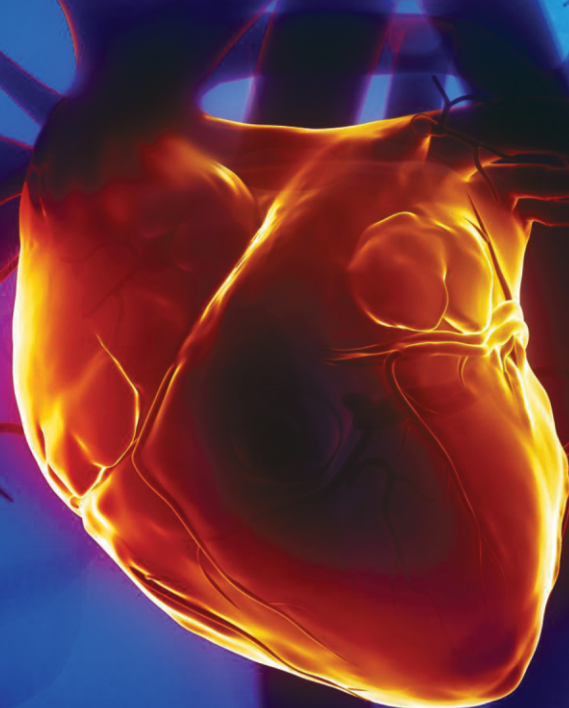




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Open Ligation of Persistent Ductus Arteriosus Still a Reliable Modality in a Resource-Challenged Environment

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Abstract

Background: Persistent ductus arteriosus (PDA) is one of the most common congenital heart diseases, and its management ranges from pharmacologic, surgical, or catheter-based therapy. Advances in cardiac surgery have made ligation of PDAs a safe surgical procedure. **Objective:** The objective of this study is to evaluate the experience in the surgical management of PDA at the University of Ilorin Teaching Hospital. **Subjects and Methods:** Retrospective data of patients who had open ligation of PDA at the Thoracic and Cardiovascular Surgery division University of Ilorin Teaching Hospital from 2006 to 2021 were reviewed. **Results:** Of the 27 patients (10 males and 17 females), 25 had left posterolateral thoracotomy for PDA ligation. Their median age was 1 year. The mean weight was 7.75 kg with a range of 3.9–20 kg. The mean preoperative PDA size by echocardiography was 5.06 mm and a range of 3–8 mm. Krichenko type B was the most common morphology seen in eight of the patients. The majority (18) had no other comorbidities, whereas two had cardiac and seven had extracardiac comorbidities. Two patients developed pulmonary complications (pneumonia and pulmonary edema), one patient developed surgical site infection and one patient postoperative pyrexia and seizures which resulted in the only observed mortality. **Conclusions:** We report our experience with surgical ligation of PDA the only treatment modality at our institution currently as we lack the capacity for transcatheter closure.

Keywords: Left thoracotomy, patent ductus arteriosus, persistent ductus arteriosus ligation, persistent ductus

INTRODUCTION

Persistent ductus arteriosus (PDA) is a vascular structure that connects the proximal descending aorta to the roof of the main pulmonary artery. This essential fetal structure becomes abnormal if it remains patent after the neonatal period^[1] causing left ventricular overload and increasing the risk of endarteritis.^[1,2] The significance of the PDA largely depends on shunt magnitude.^[1]

Moderate or large PDAs should be closed to improve the hemodynamic profile and prevent infective endocarditis.^[3] This can be accomplished pharmacologically,^[4] surgically,^[5] or with catheter-based therapy.^[6]

This study aimed to evaluate the experience of surgical management of PDA at (University of Ilorin Teaching Hospital).

SUBJECTS AND METHODS

Retrospective data of patients who had open ligation of PDA at the Thoracic and Cardiovascular Surgery Division University of Ilorin Teaching Hospital from August 01, 2006 to July 31, 2021, were obtained from patients' folders, theater records, unit books, and echocardiographic records.

The patients all had either left posterolateral thoracotomy with double ligation of the PDA using either silk 1 or 2 or PDA

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clipping through median sternotomy at the time of corrective intracardiac surgery. One patient had transfix suture ligation using prolene 4-0 in addition to double silk ligation. At surgery, the anatomy of the lesion was reconfirmed to ensure there was not any other lesion. The PDA was also palpated for calcification. Ligation of the PDA was preceded by test clamping for 3 minutes while watching for improvement in patients' hemodynamics. Preemptive analgesia with intercostal nerve block using plain marcaine (0.5% bupivacaine) was used in some patients based on availability.

