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Literature Review

Ramil Aliyev[1], Kamran Musayev[2]

[1] "Zeferan" Hospital, Baku, Azerbaijan
[2]Central Clinic Hospital, Baku, Azerbaijan

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Corresponding Author: Ramil Aliyev, "Zeferan" Hospital, Baku, Azerbaijan E-Mail: shaman_ra@mail.ru

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Modern aspects of surgical treatment of post-infarction ventricular septal defect

Abstract
Determination of the anatomical location of the ventricular septal defect (VSD), one of the complications that may develop after acute myocardial infarction (MI), affects the surgical intervention and surgical success. Improved surgical techniques and heart protection methods, increased anesthesia and reanimation experience with new prosthetic patches have increased the success of surgical intervention in post-MI VSD. Long-term survivals of patients treated surgically have been reported to be better than those who did not undergo surgery.
In autopsy studies, the incidence of VSD after acute myocardial infarction is 1-2%. According to epidemiological studies, post-MI VSD occurs more frequently in male patients 65 years of age and older who have a single-vessel disease and who have had an infarction for the first time. Post-MI VSD, which develops because of anterior MI, which constitutes 60% of myocardial infarctions, is the most common anteroapical septum, and VSDs, which are formed because of inferior MI (20-40%), are usually located in the posterior septum.
In this study, we investigated the risk factors affecting hospital mortality retrospectively in patients who developed post-MI VSD and operated.

Keywords: Ventricular septal defect, acute myocardial infarction, post-MI VSD

INTRODUCTION

Surgical treatment remains the only method of helping patients with large IVS ruptures, regardless of the anatomy of the rupture and the patient's hemodynamic state, and is characterized by a lower mortality rate (20%-50%) than conservative treatment (90-100%)(1-6). Mortality predictors are: surgery on the background of AMI, cardiogenic shock, as well as posterior localization of the IVS rupture and a short time interval between the onset of MI and IVS rupture; right ventricular dysfunction because of overload due to left-right shunt and its MI (7).

According to the STS, IVS PIR correction is 0.1% of all cardiac surgical procedures(2,5,8).

In addition, the correction of post infarction VSD can be a difficult task due to the initial severity of the patient's clinical condition, the large volume and technical complexity of the operation, on the one hand, and the limited experience of surgeons, on the other (1,9,10).

For many decades, the timing of surgical intervention for IVS rupture has continued to be a subject of debate. Current guidelines for the management of patients with AMI recommend emergency surgery for PIR of the IVS, regardless of the patient's condition, since the likelihood of a sharp deterioration in hemodynamics is too high even in stable patients (11-18).

For cardiac surgeons, issues remain debatable, such as the optimal time and method of choosing a correction.

Early surgical closure of the IVS PIR was the treatment of choice, even if the patient's condition was stable. However, such urgent operations are marked by high operative mortality when performed during the acute phase of MI (19,20).

In the largest study analyzing the US National Registry of 2876 patients, operative mortality was 54% when the operation was performed within 7 days and decreased to 18% when the operation was performed 7 days later. Mortality was quite high when surgery was performed within 6 hours of MI (18).

Some researchers believe that it is necessary to use a differentiated approach to the choice of the timing of the operation: active -

with an increase in the phenomena of heart failure and expectant with the stabilization of the patient's clinical condition (21-25).

At present, there is no unequivocal evidence that attempts to stabilize the patient through conservative therapy and mechanical hemodynamic support and delaying surgery will improve survival (23). At the same time, there are encouraging results indicating the advisability of using pharmaco-mechanical support for the patient with careful control of hemodynamic parameters to stabilize the patient's condition, which makes it possible to perform successfully such a severe surgical intervention in a planned manner (26).

Retrospective studies have shown that the best surgical results are obtained in patients with a delay of 6 weeks which is due to: covering the surface of the affected area with neo-endocardium in parallel with the resorption of subendocardial hematomas and necrotic myocardium and the formation of fibrous tissue with areas of cardiomyocytes in the hibernation phase and foci of a thickened (up to 2 mm) endocardium 13,17,18,27).

From a surgical point of view, there is no reason to delay surgery in patients for more than 4-8 weeks (28,29).

Surgical mortality of 21 patients who were in cardiogenic shock was 62% (18, 29).

Mortality is highest in patients with a rupture of the basal septum associated with inferior MI (70%, compared with 30% in patients with a rupture due to anterior infarction), which is associated with damage to the MV and the need for its correction (30-34).

The high risk of intervention in the acute stage of AMI and the high probability of suture eruption through the non-scarred edges of the defect seem to be reasonable arguments in favor of expectant management for patients with stable hemodynamics. In addition, although they are confirmed by good practical results, the number of patients who can be stabilized and brought to a delayed operation is relatively small and ranges, according to various estimates, from 5 to 15% (35-38). Data on the number of patients who died during the waiting period, due to a sudden increase in IVS rupture and hemodynamic shock, are not available.

Initial reports suggested that delaying surgery might reduce surgical mortality (39,40).

