Video-thoracoscopic surgical interruption of patent ductus arteriosus. Routine experience in 332 pediatric cases

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Abstract

Objective: Pediatric video-assisted thoracic surgery closure of patent ductus arteriosus can now be performed on a routine basis. We review here our entire experience with this technique. Methods: Three hundred and thirty two consecutive patients underwent video-assisted closure of patent ductus arteriosus from September 1991 to September 1996. Indications were symptomatic ductus or failure of closure in older children. All complications were carefully noted, as well as intensive care unit stay, and operating room time. Results: Patients were divided in three age groups: less than 6 months (101 patients, 31%), 6–48 months (179 patients, 54%), greater than 48 months (52 patients, 16%). The mean weight was 12.6 kg (range 1.2–65 kg). Associated cardiac anomalies were atrial septal defect (3), ventricular septal defect (5), anomalous pulmonary venous return (1). Six patients had a residual shunt following video-assisted interruption. Five patients had successful immediate clip repositioning (three via video-assisted interruption, two via thoracotomy). One patient continued to have a small shunt, which is followed medically. Complications included recurrent laryngeal nerve dysfunction in six patients (1.8%) (five transient, one persistent). Mean operating time was 20 ± 1.5 mn and hospital stay averaged 48 h (> 6 months), 72 h (< 6 months). Conclusions: Interruption of patent ductus can be safely performed by video-assisted technique with minimal morbidity and no mortality. It can be performed in all age group with minimal hospital stay. © 1997 Elsevier Science B.V.

Keywords: Video-assisted closure; Patent ductus arteriosus; Pediatric video-assisted thoracic surgery

1. Introduction

Pediatric video-assisted thoracic surgery (VATS) applications have been limited by a lack of equipment and techniques adapted to small patients. However recently the introduction of small video camera has allowed the development of surgical operations in children.

Patent ductus arteriosus was first surgically ligated in 1939 by Gross and Hubbard [1]. Since then VATS technique have evolved to include interruption of ductus [2–4], followed by vascular ring division, collateral interruption (arterial and venous), pericardial drainage, thoracic ductus interruption and diagnostic VATS (location of aberant coronary artery) [4]. This report reviews our entire experience with this technique for closure of PDA.

2. Material and methods

2.1. Patient population

From September 1991 to September 1996, we performed VATS closure of PDA on 332 consecutives cases. All children presenting either an isolated PDA, or a PDA associated with a more complex congenital lesion underwent closure by this technique. Age itself was not a contra-indication since this technique has been performed in premature infants. Patients were...
dissected on the pulmonary side to protect the recurrent laryngeal nerve from a traumatic injury.

It is essential to dissect on both sides of the PDA to place the clip adequately. The clip applier is then introduced through the posterior thoracostomy after removal of the trocar. A first titanium clip (8 mm) is placed as distal as possible from the aortic junction and a second titanium clip is applied on the side close to the aorta. After visual confirmation that both clips are well in place, the lung is inflated and a 2 mm diameter pleural suction catheter is placed before closure of the skin incision.

2.3. Postoperative care

For all children a transthoracic echocardiogram is performed in the operating room. If complete interruption of the PDA is seen, extubation is performed. Otherwise replacement of the clip is performed. For children > 5 kg extubation is done 4–6 h following surgery in the intensive care unit. ICU stay depends on their state and age and varies between 24 and 48 h, before being transferred to a regular room.

The pleural suction catheter is removed a few hours after extubation, a routine chest X-ray is obtained, and another echocardiogram is performed before discharge. The average stay is 72 h.

3. Results

Six patients had a residual shunt following VATS interruption related to insufficient dissection, with inadequate clip placement. Five patients had successful immediate clip repositioning (three by VATS, two by thoracotomy). Subsequent echocardiogram revealed persistent closure in these patients. A persistent PDA with minimal flow was discovered in one asymptomatic patient following discharge, this patient underwent subsequently closure of his PDA via a thoracotomy. Recurrent laryngeal nerve dysfunction was noted in 6 patients (1.8%) (5 transient, 1 persistent). There was no mortality, transfusion requirement, or chylothorax in

Table 1

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<tr>
<th>Pediatric vats instruments for PDA closure</th>
<th>Diameter (mm)</th>
<th>Company</th>
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<tbody>
<tr>
<td>Camera</td>
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<td>Monitor</td>
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<tr>
<td>Videoscope</td>
<td>4</td>
<td>Storz</td>
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<td>2 Trocars</td>
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<td>Wolf</td>
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<td>3 Right angle-hooks</td>
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<td>Suction Device</td>
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<td>Clip applier</td>
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this series. Mean operating time was 20 ± 15 mm and hospital stay averaged 48 h (>6 months), 72 h (<6 months) (Table 2).

4. Discussion

Surgical closure of PDA is now well standardized and provides excellent results, with low mortality and morbidity. Most older patients have division of the ductus through a thoracotomy, where as infants undergo closure with a clip. Surgical closure of the PDA in the neonatal intensive care unit has been described, with excellent results [5–9]. The procedure consists of placement of one or two clips through a thoracotomy, generally with an extrapleural approach. The advantages given are its low morbidity, lack of mortality, and reliable PDA closure. However the potential morbidity of thoracotomy is important especially in children. The long term postthoracotomy pain is common [10], and the risk of postoperative pulmonary complication represented by atelectasis and pneumonia is increased [11]. In addition the incidence of thoracic scoliosis as a long term complication in premature infants is above 20% [12,13].

