Int Cardiovasc Res J.2020;**14**(4):157-160.icrj.105745

International Cardiovascular Research Journal
www.ircrj.com

Transcatheter Closure of Patent Foramen Ovale in A Patient with Aneurysmal Atrial Septum and Multifenestrated Atrial Septal Defect

Zahra Khajali [1], MD; Ata Firouzi [1], MD; Mohamad Sadra Nazari [2], MD; Maryam Keshavarz Hedayati [1], MD; Fateme Jorfi [1], MD; Azin Alizadehasl [1,*], MD, FACC, FASE; Fatemeh Zohrian [1], MD

[1] Rajaei Cardiovascular Medical and Research Center, Iran University of Medical Sciences, Tehran, Iran
[2] Sina Hospital, Tehran University of Medical Sciences, Tehran, IR Iran

ARTICLE INFO

Article Type:
Case Report

Article History:
Received: 24 May 2020
Revised: 6 Jun 2020
Accepted: 25 Jul 2020

Keywords:
Multifenestrated Atrial Septal Defect
Patent Foramen Ovale
Percutaneous

ABSTRACT

Introduction: Treatment of patients with concomitant Patent Foramen Ovale (PFO), Atrial Septal Aneurysm (ASA), and multi fenestrated Atrial Septal Defects (mfASDs) is accompanied by many challenges. There may be even a need for different devices in the atrial septum, which is more challenging and costly.

Case Presentation: This study aimed to report a case of PFO closure, which turned out to have ASAs and multiple small holes. A Uni occlutech device was used to close the PFO and fenestrations, which was done successfully and without complications.

Conclusions: It is important to have a thorough evaluation of the atrial septum to rule in or out the possibility of multiple defects. This is done by accurate interrogation of the atrial septum by color Doppler echocardiography, preferably by transesophageal or three-dimensional echocardiography at the time of catheterization. Multiple small defects or fenestrations nearby may be closed by a single device, which may cover several defects or fenestrations.

1. Introduction

Treatment of patients with concomitant Patent Foramen Ovale (PFO), Atrial Septal Aneurysm (ASA), and multi fenestrated Atrial Septal Defects (mfASDs) is accompanied by many challenges and there may even be a need for multiple devices in the atrial septum, which is more challenging and costly. This is done with a complete and accurate observation of the atrial septum by color Doppler echocardiography, preferably by transoesophageal or three-dimensional Transesophageal Echocardiography (3D TEE) during catheterization.

Interatrial septal abnormalities involve a spectrum of deficiencies from small PFOs with a small alternating right-to-left shunt to PFOs with aneurysm of the atrial septum, large PFOs with a resting shunt, and large or multiple ASDs with significant left-to-right shunting (1). The prevalence of PFO has been shown to be higher among the patients with a cryptogenic Transient Ischemic Attack (TIA) or ischemic stroke. PFO has been considered a potential risk factor for ischemic stroke due to paradoxical embolism in 40 - 50% of cases. The prevalence of recurrent thromboembolic events has been reported to vary from 0% to 14% in these patients. Therapeutic options for prevention of secondary stroke in patients with PFO include two main strategies: 1) conservative long-term medical treatment strategy with antithrombotic therapy (antiplatelet aggregation drugs) or oral anticoagulants and 2) an invasive strategy involving PFO closure via a surgical operation or an intervention, which is a relatively safe method with occasional side effects (2). However, controversial findings have been obtained regarding the benefits of percutaneous closure and medical treatment using aspirin and warfarin in the prevention of recurrent neurological events (3).

ASDs account for 10 – 17% of congenital heart defects. Percutaneous closure of ostium secundum ASDs is a safe and effective alternative to surgery. Approximately 10% of patients with secundum-type ASDs have been found to have mfASDs, and closing more than one defect might pose numerous challenges for cardiologists (4, 5). Both PFO and fenestrated ASDs have been reported to be associated with ASAs. An ASA has been defined as a localized outpouching deformity of the fossa ovalis region of the interatrial septum that protrudes into the right or the left atrium or both (6). The presence of ASAs may contribute

*Corresponding author: Azin Alizadehasl, Rajaei Cardiovascular Medical and Research Center, Iran University of Medical Sciences, Tehran, Iran. Cellphone: +98-9122258582,
Email: alizadeasl@gmail.com.

to the pathophysiology of paradoxical embolism, which remains a problem for PFO closure (3).

