

## Long-term outcomes after repair with topical surgical adhesive glue in patients with post infarction left ventricular rupture

Abdallah Alameddine\*; Brian Binnall; Paul Silvi; Frederick Conlin

**\*Corresponding Author(s): Abdallah Alameddine**

Divisions of cardiac surgery, Baystate Medical Center, 759 Chestnut Street, Springfield, MA 01107, USA.  
Phone: 413-794-5303, Fax: 413-794-4212; Email: akalameddine@gmail.com

### Abstract

Left Ventricular (LV) rupture following myocardial infarction is a devastating complication of ischemic heart disease. An emergency operation remains the best option to salvage this desperately ill group of patients. Data on long-term outcomes in patients after LV rupture treated topically with adhesive glue to mitigate bleeding are lacking. We report a retrospective review of four patients. The study of this cohort was conducted at our institution from 2001 to 2005 with complete available data up to 18-year analysis. The mean age at the time of initial operation was  $69.5 \pm 12.2$  years, and the mean follow-up was  $12 \pm 4.4$  years. Associated coronary bypass grafting was performed in two patients, and urgent mitral valve replacement was required in one patient due to papillary muscle rupture. There were no early surgical deaths, and no patients required subsequent re-intervention. The freedom from LV re-rupture was 100 % as was freedom from pseudo-aneurysm formation. Postoperative arrhythmias were common. There were two late deaths at six and 10 years postoperatively. Prospective trials are needed to further assess longevity and risks of the procedure.

### Keywords

glue; biogluce; LV rupture; myocardial infarction; repair.

### Introduction/ Background

Post-infarction left Ventricular (LV) rupture leads to cardiogenic shock and pulmonary edema due to combination of pump failure and cardiac tamponade. The clinical deterioration usually progresses rapidly in these patients. This progression could be temporarily reversed by initiating infusion of large doses of inotropes, insertion of an intra-aortic balloon pump or more recently by mechanical ventricular assist devices [1,2]. The diagnosis is usually confirmed by echocardiography, and cardiac catheterization. The only treatment that can address this lethal complication is an emergency operation as conventional medical therapy usually fails. Following intervention, survival may not be achieved because the myocardium in

the area of LV rupture is often necrotic, fragile, and unable to adequately retain sutures.

Non-resorcinol glutaraldehyde-based glue (BioGlue<sup>®</sup>, Cryolife Inc, Kennesaw, GA) is an FDA approved surgical adhesive that has been used as an adjunct to adhesion and hemostasis since 1998. It can be applied either to create a flexible mechanical seal independent of the body's hemostatic pathways, or to bolster patch repair of the LV rupture. Another adhesive is ethyl cyanoacrylate (Krazy Glue<sup>®</sup>, Elmer's, Westerville, OH). It comes in one-drop applicator tube. It works in as little as 30 seconds, forming an extremely strong bond. The tube is sterilized by immersion in alcohol or Betadine solution for 3 minutes before use. Data on the long-term durability of repair represents an important information gap, especially considering the potential local myocardial toxicity of these topical hemostatic adjuncts.

The purpose of this study was to determine the longevity of this method of repair in patients with acute ischemic LV rupture secondary to myocardial infarction. We present a case-series of four patients with long-term follow-up in which operative intervention was performed to illustrate the settings in which the surgical glue was used.

## Patients & methods

This is a retrospective study of patients who have undergone surgical repair of LV rupture using BioGlue or Krazy Glue to reinforce patch repair. All patients received care at our institution from February 2, 2001 through September 9, 2005. Institutional Review Board provided research authorization and waived informed consent from patients. Perioperative clinical data and follow-up information were obtained from our cardiovascular registry database and clinic notes. We reviewed the outcomes of those patients.

## Surgery

All repairs were performed through median sternotomy. For the repair, the patient's pericardium or bovine patch was used. BioGlue with reinforcement of the repair by felt strip is used (as in case # 1), or Krazy Glue (as in cases # 2, 3, and 4). On the basis of being labeled non-sterile and despite on bench immersion in antiseptic solutions, when Krazy Glue is used a second antibiotic (usually Vancomycin) should be administered. All four patients survived the intervention. The mean length of hospital stay was  $20 \pm 16.5$  days.

Our surgical approach depends on the degree of myocardial necrosis and the extent of the gap. If bleeding is noted to be diffuse by diapedesis only, BioGlue should be broadly placed on that site with a pericardial patch apposition. If a large gaping tear is encountered in the center of the infarct, 2-0 braided pledgetted mattress sutures MH ½ circle taper needles (Deknatel Sutures by Teleflex Medical, Morrisville, NC) with felt strip buttress may be necessary for a robust repair.

