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Case Series

CASE SERIES

Off-pump external pericardial patch repair for post-infarct left ventricular free wall rupture: a case series

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Abstract

We describe an off-pump surgical approach to this challenging condition supported by our results from a case series, which would add to existing literature in the management of this life-threatening complication. We identified seven patients who underwent surgical intervention for left ventricular (LV) free wall rupture at our institution. They were all diagnosed to have cardiac tamponade secondary to free wall rupture of the LV in the presence of acute myocardial infarction. The surgical technique comprised of utilizing an external pericardial patch which was secured using surgical biological glues (fibrin-based sealants or gelatin hydrogels). The 30-day mortality, 1-year survival and 2-year survival were 57, 42 and 42%, respectively. Advanced age, female gender and use of cardiopulmonary bypass were characteristics that were not significantly associated with survival. We advocate the use of an off-pump external pericardial patch repair strategy as a 'bridge to recovery' in this extremely high-risk group of patients.

INTRODUCTION

William Harvey first described free wall rupture of the left ventricle in 1647 [1]. Further descriptions by Morgagni, ensued over the following centuries [2, 3]. However, Krumbhaar and Crowell first described the relationship between acute myocardial infarction (AMI) and free wall rupture in 1924 [4]. Furthermore, it was not until the 1970s that the first successfully described cases of surgical repair of left ventricular (LV) free wall rupture were described initially by Fitzgibbon and Montegut and then subsequently by Calick [3, 5, 6]. Fitzgibbon described the surgical technique of infarctectomy and closure of the subsequent defect, whereby Montegut described the direct suture closure of the defect [3, 5]. Calick described the first successful patch repair closure of the defect in 1973 [6]. Moreover, Núñez *et al*. described the first case series involving seven patients with free wall LV rupture treated successfully by surgery. They advocated the surgical technique of covering the ventricular tear and surrounding myocardium using a Teflon® patch, which was sutured to the epicardium using continuous prolene [7]. In 1972, Löfström and colleagues mentioned the first description of attempted patch repair of free wall LV rupture; however, this case was complicated by patch dehiscence and

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eventually by the death of the patient [8]. LV rupture can be a catastrophic sequelae of AMI complicating approximately 2–4% of patients with AMI [9, 10]. Acute free wall rupture of the left ventricle is often a terminal and fatal event, and survivors are those who survive to present with subacute or contained rupture [11]. The clinical entity of the LV rupture can be sudden and profound in its presentation with a varying clinical spectrum. Devastatingly, it can cause catastrophic blowout leading to profound cardiogenic shock and eventual cardiac arrest. This cohort of patients rarely survives any subsequent intervention. Importantly, the subacute and contained rupture presentations are attributable to slow oozing from the rupture site culminating in haemopericardium and eventual cardiac tamponade [12]. The gold-standard diagnostic investigation for LV free wall rupture is conventional transthoracic echocardiography (TTE) of which the findings of reduced myocardial thickness, haemopericardium and cardiac tamponade are pathognomic [13]. We describe an off-pump surgical approach to this challenging condition supported by our results from a case series, which would add to existing literature in the management of this life-threatening complication.

CASE PRESENTATIONS

We performed a retrospective analysis of the cases performed at our institution over the last 20 years using the Intellect Dendrite® cardiac database, identifying patients who had surgery for LV rupture. From 2005–19, seven patients were identified who underwent surgical intervention for LV free wall rupture at our institution. They were all diagnosed to have cardiac tamponade secondary to free wall rupture of the LV in the presence of AMI (71% of the patients were diagnosed with ST-elevation myocardial infarction and 29% with non-ST-elevation myocardial infarction). Of the seven patients identified, they all presented in cardiogenic shock and acute circulatory collapse requiring inotropic or mechanical support preoperatively. Furthermore, 57% of the patients had suffered cardiac arrest requiring cardiopulmonary resuscitation compared to the 43% who had presented in cardiogenic shock without cardiac arrest. These haemodynamically unstable patients would have almost certainly died without any form of intervention as has been demonstrated previously in a retrospective cohort study by Blinc *et al*. of 107 patients with short-term and long-term survivals of 10 and 3%, respectively, when managed conservatively. The median age of our cohort of patients was 71 years (range: 47–84 years old). Two patients were female and five were male. The median Euroscore II was 33.11 (range: 23.16–44.79).

SURGICAL TECHNIQUE

The surgical technique comprised of utilizing an external pericardial patch which was secured using surgical biological glues (fibrin-based sealants or gelatin hydrogels). All patients underwent patch repair of the defect without CPB using the aforementioned technique, except one patient who underwent coronary artery bypass graft surgery and suture repair of the defect with aortic cross clamp and CPB times of 134 and 70 min, respectively.

Patient characteristics and postoperative complications are demonstrated in Table 1. Four of the seven (57%) patients survived to discharge from the hospital. One patient died several months after the initial operation following discharge from the hospital. All survivors underwent salvage off-pump pericardial patch repair of the LV rupture without any concomitant revascularization procedure. Of the three patients who did not survive to discharge but who survived the initial operative procedure, median survival was 3 days. The 30-day mortality, 1-year survival and 2-year survival were 57, 42 and 42%, respectively. Advanced age, female gender and use of CPB were characteristics not associated with survival.

