CASE REPORT

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Atrial septal defect closured by hypothermic ventricular fibrillation technique without cardioplegic: a first experience case report

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ABSTRACT

Introduction: One prevalent congenital cardiac condition is atrial septal defect (ASD). There are several advantages to hypothermic ventricular fibrillation during heart surgery for ASD. This report is to explain the first experience of closure ASD with hypothermic ventricular fibrillation technique without cardioplegic.

Case description: A seven-years girl, body weight 14 kilograms, with a history of shortness of breath since birth, was diagnosed with large secundum ASD at seven months old. An ASD closured was done by using hypothermic ventricular fibrillation technique without cardioplegic because intraoperatively could not do cardioplegic cannulation due to small and short aorta. Temperature was set in 32° C. The heart became ventricular fibrillation, right atrium was opened, and ASD closured with pericardial patch. De-airing of left heart and the temperature was increased normally. Aorta cross clamped off and the heart rhythm was sinus. Aox time was 21 minutes. The right atrium then closed and the CBP machine weaning till its stop. Postoperative the patient was early extubated and good recovery. One day after surgery evaluation, the echocardiography results showed no residual of ASD.

Conclusion: In cardiac surgery, this hypothermic ventricular fibrillation procedure without cardioplegia provides an alternate way to preserve the heart. This method is comparatively safe and may be applied to heart surgery with positive results for the patient.

Keywords: atrial septal defect, hypothermic ventricular fibrillation technique, non cardioplegic methods.
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INTRODUCTION

About 25% of children have an atrial septal defect (ASD), one of the most prevalent forms of congenital heart problems.[1] It is estimated that the incidence is 56 per 100,000 live births and the frequency is 1.6 per 1000 live births worldwide. Because clinically silent anomalies may now be identified by improved echocardiography, the incidence is expected to be 100 per 100,000 live babies. The most prevalent kind of congenital heart disease (CHD) that is not identified in children is ASD.[2] Heart disease, cancer, and infections are the leading causes of mortality for those with ASD. In individuals who have had surgery, ASD is thought to be a contributing factor in 30% of fatalities.[3]

An atrial septal defect occurs when the link between the left and right atria is not closed. It comprises defects in the real septal membrane as well as extra defects that allow the two atria to communicate with one another. From least to most prevalent, atrial septal defects fall into five categories: coronary sinus defect, sinus venosus defect, ostium secundum defect, ostium primum defect, and patent foramen ovale.[4] Small atrial septal defects usually resolve on their own in children. To prevent additional complications including stroke, dysrhythmias, and pulmonary hypertension, significant anomalies that do not seal on their own may require percutaneous or surgical intervention.[5]

Most newborns have atrial septal abnormalities, although the causes are unclear. Some infants suffer cardiac problems as a result of chromosomal or gene abnormalities. Atrial septal abnormalities may be more likely to occur in those who have a mix of genes and other risk factors. These factors include things like a mother's environment, the meals and drinks she drinks, and the drugs she takes.[6] Normally, the heart's left side only pumps blood to the body, while the right side only pumps blood to the lungs. A child with autism spectrum disorder may have blood flow from the left atrium to the right atrium and then out into the pulmonary arteries. The heart and lungs have to work harder to pump the additional blood into the lung arteries if the ASD is big, and the lung arteries may eventually deteriorate. Small holes can not show any signs or issues. A Patent Foramen Ovale (PFO), a tiny remaining hole in the wall between the atria, is still present in many healthy people.[7]

ASD can be treated with surgery or percutaneous procedures if needed. The use of systemic hypothermia to prevent end organ damage during cardiopulmonary

Figure 1. Pre-operative chest x-ray.

bypass (CPB) in circumstances when open heart surgery is performed has both clinical and biochemical adverse effects.[8] Depending on the facility and the surgical strategy used, the heart is managed differently during CPB during heart surgery.

Cardioplegic procedures include antegrade or retrograde infusion of cardioplegia, blood or crystalloid cardioplegia, and non-cardioplegic techniques such ventricular fibrillation or beating-heart technique.[9] There are several advantages to hypothermic ventricular fibrillation during heart surgery.[10] We reported the first case of ASD closure surgery with hypothermic ventricular fibrillation technique without the use of cardioplegic in patients with ASD in a seven-year-old female patient.

