinical information was recorded: age; sex; symptoms; history of present illness; cardiovascular risk factors; etiology of the LVA; electrocardiography, transthoracic echocardiography, computed tomography angiography, and cardiac magnetic resonance findings (size and location of the orifice, presence or absence of mitral valve involvement or thrombus formation, and involvement of any cardiac structures); treatment; and outcomes.

Cardiac surgery and conservative drug therapy were included in the general treatment. Surgical treatment (i.e., PCI or CABG) is a better option for patients with LVA, especially for patients with symptoms and a large aneurysm ($\geq$3 cm), while drug intervention can be considered in those with asymptomatic aneurysms and small aneurysms (<3 cm) and stable heart dimensions.[12] Before therapy, each patient's New York Heart Association (NYHA) class was determined to assess heart function. The pretreatment and posttreatment left ventricular end-diastolic dimension (LVEDD) and LVEF were detected by Doppler ultrasound. We then recorded the condition of all patients through telephone interviews during a 3-year follow-up.

Statistical analysis

All analyses were performed using IBM SPSS Statistics for Windows, version 19.0 (IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean with standard deviation. Categorical variables are presented as number and/or frequency. Count data were assessed by the χ^2 test, and measurement data were assessed by the t-test. A P value of <0.05 was considered statistically significant.

Results

In total, 183 patients were included in this study. Fifty-one patients underwent CABG with left ventricular resection (40 men, 11 women; age range, 39–73 years; mean age, 56.96 ± 7.27 years). Among them, 24 patients had hypertension, 12 had diabetes, and 30 had hyperlipidemia. Additionally, 44 patients had OMI, 3 had acute anterior wall MI, 1 had acute inferior wall MI, and 4 had hemorrhagic infarction (HI) or cerebral hemorrhage. The complications were mural thrombus (n = 3), renal insufficiency (n = 2), mitral insufficiency (n = 1), ventricular tachycardia (n = 1), and cardiogenic shock (n = 1). Three patients had NYHA class I heart failure, 36 had class II, 8 had class III, and 4 had class IV. With respect to the number of coronary artery stenoses, 18 patients had a single-vessel lesion, 9 had bilateral angiopathy, and 24 had three

Table 1. Clinical characteristics and complications of patients with LVA.

Patient data	CABG (n = 51)	PCI intervention (n = 67)	Drug treatment (n = 65)
Sex			
Male/female	40/11	55/12	50/15
Age, years	56.96 ± 7.27	56.55 ± 10.97	63.71 ± 10.43
Disease history			
History of hypertension, yes/no	24/27	41/26	34/31
History of hyperlipidemia, yes/no	30/21	53/14	50/15
History of diabetes, yes/no	12/39	16/51	22/43
OMI	44	31	40
HI or cerebral hemorrhage	4	7	6
Acute anterior wall MI	3	31	23
Acute inferior wall MI	1	5	2
NYHA class			
I/II/III/IV	3/36/8/4	32/25/5/3	13/29/14/9
Number of blood vessels of coronary lesions			
0/1/2/3	0/18/9/24	0/21/26/20	4/12/9/40
Complications			
Mural thrombus	3	8	14
Renal insufficiency	2	2	12
Mitral insufficiency, atrial fibrillation, VT, cardiogenic shock, AV block, etc.	3	5	5

Data are presented as number of patients or mean ± standard deviation
LVA: left ventricular aneurysm, NYHA: New York Heart Association, OMI: old myocardial infarction, HI: hemorrhagic infarction, VT: ventricular tachycardia, AV block: auriculoventricular block; MI, myocardial infarction.

vascular lesions. Coronary artery disease and MI were the main causes of secondary LVA (Table 1).

