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Original Article

The distance from the Amplatzer septal occluder to the mitral valve in patients undergoing interventional closure of defects in the oval fossa increases with growth of the patient

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Abstract The Amplatzer septal occluder is an alternative to operative closure of atrial septal defects within the oval fossa. An issue when deploying the device is its distance from the mitral valve. The purpose of this study is to determine how this distance changes with growth of the patient. We identified, through a review of charts, all patients undergoing closure of defects within the oval fossa by insertion of an Amplatzer septal occluder. Data were obtained from the echocardiogram 24 hours after closure, and at most recent follow-up, including left ventricular end-diastolic diameter, left atrial diameter, degree of mitral valvar regurgitation, body surface area, and distance from the device to the mitral valve. We divided the patients into 2 groups based upon change in body surface area. The first group had an increase in body surface area of at least 10%. All others were in the second group.

We inserted 55 Amplatzer septal occluders in 54 patients. Of these we excluded 17 patients, 1 because quality of images was inadequate, 1 who underwent placement of 2 devices, 1 in whom the device embolised to the left ventricle the day after deployment, and 14 who have not yet had a follow-up echocardiogram.

The group which exhibited an increase in body surface area of greater than 10% demonstrated an increase in distance from the device to the mitral valve, left ventricular end-diastolic, and left atrial diameters. Those who did not undergo significant growth had no increase in distance from the device to the mitral valve, but did have an increase in left atrial and left ventricular end-diastolic diameters. No patient developed mitral regurgitation. We conclude that, when deploying an Amplatzer septal occluder close to the mitral valve in children, the distance from the device to the mitral valve can be expected to increase with growth of the patient.

Keywords: Atrial septal defect; interventional catheterisation; congenital heart disease

Closure of defects within the oval fossa using the Amplatzer septal occluder has proven to be a safe and effective alternative to operative repair in children and adults.[1,2] Several anatomic issues must be considered before deploying the device, including the adequacy of the muscular rims around the defect, residual shunting, the relationship of the pulmonary veins to the left atrial disk, and the proximity of the device to the mitral and tricuspid valves. In this study, we analyze how the distance from the left atrial disk to the aortic leaflet of the mitral valve changes with respect to increases in body surface area.

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Methods

After obtaining Human Rights Committee approval, we reviewed the charts and transthoracic echocardiograms for patients undergoing transcatheter closure of an atrial septal defect at Children's Hospital of Pittsburgh between August, 1998 and October, 2002. We recorded basic demographic data, along with size of the atrial septal defect and the device. The following measurements were made on the day following device deployment and at latest follow-up: minimum distance between the left atrial disk of the device and the aortic leaflet of the mitral valve in

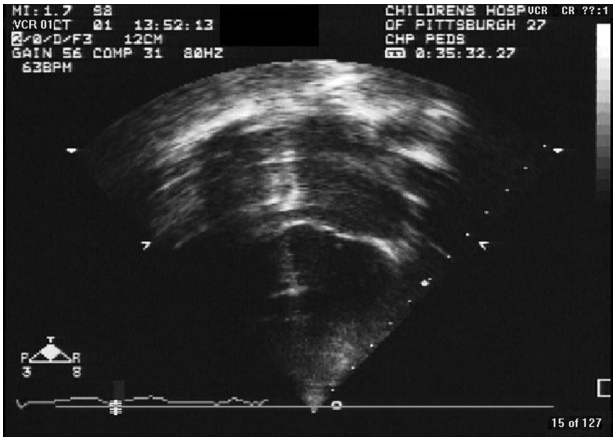

Figure 1.
Apical four chamber view 9 months after deployment of an Amplatzer septal occluder to close a defect within the oval fossa.

Table 1. Group characteristics.

	BSA change	
	>10%	<10%
Median age at ASD closure (yr)	6.4 (2.7–14.8)	16.5 (4.5–59.6)
Median age at latest follow-up (yr)	8.3 (4.1–15.3)	17.8 (5.0–60.5)
Male:female	6:8	4:19
Median BSA at ASD closure (m^2)	0.83 (0.52–1.46)	1.54 (0.72–2.43)
Median BSA at latest follow-up (m^2)	1.03 (0.63–1.62)	1.58 (0.77–2.47)
Median stretched ASD size (mm)	17	15.5
Median device size (mm)	17	16

Abbreviations: BSA: body surface area; ASD: atrial septal defect

systole from the apical four chamber view (Fig. 1), left atrial diameter and left ventricular end-diastolic diameter from the parasternal short axis view, and degree of mitral valvar regurgitation using Doppler colour flow mapping from the apical four chamber view, graded as none, trace, mild, moderate, or severe. All echocardiographic measurements were recorded in mm to 1 decimal place, and were made offline using the electronic calipers on a *Hewlett Packard 5500* ultrasound machine. One observer, who was blinded to the height and weight of the patients, performed all measurements. We recorded measurements of height and weight on the day of deployment of the device, and at latest follow-up. These were converted to body surface area using the formula: body surface area (m^2) = ((height (cm) × weight (kg))/3600)$^{1/2}$.

We divided the patients into two groups. The first group had an increase in body surface area from the time of defect closure to latest follow-up of at least 10%, while the second group had a change in body surface area of less than 10%. The increase in body surface area of 10% was chosen arbitrarily as a cut-off for significant growth prior to all collection of data. All data was then compared between these two groups. Patients were excluded if they had inadequate images to assess echocardiographic parameters, if they had more than one device deployed, if there was embolisation of the device, or if they have not yet had a follow-up echocardiogram at the time of analysis of the data.

