Double-Patch Closure using Gelatin Resorcine Formol Glue of a Ventricular Septal Perforation following Acute Myocardial Infarction

Complete closure is most important when attempting acute-phase closure of a ventricular septal perforation following acute myocardial infarction. Here, we present a case of a 76-year-old male with a ventricular septal perforation following acute myocardial infarction. The ventricular septal perforation was repaired by stitching small and large bovine pericardial patches onto the affected septum from the side of the left ventricle, then cementing the two patches together with gelatin resorcine formol glue injected into the space between them. Complete closure of the ventricular septal perforation was accomplished. Simultaneously, right coronary artery bypass grafting was performed using a saphenous vein. The postoperative course was uneventful, and the patient was discharged, with a favorable post-discharge course for 24 months to date after surgery. (Jpn J Thorac Cardiovasc Surg 2002; 50: 294–297)

Key words: double-patch closure, gelatin resorcine formol glue, ventricular septal perforation, acute myocardial infarction

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Infarcted myocardium is fragile and difficult to repair, so complete closure is most important when attempting acute-phase closure of a ventricular septal perforation (VSP) following acute myocardial infarction (AMI), since the incidence of a postoperative residual shunt is approximately 25%. Cooley et al[1] reported the first successful operation for VSP in 1957. Numerous techniques have since been devised, including a direct patch-closure of the VSP (Daggett technique),[2] patch-closure by stitching onto normal myocardium around the VSP (infarct exclusion method),[3,4] VSP closure and left ventriculoplasty using an endocardial patch while avoiding touching the VSP and the surrounding infarcted areas, and closing the VSP following removal of surrounding fragile infarcted myocardium using an ultrasonographic aspiration device.[5]

Here, we report complete closure of the VSP in a patient at ten days after AMI onset by stitching small and large bovine pericardial patches onto the affected septum from the side of the left ventricle. The two patches were cemented together with gelatin resorcine formol glue (GRF glue) — a tissue reinforcer — injected into the space between them.

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Case

Present illness: On September 1, 1999, a 76-year-old male visited a clinic complaining of chest oppression, and was admitted to a hospital with the diagnosis of AMI. On September 7, the patient was resuscitated after suffering cardiogenic shock. There was no improvement in his condition, so he was transferred to our hospital on September 10. Past history: Cerebral infarction (July 1999) Course after admission: On admission, his blood pressure was 114/70 mmHg, with a pulse rate of 75/min (regular). A Levine III/VI systolic murmur was heard in the fourth intercostal space at the left sternal border. A blood examination showed a leukocyte count of 18,400/mm^3, C-

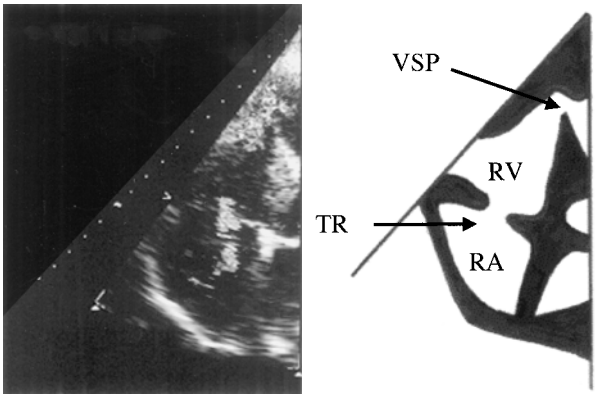

Fig. 1. Ultrasonography indicated shunting from the left to the right ventricle.
RV, Right ventricle; *RA*, right atrium; *VSP*, ventricular septal perforation; *TR*, tricuspid regurgitation.

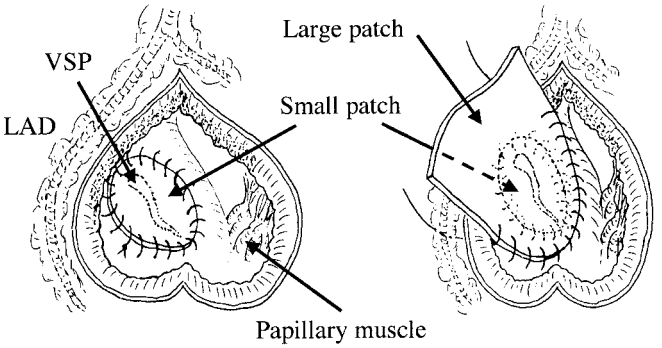

Fig. 2. Operative procedure.
The ventricular septal perforation was closed with a small bovine pericardial patch using continuous sutures. A large bovine pericardial patch was stitched onto a healthy margin around the small patch with continuous sutures on the ventricular side only.
LAD, Left anterior descending artery; *VSP*, ventricular septal perforation.

