Transient left Ventricular Systolic Dysfunction Post Transcatheter Closure of Patent Ductus Arteriosus

Chanokvanun Burana, MD¹, Kriengkrai Hengrussamee, MD¹, Pornwalee Porapakkham, MD¹, and Pramote Porapakkham, MD²

¹Department of Cardiology, Chest Disease Institute, Nonthaburi, Thailand
²Department of CVT Surgery, Chest Disease Institute, Nonthaburi, Thailand

Abstract

Background: Amplatzer ductal occluder device (ADOD) is a famous device that is used for Patent Ductus arteriosus (PDA) occlusion. There were some reports in children and few reports in adults that showed deterioration of left ventricular systolic function post ADOD occlusion.

Objectives: To assess the immediate, short and intermediate effects of the amplatzer septal occluder device to left ventricular remodeling and systolic function in adults.

Methods: From October 2008 to December 2009, we studied consecutive adult patients with PDA who successfully underwent percutaneous transcatheter closure with ADOD at the Chest Disease Institute. Transthoracic echocardiography (TTE) was done at preclosure, 1 day, 3 months, 6 months and one year post device occlusion. Left ventricular ejection fraction (LVEF), left ventricular end-diastolic and end-systolic dimension (LVEDD and LVESD), left ventricular end-diastolic and end-systolic volume (LVEDV and LVESV) were recorded and analyzed. A Student paired t test was used to compare between groups.

Results: There were 61 patients mostly female (F:M = 5.1:1) with a mean age of 30.81 ± 10.93 years (range, 16-64 years). TTE revealed the mean LVEF before, 1 day, 3 months, 6 months and 1 year after the procedure were 60.7 ± 9.2%, 49.2 ± 16.2%, 57.4 ± 13.6%, 58 ± 13.6%, 60.1 ± 13.3% respectively. LVEDV and LVEDD before the procedure were 133.8 ± 54.9 ml, 55.7 ± 14.9 mm and they decreased significantly to 114.7 ± 47.9 ml, 47.6 ± 13.8 mm at 1 day and 93.6 ± 31.5 ml, 44.1 ± 9.3 mm at 1 year respectively. LVESV and LVESD before the procedure were 55.8 ± 24.9 ml, 45.2 ± 36.9 (range 5-196 mm) and they decreased significantly to 36.8 ± 18.1 ml, 29.4 ± 7.5 mm at 1 year.

Conclusion: In adults, transcatheter closure of PDA with ADOD had an influence on the deterioration of left ventricular systolic function immediately and short term. Its effect is only transient with full recovery of left ventricular systolic function in 1 year.

Keywords: Left ventricular systolic dysfunction, Patent ductus arteriosus, Amplatzer ductal occluder device, Left ventricular ejection fraction.

Introduction

Due to its relatively asymptomatic nature, patent ductus arteriosus commonly escapes clinical detection during Childhood. Prolonged aortopulmonary shunting could result in silent pulmonary hypertension, left ventricular dysfunction and left ventricular volume overload, which may be a compensatory phenomenon to maintain systemic cardiac output (1,2).

Previous reports demonstrated that patent ductus arteriosus (PDA) closure led to immediate deterioration of left ventricular (LV) systolic function, which recovered within 6 months in children (3). On the other hand, LV systolic dysfunction was reported to persist for 4 months after PDA closure in a 12-year-old child (4).

Surgical ligation has been the standard approach in the past. With the increasing availability and general...
acceptance of a percutaneous approach (5), more and more patients started to undergo transcatheter closure of PDA, either because of the high risk in undergoing general anesthesia or because of the patients’ preference. Residual left to right shunting due to incomplete closure of the patent duct has been reported in more than 30% of patients after the procedure (6). Other reported complications included hemolysis, distal embolization on the device and device related endocarditis (7). Moreover, there have been isolated reports of protrusion of the device into the left pulmonary artery causing reduced left pulmonary perfusion (10,11).

