

Thoracoscopic Lobectomy in Infants and Children Utilizing a 5 mm Stapling Device

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Abstract

Purpose: Thoracoscopic lobectomy for congenital cystic lung disease has become an accepted and in many institutions the preferred technique. However, the technical challenges are many. Previous endoscopic staplers (12 mm) used commonly in adults are too large for use in infants. This study evaluates the safety and efficacy of using a 5 mm stapling device to seal and divide major pulmonary structures.

Methods: From July 2014 to March 2016, 26 patients of age 6 weeks to 13 months underwent thoracoscopic lobectomy for CPAM or sequestration. Weights ranged from 3.2 to 11.4 kg. There were 7 upper lobectomies, 2 middle, and 17 lower lobectomies. In each case, the 5 mm stapler (Justright Surgical; Louisville, Colorado) was the primary device for vessel and bronchial sealing and division. It is 4.8 mm in diameter with an anvil length of 25 mm and lays down four rows of staples and divides between them. A 3 mm sealing device was used for dissection and to take smaller segmental vessels as necessary. Stump lines were evaluated for bleeding or air leak in all cases.

Results: All procedures were accomplished successfully thoracoscopically. The stapler was used on the main lobar artery cases and vein in 24 cases, a large systemic sequestration vessel in 5 cases, and the bronchus in all 26. The stapler was also used to complete the minor fissure in 1 case and the major fissure in 1 case. A total of 96 staple loads were fired. Operative times ranged from 35 to 135 minutes. There was no significant bleeding of any vascular stump. In 1 case, the edge of the bronchial stump had to be reinforced, this was thought to be secondary to too much tissue being enclosed in the jaws. There were no postoperative complications.

Conclusion: The use of a 5 mm stapling device appears to be safe and effective in thoracoscopic lobectomy in infants. It allows for safe management of major pulmonary vessels and bronchi in the confined chest of an infant through a single 5 mm port.

Keywords: thoracoscopy, lobectomy, CPAM, sequestration, stapler, pediatric, infant

Introduction

OVER THE LAST DECADE, thoracoscopic lobectomy for congenital cystic lesion in infants and children has become an accepted technique.¹⁻³ Many surgeons prefer to perform these cases in the first year of life and often in the first 3-6 months.⁴⁻⁶ However, the technical demands of the procedure as well as the difficulty and risk of dealing with relatively large pulmonary vessels in the relatively confined space in these infants have made widespread adoption of these techniques slow among pediatric surgeons. The 12 mm endoscopic stapler that has become a mainstay of thoracoscopic lobectomy in adults and that has greatly advanced thoraco-

scopic techniques in adults is simply too large to fit in the small chest of neonates and infants. Therefore, the pediatric surgeon has had to look for other alternatives, such as suture ligation, endoclips, and vessel sealing to try and safely manage the main pulmonary vessels and bronchus. However, this often requires more dissection, greater mobilization of the main pulmonary vessels, often at the segmental level, and advanced suturing techniques. These added hurdles have prevented some surgeons from adopting a thoracoscopic approach for these cases.

Recently, a 5 mm surgical stapler (JustRight Surgical; Louisville, CO) has become available that easily fits into the thoracic cavity of infants with congenital cystic lung lesions. This study evaluates its use as the primary mode of ligation

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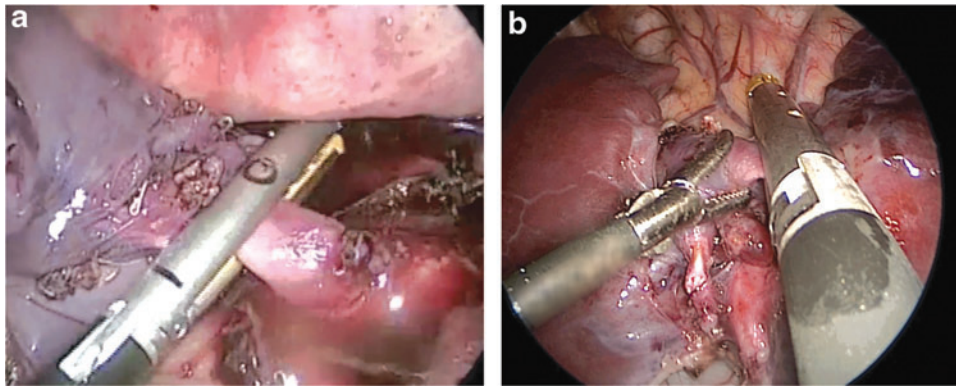


