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Hybrid interventional and surgical treatment of complex traumatic cardiac dagger wounds

Tratamento intervencionista e cirúrgico híbrido de lesões cardíacas traumáticas complexas por arma branca

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ABSTRACT – Penetrating injuries to the heart are usually devastating and few patients survive the initial trauma. The most frequent penetrating injuries are caused by projectile injuries and less commonly by melee weapons. Most of these injuries involve chamber free walls and a small percentage can affect the interventricular septum. We report a case in which an emergency surgical procedure was successful in controlling cardiac tamponade, and repairing a right ventricular laceration caused by multiple stab wounds. Subsequently, a successful interventional occlusion of a large interventricular septal defect, associated with significantly augmented pulmonary flow was performed.

Keywords: Wounds, stab; Heart injuries; Heart septal defects, ventricular; Cardiac tamponade

RESUMO – As lesões cardíacas penetrantes são geralmente devastadoras, e poucos pacientes sobrevivem ao trauma inicial. Os ferimentos penetrantes mais frequentes são causados por projéteis e, menos comumente, por armas brancas. A maioria dessas lesões envolve paredes livres das câmaras, e uma pequena porcentagem pode afetar o septo interventricular. Relatamos um caso em que um procedimento cirúrgico de emergência obteve sucesso no controle do tamponamento cardíaco e no reparo da laceração do ventrículo direito causada por múltiplos ferimentos por arma branca. Posteriormente, foi realizada a oclusão intervencionista bem-sucedida de um grande defeito do septo interventricular, associado a aumento significativo do fluxo pulmonar.

Descritores: Ferimentos perfurantes; Traumatismos cardíacos; Comunicação interventricular; Tamponamento cardíaco

INTRODUCTION

Penetrating injuries to the heart are usually devastating and few patients survive the initial trauma. The most frequent penetrating injuries are caused by projectile injuries and less commonly by melee weapons. Emergency thoracotomy should be considered for readily or suspected cardiac injuries, when the victim is critically unstable and when cardiac arrest appears imminent in the presence of circulatory shock or cardiac tamponade.¹ Most of these injuries involve chamber free walls and a small percentage can affect the interventricular septum, with an incidence of approximately 1% to 5%.² Percutaneous intervention of traumatic defects in the interventricular septum is an alternative therapeutic option to surgery,³ and can be performed with various types of prostheses.^{4,5}

The present report describes a case of hybrid treatment (surgical and percutaneous) of a complex lesion, secondary to penetrating cardiac trauma caused by multiple stabbing, with an initial clinical presentation of cardiac tamponade. This work was approved by the Research Ethics Committee of *Hospital das Clínicas* of the *Faculdade de Medicina* of the *Universidade de São Paulo* (USP), protocol 4.617.454; CAAE 44240821.7.0000.5440.

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CASE REPORT

A 48-year-old male patient, previously healthy, suffered two dagger wounds in left hemithorax. He evolved with three episodes of cardiac arrest due to pericardial effusion and cardiac tamponade, all reversed in pre-hospital care. Admitted to the Emergency Unit of *Hospital das Clínicas* of the *Faculdade de Medicina* of USP, he underwent emergency exploratory thoracotomy, followed by pericardial drainage and perforation suture in the right ventricle. During the intraoperative period, episodes of ventricular fibrillation were reversed. He evolved well after the procedure, being discharged 22 days after the stabbing event.

In the outpatient follow-up (30 days after discharge) he complained of dyspnea on moderate efforts (walking

300m in the plane) and atypical chest pain; on physical examination, he presented a 4+/6+ rough systolic murmur, on the fourth left sternal border. Electrocardiogram showed prominent ST segment changes in the antero-septal wall, with loss of electrical potential. Echocardiogram demonstrated dilation of the left chambers (left atrium with 47mL/m² and left ventricle with telediastolic diameter of 56mm), preserved global systolic function (left ventricular ejection fraction – LVEF=68%), a large ventricular septal defect in the muscular portion in the lower septum with aspect of delamination, causing left-right shunt with a peak gradient of 66 mmHg (Figure 1). He underwent invasive hemodynamic evaluation with manometry, oximetry series (Table 1), coronary angiography and left ventriculography (Figure 2).

LV: left ventricle; RV: right ventricle.

Figure 1. Echocardiogram showing ventricular septal defect in a muscular portion of the lower septum with a delamination aspect, and left to right shunt with a peak gradient of 66mmHg.

