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TRANSCATHETER DEVICE CLOSURE OF PATENT DUCTUS ARTERIOSUS WITH TRANSVENOUS APPROACH ONLY; AN EXPERIENCE OF 55 CASES

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ABSTRACT

Objective: To determine the success, technique, and immediate complications after patent ductus arteriosus (PDA) device closure under transthoracic echocardiography (TTE) guidance.

Study Design: Quasi-experimental.

Place and Duration of Study: Pediatric cardiology department of Armed forces institute of cardiology / National institute of heart disease (AFIC / NIHD) Rawalpindi Pakistan, from Jun 2015 to Oct 2016.

Material and Methods: A total of 55 patients with moderate to large patent ductus arteriosus (PDA) underwent device closure using only femoral vein puncture. After crossing the PDA from pulmonary artery side; pigtail catheter was placed in aorta to delineate the location, size and type of PDA. All patients had single procedure. Clinical, hemodynamics, follow-up morbidity and troubleshooting data were collected.

Results: Successful closure of the ductus was achieved in all the cases. The mean age was 9 months (range 3-24 months) 60% were female. All procedures were carried out under general anaesthesia. In three patients there was residual flow across the duct that closed spontaneously after 24 hours. All infants were discharged next morning confirming adequate closure and general status of the child. No emergency surgical exploration or death occurred during this period.

Conclusion: Device closure of PDA without femoral arterial puncture is a safe procedure provided good echocardiographic guidance is available for final placement. This procedure is especially useful for small infants with large PDA in which femoral puncture can be limb threatening due to prolonged large size femoral arterial sheath.

Keywords: Device closure, Femoral artery puncture, Patent ductus arteriosus, Transthoracic echocardiography.

INTRODUCTION

Patent ductus arteriosus is one of the most common a cyanotic congenital cardiac anomalies and accounts for 5-10% in children[1,2]. The symptoms appear early in infancy depending upon size of Patent ductus arteriosus (PDA). In case of moderate to large PDA there is failure to thrive, repeated episodes of chest infections, irritability and feeding difficulty so necessitates its closure[3]. The exact defect size, type of PDA, its length, size of pulmonary arteries, coarctation of aorta, location of PDA and its relation with the surrounding structures are helpful in making decision for device closure. Percutaneous closure of PDA is being innovated gradually since 1968. Device closure of patent ductus arteriosus is safe, effective and provides alternative way to surgical ligation / interruption with shorter hospital stay. Transthoracic echocardiography is excellent guiding tool for device positioning, alignment and deployment. In Pakistan our institution is one of few centers that is providing interventional therapy for various congenital heart defects. We are using transthoracic echocardiography (TTE) as guiding tool for percutaneous PDA device closure in selected small infants to save arterial puncture which may lead to femoral artery thrombosis sometimes very difficult to regain circulation in spite of administering heparin post procedure. The use of streptokinase leads to excessive uncontrollable bleeding which is very difficult to manage in certain situations. In this study we focused on the feasibility, technique, selection of appropriate

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case and problems encountered during this new technique which is very rewarding and safe compared to surgery or using large sized arterial sheaths for large PDA especially in malnourished infants.

MATERIAL AND METHODS

All children between 3 months to 24 months with moderate to large PDA were assessed in outpatient department and those considered suitable for device closure were enrolled in this study. A detailed TTE was performed in all these selected infants with good acoustic window for the assessment of defect size, type, location, length, aortic arch with descending aorta, anatomy of aortic as well as pulmonary end of PDA, estimation of pulmonary artery pressure and any other associated congenital cardiac defects. The device size was selected in outdoor and all children were treated with VSD device which would otherwise need surgery for interruption of PDA.

Informed verbal consent was taken from all patients. Ethical committee approval was taken for this procedure through non-random convenience sampling following inclusion criteria was the infants less than 24 months of age, patients with moderate to large PDA, failure to thrive, repeated chest infection and cardiomegaly.

PDA with coarctation of aorta or other associated cardiac lesion and children more than 24 months and less than 1 month were excluded from the study.

