Chinese Medical Journal®

A new surgical technique for post-myocardial infarction ventricular septal rupture with hemodynamic instability

Chao Liu[1], Li-Li Xiao[2], Lu Wang[2], Fu-Qiang Sun[1], Xing-Xing Yao[1], Yan-Zhou Zhang[2], Xiao-Yan Zhao[2], Ling Li[2], Xiao-Fang Wang[2], Jian-Zeng Dong[2,3]

[1]Department of Cardiovascular Surgery, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan 450052, China;
[2]Department of Cardiology, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan 450052, China;
[3]Department of Cardiology, Beijing Anzhen Hospital, Capital Medical University, Beijing 100029, China.

Ventricular septal rupture (VSR) is a rare but lethal complication of acute myocardial infarction (AMI).[1] Emergent repair surgery provides the only chance for survival for patients with VSR; however, the perioperative mortality rate remains extremely high at the early phase.[2] Elective surgery is widely utilized in real-world clinical practice and is associated with improved prognosis.[3] Nevertheless, the results of elective surgery might be a manifestation of survival bias, as it is usually performed in relatively stable patients with VSR who are expected to survive the early stage and have a better prognosis than patients complicated with hemodynamic instability in the early stage.[4] In this study, we aimed to present a novel surgical repair technique that can be safely, feasibly, and effectively used in hemodynamically unstable patients with VSR in the acute phase and to report the preliminary results.

This new surgical technique, named surgical repair combining an occluder and a patch (SurCOP), combines the use of a patent ductus arteriosus (PDA) occluder with a slightly larger bovine pericardial patch to close the rupture site [Figure 1A–L]. The procedure was performed via a median sternotomy under general anesthesia. Cardiopulmonary bypass and moderate systemic hypothermia were used for myocardial protection. The rupture site was approached through a longitudinal left ventriculotomy in the infarcted area, approximately 1 to 2 cm away from the left anterior descending coronary artery. After debriding the surrounding necrotic infarcted myocardium (not including the VSR surrounding myocardium) as much as possible, a corresponding T-shaped PDA occluder (Cardi-O-Fix, Starway Medical Technology, Beijing, China) was placed to close the VSR site directly through the ventriculotomy incision, with its cylindrical part filling the rupture site and the aortic retention disc facing the left ventricular (LV) side. The aortic retention disc was fixed to the surrounding septal myocardium at the 3, 6, 9, and 12 o'clock positions with mattress-sutured using sutures with gaskets. Thereafter, a bovine pericardial patch was trimmed to be slightly larger than the PDA occluder, applied to cover the aortic retention disc, and continuously sutured to the adjacent myocardium. Finally, the ventricular incision was closed with sutures buttressed on felt strips and reinforced using surgical glue.

Between August 2017 and May 2019, nine patients underwent this surgical approach. This study is followed in accordance with the 1964 *Helsinki Declaration* and its later amendments or comparable ethical standards. Informed consent was obtained from each patient. The detailed in-hospital data of the nine patients were collected. Once a VSR diagnosis was established, the patients were placed under close monitoring of hemodynamic status, consistent urine output, creatinine level, liver enzymes, and blood lactate level. At the same time, they were administered volume expansion, vasopressors, and inotropes, with additional therapy to prevent or treat multiorgan dysfunction syndrome. Any change suggesting a deterioration of the patient's clinical status signals the need for immediate intervention; otherwise, the repair operation would be delayed by medication treatment or intra-aortic balloon pumping (IABP), non-invasive positive pressure ventilation, respirator installation, or extracorporeal membrane oxygenation (ECMO).

Access this article online

Quick Response Code:

Website: www.cmj.org

DOI: 10.1097/CM9.0000000000001442

Chao Liu and Li-Li Xiao have contributed equally to this work.

Correspondence to: Xiao-Fang Wang, Department of Cardiology, The First Affiliated Hospital of Zhengzhou University, No. 1 Jianshe East Road, Zhengzhou, Henan 450052, China
E-Mail: fccwangxf6@zzu.edu.cn

Chinese Medical Journal 2021;134(8)
Received: 22-12-2020 **Edited by:** Ning-Ning Wang

