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Surgical closure of patent ductus arteriosus in pre-term babies

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Abstract

Objectives:

To present by illustration the surgical options in neonatal PDA closure with emphasis on clip application.

Methods:

Photo/video-documentation of surgical closure of PDA in a neonate by clip application coupled with free-hand drawings showing PDA closure by ligation and division. Review of 38 neonates undergoing surgical PDA closure in our institution between 1998 and 2006.

Results:

Overall survival following surgery was 100%. There was one case of residual PDA and three postoperative complications – 2 cases of pneumothorax and one chylothorax.

Conclusion:

The outcome of surgical closure of PDA in neonates is very good with zero mortality in our series and only few postoperative complications.
MeSH: patent arterial duct, surgery

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Introduction

Patent ductus arteriosus (PDA) accounts for about 10% of all congenital heart anomalies.[1] Its incidence is highest in premature babies and twice more frequent in females than in males.[2] The clinical manifestation of PDA depends on the volume of blood shunt through it, which in turn is determined by the diameter and length of the ductus and the pulmonary vascular resistance. Untreated PDA can lead to obstructive pulmonary diseases and heart failure. In pre-term babies initial treatment is usually pharmacological. Surgical options are considered when the duct fails to close following treatment with drugs. In older infants treatment options also include percutaneous closure using coil embolization or by devices. Video assisted closure (VATS) of PDA - a less invasive alternative to posterolateral thoracotomy has been used in some centres.[3] Here we present by illustration the surgical closure of PDA in a pre-term baby through a left lateral thoracotomy.

Surgical approach

The patient is in a lateral position with the left side up (Fig. 1). Surgical approach is through a left thoracotomy performed in the third or fourth intercostal space, as in the case of surgery for isolated coarctation of the aorta.

Figure 1 Patient position (All images are shown from the surgeon's view with the patient's head to the right).

A curved incision is made starting at the anterior axillary line and extending posteriorly (Fig. 2). The serratus anterior is mostly preserved while the fourth intercostal space is identified and opened.

The rib spreader is inserted and opened in stages to avoid rib fractures (Fig. 3). The lung is retracted anteriorly and the mediastinal pleura opened over the aorta. Stay sutures may be placed along each side of the pleural incision.
The ductus is partially mobilised with the aid of a dissector (Fig. 4,5).

Figure 2 Incision

Figure 3 Left thoracotomy

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Figure 4 Dissection of the ductus

