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Left ventricular pseudoaneurysm after mitral valve replacement

Review of pseudoaneurysms late after mitral valve replacement

Rupture of the left ventricle (LV) is infrequent but one of the life-threating complications after mitral valve replacement. Left ventricular pseudoaneurysm (LVPA) due to incomplete or late rupture after mitral valve replacement is very rare [1]. However, if LVPA develops into pericardial tamponade itmay lead to mortality.

Rupture of the LV after mitral valve replacement can present as: early rupture, delayed rupture, or late rupture. Late rupture in particularappears days to years after mitral valve replacement and presents as a pseudoaneurysm of the LV. LVPA may develop de novo after the surgical procedure or may be a sequela of an earlier rupture.

The clinical presentations of LVPA are shortness of breath, heart failure, chest pain, endocarditis, and pericardial tamponade. However, it can also have an asymptomatic course.

The recommended treatment is surgical repair. Conservative follow-up is an alternative approach for those patients who refuse surgical treatment or are considered as high risk for re-operation.

Methods

A search of the PubMed database using the keywords "left ventricular pseudoaneurysm," "left ventricular pseudoaneurysm after mitral valve replacement," "left ventricular rupture after mitral valve replacement," and "left ventricular subvalvular aneurysm" yielded 468 articles. These articles were screened manually and 34 were selected because of their relevance to LVPA occurring late after mitral valve replacement. The articles—all written in English—were published between 1972 and October 2014. A total of 42 cases were evaluated from 34 articles; 12 cases were evaluated from one article but some information on patients was missing and the major part of our review did not include these 12 patients. The cases were classified according to age, sex, clinical presentation, diagnosis, complication, treatment, and survival status. Besides the data of the 42 patients from the literature review, our hospital established a definite diagnosis of LVPA in a series of seven patients (**Table 1**). We included them in our review, thereby enlisting a total of 49 cases.

Table 1 Characteristics of patients diagnosed with left ventricular pseudoaneurysm at our institute

Case	Gender	Age (years)	Size (cm)	Diagnostic method	Mitral valve before surgery	Comorbidity	Treatment	Follow-up period	Survey
1	Female	47	2.7×3.8	TTE	Rheumatic mitral stenosis	COPD, HT, DM	High risk for surgery because of comorbidities	11 months	–
2	Female	62	2.2×4.1	TTE	Rheumatic mitral stenosis	Chronic kidney disease	High risk for surgery because of comorbidities	23 months	–
3	Female	68	3.0×1.7	MDCT/TTE	Rheumatic mitral stenosis	–	Refused surgery	47 months	+
4	Female	57	4.2×1.1	TTE/TEE	Rheumatic mitral stenosis	–	Refused surgery	29 months	+
5	Female	63	0.7×1.6	TTE/TEE	Rheumatic mitral stenosis	DM, HT, CAD	High risk for surgery because of comorbidities	61 months	+
6	Female	72	3.1×2.9	TTE	Rheumatic mitral stenosis	CAD	High risk for surgery because of comorbidities	18 months	+
7	Female	64	1.1×1.7	TTE/TEE	Rheumatic mitral stenosis	COPD, CAD, HT, DM	High risk for surgery because of comorbidities	36 months	+

CAD coronary artery disease, *COPD* chronic obstructive pulmonary disease, *DM* diabetes mellitus, *HT* hypertension, *MDCT* multidetector computed tomography, *TTE* transthoracic echocardiography, *TEE* transesophageal echocardiography

