Original Article

Is Transcatheter Closure Superior to Surgical Ligation of Patent Ductus Arteriosus Among Nigerian Children?

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Abstract

Background: Patent ductus arteriosus (PDA) is common among Nigerian children. It is the second only to ventricular septal defect among congenital heart diseases in Nigeria children. The study centers are the only centers in Nigeria which are able to offer both transcatheter closure of PDA and surgical ligation. The study aims to compare both methods in terms of the demographics of the individuals, cost and outcome. **Patients and Methods:** Prospective, cross-sectional involving consecutive individuals who had either transcatheter closure or surgical ligation of PDA from June 2010 to January 2014. Individuals were grouped according to the method of closure of their defect. Data on their demographics, size of the defects, cost of treatment and outcome were compared for the two groups. The analysis was done using Microsoft Excel statistical software supplemented by Statistical Package for Social Sciences version 20.0. $P < 0.05$ was considered statistically significant. **Results:** A total number of 28 individuals had either surgical ligation or device closure of PDA done at the studied period. The mean age of all the individuals was 4.58 ± 4.20 years with a median age of 3 years. The mean age of individuals that had surgical ligation was 3.40 ± 0.92 years and mean age of those who had transcatheter device closure was 6.69 ± 1.05 years ($P = 0.677$). Male to female ratio in both groups were 0.4:1. No mortality was recorded in both groups. However, 6 (21.4%) of the surgical patients and 1 (3.57%) of the patient with device closure had complications. The direct cost of the procedure for each of the patient who had device closure of PDA was about $3000 whereas the cost of surgical closure was about $1000.The indirect cost for device closure was about $100 while that of surgical closure was about $5000. **Conclusion:** Device closure of PDA has lesser risk of complications compared to surgical ligation. Its indirect cost is also cheaper. There is a need for availability and accessibility to device closure of PDA in our environment.

Keywords: Children, ligation, Nigeria, patent ductus arteriosus, transcatheter

Introduction

The incidence of congenital heart disease in Nigeria ranges from 3 to 5 per 1000 births.[1,2] Patent ductus arteriosus (PDA) is the second-most common congenital heart disease in Nigeria accounting for 22%[3] and 12.1%[4] in reported studies.

The reported incidence of PDA varies because of different population group studied and method used in its detection.[5] Functional closure of PDA occurs within the first 48 h of birth; however, some authorities consider the patency to be abnormal after 3 months of age.[6]

The first clinical attempt at ligating a PDA in a patient that had bacterial endocarditis was by Graybiel *et al*.[7] in 1938, although the patient died 4th day postoperation of acute gastric dilatation. The first successful ligation was performed by Gross and Hubbard[8] in Boston later in the year 1938, and this led to the advent of PDA ligation.

The first report on transcatheter closure of PDA was first reported it 1967 by Porstmann *et al*.[9] In Nigeria, the first transcatheter closure of a PDA was done by Animasahun *et al*.[10] in October 2010.

Studies have been done to compare the outcome and cost implications of both surgical and device closure of PDA.[8,11,12]

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Gray *et al*.[12] did a retrospective review of referrals from fourteen centers in the USA and Canada. Participants that had device closure had an average hospital stay of 2.4 days compared to 5.7 days in those that had surgical closure. One subject that had surgical closure had a major complications compared to five patients in the device ligation group. Some of the major complications that occurred in individuals that had a device closure include bacteremia and embolization while chylothorax occurred in a patient that had surgical closure. The cost analysis was higher in individuals that had device closure.

Ahmadi *et al*.[11] in Iran reported a higher morbidity and mortality rate in individuals that had surgical closure of PDA but with a lesser cost implication compare to those that had a device closure.

Zulqarnain *et al*.[13] in Pakistan reported a lesser complication and length of hospital stay in individuals with PDA that had a device closure. The residual shunt was seen in three and none of the individuals that had surgical ligation and device closure respectively. A higher cost of treatment was observed in individuals that had device closure compared to surgically ligated cases.

