Scientific Research Publishing

World Journal of Cardiovascular Surgery, 2020, 10, 122-130
https://www.scirp.org/journal/wjcs
ISSN Online: 2164-3210
ISSN Print: 2164-3202

Total Transmural Sutures (TTS) Method, Modified Infarction Exclusion Technique for Ventricular Septal Rupture after Extensive Myocardial Infarction

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How to cite this paper: Morimoto, K., Fujiwara, Y., Sasami, T., Kumagai, K. and Nii, R. (2020) Total Transmural Sutures (TTS) Method, Modified Infarction Exclusion Technique for Ventricular Septal Rupture after Extensive Myocardial Infarction. *World Journal of Cardiovascular Surgery*, **10**, 122-130.
https://doi.org/10.4236/wjcs.2020.107015

Received: June 17, 2020
Accepted: July 14, 2020
Published: July 17, 2020

Abstract

The infarction exclusion technique using endoventricular continuous sutures for ventricular septal rupture after acute myocardial infarction may be a difficult surgical technique and create residual shunt due to fragile myocardium. We present a patient of ventricular septal rupture (VSR) after extensive anteroseptal myocardial infarction who underwent successful repair using a modified infarction exclusion technique. In our procedure interrupted mattress sutures were placed through the ventricular wall in a way as to exclude the VSR and infarcted muscle of the left ventricle. A heterogeneous pericardial patch is sutured to healthy endocardium in the free and septal wall all around the infarcted area. We describe a procedure for repairing postinfarction VSR, by the infarction exclusion technique with total transmural sutures (TTS) method.

Keywords

Infarction Exclusion Technique, Ventricular Septal Rupture, Myocardial Infarction

1. Introduction

Operation for postinfarction ventricular septal rupture (VSR) is associated with high operative mortality in the acute phase of the myocardial infarction. The conventional procedure established by Daggett *et al.* [1] has been reported to prolong postoperative heart failure and result in high mortality especially in extensive myocardial infarction [2]. The infarction exclusion technique proposed

by David *et al.* [3] and Komeda *et al.* [4] has the advantage of postoperative right and left ventricular function, however the exclusion procedure may be a difficult surgical technique and create residual shunt due to fragile myocardium from using endoventricular continuous sutures [5] [6]. Gerola *et al.* [7] reported a method using transmural sutures and a patch for reinforcement of septal wall. Although this method could prevent residual shunt, it is basically considered to be a similar method to the Daggett's original. Therefore, it seems unsuitable for some cases with a large VSR and/or a widespread infarction. Our method is presented here as a procedure to prevent residual shunt by transmural sutures and exclude an infarcted area with a large patch to suppress the adverse effects on the remaining functional myocardium. We describe a procedure performed with a modification of the infarction exclusion technique to dispel some concerns.

2. Case Report

A 53-year-old male patient was referred to our institution with acute myocardial infarction. He complained of anterior chest pain. His blood pressure was 80/57 mmHg and heart rate was 120 beats/min. A twelve-lead electrocardiogram showed abnormal Q wave and T wave elevation in V2 - V5. A chest radiograph demonstrated mild cardiac enlargement with a cardiothoracic ratio of 0.54 and severe pulmonary congestion (**Figure 1**). Echocardiograph revealed an akinetic left ventricle (LV) at the apex and anteroseptal wall, and a large left-to-right shunt at the ventricular level (**Figure 2**). Cardiac catheterization showed that there was a shunt ratio of 61.7%, a pulmonary to systemic flow ratio of 2.61, pulmonary arterial mean pressure of 24 mmHg, and pulmonary capillary wedge pressure of 18 mmHg. Left ventricular stroke volume (index) was 20.0 ml/beat (12.8 ml/beat/m^2) and the cardiac output (index) was 2.40 l/min (1.54 l/min/m^2) measured by Fick method. Coronary angiogram showed a total occlusion in the proximal lesion of the left anterior descending artery (LAD) (**Figure 3**). During the catheter examination, an intraaortic balloon pump (IABP) was inserted due to cardiogenic shock.

Figure 1. A preoperative chest radiograph shows mild cardiac enlargement with a cardiothoracic ratio of 0.54 and severe pulmonary congestion.