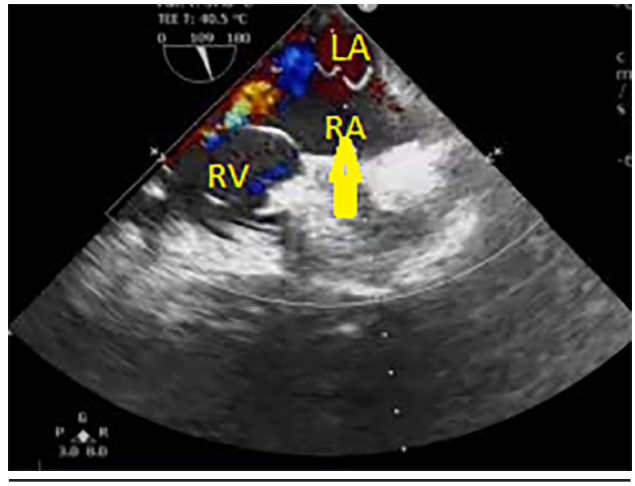
Closure of fenestrated ASDs with and without aneurysm may require a variety of devices, which is more challenging and costly. One approach is balloon atrial septostomy to convert multiple defects into a single defect to close with a single device (6). Nonetheless, it is sometimes necessary to replace two occluder devices due to the long distance between the fenestrations. However, there is little information on the use of devices to close multiple ASDs (4). Cribriform Amplatzer device is one of the devices that can be used in this situation.

Herein, we aim to report a case of PFO closure, which turned out to have an ASA and multiple small holes. A Uni occlutech device was used to close the PFO and fenestrations, which was done successfully without any complications.

2. Case Presentation

The patient was a 32-year-old lady with a history of Percutaneous Transcatheter Pulmonary Commissurotomy (PTPC) at the age of 20 years, chronic palpitation, and dizziness who had referred to the clinic with recurrent symptoms of TIA (left hemiplegia for three times). She had to undergo TEE for evaluation of the emboli source. Her general appearance was normal. In the cardiac examination, the heart rhythm was regular. In addition, the first and second heart sounds were heard in the normal intensity with no audible murmurs. The 12-lead standard electrocardiogram revealed normal sinus rhythm. The chest X-ray also showed a normal cardiothoracic ratio with a normal vascularity pattern. The TEE and three-dimensional echocardiography showed normal left ventricle size and preserved systolic function (ejection fraction = 50 - 55%), normal right ventricle size with normal systolic function, normal biatrial size, normal drainage of all pulmonary veins to the left atrium, no clot or smoke in the left atrium and its appendage, no mitral stenosis, mild mitral regurgitation, normal and tricuspid aortic valve with no stenosis and insufficiency, thickened and dome shaped pulmonary valve, no significant pulmonary stenosis (mean pressure gradient: 10 mmHg, peak pressure gradient: 18 mmHg), mild to moderate pulmonary insufficiency, mild tricuspid regurgitation, aneurysmal interatrial septum with a large PFO (4 millimeters), and at least three fenestrations (largest one = 4 millimeters) with a left to right shunt. The distance between the first and the last hole was 12 mm and the distance to the PFO was 10 mm (Figure 1). The holes had sufficient rims, but the septum was very aneurysmal. The patient had experienced a Cerebral Vascular Accident (CVA) at a relatively young age. A thorough investigation did not disclose any apparent etiologies for this event, but a cryptogenic stroke due to a paradoxical embolus through the PFO or the mfASDs. The expected benefits for the patient included the prevention of a recurrent stroke due to a presumed paradoxical embolus and prevention of further cardiac complications, including arrhythmia, heart failure, and deteriorating functional capacity. There was also a risk (though relatively low) of increasing pulmonary vascular resistance without ASDs closure. Therefore, the

Figure 1. Aneurysmal Interatrial Septum with a Large Patent Foramen Ovale and Fenestration in Transesophageal Echocardiography



