Percutaneous Treatment of Atrial Septal Aneurysm

Manuel Pan,[a] José Suárez de Lezo,[a] Alfonso Medina,[b] Miguel Romero,[a] José Segura,[a] and Dolores Mesa[a]

[a]Servicio de Cardiología, Hospital Reina Sofía, Córdoba, Spain.
[b]Servicio de Cardiología, Hospital Dr. Negrín, Las Palmas de Gran Canaria, Spain.

Among a total number of 203 patients with atrial septal defects (ASD) or patent foramen ovale (PFO) who were treated by percutaneous closure, we selected 29 (19 with ASD and 10 with PFO) who fulfilled the criteria for atrial septal aneurysm. Eight patients had functional class II or III dyspnea, and 12 had a history of previous cerebrovascular accident (38%). Seven of the patients with ASD, had a single defect and 12 had multiple defects; 14 received a single occluder and 5 patients needed 2 or 3 devices. Follow-up transthoracic ultrasound study at 6 months showed the defect to be successfully closed in all 29 patients. After a mean follow-up time of 31±19 months, all patients were alive and symptom-free. Patients with atrial septal aneurysm and associated ASD or PFO can be successfully treated with Amplatzer septal occluders.

Key words: *Atrial septal aneurysm. Atrial septal defects. Patent foramen ovale.*

Tratamiento percutáneo de los aneurismas del septo interauricular

De un total de 203 pacientes con comunicación del septo interauricular (CIA) o foramen oval permeable (FOP) que fueron tratados mediante cierre percutáneo, hemos seleccionado para el estudio a 29 pacientes (19 con CIA y 10 con FOP) que cumplieron criterios de aneurisma del septo. Ocho pacientes tenían disnea en grado funcional II o III y 12 (38%) habían tenido un accidente cerebrovascular (ACV) previo. En pacientes con CIA, 7 tuvieron un solo defecto y 12 mostraron perforaciones múltiples; 14 recibieron un solo dispositivo y 5 necesitaron 2 o 3. El control ecocardiográfico transtorácico a los 6 meses mostró el cierre del defecto en los 29 pacientes. En un tiempo medio de seguimiento de 31 ± 19 meses todos los pacientes estaban libres de síntomas.

Los pacientes con aneurisma del septo interauricular y CIA o FOP asociado pueden tratarse con éxito mediante el dispositivo de Amplatz.

Palabras clave: *Aneurisma del septo interauricular. Comunicación interauricular. Foramen oval permeable.*

INTRODUCTION

Atrial septal aneurysms are localized, bulging malformations that protrude into the right or left atrium. This malformation can be associated with patent foramen ovale (PFO), atrial septal defects (ASD) or multiple defects, and is considered a risk factor for stroke.[1-4] Growing experience with new occlusion devices[5,6] has allowed these patients to undergo percutaneous treatment. In this study, we analyze results of treatment of this malformation with Amplatzer occluder devices.

Correspondence: Dr. M. Pan.
Grupo CORPAL. Hospital de la Cruz Roja.
Paseo de la Victoria, s/n. 14014 Córdoba. España.
E-mail: grupo_corpal@arrakis.es

Received April 20, 2004.
Accepted for publication July 13, 2004.

METHOD

Patients

Between June 1993 and February 2004, 203 patients with ASD or PFO underwent percutaneous closure; 29 (14%) had atrial septal aneurysm. In the transesophageal study, all the adults met the following criteria[1]: *a)* base diameter >15 mm, and *b)* excursion 15 mm beyond the interatrial septum plane. Six children of 5-12 years presented the same morphology but on a smaller scale (aneurysm base 8 mm/m^2 body surface area).[7]

Diagnostic Catheterization

The procedure was performed under general anesthesia and transesophageal monitoring. Following angiographic and echocardiographic measurements, 1 mg/kg of intravenous heparin was administered and measurements were completed by the stretching balloon method. Patients with PFO were injected with 5 ml of shaken saline solution in the inferior cava to show