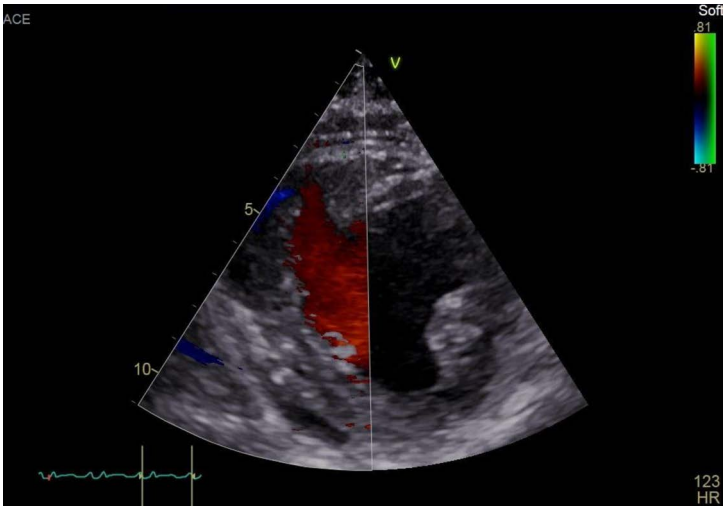

Figure 2. A preoperative echocardiograph shows a large left-to-right shunt at the ventricular level.

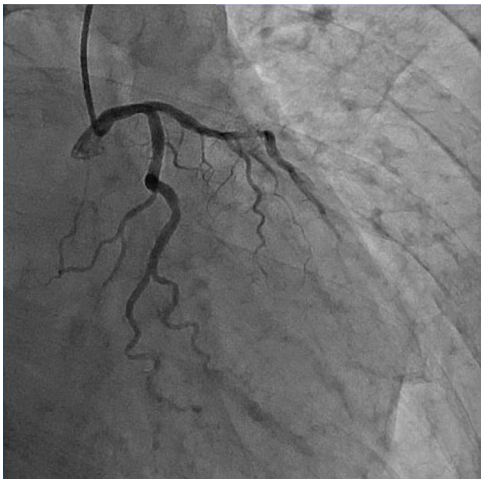

Figure 3. A coronary angiogram shows a total occlusion in the proximal lesion of the left anterior descending artery.

The patient was taken to the operating room immediately to repair the VSR. The operation was performed with cardiopulmonary bypass under mild systemic hypothermia. Cardiac arrest was accomplished by infusion of cold blood cardioplegia. Color tone changed, dark red LV was located on the anterior-apical portion. A left anterior ventriculotomy was made parallel to the LAD. A VSR was identified in the midportion of the ventricular septum. The infarcted septal wall appeared fragile. No infarcted tissue was excised. A heterologous pericardial patch preserved by a glutaraldehyde chemical fixation process was tailored in an oval shape of 6 × 7 cm. The pericardial patch was sutured with 3-0 polypropylene horizontal mattress sutures along the line of the lower part of the non-infarcted ventricular wall. The mattress sutures were brought outside the heart on the left ventricular free wall (anterior wall, apex and postero-inferior wall), and the other mattress sutures were brought outside the heart on the right ventricle (RV) of