FIG. 1. (a) Stapler applied to the main trunk of the inferior pulmonary vein in a 4.5 kg infant. (b) Stapler on the main pulmonary artery to the lower lobe as it transverse the major fissure.

and division of the main pulmonary vessels and bronchi during thoracoscopic lobectomy in these patients.

Materials and Methods

From July 2014 to March 2016, 26 patients of age 6 weeks to 13 months underwent thoracoscopic lobectomy for Congenital Pulmonary Airway Malformation (CPAM) or sequestration. Weights ranged from 3.2 to 11.4 kg. There were 7 upper lobectomies, 2 middle, and 17 lower lobectomies. In each case, the 5 mm stapler was the primary device for vessel and bronchial sealing and division. It is 4.8 mm in diameter with an anvil length of 25 mm and lays down four rows of staples and divides between them. It uses a standard B formation staple that is 2 mm in height, similar to vascular loads in the classic 12 mm stapler. A 3 mm vessel sealing device (Justright Surgical; Louisville, CO) was used for dissection and to take smaller segmental vessels as necessary to allow for an adequate length of the main trunk for mobilized safe placement of the stapler (Fig. 1a, b). In the case of the main bronchus, this was often taken at the first bifurcation to decrease the tissue load in the stapler (Fig. 2). For example, in lower lobes, the superior segmental bronchus was often taken with one application and the main trunk to the basal segment was taken with a second load. In upper lobes, the anterior segment or lingular segmental bronchus was taken separately from apical-posterior segmental bronchus. Stump lines were evaluated for bleeding or air leak in all cases. There were 50 firings on the bronchus and 46 firings on the main pulmonary artery and main pulmonary vein to the affected lobe.

Results

All procedures were accomplished successfully thoracoscopically. The stapler was used on the main lobar artery cases and vein in 24 cases, a large systemic sequestration vessel in 5 cases, and the bronchus in all 26 cases. The stapler was also used to complete the minor fissure in 1 case and the major fissure in 1 case. A total of 98 staple loads were fired. Operative times ranged from 35 to 135 minutes. There was no significant bleeding of any vascular stump. In 1 case, the edge of the bronchial stump had to be reinforced, this was a case of a left upper lobectomy in an 8 kg child, in whom the main bronchus to the upper lobe was taken at its origin rather than at the bifurcation of the lingular and the apical-posterior

segment, the very end of the staple line was slightly disrupted causing a small leak. This was reinforced with a single 5 mm clip. The separation was thought to be secondary to too much tissue being enclosed in the jaws of the stapler. There were no postoperative complications.

Discussion

Thoracoscopic lobectomy in children for congenital cystic lung disease is now an accepted and well-described technique.¹⁻⁵ Most authors agree on the relative merits of a thoracoscopic approach, including less pain, shorter hospital stay, and decreased long-term morbidity, including chest wall deformity, shoulder girdle weakness, and scoliosis.⁷ Despite this general consensus, the adoption of this technique and surgeons' comfort with the approach remain relatively low. We believe there are three main reasons for this. First, the average trainee in general surgery and pediatric surgery fellowship receives very little open or endoscopic thoracic training. Experience with lung biopsy, empyema, and