Several percutaneous closure devices have been developed to overcome these limitations during the past decades. The Rash Kind, buttoned, Botalloonoccluder devices and coils have been used for transcatheter closure of PDA with variable degrees of success and complication (10,11).

Percutaneous or transcatheter closure of the patent ductus arteriosus in adults using the new Amplatzer ductal occluder device (ADOD) is a safe and effective procedure (12). There was no mortality related to the procedure and also minimal morbidity. This should be an alternative in patients with PDA and suitable anatomy.

Despite its encouraging experience in pediatric patients, experience in adults is limited. In particular, adult patients are more likely to have a calcified and less distensible duct. They are exposed to a longer period of left to right shunt at aorto-pulmonary level and possibly secondary pulmonary hypertension and left ventricular dysfunction (13). However, LV remodeling and changes in LV systolic function after PDA closure in Thai adult patients has not been reported.

The objective of this study was to assess the immediate, short and intermediate effects of transcatheter closure of PDA with ADOD to left ventricular remodeling and systolic function in adults.

Methods
Study population

Adult patients (age ≥ 15 years) with PDA referred to the Chest Disease Institute for percutaneous transcatheter closure of the PDA using an ADOD from October 2008 to December 2009 were recruited. Baseline evaluation included clinical history, physical examination, blood tests (complete blood count, liver and renal biochemistry and clotting profiles) and a transthoracic echocardiogram.

Inclusion criteria were age ≥ 15 years, documented PDA and presence of audible continuous cardiac murmur and were to receive standard percutaneous transcatheter closure of the PDA using ADOD procedure. Exclusion criteria were other congenital heart disease and uncooperativeness to being followed up.

Procedures

This study was approved by the Ethics Committee of the Chest Disease Institute. Informed consent was obtained before the procedure. The procedure was performed under local anesthesia. Routine left and right heart catheterizations and aortography were performed to confirm the diagnosis and position of PDA, as well as to assess the diameter of PDA and the shunt ratio. The standard percutaneous transcatheter closure of PDA using ADOD was done. Complete closure was confirmed by aortography immediately after the procedure. Within 24 hours, chest radiographs in the posteroanterior and lateral positions were obtained to assess the device position and for future reference.

In a total of 61 adult patients with PDA, 2-dimensional echocardiography was repeated at more than 6 months after successful PDA closure.

Echocardiographic evaluation and follow-up

2-dimensional transthoracic Doppler echocardiography (TTE) was performed before and after PDA closure and divided into 3 terms; immediate 1 day post-procedure, short-term 1-3 months post-procedure and intermediate 6-12 months post-procedure. Echocardiogram was performed to measure LV end-systolic diameter (LVESD) and end-diastolic diameter (LVEDD) to calculate LV ejection fraction (LVEF). The presence of residual shunt was assessed by color Doppler echocardiography.

Statistical analysis

Statistical analysis was performed using a SPSS 13 Software program. Continuous variables are presented as mean ± SD and compared indices and LVEF were evaluated by the paired t test.

Results

There were 61 patients predominantly female (F:M = 5.1:1) with a mean age of 30.81 ± 10.93 years (range,
16-64 years). TTE revealed the mean LVEF before, 1 day, 3 months, 6 months and 1 year after the procedure were 60.7 ± 9.2%, 49.2 ± 16.2%, 57.4 ± 13.6%, 58 ± 13.6%, 60.1 ± 13.3% respectively (Table 1, Figure 1). LVEDV and LVEDD before the procedure were 133.8 ± 54.9 ml, 55.7 ± 14.9 mm and they decreased significantly to 114.7 ± 47.9 ml, 47.6 ± 13.8 mm at 1 day and 93.6 ± 31.5 ml, 44.1 ± 9.3 mm at 1 year respectively. LVESV and LVESD before the procedure were 55.8 ± 24.9 ml, 45.2 ± 36.9 mm (range 5-196 mm) and they decreased significantly to 36.8 ± 18.1 ml, 29.4 ± 7.5 mm at 1 year (Table 1).