just the right side of LAD in upper part of the heart (Figure 4). Technically, the interrupted mattress sutures on the left ventricular free wall (anterior wall, apex and postero-inferior wall) were placed sequentially through Teflon felt pledgetson the epicardial surface of LV, left ventricular wall, the heterologous pericardial patch on endocardium (Figure 5(a), Figure 5(b)), andthe other interrupted mattress sutureson the RV in the upper level of the heartwere placed sequentially through Teflon felt pledgets on the epicardial surface of RV, right ventricular wall, ventricular septum, the heterologous pericardial patch on endocardium (Figure 4(a), Figure 4(c)). Further a tongue-shaped Teflon felt patch was sutured to the septal wall side of left ventricular lumenon the postero-inferior and upper septal suture line of the heterologous pericardial patch (Figure 6). And a biological glue was applied to the space between the tongue-shaped Teflon felt patch on the interventricular septum and the heterologous pericardial patch. The ventriculotomy was closed using a 3-0 polypropylene buttress suture with a Teflon felt strip on either side of the incision and including the free edge of the tongue-shaped Teflon felt patch (Figures 7(a)-(c)). Then an aortocoronary bypass to the LAD was performed using a saphenous vein graft. The cardiopulmonary bypass weaning was smoothly. The patient was weaned from IABP at 3 days after the operation. He needed to wear a ventilator for 17 days due to postoperative hypoxemia, but recovered satisfactorily thereafter. Postoperative Swan-Ganz catheter examination revealed no residual shunt and pulmonary arterial mean pressure of 22 mmHg. The cardiac output (index) was 4.4 l/min (2.8 l/min/m^2) with a heart rate of 81 beats/min. The left ventricular ejection fraction was 46%. A postoperative chest radiograph demonstrated a normal cardiothoracic ratio of 0.46 and no pulmonary congestion (Figure 8). He has been well with New York Heart Association (NYHA) Class I for 3 years after the operation without heart failure. The local ethical committee approved this case report, and we obtain informed consent from the patient.

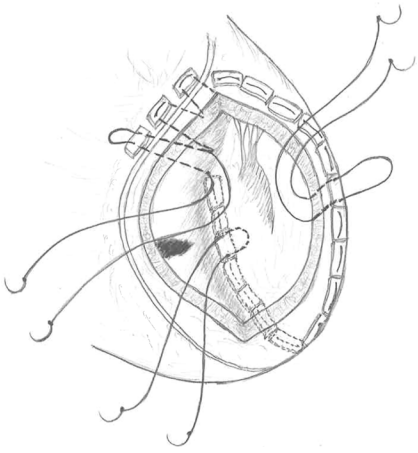

Figure 4. A schematic illustration shows the mattress sutures are brought outside the heart on the left ventricular free wall (anterior wall, apex and postero-inferior wall), and the other mattress sutures are brought outside the heart on the right ventricle of just the right side of left anterior descending coronary artery in upper part of the heart.