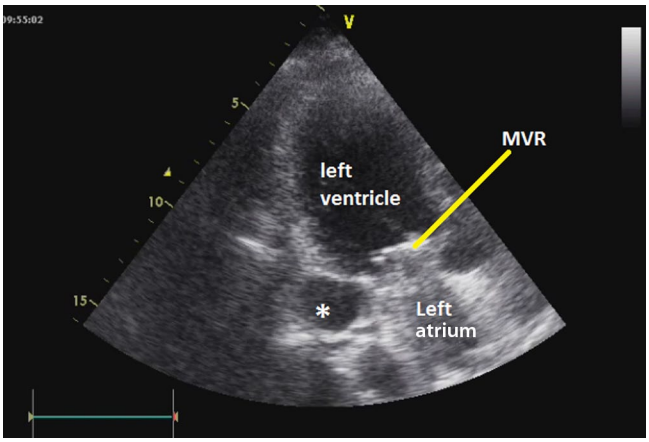

Fig. 1 ▲ Two-dimensional transthoracic echocardiographic view of left ventricular pseudoaneurysm (*). *MVR* mitral valve replacement

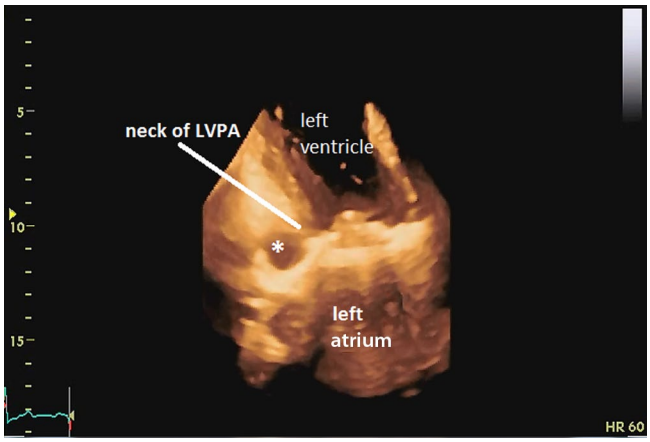

Fig. 2 ▲ Three-dimensional transthoracic echocardiographic view of left ventricular pseudoaneurysm (*). *LVPA* left ventricular pseudoaneurysm

Classification of LV rupture after mitral valve replacement

Treasures and coworkers classified the ruptures on the basis of their location on the LV wall: (1) *type-1 rupture* is located in the posterior atrioventricular groove; (2) *type-2 rupture* is in the posterior wall of the LV at the base of the papillary muscle; and (3) *type-3 rupture* is in the area between the atrioventricular groove and the papillary muscle.

The classification of Karlson et al. was based on the timing of rupture: (1) *early rupture* was defined as occurring in the operating room any time after discontinuation of cardiopulmonary bypass; (2) *delayed rupture* occurs in the recovery room usually hours to days postoperatively; and (3) *late rupture* occurs days to years after the mitral valve replacement and presents as LVPA.

Predisposing factors and pathogenesis of LVPA

Female gender, advanced age, mitral stenosis, small-volume LV, and small body size have been described as predisposing risk factors for LV rupture after mitral valve replacement.

Resection of excessive mitral tissue during the removal of the diseased mitral valve can cause injury to the annulus. The greatest injury during debridement is probably seen with heavy calcified mitral valves, especially with calcification in the posterior leaflet. The same injury can also be caused during the removal of a noncalcified mitral valve by inadvertent incision and/or forced traction of the annulus. Deeply placed sutures or excessive traction on sutures in the annulus can cause a tear through the myocardium and create small tracts in the myocardium. With the LV pressure, blood enters these small tracts and can dissect through the wall to the pericardial space. Insertion of an oversized mitral prosthesis can stretch the annulus and thus lead to rupture of the posterior wall of the LV.

Untethering of the LV by excision of the mitral valve with the chordae tendineae and papillary muscles can cause an increase in the pressure stress on the myocardium. This stretch effect leads to transverse midventricular endomyocardial disruption. Untethered myocardium promotes extension of the myocardial thickness defects produced by mechanical injury and converts these to transmural ruptures.

Insertion of oversized mitral prostheses can stretch the mitral annulus and can lead to rupture of the LV, which can result in pseudoaneurysm.

