

Percutaneous closure of ventricular septal defects in adult patients: our initial experience

Erişkinlerdeki ventriküler septal defektlerin perkütan kapatılmasında ilk deneyimlerimiz

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Objectives: We evaluated our initial experience with percutaneous closure of ventricular septal defects (VSD) in adult patients.

Study Design: Percutaneous closure of VSD in adult patients was launched in 2007 in our center. This study included the first five patients (3 women, 2 men; mean age 32.6 years; range 17 to 44) with a perimembranous (n=4) and muscular (n=1) VSD. Before percutaneous intervention, all the patients were assessed by transthoracic (TTE) and, when necessary, transesophageal (TEE) echocardiography, heart catheterization, and ventriculography. Percutaneous closure was performed under fluoroscopy and TEE or TTE guidance using the Amplatzer device (perimembranous asymmetric VSD occluder in perimembranous VSDs and muscular VSD occluder in muscular VSD).

Results: The mean VSD diameter was 7.4 mm (range 5 to 11 mm) by echocardiography, and 8.2 mm (range 6 to 11 mm) by ventriculography. The mean left ventricular end-diastolic diameter was 47.2 mm, and the mean distance between VSD and the aorta was 5.6 mm. Percutaneous closure was successful in all the patients. Ventriculography obtained immediately after the procedure showed minimal passage from the interventricular septum in three patients, but there was no passage on control TTE examination on the first day after the procedure. Aortic, tricuspid, and mitral valves showed normal function. No rhythm problems were seen. All the patients were discharged within one or two days after the procedure.

Conclusion: Percutaneous closure of VSDs has become a good alternative to surgical repair in recent years, with high success rates and low morbidity. The results of percutaneous closure of VSDs are also successful in adult patients.

Key words: Adult; angiography; heart catheterization/ methods; heart septal defects, ventricular/therapy/ instrumentation.

Amaç: Erişkinlerdeki ventriküler septal defektlerin (VSD) perkütan kapatılmasında ilk deneyimlerimiz değerlendirildi.

Çalışma planı: Merkezimizde 2007 yılından başlayarak, beş erişkin hastada (3 kadın, 2 erkek; ort. yaş 32.6; dağılım 17-44) VSD tamiri perkütan teknikle yapıldı. Dört hastada perimembranöz, bir hastada musküler VSD vardı. Hastalar işlem öncesinde transtorasik ekokardiyografi (TTE) ve gerekli görüldüğünde transözofageal ekokardiyografi (TEE), kalp kateterizasyonu ve ventrikülografi ile değerlendirildi. İşlemler floroskopi ve TEE veya TTE eşliğinde yapıldı. Transkateter kapatmada, perimembranöz VSD olan dört hastada asimetric Amplatzer membranöz VSD oklüder, musküler VSD olan bir hastada ise Amplatzer musküler VSD oklüder cihazı kullanıldı.

Bulgular: Ventriküler septal defektlerin ortalama çapı ekokardiyografi ile 7.4 mm (dağılım 5-11 mm), ventrikülografi ile 8.2 mm (dağılım 6-11 mm) ölçüldü. Sol ventrikül diyastol sonu çapı ortalama 47.2 mm, defekt aort mesafesi 5.6 mm bulundu. Beş hastada da defekt başarıyla kapatıldı. İşlemden hemen sonra çekilen ventrikülografide üç olguda interventriküler septumdan hafif geçiş izlenirken, işlem sonrası birinci günde yapılan kontrol TTE'de hiçbir hastada geçiş saptanmadı. Aort, triküspit veya mitral kapaklarda fonksiyon bozukluğu gelişmedi. Hiçbir hastada işlem sırasında veya sonrasında ritim sorunu oluşmadı. Hastalar işlemden 1-2 gün sonra taburcu edildi.

Sonuç: Ventriküler septal defektlerin perkütan kapatma işlemi yüksek başarı oranı ve düşük morbiditesi ile son yıllarda cerrahiye değerli bir seçenek durumuna gelmiştir. Erişkinlerde görülen VSD'lerin perkütan kapatılmasında da sonuçlar başarılıdır. closure of VSDs are also successful in adult patients.

Anahtar sözcükler: Erişkin; anjiyografi; kalp kateterizasyonu/ yöntem; kalp septal defekti, ventriküler/tedavi; enstrümantasyon.

