OUTCOME AND IMMEDIATE COMPLICATIONS OF DEVICE OCCLUSION OF DIFFERENT TYPES OF PATENT DUCTUS ARTERIOSUS WITH RANGE OF DEVICES

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ABSTRACT

Objective: The aim of our study was to report the outcome and immediate complications of PDA device closure, comparing ducts according to Krichenko classification.

Study Design: Quasi experimental study.

Place and Duration of Study: Pediatric Cardiology Department of Armed Forces Institute of Cardiology / National institute of Heart Diseases (AFIC/NIHD) from 1st May 2012 to 30th Nov 2013.

Patients and Methods: Total 368 consecutive cases, were included with intention of transcatheter closure of patent ductus arteriosus (PDA). Detailed echocardiography was done before procedure. Aortogram determined duct size, length, narrowest diameter and morphology. Device attempted only after duct was considered suitable.

Results: The mean narrowest duct diameter was 4.5±2.4 mm. Out of 368 cases, five cases were considered unsuitable for device closure after aortogram. In two cases, device embolized after deployment and in one case procedure abandoned due to technical reasons. There was no cardiac perforation, tamponade or death in our study population. The success according to Krichenko duct types was 100% for type A, 100% for type B, 87.5% for type C, 100% for type D and 100% for type E.

Conclusion: PDA device closure is a safe and effective therapeutic option in vast majority of cases. Type C tubular type ducts are more difficult to negotiate with high complication rates.

Keywords: PDA device closure; Krichenko; Device embolization;

INTRODUCTION

PDA is quite common congenital heart defect (CHD) and now a days is usually treated in catheterization laboratory with excellent results and safety; consequently there is rapid decline in numbers of surgical duct ligations / interruptions1. PDA device closure is quite similar in effectiveness for duct closure in comparison to surgical interruption/ligation and is associated with fewer complications along with shorter hospital stay1,2. Surgical approach is limited to few particular indications as in very young infants and large tubular type ducts1-3. Due to rapid and continuous evolution in interventional cardiology since 1967, various types of devices are currently being used with excellent occlusion rates and low complication rates, regardless of PDA type4,5.

PDAs are classified according to Krichenko classification6. Type A is a conical duct, with well defined aortic ampulla and constriction near the pulmonary artery end. Large window type ducts with short length are classified as type B. Type C is tubular duct, which is without any constrictions. Other two less common are either complex type D duct, which has multiple constrictions, and type E (“elongated”) duct, with the remote constriction. Other than type A, ducts poses special problems due to their unfavourable shapes, the device occlusion becomes quite challenging. Various devices are used for duct occlusion of large /atypical PDAs including amplatzer duct occluder (ADO) I, ADO II / ADO II aortic stenosis (AS) and ventricular septal defects (VSD) devices. The purpose of this study was to prospectively study the outcome and associated immediate problems of PDA device closure according to different ducts types as classified by Krichenko, over a period of 19 months.

PATIENTS AND METHODS

This quasi experimental study was prospectively carried out at paediatric cardiology
department of Armed Forces Institute of Cardiology / National Institute of Heart Diseases Pakistan (AFIC - NIHD), after approval by the hospital Ethical Committee, from 1st May 2012 to 30th Nov 2013. Patients with isolated PDA or with minor CHD (not requiring surgery in future) were included in the study. Patients with PDA with associated major cardiac anomalies, Eisenmenger PDA, patients with active infections and patients with coagulation disorders were excluded from the study.

Total 368 consecutive cases, which were taken to the catheterization lab with intention of transcatheter closure of PDA, were included.

Pre procedural assessment included detailed history, physical examination, blood complete picture, chest X-ray and 2-D echocardiography/ and Doppler. 2-D echocardiography was done by paediatric cardiologist to determine the anatomical morphology, length, narrowest diameters of the duct, pulmonary artery pressures and presence of any associated cardiac anomalies. Patients considered suitable for device closure on 2-D echocardiography were planned to undergo therapeutic cardiac catheterization. All patients were admitted on the same day of procedure and after written consent, PDA device closure was attempted under general anaesthesia (GA) or under sedation and local anaesthesia depending upon patient’s age. After establishing vascular access, aortogram was performed with pig tail catheter in lateral and right anterior oblique projections and duct size, length, narrowest diameter and morphology were determined as per Krichenko classification. If considered suitable, than duct was crossed from venous side and delivery sheaths were parked in the descending aorta. Appropriate device was then selected with reference to narrowest diameter of duct and duct morphology. Device was deployed after careful manipulation and released only if cardiac auscultation and aortogram were satisfactory. Routine care for next 18-24 hours in post cath wards were given along with echocardiography in evening and next morning. Cases with absent limb pulses were treated with IV heparin and streptokinase as per institution protocol. Patients were discharged next morning, if no complications occurred and advised follow up after 02 weeks and then 02 months.

Variables like patient’s age, gender, residence, size and shape of duct, Krichenko type and procedural details were recorded. Major acute complications, including death, systemic infections, major bleeding, thrombo-embolism, hemolysis, device - induced obstruction at the sides of the aortic arch and/or the left pulmonary artery, device displacement / dislodgment after release; were recorded. Data had been through SPSS version 17, Descriptive statistics were used to describe the results. Kruskal Wallis test was used to compare different variables between different Krichenko types of duct. A \( p \) value of < 0.05 was taken as significant.

RESULTS

A total of 368 patients were taken to catheterization lab with the intention of PDA device closure with male to female ratio of 0.5 :1. Basic parameters are shown in Table 1. Overall, procedure was successful in 360 (97.8%) patients. Out of 368 cases, five cases were considered unsuitable for device closure after aortogram and device closure was not attempted. In another two cases, device embolized after deployment and in one case procedure abandoned due to inability to pass the delivery sheath across the duct.