In Nigeria, Onakpoya *et al*.[14] reported a 5-year review of sixteen open cardiac surgical cases in Ile-Ife. In all, eleven of the cases were PDA. Of the subject with PDA, there was a recanalization of the ductus in a subject, two cases of chylothorax occurred, and a subject died few hours postoperation.

With careful literature search, no study has been done to compare the clinical outcome and cost implications of surgical ligation and device closure of PDA in Nigeria. This study is aimed at comparing the profiles of patients who had surgical closure and device closure of PDA in Lagos Nigeria.

Patients and Methods

This prospective, analytical, and cross-sectional study was carried out at the Lagos State University Teaching Hospital (LASUTH) and Reddington Multispecialty Hospital, Lagos Nigeria between June 2010 and January 2014. The Lagos State University Teaching Hospital is a tertiary center that receives patients from different hospitals within and outside Lagos State. The Department of Paediatrics in this center has a well-established cardiology unit with a Paediatric Cardiologist. Reddington Multispecialty Hospital is a highly recognized standard hospital in Nigeria with facilities for cardiac evaluation and some cardiac surgeries.

All individuals had PDA confirmed by a cardiologist using a transthoracic echocardiography. The cardiac evaluation was performed using a Vivid I machine with a transducer frequency of 5MHZ. Subjects were grouped according to the method of closure of their defect. Data on their demographics, size of the defects, cost of treatment, and outcome were compared for the two groups.

Collected data were analyzed using Microsoft Excel and Statistical Package for Social Sciences version 20.0 (IBM). Subjects' demographics were represented as frequency and percentages. Continuous variables were summarized using mean and standard deviation. $P < 5\%$ (0.05) was considered statistically significant.

Results

A total number of 28 subjects had either surgical ligation or device closure of PDA done at the studied period. The characteristics of the subjects are highlighted in Table 1. Sixteen subjects (57.1%) had surgical ligation and 12 (42.9%) had device PDA closure. The age range of all subjects was 8 months to 16 years. The mean age of all subjects was 4.58 ± 4.20 years with a median age of 3 years with M:F ratio of 1:3. The mean age of subjects that had transcatheter device closure was 6.69 ± 1.05 years while the mean age during surgical ligation was 3.40 ± 0.92 years ($P = 0.677$). The median age at device closure and surgical ligation was 5.50 and 1.35 years, respectively. Four and five subjects had surgical ligation and device closure respectively after the age of 5 years.

Surgical ligation of PDA was done in 12 females (75%) and 4 males (25%) patients. About 76.9% of subjects that had device closure were female and 23.1% were male. The male to female ratio for both device closure and surgical ligation was similar (1:3).

There was no subject that had device closure in infancy. However, six subjects benefitted from surgical ligation during infancy. A higher proportion of subjects had surgical closure at an earlier age compared to those that had device closure as shown in Figure 1.

The size of the defect for the patient who had surgical closure was statistically larger with a mean size of 8.5 ± 0.13 mm while those who had device closure had a mean size of 3.6 ± 0.27 mm ($P < 0.001$).

There was no mortality in both procedures. However, 6 (21.4%) of the surgical patients and 1 (3.57%) of the

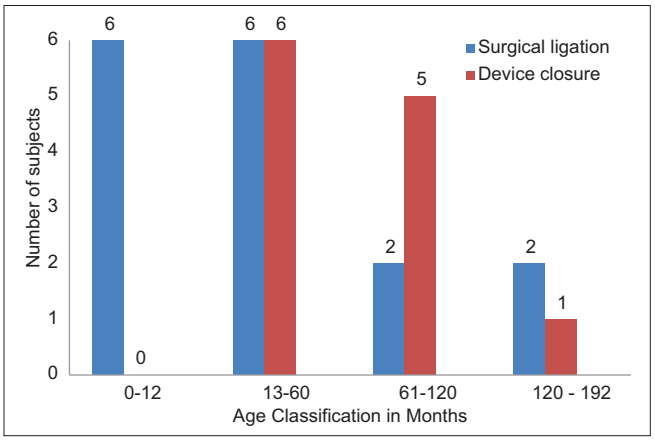


Figure 1: Age classification of the different methods of patent ductus arteriosus closure and the number of subjects

