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Minimally invasive thoracoscopic closure *versus* thoracotomy in children with patent ductus arteriosus

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ABSTRACT

Background: Patent ductus arteriosus (PDA) is one of the most common congenital heart defects. Once diagnosed, an immediate pharmacologic or invasive treatment should be performed. The purpose of this work was to evaluate the safety and efficacy of surgical PDA ligation in children using video-assisted thoracoscopic surgery (VATS) in comparison with a conventional muscle-sparing posterolateral thoracotomy technique (MSPLT).

Materials and methods: In this single-center, retrospective study 173 children qualified for surgical PDA closure were enrolled. Patients were divided according to their weight and type of surgery performed. The groups consisted of patients operated through thoracotomy (54%) or VATS (46%). Operative characteristics, cosmetic effect, postoperative complications and long-term survival were evaluated.

Results: Regardless of weight, fewer complications were noted in children after thoracoscopic clipping. Fifteen VATS patients required intraoperative conversion to thoracotomy; however, adverse sequelae were not observed. Aesthetics seemed to be the major complaint after conventional surgery. We did not observe any statistically significant differences in the long-term survival between both groups.

Conclusions: Both techniques were shown to be safe and effective. Unsuccessfully performed thoracoscopic surgeries were safely converted to conventional thoracotomy. VATS, being a less invasive approach, leads to a better aesthetic effect and lower surgical complication rate.

Introduction

Patent ductus arteriosus (PDA) is an essential fetal vessel that physiologically closes spontaneously 24-48 h after the labor. Usually, in the left-sided aortic arch, PDA serves as a connection between the upper descending thoracic aorta and proximal left pulmonary artery. PDA affects one in 2000 newborns and accounts for 5%-10% of all congenital heart defects.[1] In term infants, PDA is mostly idiopathic, but it is also considered that genetic factors and infection may play a

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role.[2] The most common risk factor for persistent patency of the duct remains prematurity, which increases the incidence of PDA by 65%.[3] When pharmacologic treatment is ineffective or contraindicated, the only solution for PDA closure is an invasive treatment, especially when heart failure supervenes.[4] In most patients, percutaneous therapy might be the preferred method of closure; however, there are several contraindications such as large ductal diameter, very small weight of a preterm, infection, bad clinical condition, calcification of the duct, institutional and surgeon experience, or parental decision. In such case, patients should undergo surgical closure.[5-11] This study was designed to compare survival and surgical outcomes of patient submitted to PDA closure using video-assisted thoracoscopic surgery (VATS) and muscle-sparing posterolateral thoracotomy (MSPLT).

Materials and methods

After appropriate review and approval by the institutional review board, 173 children qualified for isolated surgical PDA closure were enrolled in the study, and divided into two groups. Institutional review board waived an individual patient consent due to the retrospective nature of the study. Outcomes of VATS performed between 2012 and 2015 were compared with outcomes of the MSPLT which was the method of choice between 2003 and 2012. VATS was the only method for all patients with PDA starting from June 2012 until today. We analyzed all consecutive patients after isolated PDA surgery, which were performed in Medinet Heart Center, Department of Cardiac Surgery, Wroclaw, Poland. All surgeries took place in an operating room, which is located right next to the Pediatric Cardiothoracic Intensive Care Unit. Low-birth-weight infants (LBWI) were operated in an infant incubator in the operating room to minimize the transfer risk. The exclusion criterion for both methods was preexisting cardiac anomalies requiring simultaneous surgical intervention. In our institution, previous thoracotomy and/or a large ductal diameter (higher than 9 mm) are treated as contraindications to VATS PDA closure. However, during the study period, no patient was excluded due to previous thoracotomy or ductal diameter.

Surgical closure techniques

MSPLT was performed under general anesthesia using standard endotracheal intubation. PDA was closed by standard left posterolateral muscle-sparing thoracotomy through third (83%) or fourth (17%) intercostal space. After mediastinal pleura opening, subclavian artery, descending aorta, and the aortic arch dissection supervened. After achieving good visualization of the duct, ligation was performed by titanium clips (84%) or threads (16%). After PDA closure, muscles were sutured, and the wound was closed using intracutaneous suture.

VATS was also performed under general anesthesia. Single-lumen, endotracheal intubation with isolated, right lung ventilation was used. The patient was then placed in the right lateral decubitus position. The first port was inserted in the anterior axillary line through the fourth or fifth intercostal space. The cavity was insufflated with CO_2 under pressure of 5-7 mm Hg. The first port was used for a video-camera insertion (KARL STORZ Endoskope)—5-mm long incision. Surgical instruments were inserted through the 3-mm long access ports in the third and sixth intercostal spaces in the posterior axillary line. Mediastinal pleura was entered, and PDA was dissected carefully from the surrounding aorta and the left pulmonary artery. Finally, the PDA was closed by two titanium clips. Depending on the size of the duct, 5, 8, or 10-mm clips were used. Before the last suture was placed, the remaining CO_2 was aspirated from the thorax. Postoperative echocardiography was performed routinely in all patients to confirm the absence of the ductal residual shunt.

Unplanned conversion to traditional thoracotomy was performed through the primary incision of the first VATS-port in the anterior axillary line through the fourth intercostal space. Mediastinal pleura was then opened, and ligation was done by clips in all patients. The remaining part of the surgery was performed in a standard manner.

Statistical methods

All variables were tested for normality using the Shapiro–Wilk test and the Brown–Forsythe for the equality of variance between groups. Continuous variables were compared among groups by the Mann–Whitney test, categorical variables were compared by the χ^2 test or the Fischer's exact test when small numbers were taken into analysis. Survival analysis was performed with Kaplan–Meier method with the log-rank test used for comparison between groups. Statistical significance was assumed at $P < 0.05$. Statistical analysis was computed with StatSoft, Inc (2014). STATISTICA (data analysis software system), version 12 and R version 3.2.2. (2015) The R foundation for statistical computing.

Results

Patients characteristics

All demographics and preoperative clinical data in both groups, according to their weight at the time of surgery are presented in Table 1. In patients weighing less than 2500 g who underwent VATS, heart failure, and bronchopulmonary dysplasia were significantly more prevalent. Mean age, weight at the time of surgery, and birth weight were significantly lower, whereas mean size of the duct was greater in non-LBWI patients enrolled to conventional surgery.

Early postoperative results

Patients scheduled primarily for VATS, who underwent conversion to thoracotomy ($n = 15$ patients), are discussed as a separate group and were excluded from Tables 2-4. In LBWI patients, no differences were observed between groups except number of patients with postoperative chest tube insertion. Perioperative doses of fentanyl analgesia (μL) were similar after MSPLT and VATS in LBW groups (22.4 ± 14.7 *versus* 21.5 ± 13.4 $P = \text{NS}$). Patients weighing over 2500 g at the time of