



Patent Ductus Arteriosus from Diagnosis to Surgical Closure: 10 Years Experience at Federal Medical Centre Abeokuta, Ogun State, Nigeria

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Abstract

Introduction: Patent ductus arteriosus is a common congenital heart defect. PDA accounts for 10% - 22% of CHD in various studies conducted in Nigeria. The addition of the paediatric cardiology sub-specialty unit at Federal Medical Centre Abeokuta was in 2013, and the centre began surgical PDA ligation in 2019. The general aim is to describe the prevalence, demographics and 10-year trend of PDA cases and our experience as a recent provider of surgical PDA ligation. The study set out to describe the prevalence, demographics and 10-year trend of PDA as seen at Federal Medical Centre, Abeokuta from January 2013 to December 2022 and also to describe the demographics and outcomes of patients who had PDA surgical closure from December 2019 to Dec 2022. **Materials and Methods:** This is an analytical cross-sectional study. Data was prospectively collected from all consecutive cases of Patent ductus arteriosus diagnosed by echocardiography in children aged 3 months to 15, between January 2013 and December 2022. Echocardiogram report was the main study instrument. All echocardiography was performed by the pediatric cardiologist using GE Vivid IQ and GE Vivid E95 with a probe frequency of 2.4 - 8.0 mHz. This machine has standard 2D echocardiography, Doppler and M-mode functions. Data was analysed using SPSS version 29 and Microsoft Excel. **Results:** A total of 90,894 patients were seen in all Paediatric units out of which 1065 new patients were evaluated using echocardiography during the period studied. Of these, 76 (8.2%) patients had PDA as a primary cardiac abnormality. Analysis of the trend shows that 5% of the reported PDA cases were seen in the first 2 years (2013-2014), following which the centre has recorded an increase in the number of cases.

Hence 51% of the PDA cases were seen in the last 4 years. The mean age at diagnosis was 1.35 years \pm 2.60. Females were more commonly affected than males with a male-to-female ratio of 1:1.15. In the study period, 19 (25%) had surgical ligation of PDA. Of these, 12 (63%), were done locally in our centre while 7 (31%) were done elsewhere. The youngest child at the time of surgery in our centre was 5 months old while the oldest was 9 years old. The average weight at surgery was 9.4 kg \pm 7.0 and the smallest child by weight weighed 3.2 kg. There was no recorded perioperative mortality. **Conclusion:** PDA constitutes a significant burden of CHD in this study. Long-term medical treatment of hemodynamically significant PDA with anti-congestive medications can be avoided if more centres have the capacity for PDA closure. Providing holistic care from diagnosis to surgical or device PDA closure should be the goal of more secondary and tertiary centres in Nigeria as a route to scale up comprehensive paediatric cardiac services.

Subject Areas

Pediatrics

Keywords

Congenital Heart Defect, Children, Patent Ductus Arteriosus

1. Introduction

Ductus arteriosus (DA) is a vascular structure that connects the proximal descending aorta to the main pulmonary artery near the origin of the left pulmonary artery branch. Although DA is a normal component of fetal circulation, spontaneous closure tends to occur soon after birth in normal-term infants such that almost all DA would have undergone spontaneous functional closure by 96 hours of age [1]. In preterm infants, the closure of DA may be delayed due to structural and physiological immaturity of the ductus, however, in term infants, patent ductus arteriosus arises mostly from genetic alterations that affect the ability of the ductus to close normally [2]. The presence of respiratory distress in term infants could also result in delayed closure. Patent ductus arteriosus (PDA) is a congenital heart defect in which the DA remains patent beyond the expected time of closure. Whatever the case in term infants, the persistent patency of the DA beyond 3 months of age is generally accepted as abnormal [3]. PDA can occur as a single cardiac lesion but is often associated with other congenital heart defects.