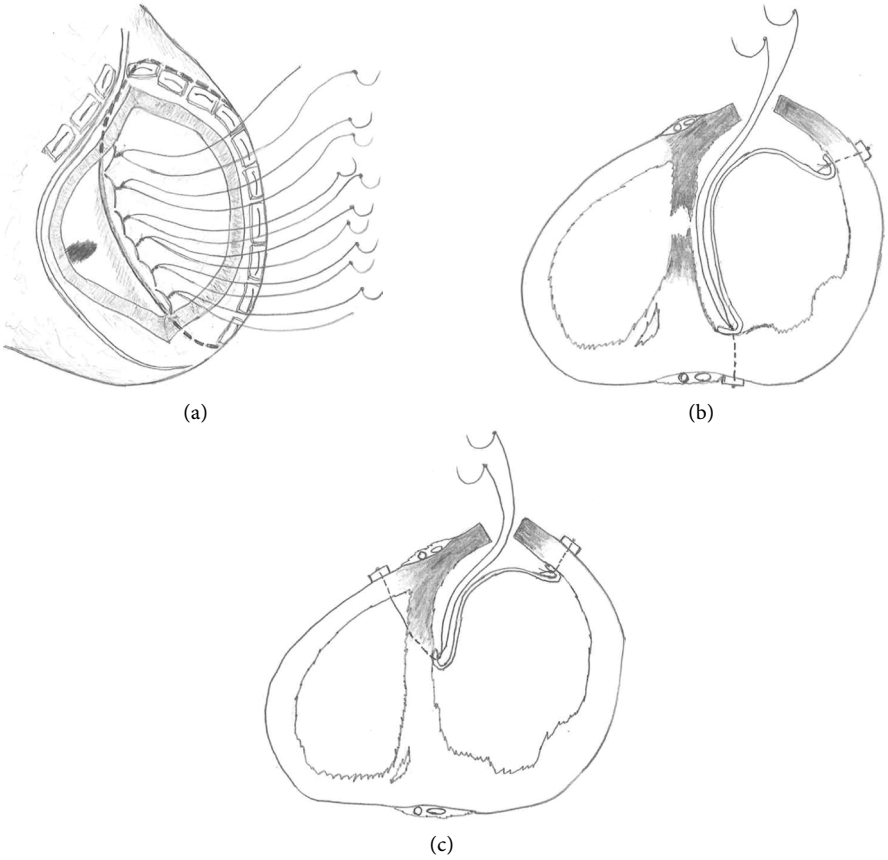

Figure 5. Schematic illustrations show the interrupted mattress sutures on the left ventricular free wall (anterior wall, apex and postero-inferior wall) are placed sequentially through Teflon felt pledgets on the epicardial surface of left ventricle, left ventricular wall, the heterologous pericardial patch on endocardium (a) (b), and the other interrupted mattress sutures on the right ventricle in the upper level of the heartare placed sequentially through Teflon felt pledgets on the epicardial surface of right ventricle, right ventricular wall, ventricular septum, the heterologous pericardial patch on endocardium (a) (c). (b) Across section at the middle (ventricular septal rupture) level of the heart. (c) Across section at the upper level of the heart.

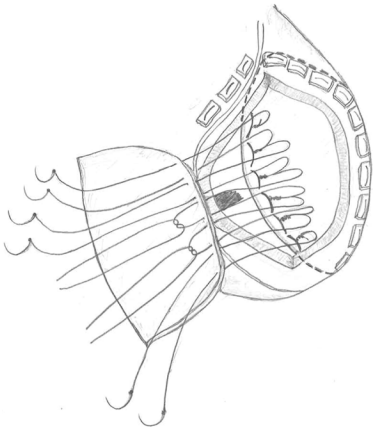

Figure 6. A schematic illustration shows a tongue-shaped Teflon felt patch is sutured to the septal wall side of left ventricular lumen on the postero-inferior and upper septal suture line of the heterologous pericardial patch.

