# SURGICAL LIGATION OF PATENT DUCTUS ARTERIOSUS IN A NON-CARDIAC SURGICAL CENTRE

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**Background**: Surgery for Patent Ductus Arteriosus (PDA) is usually performed in specialized cardiac centres with either open surgery or percutaneous embolisation using different materials and devices. This involves high cost of treatment especially for those poor patients who have grown up to several years of age without seeking any treatment for their disease. The objective of this study is to evaluate the safety of surgery for PDA in a non cardiac paediatric surgical setup. **Methods**: A total of 89 patients of 8 months to 12 years (mean 3 years) age were operated over a period of 13 years (from 1993 to 2006). Fifty-five cases were females and 34 were males. Investigations included x-ray chest, ECG and echocardiography. All patients with PDA were included in the study except those who had other associated cardiac anomaly and those who had a calcified ductus. The ductus was dissected out and ligated with non-absorbable suture (Silk No. 1 or 2). The patients were discharged by the 5th post-operative day. **Results**: In majority of the patients the recovery was smooth and uneventful. Eight patients had minor complications which were treated conservatively. There were 3 mortalities in this series; 2 patients were over 10 years of age and had calcified ductus. They died during surgery due to primary haemorrhage and 1 died after 24 hours in the intensive care unit. All patients were reviewed at 1 week, 1 month, 3 months and 1 year after surgery. In majority, the typical machinery murmur disappeared immediately or a soft systolic murmur persisted for up to 4 weeks and then disappeared. **Conclusion:** With proper patient selection, the procedure can safely be performed in a paediatric surgical setup with facilities for cardiac monitoring. The surgeon needs to receive some additional training in the cardiac institution for safe surgery on these children. This will significantly reduce the cost with minimal complications especially for those poor patients who cannot afford the modern procedures due to monitory constraints. Children older than 10 years are not suitable for open surgery because of calcification of the duct.

**Keywords:** Patent ductus arteriosus, surgical ligation, cardiac surgery

## INTRODUCTION

Surgical ligation of patent ductus arteriosus (PDA) was first reported in 1939 by Gross.[1] This was followed by many others and reported good outcome in terms of low morbidity and mortality.[2,3]

Surgery for PDA is usually performed in specialized cardiac centres. Various methods have been used for ligation of PDA, e.g., pharmacological, transcatheter embolisation, Video Assisted Thoracoscopic Surgery (VATS) and open surgery. Open surgery can however can be performed in a paediatric surgical unit. This significantly reduces the cost of treatment for the poor patients.

We conducted this study in our department to evaluate the safety of surgery for PDA in a non-cardiac surgical centre. The initial part of the present study was published in 1998 by one of the principal authors of this series.[4] The present study is in fact a continuation of the same study after adding some more cases.

In this study we reviewed our experience with surgical ligation of PDA in our own department which is a non-cardiac paediatric surgical centre. We think that the procedure can safely be performed in a paediatric surgical setup with facilities for cardiac monitoring and some training in paediatric cardiac surgery. This significantly reduced the cost of surgery to those poor patients who have no access to the specialised centres. Complications can be minimal if proper patient's selection is done.

## PATIENTS AND METHODS

This study was conducted at the department of paediatric surgery, the Children Hospital, Pakistan Institute of Medical Sciences, Islamabad from June 1993 to June 2007. Old files were retrieved and a retrospective review was done. Age of the patients, type of surgery, post operative complications, total stay in the hospital and follow up visits were analysed.

A total of 89 patients with isolated PDA were included in the study. Initial assessment was done by the paediatric cardiologist and then referred for surgery. Patients with complex associated cardiac anomalies were excluded from the study. In the initial part of the study some cases with calcified vessels were operated but later they were excluded from the study. Premature babies were also excluded. All those poor patients who could not afford treatment in specialized cardiac centres and were willing for open surgery at our centre were included in the study. Age ranged from 8 months to 12 years with a mean of 3 years.

Initial assessment included detailed history and physical examination. Common clinical features were dyspnoea, easy fatigability, cough, palpitation, sweating, repeated chest infection, and a machinery murmur. Investigations included x-ray chest, electrocardiogram (ECG) and echocardiography.