Clinical presentation

LVPA may remain asymptomatic in the absence of complications. The most common clinical presentation in the reviewed articles was shortness of breath/heart failure. Dyspnea and heart failure were the major symptoms for 35 patients [2–20]. Six patients had been asymptomatic at the time of diagnosis [21–26], whereas six other patients had described chest pain [3, 11, 12, 19, 27, 28]. One patient had pericardial tamponade [29] and another patient had symptoms of endocarditis [12].

Diagnosis

Echocardiography is the most widely used method for the diagnosis of LVPA (**Fig. 1 and 2**). Transthoracic echocardiography (TTE) was performed on 49 patients. Definitive diagnoses were made for 43 patients using TTE, as well as transesophageal echocardiography [2, 6, 8, 10, 16–18, 23], computed tomography [2–8, 11, 14, 16, 19, 21–23, 25–29], and heart catheterization [6, 7, 11, 15, 20, 21, 23, 24, 27] as additional visualization methods. Suspected pericardial pathology was observed in four patients with TTE; the diagnosis was confirmed by transesophageal echocardiography [8] and computed tomography [7, 11, 27] in these patients.

The typical finding on echocardiography is an echo-free annular aneurysmal sac that is adjacent to the posterior wall of the LV [1, 30]. A turbulent flow on the orifice of the pseudoaneurysm can be seen with two-dimensional color Doppler echocardiography (**Fig. 3**). Color Doppler echocardiography can help in the visualization of blood flowing forward into the pseudoaneurysm with systole and backflow into the LV with diastole.

Transesophageal echocardiography helps demonstrate the relationship between the pseudoaneurysm and other heart structures. Moreover, transesophageal echocardiography can help estab-

lish the paravalvular leak and regurgitation [1, 30].

Another useful method for establishing a definitive diagnosis is computed tomography (**Fig. 4 and 5**). Computed tomography can be used to evaluate the relationship of the LVPA with the left ventricle.

Differential diagnosis

Ante- and retrograde blood flow visualized using color Doppler imaging may be confused with paravalvular leak flow or paravalvular mitral regurgitation. Other differential diagnoses include localized pericardial effusion or hematoma, pericardial cyst, or diverticulum.

Management and treatment

Surgery

The clinical outcome of LVPA is difficult to predict. Rupture of the pseudoaneurysm into the pericardium may be fatal with pericardial tamponade; therefore, when LVPA is diagnosed, surgical correction should be recommended to all patients. The recommended surgical methods include internal, external, and combined approaches. The method most preferred is the internal approach in cases of tear involving the mitral annulus, the posterior wall, or a large area of the LV with reopening of the left atrium. Buttressed sutures are inserted from outside through the prosthesis ring in the lateral side avoiding the circumflex artery. In cases with late ruptures, closure using pericardial or synthetic patch materials can be performed. The neck of the pseudoaneurysm can also be closed directly because of its firm fibrotic edges. External repair by direct buttressed sutures is generally preferred for small tears. In cases of widespread tears, removing the prosthetic valve and patching both the inside and outside of the ventricle can be combined [31].

Patch closure was the surgical method most preferred in our review and was used for 20 patients [5, 6, 9–13, 16–18, 20, 22, 25, 27–29, 32–34]. Simple closure of the LVPA with sutures was used for five patients [2, 4, 12, 21, 24]. Pseudoaneurysm closure with a coronary sinus approach was selected for one patient [19].

Conservative approach with follow-up

Conservative therapy is an alternative approach to surgical management. Comorbidities could cause contraindications for surgical correction and these patients should be followed up with a conservative approach. The clinical outcome of LVPA remains hard to predict. Therefore, frequent clinical visits with echocardiography are essential. Although surgical treatment is the generally recommended approach, conservative follow-up proved to be an important alternative approach in this review because of the number of patients: The conservative approach was used for 20 patients [1, 14, 15, 23, 26, 35]. In one patient, LVPA resolved spontaneously [35]. All of our patients were followed up conservatively; two patients died of noncardiac reasons, pneumonia and renal failure. The follow-up periods for our patients ranged from 11 months to 6 years (mean, 32 months). The size of the LVPA did not increase during the follow-up periods.