LA, left atrium; RA, right atrium; RV, right ventricle

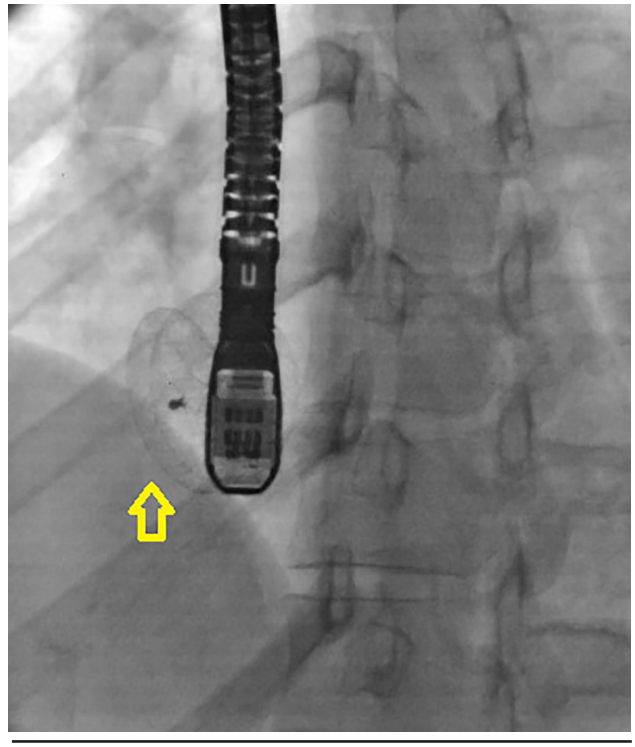


Figure 2. The Uni Device Chosen for the Procedure

patient was scheduled for PFO and mfASDs device closure. Percutaneous intervention was decided to be performed. Yet, the most important factor was covering all the defects. A Uni device was selected for this procedure (Figure 2). The transesophageal and three-dimensional echocardiographies that were done after prep and drape under local anesthesia with mild conscious sedation revealed multiple small fenestrations (at least three) with sufficient rims. During transcatheter closure, hemodynamic and saturation were obtained. The hemodynamic study showed normal blood pressure and heart rate with O2 saturation of about 95%. A guidewire was advanced from the femoral vein, across the PFO, into the left upper pulmonary vein under TEE guidance. The tricky part of the procedure was passing the

middle hole for covering all fenestrations and the PFO. The delivery sheath was then advanced over the wire, across the defect into the left atrium and the left upper pulmonary vein. Afterwards, the closure device (Uni device, size = 33 mm) was chosen and advanced through the sheath into the left atrium. The left disc of the device was deployed with the catheter in the left atrium and then, the catheter and the device were withdrawn until the left disc got parallel with the left atrium aspect of the interatrial septum. The right dick was then opened completely. No desirable results were obtained in the first and second attempts. In the end, by 3D TEE guidance, the device could pass the middle fenestration and cover all fenestrations and the PFO. Before the device was released from the catheter, appropriate positioning was confirmed by interrogating all rims with echocardiography, and push/pull maneuvers were performed to confirm device stability. After the device was released, no complication was detected (no pericardial effusion, no compressive effect on contiguous structures, such as the aortic, mitral, and tricuspid valves, superior vena cava, inferior vena cava, and pulmonary veins, and no residual leakage even after contrast injection).

3. Discussion

Transcatheter closure of multiple ASDs is possible, safe, and effective. However, the percutaneous transcatheter closure of fenestrated ASDs may be more complex compared to the closure of a single ASD and requires careful consideration of the anatomy of the defects and their surroundings as well as the exact selection of the most appropriate method. When the distance between the ASDs is more than seven mm, the defects may be closed using several devices each of which is implanted to close one or more defects. It has been suggested that residual leaks tend to settle with time. The advantages of using a single device include the shorter duration of the procedure and the lower probability of interference with venous blood flow, atrioventricular valves function, and adjacent tissue erosion (5).

It is important to have a thorough evaluation of the atrial septum to rule in or out the possibility of multiple defects. This is done by accurate interrogation of the atrial septum by color Doppler echocardiography, preferably by transesophageal or three-dimensional echocardiography at the time of catheterization. Two-dimensional TEE can provide useful information by monitoring transcatheter closure, while three-dimensional TEE increases the ability to understand the atrial septum anatomy and facilitates catheter closure (3).

In closely positioned PFOs and multiple defects, the septal occluder may be implanted in the PFO aiming to cover any smaller defects. In widely separated defects, however, more than one device is needed. This is difficult to diagnose using TTE, because the abnormal color flow obscures the source of the shunt, especially if there are small defects in the lower part (7).