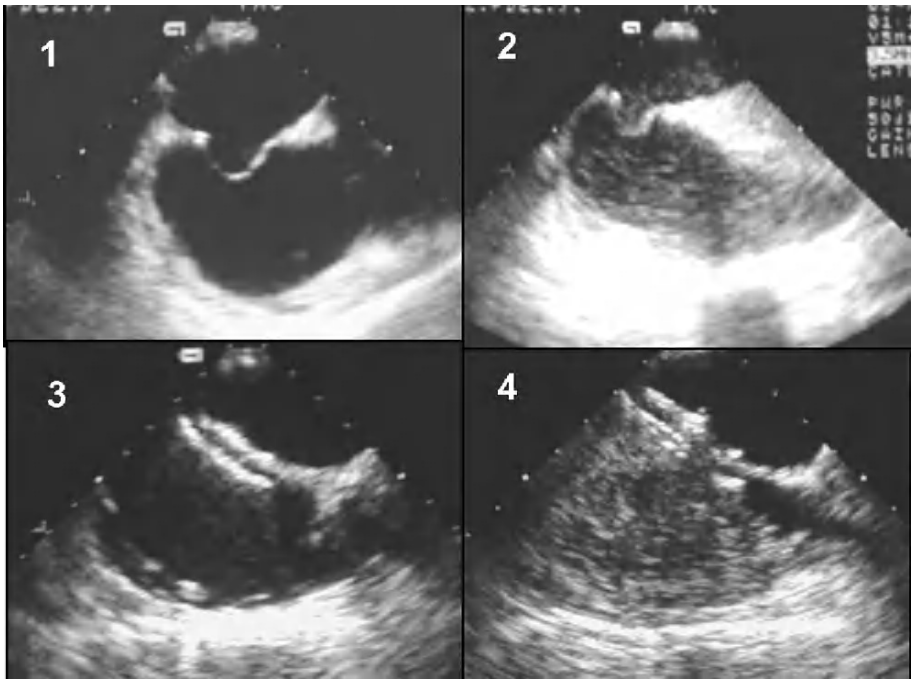

Figure 1. Patient with patent foramen ovale associated with aneurysm: 1) baseline transesophageal study; 2) following injection of physiological saline solution in the cava, a significant contrast shunt in the left atrium is seen; 3) Amplatzer device occludes the defect; 4) absence of contrast shunt following implantation.

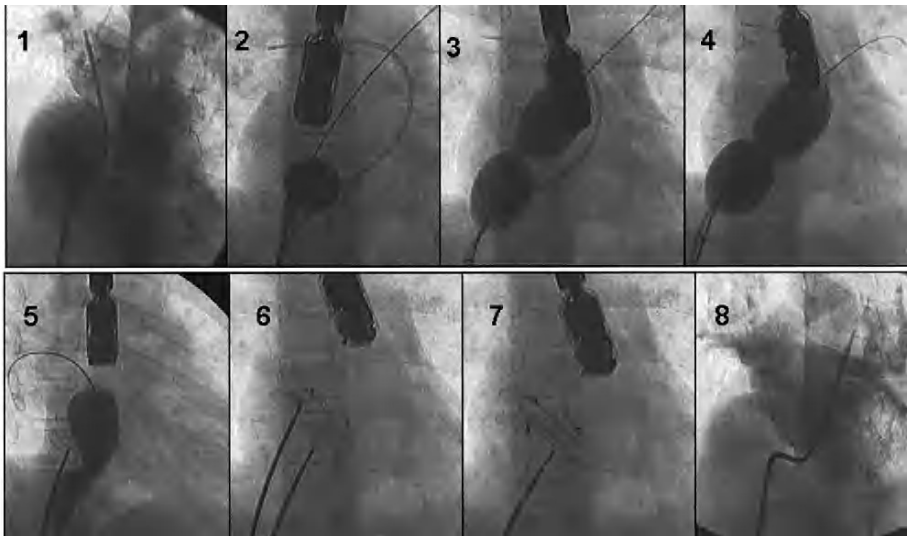

Figure 2. Patient with 2 separate orifices who receives 2 occluders: 1) baseline angiography in superior right pulmonary vein; 2-4) measuring defect size with occlusion balloon; 5) after implantation of a first device the residual defect is measured; 6-7) implantation of a second device; 8) occlusion of all defects as shown in pulmonary arteriography.

presence of right to left shunt (Figure 1) and this was repeated during an intermittent positive pressure maneuver performed by the anesthetist.

