

Follow-up of P dispersion after transcatheter closure of an atrial septal defect in children

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Abstract

Objectives: To determine in paediatric patients with atrial septal defects whether differences in P wave dispersion occurred with transcatheter closures using the Amplatzer septal occluder.

Method: A total of 31 children who had undergone transcatheter closures were evaluated. P maximum, P minimum, and P dispersion were measured with 12-lead surface electrocardiography, before the procedure and one week, one month, three months, six months and one year following the procedure. SPSS 10 was used for statistical analysis.

Results: There were 23 (74.2%) females and 8 (25.8%) males with an overall mean age of 7.5 ± 4.1 years and mean weight of 26.2 ± 16.9 kg. The P maximum and P minimum measurements differed between patients during the follow-up period. Both measurements decreased with time. However, P dispersion was not significantly different throughout the follow-up period (before the procedure P maximum 95.4 ± 15.6 ms, P minimum 64.5 ± 15.4 ms, and P dispersion 30.8 ± 11.4 ms; one year later, P maximum 76.1 ± 14.6 ms, P minimum 47.1 ± 12.1 ms, and P dispersion 29.1 ± 9.1 ms).

Conclusion: Over time, there are no P dispersion differences in transcatheter closures using the Amplatzer septal occluder.

Keywords: Amplatzer device, Childhood, P wave dispersion, Transcatheter closure. (JPMA 64: 546; 2014)

Introduction

One reason for recommending the closure of secundum atrial septal defects (ASDs) is to prevent atrial arrhythmias. Electrophysiological studies in children with secundum ASDs have demonstrated that sinus node dysfunction begins in early childhood.¹ Atrial arrhythmias, particularly in atrial fibrillation, are responsible for significant morbidity and mortality. Two simple electrocardiographic markers, P wave maximal duration and P wave dispersion, have been used to evaluate the intra-atrial and inter-atrial conduction times and the inhomogeneous propagation of sinus impulses which are well-known electrophysiological characteristics of atria that prone to fibrillation.^{2,3} P dispersion is defined as the difference between the longest and shortest P wave durations recorded from 12-lead surface electrocardiogram (ECG) leads. In ASDs, the right atrial pressure increases, and the right atrium stretches and becomes more enlarged.⁴ Thus, the depolarisation of the right atrium is prolonged, which increases the P dispersion.⁵ Increased P dispersion can be used to predict atrial fibrillation. In this study, we aimed at monitoring the P wave dispersion changes over a one-year period after the transcatheter closure of secundum ASDs in children.

Patients and Methods

A total of 105 children who had undergone successful transcatheter closures in Gaziantep University Medical Faculty Paediatric Cardiology Department were initially evaluated for enrollment in the study. The protocol was approved by the institutional ethics committee. Written informed consent was obtained from the children's parents. All patients had a normal sinus rhythm. Those excluded were patients using devices other than the Amplatzer septal occluder; patients with follow-up periods $\leq$ one year; patients with histories of symptomatic arrhythmia or syncope; patients with additional cardiac abnormalities and/or cardiac rhythm problems; and patients with deficient ECG measurements. A 12-lead ECG with a paper speed of 50 mm/s and 1- mV/cm standardisation was obtained the day before and, one week, one month, three months, sixth months, and one year after the procedure. In 2007, the first patient was enrolled in the study and in 2009 the last patient was taken in. The follow up of the last patient was completed in December 2010. A Schiller Cardiovit AT-2 light 12-channel ECG machine (Boston, MA, USA) with optimised print quality using a Schiller smoothing filter and baseline stabiliser was used. P wave duration was measured with an electronic digital compass with a sensitivity of 0.001mm in all 12-leads by one observer to exclude inter-observer variability. In each derivation, the distance between the points of the

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earliest and latest P wave activity was recorded as the P wave duration. In each ECG, the longest and shortest P wave measurements were noted as P maximum and P minimum, respectively. P dispersion was defined as the difference between the P maximum and P minimum. An acceptable ECG was defined by the ability to measure the P wave duration in at least eight of the 12 electrocardiographic leads that were simultaneously recorded.

Amplatzer septal occluder device was used in the study (AGA Medical Corporation, Golden Valley, Minnesota). The transcatheter ASD closure technique has previously been described.⁶ These devices have a nitinol-braided skeleton with a thrombogenic effect provided by polyester Dacron fibres that are composed of double discs with self-expanding and self-centering features and a connecting waist joining these double discs. The pulmonary-to-systemic flow ratio was calculated from cardiac catheterisation using the Fick method. Echocardiographic follow-up was done to ensure no residual flow from the closed defects.

Data was expressed as mean $\pm$ standard deviations. A Friedman two-way analysis of variance (ANOVA) was used in the significance tests to compare the values at baseline and after the procedure. $P < 0.05$ was considered statistically significant. SPSS 10.0 was used for all calculations.

Results

Of the 105 children initially evaluated, 31 (29.5%) were finally enrolled. Of them, 23 (74.2%) were girls and 8

Table-1: Demographic characteristics.

Patient number	31 patients (23 girls, 8 boys)
Age	7.5 $\pm$ 4.1(3.5-16) years
Weight	26.2 $\pm$ 16.9 (12-75.5) kg
Stretched secundum atrial septal defects diametres	15.3 $\pm$ 4.1 (7-22.6) mm
Systemic/pulmonary shunt ratio	3.3 $\pm$ 2.2 (1.1-9.8)
Device diametres	16.8 $\pm$ 4.6 (10-24) mm

Table-2: P maximum, P minimum and P dispersion measurements at the all patients throughout the follow-up.