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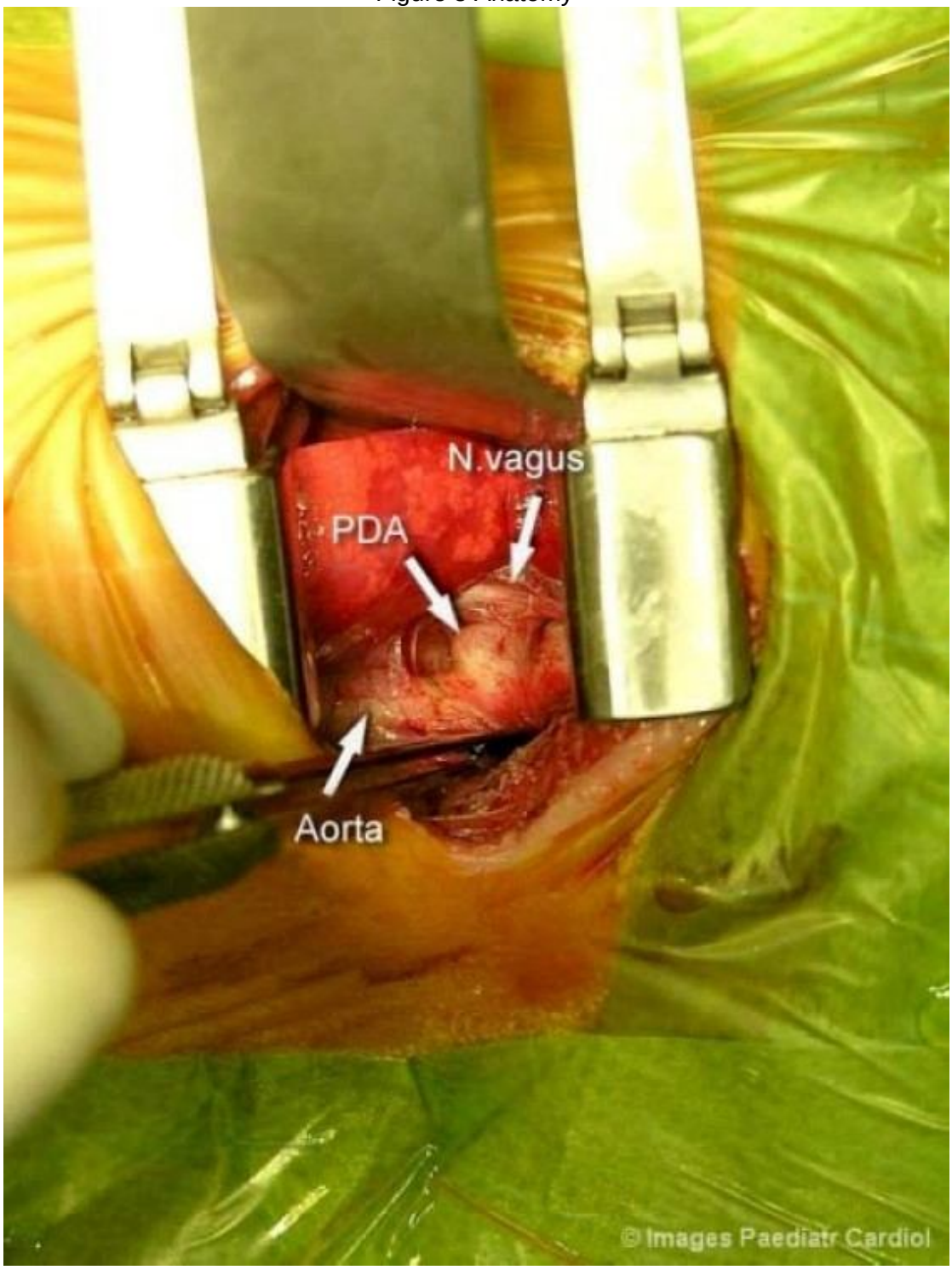
Figure 5 Anatomy



