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CASO CLÍNICO / CASE REPORT

A New Perspective for Implementing One Lung Ventilation Using Endobronchial Intubation in a Child

Uma Nova Perspetiva para a Implementação de uma Ventilação Pulmonar Usando Intubação Endobrônquica em Criança

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Palavras-chave
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ABSTRACT

Hydatidosis caused by *Echinococcus granulosus* most commonly affects the lung, followed by the liver. Surgical treatment, consisting of excision of the cyst, requires anesthesia with one lung ventilation and an accompanying cysto-bronchial fistula poses an additional challenge of preventing contamination of the preserved lung during surgical manipulation. There are limited options for isolating a lung in children, especially those below 8 years of age, due to the unavailability of double-lumen tubes for this age group. One lung ventilation with an endobronchial cuffed tube, along with a coaxial suction catheter placed in the trachea, helps in preventing cross-contamination of the preserved lung. This case report demonstrates how this technique can be applied successfully in an 8-year-old child with a communicating hydatid cyst posted for emergency thoracotomy.

RESUMO

A hidatidose causada por *Echinococcus granulosus* afeta mais comummente o pulmão, seguido pelo fígado. O tratamento cirúrgico que consiste na excisão do quisto requer anestesia com ventilação de um pulmão e uma fístula quisto-brônquica associada representa um desafio adicional de prevenção da contaminação do pulmão preservado durante a manipulação cirúrgica. Existem opções limitadas para isolar um pulmão em crianças, especialmente nas que têm menos de 8 anos de idade, devido à indisponibilidade de um tubo de duplo lúmen para esta faixa etária. A ventilação monopulmonar com um tubo endobrônquico com braçadeira, juntamente com um cateter de sucção coaxial colocado na traqueia, ajuda a prevenir a contaminação cruzada do pulmão preservado. Este relato de caso demonstra como esta técnica pode ser aplicada com sucesso numa criança de 8 anos com um quisto hidático comunicante encaminhada para toracotomia de emergência.

INTRODUCTION

Hydatid cyst caused by *Echinococcus granulosus* affects the lungs more commonly in children and occasionally may lead to the formation of cysto-bronchial fistula.[1] Surgical excision of the cyst is the definitive treatment, but it carries the risk of inadvertent spillage of cystic contents into the preserved lung, which may lead to aspiration pneumonitis and the development of secondary cysts. Therefore, isolation of the infected lung is necessary during the surgical procedure to prevent further complications. In adults, one-lung ventilation (OLV) with a double-lumen tube (DLT) is the gold standard as it overcomes all the challenges.[2] However, in a pediatric patient, especially under 8 years of age, the option of DLT is not feasible and other means of differential lung ventilation are a constraint in a resource-limited emergency setup. Therefore, familiar techniques and equipment have to be employed. This case report presents a simple and new technique of OLV for the anesthetic management of an 8-year-old child diagnosed with a hydatid cyst that was communicating with the bronchus using endobronchial intubation.

CASE REPORT

An 8-year-old female child weighing 18 kg presented with complaints of fever, malaise and shortness of breath for the past 2 months with sudden worsening of symptoms. She was scheduled for an emergency open thoracotomy for excision of the cyst. The preoperative examination revealed decreased air entry and crepitations in the right middle zone. The respiratory rate was 28/minute and oxygen saturation was 96% with supplemental oxygen via the nasal prongs. A chest X-ray revealed a non-homogeneous opacity in the middle lobe (**Fig. 1**) and the contrast-enhanced computed tomography (CECT) confirmed the diagnosis along with a cysto-bronchial fistula in the right lung. Laboratory investigations including blood gas analysis were within normal limits. Written and informed guardian consent was obtained.

