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CLINICAL CASE OF LONG-TERM MECHANICAL CIRCULATORY SUPPORT IN A PATIENT WITH BIVENTRICULAR HEART FAILURE AFTER CARDIAC STAB WOUND

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Cardiac injury remains one of the most complex conditions in emergency surgery. Only 6% of patients with penetrating heart wounds manage to be delivered to the operating room for surgery, and the mortality rate is still extremely high. Unfortunately, such emergency interventions are often performed in institutions lacking the ability to provide the full range of reconstructive techniques, resulting in suboptimal correction and a high risk of developing postoperative complications. This paper describes a clinical case of successful repair of multiple stab wounds to the heart with concomitant anterior descending artery injury followed by severe heart failure requiring biventricular mechanical circulatory support.

Keywords: cardiac injury, mechanical circulatory assist device, heart failure, assisted circulation, biventricular support.

INTRODUCTION

Despite the fact that heart injury was first mentioned in medical literature 3,000 years BC, this condition is still one of the most complex in emergency surgery practice [1]. An analysis of 1,198 cases of penetrating heart wounds showed that only 6% of patients with such wounds manage to get to the operating room for surgical treatment, with a mortality rate of 70–90% [2–4]. The location of two-thirds of the heart mass to the left of the midline forms a statistically decreasing frequency of damage to the chambers of the right ventricle (40–43%), left ventricle (34–40%), right atrium (18–24%) and left atrium (3–5%) [3].

Coronary artery injury is not the most common companion of penetrating heart wounds, occurring only in 3–9% of cases. However, these figures indicate only the occurrence in those patients who were on the operating table and underwent surgical treatment [5, 6]. A combination of penetrating wounds of the cardiac cavities with damage to the major coronary artery branches is an extremely difficult condition to correct in emergency surgery. Patients with such wounds require prompt diagnosis and treatment in the nearest hospital. Unfortunately, such emergency interventions are often performed in institutions that do not have the capacity to provide a full range of reconstructive techniques. Therefore, elimination of heart wall defects and bleeding becomes the main goal of emergency care. Stopping bleeding in coronary artery injury in most cases is limited to simple ligation or stitching, which leads to myocardial infarction in 90% of cases [7].

This report describes a clinical case of successful repair of multiple stab wounds of the heart with concomitant damage to the anterior descending artery, followed by severe heart failure, which required biventricular mechanical circulatory support.

CLINICAL CASE

A 21-year-old female patient (weight 53 kg, height 179 cm) was criminally assaulted with six penetrating stab wounds to the chest. The patient was rushed to the nearest surgical hospital. After performing left anterolateral thoracotomy and chest revision, three penetrating stab wounds in the left ventricular cavity, with damage to the anterior descending artery in the middle third, were found.

During surgical intervention, due to the urgency of the condition and massive bleeding, the anterior descending artery was sutured, resulting in an early postoperative period that was complicated by acute myocardial infarction. After discharge from the hospital 11 months later, the patient was hospitalized again with signs of progressive heart failure, dyspnea, pulmonary edema and ascites. Echocardiography revealed dilatation of all heart chambers, akinesis of segments 2, 4, 8, 9, 10, 11, 13, 14, 17, reduced left ventricular (LV) and right ventricular (RV) contractile function; LV ejection fraction (EF) was 18%, LV end-diastolic volume (EDV) was 220 mL, RV EF was 18–20%, grade 2–3 mitral regurgitation, and

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flow area was 8.1 cm^2; there was pulmonary hypertension (PH) with mean pulmonary arterial pressure being 41 mmHg and pulmonary vascular resistance (PVR) 9.9 Wood's units.

Considering biventricular heart failure, PH and high risk of posttransplant contractile dysfunction of the transplanted heart, the patient underwent concurrent implantation of two mechanical circulatory support devices (Sputnik, Russia) in a biventricular configuration. Left ventricular assist device (LVAD) was implanted using a standard technique according to the "left ventricular apex-to-aorta" model. The right ventricular assist device (RVAD) was connected according to the "right atrium-to-pulmonary trunk" model. A two-stage venous cannula (Medtronic Inc., 34/46 French), inserted into the superior vena cava through the right atrial wall, was used as an inflow cannula. The RVAD outflow line was anastomosed to the pulmonary artery trunk as shown in Figure.

