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Spontaneous rupture of left ventricular posterior wall as a complication of mitral valve replacement

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Abstract

In this article, we provided summary of knowledge on left ventricular posterior wall rupture as a complication of mitral valve replacement surgery and shared our experience with such complication.

Key words: mitral valve replacement surgery, complications, cardiac surgery procedures, left ventricular posterior wall rupture

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Spontaneous rupture (SR) of the left ventricular posterior wall (LVPW) following mitral valve replacement (MVR) is infrequent but a highly lethal complication. It was first reported by Roberts and Morrow in 1967 (1). The reported incidence is 0.5–2% (2, 3). Rapid exsanguinating hemorrhage results in high mortality, which constitutes up to 75% with or without the use of cardiopulmonary bypass (CPB) (4). If one assumes a 5% operative mortality for mitral valve replacement, then left ventricular rupture is responsible for 18% of all deaths from the procedure (3). Despite the accumulation of surgical experience on management of SR of LVPW following MVR mortality remains high in this fatal complication. Therefore, insights into its prevention and management are important. Ruptures of LVPW following MVR are classified according to anatomical localization and duration of emergence. According to anatomical localization ruptures are classified to I type - rupture of AV groove; II type – rupture of bases of papillary muscles; III type – intermediate rupture of LVPW between AV groove and papillary muscle bases. (5, 6). Clinical practice shows frequent combination of I-III and III-II types of ruptures, developing simultaneously or consequently after the correction of one of the previously existing ruptures. In some cases, verification of a particular type of rupture is complicated by a "continuing" lesion, changing the initial linearity trajectory up to the left atrium (LA) with the dissection and rupture of its wall. According to the observations of combined ruptures of LVPW and LA, especially in patients older than 70 years, some authors consider classifying them into an independent type IV ruptures (7). According to time of occurrence, ruptures are classified as early, delayed and late lesions (3). Early ruptures are the intraoperative ruptures, which occur mostly after the completion of the main stage of the operation, making up 30-66% of all LVPW lesions (3, 5). In terms of prognosis, they are considered as favorable ruptures due to the possibility of correction in a short period of time by using cardio-pulmonary by-pass (CPB). Delayed rupture of LVPW, 33-69% of all cases, present hours to days after leaving the operating theatre. Clinically, these present with massive bleeding into the drainage tubes and hypotension. Most patients with delayed ruptures do not survive after that complication (3, 8). Late rupture of the left ventricle appears days to years after valve replacement and presents as a pseudoaneurysm of the left ventricle (3, 8).

The overall mortality rate at the occurrence of left ventricular ruptures varies from 75 to 86% and depends on the duration of the development of this complication and currently does not have a significant tendency to decrease (4, 9). Despite the numerous works described the clinical significance of ruptures, few publications in literature were devoted to the prevention of these fatal complications.

The causes of each type of ruptures are well described in the literature. Thus, the main reason for the rupture of the left ventricle type I is excessive tissue excision during

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resection of the diseased mitral valve (3, 5). Other causes include: 1) excessive valve traction and accidental damage to the annulus; 2) poor exposure of the mitral valve due to the small size of the left atrium; 3) excessive resection of the posterior cusp;4) extensive decalcification of the fibrous ring; 6) the discrepancy between the size of the prosthesis and the diameter of the annulus; 7) careless lifting of the heart from pericardial cavity when the left ventricle overflows with blood; 8) excessive tension of the sutures in the fibrous ring with their wide imposition, leading to the eruption of tissue; 9) a deep suturing annulus and their eruption when tying, which may cause development of a large intramural hematoma which subsequently breaks and causes late complication (7, 10). The causes of ruptures of types II and III are excessive traction of the subvalvular structures during removal of the mitral valve cusps, as well as excessive excision of the papillary muscles (3). Independent predictors of rupture are: age 60 years and older, repeated operations, resection of the posterior cusp of MV, plication and plastic surgery of LA, long-term hemodialysis, and left ventricular end-diastolic volume less than 50 ml (11). Identified predictors that contribute to left ventricular rupture: female gender, mitral stenosis, diabetes mellitus, pulmonary hypertension and myocardial infarction occurred no longer than a day prior to mitral valve replacement (9, 10).

The proposed algorithm by Sersar et al. (2009), for management of left ventricular ruptures provides three options for operating tactics: external (extracardiac) correction, endocardial - restoring the integrity of atrioventricular continuation and unconventional techniques for endocardial correction (10).