PDA accounts for 5% - 10% of all congenital heart defects in the United States [4]. Studies in Nigeria have reported a prevalence of 10.5% in Enugu [5], 12.1% in a multicentre study [6] and 13.1% in Ilorin [7]. The highest prevalence (22%) was reported by Jaiyesimi *et al.* [8] in UCH, Ibadan. The diagnosis of PDA is predominantly by transthoracic echocardiography (TTE). Although cardiac magnetic resonance imaging and tomographic scans can also be used reliably for

diagnosis, the majority of PDAs are diagnosed by TTE [2]. On two-dimensional TTE, PDA is easily visualised in the parasternal short axis and the suprasternal views and the size of the ductal orifice can be measured. Colour flow Doppler mapping shows the presence of a red flow colour jet of the PDA shunt entering into the main pulmonary artery. Spectral Doppler shows a continuous flow pattern [2]. The velocity of the PDA shunt can then be measured on spectral Doppler. Small asymptomatic PDA can be treated conservatively but hemodynamically significant PDA requires closure which can be achieved either by using a device or by surgery.

Aims and Objectives

- 1) To describe the burden, demographics and 10-year trend of PDA at the Federal Medical Centre, Abeokuta, Ogun State, South West Nigeria.
- 2) To describe our experience as a recent provider of surgical PDA ligation

2. Materials and Methods

2.1. Study Design

This is an analytical cross-sectional study.

2.2. Study Setting

The study setting is Federal Medical Centre, Abeokuta which is the capital of Ogun State in South West Nigeria. The study was conducted in Abeokuta which is the capital of Ogun state in south-western Nigeria. Abeokuta is a city located about 100 km north of Lagos, Nigeria, at an altitude of 79.87 m, with an estimated population of about four million people. FMCA was established in 1993 [9] but started providing Paediatric cardiac services in 2013 and PDA surgical ligation services in 2019. FMCA is a 750-bed Hospital tertiary Hospital that caters to the health needs of people in the locality and also receives referrals from various Hospitals in neighboring towns of Ogun State.

2.3. Study Instrument

The main study instrument used was echocardiogram. All echocardiography was performed by the pediatric cardiologist using GE Vivid IQ and GE Vivid E95 with a probe frequency of 2.4 - 8.0 mHz. This machine has standard 2D echocardiography, Doppler and M-mode functions.

2.4. Study Protocol

PDA was diagnosed according to the guidelines of the American Society of Echocardiography [10]. The diagnoses of interest in this study were patients with PDA as a primary echocardiography diagnosis and whose PDA persisted up to 3 months of age and beyond. Preterm neonates were excluded. Those who had needed PDA closure were referred to the cardiothoracic surgery unit. The surgical approach for PDA ligation in all cases was through a strictly posterior

thoracotomy (SPOT) incision on the chest wall (**Figure 1**) and a triple suture ligation or haemalock clipping of PDA (**Figure 2**). All patients were followed up in the paediatric cardiology unit.

Variables of interest were primary diagnosis of PDA, age of the children, sex, surgical ligation done or not done, age and weight of patient at the time of surgery.

2.5. Data Management

The source of data was echocardiography reports and the case file of patients. Details regarding the echocardiogram diagnosis, age, sex, and PDA surgical ligation were recorded prospectively. Data were analyzed using statistical package for social sciences (SPSS) version 29 and Microsoft Excel data sheet. Descriptive statistics were presented as means and standard deviations or percentages. Graphical presentation is used to display trend.

3. Results

3.1. General Description

A total of 90,894 pediatric patients were seen between January 2013 and December 2022. Of these, 1065 (1.2%) had transthoracic echocardiography (TTE) for various indications. Of those who had TTE, 455 (43%) had congenital heart defects (CHD), and isolated PDA constituted 76 (16.7%) of all CHD seen in this period. The prevalence of CHD was 5/1000. Regarding PDA, females were more commonly affected than males with a male-to-female ratio of 1:1.15. The mean age of cases at diagnosis was 1.35 years \pm 2.6 years. The oldest child diagnosed with PDA was 12 years old.

3.2. Analysis of Trend

Analysis of the trend shows that only 5% of the PDA cases were seen in the first 2 years (2013-2014), following which the centre recorded a predominant increase in the number of cases. Furthermore, with the availability of PDA surgical ligation, the last 4-years cumulatively witnessed 51% of the documented cases. This analysis is shown in **Figure 3**.