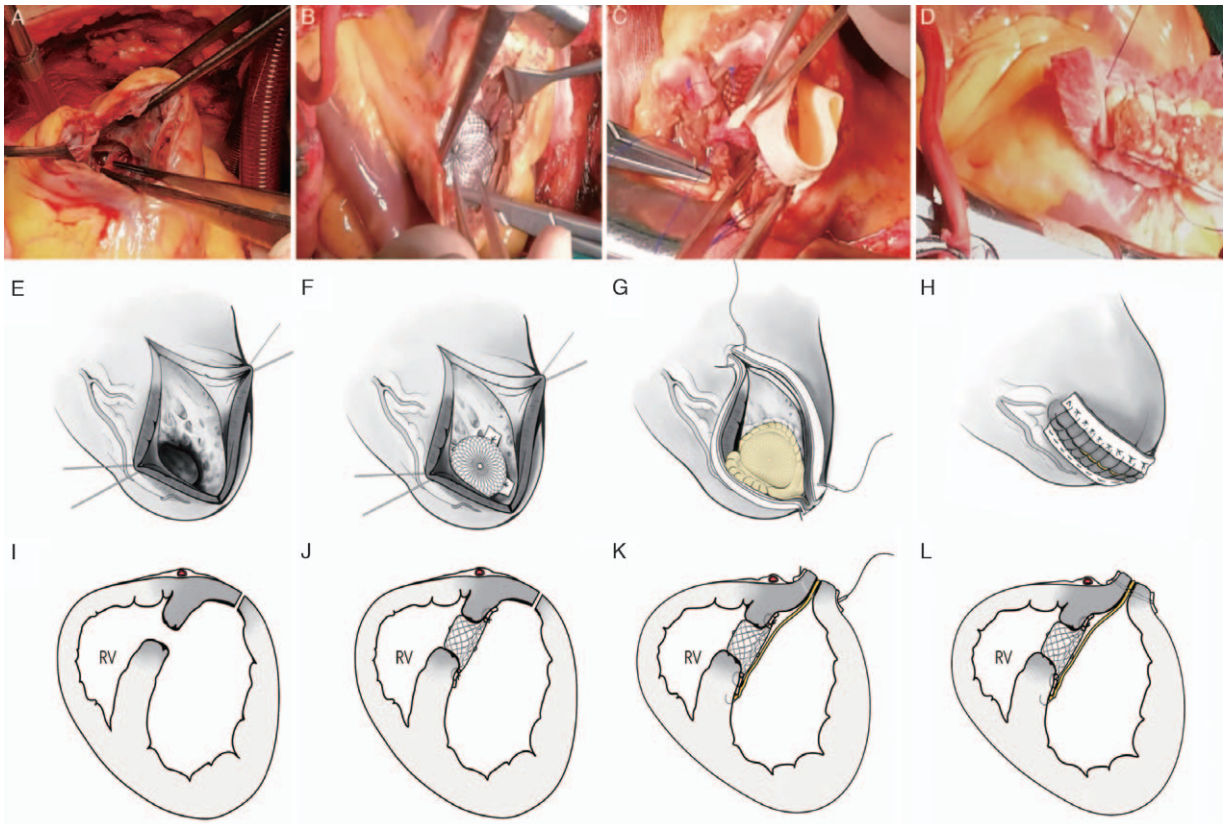

Figure 1: Schematic drawings of SurCOP. (A) Longitudinal ventriculotomy to reach the VSR. (B) PDA occluder placed into the rupture site. (C) Bovine pericardial patch covered the occluder on the LV side. (D) Closing of ventricular incision. (E–H) LV longitudinal view of SurCOP. (I–L) A cross-sectional view of SurCOP. LV: Left ventricle; PDA: Patent ductus arteriosus; SurCOP: Surgical repair combining occluder and patch; VSR: Ventricular septal rupture.

After the surgery, patient survival data, additional complications (eg, low cardiac output syndrome [LCOS], renal failure requiring renal replacement therapy [CRRT], post-operative residual shunt, hemolysis, and pneumonia), and length of stay in the intensive care unit were recorded.

Kaplan-Meier curve analysis and log-rank test were used to calculate the survival difference between the nine patients with VSR who underwent SurCOP repair surgery and another 54 patients with VSR who received conservative therapy using GraphPad Prism v9.0 (GraphPad Software, La Jolla, CA, USA) [Supplementary Figure 1, http://links.lww.com/CM9/A507].

Before the surgery, three patients were supported with inotropes, six patients were sustained with IABP, and one patient received IABP and ECMO. Eight patients underwent SurCOP within 14 days, and one patient underwent the surgery on day 23. The VSR was located in the apical area in five patients, the anterior area in two patients, and the posterior area in two patients. The rupture was reached through the ventricular aneurysm in four patients, through the LV apical region in two patients and the LV posterior region in two patients, and was parallel to the left posterior descending branch in one patient. The mean size of the VSR was 15.0 mm (14.5–20.0 mm). The PDA occluder was correspondingly chosen from sizes of 16/18 to 24/26, and the patch was trimmed according to the size of the occluder. The PDA occluder and patch were all successfully deployed without any sizing-related complications. Additional operations, as necessary to the individual patient's condition, were also performed during the surgery, including coronary artery bypass grafting operation in five patients (left anterior descending coronary in three patients, right coronary artery in two patients), ventricular aneurysm resection in five patients, and tricuspid annuloplasty in one patient.