At day 34 of hospital stay, with mechanical circulatory assist devices functioning in a stable condition, PVR decreased to 1.9 Wood units, the patient was placed on the heart transplant waitlist and discharged home. Five months after implantation of the biventricular assist device (BiVAD), multiple alarms were triggered on the LVAD controller. Against the alarms, there was a significant deterioration in well-being and the appearance of heaviness in the heart area. The patient was hospitalized with suspected mechanical circulatory support dysfunction. On examination, RVAD cavity thrombosis was detected. At the same time, the patient's condition remained stable during the LVAD functioning. Doppler echocardiography showed LV contractile function to be normal; LV EF, 62%; LV EDV, 98 mL. RV myocardial contractility was not decreased, RV EF was 44%, RV EDV was 42 mL. Estimated systolic pulmonary artery pressure was 39 mmHg, mean pulmonary arterial pressure was 32 mmHg. Grade 1–2 mitral regurgitation, flow area was 5.4 cm^2, S flow / S of left atrium was 20.53%. After discharge from the hospital, the patient was active and had no complaints. However, due to food poisoning, against the background of hypocoagulation, an extensive hemorrhagic stroke developed. This led to the death of the patient 9 months after the mechanical circulatory support device was implanted.

DISCUSSION

The incidence of penetrating heart wounds has increased over the past few years, with stab and gunshot wounds predominating. According to A. Isaza-Restrepo et al., the mortality rate in gunshot and stab wounds to the heart is 54.5% and 18% respectively (p = 0.0120) [8]. Despite the high mortality rate in cardiac wounds, even successful management of this life-threatening condition is associated with a high risk of complications. For example, in a clinical case, where multiple penetrating heart wounds, described by us, were sutured successfully, coronary bed and valve damage resulted in biventricular heart failure that required orthotopic heart transplantation (OHT). However, OHT was contraindicated due to high PVR, which, according to literature, is associated with a high risk of graft dysfunction and early death [9, 10].

LVAD implantation can reverse PH within certain limits in OHT candidates as part of a bridge-to-transplantation strategy [11–14]. Thanks to the development of assisted circulation technology, OHT has become available to recipients previously considered unsuitable for this operation [15–17]. The possibility of preparing a recipient with PH for OHT using circulatory support techniques has also been shown in the clinical case we have described. The use of prolonged biventricular mechanical circulatory support contributed to a decrease in blood pressure and pulmonary circulation resistance one month after implantation. This allowed to list the patient for heart transplantation. It is also curious that RV myocardial contractility was restored against the background of thrombosis and RVAD withdrawal with compensation of hemodynamic parameters.

Optimal timing of OHT, especially in patients with PH and an implanted LVAD, remains a subject of research. According to Mikus et al., PVR reduces in the first 6 months after LVAD implantation, and longer support does not add useful effects on hemodynamic parameters of pulmonary circulation [11]. At the same time, according to Moayedifar et al., long-term posttransplant survival in patients with fixed PH who were successfully bridged to candidacy for heart transplantation with LVAD implantation was 83.5% and 81.0% at 3 and 5 years, respectively. This was comparable with the survival rate in patients who underwent OHT on the

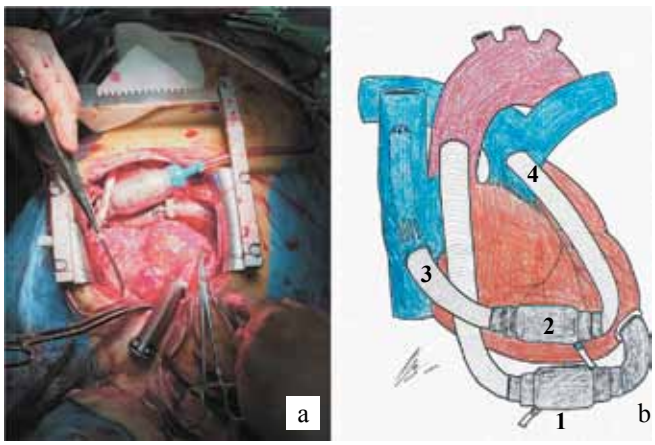

Fig. Concurrent implantation of two mechanical circulatory assist devices in a biventricular configuration. a, view of the operating wound; b, implantation scheme; 1, LVAD; 2, RVAD; 3, RVAD inflow cannula; 4, RVAD outflow cannula

background of earlier implanted LVAD for reasons not related to PH (3 years: 87.5%, 5 years: 85.4%) [18]. These survival rates were comparable to OHT outcomes in PH-free patients, 84% and 75% at year 1 and 5, respectively [19].

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The authors declare no conflict of interest.

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