Table 1. Changes in LV volumes, dimension and EF after closure of PDA in adults

<table>
<thead>
<tr>
<th></th>
<th>Preclosure</th>
<th>1 day</th>
<th>3 month</th>
<th>6 month</th>
<th>12 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEF (%)</td>
<td>60.7 ± 9.2</td>
<td>49.2 ± 16.2</td>
<td>57.4 ± 13.6</td>
<td>58 ± 13.6</td>
<td>60.1 ± 13.3</td>
</tr>
<tr>
<td>LVEDD (mm)</td>
<td>55.7 ± 14.9</td>
<td>47.6 ± 13.8</td>
<td>46 ± 8.7</td>
<td>43.8 ± 10.8</td>
<td>44.1 ± 9.3</td>
</tr>
<tr>
<td>LVEDV (ml)</td>
<td>133.8 ± 54.9</td>
<td>114.7 ± 47.9</td>
<td>103.7 ± 34.3</td>
<td>95.4 ± 34.3</td>
<td>93.6 ± 31.5</td>
</tr>
<tr>
<td>LVESD (mm)</td>
<td>45.2 ± 36.9</td>
<td>35.5 ± 10.7</td>
<td>32 ± 8</td>
<td>30.4 ± 9</td>
<td>29.4 ± 7.5</td>
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<tr>
<td>LVESV (ml)</td>
<td>55.8 ± 24.9</td>
<td>54.1 ± 29.3</td>
<td>44.2 ± 22.4</td>
<td>42.6 ± 22.6</td>
<td>36.8 ± 18.1</td>
</tr>
</tbody>
</table>

LVEF = left ventricular ejection fraction, LVEDD = left ventricular end-diastolic diameter, LVEDV = left ventricular end-diastolic volume, LVESD = left ventricular end-systolic diameter, LVESV = left ventricular end-systolic volume

Figure 1. Changes in LVEF after PDA closure using Amplatzer duct occluder device

During the short (1 month-3 month post-procedure) and intermediate (6 month-12 month post-procedure) term follow-up period, LVESV and LVESD as well as LVEDV and LVEDD decreased significantly and LVEF recovered compared to the immediate postclosure state (1 day post-procedure) at short term follow up (1-3 months post-procedure) and was completely recovered at 12 months after transcatheter PDA closure compared to the preclosure state.

Discussion

Previous reports demonstrated that PDA closure leads to immediate deterioration of LV systolic function which recovers within 6 months (3,4,8). Left ventricular volume overload is frequently associated with PDA and seems to be required to increase cardiac output by Frank-Starling response to overcome significant left-to-right
shunt and maintain systemic circulation. Because the LV remodeling is caused by significant left-to-right shunt through PDA, it is conceivable that LV reverse remodeling can occur post PDA closure.

Recently, Eerola et al (3) demonstrated, using 2- and 3-dimensional echocardiography, that changes in LV volume, LV diameter and function caused by PDA closure disappeared by 6 months, after percutaneous closure in children. Consistent with previous reports, our current study has demonstrated that LVEF was reduced immediately after PDA closure (1 day post-procedure) and recovered during the long-term follow-up period (12 month post-procedure) in Thai adult PDA patients. Immediate post closure deterioration of LVEF was attributed to the immediate decrease in LVEDV, LVEDD and stationary LVESV, LVESD, whereas late recovery of LVEF was mainly due to a late decrease in LVESV, LVESD. A unique finding in this study performed with Thai adult patients with PDA was that LV systolic function was completely recovered within 12 months after PDA closure compared to the preclosure state.

The present study has some limitations. The study was prospectively analyzed in a single center. Echocardiographic follow-up was dependent on the discretion of the attending physician and was not uniform and also a less accurate LVEF (M-mode) method. Finally, we did not demonstrate the effect of medication on LV remodeling and systolic functional change.

LVEF is completely recovered within 12 months after PDA closure compared to the preclosure state in Thai adult patients with PDA, and it is recovered from the immediate postclosure deterioration (1 day post-procedure) at a short term follow up period (1 month - 3 month post-procedure).