CASE DESCRIPTION

The patient is a 7-years old girl with body weight 14 kg came with chief complaints of frequent shortness of breath and coughing since infancy. Patients were often hospitalized and diagnosed with congenital heart disease at seven months old. Shortness of breath and palpitations were aggravated during activity. Since birth, she has difficulty in weight gaining. There was no history of cyanosis of the lips and fingers. The development in toddler according to the child of her age. History of birth with caesarean section, not full-term gestation and born crying immediately, birth weight

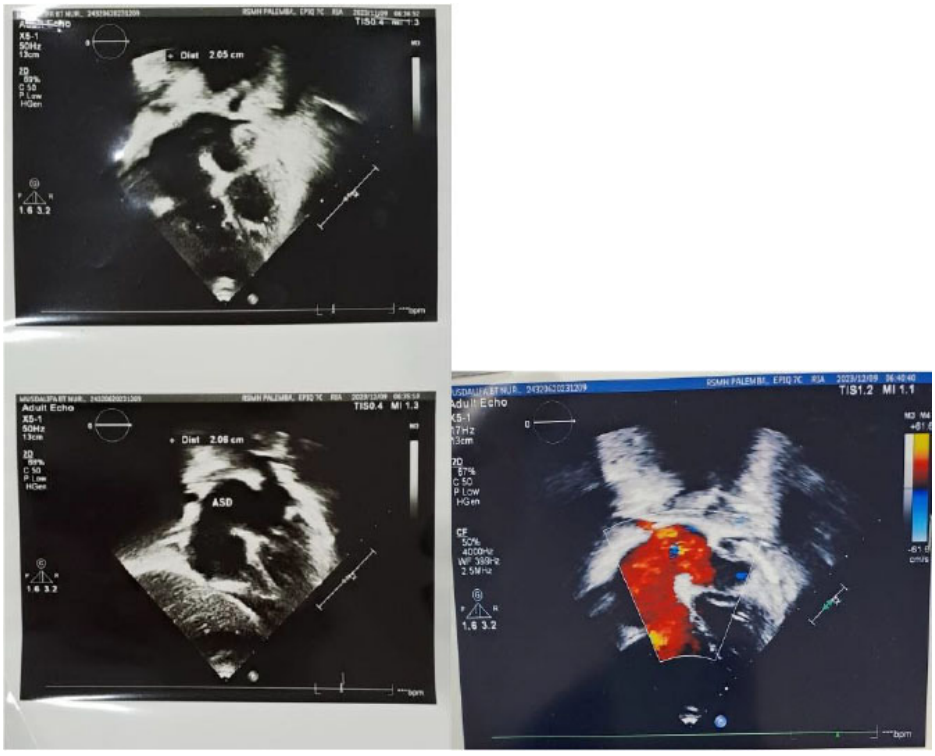

Figure 2. Pre-operative echocardiography.

1,200 gr and treated in the NICU for three weeks. There was no history disease of mother during pregnancy.

In physical examination, there was no cyanosis in lips and there is no clubbing finger but systolic murmur was detected along the left parasternal area during cardiac auscultation. Laboratory examination was within normal limit. Pre-operative chest x-ray found congenital heart disease with pulmonal hypertension (Figure 1). Echocardiography reveals atrial situs solitus, AV-VA concordance, normal systemic and pulmonary venous drainage, hpertrophy RV Diameter 31.4 mm, diameter LV 30.4 mm, AV and semilunar valves are normal, mild pulmonal regurgitation, mild tricuspid regurgitation, large atrial septal defect secundum 20.6 mm seen, no ventricle septal defect, no patent ductus arteriosus, no persistent foramen ovale, well contracting ventricles, no paradoxical movements, LV systolic function normal, left aortic arch, no coarctation of aorta and no Pericardial effusion (Figure 2).

The decision was made to perform ASD closure surgery on the patient. To obtain access, a median sternotomy is performed. The pericardium has been prepared for pericardial patch to close the defect. There is no innominate vein but there is persistent left superior vena cava (PLSVC). Aortic canulation also SVC, IVC, and PLSVC canulation where perform after heparinization. We want to perform antegrade cardioplegic, but we could not do due small and short of aorta. We decided to activate the cardiopulmonary bypass machine, and the aortic cross clamp was done. The temperature was decreased until 32°C. The heart become ventricular fibrillation. Right atrium was opened, there was ASD secundum with diameter 23 mm. We did ASD closure with pericardial patch. Then we do de-airing of left heart, and the temperature was increased normally. Aorta cross clamped off and the rhythm was sinus rhythm. The right atrium then close and the Cardiopulmonary bypass machine weaning till its stop. When the hemodynamic stable, we processed the decannulation SVC, IVC, PLSVC and aorta. The patient was given protamin solution and the bleeding was controlled, and we put one chest substernal drain number 24 Fr and one pigtail into pericardium. The operating field is closed layer by layer. The CPB time was 96 minutes and AoX time 21 minutes.