Table 1. Cardiac chamber manometries showing absence of pulmonary hypertension and normal systemic blood pressure. Oximetry of cardiac chambers and hemodynamic calculations showing oximetry jump at the level of the right ventricle with moderate hemodynamic repercussion, but with normal pulmonary vascular resistance and moderate increase in pulmonary flow

Manometry (mmHg)	Systolic	Initial diastolic	Final diastolic	Mean
Superior vena cava	---	---	---	4
Inferior vena cava	---	---	---	4
Right atrium	---	---	---	4
Right ventricle	24	0	6	---
Pulmonary artery	24	10	---	13
Pulmonary capillary	---	---	---	8
Left ventricle	104	0	8	---
Aorta	104	60	---	74

Blood gases	SatO ₂ (%)	PaO ₂ (mmHg)
Superior vena cava	75.4	41.7
Inferior vena cava	76.1	41.1
Right atrium	75.7	41
Right ventricle	86.9	50.5
Right ventricular outflow	85.1	48.3
Pulmonary artery	84.4	47.1
Left ventricle	97	82.5
Aorta	96.9	83.1

Pulmonary flow (Qp)=8.0L/minute	Qp/Qs=1.70
Systemic flow (Qs)=4.7L/minute	
Pulmonary vascular resistance=0.6UW	
Systemic vascular resistance=14.9UW	

SatO₂: arterial oxygen saturation; PaO₂: partial pressure of oxygen in arterial blood.

The Heart Team opted for percutaneous occlusion of the defect (Figure 3) performed under general anesthesia, with the aid of transesophageal echocardiography, through puncture of the right femoral artery and vein (5F and 7F

sheaths, respectively). Ventriculography confirmed the anatomy of the interventricular septum defect. A Judkins R 5F diagnostic catheter was used with positioning in the left ventricle. Crossing the defect with a 300-cm hydrophilic

Figure 2. Right coronary artery in left oblique projection with no obstructive lesions (A); left coronary artery in right oblique projection (B) and left cranial projection (C) showing left circumflex artery with no obstructions and left anterior descending artery with an abrupt interruption in distal segment (red arrows). Left ventriculography, in right oblique projection, in diastole (D) and systole (E) with opacification of the right ventricle and pulmonary artery by the passage of contrast through ventricular septal defect (yellow arrows) and loss of contractility in apical segment (blue arrow); left ventriculography, in left cranial projection, showing ventricular septal defect with delta format and delamination aspect on left portion of septum (white arrow) (F).

Figure 3. Steps of percutaneous closure procedure. Ventriculography confirmed the anatomy of the interventricular septum defect (A). The diagnostic catheter was advanced up to the prosthesis sheath in the inferior vena cava, forming a final arteriovenous loop, with the prosthesis sheath and the diagnostic catheter (B). Initial release of the PDA Occluder 6 x 8 mm prosthesis (Occlutech®) (C). Next, final positioning of the prosthesis (D) and complete release of the device (E). Final ventriculography showing good prosthesis positioning and absence of residual flow through the defect (F).

0.035" guidewire (Terumo) and positioned at the level of superior vena cava. The snare-catheter was used to capture the guidewire and form the arteriovenous loop. The diagnostic catheter was advanced to the delivery sheath in the inferior vena cava, and with the formation of a final arteriovenous loop with the associated delivery sheath and the diagnostic catheter. Delivery sheath was advanced with support of the diagnostic catheter to the left ventricle. Initial release of the PDA Occluder 6x8mm prosthesis (Occlutech®). Final

positioning of the prosthesis and complete release of the device. Final ventriculography showing good prosthesis positioning and absence of residual flow through the defect. Patient presented good clinical recovery and was discharged the next day. The echocardiogram performed after the procedure showed good prosthesis apposition, without residual flow (Figure 4). At outpatient visit after 30 days, he reported clinical improvement, becoming asymptomatic. After 6 months of follow-up, he remained asymptomatic.

Figure 4. Transesophageal echocardiogram after the procedure showing a well-positioned prosthesis, with no signs of complications and no residual transseptal flow.

DISCUSSION

The patient's initial clinical presentation, with cardiac tamponade and cardiorespiratory arrest, is considered the most critical of the complications of perforating injury to the heart. The excellence of pre-hospital care with cardiopulmonary resuscitation, and later at *Hospital das Clinicas* of the *Faculdade de Medicina* of USP, with emergency thoracotomy was crucial for the successful treatment of these critical conditions. Cardiac perforating injuries led to laceration of the right ventricle (causing cardiac tamponade), a ventricular septal defect, and interruption of the distal segment of the anterior descending artery (contributing to cardiac tamponade and causing acute myocardial infarction in the apical segment of the left ventricle). This last complication may help to explain the ventricular fibrillation episodes during the emergency surgical procedure, the electrocardiographic changes and the dyssynergy of the apical segment of the left ventricle. However, the coronary artery lesion and the ventricular septal defect were not detected at the time of the surgical procedure. Since the coronary obstruction involved only a distal segment of the left anterior descending artery, no specific treatment was warranted in the setting of a previous myocardial infarction, at the

apical portion of the left ventricle. The ventricular septal defect was not identified in the initial clinical-surgical context, since only emergency damage containment measures were performed, with suture of the right ventricle and pericardial drainage to reverse cardiac tamponade.