Table 1: Characteristics of the subjects

	Device closure	Surgical ligation	*P*
Number of patients	16	12	
Age at intervention (years)	6.69±1.05	3.44±0.92	0.027*
Age at diagnosis (years)	1.54±1.32	2.42±2.19	0.53
Female (%)	75	76.90	
Male (%)	25	23.10	
Hospital stay (days)	2	9	0.00*
Size of defect (mm)	3.6±0.27	8.5±0.13	<0.0001*
Complications (subjects)	1	6	0.001*

*Significant *P* value

patient with device closure had complications. One out of the six surgical patients had a low ejection fraction of 40%, postoperative right ventricular dysfunction and elevated blood pressure. Three of the patients had a fever, a patient had sepsis and two cases of residual PDA were seen. The only patient with the device closure who had complication had transient hypertension.

The direct cost of the procedure for each of the patient who had device closure of PDA was about $3000 whereas the cost of surgical closure was about $1000.The indirect cost for device closure was about $100 while that of surgical closure was about $5000. All the procedures were self-funded by the caregivers.

Discussion

In the present study, the mean age of subjects that had transcatheter device closure was higher than the mean age of subjects that had surgical ligation which was statistically significant. Mean age of subjects that had device closure in the present study was similar to the mean value of 3.1 ± 3.4 years of subjects that had intervention in India which was reported by Arodiwe *et al*.[15]

The mean age of subjects that had surgical ligation in the present study was lower than the reported mean age of 7.1 ± 6.7 years by Onakpoya *et al*.[14] in Ile-ife. The time of surgical interventions in the reported studies in Nigeria were remarkably higher than a report by Lin *et al*.[16] in Taiwan where ligation was done at a mean age of 17.4 ± 10 days. Interventions in individuals above 5 years are associated with life-threatening complications such as pulmonary hypertension[17], and this calls for measures that will enhance more accessibility to and availability of interventions for PDA closure in our environment.

Two-thirds of subjects in the current studies are female. This similar higher number of female subjects was reported by Onakpoya *et al*.[14] and Arodiwe *et al*.[15] This is not surprising because PDA is commoner in females than males.[17] Patients that had surgical ligation had a longer hospital stay compared to those that had device closure in the present study. This is similar to the finding by Zulqarnain *et al*.[13] in Pakistan Ahmadi *et al*.[11] in Iran and Costa *et al*.[18] in Brazil. The lesser duration of hospital stays in subjects that had device closure is expected because device closure is minimally invasive compared to surgical ligation.

In the present study, a higher percentage of patients that had surgical ligation had complications compared to the group that had a device closure. This is similar to the report by Zulqarnain *et al*.[13] and Ahmadi *et al*.[11] where mortality and a higher morbidity were seen in surgically ligated group compared to subjects that had device closure. Residual shunt was seen in the present study in two cases (12.5%) that had surgical ligation and none in the device group. This is similar to the finding of Zulqarnain *et al*.[13] where residual shunt was seen in 1.5% of surgically intervened group and none of those that had a device closure. The outcome of transcatheter closure of PDA in Nigeria in the present which was commenced in the year 2010 is encouraging. In comparison to device closure on Nigerian children that travelled to India to have the surgery,[15] there was no failure of procedure in the current study and complication such as protrusion of the device into the aorta did not occur.

Device closure is more expensive than surgical ligation as seen in the present study and studies by Zulqarnain *et al*.[13] and Ahmadi *et al*.[11] However, prolonged hospital stay, higher risk of complications and the cost of its management in patients that had surgical ligation makes device closure of PDA a better option. There is a need for embracement of transcatheter closure of ductus in our environment to reduce the morbidity and mortality that is more associated with surgical ligation. There is a need for an intense intervention of health financing in Nigeria where out of pocket is still mostly what is in existence. Insurance scheme will enhance early intervention with a more preferable device closure technique that will translate to reduction of morbidity and mortality that can occur from PDA.

Conclusion

Device closure of PDA has lesser risk of complications compared to surgical ligation. There is need for availability of and accessibility to device closure in our environment

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Conflicts of interest

There are no conflicts of interest.

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