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Transcatheter Closure of Multiple Defects of the Atrial Septum: Technique and Follow-Up

H. Felice, S. Chandran, P. Bhamra-Ariza, S. Brecker

Department of Cardiology, St. George's Hospital, London, UK
Email: helenafelice@doctors.org.uk

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Abstract

Introduction: Although multiple defects of the atrial septum are not uncommon, there remain limited data regarding the use of multiple devices in these patients. A variety of approaches to transcatheter closure have been used, and in this paper we describe the experience from two operators in a single centre. Methods: From September 2002 to September 2012, 673 transcatheter atrial septal defects (ASD) and patent foramen ovale (PFO) closure procedures were performed and retrospectively examined in a registry analysis. Results: Of these, 22 patients had multiple discrete defects, and four different approaches to closure were used. In 4 patients (18.2%) one device was used percutaneously to close multiple defects. Eleven patients (50%) had two devices inserted during the same procedure while two patients (9%) had two devices inserted as staged procedures. One patient (4.5%) had three devices inserted over two procedures. Four patients (18.2%) were found not to be suitable for percutaneous closure during the procedure and were referred for surgical closure. Conclusion: Our experience with the implant procedures, and clinical follow up of patients, shows that patients with multiple defects can be effectively treated with transcatheter device techniques including single device closure, multiple devices in one procedure and multiple devices in staged procedures and also with surgical repair.

Keywords

Transcatheter, Atrial Septal Defects

1. Introduction

Atrial septal defects (ASD) and patent foramen ovale (PFO) are common cardiac defects. Over the past fifteen

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years, transcatheter device closure has become the more common method of treatment. Transcatheter device occlusion of atrial septal defects has been shown to be as successful as surgical closure and is the preferred option which is feasible and safe given the low incidence of major complications and shorter length of hospital stay [1]-[4]. Closing multiple defects with multiple devices is feasible and has been demonstrated with relative safety and efficacy in both adults and the paediatric population [5] [6].

For single defects, there is a 98% closure rate with no significant residual shunt at follow-up in suitable patients [7] [8]. There are limited data on transcatheter closure of multiple defects of the atrial septum. There is considerable morphological variation in size and location of the defects, and as such there are a variety of approaches to percutaneous closure. One device can be used for multiple defects or alternatively two or more devices can be used. If more than one device is used, these can be inserted during the same procedure or as staged prodecures. A recent study has suggested that there is an increased risk of residual shunt with the use of more than one device for multiple defects [9].

The objectives of our study were to analyse how many patients in our centre with atrial septal defects had multiple lesions, to see which methods of closure were utilised and to follow up these patients to look at their outcomes.

2. Methods

From September 2002 to September 2012, 673 percutaneous ASD and PFO closure procedures were performed and retrospectively examined in a registry analysis. Of these consecutive patients, 22 had multiple septal defects and they were analysed further to determine the method of closure used. There were no inclusion or exclusion criteria. The principal indication for ASD closure was to treat symptoms of dyspnoea, while cryptogenic stroke in the absence of other clear risk factors for stroke was the principal indication for PFO closure. Rarer indications for the closure of PFOs include recurrent transient ischaemic attacks (TIAs), severe migraine refractory to drug therapy and as a prophylactic treatment for decompression illness in professional divers. All patients had a degree of right ventricular impairment.

3. Results

The mean age of the patients was (41.2 ± 9.5), and (78%) were female. The devices used for closure included, the Amplatzer (AGA Medical) Septal occluder (ASO), Amplatzer PFO occluder, the Amplatzer Cribriform device, the Premere device, the Gore Helex occluder, the Gore Septal Occluder, Occlutech devices and CardioSEAL-STARFlex devices. Multiple ASDs or a combination of ASD and PFO were present in 3.3% (n = 22) of all patients in whom closure was attempted. For these patients, a total of 34 closure devices were used of which 22 were Amplatzer PFO and Septal occluders, 2 Helex occluders, 3 Premere devices and 7 Amplatzer Cribriform devices.

Of the 22 patients with multiple defects, four different strategies to closure were used. In 4 patients (18.2%) one device was used percutaneously to close multiple defects. Eleven patients (50%) had two devices inserted during the same procedure while two patients (9%) had two devices inserted as staged procedures over a period of time. One patient (4.5%) had three devices inserted on two separate procedures for three defects. Four patients (18.2%) were found not to be anatomically suitable for percutaneous closure during the procedure and went on to be referred for surgical closure. Examples of cases from each of these four groups are described below (**Table 1**).

We have obtained long term follow up data for 15 of the 22 patients with multiple defects. The follow up was conducted in September 2014, between 2 and 12 years from the original procedures. Of the 15 patients on whom

Table 1. Four strategies for multiple defect closure.

	Number of patients	% of total (n = 22)
One Device	4	18
Multiple Devices—Same procedure	11	50
Multiple Devices—Staged procedure	3	14
Surgical closure	4	18

long term follow up data is available, two patients have died, one of whom had multiple medical comorbidities. One patient has developed palpitations and has a small device leak seen on TOE which is being medically managed. Another patient developed atrial fibrillation and a pulmonary embolus post-procedure. The remaining patients were well at follow up. Of the patients referred for surgery follow up data was obtained for 2 of the 4 patients and they are well.

