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A strategic approach to transcatheter closure of patent ductus: Gianturco coils for small-to-moderate ductus and Amplatzer duct occluder for large ductus

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Abstract

Objective: To investigate the effectiveness of the strategy of transcatheter occlusion with the Gianturco coil for small-to-moderate sized ductus and with Amplatzer duct occluder (ADO) for large ductus.
Patient and methods: For ductus closure, the following strategy was applied: ADO was used in large ductus: infants and young children weighing < 15 kg with a ductus diameter ≧3 mm and in older children or adults with a ductus diameter ≧4 mm and coils were employed in patients with small-to-moderate sized ductus. During a 3-year period, this strategy was applied in 136 patients. The results were compared between 214 patients (group I) undergoing ductus closure using only coil before application of this strategy and strategic closure in 136 patients (group II). Each group was divided into 2 subgroups: subgroup A with large ductus and subgroup B with small-to-moderate ductus. There were 54 patients in subgroup IA, 160 in subgroup IB, 33 in subgroup IIA and 103 in subgroup IIB, respectively.
Results: In group I, PDA occlusion was successful in 207 (96.7%) and failed in 7 (6 of group IA and 1 of group IB). In group II, ductus closure was successful in 134 patients (98.5%) (32/33 with ADO and 102/103 with coils).There was no significant difference in success rate between group I and II. Distal embolization occurred in 19 patients of group I and in 2 of group II, respectively (19/214 vs. 2/136, $P<0.01$). There was no significant difference in success rate between group IA and IIA but the distal embolization rate was higher in group IA than IIA (13/54 vs. 1/33, $P=0.014$). Left pulmonary artery stenosis was found exclusively in 9 patients of group I at the 6-month follow-up ($P<0.05$). Nine patients in group I required second intervention to achieve complete occlusion.
Conclusions: The strategy of ductus closure worked well by reducing embolization rate, incidence of left pulmonary artery stenosis and the need of second intervention.

Keywords: Patent ductus arteriosus; Transcatheter closure; Gianturco coil; Amplatzer duct occluder

1. Introduction

Transcatheter closure of patent ductus arteriosus (PDA) has gained wide acceptance as a treatment of choice. Several devices have been developed for this purpose and among them the Gianturco coil was the most common device used [1–6]. The Gianturco coil has been used to close small-to-moderate sized ductus with good long-term results [4–8]. However, coil closure for patients with large ductus remains a problem, because of a relatively higher both failure rate and distal embolization rate [9–13]. We encountered these problems in coil closure for large ductus despite application of a balloon occlusion technique in combination with a multiple coil technique. Since May 2000, we used the strategy of ductus closure with coil for small-to-moderate

Abbreviations: ADO, Amplatzer duct occluder; PDA, Patent ductus arteriosus.

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sized ductus and with Amplatzer duct occluder (ADO) (AGA, Medical, Golden Valley, MN) for large ductus. The acute outcome and follow-up results in patients undergoing ductus occlusion using this strategy were compared with those in patients undergoing closure using only coils before application of this strategy.

2. Methods and patients

2.1. Patients

The Gianturco coil has been used for ductal closure in this institution since November 1995. Between November 1995 and May 2000, transcatheter closure of ductus with Gianturco coils was attempted in 214 patients (group I) with ages ranging from 1.5 months to 63 years (median 3.4 years). During this 4.5-year period, 27 patients were excluded for attempted transcatheter closure with coils because of patients' or parents' preference in 4, heart failure in 15 young infants, and ductus diameter >4 mm in 8 children. After May 2000, we used the following strategy for ductal closure: coil for small-to-moderate ductus and ADO for large ductus. Large ductus is defined as a ductus with a minimal diameter ≧4 mm in children and adults or ≧3 mm in infants and children weighing <15 kg. During a 3-year period (between May 2000 and April 2003), there were 136 patients (group II) who underwent attempted transcatheter closure of ductus using this strategy. Not included were 3 young infants in severe heart failure, where transcatheter closure was considered not feasible and were operated. Of the 136 patients, their ages ranged from 1 month to 75 years (median 3.2 years). Fourteen patients of group I and 4 of group II had associated cardiovascular anomalies. Each group was further divided into 2 subgroups: subgroup A consisted of patients with large ductus and subgroup B was comprised of patients with small-to-moderate ductus. In group I, 54 patients (group IA) had a large ductus and 160 patients (group IB) had a small-to-moderate ductus. In group II, 33 patients had a large ductus (group IIA) underwent ADO closure and the remaining 103 patients (group IIB) underwent coil closure. In group IIA, there were 10 males and 23 females with ages ranging from 2 months to 75 years and body weights ranging from 3.5 to 67 kg.

2.2. Methods

Informed consents from parents or patients were obtained before catheterization. Premedication with merperidine, wintermine and pyrethia was administered in patients less than 14 years of age. Heavy sedation with midazolam or ketamine was used when required. One dose of antibiotic was given 30 min before cardiac catheterization. Following local anesthesia, femoral vein and artery were accessed. Appropriate sized sheaths were cannulated. No hepain was given. Normal saline containing heparin (10 U/ml) was used to flush the catheters. After hemodynamic studies, a descending aortogram was performed at lateral and 30° right anterior oblique projections. The narrowest dimension of the ductus was measured on a frozen digitalized aortogram using a known catheter diameter or marker bands on a marker catheter as reference. For coil closure, four-to-five-loop 0.038 Gianturco coils (Cook Bloomington, IN) were used. The diameter of coils selected was around 1.5~2.5 times of the narrowest diameter of the ductus. Coils were generally delivered via a retrograde route. In group I, a multiple coil technique was generally used for a ductus diameter >3 mm since June 1996, and a multiple coil technique in combination with a balloon occlusion technique was used for a ductus diameter >4 mm since July 1997 [7–10]. If residual flow in the form of a discrete jet or significant opacification of the pulmonary arteries was seen on the repeat aortogram 10 min following coil deployment, additional coils were deployed as required to achieve complete occlusion.

For deployment of the ADO, an appropriate size long sheath (AGA) was used to deliver the device. The technique of deployment of ADO was similar with those described in literature [16]. The diameter of the ADO selected was 1~2 mm larger than the ductal diameter for young children, and at least 2 mm larger than ductus diameter for older children and adults. An exception was made in 3 patients: in an adult a device less than 2 mm greater than ductus diameter was used and in an infant and a child, respectively, a device <1 mm greater than ductus diameter was used. Antibiotic was administered for 3 additional doses in an interval of 6 h. Patients were generally discharged on the next day. Follow-up echocardiography was performed 1, 3, 6, 12 months and yearly after device deployment. The acute results, incidence of distal embolization and left pulmonary artery stenosis, complete closure rate at 3 months, and need for second intervention were compared between the 2 groups. To compare the effectiveness of ADO and coil in closure of large ductus, the results and complications were compared between group IA and IIA.

2.3. Statistical analysis

Student's t test was used to evaluate the significance of difference in age, Qp/Qs ratio, and ductus diameter between the 2 groups. For comparison of failure rate, embolization rate, incidence of left pulmonary artery stenosis and percentage of patients requiring second intervention between the 2 groups or 2 subgroups, the Chi-square test or Fisher's exact test was used. A p value <0.05 was defined as significance.