reactive protein level of 17.8mg/dl, aspartase aminotransferase of 29 IU/l, alanine aminotransferase of 62 IU/l, lactate dehydrogenase of 823 IU/l, creatine phosphakinase of 105 IU/l, and creatine kinase myocardial band of 6 IU/l. An electrocardiogram revealed a QS pattern with ST elevation in leads V_1 through V_4, indicating acute anteroseptal infarction. On chest X-ray, the cardiothoracic ratio was 62%, and pulmonary congestion was observed in the bilateral lungs. Ultrasonography indicated shunting from the left to the right ventricle (Fig. 1). The left ventricular diastolic dimension was 46 mm, and compensatory enlargement of the left ventricle was not marked, probably due to the disease phase being acute.

A coronary angiogram revealed 75% stenosis in the right coronary artery #3, 99% stenosis in the left anterior descending coronary artery #7, and 90% stenosis in the left circumflex coronary artery #13. The magnitude of the right-to-left shunt (pulmonary-to-systemic flow ratio) was 2.4. The pulmonary arterial pressure was 39/13 mmHg, indicating mild pulmonary hypertension. The left ventricular ejection fraction was 39%.

These findings led to a diagnosis of VSP associated with AMI. Then intra-aortic balloon pumping support was initiated. On September 11, complete atrioventricular block occurred, and the pulse rate decreased to 30/min. The blood pressure dropped to 80 mmHg in systole, and there was renal hypofunction with a blood urea nitrogen level of 49 mg/dl and creatinine of 1.5 mg/dl. ST elevation was observed in leads II, III and aV_F on a second electrocardiogram. Areas supplied by the right coronary artery were thought to be at risk to ischemia, so emergency surgery was performed on the same day (at ten days after the AMI onset).

Operative findings: Employing a cardiopulmonary bypass, right coronary artery bypass surgery was performed using a saphenous vein graft, and the left ventricular anterior infarct was incised to identify the

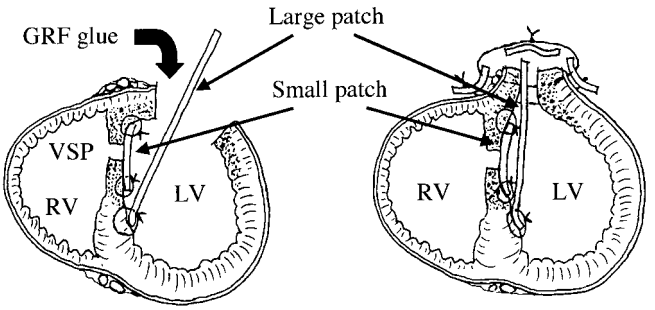

Fig. 3. Operative procedure
The gelatin resorcine formol glue was injected into the space between the small and large bovine pericardial patches.
LV, Left ventricle; *RV*, right ventricle; *VSP*, ventricular septal perforation; *GRF glue*, gelatin resorcine formol glue.

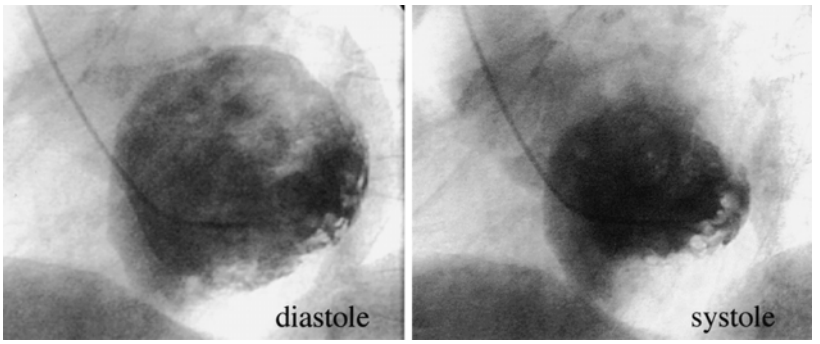

Fig. 4. Postoperative left ventriculography (left anterior oblique position) demonstrated no evidence of residual shunting.