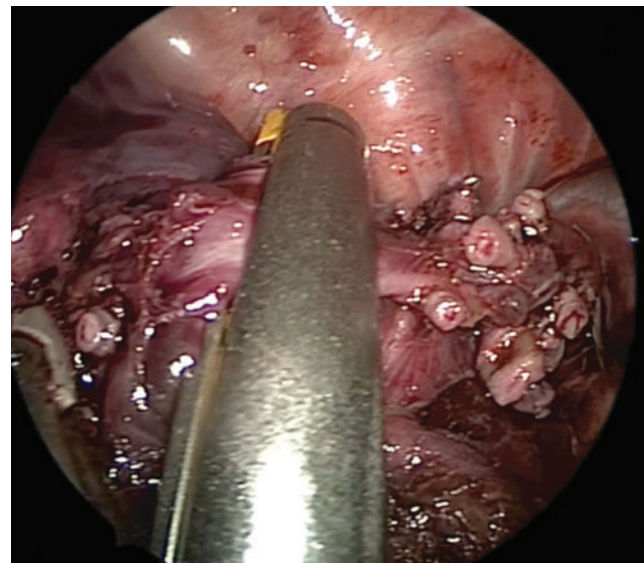


FIG. 2. Taking the bronchus to the right upper lobe in a 4 kg infant with CPAM.

mediastinal masses is usually adequate, but exposure to complex lung resections may be limited. This lack of volume results in a decreased familiarity with pulmonary anatomy. Using a thoracoscopic approach further compounds this, as the surgeon can no longer put his or her hand in the chest cavity to palpate the structures and identify the anatomy.

The second issue has been standardizing an anterior approach. During an open thoracotomy, the surgeon is generally positioned at the patient's back. For thoracoscopic lobectomies, the surgeon and assistant are positioned at the patient's front.¹ This is especially important in smaller patients, as there is more room from the chest wall to the mediastinum, from where the pulmonary vessels arise. This added space has been even more important until recently because of the relatively large nature of the sealing and stapling technology previously available for these cases. In many cases, the jaws of the instruments barely fit into the thoracic cavity, and this could make the manipulation and firing the devices difficult.

The last major reason has been the lack of adequate right sized instruments to perform these procedures safely. Surgical staplers have long been a mainstay of pulmonary resections, both open and thoracoscopic, in larger patients. However, these devices are much too large to use in the chest of a neonate, infant, or smaller child. The endoscopic staplers to date have a diameter of 12 mm and the smallest staple load is 35 mm in length. This requires a space of 6–8 cm just to get the working portion in the chest just to open the jaws. However, this large size makes manipulation and safe application of the device extremely difficult and at times unsafe, especially in children below 10 kg.

The availability of a 5 mm stapler has changed this significantly. Before its availability, the primary mode of vessel ligation was vessel sealing. This is a very safe and effective technique but requires more dissection and tissue manipulation. The vessels often need to be taken at the segmental level because of their size, and at times this requires dissecting into the lung parenchyma. This maneuver is more difficult and can add significantly to the operative time, especially for a less experienced surgeon.

The management of the bronchus has also been a significant issue. In smaller infants (<5 kg), we previously would place a clip on the bronchus to occlude it, but even in this small infant, the clip often was too small to completely traverse the bronchus. Most of the 5 mm endoscopic clips are 10 mm in length, so the stapler allows for division of structures almost 2½ times longer. The other option is to sharply divide and suture the bronchus, but this can definitely be time consuming and requires advanced endoscopic suturing skills. There can also be a significant loss of tidal volume while the bronchial stump is open, making it more difficult for the anesthesiologist to ventilate the infant.

Half of these procedures were performed by pediatric surgery residents. The ability to take the main pulmonary vessels near their origin, rather than at the segmental level, significantly decreased the procedure time. Also, management of the bronchus seemed to be much easier for the trainees when using the stapler. In addition, there were 5 cases of intralobar sequestration, in which there was a systemic artery of more than 1 cm in diameter. In each case, these vessels were handled safely and efficiently with a single application of the device. The stapler was also used to complete the fissure

in 2 patients. This proved to be a fairly effective and rapid way to accomplish this as well.

Conclusion

Thoracoscopic lobectomy in infants and children continues to be a technically challenging procedure. The use of a 5 mm endoscopic stapler for the management of the main pulmonary vessels and bronchi appears to be a safe and effective way to facilitate the procedure in this initial patient cohort. Further study will be necessary to completely evaluate the benefits in terms of time in the operating room, intraoperative and postoperative complications, and recovery as compared with previous used techniques.

Disclosure Statement

Dr. Rothenberg has an ownership interest in, and is Medical Director of, JustRight Surgical.

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