The data were reviewed and analyzed with the Statistical Package for the Social Sciences (SPSS) software version 21 (IBM Corp., Armonk, N.Y., USA). Descriptive frequencies were analyzed for quantitative data, and percentages were documented for qualitative data.

RESULTS

Of the 27 patients (10 males and 17 females), 25 had left posterolateral thoracotomy for PDA ligation. Two others had PDA clipping through median sternotomy before repair of concomitant intracardiac defects. The median age was 1 year (range 4 months–20 years). Eleven patients had their weight measured at presentation, and the mean weight was 7.75 kg with a range of 3.9–20 kg. Only 15 of the patients had preoperative echocardiography reports retrievable, and the mean PDA size was 5.06 mm (SD 1.4, range 3–8 mm) Table 1. When subdivided into 3-time intervals, there were 5, 9, and 13 cases in 2006–2010, 2011–2015, and 2016–2021, respectively [Figure 1].

The mean intraoperative PDA size was 7.82 mm (SD 4.53, range of 3–20 mm) Table 1. Krichenko type B was the

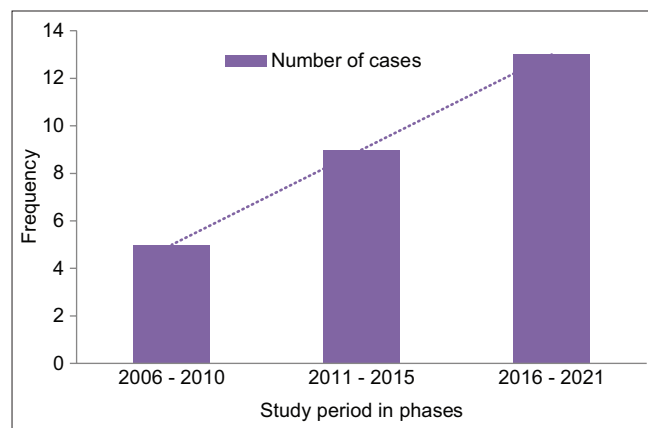


Figure 1: Trend of cases.

most common morphology seen in eight of the patients Figure 2. The majority (18) had no other comorbidities while seven had extracardiac and two had cardiac comorbidities Figure 3.

Twenty-two of the 27 patients had thoracostomy tube drainage ranging from 1 to 3 days with a mean of 2.2 days. Postoperative echocardiography was routinely done 3–5 days postsurgery and no residual shunt was documented in any of the patients.

Two patients developed pulmonary complications (pneumonia and pulmonary edema), one patient developed surgical site infection, and another patient developed postoperative pyrexia and seizures resulting in the only observed mortality. The mean hospital stay was 8.0 days (range 6–13 days).

DISCUSSION

Open thoracotomy is a safe procedure and still relevant in the management of PDA despite recent advances in minimally invasive intervention techniques. This has been validated by a study done by Kari Vanamo *et al.* in 2006 which showed that video-assisted thoracoscopic surgery (VATS) PDA ligation gave results equal to traditional open surgery with a shorter operative time, faster recovery, and shorter hospital stay but with more complications, especially recurrent laryngeal nerve injuries.^[5]

In another study by Omar Galal *et al.* in 1997 comparing open ligation with transcatheter closure shows that 46 (19.5%) of the 236 patients having transcatheter PDA closure, the procedure either was abandoned or failed. Twenty other patients underwent reocclusion because of a residual shunt and this was addressed through the open approach.^[7]

Options available to the surgeon at open PDA ligation include simple ligation of the duct (either singly, doubly, or triply), ligation and division of the duct (especially for large and short PDAs), and the use of titanium clips.^[1,5,8-11] While some authors have advocated for ligation and division in an attempt to reduce the chance of recanalization, several others have demonstrated acceptable outcomes with simple ligation alone.^[9,11] With simple ligation, the surgeon needs to exercise caution and good surgical judgment while tying the ligature to avoid either the ligature being too loose and risking later recanalization or being too tight and tearing the fragile vessel with possible major hemorrhage. The risk of recanalization may be further prevented by double or triple ligation.^[11]