The patient was shifted to the pre-warmed operating room while receiving supplemental oxygen. Routine monitoring was instituted. A 22G IV cannula was already *in situ*. Gen-

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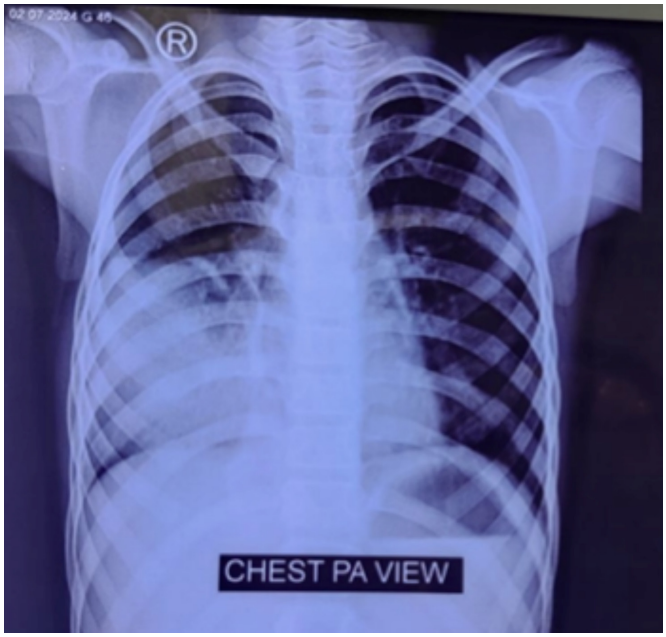

Figure 1. Chest X-ray demonstrating a non-homogenous opacity in the right lung

eral anesthesia was induced as per protocol using fentanyl and propofol and muscle relaxation was achieved with atracurium. After ensuring muscle paralysis video laryngoscopy was done, a 10 French suction catheter (which was prepared by railroading it on a guide wire of an adult central venous line; 18G B Braun) was placed in the trachea and fixed at the 20 cm mark at the lip. The trachea was then intubated with a #4 micro laryngeal surgery (MLS) tube under video laryngoscopy vision and bilateral air entry was confirmed. A fiberoptic bronchoscope (FOB) was introduced through the MLS tube and the suction catheter was visualized in the trachea with the tip above the carina. The MLS tube was guided into the left main bronchus over the FOB and fixed at 22 cm at the lip. Left lung isolation was confirmed with auscultation and point-of-care ultrasonography. Anesthesia with one-lung ventilation was maintained with sevoflurane in air and oxygen and bolus doses of atracurium were administered as and when required.

A left lateral position was assumed and a thoracic epidural catheter was placed at the level of T9-T10 for perioperative analgesia with a bupivacaine 0.25% infusion. Intraoperatively, the vitals remained stable with a SpO_2 of 91-95% on a FiO_2 of 0.5 and approximately 50 mL of hemorrhagic secretion was suctioned out via the tracheal suction catheter.

After completion of the surgery, the child was made supine and repeat suctioning was performed. The endobronchial tube was retracted into the trachea and bilateral air entry was confirmed. The tracheal suction catheter was withdrawn into the oropharynx. Muscle relaxation was then reversed with neostigmine and glycopyrrolate. The trachea was extubated after the return of airway reflexes and adequate muscle power.

The child was shifted to the high-dependency unit (HDU), and oxygen supplementation was provided to maintain adequate oxygen saturation. Postoperative analgesia was provided via epidural infusion using an elastomeric pump primed with bupivacaine 0.125% and fentanyl 2 mcg/mL started at the rate of 3 mL/h (subsequently titrated according to FLACCS pain score). The child was closely observed for any signs of respiratory distress and a chest X-ray was performed postoperatively to assess the lung condition. No significant complications or sore throat were observed and oxygen levels remained stable. The epidural catheter was removed on postoperative day 3 and the child was discharged on postoperative day 6 after optimal recovery with oral antibiotics and scheduled follow-up visits for monitoring.

DISCUSSION

The definitive treatment of pulmonary hydatid cyst is surgical excision with removal of all parasitic substances and ligation of bronchial fistulas while preserving maximum lung tissue. It is necessary to isolate the healthy lung during surgery to prevent transbronchial spread of the hydatid fluid during intraoperative handling of the cyst, particularly in the setting of a cysto-bronchial fistula. In older children (>8 years), the double-lumen tube is the best technique for isolating the healthy lung and, at the same time, facilitating the toileting of the infected lung.[3] Other methods of lung isolation in children of this age group include bronchial blocker, Fogarty catheter, univent tube, or endobronchial intubation using an SLT.[3] However, besides a DLT, other techniques have the limitation of not allowing the application of CPAP to the operated lung and also leave no provision for suctioning.