Surgical Techniques

1. PDA closure by clip - single or double

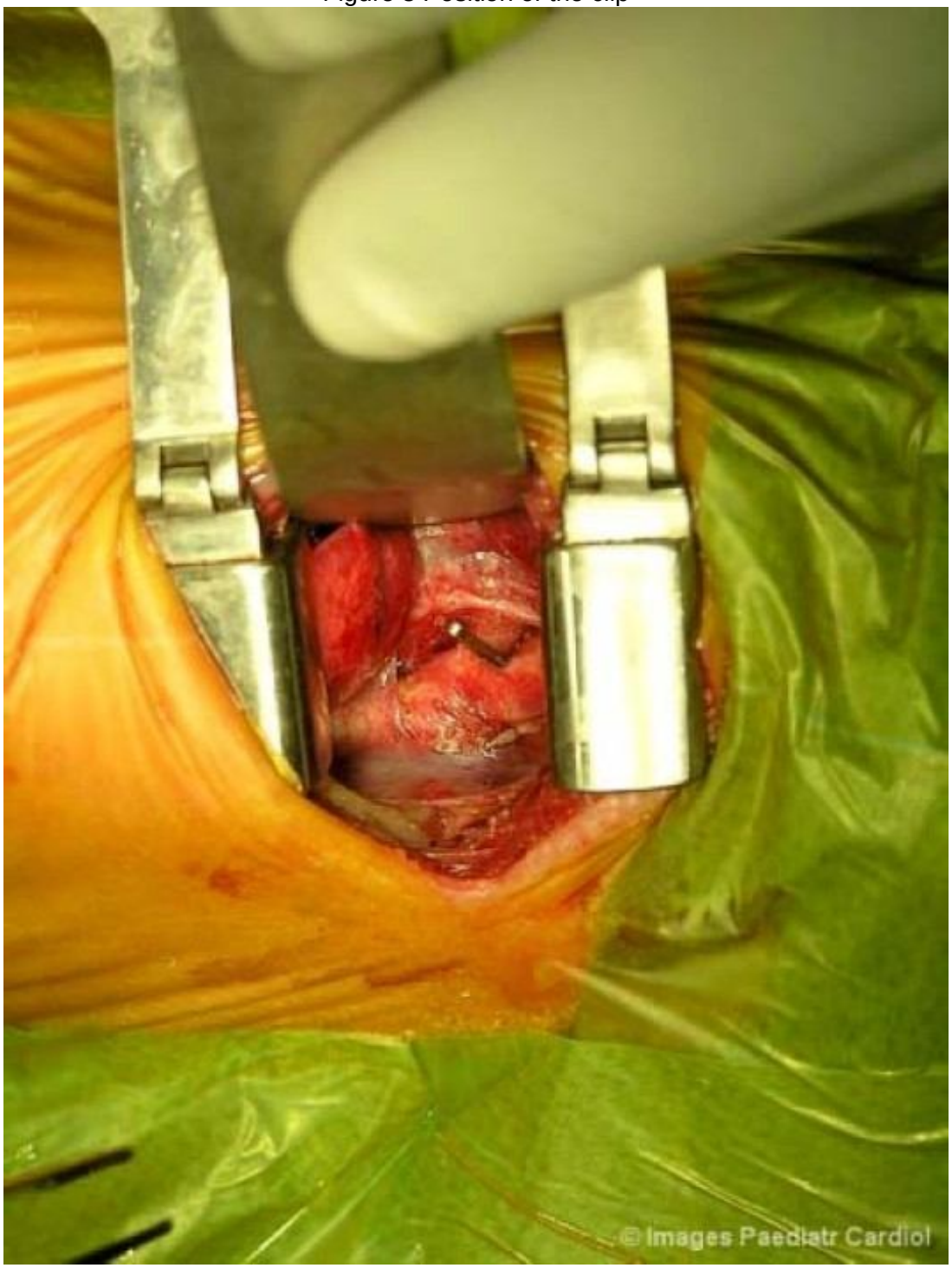
After the ductus has been dissected, a clip of appropriate size is placed around it and closed by applying gentle pressure on the clip holder (Fig. 6,7).

Figure 6 Position of the clip

Figure 7 Position of the clip

Care should be taken to avoid injury to the recurrent laryngeal nerve. The position of the clip is reviewed before closing the chest (Fig. 8).

Figure 8 Position of the clip



A second clip can be placed to ensure the ductus is completely closed. The entire procedure is shown on the attached video (Fig. 9).

2. PDA ligation: The ductus is mobilized; a ligature is passed around it and gently tied down.
Double ligation technique involving ligatures on the pulmonary and aortic ends of the ductus has also been widely used (Fig. 10).[4,5] Purse-string sutures may be used in place of simple ligatures. A metal clip may be placed for additional security.
3. Ligation and Division: This method is rarely used for the closure of isolated PDA. It entails placing two 6/0 prolene purse-string sutures around the ductus, tying and dividing the ductus as shown in Fig. 11. In coarctation patients a single purse-string suture is used, hence the aortic end of the ductus is completely excised prior to coarctation repair.