The percutaneous closure of ventricular septal defect was later decided by the Heart Team, because the location in the mid-muscular portion of the septum is usually favorable to such procedure. Several devices have been described for the closure of defects in the interventricular septum. These devices include the VSD Occluder and ASD Occluder (Amplatzer®) and the PDA Occluder (Occlutech®). Xi et al. described the use of the PDA Occluder for successful percutaneous closure of post-traumatic interventricular septal defects.⁵ The rationale for using these devices is due to the length of this type of post-traumatic defect, which is usually longer (>9mm); therefore, Amplatzer® prostheses are not appropriate.⁶ Nonetheless, there is no consensus on selection of devices,⁷ the choice being made by individualized clinical criteria, and according to the morphology of the septal defect.

In the present clinical case, due to the length of the lesion and its triangular conformation (delta shape), we opted for closure with PDA Occluder prosthesis, with the

release of the larger disc in the left ventricular portion of the septum, and the smaller disc in the right ventricular portion of the septum. The greatest technical difficulty of the procedure was crossing of the guidewire between the left ventricle and the right ventricle, due to the aspect of delamination in the left ventricular portion of the lesion; after the passage of the guidewire, the arteriovenous loop at the level of the superior vena cava was formed, and the procedure continued without any complications.

As in the present clinical case, the interventional occlusion of ventricular septal defects caused by penetrating cardiac trauma is effective, and can be performed using several devices to complement a previous emergency surgical treatment. The interventional procedure is indicated when there are favorable anatomical features of the ventricular septal defect, and hemodynamic overload of the pulmonary circulation. Such intervention should be carried out in centers with experience in structural procedures, after a meticulous evaluation for programming the procedure and choosing the type of prosthesis to be used.

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None.

CONFLICTS OF INTEREST

The authors declare there are no conflicts of interest.

CONTRIBUTION OF AUTHORS

Conception and design of the study: JRAC, GLF and IML; data collection: JRAC; data interpretation: JRAC, GLF, MOLF and JAMN; text writing: JRAC, GLF and JAMN; approval of the final version to be published: JRAC and GLF.

REFERENCES

1. Bastos R, Baisden CE, Harker L, Calhoon JH. Penetrating thoracic trauma. *Semin Thorac Cardiovasc Surg.* 2008;20(1):19-25. <https://doi.org/10.1053/j.semtcvs.2008.01.003>
2. Sugiyama G, Lau C, Tak V, Lee DC, Burack J. Traumatic ventricular septal defect. *Ann Thorac Surg.* 2011;91(3):908-10. <https://doi.org/10.1016/j.athoracsur.2010.08.071>
3. Pesenti-Rossi D, Godart F, Dubar A, Rey C. Transcatheter closure of traumatic ventricular septal defect: an alternative to surgery. *Chest.* 2003;123(6):2144-5. <https://doi.org/10.1378/chest.123.6.2144>
4. Santos RA, Guedes H, Marques L, Lourenço C, Silva JC, Pinto P. Transcatheter closure of a traumatic VSD with an ASD occluder. *Arq Bras Cardiol.* 2018;111(2):223-5. <https://doi.org/10.5935/abc.20180122>
5. Xi EP, Zhu J, Zhu SB, Yin GL, Liu Y, Dong YQ, et al. Percutaneous closure of a post-traumatic ventricular septal defect with a patent ductus arteriosus occluder. *Clinics (Sao Paulo).* 2012;67(11):1281-3. [https://doi.org/10.6061/clinics/2012\(11\)10](https://doi.org/10.6061/clinics/2012(11)10). Erratum in: *Clinics (Sao Paulo).* 2013;68(3):435.
6. Zhu J, Xi EP, Zhu SB. Percutaneous closure of traumatic ventricular septal defects: device selection and reasoning. *Clinics (Sao Paulo).* 2014;69(2):150-1. [https://doi.org/10.6061/clinics/2014\(02\)12](https://doi.org/10.6061/clinics/2014(02)12)
7. Demirkol S, Balta S, Cakar M, Kucuk U. Which device should be chosen for the percutaneous closure of post-traumatic ventricular septal defects? *Clinics (Sao Paulo).* 2013;68(3):423. [https://doi.org/10.6061/clinics/2013\(03\)le03](https://doi.org/10.6061/clinics/2013(03)le03)