A 26 French DLT, which is the smallest size DLT available, is recommended for children aged 8 years and above or for those greater than 25 kg. Though not available to us, based on the measurements of the airway obtained by CECT, it was found to be too large for our patient. This may stem from previous studies conducted on the Indian adult population, where their stature is smaller than that of the western population and anesthesiologists have been downsizing DLT used for lung isolation. The next best and preferred alternative in children of 6 to 8 years is a univent tube.[4] Since both the univent tube and bronchial blockers were unavailable, we planned to proceed with endobronchial intubation using a single-lumen tube.

The minimum length required for endobronchial placement of an ETT in an 8-year-old child is 22.7 cm.[4] However, the conventional micro-cuffed ETT size 5 available in our theatre had a length of only 18 cm. Therefore, an MLS tube size 5 with a total length of 28 cm was considered. Telescoping a smaller-sized tube over a larger-diameter tube can be another method for increasing the length of the tube.[5] However, the authors cautioned against using such 'homemade' assemblies for critical areas such as securing the airway.

Airway dimensions can be obtained from a CECT scan if a prior request for specific measurements such as bronchial length and diameters is sent to the radiologists. We did not have all the required dimensions in the CECT report and we relied on the scant literature on paediatric airway dimensions. On inflation, we found that the cuff length of MLS tube

size 5 was 3.6 cm and the length of the left main bronchus from the carina to the primary bifurcation has been reported to be 3.4 cm in an 8-year-old child.[6] Hence, we selected an MLS tube size 4 (**Fig. 2**), which had an inflated cuff length of 3.2 cm, which was optimal to prevent cuff herniation. Using a smaller size tube has its own drawbacks such as causing increased airway resistance to ventilation and a higher probability of the lumen getting plugged with secretions. However, intraoperatively we could maintain ventilation with peak pressure remaining below 20 cm H_2O.

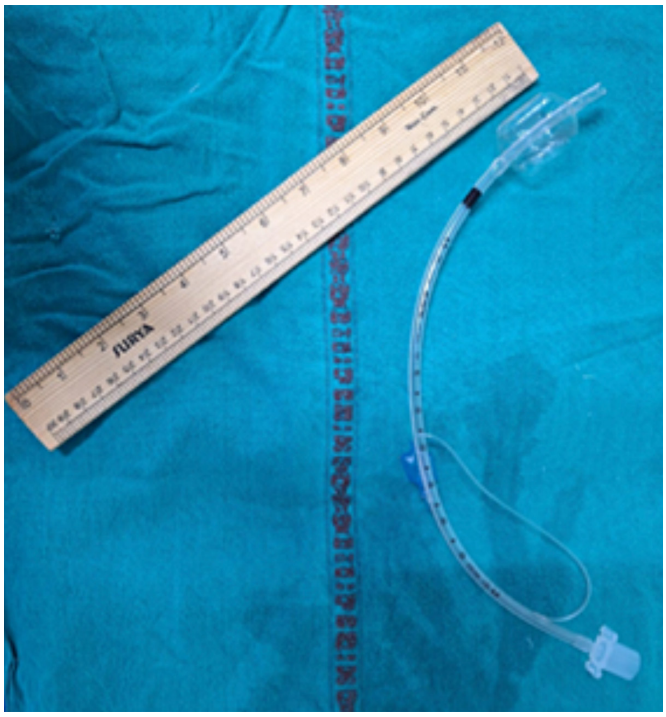

Figure 2. MLS tube size 4

Extraluminal suction catheter placement in the trachea provides an opportunity to suction out the hemorrhagic cystic contents that drain into the trachea through the cysto-bronchial fistula during intraoperative handling of the cyst. If this collection is not removed timely, it can enter into the other lung, especially when the endobronchial tube cuff is deflated before resuming both lung ventilation.

We would like to highlight that for placement of the ETT-suction catheter assembly, a thorough evaluation of the outer diameter of both these tubes with respect to the internal diameter of the trachea has to be considered. The internal diameter of the trachea in an 8-year-old is reported to be 10.3-10.9 mm[7] and in our patient, it was 10.1 mm. The outer diameter of MLS tube size 4 was 6 mm and that of the 10 French suction catheter was 3.38 mm. Therefore, the total diameter of the assembly (9.38 mm) was just appropriate for our patient.

The 10 French suction catheters available were extremely pliable and would not fall in line to pass through the glottis. We found that the length of the guide wire of the 10 French adult central venous catheter was longer than the suction catheter and hence we devised an assembly of a suction catheter railroaded on the guide wire for easy placement into the trachea.

