



Transcatheter Closure of Patent Ductus Arteriosus: Initial Study on Echocardiographic Estimation of Device Size

Alimohammad Hajizeinali, MD, Hakimeh Sadeghian, MD*, Mehrnaz Rezvanfard, MD, Mohammad Alidoosti, MD, Seyed Ebrahim Kassaian, MD, Ebrahim Nematipour, MD

Tehran Heart Center, Tehran University of Medical Sciences, Tehran, Iran.

Received 06 June 2010; Accepted 13 August 2010

Abstract

Background: Transcatheter occlusion of the patent ductus arteriosus (PDA) is a minimally invasive treatment. The appropriate device size is chosen based on the angiographic measurement of the PDA. The current study aimed to assess the relationship between the transthoracic echocardiographic (TTE) measurements of the PDA prior to the occlusion procedure and the actual size of the deployed device.

Methods: We reviewed the available records of 7 patients (2 male) who underwent the procedure at our institution (mean age: 21 ± 12.7 years, range: 7 to 46 years). PDA closure was performed successfully using the Amplatzer Duct Occluder ($n = 5$) and its Chinese copycat, Cardi-O-Fix Occluder ($n = 2$).

Results: The TTE measurement of the aortic end diameter of the PDA showed a good linear regression correlation with the size of the implanted duct occluder [duct occluder size = $0.543 + (0.941 \times \text{TTE measured diameter})$, $R = 0.907$; p value ≤ 0.01].

Conclusion: TTE can provide a good estimation of the size of the Amplatzer duct occluder.

J Teh Univ Heart Ctr 4 (2010) 199-201

Keywords: Ductus arteriosus, patent • Septal occluder device • Echocardiography

Introduction

The Amplatzer duct occluder (ADO) has been used extensively in many medical centers and its effectiveness and safety for transcatheter patent ductus arteriosus (PDA) closure have been confirmed by many studies.¹⁻⁴ The ADO is manufactured in several sizes, and the proper size is generally chosen based on angiographic findings. PDA diameters and characteristics can also be obtained via the non-invasive method of transthoracic echocardiographic (TTE) imaging prior to the occlusion procedure. Echocardiographic and angiographic measurements of the PDA have revealed good association in canine models^{5,6} and human studies.^{7,8}

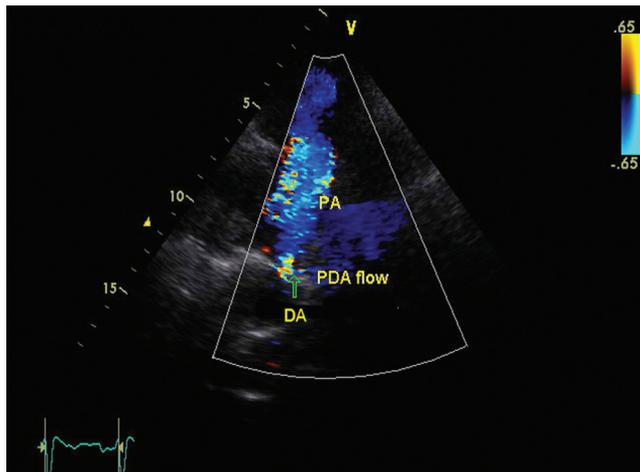
The aim of this study was to establish whether or not TTE measurements could make it feasible to estimate an adequate ADO size before catheter intervention.

Methods

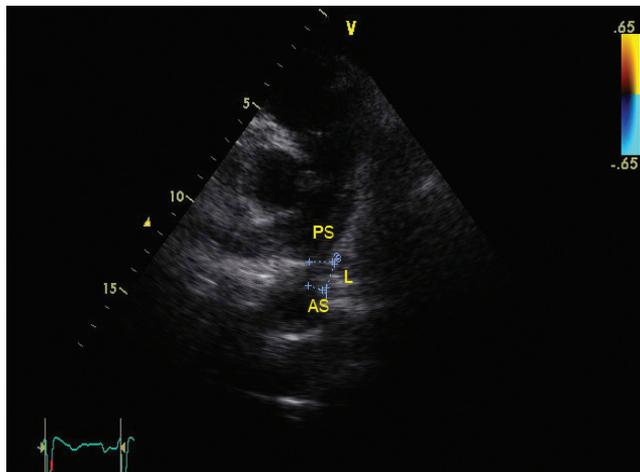
We reviewed the records of 21 patients who underwent successful transcatheter closure of PDA (appropriate device position with no shunt) between July 2005 and November 2009 in our institution. Seven patients (2 men / 5 women) were included in our study since detailed data of the TTE