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Ventricular septal defects (VSD) are the most commonly encountered congenital heart defects.^[1] Perimembranous VSD is the most common type, accounting for as many as 80% of VSD cases. The first attempt to close these defects was made in the late 1980s,^[2] using devices developed for atrial septal defect and patent ductus arteriosus.^[3-7] Successful closure of the defects initially started with muscular ventricular septal defects following the developments of the Amplatzer devices.^[8,9] In recent years, asymmetric Amplatzer membranous VSD occluders designed specifically to prevent regurgitation in the tricuspid and aortic valves allows percutaneous closure of perimembranous defects with a high rate of success and low complication rate.^[10-14]

Patients with ventricular septal defects are generally diagnosed by pediatric cardiologists in their early ages and their treatments are performed in pediatric cardiology clinics. As a result, there is a limited number of adults patients with VSD who arrive at cardiology clinics. Treatment and monitoring of congenital heart diseases in adults at cardiology clinics by cardiologists, and the gaining of experience in this field has become increasingly important. In this article, we present the first five adult patients with VSD treated in the cardiology clinic.

PATIENTS AND METHODS

Percutaneous closure of VSD in adult patients is being performed in our center since 2007. This study included five patients (3 women, 2 men; mean age 32.6 years; range 17 to 44) with a perimembranous (n=4) and muscular (n=1) VSD.

The major complaint at presentation was dyspnea, including palpitation in one patient. Before the procedure, all the patients were assessed by transthoracic (TTE) and transesophageal (TEE) echocardiography, when necessary. The VSD diameter, VSD type, left ventricular size, pulmonary artery pressure, and the distance and relationship of the defects with the aortic, mitral and tricuspid valves were determined. In addition, the shunt ratio was measured by pre-procedural right and left cardiac catheterization, while the VSD diameter and the relationship between VSD and aorta were assessed by ventriculography in the left cranial position. The echocardiographic and catheter findings of the patients are summarized in Table 1. Consent was obtained from every patient in order to perform the percutaneous closure procedure. Prophylactic antibiotics and premedication was given two hours before the procedure. All the procedures were performed under the general anesthesia accompanied with fluoroscopy and TEE or TTE (TEE was not

used in one of the patients with perimembranous VSD).

Procedure. Asymmetric Amplatzer membranous VSD occluder devices (8 mm in 2 patients; 10 mm in 2 patients) were used in the four of the patients with perimembranous VSD. Anticoagulation therapy with heparin at a dose of 100 IU/kg was given to the patients through the right femoral vein and the left femoral artery. A 6-F Judkins catheter was advanced through the left femoral artery to enter into right ventricle from the left ventricle via the VSD. A guide wire (300 cm noodle guide wire, 0.035 inches, with a J end) was advanced through the right Judkins catheter into the pulmonary artery. The guide wire was removed from the right femoral vein capturing it in the main pulmonary artery by a macro clamp (AndraSnare AS-25 set) advanced through the right femoral vein. By so doing, an arteriovenous pathway was formed by passing through the VSD by the guide wire (Figure 1a). A Carrier (7F) was advanced to the left ventricle by the guide wire and the ascending aorta through the femoral vein by way of the VSD (Figure 1b). The carrier was then dropped in the left ventricular apex (Figure 1c). The dilator of the carrier and guide wire were retrieved gently. The asymmetric Amplatzer membranous VSD occluder was loaded to the carrier and advanced to the left ventricle (Figure 1d). The left ventricular disc of the device was opened between the mitral anterior leaflet and the left ventricular exit pathway (Figure 1e). The system was then retrieved and the left ventricular disc was rested against the septum (Figure 1f). The appropriate position of the left ventricular disc was confirmed by the direction of the platinum marker towards the leg of the patient. The relationship between the disc and interventricular septum (IVS) was checked by electrocardiography and ventriculography. The waist of the occluder device was expanded and the right ventricular disc opened (Figure 1g). The device was positioned on the IVS after confirming the appropriate position of the device, and normal functions of mitral, aortic and tricuspid valves by echocardiography and ventriculography (Figure 1h, 1i). The presence of a resi-

Table 1. Patient measurements and hemodynamic data associated with ventricular septal defects

	Mean	Range
Ventricular septal defect diameter (mm)		
by echocardiography	7.4	5-11
by ventriculography	8.2	6-11
Left ventricular end-diastolic diameter (mm)	47.2	41-55
Distance between VSD and the aorta		
(for patients with perimembranous VSD)	5.6	5-9
Qp/Qs	1.8	1.5-2.2
Systolic pulmonary artery pressure (mmHg)	34	30-40