Despite the ACC/AHA recommendations for immediate surgical intervention for IVS PIR to prevent further hemodynamic deterioration in patients, various studies illustrate improvements in postoperative mortality rates in cases where surgery was performed after hemodynamic stabilization. In the largest study, operative mortality was 54% when surgery was performed within 7 days and decreased to 18% when surgery was performed 7 days later. Mortality was quite high when surgery was performed in an emergency, especially within 6 hours after MI (20,22,52).

Thiele et al. reported a higher mortality rate (83%) with early surgical repair of IVS PIR versus a mortality rate (29%) with delayed recovery after initial medical stabilization and hemodynamic support (37).

Papalexopoulou N et al. described operative mortality in the early recovery group of approximately 31-75%, and in the late treatment group 0-18.4%, and suggested that the Qp/Qs ratio should be the determining factor for the timing of surgery.

When the ratio Qp/Qs increases, the operation should be carried out at an early stage. Surgical repair of the septum is almost always necessary if the shunt is large from left to right (QP/WS>3) (40-45). The need for emergency surgery in patients with PIR IVS to avoid potential hemodynamic collapse should always be weighed against the lower mortality rates seen with delayed recovery. The rationale for expecting a better outcome with delayed surgery is that the necrotic myocardium undergoes fibrous remodeling and its tensile strength increases. However, in some patients, delaying surgery can lead to multiple organ failure, which is associated with a 100% mortality rate (46,47). Therefore, the time of the operation should be determined individually, taking into account hemodynamic and metabolic parameters.

In anterior IVS PIR, it is important to assess the severity of LV dysfunction, the presence of coexisting anatomical lesions, the feasibility of revascularization, and the anatomy of previous infarcts. For posterior PIR of the IVS, additional understanding of RV function and the presence of mitral regurgitation are important.

Most patients with acute IVS PIR are admitted in cardiogenic shock, and there is a high probability of emergency connection to CPB. Many surgeons prefer to perform a left ventriculotomy through the infarct zone to gain access to the IVS defect because it provides direct visualization of the defect, but perform infarctectomy or aneurysmectomy only when needed.

Currently, there are two common methods of IVS correction - Daggett and David. The Daggett method is a single or double patch technique that closes the IVS defect. In 1387, W. Daggett et al. fundamentally changed the methodology of operations, performing ventriculotomy through the zone of MI: with posterior localization - through the posterior, with anterior - through the anterior wall of the left ventricle. This made it possible to minimize the development of ischemic myocardial dysfunction after surgery. The same authors, in cases where the rupture was located in the region of the apex of the heart and was small, tested the method of resection (or amputation) of the apex of the heart, including the area of the rupture, with the application of Teflon gaskets. However, this approach did not find active support in view of the unnatural distortion of the geometry of the ventricles, as well as the creation of a large stress on the “loose” myocardial tissue. In contrast, the David method is an infarction exclusion procedure with all sutures located in the left ventricle (42,46). In 1922 T. David et al. published the results of using the described technique in 44 patients. All patients were operated on in the acute phase of MI, in addition, 29 of them were taken to the

operating room in the state of CABG. Operational lethality was 13.6% compared to 60% with previous approaches. This method of elimination of PIR IVS led to a significant improvement in the contractile function of the left ventricle and right ventricle. Long-term (6-year) survival was 66 ±7% (41,43,48).

The myocardium in the area of infarction is weak and friable, which creates the basis for suture failure and leads to an increased risk of rupture and recurrent defects of the IVS. The principles of successful correction include treating the tissue down to healthy myocardium (even if it involves enlargement of the defect) and avoiding tension when correcting with an appropriately sized pad.

The strength of the closure of the defect can be ensured by the use of a pericardium or pad.

This is especially important on the first day of MI development if it is impossible to differentiate visually the viable and infarcted areas. İn case of a large defect, there is a deficiency of IVS tissue, so it is difficult to ensure adequate patching. In this case, horizontal mattress sutures can be placed through the wall of the RV. The posterior PIR of the IVS create additional technical challenges due to the lack of conditions for easy access.

The STS database contains 2876 cases of patients over the age of 18 who were operated on for IVS PIR in the period from 1999 to 2010. The overall operative mortality was 42.9%, which is a high rate for cardiac surgery. Patients who died within 30 days were generally older, female, and had higher serum creatinine levels. The noted cardiogenic shockç decreased LVEF. Mortality of patients in the STS database varied significantly depending on the timing of the operation. Patients who underwent surgery within 7 days of discharge had a mortality rate of 54.1% compared with a mortality rate of 18.4% if correction was delayed up to 7 days. Mortality is highest (60%) in patients undergoing surgery within the first 24 hours, consistent with other investigators (18,41-44,45-49).