	P maximum (ms)	25th-50th-75th percentiles	P minimum (ms)	25th-50th-75th percentiles	P dispersion (ms)	25th-50th-75th percentiles
Before	95.4 $\pm$ 15.6	84.8-93.8-105.6	64.5 $\pm$ 15.4	55.8-62.4-73.2	30.8 $\pm$ 11.4	20.0-31.2-38.4
First week	92.5 $\pm$ 17.4	83.0-90.2-98.4	61.6 $\pm$ 17.4	51.8-58.0-69.2	29.9 $\pm$ 10.5	23.2-28.0-36.8
First month	92.1 $\pm$ 16.7	85.6-90.0-100.0	63.1 $\pm$ 21.7	48.6-63.6-70.0	28.6 $\pm$ 10.3	22.2-31.0-36.8
Third month	87.1 $\pm$ 14.1	77.0-85.4-99.2	56.5 $\pm$ 12.5	46.3-56.6-67.0	30.5 $\pm$ 9.2	24.2-30.8-35.4
Sixth month	83.9 $\pm$ 14.7	76.0-85.0-95.2	52.7 $\pm$ 13.3	42.3-52.6-64.9	31.1 $\pm$ 11.1	25.0-30.0-35.6
First year	76.1 $\pm$ 14.6	62.0-78.9-87.6	47.1 $\pm$ 12.1	37.4-45.7-55.3	29.1 $\pm$ 9.1	22.5-27.2-35.0
p	<0.001*		0.002*		0.715	

ms: millisecond, *statistically significant.

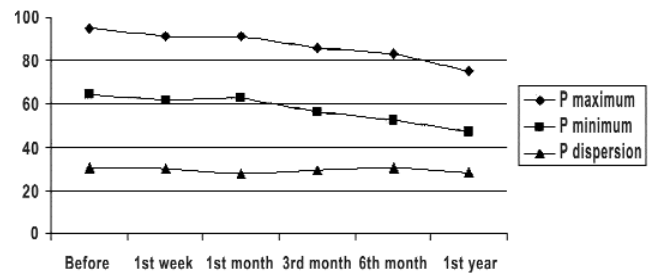


Figure: P wave measurements with time.

(25.8%) were boys, with an overall mean age of 7.5 $\pm$ 4.1 years, and mean weight of 26.2 $\pm$ 16.9kg (Table-1). None of the patients had documented arrhythmias or any other clinically significant adverse events, regardless of therapy, during the postoperative follow-up period. ECG parameters were measured before the procedure and, one week, one month, three months, six months, and one year after the procedure.

The P maximum and P minimum measurements differed in the patients during the follow-up period and both measurements decreased with time ($p < 0.05$). However, P dispersion was not significantly different throughout the follow-up ($p = 0.715$; Figure and Table-2).

Discussion

Atrial fibrillation is a common arrhythmia found in conjunction with ASDs in adults and it is a significant cause of morbidity.^{5,7} Dilation of the atrium with age may explain why atrial arrhythmias are more common in adult patients. Oliver et al. demonstrated that advanced age is the most important factor related to the presence of atrial fibrillation in patients with ASDs before and after surgical closure.⁸ The degree of atrial dilation and the size of the ASD positively relate to changes in the atrial conduction time.^{1,4} We think that earlier closure of the defect can result in a more homogeneous and organised conduction of the atrial impulse.

The size of the secundum ASD affects the shunt volume

and right heart dimensions.⁹ Increased P dispersion is correlated with the defect size and the degree of right atrial dilatations in children with secundum ASDs. P wave dispersion can be used to predict idiopathic paroxysmal atrial fibrillation. In normal healthy children, the normal P dispersion has been described as 27.0 ± 5.4 ms.^{2,3,10} In our study, P dispersion was measured as 30.8 ± 11.4 ms before the procedure, but changes in the atrial myocardium may become more overt with age because of the continuous pressure and potential volume overload. Therefore, not too much prolonged P dispersion values, in contrast to study population, may be attributed to the younger age of ASD patients in our study (mean 7.5 ± 4.1 years).

We found a significant correlation between P maximum and P minimum during the follow-up period. These measurements decreased with time. The study results suggested that transcatheter closure of the secundum ASDs with Amplatzer septal occluder in children caused the left-to-right shunt to disappear and decreased the right atrial dimensions. In our study, decreased P maximum and P minimum levels over time were most likely related to a decrease in the right atrial volume and a decreased shunt ratio. Transcatheter ASD closure caused changes in the cardiac geometry, regardless of the magnitude of the pre-closed cardiac overload.^{11,12} Ho et al demonstrated that P dispersion was higher in children with ASDs.¹³ Reduced P dispersion after surgical ASD closure in adult and paediatric patients has been demonstrated.^{14,16} Kaya et al. reported a reduction in P maximum and P dispersion after transcatheter closure in children and adults.¹⁷ However, our study demonstrated that P dispersion was unchanged in children. A possible explanation for the unchanged P wave dispersion may be related to the decreased P maximum to P minimum ratio or the mass effect and metal configuration of the device. Using long-term instead of intermediate measurements, P wave dispersion may be found different in current literature.

The limitation of our study was the manual calculation of the P wave measurements rather than the use of the computer-assisted method.

Conclusion

Although P wave dispersion is a simple and useful parameter of predicting atrial arrhythmias, but there is no P dispersion difference when performing transcatheter closure with Amplatzer septal occluder.

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