3.3. PDA Closure

Surgical closure was the only documented method of PDA closure that was recorded. No patient had device closure in the study period. Of those 76 children with PDA in this 10-year period, 19(25%) had surgical ligation (**Figure 4**). Of these, 12 (63%), were done locally in our centre while 7 (36.8%) were done elsewhere (**Figure 5**). Other centres where PDA ligation was done include University College Hospital, Ibadan (two patients), Tristate Cardiovascular Centre, Ilesha-Remo (three patients) and the University of Nigeria Teaching Hospital, Enugu (two patients). All the PDA cases done elsewhere were performed prior to December 2019. All were also PDA surgical ligation.



Figure 1. Strictly posterior thoracotomy (SPOT) incision on the chest wall.

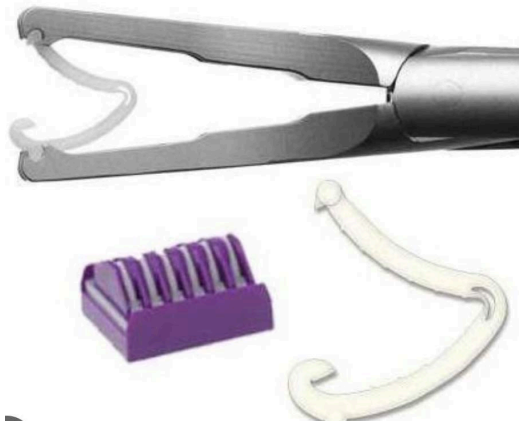


Figure 2. Haemalock clip.

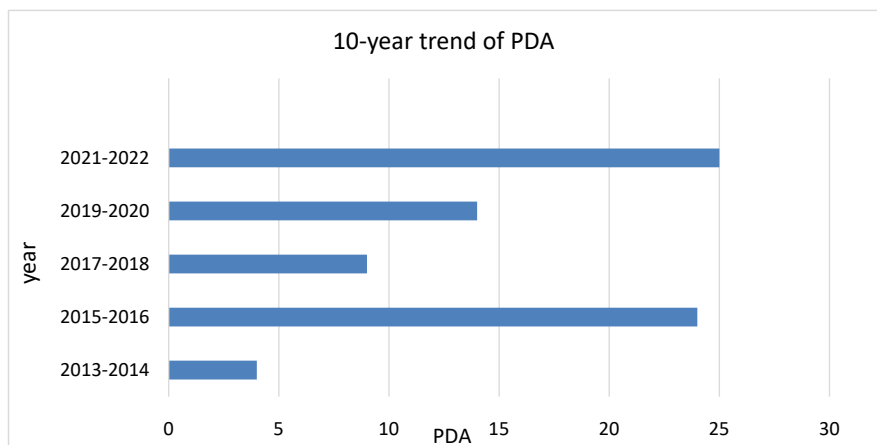


Figure 3. 10-year trend of PDA cases.

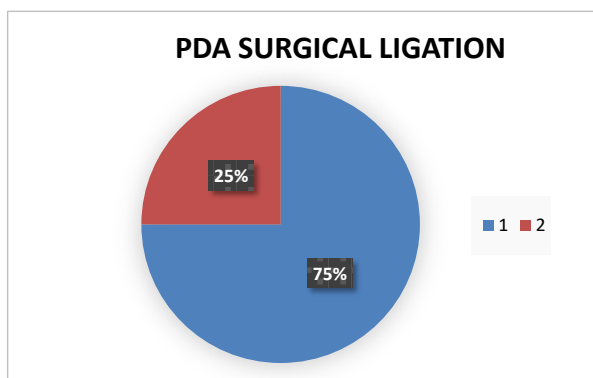


Figure 4. PDA surgical ligation (1-No surgery 2-Had surgery).

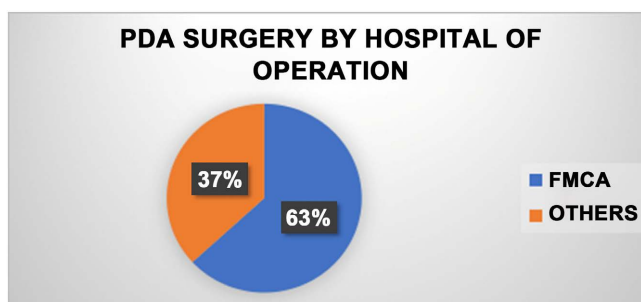


Figure 5. PDA surgery distribution by hospital of operation.