The improved outcome with delayed surgery may be related to the evolution of infarction and improved cardiac tissue stability, allowing for improved repair efficiency, but is also indicative of a survival bias, as early surgery is usually performed in individuals with severe hemodynamic instability and circulatory compromise. Ultimately, only 886 out of 2876 patients (30.8%) in the STS database had surgery more than 7 days after presentation, indicating that a minority of patients survive until scheduled repair. In addition, the number of patients who refused surgery was not reported. Similarly, the GUSTO-I trial demonstrated 47% mortality at 30 days among 34 patients who underwent surgical correction (mean time 3.5 days, 2% CI, 1-7) versus 94% mortality for 35 patients without surgery (although again sample bias should be taken into account). The findings suggest that while surgical mortality remains very high, non-surgical mortality is certainly even higher. Thus, the clinician must weigh the known risk of advising for surgery against the unknown risk of delaying surgery and further worsening the condition.

It should be noted a number of publications of cardiac surgeons NTS SSH them. A.N. Bakulev of the Russian Academy of Medical Sciences, who presented the results of many years of experience in the treatment of patients with PIR IVS. According to the authors, the successful surgical treatment of such patients is based on the principle of optimal correction of all affected anatomical structures of the heart, in particular, closure of the gap; geometric reconstruction of the left ventricle; performing direct myocardial revascularization and, in case of damage to the valvular apparatus, restoring the function of the MV and TC (44,45).

The concept that the preservation of LV geometry plays a key role in preserving its function has formed the basis of the latest developments in surgical approaches to the correction of IVS PIR. The authors formulated the tactical and technical principles of surgical treatment of IVS PIR: 1) avoiding surgery in the early stages; 2) use of IABP to stabilize hemodynamics; 3) the optimal time for the successful completion of the operation is more than three weeks from the moment of rupture; 4) a double patch for reliable sealing of the IVS defect and reducing the likelihood of recanalization; 5) more widely use tricuspid valve annuloplasty; 6) take into account that attempts to percutaneously close the defect are ineffective ineffective(50,51,52). Developed in 2006, the method of LV reconstruction for post-infarction IVSR using a double butterfly patch and with the condition that surgery be performed in the long-term period after the rupture helped to reduce mortality to 11.7%, but this work does not mention patients who simply did not live up to the operation (52).

It is practically important that only the stable condition of the patient with the absence of hemodynamic disturbances and associated dysfunction of other organs allows postponing the operation until scar tissue is formed. Under any other circumstances, the issue is resolved in favor of emergency intervention. On the other hand, a retrospective analysis of the data showed that in some cases the diagnosis of this complication is carried out with an unjustified delay in some situations. The delay in transfer to a specialized center is associated with an erroneous interpretation by practitioners of the indications for surgery and the risk of performing it. All this together leads to an increase in the number of complications of varying severity both before (61.3%) and after (67.7%) surgery (53).

Thus, despite the high clinical risk profile of this group of patients, the choice of the optimal timing of the operation, careful preoperative preparation, the use of rational surgical technique and effective therapeutic measures after surgery allow achieving satisfactory results in the long-term period.

Operative methods for correcting PIR of the IVS include excision of necrotic tissues and reconstruction of the IVS using Dacron.

Also in the literature, repair of the interventricular septum with bovine pericardium and closure of the left ventricle with a swab

or felt in combination with surgical glue have been described. Postponement of surgery until scar tissue is formed and the patient's condition stabilizes contributes to the improvement of surgical results, because the necrotic myocardium is less suitable for suturing. Operations performed against the background of cardiogenic shock and multiple organ failure due to low cardiac output show unsatisfactory results.

Over the past decade, these principles have been improved and a technique has been proposed for safe surgical repair of the IVS, in which necrotic tissue is not excised, the LV cavity is isolated with a PTFE patch, and the LV incision is closed without gaskets. Preservation of LV geometry and minimization of bleeding from the ventriculotomy site are important factors in this procedure (54).

ACC/AHA guidelines recommend immediate surgical intervention to prevent further hemodynamic deterioration in a patient with IVS PIR.

Long-term outcomes of surgical treatment are quite effective. Despite the high operational risk in the restoration of IVS PIR, the majority of patients in the postoperative period show an improvement in the clinical condition.

Survival for up to 5 and 10 years after surgery was 60 - 85% and 31 - 77%. The deterioration of long-term results is due to the progression of atherosclerosis, a decrease in the contractile ability of the myocardium.

The presented data to some extent justifies the risks associated with high early surgical mortality.

An analysis of the literature allows us to highlight the fundamental positions of the tactics of treating patients with postinfarction VSD, which have not been interpreted unambiguously so far:

The objectivity of assessing the clinical profile of the patient and the tactics of his life support before performing endovascular or surgical intervention;

Efficiency of options for mechanical support of systemic hemodynamics: IABP / ECMO / bypass modules of the left or right ventricle of the heart;

The feasibility of primary endovascular correction of post infarction VSD, taking into account the morphostructure of the rupture of the infarcted VSD, regardless of the patient's clinical status;

Efficiency of hybrid correction of postinfarction VSD performed at early stages of IVS rupture formation, regardless of the patient's clinical status;

The limiting factor of a single concept “when and how to correct?” is a limited, fragmented and extended experience in the treatment of such patients.

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