A total of 67 patients underwent PCI (55 men, 12 women; age range, 40–85 years; mean age, 56.55 ± 10.97 years). Among them, 41 patients had hypertension, 16 had diabetes, and 53 had hyperlipidemia. Additionally, 31 patients had OMI, 7 had HI or cerebral hemorrhage, 31 had acute anterior wall MI, and 5 had acute inferior wall MI. The complications were mural thrombus (n = 8), renal insufficiency (n = 2), carcinogenic shock (n = 4), and auriculoventricular block (n = 1). Thirty-two patients had NYHA class I heart failure, 25 had class II, 5 had class III, and 3 had class IV. With respect to the number of coronary artery stenoses, 21 patients had a single-vessel lesion, 26 had bilateral angiopathy, and 20 had three vascular lesions (Table 1).

A total of 65 patients underwent traditional drug treatment (50 men, 15 women; age range, 35–84 years; mean age, 63.71 ± 10.43 years). Among them, 34 patients had hypertension, 22 had diabetes, and 50 had hyperlipidemia. Additionally, 40 patients had OMI, 6 had HI or cerebral hemorrhage, 23 had acute anterior wall MI, and 2 had acute inferior wall MI. The complications were mural thrombus (n = 14), renal insufficiency (n = 12), carcinogenic shock (n = 4), and auriculoventricular block (n = 1). Thirteen patients had NYHA class I heart failure, 29 had class II, 14 had class III, and 9 had class IV. With respect to the number of coronary artery stenoses, 18 patients had a single-vessel

Table 2. Preoperative and postoperative LVEDD and LVEF.

	CABG (n = 51)	PCI intervention (n = 67)	Drug treatment (n = 65)
LVEDD, mm			
Preoperative	58.73 ± 7.09	55.15 ± 6.25	58.62 ± 8.94
Postoperative	54.00 ± 6.57	54.69 ± 6.29	57.06 ± 8.50
P	<0.001	<0.001	<0.001
LVEF, %			
Preoperative	39.77 ± 8.18	44.64 ± 8.53	38.12 ± 9.00
Postoperative	45.59 ± 7.31	49.66 ± 8.80	41.12 ± 9.82
P	<0.001	<0.001	<0.001

Data are presented as mean ± standard deviation
CABG: coronary artery bypass grafting, PCI: percutaneous coronary intervention, LVEDD: left ventricular end-diastolic dimension, LVEF: left ventricular ejection fraction.

Table 3. Survival and recurrence during the 3-year follow-up.

Patient data	CABG (n = 51)	PCI intervention (n = 66)	Drug treatment (n = 65)
Deaths, n	2	17	7
Recurrence, n	1	10	17
Survival rate	96.08%	73.85%	89.55%
Non-recurrence rate	98.04%	84.62%	74.63%

CABG: coronary artery bypass grafting; PCI: percutaneous coronary intervention.

lesion, 9 had bilateral angiopathy, and 24 had three vascular lesions (Table 1).

In all three groups, the postoperative LVEDD was significantly lower than the preoperative LVEDD, and the postoperative LVEF was significantly higher than the preoperative LVEF ($P < 0.001$ for all) (Table 2). These results suggest that the left ventricular function significantly improved after the operation. In addition, the LVEF and LVEDD were better in the CABG-resection group than in the drug and PCI groups, although the difference was not statistically significant (Table 2). Finally, the survival and recurrence data during the 3-year follow-up are presented in Table 3. No significant differences were found in the number of deaths, number of recurrences, survival rate, or non-recurrence rate among the three groups.

Discussion

In the present study, we retrospectively reviewed the data of 183 patients with LVA from Fuwai Hospital to analyze and compare the efficacy of three treatment methods for LVA: CABG with resection, drug treatment, and PCI. The results showed that the LVEF and LVEDD were better in the CABG-resection group than in the drug and PCI groups. In addition, the survival rate and non-recurrence rate were higher in the CABG group than in the other two groups. The survival rate after CABG with ventricular resection was closely associated with cardiac function. However, the efficacy was not significantly different among the three treatment methods.