The patient was admitted to the

Intensive Care Unit (ICU) with the blood pressure 115/47 mmHg, Central Venous Pressure (CVP) 10 mmHg, heart rate 170x/minutes with oxygen saturation 100%. Patient was given support dobutamine 5 mcg/BW/minute and milrinone 0,375 mcg/BW/minute. Clinically the patient early extubated and one day after surgery, the post operative echocardiography revealed no residual of ASD.

DISCUSSION

Since the 1940s, attempts have been undertaken to blindly repair the hole by flipping the atrial appendage, which is one of the most prevalent congenital cardiac defects. Both Gordon Murray and Bailey tried this approach separately. Next was Robert Gross's semi-open method of digging a well to perform ASD closure. Lewis et al. used inflow occlusion and profound hypothermia to close it under observation. Following the development of the cardiopulmonary bypass, open surgical closure emerged as the preferred method.[11] In a multidisciplinary congenital heart disease team setting, the best course of action for treating ASD should be decided.[12]

Depending on the facility and the surgical approach, CPB during heart surgery entails varying cardiac care. Hypothermic ventricular fibrillation during heart surgery has the advantage of allowing the surgeon to easily handle the operating field and maintaining continuous coronary perfusion, which can help avoid the right ventricle (RV) flooding due to contraction when the pulmonary artery is open. Ventricular fibrillation, on the other hand, involves a hyperactive state in contrast to the beating-heart condition, raising concerns about increased myocardial energy consumption.[10,13] The ASD procedure is often carried out with aortic crosclamping and CPB. Following aortic crossclamping, cardioplegia solutions are utilized to maintain myocardial function during cardiac arrest. For the protection of the heart during cardiac procedures, these options are both safe and efficient.[14] However, in this instance, the narrow and short aorta prevented us from doing cardioplegic cannulation, therefore we chose to employ other surgical technique.

Salman et al. presented the outcomes of hypothermic ventricular fibrillation as a substitute for conventional cardioprotection. Patients with hypothermic ventricular fibrillation did not have worse outcomes or more severe adverse events than those who received standard cardioprotection. Therefore, it appears that hypothermic ventricular fibrillation is a useful cardioprotective technique.[15] Reperfusion damage is an inevitable consequence of cardioplegic arrest. The beating-heart technique's main goal is to prevent ischemic-reperfusion harm. Myocardial oedema is reduced and myocardial function is improved while the heart continues to beat. It is a safe and efficient method for a number of noncoronary operations, including as valve replacements and repairs, in addition to closing ASDs. Compared to traditional methods, beating-heart ASD closure is safe and doesn't need any sacrifices, according to Pendse et al.[16]

In this study, a seven-year-old girl had the first instance of ASD closure surgery using the hypothermic ventricular fibrillation technique without the need for cardioplegic. The patient recovered well after surgery and was extubated early. Echocardiography results one day following surgical assessment revealed no residual ASD. Our decision was based on limited research due to constraints in accessing information and resources and a short follow-up time after the therapy. Further evaluation of the effectiveness and safety is warranted on a larger scale and over a more extended observation period to provide more comprehensive insights.

CONCLUSION

In cardiac surgery, this hypothermic ventricular fibrillation procedure without cardioplegia provides an alternate way to preserve the heart. This method is comparatively safe and may be applied to heart surgery with positive results for the patient. Continued cross-specialty research and collaboration is critical to optimizing care for these patients.

DISCLOSURES

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Conflict of Interest
None.

Author Contribution
NS, B, GS, AU, and AN contributed to the manuscript preparation, revising, and drafting. AH and IHN contributed to the design of this study and supervision.

Ethical Consideration
The patient consented to the publication of this case for research purposes or in a journal.