*Corresponding Author: **Hakimeh Sadeghian**, Associate Professor of Cardiology, Echocardiography Department, Tehran Heart Center, North Kargar Street, Tehran, Iran. 1411713138. Tel: +98 21 88029257. Fax: +98 21 88029256. E-mail: sadeghianhakimeh@yahoo.com.

imaging of their PDA were available. Each patient underwent a complete two-dimensional TTE study and Color Flow Mapping (VIVID-7 Computed Sonography Machine, Vingmed-GE, Horten, Norway, 3.5-MHz transducer) within 1 month before the procedure. Conventional cross-sectional studies of the PDA were performed from the parasternal short-axis view. After visualization of the descending thoracic aorta and ductus arteriosus through TTE imaging, the diameters of the duct at the aortic and pulmonic sites were measured. The distance between the mid-position of these two diameters was defined as the PDA length.



A



B

Figure 1. Visualization of patent ductus arteriosus (PDA) in parasternal short-axis view (A) and echocardiographic measurements of PDA in the same view (B)

PA, Pulmonary artery; DA, Descending aorta; AS, Diameter of PDA at aortic site; PS, Diameter of PDA at pulmonic site; L, Length of PDA

Figure 1 demonstrates a two-dimensional image of a PDA and its measurements. The PDA types were defined based on a previously used echocardiographic classification. In type

A, the narrowest segment was at the pulmonary insertion, whereas in type B the ductus was short and narrowest at the aortic insertion.⁸ The following echocardiographic measurement was assessed based on the American society of echocardiography (ASE) guidelines and standards: left ventricular ejection fraction (LVEF), systolic and diastolic left ventricular dimension (LVD), left atrium (LA) size, pulmonary artery pressure (PAP), and systolic and diastolic peak gradient (PG).

The technique of transcatheter closure was similar to that described by Pass et al.² To summarize, an angiogram was obtained in biplane projections so as to profile the shape and the position of the ductus. The selection of a device was to ensure that the smallest diameter of the device at the attachment point was at least 2 mm larger than the narrowest angiographic diameter of the ductus. (The diameter of the device neighboring the retention disk is 2mm larger than that at attachment point) The proper size of the device was advanced into the descending aorta until the retention disk was opened in the proximal descending aorta and snug against the aortic end of the ampulla. Transcatheter PDA closure was performed using the ADO (AGAMedical Corporation, Golden Valley, MN, USA) and its Chinese copycat, Cardi-O-Fix Occluder (Starway Medical Technology Inc, Beijing, China).

With respect to the normal distribution of the homogeneity of the scores and variances, linear regression analysis was performed to show the linear relationship between the TTE diameter of the PDA and the ADO actual size. The measured ADO diameters were further examined by plotting scattergrams and developing regression lines.

Results

Seven patients underwent transcatheter closure using Amplatzer type occlusion devices (Amplatzer: 5 and Cardi-O-Fix: 2). The demographic data, PDA echocardiographic measurements, and deployed device size for all these patients are presented in Table 1. The TTE-diameter of the aortic end of the PDA also strongly correlated with the smallest size of the occluder device (Duct occluder size = $0.543 + 0.941 \times$ TTE measured diameter, $R = 0.90$; p value ≤ 0.01). The TTE diameters of the PDA (at aortic end) were the same as the smallest device size (at attachment point) in 4 patients and the larger difference was 1 mm in the other patients.

Discussion

Our results indicate a good correlation between the TTE measurement of PDA at the aortic site and the size of the implanted ADO device. We provide an equation to predict the size of the ADO using a TTE evaluation of the PDA prior the procedure. Chiming in with our results,



Table 1. Demographic data and echocardiographic measurements of all patients according to the type of occluder device