More than 95% of LVAs are caused by coronary artery disease and MI.[13] LVA is mainly caused by severe transmural MI after a large coronary artery occlusion. The necrotic myocardium is replaced by scar tissue, and the contractible left ventricle exhibits anti-phase contradictory movement, causing the ventricles to lose their contractility with less output per beat and lower left ventricular function (significantly reduced LVEF). LVA causes the left ventricular cavity to enlarge and changes its original normal geometrical morphology. Common clinical manifestations of LVA are shortness of breath, left heart failure, angina pectoris, arrhythmia, and systemic circulation embolism. The degree of clinical symptoms is closely associated with the size of the LVA and the amount and function of normal myocardial tissue in the left ventricle. Therefore, surgical treatment should be performed for patients with LVA who exhibit cardiac function aggravation, ventricular arrhythmias, and lateral thrombus formation.

The surgical methods for LVA are divided into linear suture repair, inner circle contraction, and left ventricular reconstruction. In 1955, Likoff and Bailey[14] used lateral wall forceps to perform the first closed LVA excision, which began the era of surgical treatment of LVA. In 1988, Cooley[15] used a linear suture technique in the extracorporeal circulation to perform the first successful ventricular aneurysm resection, which has since been used as a standard operation. In the 1980s, Jatene[16] and Dor et al.[17]proposed the concept of left ventricular geometric reconstruction using a pericardial patch. They considered that left ventricular wall resection involved not only resection of the LVA but also reconstruction of the left ventricle to its original shape before the onset of the disease. Since then, many scholars have revised the techniques of traditional linear suture repair, the patch technique, and left ventricular reconstruction to improve the surgical treatment of LVA.[15,18–20] Vural et al.[21] reported that left ventricular reconstruction was significantly better than traditional linear prosthetics in restoring the left ventricular geometry and improving the left ventricular function and long-term effect of surgery. However, one study showed no significant difference in improvement of the long-term cardiac function or therapeutic effect between traditional linear prosthetics and left ventricular reconstruction.[22] Coskun et al.[23] reported that there was no difference in the mortality rate between the two techniques but stated that left ventricular reconstruction could improve the postoperative survival rate within 10 years. Therefore, controversy remains over which is the best surgical technique for LVA after MI.

Revascularization during CABG can alleviate patients' symptoms and enhance cardiac function, which is very important for patients with LVA and concurrent coronary artery disease because this treatment technique improves the postoperative long-term efficacy and decreases mortality.[11] For patients with LVA, PCI can restore the blood supply of the ischemic myocardium, improve left ventricular function, and improve the short- and long-term prognosis of patients with coronary heart disease.[9] Traditional drug treatment is generally administered for small LVAs during the early stage, and surgical treatment is performed for large LVAs. In the present study, we analyzed and compared the efficacy of CABG with ventricular resection, drug treatment, and PCI for LVA. The results showed that CABG with resection had good efficacy for LVA. This study also showed that there are four important points that should be given close attention during CABG. First, before surgery, it is very important to maintain mild hypothermia and keep the ascending aorta open to determine whether the ventricular wall is functional, which can shorten the aortic dissection time and promote the recovery of patients. Mild hypothermia can also promote myocardial protection and prevent further tissue damage. In patients with a mural thrombus, the movement and stimulation of the heart should be reduced to decrease the risk of arterial embolism. Reducing the stimulation of the heart can also help to recover cardiac function as quickly as possible. Second, the incision should not be too close to the anterior papillary muscles, which can protect the heart and reduce adverse stimulation. Third, the scope of left ventricular resection should not exceed 40%. If the scope is too large, it may damage the normal structure of the heart and cause severe sequelae. Finally, the operation time should be strictly controlled to avoid adverse effects on the patient's prognosis.

Conclusions

Surgery is recommended as the first-choice treatment for LVA, and conservative therapy can be considered for appropriate patients. Although the difference was not statistically significant, CABG with ventricular resection was associated with a better LVEF and LVEDD and higher survival and non-recurrence rates than PCI and drug treatment.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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