All patients were called a day before the procedure and clinical examination with complete blood count and chest X-Ray was done to rule out infection. An approval from ethical committee of the institution as well as written consent was taken before the procedure. The procedure was carried out with general anaesthesia. After adequately sterilization of both groins, a femoral vein sheath 5F was placed under general anaesthesia. The PDA was crossed with exchange wire over 5F JR catheter and the exchange wire stabilized in the descending aorta, then 5F pigtail catheter was exchanged by wire (fig-1a and 1b). The aortogram was recorded by in right anterior oblique 30 degree and left anterior oblique 90 degree views. The final selection of device was decided based on both echocardiogram and aortogram views. The pigtail catheter was again exchanged with the wire and the femoral sheath was also withdrawn along with catheter. Following that an appropriate sized sheath was introduced over the exchange wire keeping the wire stiff during the cause of sheath placement. The sheath was finally

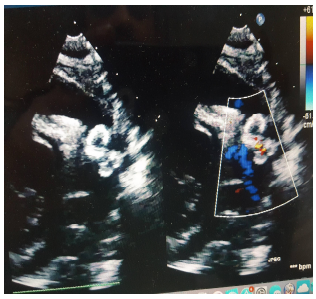

Figure-1(a): Echo shows no residual flow across patent ductus arteriosus device.

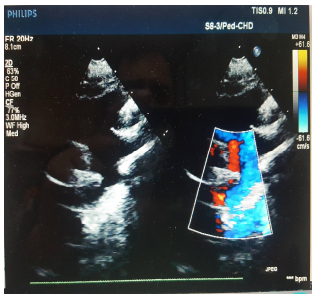

Figure-1(b): Patent ductu arteriosus device closu visualize on echo.

placed in the descending aorta about few centimeters down the site of PDA. The VSD device loaded over loader system was introduced in to the sheath under fluoroscopy till the end of sheath. At this moment, the aortic end was released and whole system was drawn back till the aortic end of PDA). With the help of TTE high parasternal short axis medially angulated as well as suprasternal short axis views, the pulmonary end of the device was released with little more gentle pull on whole system. At this point color Doppler along with 2 dimensional high quality imaging was used for confirming the position of device before releasing it. The cardinal consideration was any amount of residual leakage on color Doppler and proper anchorage of device circumferentially on 2 dimensional echocardiogram. Additionally any sort of gradient was looked for in the descending aorta which may be due to bulky device obstructing the aorta with simultaneous estimation of obstruction in left pulmonary artery which may be obstructed. All these echocardiographic views

were precisely undertaken before releasing the device. All children were given (ceftriaxone) 50mg/kg during the procedure followed by two additional doses. The patients were discharged after 24 hours and TTE was performed at the time of discharge. The patients were advised regular follow ups at 1, 3 & 6 months.

RESULTS

All of the 55 children (100%) had successful device closure of PDA including 60% (33) female and 40% (22) were male. The age of patients varied from 3 to 24 months (mean 9 ± 2.6 SD). TTE guidance was used in all children for device deployment during the procedure. The procedure was carried out under general anaesthesia in 100% (55) patients. The defect size ranged from 2-10mm (mean 4 ± 2 SD) and the occluders (ADO II type; VSD device) used varied from 4-12 mm. The median procedure time was 45 minutes and while fluoroscopic time was 9 minutes. In two patients there was residual low velocity leak through the device that resolved within 24 hours. In one patient the device appeared small (12 mm) and replaced with larger one (14mm) with good result. No emergency surgical exploration or death occurred during this period.

DISCUSSION

Percutaneous closure of the ductus arteriosus is the method of choice for treatment of this malformation in all age groups, except for the youngest patients, i.e. those whose weight is less than 5-6 kg. The surgical approach is still a standard method of treatment for them although there are reports of transcatheter arterial duct closure in premature babies of 1.7 kg and 2.2 kg body weight[4,5]. The limitations in this age group are connected with the lack of suitable delivery systems small enough to be safe for such tiny vessels. It is also a rule that arterial ducts in this period of life are often much wider than in older groups, so they require the introduction of larger implants. In the presence of small diameter of the blood vessels it can lead to their narrowing or even occlusion and rupture.