A left anterolateral thoracotomy was performed through the 4th intercostals space. Patent ductus arteriosus was identified and carefully dissected out, recurrent laryngeal nerve identified and preserved. The ductus was dissected out and ligated with non-absorbable suture (Silk No. 1 or 2). In 12 cases we did repair and division of PDA and the rest had ligation only. A chest drain was placed only in the initial cases. In last 30 cases no chest drain was put in. Patients were kept in Paediatric Intensive Care Unit (PICU) for 24 hours, then shifted to the paediatric surgical ward and discharged home after 3–4 days. They were followed for a minimum of 1year; first follow up at 1 week, then at 1month, 3 months and last at 1year.

## RESULTS

A total of 89 patients were included in the study. Age ranged from 8 months to 12 years; mean age was 3 years. Weight of the patients raged from 6 to 25 Kg. Male to female ratio was 1:1.6. Average operating time was 80±15 min. Average hospital stay was 3±1 day.

Complication occurred in 8 (9%) patients. Pneumothorax in 2 (2.2%), post operative chest infection in 5 (5.6%), wound dehiscence in 4 (4.5%) patients. Blood transfusion was required in 13 (14.6%) patients and in 1 (1.1%) patient chest tube required repositioning. There were three mortalities (3.3%) in this series. Two of them had exsanguinating haemorrhage during the procedure and one died on 1st post operative day in ICU due to sudden cardiac arrest.

In the majority, murmur disappeared immediately or a soft systolic murmur persisted for up to 4 weeks and then disappeared. Initially all patients were also followed up to 6 months by the cardiologist who confirmed the 100% ductal closure rate by auscultation and echocardiography. Out of the survived 86 patients, 53 (60%) were followed up for 1year and 36 (40%) lost follow up after 3 months.

No patient had any recurrence nor required any re-do surgery. In majority the recovery was smooth. Success rate was 96.6%.

## DISCUSSION

Patent Ductus Arteriosus (PDA) is a frequently seen problem in children and preterm infants. The basic objective of treatment is to avoid left to right shunting through PDA.[5]

The incidence of symptomatic PDA is high in preterm infants. Indomethacin and Ibuprofen are widely used with high success rate and low morbidity.[6] But if it fails to achieve ductal closure then surgical ligation is indicated.[5,7]

Patent Ductus Arteriosus was the first congenital heart lesion to be treated surgically and also the first to be treated with non-surgical catheter intervention; surgical ligation is still the gold standard for achieving complete occlusion.[8]

Conventional thoracotomy for PDA ligation was first described in 1939 but over the last few decades the management of PDA has changed significantly.[9,10]

Surgical ligation of PDA may be performed with Video-Assisted Thoracoscopic Surgery (VATS). Even the LigaSure vessel sealing system has been practiced and found more practical than vascular clips.[11] In specialised centres, transesophageal echocardiography is being utilised intra and postoperatively to determine the adequacy of repair and hence avoid residual ductal flow.[12,13]

Mavroudis *et al* has reported a large series of 1108 patients over a 46-years period and demonstrated a 100% success rate with a morbidity rate of only 4.4%, an average length of stay 2.8 days and no mortality.[10]

In recent decades, efforts have been made to perform the procedure through a transcatheter approach. This has now been practiced extensively with several modifications like the Portsmann plug, Rashkind device and more recently, Gianturco embolisation coils.[14,15] The main objective of these efforts is to avoid surgery and hence all its related risks. All these techniques have been proved efficacious although each has problems in terms of length of procedure, prolonged fluoroscopy times, large delivery systems, potential risks to the femoral vessels and perhaps more importantly residual leaks.[14] A mortality of 0.3 % have been reported and inadvertent embolisation of the pulmonary trunk or the descending aorta in 2.4% requiring surgical retrieval.[16]

In one animal study surgical ligation was compared with transarterial catheter occlusion for PDA and it was concluded that surgical ligation was associated with higher incidence of major complications whereas transarterial catheter occlusion with lower initial success. No significant difference in mortality was seen.[17] It can also be used for correction of haemodynamically significant residual shunts after incomplete PDA occlusion.[18]