Figure 10 Ligation

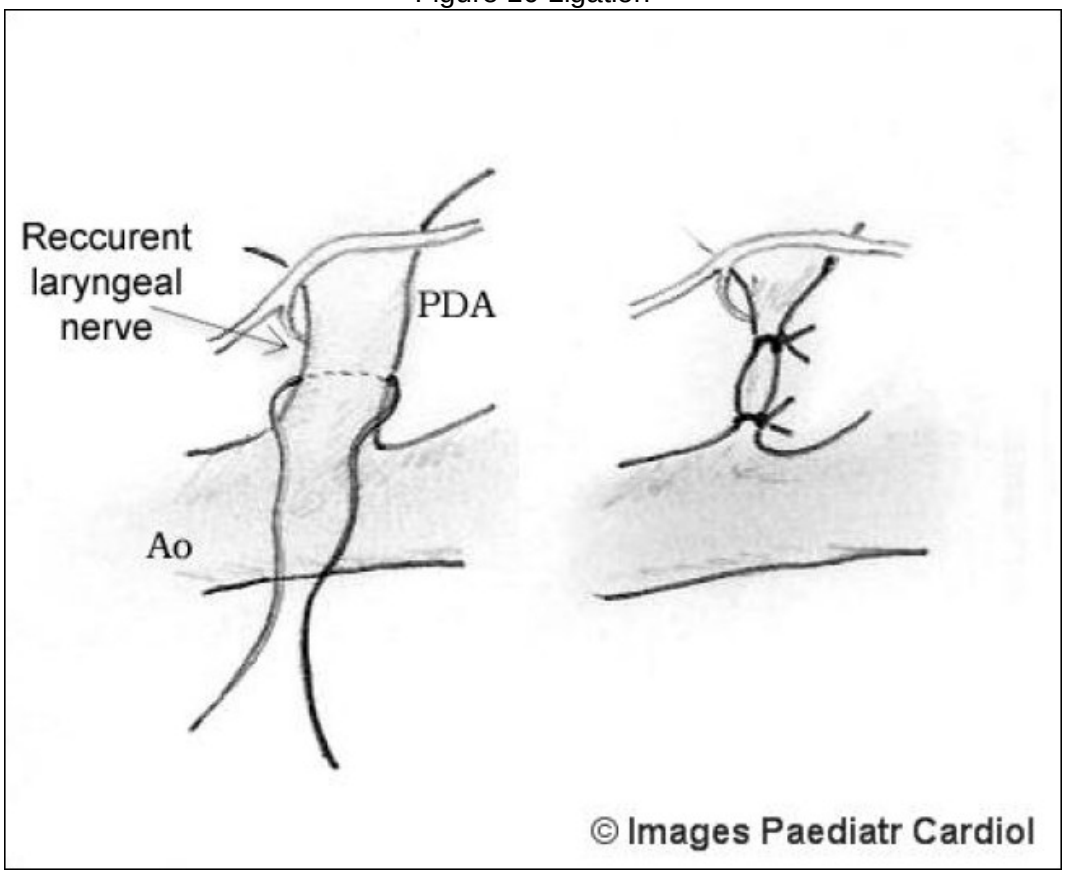
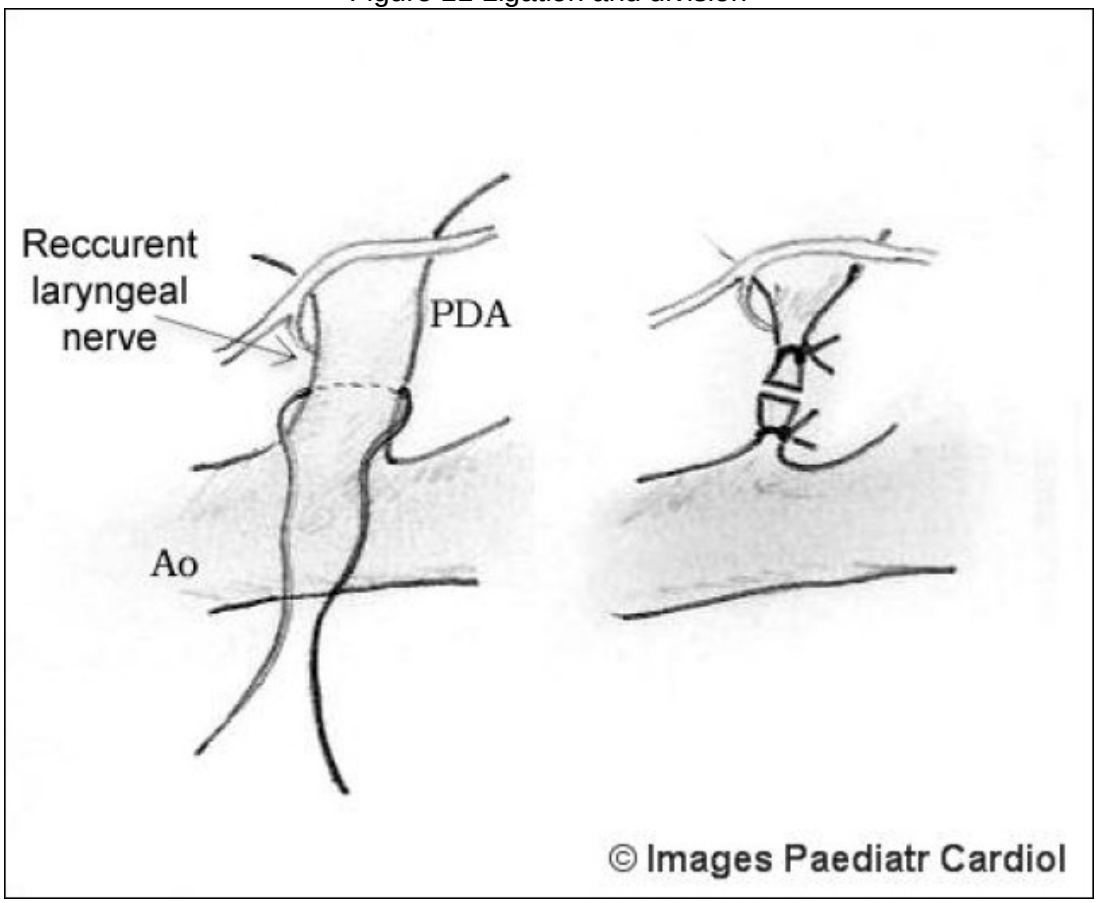