OLV achieved via endobronchial intubation using SLT has been previously reported by Jha *et al*[5] in a 6-year-old child. They used two ETTs of sizes 4.5 mm and 3.5 mm for endotracheal and endobronchial intubation, respectively, mimicking a DLT. In such an assembly, they could provide continuous positive airway pressure (CPAP) to the operative lung to improve oxygenation. The total outer diameter of both these tubes, as reported by the authors,[5] was 11.5 mm (6.2 + 5.3) and they were able to manage intubation since the internal diameter of the trachea of their patient was 13 mm. However, the internal diameter of the trachea in a 6-year-old has been reported to be 9.4-10.3 mm.[7] Hence, this arrangement may not be possible for all pediatric patients.

In another case report, Paquet *et al*[8] used two cuffed ETTs of size 3.5 mm and 3 mm for endobronchial and endotracheal intubation, respectively, for performing lavage in a 2-year-old child with pulmonary alveolar proteinosis. This assembly was aimed at achieving simultaneous independent lung ventilation and the ability to collect lavage returns in each lung. However, the patient developed hoarseness of voice and stridor after the procedure, so they had to downsize the tubes in the subsequent procedure. However, a smaller-sized tube had a shorter length, and so they had to attach a separate connector to lengthen the tube for endobronchial intubation. Such connectors are not commonly available and may reduce the ID of the conduit, posing difficulty in suctioning.

Using 2 ETT gives the added advantage of providing CPAP to the operated lung while the other lung is being ventilated and simultaneously prevents cross-contamination. Disadvantages of this technique reported previously are the potential for vocal cord edema, stridor, mucosal damage, and a technical challenge to find two appropriately sized ETTs that can maintain optimal ventilation without causing injury. Providing CPAP to the operated lung during OLV helps prevent atelectasis and improves oxygenation during the procedure.[9] This can be achieved only with a DLT or using two cuffed ETTs. Our patient had a cysto-bronchial fistula where the application of CPAP was not desirable, and the major concern to prevent spillage was overcome by simply placing a suction catheter alongside the endobronchial tube. This is a simple technique that utilizes readily available equipment in the theatre and yet has never been reported in the literature.

CONCLUSION

Endobronchial intubation for achieving one-lung ventilation in pediatric patients where specialized equipment like DLT is not available is a convenient method but has its limitations. Extraluminal suction catheter placement in the trachea alongside the endobronchial tube prevents contamination of the preserved lung, especially in patients with a cysto-bronchial fistula. However, meticulous selection of endotracheal and catheter customization for the child is a prerequisite.

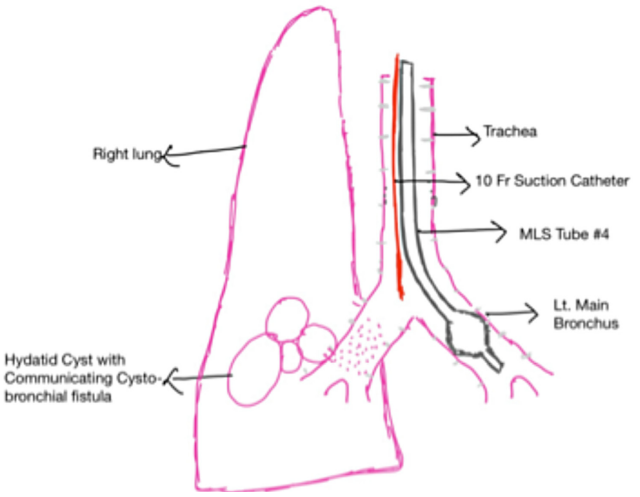

Figure 3. Pictorial representation of MLS tube size 4 and suction catheter assembly

DECLARAÇÃO DE CONTRIBUIÇÃO / *CONTRIBUTORSHIP STATEMENT*

GA e VAS: Conceito, projeto, pesquisa bibliográfica, preparação do manuscrito, edição e interpretação dos resultados.
RK: Conceção, desenho, edição do manuscrito e revisão crítica do manuscrito.
SS: Conceção, pesquisa bibliográfica, aquisição de dados, análise e edição.
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GA and VAS: Concept, design, literature search, manuscript preparation, editing and interpretation of results.
RK: Concept, design, manuscript editing and critical review of the manuscript.
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