The technique of PDA closure by VATS [2–4] provides the same results without a thoracotomy. This technique is simple and safe, and it becomes quite expedient with good practice. Although six patients in our series had a residual shunt after VATS, none occurred in our last 200 patients. It is extremely important to dissect both sides of the ductus adequately to place the clips. The application of metal clips near the aorta reduces the risk of recurrent laryngeal nerve injury and does not require complete mobilization of the ductus, reducing the risk of surgical bleeding. For the same reason we do not divide the ductus, in order to minimize laryngeal nerve injury.

Four patients had a pneumothorax after the procedure; we did not see any occurrence of pneumothorax after we initiated chest tube drainage. The main complication was transient paralysis of the left vocal cord (1.8%). can also be seen after open surgical interruption of the ductus, with the same incidence [14].

Risks factors generally given are low weight (<1500 gm) and extensive dissection around the ductus. We believe that minimal dissection around the ductus should be performed to avoid this complication.

Percutaneous catheter closure of PDA has been described elsewhere [15–17]. Persistent shunting remains in the order of 27% at 6-week follow-up, which decreases generally between 10% and 20% at 6 months. Persistent shunting increases with the size of the ductus. Possible migration or embolization of the device may necessitate surgical removal. Also reported are hemolysis and the problem of prophylaxis against bacterial endocarditis in residual shunts. In addition, this technique is applicable only for patients weighing more than 10 kg because the size of these small vessels, makes the use of the device difficult. In addition, recent results showing superiority of surgical versus transcatheter closure for outcome and cost, VATS probably can reduce the hospital cost even further [18]. Only a prospective trial comparing all alternatives can clarify the issue.

The technique of VATS can also be performed in premature infants, as we and others have demonstrated with excellent results and no morbidity. The procedure is rapidly performed, with an average of 15 to 20 min. No complications related to the procedure have been reported in this age group as yet. We therefore believe that this technique can be safely applied to premature infants.

The only contra-indication is if the diameter of the ductus is greater than the size of the clip (8 mm), or if the ductus is calcified. Both of these situations can be encountered in older children or adults. In children, the only contra-indication would be a previous thoracotomy with pleural adhesions.

In our series, we had no cases of chylothorax, hemorrhage, blood loss, phrenic nerve injury, or in-hospital infection. There were no deaths related to the procedure. Prospective efforts must be made to demonstrate reductions in cost, pulmonary injury, and hospital stay.

Finally we think that this technique can be easily learned by experienced surgeons and provides extremely good results. It can be performed in all age group, in a minimum operating time, and provides a satisfactory cosmetic result.

References


Appendix A. Conference discussion

Dr O. Oto (Izmir, Turkey): We have been performing the same procedure in the last year. And although we have a restricted number of patients up to now, we have started to use endo-ligatures, two ligatures plus a transfixion suture, because we thought that these clip systems are not safe. And since we have some experience with thoracoscopic surgery in lung surgery, it hasn’t been seen as difficult to put endo-ligatures, endo-corpostral ligatures, and by this means we can use any size of ligature, which is cheap too.

Dr F. Laborde: Actually, we don’t do that because we are confident in those clips, but I’m sure that it’s possible to also use another technique. But you need for this to surround the ductus. And in terms of risk, you probably increase the risk, but if you pay attention you will have no problem and ensure that this adds a little step more in the complication of this surgery.

Dr T. Tlaskal (Prague, Czech Republic): I’d like to ask you one question do you think, based on your experience, are there some limits of this technique and are you able to close the PDA in all the patients, even in neonates in patients with really high pulmonary hypertension?

Dr F. Laborde: We use this technique for all the children and especially the neonates. And the problem of the pulmonary hypertension is not a problem in the beginning of life. But it’s sure that we will not use this technique for adults or patients with pulmonary hypertension in adults, because I think that you will have a risky dissection, a risky placement of the clips. And also, the clips we have, which are disposable, have no more than 1 cm when they are applied, and it’s sure that this represents a limit to the size of the ductus. And this is the reason why this technique fits perfectly for the children and the neonates, but T will not recommend it for adults or older children.

Dr J. Waldhausen (Hershey, Pennsylvania, USA): I enjoyed your paper very much. Could you tell us a little bit more about persistence of the shunt after this operation?

Dr F. Laborde: At the beginning of our experience we did not dissect enough each size of the ductus, so the clips could not be correctly placed over the ductus, and we had to move away the clip and proceed with a better dissection than to put away clips and obtain the correct closure of the PDA. But we never observed any repair mobilization or secondary motion of the clips. If the dissection is correctly done at the first step, the clips are perfectly placed over the ductus and the ductus is closed.

Dr B. Hudin (Prague, Czech Republic): Is there any danger of thermic injury of the recurrent nerve during the resection?

Dr F. Laborde: Yes. This is probably the reason why we had some injury to the recurrent nerve, and this is the reason why we now proceed to do an incision more posterior than in the beginning, to be far away from the nerve, but it’s sure that this represents a potential danger.

Dr D. Anderson (London, UK): The smallest child was 1.2 kilos, I think you said. My concern is that most of the ducts that I’m asked to deal with are in babies with a very high flow, very congested lungs, and even with the conventional open technique the lung is difficult to retract. Would you regard the very high flow, congested lung as a contraindication to this technique because of the danger of injury with the introduction of the trocar, et cetera?

Dr F. Laborde: No, we never take this as a contraindication. We operated all the patients even though with a high pulmonary flow. And it’s sure that it is more difficult to retract the lung in those cases than in cases in which the ductus has a normal flow, but it’s possible with this technique. If you have difficulty to retract the lung – we use one hook you can place two hooks.