Therapeutic Phase

We used Amplatzer occluders (Golden Valley, Minnesota) and varied implantation strategies according to anatomy. In patients with a single orifice, just 1 occluder was implanted. The device chosen was of a diameter suitable for deployment by balloon occlusion. Patients with multiple orifices received 1, 2, or 3 devices according to the site of the malformation (foramen ovale or entire septum) and proportion of thin septum compared with the thicker remains of the real septum. Patients with a small hole near the major orifice also received a single occluder. Five patients with separate orifices received 2 or 3 devices. In these procedures we used a simultaneous double balloon occlusion technique to measure the exact size of the defects (Figure 2). Following the procedure, all patients received subcutaneous dalteparin for 1 month and aspirin for 6 months. Patients with a history of stroke were assigned an antiplatelet regimen indefinitely. We defined primary success as echocardiographic absence of residual shunt at discharge. Noninvasive clinical follow-up was carried out at 3, 6, and 12 months post-treatment and yearly thereafter.

TABLE 1. **Baseline Procedure Data***

Age, years	40±22
Women	19/29 (65%)
Symptoms	
History of respiratory infections	9
Dyspnea	
Functional class II	5
Functional class III	3
Arrhythmias	1
Previous ischemic cerebral events	12
Entire interatrial septum	38±9 mm
Superior remains, patients with ASD	12±5 mm
Inferior remains, patients with ASD	13±6 mm
Anterior remains, patients with ASD	11±8 mm
ASD diameter	
Balloon occlusion	20±5 mm
Transesophageal echocardiography	13±4 mm
Device diameter	
Patients with 1 device	20±6 mm
Patients with 2 devices	12+14, 22+14, 16+10, 16+10 mm
Patients with 3 devices	18+10+14 mm
Patients with PFO occluder	35 mm

*IAD indicates interatrial defect; PFO, patent foramen ovale.

We performed paired Student-Fisher test to compare each patient's mean values.

RESULTS

TABLE 2. **Results in Patients With Interatrial Defect (n=19)**

Peak pulmonary systolic pressure, mm Hg	
Baseline	40±23
Post	33±16*
Pulmonary/systemic flow ratio, QP/QS	
Baseline	1.9±0.6
Post	1±0.1†
Primary success	18/19 (95%)
Complications	
Tamponade (resolved by pericardial draining in the laboratory)	1 (5%)
Residual shunt	
Angiography (post in laboratory)	
No	10
Mild	9
Transesophageal (post in laboratory)	
No	13
Mild	6
Transthoracic at discharge	
No	18
Mild	1
Transthoracic at 6 months	
No	19
Residual shunt	0

*$P<.05$.
†$P<.01$.

Baseline and procedure data are summarized in Table 1. In order to close the entire aneurysm, the 10 patients with PFO received 35 mm Amplatzer PFO occluders. In patients with ASD, we found a significant reduction of pulmonary pressure and pulmonary/systemic flow ratio (Table 2). We often found mild residual shunting in the post-immediate study (Table 2). However, this disappeared in the transthoracic echocardiographic evaluation performed prior to discharge in all but 1 patient (Table 2). In patients with PFO, transesophageal echocardiography performed in the laboratory showed a significant right-left shunt in baseline conditions that became massive following the positive pressure ventilation maneuver (Table 3). Immediately after implantation, all these patients presented without shunt in baseline conditions (Figure 1) whereas during the positive pressure maneuver we identified a small <10-15 microbubble right-left shunt in the left atrium in 6 patients (Table 3).

Complete closure was found in all patients after a mean follow-up of 31±19 months. In 1 patient with residual shunt at discharge, echo-Doppler at 6 months showed complete closure (Table 2). In patients with PFO, transthoracic echocardiography at 6 months showed an absence of residual shunt after intravenous injection of saline solution in the antecubital vein and Valsalva maneuver (Table 3). Patients with dyspnea at the time of the procedure presented improved functional status. No embolic events occurred during follow-up.