The next problems that may occur are vascular complications connected with the arterial puncture. It is of great concerns especially in patients with low body weight. In most of the cases it is possible to postpone the date of intervention until it is safe for the patient and allows one to avoid complications but in some cases the closure of the duct should not be postponed too long because of the danger of development of pulmonary hypertension or heart failure.

According to the data from the literature, vascular complications occur most frequently in patients with body weight below 10kg. More than 20 years ago about 60% of patients had impalpable or very weak pulse at punctured arterial site at the time of discharge[6]. Low profile vascular sheaths, minimized delivery systems and implants reduced the percentage of vascular complications although it is still high in the youngest group of patients.

One patient (8 months) with 8mm PDA had severe malnutrition, repeated episodes of chest infection, irritability in whom surgical interruption was very risky, underwent successful PDA device closure by this procedure saving the femoral artery as well as surgical morbidity and mortality. In this particular infant 8 mm ventricular septal defect (VSD) device seemed to be very bulky with suspicion of obstruction in the descending aorta and left pulmonary artery but precise echocardiogram revealed no such finding and the device was released successfully. In two patients there was difficulty in crossing the sheath over the wire but placing the JR catheter over the wire within sheath could ease the sheath crossing from right ventricle to pulmonary artery and finally to aorta through PDA. So far there was no procedure failure or embolization of the device. The other complications were residual leak (n=4) transient heart block (n=2) which settled immediately without medication. The mean procedure time was 20 minutes[7].

The latest data show that arterial occlusion concerns about 16% of the patients with body weight lower than 10 kg and 5.5% of patients with higher body weight[8]. Avoiding the arterial access eliminates all possible complications connected with arterial puncture: its occlusion, embolism, dissection, pseudo aneurysm formation, and bleeding. Certainly it does not exclude venous complications, which are as probable as arterial ones, but their consequences are definitely less important. The most serious arterial complications may end up with leg amputation or unequal development of lower extremities.

The new method of PDA occlusion seems to be an attractive therapeutic proposal. The biggest difficulty in this method is the lack of precise angiographic imaging immediately before deployment of the device. Based on our experience, good echocardiographic visualization is sufficient for the safety of the procedure. The experienced echocardiographer is able to determine precisely the location of the occluder. During the echo imaging we are able to estimate the flow in the aorta and in both pulmonary arteries in order to be sure that none of the vessels (especially the left pulmonary artery) are narrowed[9]. An additional advantage of our method is the reduction of the volume of contrast medium. In one of the child of 40 days having congenital rubella syndrome with severe respiratory distress, PDA was closed with 8mm device even without aortogram but only under TTE.

Sometimes there are problems in passing the guide wire through the arterial duct from the pulmonary artery. In such situations it is not possible to perform the PDA closure only from the venous approach. It is far easier to go through the duct from the aortic side and in those patients it is unavoidable to puncture the femoral artery. Then after passing the guide wire from the aorta through the duct to the pulmonary artery we exteriorize it using a vascular goose neck wire. After that it is possible to introduce the delivery system with the occluder.

An additional complication that appeared in one of our patients was the vasoconstriction of the duct. The structure of this vessel may predispose to constriction as the reaction to different factors[10]. We dealt with such a situation in our patient. The modified method of duct occlusion that we propose comprises additional manipulations within the duct and that was probably the reason for the temporary total constriction of a large arterial duct in 1 of our patients. Ten minutes after the removal of all devices from the lumen of the duct we saw the relaxation of the duct walls and then we were able to occlude the PDA effectively. Such reaction of the duct walls is more likely to happen in younger patients when fibrosis or calcification has not been developed. It is quite important to be aware of the possibility of such a complication and it should always be considered when the differences between the diameter of the duct before and during the procedure become substantial. It may end up with the choice of too small an occluder and, in consequence, the migration of the device.

CONCLUSION

Device closure of PDA without femoral arterial puncture under echocardiographic guidance is especially useful for small infants with large PDA in which femoral puncture can be limb threatening due to prolonged large size femoral arterial sheath.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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