3.1. Single Device Closure

Case One: A 27-year-old lady with a history of cryptogenic stroke was found on echocardiography to have a PFO and also a small ASD. A 35 mm Cribriform Atrial Septal Occluder was placed across the ASD which closed both holes with a good result. Post-procedure transthoracic echocardiography (TTE) showed a minute flash within the closure device on colour flow Doppler. Subsequently she experienced a transient episode of pins and needles in her left arm and leg, although CT head demonstrated no abnormality. Repeat echocardiography at 5 weeks confirmed the device was well seated with no residual shunt.

3.2. Multiple Devices, One Procedure

Case Two: A 52-year-old man was found to have an atrial septal aneurysm on echocardiography and a positive bubble transoesophageal echocardiogram (TOE), following a stroke. Two devices were implanted, one across the PFO and one across an adjacent ASD. Post-procedure TTE showed no residual shunt. Repeat echocardiography at 4 months showed minimal left to right colour flow. Post closure of the defect, the patient developed atrial fibrillation (AF).

Case Three: A 37-year-old lady was found on TOE to have two atrial septal defects—one at the inferior border of the septum and one large defect superiorly, which was multifenestrated. The upper defect was closed first and the lower defect reassessed. There was ongoing flow through the smaller defect, and so a second device was deployed across it (see **Figure 1**). The devices were aligned at right angles to one another because of the aneurysmal nature of the septum. There was some residual flow through the larger device, however an echocardiogram 15 months later showed no obvious residual shunt. The patient developed post-procedure haematemesis and oesophagogastroduodenoscopy (OGD) showed a Mallory-Weiss tear. Therefore Clopidogrel was given in place of Aspirin.

Case Four: A 72-year-old lady was admitted for elective closure of ASD. After the 26 mm ASO was placed, it became clear that there was a second defect. A further 12 mm ASO was used and in order to interdigitate the devices correctly, the discs were retrieved and then redeployed in the following order: left atrium (LA) disc of smaller device, LA disc of larger device, right atrium (RA) disc of larger device, RA disc of smaller device (see

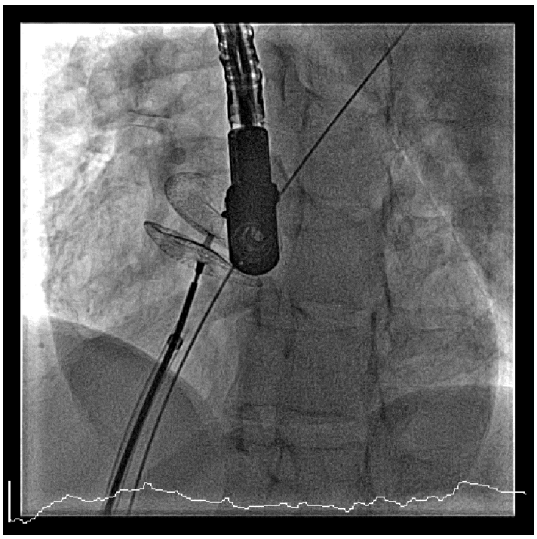

Figure 1. Amplatzer septal occluder device in place with 0.035 guidewire across second defect.

Figure 2 and **Figure 3**). There was no residual shunt and follow up TTE at 4 months showed some residual flow with a small left to right shunt.

3.3. Multiple Devices, Staged Procedure

Case Five: A 36-year-old man was admitted for PFO closure post-cerebrovascular event. During the procedure when the interatrial septal anatomy was studied, it was found that there was both an ASD and a PFO. A single device was deployed across the ASD (ASO) which was thought to also occlude the PFO. However, 7 months later the patient required a further procedure for closure of the PFO due to ongoing residual shunt using an Amplatzer PFO occluder. Post-procedure TTE showed resolution of the shunt.

3.4. Unsuccessful Percutaneous Closure (Surgical Referral)

Case Six: A 49-year-old lady was admitted electively for ASD closure. TOE showed multiple defects in the atrial septum. A device was placed in an attempt to close the septal defects, but after deployment there were still

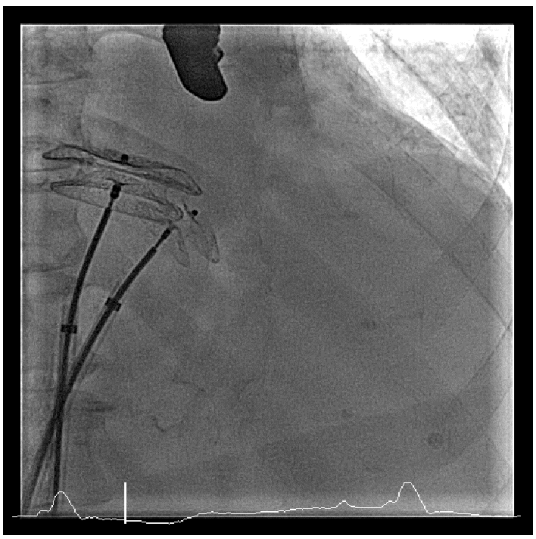

Figure 2. Simultaneous deployment of two ASO devices, interdigitating.