Mortality

Mortality occurred in five patients during follow-up, which was due to: pneumonia and pulmonary complications in two patients, complications due to chronic kid-

Abstract · Zusammenfassung

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Left ventricular pseudoaneurysm after mitral valve replacement. Review of pseudoaneurysms late after mitral valve replacement

Abstract

Left ventricular pseudoaneurysm (LVPA) due to incomplete or late rupture after mitral valve replacement is a rare condition but can be life threatening if it develops into perdicardial tamponade. LVPA may develop de novo after the surgical procedure or may be a sequela of an earlier rupture. Clinical presentation includes shortness of breath, heart failure, chest pain, endocarditis, and pericardial tamponade. However, it can also have an asymptomatic course. The recommended treatment for LVPA is surgical repair. Conservative follow-up is an alternative for patients who refuse surgical treatment or are considered high risk for re-operation. We conducted a review of all the available literature on cases of LVPA after mitral valve replacement and present the findings here.

Keywords

Mitral valve · Left ventricle · Pseudoaneurysm · Pericardial tamponade · Rupture

Linksventrikuläres Pseudoaneurysma nach Mitralklappenersatz. Übersichtsarbeit über Pseudoaneurysmen als Spätfolge nach Mitralklappenersatz

Zusammenfassung

Ein linksventrikuläres Pseudoaneurysma (LVPA) aufgrund inkompletter oder erst spät auftretender Ruptur nach Mitralklappenersatz ist selten, kann jedoch lebensbedrohlich verlaufen, wenn sich daraus eine Perikardtamponade entwickelt. Ein LVPA kann postoperativ de novo oder als Folge einer früheren Ruptur entstehen. Zu den klinischen Symptomen gehören Kurzatmigkeit, Herzinsuffizienz, Thoraxschmerz, Endokarditis und Perikardtamponade. Der Verlauf kann jedoch auch asymptomatisch sein. Als Therapie eines LVPA wird die chirurgische Rekonstruktion empfohlen. Die konservative Verlaufsbeobachtung stellt eine Alternative für Patienten dar, die einen chirurgischen Eingriff ablehnen oder als Hochrisikopatienten für eine erneute Operation gelten. Die Autoren haben sämtliche verfügbare Literatur zu Fällen eines LVPA nach Mitralklappenersatz ausgewertet und präsentieren hier die Ergebnisse.

Schlüsselwörter

Mitralklappe · Linker Ventrikel · Pseudoaneurysma · Perikardtamponade · Ruptur

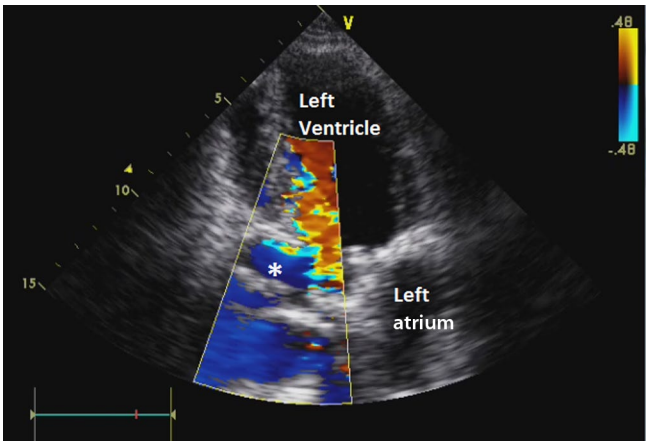

Fig. 3 ▲ Blood flow forward into the left ventricular pseudoaneurysm (*)