Figure 11 Ligation and division



Surgical Closure of PDA in Pre-term Babies – Our Experience

We conducted a retrospective study of 38 pre-term neonates who underwent surgical PDA closure in our centre between 1998 and 2006. Of these, 24 were females and 14 males. The average age of gestation was 30 weeks (range: 24 – 37 wks), the median birth weight was 1200g (range: 670 – 3580g). The median age at operation was 34 days (range: 10 – 130days). 66% of patients weighed less than 1500g at the time of surgery; median weight at operation was 1430g (range: 730 – 4170g). 84% of all procedures were performed in the operating room; the remaining cases were done in the neonatal intensive care unit.

In 71% of cases, PDA closure was achieved by use of single or double clip. One patient had PDA ligation only, while 10 patients (26%) had both ligation and clip. The mean time of surgical procedure was 58min ± 20 (27-101).

There was zero mortality in our series and only few procedure-related complications. 2 patients (5%) had pneumothorax, while one patient (2.6%) had chylothorax requiring surgical revision. There was only one case of residual PDA on immediate postoperative echo, which on follow-up examination was discovered to have spontaneously closed.

Comments

Despite the advance on pharmacological and other less invasive procedures, surgery still plays a vital role in the treatment of patients with persistent arterial duct. The surgical procedures are quite straight-forward, postoperative complications are few with near-zero mortality in recent years.[6] Our preferred surgical technique for ductal closure in pre-term neonates is clip application. A single clip will always suffice, but where in doubt, the surgeon may place a second clip to achieve complete closure. This method is relatively simple and entails minimal dissection around the friable ductal tissue unlike ligation. Hence, it is a safer procedure with very low risk of ductal tissue tear and consequent life-threatening bleeding.[6]

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