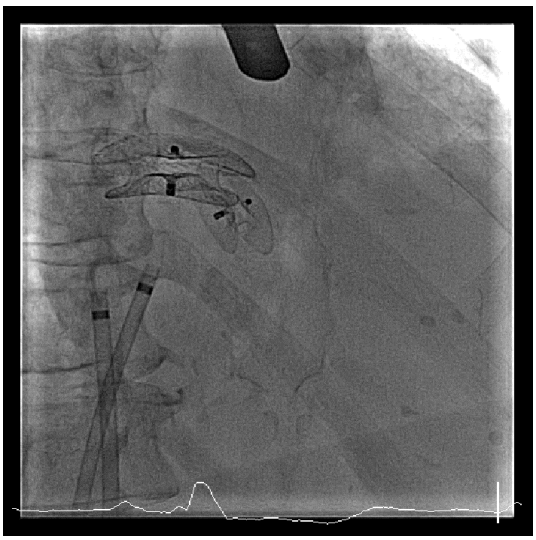

Figure 3. Devices after deployment.

multiple shunts at both ends of the device. The device was therefore removed and the patient was referred for surgical closure.

4. Discussion

Limited data exist on the outcome of using multiple devices to close multiple defects of the atrial septum. A single device is generally used if it can effectively close two adjacent defects. It is deployed across the largest defect and ideally covers any adjacent defects. Multiple devices are more commonly used when the separation of the defects is more than a few millimetres.

Single device occlusion is more cost effective, avoids a bulky profile and results in shorter fluoroscopy times. If two or more devices are used they must be placed either simultaneously (with one sandwiching the other) or sequentially, either at the same procedure or in a staged procedure sequence. The interleaving technique had been shown to achieve the lowest possible profile with overlapping devices (see **Figure 4**).

This method will reduce the risk of device embolisation and also decreases pressure on surrounding structures. As it is not possible to interleave at a later stage, a staged procedure using multiple devices leads to overlapping and a higher profile [10]-[12]. However, because most residual defects close over a period of time it has been suggested that a single device be used initially and then a second device at a later stage if necessary, which may result in fewer and smaller second devices [13].

Device erosion is a recognised complication of transcatheter ASD closure. Device diameter, multiple devices, deficient rims in vulnerable areas (e.g. antero-superior rims) all increase the risk of erosion. Of cases reported, very few have involved structural deterioration of the actual devices but in comparison atrial free wall erosion is the more common complication. Furthermore it does not appear that more than one device is a risk factor for erosion, but this may simply reflect the paucity of cases undertaken.

Imaging techniques including transesophageal (TOE) echocardiography are used to measure the extent of tissue between multiple defects and ideally at least 6 - 7 mm is needed in order for two devices to be used [14]. However, even with a separation of more than 7 mm, it may still be possible to use a single device depending upon the precise location and morphology of the defects.

There are no differences between the single device and the multiple devices groups in terms of anti-platelet therapy and endocarditis prophylaxis and treatment.

5. Conclusion

Our experience shows that our patients with multiple defects were treated with one of four methods—single device closure, multiple devices in one procedure, multiple devices in staged procedures and unsuccessful percutaneous repair requiring surgical referral. These registry data confirm that transcatheter closure for multiple defects appears to be safe and efficiacious in selected cases but the study is limited by small numbers. Although

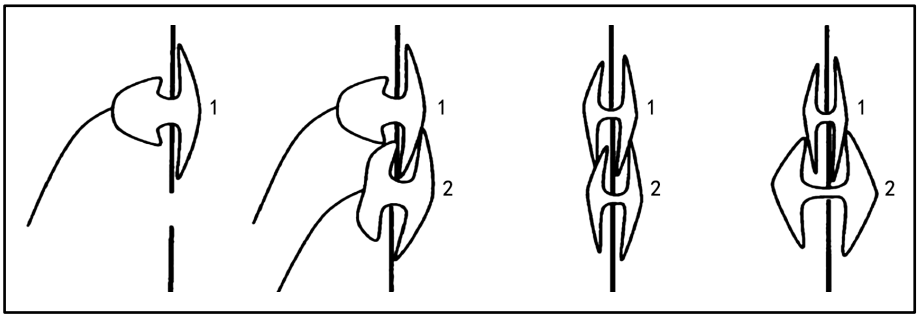

Figure 4. Technique of “interleaving”. (a) Deployment of device I, maintaining tension on right atrial disk with delivery wire; (b) Placement of device 2 so that left atrial disk lies on left atrial side of device 1. While maintaining tension on device 1, the right atrial disk of device 2 is deployed; (c) Release of tension on device 1 allows its right atrial disk to rest on right atrial side of device 2. The result is the lowest possible profile; (d) Overlapping devices without “interleaving” and a resulting high profile of device 2 [8].

follow-up data are incomplete, the results are encouraging and there is no obvious difference in outcomes between the four groups.

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