DISCUSSION

Atrial septal aneurysms are infrequent malformations which have begun to be understand only recently following systematic use of 2D echography.[8]

Atrial Septal Aneurysm Associated

TABLE 3. **Results in Patients With Patent Foramen Ovale (n=10)**

Right-left shunt (shaken physiological saline solution) prior to implantation of the device	
Baseline: significant shunt	10/10
Positive ventilation pressure: massive shunt	10/10
Right-left shunt after implantation of device (in laboratory)	
Baseline: no shunt	10/10
Positive pressure ventilation:	
No shunt	4/10 (40%)
Mild shunt (<10 bubbles)	6/10 (60%)
Right-left shunt at 6 months (transthoracic echocardiography)	
Baseline: no shunt	10/10
Valsalva maneuver: no shunt	10/10

TABLE 4. **Prior Experience of Percutaneous Closure of Atrial Septal Aneurysms**

Author, Year	n	Associated Patent Foramen Ovale	Associated IAD	Device	Success of Procedure, %	Complications, %	Mean Follow-up	Events at Follow-up
Ewert et al (2000)[7]	33	18	15	Amplatzer Cardioseal	88	0	13 months (5-30)	0
Windecker et al (2000)[9]	20	20	–	Sideris Star Cardioseal	95	5	19±16 months	4.1%*
Krumsdorf et al (2001)[10]	63	51	12	Amplatzer Angelwings Cardioseal Starflex Helex Amplatzer Star	92	2	10.4±9.2 months	4/63 (6%)
Bruch et al (2002)[11]	33	33	–	Amplatzer Star Cardioseal Starflex	100	0	1.3-42 months	0
Martin et al (2002)[12]	16	16	–	Sideris Cardioseal	98†	2†	27±20 months	0
Braum et al (2004)[13]	70	70	–	Amplatzer Star Cardioseal	97	3†	24 months	1/70 (1.4%)
The current series	29	10	19	Amplatzer	96	5	30±18 months	0

*Annual risk of recurrence of stroke.
†Percentage of total patients with patent foramen ovale (n=110). IAD indicates interatrial defects.

With Patent Foramen Ovale

The mechanisms implied in embolic episodes in patients with atrial septal aneurysm are related with the right-left passage through the PFO, the presence of supraventricular arrhythmias or the formation of thrombus in the aneurysm itself.[2-4] Patients with a first ischemic embolism have a 15% risk of a second event in a 4 years period even when they receive aspirin.[4] Mechanical closure of the defect seems a logical alternative therapy (Figure 1).

Table 4 summarizes the principle series published.[7,9-13]

Comparing results of these studies is difficult given the differences in the devices used (7 types). Most publications describe a high percentage of success with a very low incidence of embolic events during follow-up. In fact, implanting one of these devices in patients with PFO, whether associated with atrial septal aneurysm or not, is relatively easy. However, the unanswered questions focus on the long-term efficacy of these procedures and the appropriate selection of candidates for PFO closure.

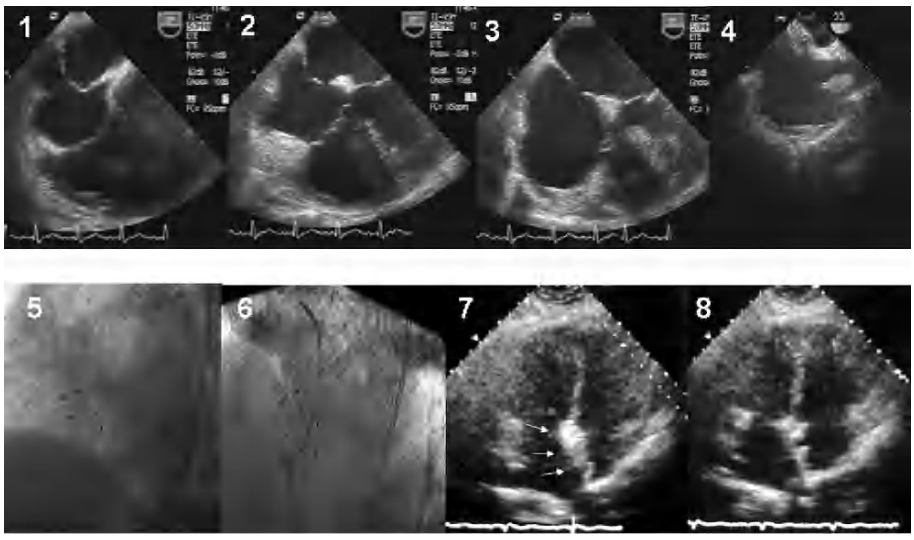

Figure 3. Patient with multiperforated atrial septal aneurysm (1-3). Following implantation of a first device (4), 2 additional devices are required (5 and 6). At 6 months, transthoracic echocardiography shows reconstruction of a thicker interatrial septum without residual shunt (7 and 8).