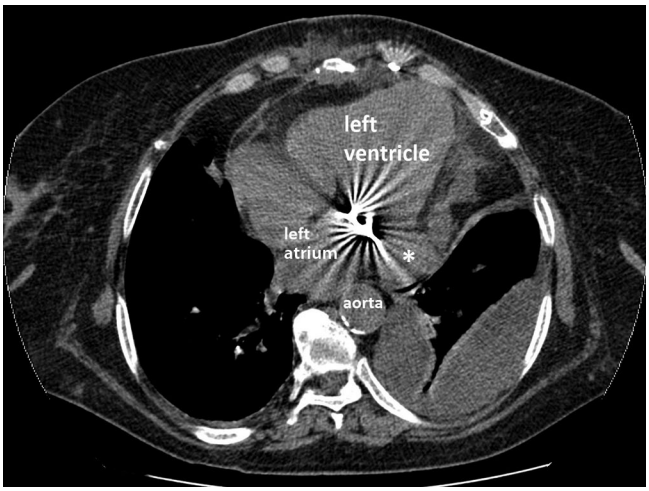

Fig. 4 ▲ Computed tomography view of left ventricular pseudoaneurysm

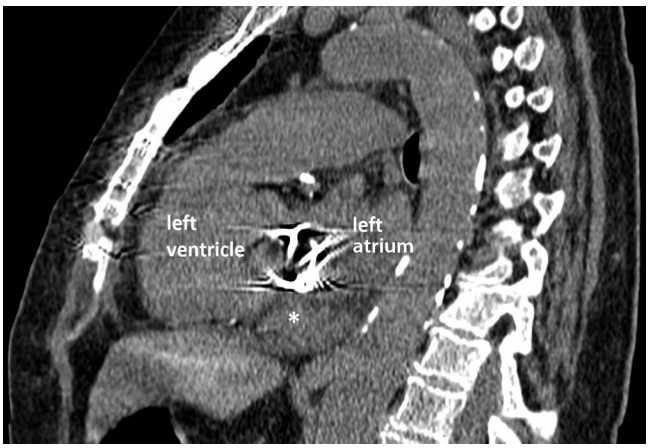

Fig. 5 ◀ Computed tomography view of left ventricular pseudoaneurysm

ney disease in one patient, and LV failurein two patients.

Discussion

As mentioned, LVPA is a rare complication of mitral valve replacement with an increased risk of rupture and consequently with high mortality. Owing to the rise in the rate of mitral valve surgeries, the number of LVPA diagnoses has been increasing progressively.

Predisposing risk factors of LVPA are female gender, advanced age, mitral stenosis, small-volume LV, and small body size. All of our patients were female, older than 60 years, and had rheumatic mitral stenosis.

Resection of excessive mitral annular tissue, inadvertent incision and/or forced traction of the annulus, deeply placed sutures or excessive traction on sutures, untethering of the LV by excision of the chordae tendineae and papillary muscles can cause injury to the mitral annular tissue. LVPA after mitral valve surgery develops as a result of these injuries.

Surgical correction is the treatment of choice for LVPA, and the most frequently preferred surgical method is patch closure. Simple closure with primary sutures is another surgical method for closure of the neck of the LVPA.

The conservative approach to LVPA treatment played a major role in our review. A conservative approach was chosen for all our patients, and only two of them died (because of pneumonia and renal failure). Sakai et al. in their series of eight patients with LVPA following mitral valve surgery treated seven of them medically without any complications. They, too, emphasized that when the LVPA is small and the communicating neck of the LVPA is very narrow, conservative management of a patient with LVPA may be possible.

Limitations

Our study was limited by some incomplete and/or missing patient reports and by the relatively small sample size. Furthermore, we only reviewed the English language literature on this rare disease entity.

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Compliance with ethical guidelines

Conflict of interest. S. Ekrem states that there are no conflicts of interest.

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