Table 1: Demography and persistent ductus arteriosus size

Data	n	Minimum	Maximum	Mean	SD
Age (years)	27	0.33	20.00	2.55	3.99
Echocardiographic PDA size (mm)	15	3.00	8.00	5.06	1.44
Intra operative PDA size (mm)	11	3.00	20.00	7.82	4.53

SD: Standard deviation, PDA: Persistent ductus arteriosus

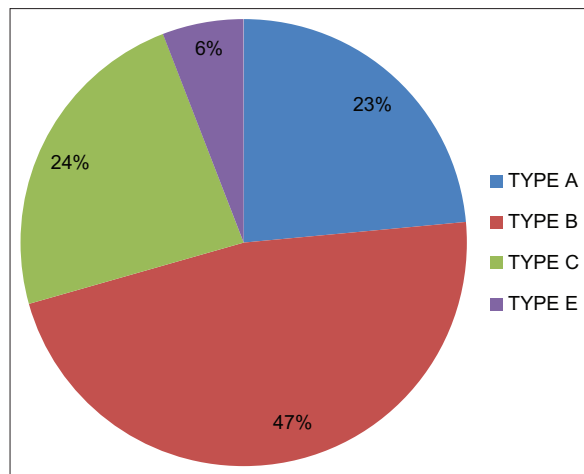


Figure 2: Persistent ductus arteriosus morphology.

Titanium clips were used for two of our patients during concomitant corrective open-heart surgery. The clips can also be used during routine PDA closure through thoracotomy. The safety profile of titanium clips has been documented in preterm neonates. In addition, it reduces surgery time by minimizing the need for dissection and the chances of recanalization.^[10] This is not without caution as calcified ductal tissue (especially as seen in older patients) is prone to injury when clips are used.

Currently, with advances and improvement of occluding devices, transcatheter PDA closure is now the preferred modality. In a study done by Mostafa Behjati-Ardakani *et al.* in 2015, 69 patients (52 females and 17 males) had PDA closure with Amplatzer ductal occluder from 2004 to 2012. There was no residual shunt noted beyond 24 h postsurgery and no severe complications at immediate and long-term follow-ups.^[12]

In 2016, Zulqarnain *et al.* found that the cost of PDA device closure was 16.52% higher than the surgical ligation of PDA (110695 + 1054 Pakistani rupees in the PDA Device group vs. 92414 + 3512 in the surgical group), although there were fewer complications and shorter hospital stay in the device closure group.^[13]

The estimated direct cost of transcatheter closure of PDA in a study done in 2019 in two centers in Lagos, Nigeria by Animasahun *et al.* 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. Device closure of PDA was also found to have lesser risk of complications compared to surgical ligation.^[14]

However, because of the lack of facilities for VATS and transcatheter procedure at our center and the low-socioeconomic status of our patients population, open technique which costs about \$300 in our facility is what is still currently practiced.

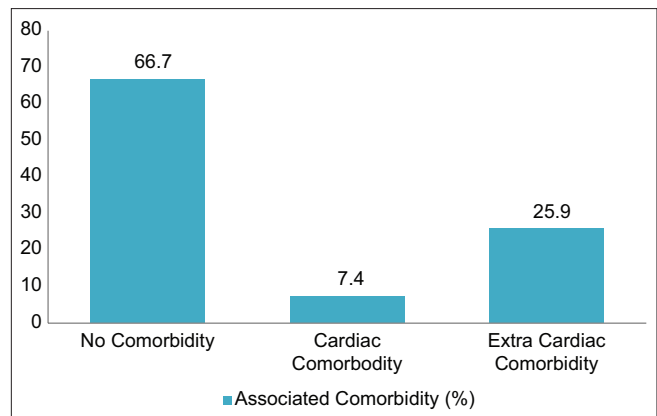


Figure 3: Associated comorbidity.

The experience in our facility over a 15-year period has further reinforced the safety and effectiveness of open thoracotomy for the management of PDA as only one mortality was recorded throughout this period

CONCLUSIONS

Surgery still plays a major role in the management of patients with PDA despite the advent of new advancements in PDA management. It has been shown to have the least recurrence and complication rates and should still be considered reliable modality in a resource-challenged environment like ours where VATS and catheter-based intervention modality are still beyond our reach.

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Conflicts of interest

There are no conflicts of interest.

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