Atrial Septal Aneurysm Associated With Interatrial Defect

Experience of percutaneous closure this type of association is more limited than in patients with PFO (Table 4). Given that multiperforated septal defects are frequent (Figure 3), this increases the complexity of the percutaneous intervention.[5] Consequently, surgery is preferred in many centers. When the decision is taken to perform a percutaneous procedure, the implantation strategy must be carefully considered. The simplest strategy is to implant a single device that traps the entire aneurysm between the disks. However, sometimes more than 1 device is needed and different measurements of the defect are required in order to make the final decision (Figures 2 and 3). Given the discrepancies in defect measurement between echography and balloon, we believe procedures should not be undertaken without previously using the stretching balloon method.

Our study suggests that patients with an atrial septal aneurysm associated with an ASD can be treated successfully by implanting an Amplatzer occluder. However, patients with multiperforated septum (Figure 3) should be intervened by teams of experts.

REFERENCES

1. Hanley PC, Tajik AJ, Hynes JK, Edwards WD, Reeder GS, Hagler DJ, et al. Diagnosis and classification of atrial septal aneuryms by two dimensional echocardiography: report of 80 consecutive cases. J Am Coll Cardiol. 1985;6:1370-82.
2. Mugge A, Daniel WG, Angerman C, Spes C, Khandheria BK, Kronzon I, et al. Atrial septal aneurysm in adult patients. A multicenter study using transthoracic and transesophageal echocardiography. Circulation. 1995;91:2785-92.
3. Mattioli AV, Aquilina M, Oldani A, Longhini C, Mattioli G. Atrial septal aneurysm: asneurysm as a cardioembolic source in adult patients with stroke and normal carotid arteries. Eur Heart J. 2001;22:261-8.
4. Mas JL, Arquizan C, Lamy C, Zuber M, Cabanes L, Derumeaux G, et al. Recurrent cerebrovascular events associated with patent foramen ovale, atrial septal aneurysm, or both. N Engl J Med. 2001;345:1740-6.
5. Suárez de Lezo J, Medina A, Pan M, Romero M, Segura J, Pavlovic DJ, et al. Transcatheter occlusion of complex atrial septal defects. Cathet and Cardiovasc Intervent. 2000;51:33-41.
6. Rodríguez M, Suárez de Lezo J, Pan M, Romero M, Segura J, Pavlovic DJ, et al. Cierre percutáneo de comunicaciones interauriculares grandes. Rev Esp Cardiol. 2003;56:888-93.
7. Ewert P, Berger P, Vogel M, Dähnert I, Meshkishvili VA, Lange PE. Morphology of perforated atrial septal aneurysm suitable for closure by transcatheter device placement. Heart. 2000;84:327-31.
8. Pasalodos FJ, González V, Pan M, Gil R, Vallés F. Aneurisma del tabique interauricular. Diagnóstico ecocardiográfico. Rev Esp Cardiol. 1984;37:219-22.
9. Windecker S, Wahl A, Chatterjee T, Garachemani A, Eberli FR, Seiler C, et al. Percutaneous closure of patent foramen ovale in patients with paradoxical embolism. Circulation. 2000;101:893-8.
10. Krumsdorf U, Keppeler P, Horvath K, Zadan E, Schrader R, Sievert H. Catheter closure of atrial septal defects and patent foramen ovale in patients with an atrial septal aneurysm using different devices. J Interv Cardiol. 2001;14:49-55.
11. Bruch L, Parsi A, Grad MO, Rux S, Burmeister T, Krebs H, et al. Transcatheter closure of interatrial communications for secondary prevention of paradoxical embolism. Circulation. 2002;105:2845-8.
12. Martín F, Sánchez PL, Doherty E, Colón-Hernández PJ, Delgado G, Inglessis I, et al. Percutaneous transcatheter closure of patent foramen ovale in patients with paradoxical embolism. Circulation. 2002;106:1121-6.
13. Braun M, Gliech V, Boscheri A, Schoen S, Gahn G, Reichmann H, et al. Transcatheter closure of patent foramen ovale in patients with paradoxical embolism. Eur Heart J. 2004;25:424-30.