Concerning those who had surgical ligation at our centre, the youngest child at the time of surgery was 5 months old while the oldest was 9 years old. Five (41.6%) were males and 7 (58.3%) were females. The average weight at surgery was $9.4 \text{ kg} \pm 7.0$ and the smallest child by weight weighed 3.2 kg. The duration of post-operative hospital stay was 1 - 3 days. No recorded perioperative mortality.

4. Discussion

In this study, isolated PDA constituted 16.7% of all CHD. This figure is similar to the 18.4% reported in a systematic review of all studies on patterns of CHD among children in Nigeria from 1964 to 2015 [11]. Similarly, Otaigbe *et al.* [12] in a study in Portharcourt reported that PDA constituted 14.5% of all CHD. Sadoh *et al.* [6] reported 12.1% in a multicentre study while 13.1% was reported by Kolo *et al.* [7] in Ilorin. The highest PDA occurrence was reported in Ibadan where up to 22% of CHD were PDA while the lowest report is from Lagos with 5.7% according to a study by Okoromah *et al.* [8] [13]. The high prevalence in Ibadan could have been due to the high altitude of Ibadan, which is elevated above 200 meters whereas Abeokuta is at 68 - 79 meters, and Lagos at mostly < 41 meters according to the data from the online elevation map finder [14]. Some studies have demonstrated that there is a relationship between altitude of residence and CHD, with higher prevalence being recorded in higher altitudes [15]

The trend analysis shows that the percentage number of PDA (5%) was lowest in the first two years, and this is probably due to the reason that paediatric cardiac TTE had just become available in the Hospital. However, in 2015-2016,

there was a sixfold increase in the number of cases of PDA, and again, this could be due to not only increased awareness but also increased sensitivity to better cardiovascular evaluation in children. The next decline in 2017-2018 was due to an interruption in the delivery of TTE due to equipment breakdown. By 2019-2022, the numbers increased year-on-year, giving some credence to the fact that the institution built on its capacity by increasing necessary professional manpower and upscaling our services to provide surgical services. Our first congenital heart defect surgery was performed in December 2019 on a 4-year-old female child who had PDA surgical ligation. Following that success, more cases have been done and continue to be done to date. It is interesting to note that our first surgical patient was born in our hospital, the diagnosis was also made in the early neonatal period but the unaffordability of required intervention saw this child on long-term anti-failure medications until 4 years old. In a similar manner, many clinics across Nigeria are still replete with children on long-term avoidable medical treatment for surgically correctable CHD due to the unavailability of accessible and affordable surgical alternatives. This underscores the benefit of improving manpower and equipment for the upscaling of cardiac services for the paediatric age group in Nigeria. If this is done, these children can have cardiac surgery without their parents having to travel to far locations, which increases direct and indirect costs and often makes surgery unattainable for them. We can also derive that the fear of surgery could contribute to the impediments towards its uptake; parents are scared of having surgery and this is worse with cardiac-related procedures. The tendency to default from orthodox treatment to prayer houses and other non-surgical alternatives is common, leading to late presentation. However, as more successful procedures are documented, it is believed that the fear index will continue to decline.

It is pertinent to mention the issue of cost. The cost of PDA ligation in our centre is subsidised being a public (Government-owned) hospital, such that whereas it costs N250,000 - N350,000 (\$330 - \$460 at an exchange rate of N758 = \$1) to have it done at our Hospital, the same procedure costs as high as 6 times more in private facilities. There was no device closure in this period because even when this is desirable, its higher cost precludes the patients who often have to pay out of pocket. Again, this emphasises the need for our National health insurance coverage to be expanded to accommodate more families and also include paediatric cardiac surgery which is still an excluded service. Similarly, the Government should collaborate with the private sector to upscale our cardiac services for teaming Nigerian children.

Conflicts of Interest

The authors declare no conflicts of interest.

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