| Subject | Device type | Demographic Data | | Echocardiographic measurements* | | | | | | | PDA measurement | | | | Device diameter (mm) |
|-----------|-------------|------------------|-----|---------------------------------|--------------|------------|------------|------------|--------------|--------------|-----------------|-------------|-------------------|---------------------|----------------------|
| | | Age (y) | Sex | LVEF (%) | LA size (mm) | LVDs (mm) | LVDD (mm) | PAP (mmHg) | PG(s) (mmHg) | PG(d) (mmHg) | PDA type | Length (mm) | Aortic width (mm) | Pulmonic width (mm) | |
| 1 | Am | 22 | F | 60 | 39 | 31 | 47 | ND | ND | ND | B | 11 | 7 | 11 | 8 |
| 2 | Am | 7 | F | 60 | 26 | 27 | 38 | ND | 55 | 109 | B | 8 | 4 | 6 | 4 |
| 3 | Am | 46 | F | 55 | 33 | 44 | 61 | 41 | 59 | 74 | A | 13 | 8 | 6 | 8 |
| 4 | Am | 13 | F | 55 | 31 | 28 | 42 | 32 | 71 | 42 | A | 7 | 5 | 4 | 6 |
| 5 | Am | 18 | M | 60 | 23 | 35 | 45 | 25 | ND | ND | B | 14 | 7 | 8 | 6 |
| 6 | COF | 14 | M | 60 | 27 | 30 | 45 | 35 | 37 | 83 | A | 6 | 4 | 2 | 4 |
| 7 | COF | 27 | F | 60 | 39 | 36 | 52 | 27 | 63 | 89 | ND | ND | 6 | ND | 6 |
| Mean (SD) | | 21.0 (12.8) | | 58.6 (2.4) | 31.1 (6.2) | 33.0 (6.4) | 47.1 (7.5) | 32.0 (6.4) | 57.0 (12.6) | 79.4 (24.5) | | 9.8 (3.3) | 6.0 (1.6) | 6.2 (3.1) | 6.0 (1.6) |

*Echocardiographic measurement was assessed based on American society of echocardiography (ASE) guidelines and standards

PDA, Patent ducts arteriosus; LVEF, Left ventricular ejection fraction; LA, Left atrium; LVDs, Left ventricular dimension (systolic); LVDD, Left ventricular dimension (diastolic); PAP, Pulmonary artery pressure; PG(s), Peak gradient (systolic) across PDA; PG(d), Peak gradient (diastolic) across PDA; Am, Amplatzer; F, Female; ND, No data were available; M, Male; COF, Cardi-O-Fix

the Ramaciotti et al. study of 52 subjects reported a good correlation between TTE-derived and angiographic diameter of the PDA at the aortic site with no significant association between the measurements of the PDA length.⁸ Ting-Liang et al. also found a good correlation between pre-procedure TTE measurements and the waist of the implanted ADO (Ting-liang LIU, Yu-lin W, Jian-jun Z. Comprehensive assessment of the diameter variations of patent ductus arteriosus during the transcatheter closure procedure. [Abstract] Journal of Medical Imaging, 2004). In regard to our findings, no significant association existed between the device size and the PDA diameter at the pulmonic site; however, Ramaciotti et al. showed an established association between echocardiographic and angiographic measurements at pulmonic sites. This difference may be attributed to the smaller sample size enrolled in the current study.⁸

Conclusion

In conclusion, echocardiographic assessment may provide an accurate estimation of the adequate size of the ADO prior the occlusion procedure. Still, further clinical testing in large population samples with a variety of angiographic types of the PDA is necessary to establish a more precise formula for the prediction of the adequate size of such devices in our institution and to evaluate the limitations of this method more precisely.

Acknowledgment

This study was supported by Tehran University of Medical

Sciences.

References

- Masura J, Tittel P, Gavora P, Podnar T. Long-term outcome of transcatheter patent ductus arteriosus closure using Amplatzer duct occluders. *Am Heart J* 2006;151:755e7-755e10.
- Pass RH, Hijazi Z, Hsu DT, Lewis V, Hellenbrand WE. Multicenter USA amplatzer patent ductus arteriosus occlusion device trial initial and one-year results. *J Am Coll Cardiol* 2004;44:513-519.
- Thanopoulos BD, Hakim FA, Hiari A, Goussous Y, Basta E, Zarayelyan AA, Tsaousis GS. Further experience with transcatheter closure of the patent ductus arteriosus using the Amplatzer duct occluder. *J Am Coll Cardiol* 2000;35:1016-1021.
- Bilkis AA, Alwi M, Hasri S, Haifa AL, Geetha K, Rehman MA, Hasanah I. The Amplatzer duct occluder: experience in 209 patients. *J Am Coll Cardiol* 2001;37:258-261.
- Saunders AB, Miller MW, Gordon SG, Bahr A. Echocardiographic and angiographic comparison of ductal dimensions in dogs with patent ductus arteriosus. *J Vet Intern Med* 2007;21:68-75.
- Schneider M, Hildebrandt N, Schweigl T, Wehner M. Transthoracic echocardiographic measurement of patent ductus arteriosus in dogs. *J Vet Intern Med* 2007;21:251-257.
- Sahn DJ, Allen HD. Real-time cross-sectional echocardiographic imaging and measurement of the patent ductus arteriosus in infants and children. *Circulation* 1978;58:343-354.
- Ramaciotti C, Lemler MS, Moake L, Zellers TM. Comprehensive assessment of patent ductus arteriosus by echocardiography before transcatheter closure. *J Am Soc Echocardiogr* 2002;15:1154-1159.