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Does earlier lobectomy result in better long-term pulmonary function in children with congenital lung anomalies? A prospective study

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Abstract

Background: Management of asymptomatic congenital pulmonary airway malformations remains controversial when addressing the optimal timing of surgical resection. Neonatal resection is advocated by some based on the theory that earlier lobectomy results in greater compensatory lung growth. We examined whether age at lobectomy is correlated with better pulmonary outcomes as reflected by pulmonary function and exercise testing.

Methods: Patients who had lobectomy for congenital pulmonary airway malformation between 1985 and 2002 were identified and underwent detailed clinical history, physical examination, pulmonary function testing (total lung capacity, forced vital capacity, forced expiratory volume in 1 second), and exercise testing (power, maximal oxygen uptake [V_{O_2}max]).

Results: Of 87 patients identified, 47 met the inclusion criteria, and 28 were tested prospectively. Age at the time of lobectomy ranged from 3 days to 56 months. There was no correlation between age at lobectomy and pulmonary function (total lung capacity, $P = .408$; forced vital capacity, $P = .319$; forced expiratory volume in 1 second, $P = .174$) or maximal work capacity (power, $P = .280$). There was a trend toward lower V_{O_2}max in patients who had undergone lobectomy at an older age (V_{O_2}max, $P = .055$).

Conclusion: Most children undergoing lobectomy have normal long-term pulmonary function. We found no correlation between age at lobectomy and future pulmonary function. Cardiopulmonary exercise testing should be considered in evaluating functional outcome in these patients.

Congenital pulmonary airway malformations (CPAMs) are characterized by abnormal lung formation during fetal life, which results in a cystic malformation involving part or all of a pulmonary lobe. These lesions occur between 1 in 10,000 and 1 in 35,000 live births [1,2] and are increasingly being diagnosed prenatally by ultrasound [3]. Some fetal CPAMs grow rapidly and result in hydrops and fetal death, but most remain stable or decrease in size and are often asymptomatic at birth.

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Whether or not lobectomy should be done routinely for asymptomatic CPAM is controversial, and the optimal timing of surgery has not been established [3-7]. Early lobectomy has been suggested by some to avoid the potential development of complications such as: recurrent infections, pneumothoraces, or even the rare development of lung malignancy [2,8-12]. Balanced against this are the risks of lobectomy, which include bleeding, infection, chest wall deformity, and risks associated with general anesthesia [13,14].

Early routine lobectomy has been advocated by some surgeons based on the presumption that compensatory lung growth is more complete if the lobectomy is performed as early as possible. Arguments have been made regarding the fact that delaying the lobectomy until later childhood increases the risk of infection and may result in less or no compensatory lung growth [15,16]. However, anecdotal reports suggest that the relationship between timing of lobectomy and degree of compensatory lung growth remains unclear [17,18]. In this study, we sought to prospectively examine whether age at lobectomy is correlated with functional outcome, as reflected by pulmonary function and exercise testing.

1. Methods

Patients who underwent lobectomy for benign cystic lung disease between 1985 and 2002 were identified through health records at the Hospital for Sick Children. All patients were considered for enrollment from this list if they met the inclusion criteria. The inclusion and exclusion criteria are listed below:

Inclusion criteria are as follows:

1. A patient who underwent previous lobectomy for suspected CPAM
2. A Patient who is 8 to 23 years old at the time of enrollment
3. A patient who is able to perform body plethysmography
4. A patient who is able to perform exercise testing
5. A patient or parent who can complete questionnaires

Exclusion criteria are as follows

1. Patients with underlying diffuse lung disease (eg, cystic fibrosis)
2. A patient who had underwent surgical procedure of the thorax other than lobectomy (eg pneumonectomy or partial lobectomy)
3. Refusal to consent to participate

Patients who met the inclusion criteria and who signed a consent form underwent a detailed clinical history and physical examination, pulmonary function, and cardiopulmonary exercise testing. Total lung capacity (TLC), forced vital capacity (FVC), and forced expiratory volume in 1 second (FEV_1) were used as indicators of pulmonary growth. Measures below 80% predicted were considered to represent impaired pulmonary function. Maximal work capabilities (power) and maximal oxygen uptake (Vo_2max) were determined by cardiopulmonary exercise testing. The results obtained from the patients were compared with the normal reference based on sex and body surface area [19]. Statistical analysis was performed using Student t test, χ^2 test, and analysis of variance test, with a $P < .05$ considered significant. Multivariate statistical analysis with logistic regression was used to assess the effect of various factors on pulmonary function and exercise capacities. The SPSS version 16.0 was used to perform the statistical analyses (SPSS, Chicago, IL). The study was approved by the Research Ethics Board of The Hospital for Sick Children, Ontario, Canada (No. 1000013651).

2. Results

A total of 87 patients were identified through health records. Forty patients were excluded from the study because they did not meet the inclusion criteria or declined to participate. Forty-seven patients met the inclusion criteria, and study packages containing a study invitation letter and a research consent form were sent by mail. We then attempted to contact parents or patients via telephone to follow-up. Patients who agreed to participate then came for a clinic visit, which included a detailed clinical history, physical examination, pulmonary function testing, and cardiopulmonary exercise testing. Of the 47 patients, 28 agreed to participate and were prospectively tested. Twelve patients could not be contacted, and 7 were either too busy or lived too far to come for testing (Fig. 1).

Of 28 patients in the study population, 12 were male and 16 were female. The mean age at the time of lobectomy was 13 months (range, 3 days to 56 months). Nineteen patients (68%) had an antenatal diagnosis. Thirteen patients (46.4%) were asymptomatic before lobectomy. There were complications in 5 patients: 2 with persistent pneumothoraces and 3 with atelectasis. All patients underwent thoracotomy. The distribution of the types of operation was as follows: 8 right upper lobectomy, 10 right lower lobectomy, 4 left upper lobectomy, and 6 left lower lobectomy. Twenty-six patients (92%) had a CPAM, 1 patient (4%) had an intralobar sequestration, and 1 patient (4%) had chronic pneumonia confirmed on pathology. The mean follow-up age of the participants was 12.8 years (range, 8-18 years).

Twenty-eight patients underwent pulmonary function testing, and 27 patients underwent cardiopulmonary exercise testing (Table 1). The mean TLC was 96% predicted, the mean FVC was 90% predicted, and the mean FEV_1 was 82% predicted. Five patients (18.5%) had FVC lower than 80% predicted, and 13 patients (46.4%) had FEV_1 lower than 80% predicted. There was no correlation between age at