Conclusion

In adults, transcatheter closure of PDA with ADOD had an influence on the deterioration of left ventricular systolic function immediately and short term. Its effect is only transient with full recovery of left ventricular systolic function in 1 year.

Clinical Implication

Left ventricular systolic dysfunction post transcatheter PDA closure is a transient effect with no clinical significance and recovery occurs within 1 year.

Conflict of Interest

None

References

การลดลงของการบีบตัวของหัวใจห้องล่างซ้ายชั่วคราวหลังได้รับการรักษาด้วยวิธี Transcatheter closure ของ PDA โดยใช้ Amplatzer Ductal occluder device ในผู้ใหญ่

 Chanokvanun Burana, MD

บทคัดย่อ
ความสำคัญและที่มาของการวิจัย: ปัจจุบันการรักษา PDA โดยวิธี Transcatheter closure โดยใช้ Amplatzer Ductal occluder device ในผู้ป่วยได้รับความนิยมอย่างแพร่หลายที่มีการศึกษาในเด็กและผู้ใหญ่จำนวนน้อยเท่ากับความสามารถในการบีบตัวของหัวใจห้องล่างซ้ายหลังการรักษาด้วยวิธีดังกล่าว จึงเป็นที่มาของการศึกษาวิจัยครั้งนี้
วัตถุประสงค์ของการวิจัย: เพื่อประเมินความสามารถในการบีบตัวของหัวใจห้องล่างซ้ายและ left ventricular remodeling ภายหลังการรักษาด้วยวิธี Transcutaneous closure of PDA โดยใช้ Amplatzer Ductal occluder device ในผู้ป่วย
วิธีการศึกษา: คัดเลือกผู้ป่วยรายๆที่มีการศึกษาข้อมูลเกี่ยวกับความสามารถในการบีบตัวของหัวใจห้องล่างซ้ายหลังการรักษาด้วยวิธี Transcatheter closure โดยใช้ Amplatzer ductal occluder device ในช่วงเดือนตุลาคม 2551-ธันวาคม 2552 หลังจากนั้นประเมิน Transthoracic echocardiography (TTE) เพื่อวัด Left ventricular ejection fraction (LVEF), left ventricular end-diastolic và end-systolic dimension (LVEDD, LVESD), left ventricular end-diastolic và end-systolic volume (LVEDV, LVESV) ที่ preclosure, 1 วัน, 3 เดือน, 6 เดือน, 1 ปี post-closure เก็บข้อมูลในรูปแบบ mean ± SD, และเปรียบเทียบความแตกต่างระหว่างตัวแปรโดยใช้ Student paired t test
ผลการศึกษา: มีผู้ป่วยที่เข้าร่วมการศึกษาทั้งหมด 61 คน หญิงมากกว่าผู้ชาย 5 ต่อ 4 ผู้ป่วยมี LVEF ก่อนปิด PDA, 1 วัน, 3 เดือน, 6 เดือน, และ 1 ปี post-closure PDA เท่ากัน 60.7 ± 9.2%, 49.2 ± 16.2%, 58 ± 13.6%, 60.1 ± 13.3% ตามลำดับ LVEDV และ LVESD ก่อนปิด PDA เท่ากัน 55.8 ± 24.9 มล, 45.2 ± 36.9 มล และลดลงเป็น 36.8 ± 18.1 มล, 29.4 ± 7.5 มล ที่ 1 ปี
บทสรุป: ในผู้ใหญ่ที่ได้รับการรักษา PDA ด้วยวิธี Transcatheter closure of PDA โดยใช้ Amplatzer ductal occluder device มีผลทำให้ความสามารถในการบีบตัวของหัวใจห้องล่างซ้ายลดลงในระยะ immediate และ short term ซึ่งเป็นการลดลงชั่วคราว หลังจากนั้นจะกลับมาเป็นปกติที่เท่ากับก่อนการรักษา ภายในระยะเวลา 1 ปี
คำสำคัญ: Left ventricular systolic dysfunction, Patent ductus arteriosus (PDA), Amplatzer ductal occluder device (ADOD), Left ventricular ejection fraction (LVEF)