Extracardiac correction of LV rupture is more justified during primary operations and with ruptures of type II and III (9, 12, 13), under the echocardiographic control on the operating table. Endocardial restoration of the integrity of the atrioventricular continuity is indicated in case of type I ruptures or combined ruptures, as well as inadequate correction of type II and type III ruptures, manifested pericardial adhesions (9, 14). The mandatory conditions for this type of correction are mobilization and good exposure of the rupture. To perform this option removal of the prosthesis, plastic or suture closing LV defect and reimplantation of the prosthesis must be achieved. In case of type I ruptures, a suture closure of the defect by the counter pads and using various bio-adhesives is increasingly used, but there is a risk of injury to the left coronary artery or coronary sinus (7, 15). Therefore, a transannular patch is preferred, covering the endocardium of LA and LV (12, 16). The endocardium under the patch can be sealed with bio-adhesives or composite adhesives. S. Masroor et al. (12) proposed a transannular patch of xenopericardum with a Teflon liner impregnated with bio-glue. An exemplary operation was performed on an elderly patient with early left ventricular rupture Type I after mitral valve bioprosthetic replacement and closure of the atrial septal defect. According to the authors, this technique is justified in elderly patients, with myocardial dystrophy and the potential possibility of eruption during valve replacement. After the closure of the defect, the prosthesis is reimplanted (7, 12), and this option enables the possibility of translocation of artificial valve (11). A number of surgeons complement the endocardial correction with external repair or the imposition of individual sutures (9, 13, 15). The latter is justified before the reimplantation of the artificial heart valve, since the dislocation of the heart is fraught with a new myocardial injury by prosthesis and a relapse of bleeding.

Achieved success in mitral valve surgery over time contributed to a decrease in mortality during early left ventricular ruptures after MVR to 25.0–33.3% (10, 13), but nevertheless, the complication remains unpredictable and difficult to control with high hospital mortality. And above all, mortality is associated with number of events in the earlier postoperative period after the elimination of the LVPW ruptures, which are represented by a low cardiac output syndrome, renal and hepatic failure, coagulopathies, respiratory complications and wound infections. In turn, this contributes to the duration of CPB and aortic clamping; increased blood transfusion, prolonged mechanical ventilation, delayed chest sealing (up to 3-5 days), associated with the potential probability of recurrence of bleeding (12, 14).

In our clinic, from 2014 to 2018, we performed mitral valve replacement in 427 patients. Among patients, 8 (1.7%) of them encountered to terrible complication - spontaneous rupture of the posterior wall of the left ventricle. Survival rate was 12.5%. Mortality rate was 87.5%. Our team performed mitral valve replacement by different methods: with preservation of the chord-papillary apparatus and without preservation, with a continuous suture and U-shaped suture. A number of patients underwent parallel plastic surgery of the left atrium due to severe dilatation. One patient encountered type I rupture, while two of eight developed combined a type of "continuing" rupture, changing the original trajectory up to the LA with dissection and rupture of its wall. And the rest had combinations of I-III and III-II types of ruptures, developing simultaneously or consequently after the correction of one of them. In terms of occurrence, the delayed form was registered in 2 patients in intensive care unit, others had an early form which was developed immediately after the restoration of cardiac activity in the operating theatre. Of the 8 patients, only 2 were male, and 6 were women.

As a correction option, we had applied the extracardiac suture closure of the defect on the oncoming pads, however, the desired success was not observed and ruptures were further complicated by changing the original linearity. Using the extracardiac suture method, we could stop the rupture only in one patient. Nonconventional extracardiac, endocardial correction methods were used in the absence of the desired effect of extracardiac suture closure. We used the combined method of closure for one patient: Implementation of transannular patch from the vascular prosthesis covering the beginning of annulus and the endocardium and epicardium, complemented by extracardiac suture closure on the pads.

Conclusion

Despite the accumulation of experience in the surgical treatment of spontaneous rupture of LVPW, mortality remains high in case emergence of such fatal complication. The spontaneous rupture of the LVPW following the mitral valve replacement is a terrible complication, which occurred in 1.7% of patients. Important roles the occurrence of this complication are given to female gender, excessive resection of subvalvular apparatus and plastic surgery of left atrium. Selection of surgical option to close a defect depends on the anatomical type of rupture. In type I, immediate application of combined method using transannular repair and extracardiac suture plastics is indicated. In types II-III, it is also desirable to use combined correction methods. With the use of extracardiac suture repair, it is possible to obtain an ongoing tearing, changing the initial trajectory up to the left atrium with the dissection and rupture of its wall. If endocardial correction is planned, mobilization and a good exposure of the defect are mandatory to this type of correction. For this option, it is recommended to remove the prosthesis, repair or suture closure of the LV defect and reimplantation of the prosthesis.

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