VSP. The VSP was located in the center of the ventricular septum, and consisted of a fissure of 30×5 mm. The VSP was first closed with a small bovine pericardial patch, 30×40 mm, using continuous sutures. A large bovine pericardial patch, 40×60 mm, was then stitched onto a healthy margin, myocardium around the small patch, with continuous sutures (Fig. 2) on the ventricular side only. As shown in Fig. 3, the GRF glue was then injected into the space between the two patches, and the septum, including the small patch, and the large patch were cemented together to completely close the VSP. The left ventricular incision was closed, sealing with the large patch holding the VSP within it. Bovine pericardial strips and GRF glue were used for reinforcement. The operating time was 455 minutes, the cardiopulmonary bypass time was 307 minutes, and the aortic cross clamp time was 130 minutes. Postoperative course: On chest X-ray, the cardiothoracic ratio was reduced from 62% before surgery to 50% after surgery, and pulmonary congestion had improved. Postoperative bypass graft angiography demonstrated good patency in the saphenous vein graft anastomosed to the right coronary artery, and left ventriculography revealed no evidence of residual shunting (Fig. 4). Left ventricular stroke volume increased from 52 ml before surgery to 72 ml after surgery, the ejection fraction improved from the 39% before surgery to 48% after surgery, and the pulmonary arterial pressure was normalized. The patient made an uncomplicated recovery and was discharged from our hospital, with a favorable postdischarge course for 24 months to date after surgery.

Discussion

A VSP complication occurs after AMI in 1–3% of patients, mostly in those with an initial infarction. VSP has been reported to occur within 48 hours postinfarction in half the cases, and within one week in 95% of the cases. VSP develops commonly in the elderly, and volume overload is imposed on the left ventricle, due to decreased function caused by the infarction. Once VSP develops, cardiac failure develops rapidly and, because of shock, frequently progresses to multiple organ failure. Since the myocardium immediately post-infarction is fragile, therapeutic strategies for VSP have previously been to get through the acute phase with medical treatment, and then perform surgery in the chronic phase once fibrosis in the infarcted myocardium has developed. Cardiac

failure commonly progresses to multiple organ failure while waiting for surgery, however, losing the opportunity for surgery. Recently, with the development of circulatory assist devices, such as intra-aortic balloon pumping, and improvements in operative morbidity, there is a current trend towards early surgery.[6] Important considerations for acute-phase surgery include; (1) complete closure of the perforation via a left ventricular incision, (2) resection of the most fragile portion of the necrotic myocardium, (3) complete hemostasis of the left ventricular suture wounds, (4) prevention of excessive reduction in the left ventricular volume, and (5) simultaneous use of coronary artery bypass grafts. Complete closure of the VSP, without leaving any residual shunting, is essential.

The origin of our double-patch closure of VSP was based upon the Daggett technique. However, the present method seems to be superior to the aforementioned operative methods in this situation. Unlike the hemiexclusion technique using GRF glue performed by Skillington et al.,[7] we injected GRF glue into the space formed between the small patch attached to the infarct around the VSP and the large patch attached to the outside of the small patch, in order to prevent GRF glue flowing into the right and left ventricles. This technique was able to close the perforation with more certainty than the megapatch techniques. Since the use of GRF glue in the body has been associated with toxicity and a risk to thrombus,[8] care is required to prevent GRF glue entering the blood. On the other hand, GRF glue is said to be effective for tissue adhesion and hemostasis, and has been reported to enhance proliferation of collagen and elastic fibers histopathologically.[9] Recently, the successful use of new tissue bioadhesive for the repair of thoracic aortic dissection has been reported.[10] Bioglue generated only a minimal inflammatory response, and is therefore expected to provide benefit for a patient undergoing surgical repair of a VSP. Furthermore, since the large bovine pericardial patch is placed within the left ventricular incision, the fragile tissue around the VSP experiences left ventricular pressure on its surface, and is able to withstand internal pressure. In this surgical method, less direct stitching of the right ventricle is needed than in conventional methods, suggesting that it is effective in the preservation of right ventricular function.

Conclusion

We performed double-patch closure using GRF glue in a patient with VSP following AMI, and were able to close completely the perforation. The advantages of this method include the following; (1) a more reliable closure of the perforation, (2) since a large septal patch is applied, the left ventricular pressure imposed on tissue around the VSP is absorbed by the patch surface, and (3) preservation of the right ventricular function is possible, since the right ventricle is minimally trimmed. This surgical method can therefore be considered an effective technique for acute-phase closure of VSP.

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