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## ORIGINAL ARTICLE

# Congenital Lung Malformations: Shifting from Open to Thoracoscopic Surgery

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## Key Words

congenital lung malformations;  
CPAM;  
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**Background:** Over the years the need for surgical treatment, timing of intervention, and the type of surgical approach have been discussed, but the treatment of congenital lung malformations remains controversial. The aim of this study was to compare the thoracotomy approach with the thoracoscopic technique by evaluating different surgical outcomes (duration of surgery, postoperative hospital stay, and complications).

**Methods:** All patients operated from January 2011 to March 2015 for suspected congenital cystic lung were included in the study. Patients treated for congenital lobar emphysema and tracheobronchial neoplasms were excluded from the study.

**Results:** In the analyzed period, 31 asymptomatic patients were treated: 18 lung resections were performed with thoracotomy (Group A) and 13 with the thoracoscopic approach (Group B). No significant differences were observed between the age and weight at surgery, length of the procedures, complications, and the need for postoperative intensive care between the two groups. The postoperative hospital stay in Group A was twice that for Group 2 ( $p = 0.0009$ ).

**Conclusion:** Comparing thoracoscopic surgery with the traditional open approach, we confirmed the superiority of minimally invasive treatment in terms of postoperative hospital stay. Common technical recommendations can help pediatric centers to develop the thoracoscopic approach for the treatment of congenital pulmonary malformations.

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## 1. Introduction

Congenital pulmonary adenomatoid malformations (CPAM) and pulmonary sequestration are the most common congenital pulmonary malformations, with an incidence of 1:10,000 to 1:35,000 newborns, without predilection for side, sex, or race.<sup>1</sup> The treatment of these congenital malformations is one of the most debated topics in pediatric surgery. Surgical resection or active surveillance has been discussed. Three issues have been identified in favor of surgical treatment: (1) risk of malignancy: the differential diagnosis between a lung malformation and pleuropulmonary blastoma (PB) is not always easy on imaging, and lung malformations can transform later into malignant tumors, as reported in literature<sup>2</sup>; (2) prevention of infections, occurring in 10% within the 1<sup>st</sup> 12 months and in 86% within the 1<sup>st</sup> 2 years of age according to literature<sup>3,4</sup>; and (3) the lack of validated recommendations on the need and timing of long-term follow-up for those patients who are conservatively treated.<sup>2</sup> The timing of surgery is another matter for debate. Despite the association between lung infections and poor surgical outcome,<sup>5</sup> the timing of surgical treatment has still not been clearly defined.

The thoracoscopic approach was shown to be superior when compared with the open approach in terms of length of postoperative ventilation and hospital stay, as well as the incidence of surgically-related complications.<sup>6</sup> The perioperative anesthetic management is a mandatory part of the overall patient management and it can have a significant impact on the surgical approach. In particular, intraoperative one-lung-ventilation is essential for the adequate visualization and exposure of the other lung, especially during the thoracoscopic approach. This can be challenging, even in tertiary level pediatric institutions, especially for very young patients.<sup>7</sup> Moreover, most devices available on the market for one-lung-ventilation are standardized for adults and no devices are available in infant size.<sup>8</sup> This makes adequate one-lung-ventilation very challenging if surgery is required at an early age.<sup>7,9,10</sup>

The decision to prospectively perform thoracoscopic approach in children with suspected congenital pulmonary malformation (SCPM) was made in 2012 after the adoption of a single-lung ventilation technique with an endobronchial blocker in a case series of 17 patients.<sup>9</sup>

This study reports our initial experience on thoracoscopic resection for pediatric pulmonary malformations, analyzing the differences between an open approach and thoracoscopic resection in terms of surgical outcome.

## 2. Methods

All children who underwent pulmonary resection for SCPM between January 2011 and March 2015 were retrospectively reviewed. We excluded all the other indications such as

primary tracheobronchial tumors or congenital lobar emphysema from the study. Patient data included sex, age and weight at surgery, timing of diagnostic imaging, previous history of pneumonia or respiratory distress, anesthesia management, the American Society of Anesthesiology score (ASA), type of surgical resection (lobectomy or atypical resection) performed, and histology using Stocker classification.<sup>11</sup>

Sparing-lung resection was performed when preoperative computed tomography (CT) scan and intraoperative finding showed only a segmental lesion in order to achieve the parenchymal preservation. This policy is in line with current literature, reporting segmental resection as a safe procedure without risk of residual disease and recurrence.<sup>12,13</sup>

Surgical outcomes included operative time, need of postoperative intensive care unit (ICU), complications, and length of hospital stay. Surgical complications were recorded using Clavien–Dindo classification.<sup>14</sup>

Two groups were identified: Group A (thoracotomy approach) and Group B (thoracoscopy approach). Statistical analysis was performed using Mann–Whitney U test for continuous variables (age and weight at intervention, operative time, length of hospital stay, and ASA score) and Fisher exact test for categorical variables (complications, postoperative ICU), and a *p* value <0.05 was considered as statistically significant. A 30-day postoperative clinical and radiological (thoracic x-ray) follow-up was performed by the institutional pulmonologist.

## 3. Results

Between January 2011 and March 2015, a total of 31 pulmonary resections were performed for SCPM with a total of 18 thoracotomies (Group A), and 13 thoracoscopic procedures (Group B). CT was performed at median age of 6 months in both groups (Group A range: 4 days to 5 years; Group B: 2 months to 5 years). All procedures were performed by the same surgeon. All cases of pulmonary sequestration detected with a CT scan were treated with endovascular embolization of the aberrant artery before surgical procedure in order to reduce surgical risk of bleeding and abolish existing shunt.

Of the 18 thoracotomies (Group A), nine were lobectomy and nine atypical resection. A total of eight lobectomies and five atypical resections were performed by the thoracoscopic approach (Group B). Thoracotomies were performed with a muscle-sparing antero-lateral access and anesthesia was conducted with double lung ventilation. Single lung ventilation was obtained with an Arndt 5 French pediatric bronchial blocker (Cook Critical Care Bloomington, IN, USA). Parenchymal resection was performed using Ligasure (ValleyLab Inc., Boulder, Colorado). Vascular and bronchus closure was sutured using ligature or stapler. The surgical specimen was extracted enlarging one

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