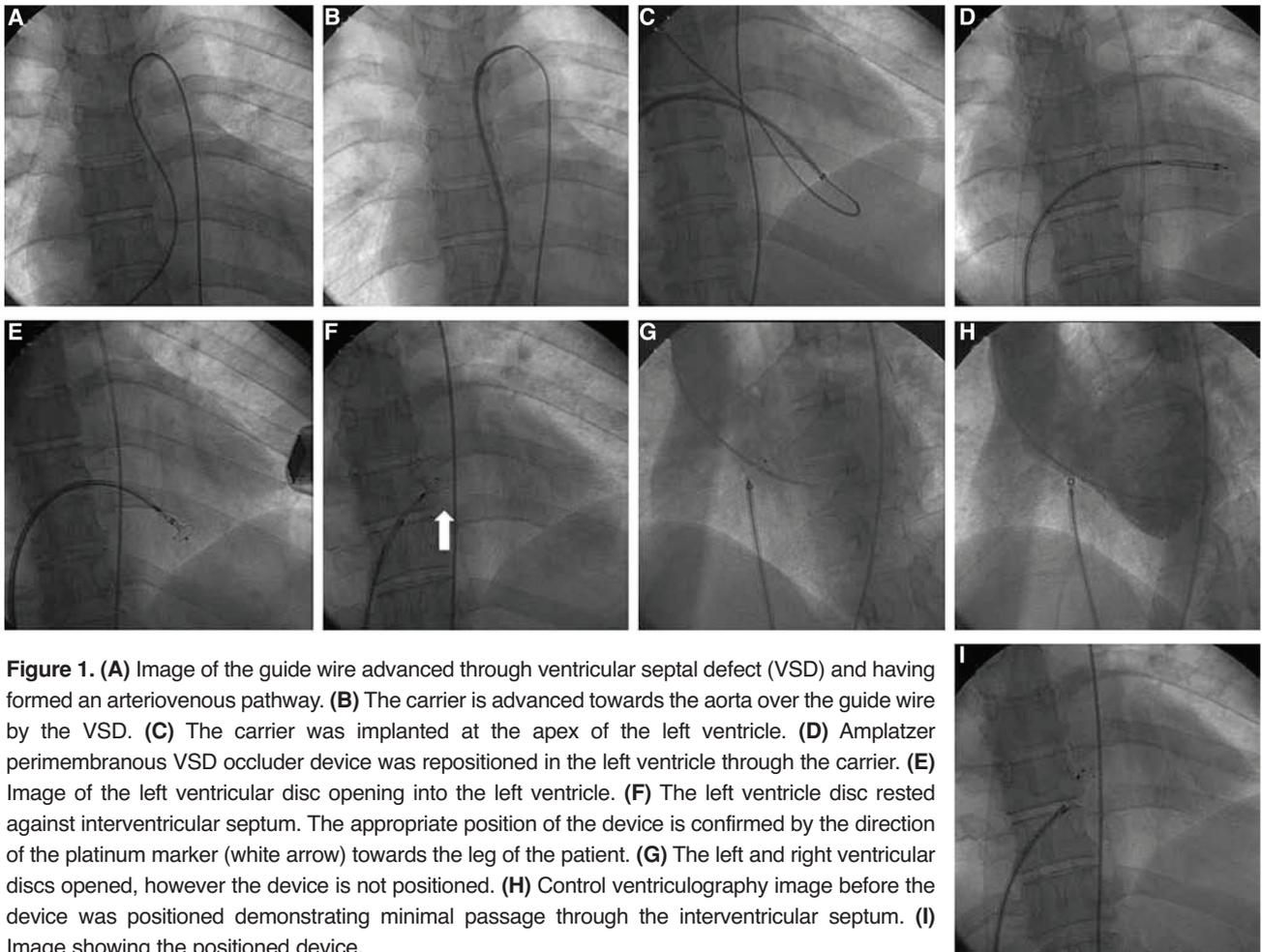


Figure 1. (A) Image of the guide wire advanced through ventricular septal defect (VSD) and having formed an arteriovenous pathway. (B) The carrier is advanced towards the aorta over the guide wire by the VSD. (C) The carrier was implanted at the apex of the left ventricle. (D) Amplatzer perimembranous VSD occluder device was repositioned in the left ventricle through the carrier. (E) Image of the left ventricular disc opening into the left ventricle. (F) The left ventricle disc rested against interventricular septum. The appropriate position of the device is confirmed by the direction of the platinum marker (white arrow) towards the leg of the patient. (G) The left and right ventricular discs opened, however the device is not positioned. (H) Control ventriculography image before the device was positioned demonstrating minimal passage through the interventricular septum. (I) Image showing the positioned device.

dual shunt was checked by ventriculography after device implantation.