Additional interrupted sutures or a second layer of 3-0 monofilament placed at the edge of viable myocardium may be used for further hemostasis. A dry field is paramount for the successful use of the glue. Thus, the glue application must be completed during cardioplegic arrest with the LV totally empty. If bleeding reoccurs following myocardial contractility and with increased LV pressure, the glue may be reapplied

with or without additional sutures, but only after the re-institution of cardiopulmonary bypass and cardioplegic arrest with an established LV venting.

## Results

The clinical surgical data and outcomes are outlined in the Table 1 below.

**Table 1:** Demographics, procedures and outcomes of patients.

#	Age/year sex	Diagnosis	Procedure	Procedure date	LOS/days	Comorbidity	Bioglue patch	Re-rupture	Present condition	Follow-up/ Years
1	62 F	Inferior MI	Emergent repair/posterior LV rupture IABP BT 87 min CT 45 min	2001	6	HTN HLD PVD DM RA	Yes	No	Alive & well	18
2	58 F	Inferior/MI Cardiogenic shock Severe MR	CABGx2 (SVG-LAD, SVG-RCA), MVR Repair of LV rupture IABP BT 144 min CT 108 min	2005	10	CAD HLD CHF CKD COPD PVD	Yes	No	Alive & well	15
3	84 F	MI	CABG repair of contained LV rupture BT151 min CT 98 min	2003	16	AF,CAD HFrEF HTN HLD PVD		No	Died of ovarian cancer	6
4	72 M	MI, PCI/ OM2	Repair LV rupture, CABGx2 (LIMA-LAD, SVG-RCA) BT 91 min CT 71 min	2005	12	HLD CAD	Yes	No	Died of viral illness	10

AF: Atrial fibrillation; BT: Bypass Time; CABG: Coronary artery bypass grafting; CAD: Coronary artery disease; CHF: Congestive heart failure; CKD: Chronic kidney disease; CT: Clamp Time; COPD: Chronic obstructive pulmonary disease; DM: Diabetes mellitus; HFrEF: Heart failure with reduced ejection fraction; HLD: Hyperlipidemia; HTN: Hypertension; LAD: Left anterior descending; LIMA: Left internal mammary artery; LOS: Length of hospital stay; LV: Left ventricle; MI: Myocardial infarction; MR: Mitral regurgitation; MVR: Mitral valve replacement; PAD: Peripheral artery disease; PCI: Percutaneous coronary intervention; RA: Rheumatoid arthritis; RCA: Right coronary artery; SVG: Saphenous vein graft.

**Early outcomes:** There was no early postoperative in-hospital death. The mean length of hospital stay was 20 ± 16.5 days.

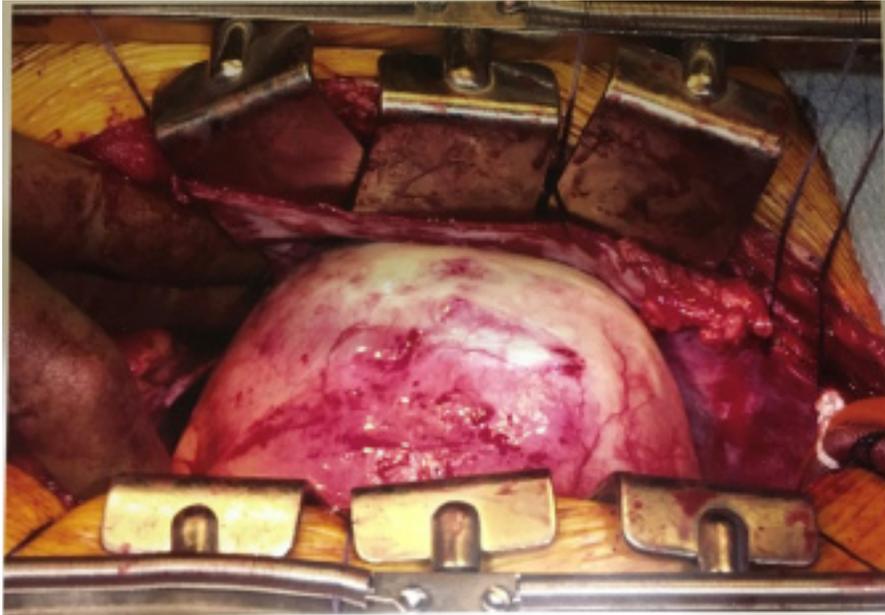
**Late outcomes:** Mean follow-up was 51 ± 9 months and median follow-up was 60 months (range. 72-226 months). During follow-up, clinical data were available for all patients. Overall survival at 5, 10, and 15 years was 100 %, 75 %, and 50 % respectively. Of note, late deaths occurred in two patients from non-cardiac causes.