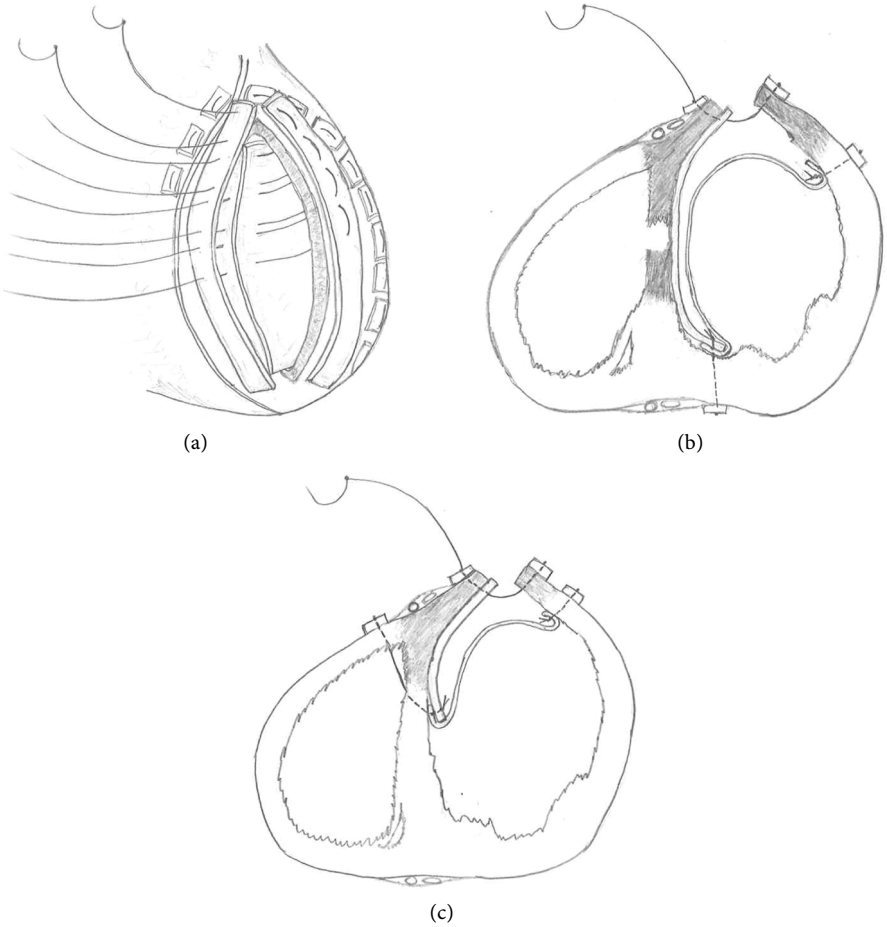

Figure 7. A schematic illustration (a) shows the ventriculotomy is closed using a buttress suture with a Teflon felt strip on either side of the incision and including the free edge of the tongue-shaped Teflon felt patch. (b) Across section at the middle (ventricular septal rupture) level of the heart. (c) Across section at the upper level of the heart.

Figure 8. A postoperative chest radiograph shows a normal cardiothoracic ratio of 0.45 and no pulmonary congestion.

3. Discussion

Despite the evolution in surgical treatment of patients with heart failure, mortality and morbidity rates of postinfarction VSR remain high. The prognosis of the VSR is related to the residual shunt and the postoperative cardiac function. Repair of postinfarction VSR using infarction exclusion technique [3] [4] has been reported to be excellent in restoring postoperative ventricular function as compared with traditional operative technique, infarctectomy and reconstruction of the left and right ventricular walls [1]. However, the infarction exclusion technique is technically difficult due to the need for repair with a continuous suture requiring a large patch placed for uneven ventricular cavityin a three-dimensional manner. Some reports described residual shunt after the infarction exclusion operation [5]. In the acute phase of myocardial infarction the margin between infarcted and healthy myocardium was often unclear. The technique may be insufficient for suturing fragile myocardium in the acute phase of myocardial infarction. In our method a pericardial patch is anchored tightly to endocardium with transmural sutures, therefore our technique may reduce the risk of residual shunt. The method allows fairly easy suture of pericardial patch to exclude the infarcted area. Gerola *et al.* [7] reported a method using transmural sutures and a patch for reinforcement of septal wall with an emphasis on preventing residual shunt, however it is basically considered to be a similar method to the Daggett's original. Therefore, it seems unsuitable for cases with a large VSR and/or a widespread infarction. Our method is presented here as a procedure to prevent residual shunt by transmural sutures and exclude an infarcted area with a large patch to suppress adverse effects on the remaining functional myocardium.

And we added a tongue-shaped large Teflon felt patch to the septum wall side, furtherapplieda biological glue to the space between the Teflon felt patch on the interventricular septum and the pericardial patch. We believe these additional reinforced measures could result in less residual leakage and bleeding. Musumeci *et al.* [8] reported the application of gelatin-resorcin-formol (GRF) biological glue in the space between the pericardial patch and infarcted septum. Theoretically the method may contain the risk of contamination of the systemic circulation with formaldehyde because GRF glue is directly applied on the interventricular septum with a ventricular septal defect. Our method prevents the risk by the Teflon felt patch being on the interventricular septum.

Once we reported a transmural suture technique for postinfarction VSR [9]. In the procedure the interrupted mattress sutures to exclusion the midportion of ventricular septum were placed on the septal wall of non-infarcted LV to anchor the pericardial patch through the RV. We considered to minimize adverse effects on right ventricular functionin this current patient with an extensive myocardial infarction, and placed the interrupted mattress sutures along the inferior interventricular groove on postero-inferior wall of the LVto exclusion the midportion of the ventricular septum.

The concern about our operative technique is the effect on right ventricular function because the interrupted mattress sutures on the septal wall in upper part

of the LV are anchored to the RV and reduce a part of right ventricular space. The other concern is the myocardial damage of the transfixed suture line. The postoperative cardiac catheter study demonstrated normal pressure, cardiac output and contraction of the left ventricular wall except for the infarcted anteroseptal wall. These drawbacks could be minimized. The patient has had a good postoperative course without formation of left ventricular aneurysm and heart failure in the midterm follow-up.

4. Conclusion

We report a case of VSR after extensive anteroseptal myocardial infarction that underwent successful surgical treatment using a modified infarction exclusion technique, specifically total transmural sutures (TTS) method. This procedure is technically easy and can be effective for the surgical treatment of postinfarction VSR.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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