Video-Assisted Thoracoscopic Surgery PDA ligation gives results equal to traditional open surgery with shorter operation time, faster recovery and shorter hospital stay but with increased chances of injury to the recurrent laryngeal nerve.[19] Such injury has been reported as 7% but remains asymptomatic due to rapid compensation with no long term problem of airway or feeding.[20]

Robotically assisted PDA closure and vascular ring division has been practiced in specialized centres and have been found feasible and safe.[21]

Minimally invasive open surgery for PDA through a short 3–5 cm. mini-thoracotomy skin incision, muscle sparing extrapleural approach offers an alternative to other minimally invasive approaches. This has shown low incidence of complications.[22]

There are some centres where PDA ligation is routinely performed at the bedside in NICU and they claim that an experienced team can perform PDA ligation safely in NICU of even other hospitals without paediatric cardiac surgical capabilities and thus avoid the inherent high risks of patient transport.[7]

Video Assisted Thoracoscopic Surgery and coil occlusion are complementary techniques; case selection is based on size and age of the patient and morphology of the PDA.[23]

Amongst the transcatheter procedures are Amplatzer duct occluder[24], and Jackson coil implants. They can also be used for residual or recurrent PDA by adding extra coils.[25]

The reported frequency of residual leaks after transcatheter varies from 6 to 23% necessitating repeated procedure.[25]

In premature babies the mortality can be as high form 8–20% due to other causes like respiratory failure due to lung disease.[27,28]

In our study complications occurred in 8 patients (9%) which included pneumothorax in 2 (2.2%) which was managed with chest tube, post operative chest infection in 5 (5.6%), wound dehiscence in 4 (4.5%) patients, managed with local wound care and antibiotics. Blood transfusion was required in 13 (14.6%) patients and in 1 patient chest tube required repositioning. (1.1%)

When compared to other studies like VATS an injury to recurrent laryngeal nerve has been reported as 2.5%, pneumothorax 10%, with a total stay of 2–4 days.[29,30] None of our patient had injury to the recurrent laryngeal nerve as it is being preserved under vision.

All patients were followed at 1 week after discharge from the hospital, then at 1month, 3 months and 1 year. Patients were also followed up to 3 months by cardiologist who confirmed the 100% ductal closure rate by auscultation and echocardiography, 60% patient were followed up for 1 year and 40% lost follow up after 3 months. In the majority, murmur disappeared immediately or a soft systolic murmur persisted for up to 4 weeks and then disappeared. In others studies, with transcatheter ligation, the absence of murmur has been reported as 87.6%.[31]

In our study majority of the patients had a smooth recovery. None of the patients had any recurrence, residual leaks or required any re-do surgery. A similar study of open surgical ligation on older children was conducted by Thomas *et al* and they have reported no deaths, no intra operative complications and no need of transfusions.[32]

In our series there are 3 (3.3%) mortalities, two died on table because of exanguinating haemorrhage. Both were above the age of 10 years and had calcified PDA. The vessel started bleeding at the time of mobilisation. That is why in the later part of the study such patients who had calcified PDA were excluded and were not operated. One patient died in ICU on 1st post operative day, went into arrest; no definite cause of his death could be known. After these mortalities we made our selection criteria strict and those patients who were older than 10 years or had a calcified vessel were not operated upon and were referred to the cardiac centres for other methods of ligation.

## CONCLUSION

The idea of operating upon these patients with PDA in a non-cardiac surgical set up is to provide services to that part of the community who otherwise have no access to specialized cardiac centres due to enormous cost.

With proper patient's selection, the procedure can safely be performed in a paediatric surgical setup with facilities for cardiac monitoring. The surgeon needs to receive some additional training in the cardiac institution for safe surgery on these children. This will significantly reduce the cost with minimal complications especially for those poor patients who cannot afford the modern procedures due to monitory constraints.

We recommend that children older than 10 years are not suitable for open surgery because of calcification of the duct.

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