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Introduction

Single-lung ventilation is routinely used to facilitate surgical exposure in adults. In children, however, it is used less frequently due to the specific anatomic challenges of the pediatric airway and the limitations of available single-lung ventilation devices. Thoracoscopy is associated with decreased mortality, musculoskeletal morbidity, length of stay, and in adults, less development of chronic pain compared to open thoracotomy. This is often the primary goal of single-lung ventilation. Techniques for lung isolation have a high failure rate among those with limited experience in anesthesia for thoracic surgery (2). Most prior descriptions of single-lung ventilation in children are case reports describing a small number of successes at lung isolation or a case series noting a low failure rate of a new device such as the Amplatz endobronchial blocker (0,4). Our study sought to review all intrathoracic procedures performed by pediatric surgeons to determine the prevalence and success rate for single-lung ventilation.

Methods

• After Institutional Review Board approval, a retrospective review was performed of all intrathoracic cases by pediatric surgeons from January 2009 to June 2011 at our institution.
• Inclusion criteria:
  o All procedures performed by pediatric surgeons using billing codes indicating thoracic surgery or thoracoscopy
• Exclusion criteria:
  o Patients over age 18
  o Use of Cardiopulmonary Bypass (CPB) or Extra Corporeal Membrane Oxygenation (ECMO)
  o Cases performed outside the operating room

Results

• 122 cases reviewed
  • 65% performed thoracoscopically
  • 65% of thoracoscopic procedures performed with lung isolation
  • 15% of open procedures performed with lung isolation
  • Lung isolation abandoned due to patient intolerance or technical issues in approximately 15% of all attempts (Table 1)
  • Failure rates similar between age groups
    o 0-30 days 0%, 1-24 months 14%, 2-7 years 18%, 8-18 years 16%
  • Failure rates similar between lung isolation types
    o EBB 16%, Mainstem 13%, DLT 19%

Discussion

Lung isolation in children has been increasingly described in children. This study reviewed all cases at a single site, and included anesthesiologists both experienced and novice at single-lung ventilation techniques in children. Abandonment of single-lung ventilation was most commonly due to failure to achieve adequate isolation, and this failure rate is similar to the conversion to thoracotomy due to poor exposure in another recent audit of single-lung ventilation (1). Despite a 15% incidence of failure or abandonment of lung isolation, the surgeons were able to complete the procedures thoracoscopically, in contrast to another recent description of single-lung ventilation in infants (4). Successful completion of these procedures thoracoscopically may be partially attributable to the use of carbon dioxide insufflation to facilitate exposure was common (86%) in thoracoscopic patients in this case series. We include data regarding hospital length of stay and mortality in Table 1. Thoracoscopy, which is facilitated by lung isolation, carries lower morbidity, mortality and a shorter hospital length of stay (1). However, anatomic and patient disease considerations may require an open procedure, and as a retrospective analysis, no correlation can be made between lung isolation and mortality or length of stay in this case series. Limitations of our study include the retrospective chart review design, which is not predictive of outcomes, along with the fact that our information is limited by what was entered into the chart as success/failure/abandonment and these records may be incomplete. Failure in lung isolation in this study was most commonly attributed to a technical failure in achieving lung isolation. Numerous other causes or contributory factors exist and may be poorly captured with this study design. These may include difficulty with oxygenation or ventilation, hemodynamic compromise, loss of lung isolation, change in surgical requirements, technical error, production pressure, and/or device malfunction. There was also a wide variety of provider experience with lung isolation with some experienced pediatric thoracic anesthesiologists and others without this experience, which has been shown to have an effect on failure rate. No validated tool for assessing lung isolation or surgical exposure currently exists, which would facilitate subsequent evaluations of lung isolation devices and techniques, and would be an appropriate avenue for future research.

Table 1

<table>
<thead>
<tr>
<th>Patient Age</th>
<th>0-0 days</th>
<th>0-30 days</th>
<th>1-24 months</th>
<th>2-7 years</th>
<th>8-18 years</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>29</td>
<td>27</td>
<td>25</td>
<td>45</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>Thoracoscopic</td>
<td>11(37%)</td>
<td>6(22%)</td>
<td>12(48%)</td>
<td>33(73%)</td>
<td>71(58%)</td>
<td>122</td>
</tr>
<tr>
<td>Thoracoscopic with Lung Isolation</td>
<td>7(24%)</td>
<td>6(22%)</td>
<td>12(48%)</td>
<td>33(73%)</td>
<td>71(58%)</td>
<td>122</td>
</tr>
<tr>
<td>Lung Isolation Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBB</td>
<td>11/29(38%)</td>
<td>6/22(22%)</td>
<td>12/48(48%)</td>
<td>33/73(73%)</td>
<td>71/58(58%)</td>
<td>122</td>
</tr>
<tr>
<td>Mainstem</td>
<td>1/29(3%)</td>
<td>7/22(32%)</td>
<td>0/48(0%)</td>
<td>0/73(0%)</td>
<td>0/58(0%)</td>
<td>122</td>
</tr>
<tr>
<td>DLT</td>
<td>0/29(0%)</td>
<td>0/22(0%)</td>
<td>0/48(0%)</td>
<td>0/73(0%)</td>
<td>0/58(0%)</td>
<td>122</td>
</tr>
<tr>
<td>Abandonment</td>
<td>11/29(38%)</td>
<td>7/22(32%)</td>
<td>0/48(0%)</td>
<td>0/73(0%)</td>
<td>0/58(0%)</td>
<td>122</td>
</tr>
</tbody>
</table>

Legend:
Lung Isolation Type: EBB – endobronchial blocker (4 & Fogarty or 5-9 Fr Arndt), Mainstem – endobronchial intubation with conventional endobronchial tube (ETT), DLT – left-sided double lumen ETT
LOS: Length of Stay (in days)

References


A) right mainstem intubation  B) endobronchial blocker  C) left-sided double lumen ETT