An Amplatzer muscular VSD occluder device (12 mm) was used in a patient with muscular VSD. Apart from using the right internal jugular vein for venous intervention, the protocol of the procedure was performed as stated above.

RESULTS

Percutaneous closure was successful in all the five patients. Post-procedural ventriculography demonstrated minimal passage from the interventricular septum in three patients, whereas the control TTE which was performed on day one after the procedure showed no passage. In addition, the aortic, tricuspid or mitral valves showed normal function. No periprocedural or postprocedural rhythm problems were observed. All patients were discharged one to two days after the procedure. All patients were recommended the use of as-

pirin 300 mg/day for six months and prophylactic premedication for infective endocarditis.

DISCUSSION

The success rate of the percutaneous closure of ventricular septal defects is 90% to 100%,^[10-20] while the rate of the percutaneous closure of muscular defects is 88% to 100%.^[8,9,18,21,22] Successful closure of defects initially started with defects in the muscular septum.^[8,9] Before asymmetric Amplatzer membranous VSD occluder devices were being used, closure of several cases with perimembranous VSD by Amplatzer muscular VSD occluder devices were also reported.^[12,16] However, proximity of the defects to the aortic and atrioventricular valves restricted the utilization of the muscular VSD occluder devices. A minimum of 5 mm distance between the upper margin of the defect and the aortic valve is required to utilize the device. After the asymmetric Amplatzer membranous VSD occluder devices came into use, defects which are 1-2 mm distant from the aortic valve are

able to be closed percutaneously.^[11,15]

Four groups for the amount of post-procedural residual shunt were described according the color Doppler findings, including non-significant (color flow width <1 mm), small (color flow width 1-2 mm), intermediate (color flow width 2-4 mm), large (color flow width >4 mm).^[23] Butera et al.^[12] reported non-significant residual shunts in 47% of the patients (n=104) following the procedure and in 16% following discharge, and that this percentage decrease to 1% during the long-term follow-up period (mean 38.5 months).

The complication rates of percutaneous closure of perimembranous VSDs and muscular VSDs are reported as 0% to 15%^[10-20] and 10.7%, respectively.^[22] The complications include device embolization (1.9%), vascular complications (2.9%), arrhythmic complications (6.7%), valvular (aortic, mitral or tricuspid) regurgitation (9.2%), cardiac perforation and hemolysis.^[12,13,22] Arrhythmic complications include ventricular arrhythmias, transient atrial fibrillation and conduction defects including complete atrioventricular (AV) block. Conduction defects may be transient or permanent. The literature review shows the rate of complete AV block to be 0% to 5%.^[12] Complete AV block may occur both during or after the procedure (from the first day to the 20th month). The ratio of the patients with complete AV block who had to undergo pacemaker implantation was reported as 1%.^[24] This complication is associated with the proximity of VSD to the conduction system. Complete AV block is suggested to occur due to direct trauma from the device or due to the development of inflammatory reaction or scar tissue in the conduction system associated with the procedure. A study consisting mainly of pediatric patients demonstrated a significant association between age and complete AV block (relative risk 0.25, p=0.028). All patients developed complete AV block during the procedure were reported to be under the age of 6.^[12]

Surgical repair is currently the gold standard for the treatment of VSD. Although surgery is generally a safe approach, it also has some risks. A total of 1-5% of the patients develop complete AV block; 1-5% develops severe residual VSD; 2% need repeated surgery, and 0.5% die.^[25-27] Likewise, infection, tachyarrhythmia, and neurologic complications may be present. As a consequence, percutaneous closure of VSD has become an ideal alternative to surgical repair in recent years with high success rates and low morbidity. Results of the procedure are also successful in the adult population. Percutaneous closures of VSDs performed on the first five adult patients in our clinic were successful and no complication was reported.

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