DISCUSSION

Evidence from the SHOCK trial registry highlights the poor outcome for revascularization in patients presenting in cardiogenic shock following AMI, and subgroup analysis of patients with free LV wall rupture had a similar survival to the overall cohort [14]. LV rupture is a devastating complication of AMI with extremely high mortality [15]. Pertaining to the surgical management of LV free wall rupture conventional surgery has involved the use of CPB and infarctectomy and the direct closure of the defect, direct suture closure of the defect or endoventricular patch closure with survival rates in some conventional surgical cohorts reportedly as high as 65%. [16]. A prospective case series involving 13 patients with acute LV free wall rupture treated surgically with the use of a polytetrafluoroethylene patch and surgical glue has been successfully described with 100% survival at 5 years [12]. In this study, 12 of the 13 patients underwent sutureless repair with a PTFE patch covering the LV rupture defect without the use of CPB. Similarly, another case series of six patients underwent sutureless patch repair, with five of the six patients surviving to discharge. However, in this study, two of the patients required use of CPB due to excessive bleeding and three of the patients underwent concomitant revascularization procedures with coronary artery bypass graft surgery [17]. Conventional surgical series on patients with LV free wall rupture using CPB has variable mortality, with some series reporting a mortality of 11.8% in the oozing or subacute type rupture and as high as 61% in patients with acute blowout LV ruptures [18, 19]. Our cohort demonstrated reasonable survival out to 2 years without the use of CPB in patients with oozing type rupture and stable haemodynamics. However the use of CPB should be employed in situations where there is a situation of profound cardiogenic shock, which necessitates the need for mechanical circulatory support. Moreover, on-pump sutureless repair of the LV free wall rupture can then be considered.

A systematic review of off-pump sutureless repair of LV free wall rupture concluded that off-pump sutureless patch repair of the defect can be performed with fibrin glue sheets or patches and collagen-based sponge adjuncts which are used to conform to the native myocardial tissue and provide haemostasis [20]. Furthermore, the late complication of pseudo aneurysm formation must be considered in patients for whom sutureless patch repair is performed [20]. The use of fibrin sheets or pericardial patches on the rupture site under stable haemodynamic conditions can be done on a beating heart on or off pump. The likely detriment is going to be from excess aortic cross clamp times as the issue of myocardial protection is all the more important in this high risk group of patients and therefore the threshold for timing is likely to be a lot less. Multi-modality assessment using echocardiography or computed tomography (CT) imaging may be useful if the patient is relatively stable prior to surgery [21]. Unconventionally, a successful case of interventional therapy in the form of percutaneous drainage and fibrin glue injection has been reported [22].

We advocate a philosophy of early surgical intervention without the use of cardiopulmonary bypass on a beating heart if the patient's cardiovascular status and nature of the bleed from the

Table 1. Cohort characteristics

No.	Presentation	CPR preop	Site of rupture	Angiogram	Postoperative complications	Euroscore II	Alive	CPB use
1	Inferolateral NSTEMI	No	Lateral	Subacute occlusion of circumflex	Death	28.79	No	No
2	NSTEMI	No	Inferior	Occluded right coronary artery, severe circumflex	Acute kidney injury and delayed chest closure	23.16	Yes	No
3	Posterior STEMI	Yes	Lateral	Occluded circumflex	Tracheostomy, respiratory wean and re-wiring	33	No	No
4	Missed lateral STEMI	Yes	Lateral	Not performed	Death	44.79	No	Yes
5	NSTEMI	Yes	Inferior	Occluded circumflex, severe intermediate and RCA disease	Death	40.65	No	No
6	Lateral STEMI	No	Lateral	Occluded circumflex	Nil	40.65	Yes	No
7	Inferior STEMI	Yes	Inferior	Occluded posterior LV branch	Low cardiac output syndrome, atrial fibrillation, tracheostomy and respiratory wean	33.11	Yes	No

NSTEMI, Non-ST elevation myocardial infarction; STMI, ST elevation myocardial infarction; RCA, right coronary artery.

rupture site allow for it; indeed this appears to be a prognostic factor in patient survival. This approach allows for a predictable postoperative recovery period and long-term definitive treatment. The use of cardiopulmonary bypass is likely to lead to greater haemostatic and haemodynamic complications and is consequently an adverse prognostic indicator; however, this cannot always be avoided, especially in situations of profound cardiogenic shock and impending cardiopulmonary arrest.

Previous studies have shown advanced age and female gender to be associated with reduced survival [19]. Concomitant coronary artery bypass grafting has to be carefully considered in this cohort of patients, and judgement would need to be made on an individual case basis to assess the overall benefit and risk when considering additional procedures in this salvage setting. We advocate that the use of an off-pump external pericardial patch repair strategy as a 'bridge to recovery' in this extremely high-risk group of patients offers good results and believe our case series adds to the existing literature on this subject.

CONFLICT OF INTEREST STATEMENT

None declared.

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