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REFERENCES

1. Menillo AM, Lee LS, Pearson-Shaver AL. Atrial Septal Defect [Internet]. 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535440/
2. Xuan Tuan H, The Phuoc Long P, Duy Kien V, Manh Cuong L, Van Son N, Dalla-Pozza R. Trends in the Prevalence of Atrial Septal Defect and Its Associated Factors among Congenital Heart Disease Patients in Vietnam. J Cardiovasc Dev Dis. 2019;7(1):2. Available from: 10.3390/jcdd7010002
3. Muroke V, Jalanko M, Haukka J, Sinisalo J. Cause-Specific Mortality of Patients With Atrial Septal Defect and Up to 50 Years of Follow-Up. J Am Heart Assoc. 2023;12(2):e027635. Available from: https://doi.org/10.1161/JAHA.122.027635
4. Celermajer DS. Atrial septal defects: even simple congenital heart diseases can be complicated. Eur Heart J. 2018;39(12):999–1001. Available from: 10.1093/eurheartj/ehx633
5. Grygier M, Sabiniewicz R, Smolka G, Demkow M, Araszkiewicz A, Sorysz D, et al. Percutaneous closure of atrial septal defect A consensus document of the joint group of experts from the Association of Cardiovascular Interventions and the Grown-Up Congenital Heart Disease Section of the Polish Cardiac Society. Kardiol Pol. 2020;78(10):1066–83. Available from: 10.33963/KP.15629
6. Centers for Disease Control and Prevention. About Atrial Septal Defect (ASD) [Internet]. 2024. Available from: https://www.cdc.gov/heart-defects/about/atrial-septal-defect.html#:~:text=What it is-,An atrial septal defect is a hole in the wall,of the heart (atria).
7. American Heart Association. Atrial Septal Defect (ASD) [Internet]. 2024. Available from: https://www.heart.org/en/health-topics/congenital-heart-defects/about-congenital-heart-defects/atrial-septal-defect-asd

8. Özçobanoğlu S. Atrial Septal Defect Surgery With Normothermic Cardiopulmonary Bypass and Normothermic Blood Cardioplegia in the Pediatric Age Group. Akdeniz Med J. 2020;6(1):87–91. Available from: http://dx.doi.org/10.17954/amj.2019.1774
9. Hoffman JIE, Kaplan S. The incidence of congenital heart disease. J Am Coll Cardiol. 2002;39(12):1890–900. Available from: http://dx.doi.org/10.1016/s0735-1097(02)01886-7
10. Lee J-H, Lee J-E, Shin J, Song I-K, Kim H-S, Kim C-S, et al. Clinical implications of hypothermic ventricular fibrillation versus beating-heart technique during cardiopulmonary bypass for pulmonary valve replacement in patients with repaired tetralogy of Fallot. Interact Cardiovasc Thorac Surg. 2017;25(3):370–6. Available from: http://dx.doi.org/10.1093/icvts/ivx148
11. Gupta A, Singh S, Jhalani I. Evolution of atrial septal defect closure: Is MICS a new standard of care? IP J Surg Allied Sci. 2024;6(2):41–3. Available from: http://dx.doi.org/10.18231/j.jsas.2024.009
12. Brida M, Chessa M, Celermajer D, Li W, Geva T, Khairy P, et al. Atrial septal defect in adulthood: a new paradigm for congenital heart disease. Eur Heart J. 2021;43(28):2660–71. Available from: http://dx.doi.org/10.1093/eurheartj/ehab646
13. Antunes PE, Ferrão de Oliveira J, Prieto D, Coutinho GF, Correia P, Branco CF, et al. Coronary artery bypass surgery without cardioplegia: hospital results in 8515 patients. Eur J Cardio-Thoracic Surg. 2015;49(3):918–25. Available from: http://dx.doi.org/10.1093/ejcts/ezv177
14. Thapmongkol S, Sayasathid J, Methrujpanont J, Namchaisiri J. Beating heart as an alternative for closure of secundum atrial septal defect. Asian Cardiovasc Thorac Ann. 2012;20(2):141–5. Available from: http://dx.doi.org/10.1177/0218492311434807
15. Salman J, Franz M, Aburahma K, de Manna ND, Tavil S, Ali-Hasan-Al-Saegh S, et al. Hypothermic Ventricular Fibrillation in Redo Minimally Invasive Mitral Valve Surgery: A Promising Solution for a Surgical Challenge. J Clin Med. 2024;13(14):4269. Available from: https://pubmed.ncbi.nlm.nih.gov/39064309
16. Pendse N, Gupta S, Geelani MA, Minhas HS, Agarwal S, Tomar A, et al. Repair of atrial septal defects on the perfused beating heart. Texas Hear Inst J. 2009;36(5):425–7. Available from: https://pubmed.ncbi.nlm.nih.gov/19876418/