## Case Series

**Case 1:** A 62-year-old woman was admitted with a 4-day history of chest pain. Posterior myocardial infarction secondary to circumflex coronary artery occlusion was diagnosed on electrocardiogram and coronary angiogram. Cardiogenic shock occurred following coronary stenting of the culprit vessel. Inotropes were administered and an intra-aortic balloon pump was introduced. A large pericardial effusion with tamponade physiology was demonstrated on transthoracic echocardiography. Infero-lateral akinesis overlying a thinned area of myocardium that is adjacent to the postero-medial papillary muscle was also present. That area had slow flow penetrating into the pericardium which was confirmed by injection of contrast material. There was mild mitral regurgitation. Cardiopulmonary bypass (CPB) was instituted and the heart was arrested with antegrade and retrograde warm cardioplegia. There was large amount of blood and clots present in the pericardium contributing to tamponade physiology. In addition, there was a large inferior infarct with a central necrotic area near the coronary sinus at the base of the heart. The ruptured area, which was 4x2 cm in size, was large enough that simple application of the adhesive was thought to be inadequate. Hence pledgetted sutures were used to close the defect that was approximated using two longitudinal buttressing felt strips and horizontal mattress with # 0 Tefdek sutures. The sutures were tied just snug enough to avoid tearing of the sutures in a friable myocardium. Resection of necrotic myocardium was not attempted due to the proximity of the papillary muscle insertion site. BioGlue placement was necessary to cover over the myocardium and the felt strips preventing further bleeding from needle holes. Hospital course was uneventful with the exception of episodes of atrial flutter. The patient was discharged on the sixth postoperative day.

**Case 2:** A 58-year old woman presented in cardiogenic shock following an inferior myocardial infarction. Intra-aortic balloon pump (IABP) was inserted and inotropic support was administered. Cardiac catheterization and transthoracic echocardiography showed severe mitral regurgitation secondary to a ruptured papillary muscle, two-vessel coronary disease, and possible left ventricular (LV) rupture with no associated ventricular septal defect. The patient arrived to the operating room in critical condition. An attempt to harvest the left intrathoracic artery (ITA) was abandoned because of unstable hemodynamics. Upon opening the pericardium, free blood clots were collected posteriorly. CPB was commenced and the heart arrested with initial cold (28°C) antegrade cardioplegia solution, then followed by continuous retrograde warm (32°C) cardioplegia. No LV vent was placed owing to the known or questionable myocardial muscle rupture. The pericardium was evacuated completely of clots revealing a small serpiginous tear in the inferior left ventricular wall (Figure 1). The repair of the LV rupture was performed with Krazy Glue placed on a piece of bovine pericardium (2x5 cm in size). Two coronary bypass grafting (CABG) with reversed saphenous veins were performed. One graft went to the distal right coronary and the other to the left anterior descending artery (LAD). Each of these vein grafts was then perfused with antegrade cardioplegia after completion of their respective distal anastomoses. The interatrial septum was opened revealing a regurgitant mitral valve with a ruptured posterior papillary muscle that was debrided as was its attached chords. A size 27 St. Jude mechanical prosthesis (St. Jude, St. Paul, MN) was seated and tied down to the annulus. The patient was weaned off CPB in normal sinus rhythm. Intraoperative transesophageal echocardiography showed a competent mitral prosthesis. The patient's convalescence was complicated by re-

current polymorphic ventricular fibrillation with no obvious ischemia found on electrocardiography. Her rhythm converted to sinus after the administration of magnesium and lidocaine. The IABP was removed on the 3rd postoperative day. The likely etiology of her torsade was the healing injured LV myocardium. The patient was discharged from the hospital on the 10<sup>th</sup> day after the operation on antiarrhythmic drugs.



**Figure 1:** The subclinical left ventricular tear is shown.

**Case 3:** An 84-year-old woman was transferred to our hospital for hypotension and severe back pain. She was ruled in for non-Q myocardial infarction. The cardiac catheterization demonstrated triple coronary artery disease; with 90 % LAD stenosis, totally occluded circumflex that did not fill via collaterals and a proximal right coronary artery (RCA) stenosis of 80 %. The LV function was severely depressed with an ejection fraction of 20 %. Inotropes were administered and an IABP was introduced for hemodynamic support. The mid-sternotomy exploration revealed the pericardium full of blood clots. The patient was placed on CPB with cold cardioplegic cardiac arrest. There was a small LV tear noted along a large infarcted area in the lateral wall that was supplied by the totally occluded circumflex vessel. Three coronary bypass grafts were performed with reversed saphenous veins, one to the distal RCA, the second to the LAD, and the third to the circumflex vessel. Krazy Glue was then applied over the infarction site and an autologous piece of pericardial membrane (2.5x2.5 cm in size) was appositional over the glue. The patch was then held in place and no further bleeding was noted upon filling of the heart. She remained in the critical care unit for 6 days at which time her IABP was discontinued. Her convalescence was uncomplicated and was discharged to a rehabilitation center 17 days after operation.