The success according to ducts types were 100% for type A, B, D and E whereas it was 87.5% for type C (Table 2). Table 3 is showing various devices used in our study population in different ducts types. Echocardiography after 24 hours revealed no residual leak in any of these patients. In one case, device embolized after deployment and in one case procedure abandoned due to inability to pass the delivery sheath across the duct.

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Out of 368, five (1.4%) cases were abandoned after aortogram and device closure was not offered as these ducts were considered as not
suitable for device closure (too large tubular type C ducts to risky to be closed).

Out of remaining 363 cases, three cases were unsuccessful and again all were type C ducts. In first case, a seven year old girl, device (16 mm ventricular septal defect (VSD) device for 12 mm type C duct) was deployed but after about 10 hours, it was dislodged to main pulmonary artery (MPA). After discussion with parents and department team, it was decided to go for surgery and surgical device retrieval and duct interruption was successfully accomplished. Second case, a 08 month-old girl, here the delivery sheath could not be crossed across duct after every possible trouble shooting, necessitating procedural abandonment and surgical referral. Third case, a 09-year-old boy, device (20 mm VSD device for 16 mm type C duct) embolized immediately after deployment, snared in cath lab and referred to cardiac surgeon for duct interruption.

Three cases were transfused blood after procedure due to blood loss while device closure. However, there was no cardiac perforation, tamponade or death in our study population.

Minor problems included 43 (11.7%) cases with pulse loss for 06-24 hour (femoral artery) and 20 (5.4%) patients with pulse loss > 24 hour. These cases were successfully managed with IV heparin and additional IV streptokinase in 15 cases, with no residual problems.
DISCUSSION

Management of PDA is continuously evolving since the first surgical ligation in 1939 and device closure in 1967. Percutaneous device closure of PDA is considered safe and preferred mode of treatment for both children and adults. Techniques and devices have rapidly evolved especially in the field of interventional cardiology, and now a days, almost all PDAs can be occluded in cath lab with limited surgical indications. Recent studies have reported success rates of even up to 100%. Depending on the size and shape of PDA, various types of devices have been used in transcatheter closure of PDA. Important determinants of duct occluder include age and weight of the patient, size and morphology of the duct and the experience of center and operators. In our study population, the narrowest duct diameter ranged from 1-16 mm with mean of 4.5 ± 2.4 mm. When we taken into the account the ducts types according to Krichenko classification, 279 (75.8%) cases were type A, 9 (2.5%) were type B, 64 (17.4%) were of type C and only one (0.3%) case was of type D, whereas there were 15 (4.1%) type E duct in our study population.

In our study, 363/368 patients were attempted PDA device closure after aortogram revealed device suitability with overall 97.8% success (360/368). Parra-Bravo et al reported 92.3% success in their small study, whereas Brunetti et al reported that out of 359 attempted device closure the success was achieved in 357 in patients with diameter 2.1 mm. Similarly, Dimas et al has recently reported their experience of 62 infants with (weight < 6 kg) with 94% success in PDA device occlusion and 93% success was reported by Sivakumar et al. Female patients (65.5%) out numbered the male, endorsing that PDA is more common in female gender as also reported by Atiq et al from Pakistan who showed a ratio of 2:1 in the favour of female in adult patients underwent PDA device closure. Similar observations are also made by other studies as well.

Among 360 successful cases, occluder devices were used in 357 while coil was used only in three cases (tables 2 and 3). The maximum number of devices used were 8/6 in 113 (31.4%) patients followed by 6/4 in 88 (24.4%) cases. Similar statistics were reported by Parra-Bravo et al.

The most feared complication is device embolization, usually due to improper selection of device size or lack of experience of the operator. Three (0.8%) major complication occurred in our study. In one case the device dislodged after deployment after about ten hours of deployment. He underwent surgical duct interruption and device retrieval next day. In second case the device dislodged immediately after its deployment, snared from MPA and procedure abandoned and patient was referred for surgical duct interruption. Both these cases had type C large tubular type ducts, and device closure was attempted with 16 and 20 mm VSD device. In third case, device dislodged after five hours of deployment into LPA, but snared in cath lab and redeployed with success. This case was again a type C duct and 12 mm VSD device was used to occlude the duct. All these cases suggest to us, that device closure in tubular type C ducts are most difficult and risks of procedural failure /device dislodgement is also higher in this group. Though left pulmonary artery (LPA) stenosis is reported complication of duct device closure, but in our study there was no case of LPA compression or acquired coarctation.

The mean procedural time was 39.8 minutes and mean fluoroscopy time was 9.2 minutes, quite comparable to 30 and 10.6 minutes as reported by Karapinar et al. Dimas et al reported mean fluoroscopy time of 34 minutes in comparison to 7.1 minutes in our study. This disparity may be attributable to the vast experience of our operators in last 10 years and the data reported by Dimas VV was from relatively early experience of PDA device closure.

Limitations of this study were because of no comparison with surgical interruption / ligation...
(as very few ducts need surgical treatment in present era), they are single centred and no follow up is presented. Nevertheless, in face of its safety and high success rates, we consider PDA device closure in all types of ducts as a feasible and attractive therapeutic option. Nevertheless, type C tubular type ducts are more difficult to negotiate with high complication rates.

CONCLUSION

PDA device closure is a safe and effective therapeutic option in vast majority of cases. Type C tubular type ducts are more difficult to negotiate with high complication rate.

REFERENCES