Many strategies have been proposed for the treatment of PFO associated with medium or large ASAs. These include the use of large devices to cover the entire ASA, a transseptal puncture for placement of the device as far as possible in the center according to the fossa ovalis, planting multiple devices, and medical therapy. In such cases, complete ASA coverage is performed only by a large device or by approximating the length of the interatrial septum, a strategy that carries the inherent risks associated with large-sized devices. The implantation of large devices, especially if the discs are larger than the length of the interatrial septum, is associated with medium- and long-term complications, such as increased arrhythmic frequencies, device thrombosis, aortic and atrial erosion, and residual shunt (8, 9).

The approach to percutaneous closure of multiple defects depends on their sizes and distances from each other, their relationships with adjacent structures such as the aorta, the coronary sinus, the pulmonary veins, the mitral and tricuspid valves, and the free walls of the right and left atria. Multiple small defects or fenestrations nearby may be closed with a single device, which may cover several defects or fenestrations. As three-dimensional echocardiography has become more available, it is more likely to define anatomy in the pre-processing period. Despite careful pre-procedure planning, closing multiple defects prolongs the procedure and, consequently, it is important to have a cooperative patient for accurate placement of the closure device (1).

In the present study, the rate of immediate closure was very high due to accurate echocardiography as well as the operator's experience. The patient was recommended to receive antiplatelet agents (aspirin and Plavix) for at least six months to prevent any possible thromboembolic events.

3.1. Ethical Approval

Not applicable.

3.2. Informed Consent

Written informed consent form was obtained.

Acknowledgements

There is no acknowledgment.

Authors' Contribution

Study concept and design: ZK and MKH; critical revision of the manuscript for important intellectual content: MKH and MN; the original idea and the protocol: AA and FZ; abstracting and writing the manuscript: MKH and MN; guarantor: MN and AF; development of the protocol and preparing the manuscript: MN and FZ.

Funding/Support

No funds were received from any company or institution.

Financial Disclosure

The authors have no financial interests related to the material in the manuscript.

References

1. Rigatelli G, Dell'avvocata F, Cardaioli P, Braggion G, Giordan M, Mazza A, *et al.* Long-term results of the amplatzer cribriform occluder for patent foramen ovale with associated atrial septal aneurysm: impact on occlusion rate and left atrial functional remodelling. *Am J Cardiovasc Dis*. 2012;**2**(1):68-74.
2. Braun MU, Fassbender D, Schoen SP, Haass M, Schraeder R, Scholtz

W, *et al.* Transcatheter closure of patent foramen ovale in patients with cerebral ischemia. *J Am Coll Cardiol*. 2002;**39**(12):2019-25.
3. Egred M, Andron M, Albouaini K, Alahmar A, Grainger R, Morrison WL. Percutaneous closure of patent foramen ovale and atrial septal defect: procedure outcome and medium-term follow-up. *J Interv Cardiol*. 2007;**20**(5):395-401.
4. Mitchell AR, Roberts P, Eichhofer J, Timperley J, Ormerod OJ. Echocardiographic assessment and percutaneous closure of multiple atrial septal defects. *Cardiovasc Ultrasound*. 2004;**2**:9.
5. Tal R, Dahud Q, Lorber A. Fenestrated atrial septal defect percutaneously occluded by a single device: procedural and financial considerations. *Cardiol Ther*. 2013;**2**(1):97-102.
6. Tillman T, Mulingtapang R, Sullebarger JT. Approach to percutaneous closure in patients with multiple atrial septal defects. *J Invasive Cardiol*. 2008;**20**(5):E167-70.
7. Cao Q, Radtke W, Berger F, Zhu W, Hijazi ZM. Transcatheter closure of multiple atrial septal defects. Initial results and value of two- and three-dimensional transoesophageal echocardiography. *Eur Heart J*. 2000;**21**(11):941-7.
8. Khajali Z, Sanati HR, Pouraliakbar H, Mohebbi B, Aeinfar K, Zolfaghari R. Self-expandable stent for repairing coarctation of the left-circumferential aortic arch with right-sided descending aorta and aberrant right subclavian artery with Kommerell's aneurysm. *Annals of Vascular Surgery*. 2017;**38**:318. e7-. e10.
9. Numan MT, El-Said H, Dilawar M, El Sisi A. The Challenge of Fenestrated Atrial Septal Defects closure; which device to choose?