After the surgery, three patients were further supported with IABP and two patients needed CRRT. Two patients died: one patient at 7 days after the surgery and one patient at 44 days after the surgery. Neither of the two deaths was caused by LCOS. The remaining seven patients showed excellent outcomes. The 30-day mortality rate was 11.1% (1/9). Patients who survived for 30 days were scheduled for follow-up until the end date of the study (August 20, 2019). The follow-up continued until 187 days (interquartile range 70–550 days), and the overall mortality rate was 22.2% (2/9). The details of clinical characteristics on admission and the perioperative data are shown in Supplementary Tables 1 and 2, http://links.lww.com/CM9/A507.

Hemodynamically unstable VSR as a complication of AMI is considered a surgical emergency; however, surgery is associated with high mortality if performed within 2 weeks.[3] In the real-world setting, surgical repair is often postponed for 4 to 6 weeks.[5] However, a timely operation

is the only life-saving treatment for hemodynamically unstable patients. Currently, the David infarct exclusion technique has been widely used in surgical procedures. The use of patch exclusion closure is the real advancement in the treatment of this complication; however, insertion of a large patch that bears strong tension might tear off the friable myocardium from the suture line, which can result in the major operative complication of concern, post-operative residual shunt, which has been considered the most important risk factor for poor outcomes.[6] Percutaneous transcatheter closure has recently emerged as a potential strategy; however, it is mainly restricted to patients with a small VSR in the sub-acute or chronic phase. When applied in more advanced cases, it is associated with high operative mortality.[7]

Based on our experience with the surgical repair of VSR, we believe that the VSR closure material is the most crucial factor in the repair approach. The material should satisfy the following criteria: The material could be precisely released without enlarging the rupture or tearing off the rest of the fragile myocardium, should remain stable under persistent exposure to high left-to-right pressure gradient, and could reliably prevent the remaining shunt and maintain cardiac function after the surgery. The combination of a T-shaped PDA occluder and a slightly larger patch in the VSR site is a suitable candidate. Together, the occluder and patch can be released and fixed at the rupture location directly through the intuitively open heart. This double fixation could avoid device dislocation, valve impingement, and ventricular rupture enlargement. Most importantly, they could bear the high pressure of the LV load, thus avoiding potential tension to the infarction and preventing residual shunt formation. In addition, by debriding the necrotic myocardium as much as possible and mattress suturing with felt strips with surgical glue reinforcement, the ventriculotomy was successfully closed in all nine patients. Moreover, if the myocardial infarction is large, extension with another bovine pericardial patch to support the suture in the non-infarcted area can be considered; however, it was not needed in our initial cases.

Because of the infrequent occurrence of VSR to date, our study had a relatively small sample size, which is the major limitation of this study. Nevertheless, our experience has shown that the SurCOP technique is a safe, easy-to-manipulate, and effective method. We hope that we could receive feedback from surgeons who will attempt performing this alternative therapeutic technique and work together to improve the prognosis of patients with VSR.

Conflicts of interest

None.

References

1. Fu Y, Li K-B, Yang X-C. A risk score model for predicting cardiac rupture after acute myocardial infarction. Chin Med J 2019;132:1037–1044. doi: 10.1097/CM9.0000000000000175.
2. Omar S, Morgan GL, Panchal HB, Thourani V, Rihal CS, Patel R, *et al*. Management of post-myocardial infarction ventricular septal defects: a critical assessment. J Interv Cardiol 2018;31:939–948. doi: 10.1111/joic.12556.
3. Papalexopoulou N, Young CP, Attia RQ. What is the best timing of surgery in patients with post-infarct ventricular septal rupture? Interact Cardiovasc Thorac Surg 2013;16:193–196. doi: 10.1093/icvts/ivs444.
4. Thiele H, Ohman EM, de Waha-Thiele S, Zeymer U, Desch S. Management of cardiogenic shock complicating myocardial infarction: an update 2019. Eur Heart J 2019;21:2671–2683. doi: 10.1093/eurheartj/ehz363.
5. Shahreyar M, Akinseye O, Nayyar M, Ashraf U, Ibebuogu UN. Post-myocardial infarction ventricular septal defect: a comprehensive review. Cardiovasc Revasc Med 2018;18:6–11. doi: 10.1016/j.carrev.2018.11.017.
6. Murday A. Optimal management of acute ventricular septal rupture. Heart 2003;89:1462–1466. doi: 10.1136/heart.89.12.1462.
7. Calvert PA, Cockburn J, Wynne D, Ludman P, Rana BS, Northridge D, *et al*. Percutaneous closure of postinfarction ventricular septal defect in-hospital outcomes and long-term follow-up of UK experience. Circulation 2014;129:2395–2402. doi: 10.1161/CIRCULATIONAHA.113.005839.

How to cite this article: Liu C, Xiao LL, Wang L, Sun FQ, Yao XX, Zhang YZ, Zhao XY, Li L, Wang XF, Dong JZ. A new surgical technique for post-myocardial infarction ventricular septal rupture with hemodynamic instability. Chin Med J 2021;134:981–983. doi: 10.1097/CM9.0000000000001442