**Case 4:** Four days prior to admission, this 72-year-old man had an acute posterior myocardial infarction. The cardiac catheterization showed total occlusion of distal circumflex coronary artery which was then successfully stented. The ejection fraction was 55 %, and the patient was hemodynamically stable. The echocardiogram demonstrated large amounts of clots in the pericardial space. For fear of an acute lethal LV rupture, the decision was made to proceed with urgent surgery two days after admission. At operation, upon opening the pericardium there was dark blood and blood clots located posterior to the LV and stuck to the epicardium, representing most likely leakage from the infarct. Before disturbing the clot any further,

the patient was placed on CPB with cardioplegic arrest. At this point, the heart was elevated and all the blood and clots were suctioned exposing a large area of infarct. The sterilized synthetic Krazy Glue was applied over the entire surface of the infarct, and a large (5x7 cm) sheath of bovine pericardium was held over the glue until it adhered completely. Next, the ITA was anastomosed to the LAD, and a venous graft was anastomosed to RCA. The procedure was well tolerated. The patient was weaned from CPB with the aid of epinephrine without IABP. He was transferred out of ICU on the 5<sup>th</sup> postoperative day. His subsequent postoperative course was uneventful, and he was discharged to home 11 days after operation.

## Discussion/ Conclusion

LV rupture following myocardial infarction remains a highly lethal complication of ischemic heart disease, even following emergency operation [3,4]. Patients expire either secondary to profound cardiogenic shock or following unsuccessful repair with exsanguinating hemorrhage. Current management includes suture repair and the use of patch with adhesive glue [2]. Variable success has been achieved owing to the fact that a fresh necrotic myocardium does not hold sutures well, leading to perioperative uncontrollable bleeding. Furthermore, attempts to place sutures in adjacent normal myocardium may avoid troublesome tears, but could result in additional LV compromise that may not be compatible with life.

In conclusion, this is a retrospective observational study involving four patients at one institution that limit its generalizability. Long-term follow-up analysis to determine the outcomes associated with this repair in a larger group of patients is warranted.

## References

1. Padro JM, Mesa JM, Silvestre J, Larrea JL, et al. Subacute Cardiac Rupture: Repair With a Sutureless Technique. *Ann Thorac Surg.* 1993; 55: 20.
2. Zoffoli G, Battaglia F, Venturini A, Asta A, et al. A Novel Approach to Ventricular Rupture: Clinical Needs and Surgical Technique. *Ann Thorac Surg.* 2012; 93: 1002
3. Formica F, Corti F, Avalli L, Paolini G. ECMO support for the treatment of cardiogenic shock due to left ventricular free wall rupture. *Interact Cardiovasc Thorac Surg* 2005; 4: 30–32.
4. Korabathina R, Pham DT, Kapur NK. Subacute Left Ventricular Rupture Supported with a Percutaneous Left Ventricular Assist Device. *J INVASIVE CARDIOL.* 2011; 23: 246–247.

**Manuscript Information:** Received: December 26, 2019; Accepted: February 20, 2020; Published: February 28, 2020

**Authors Information:** Abdallah Alameddine<sup>1</sup>; Brian Binnall<sup>1</sup>; Paul Silvi<sup>1</sup>; Frederick Conlin<sup>2</sup>

<sup>1</sup>Division of cardiac surgery, Baystate Medical Center, Springfield, MA 01107, USA.

<sup>2</sup>Department of anesthesiology, Baystate Medical Center, Springfield, MA 01107, USA.

**Citation:** Alameddine A, Binnall B, Conlin F. Long-term outcomes after repair with topical surgical adhesive glue in patients with post infarction left ventricular rupture. Open J Clin Med Case Rep. 2020; 1632.

**Copy right statement:** Content published in the journal follows Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>). © **Alameddine A 2020**

**About the Journal:** Open Journal of Clinical and Medical Case Reports is an international, open access, peer reviewed Journal focusing exclusively on case reports covering all areas of clinical & medical sciences.

Visit the journal website at [www.jclinmedcasereports.com](http://www.jclinmedcasereports.com)

For reprints and other information, contact [info@jclinmedcasereports.com](mailto:info@jclinmedcasereports.com)