Statistics

Demographic data, the stretched diameter of the defect, the size of the device, and measurements of body surface area were described using standard statistical analysis. Measurements of the left atrial diameter, left ventricular end-diastolic diameter, and distance from the device to the mitral valve on the day after deployment and at latest follow-up were compared using the student's t-test for paired samples. A p value of <0.05 was considered significant. Statistical analysis was carried out using *SPSS for Windows version 8.0*.

Results

A total of 55 Amplatzer septal occluder devices were deployed in 54 patients. We excluded 17 patients for the reasons described above, 14 because they had not received a follow-up, and one patient each for the other criterions. This left 14 patients in the group exhibiting an increase in body surface area of at least 10%, and 23 in the group whose body surface area increased by less than 10%. Demographic data, measurements of body surface area, and the sizes of the defect and device are presented in Table 1.

The group exhibiting significant growth had a significant increase in left ventricular end-diastolic diameter, left atrial diameter, and distance from the device to the mitral valve. The group in which body surface area increased by less than 10% had no significant increase in distance from the device to the mitral valve, but did have a significant increase in left atrial and left ventricular end-diastolic diameters. Results are shown in Table 2. No patients in either group developed mitral regurgitation.

Discussion

The decision to deploy an Amplatzer septal occluder is affected by several factors, including the stability

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Table 2. Comparison of initial and latest echocardiographic data (all data are presented in mm).

	Initial	Latest	Mean difference/SEM	
Distance from the ASO to the mitral valve for patients with BSA increase ⩾10%	5.4	7.7	2.2/0.6	p = 0.004
Distance from the ASO to the mitral valve for patients with BSA change <10%	9.5	9.7	0.1/0.7	NS
LVED for patients with BSA change ⩾10%	34.1	40.7	6.6/1.1	p < 0.001
LVED for patients with BSA change <10%	42.4	45.9	3.4/0.7	p < 0.001
LA diameter for patients with BSA change ⩾10%	21.4	26.0	4.6/1.0	p = 0.001
LA diameter for patients with BSA change <10%	28.0	32.0	4.0/1.4	p = 0.012

Abbreviations: SEM: standard error of the mean; ASO: Amplatzer septal occluder; BSA: body surface area in m^2; LVED: left ventricular end-diastolic diameter; LA: left atrial

of the device, the proximity of the device to the pulmonary veins, residual shunting, and the relationship of the device to the atrioventricular valves. Previous reports have commented on the rates of failure of deployment due to inadequate muscular rims surrounding the oval fossa, significant residual shunts, malpositioning of the device, and other technical problems.[3] It has also been shown that the profile of the device decreases over time.[4] Clearly, there are dynamic changes that occur with closure of these defects, the effects of which may not be evident over the short term.

Frequently, the device lies in close proximity to the mitral valve immediately after deployment. Salaymeh et al.[5] described 2 patients in a series of 29 successful deployments who had abutment of the left atrial disk onto the aortic leaflet of the mitral valve without evidence of obstruction. In our series, 4 of 37 patients had a distance from the device to the mitral valve of 2 mm or less on the day following deployment. Given that a close spatial relationship between the device and the mitral valve is not an infrequent occurrence, and knowing that both the device and the chambers undergo changes in size following closure of an atrial septal defect, we wondered how their spatial relationship changes over time with respect to changes in the body surface area of the patients. Of particular concern is the possibility of developing significant mitral valvar regurgitation due to repetitive trauma from a leaflet striking the device.

We have shown that the distance between the Amplatzer septal occluder and the aortic leaflet of the mitral valve tends to increase concomitant with increases in body surface area, while this distance tends to remain static in patients who do not undergo significant growth. The left atrial diameter and left ventricular end-diastolic diameter tend to increase in all patients following closure of the atrial septal defect by insertion of the septal occluder.

The relative effects of somatic growth and altered atrial and ventricular hemodynamics on these dimensions have not been elucidated. It seems reasonable to presume that the increase in left atrial size is due at least in part to the loss of the previously decompressing effect of the atrial septal defect. How this change in left atrial size might affect the position of the device with respect to the mitral valve has not been previously shown. Regarding the increase in left ventricular end-diastolic diameter observed in both groups, this may be due to changes that take place in the right ventricular volume following closure of the atrial septal defect.[6]

The primary limitations of our study are the small number of patients studied, and the relatively short follow-up period. These can be easily redressed over time as more patients undergo closure with the Amplatzer occluder. Also, the number of patients could be increased by continuing to follow the echocardiographic data on those patients for whom follow-up was pending at the time of the analysis. Finally, there is the issue of taking echocardiographic measurements to 1 decimal place. While this certainly introduces a degree of error, this method was chosen so as to avoid more significant rounding of measurements which might obscure differences in the measurements taken.

In conclusion, we have shown that the distance between the left atrial disk of the Amplatzer septal occluder and the aortic leaflet of the mitral valve tends to increase concomitantly with increases in body surface area. Thus, when deploying the device relatively close to the mitral valve, one can be reassured that the device will tend to adopt a position further from the mitral valve as the patient grows. In patients who are not expected to grow significantly following deployment, nonetheless, the occluder may remain in close proximity to the mitral valve.

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