Use of Fogarty embolectomy catheter for one lung ventilation during thoracic surgery in children: A prospective study

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ABSTRACT

Introduction

One lung ventilation (OLV) in pediatric patients is challenging. Fogarty Catheter can be used as a mechanical bronchial blocker to achieve OLV.

Methods

Ten pediatric patients undergoing lung isolation for thoracic surgery with Fogarty embolectomy catheter were prospectively studied. Catheter was inserted either through the endotracheal tube (ETT) or by the side of ETT. Proper positioning was done under C-arm fluoroscopy guidance and lung isolation confirmed with auscultation of chest.

Results

Eighty percent of patients underwent right lung isolation. Half of the subjects had Fogarty catheter placed through the ETT and remaining half had the catheter placed by the side of the tube. Number of attempts required for lung isolation was 1 to 4 and time required for proper catheter placement was 5 to 18 minutes. There were 4 episodes of desaturation in three patients which were successfully managed. Quality of lung isolation was good to excellent as per the feedback of operating surgeon. Number of attempts and time consumed for proper catheter placement were similar in both techniques. Number of attempts was more and time required for lung isolation was longer for isolation of left lung. Similarly, in patients who desaturated during the procedure, number of attempts were more and time consumed for lung isolation was longer.

Conclusions

Fogarty embolectomy catheter can be considered for lung isolation in pediatric patients. Both - through and by the side of endotracheal tube techniques of catheter insertion were similar in terms of time required for isolation, success of insertion, surgeons' comment on lung isolation and rate of complications.

Keywords: **children, Fogarty embolectomy catheter, one lung ventilation.**

Introduction

One lung ventilation (OLV) is performed to facilitate the thoracic surgical procedures[1]. Three types of devices are available for providing OLV during anesthesia: double-lumen endotracheal tubes (DLT), bronchial blockers (BB), and endotracheal tubes (ETT) [2,3]. There is no consensus on the best technique for lung isolation for thoracic surgery[4]. In adults and older children, the use of DLT is a standard practice[1,2,5,6]. The smallest sized DLT available is 26 Fr, which cannot be used in children younger than 7-8 years. In a resource limited setting, BB may not be routinely available.

Fogarty embolectomy catheter, though designed for the vascular occlusion, had been used successfully in pediatric patients for lung isolation[3,7]. This study was designed to evaluate the efficacy and safety of Fogarty catheter as bronchial blockers in pediatric population.

Material and methods

The study was conducted over the duration of two years (January 2015 to December 2016) at Tribhuvan University Teaching Hospital, Kathmandu, Nepal. All the consecutive pediatric patients aged 14 years or below, undergoing thoracic surgery and requiring one lung ventilation were enrolled in the study after due ethical and procedural consents as per the institutional regulations were obtained.

Patients were fasted as per institutional guidelines. Clear fluid was permitted till 2 hours before surgery and solid food or light meal was permitted till 6 hours before planned surgery[8]. In the operating room, IV access was secured with 20 or 22G cannula and standard monitoring was done. After preoxygenation, Fentanyl at dose of 2µg/kg and induction with Propofol titrated to loss of eye lash reflex and vecuronium at dose of 0.1mg/kg were administered. Appropriate sized Macintosh blade and endotracheal tube were used to secure the airway and the confirmation was done with auscultation and capnography. Lung isolation was done using 4-6 Fr. Fogarty embolectomy catheter, which was inserted either through or by the side of the ETT decided by randomization. For patients weighing less than 15 kgs, 4-5 Fr catheter was used. For larger patients, 6 Fr catheter was used. Fogarty catheter was placed by the consultant anesthesiologist involved in the intraoperative care of the patient. The tip of Fogarty catheter was advanced just distal to the carina (to the right or left side as indicated) and under real time guidance of C-arm fluoroscopy. Lung isolation was confirmed by auscultation of chest (Fig. 1).

The pressure in Fogarty catheter was not measured due to non-availability of pressure manometer. Fixed volume of air (as recommended by device production company) was used to inflate the balloon. If Fogarty catheter placement and lung isolation was unsuccessful, blind endo-bronchial intubation of the bronchus contralateral to the side of surgery would be attempted to facilitate one lung ventilation and if endobronchial intubation was also not successful, surgery would be attempted without lung isolation.

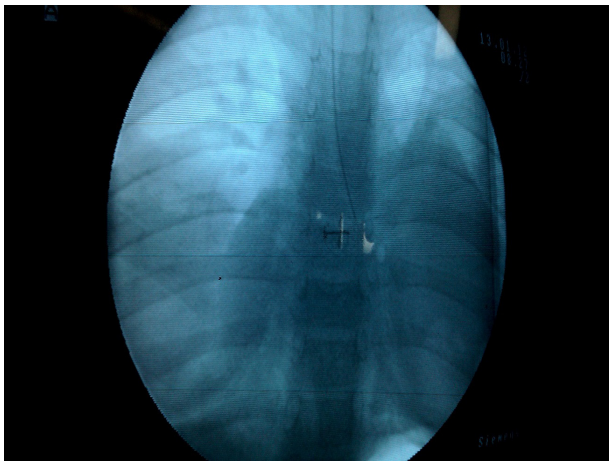

Figure 1. Isolation of left lung using Fogarty embolectomy catheter under C-arm fluoroscopy guidance.

Demographic characteristics of the patients, indication for surgery, side operated, size of Fogarty catheter used, method of catheter placement, number of attempts and time consumed for proper catheter placement and any episodes of desaturation during lung isolation were documented. Episode of desaturation was defined as peripheral oxygen saturation less than 90%, as detected by pulse oximeter. Mechanical ventilator was set at tidal volume of 6-8ml/kg and rate of 10-20 breaths/min to maintain end-tidal CO_2 below 40 mmHg and peak airway pressure below 35cm of H_2O. Anesthesia was maintained with Isoflurane and 100% oxygen. Muscle relaxation was attained using Vecuronium. Perioperative fluid management was done using Holliday and Segar's formula with Ringer's Lactate solution. After opening the thorax, the operating surgeon was asked to judge the quality of lung isolation using a 5-point scale (1 – poor; 2 – below average; 3 – average; 4 – good; 5 – excellent) as suggested by Grocott et al. in their study[9].

Results

Ten patients ranging from age 4 to 11 years and weighing 9 to 33 kg were enrolled. Of them, 80% were male and majority of them (80%) underwent surgery on the right side after lung isolation. Surgical procedures performed were pneumonectomy, lobectomy, enucleation of cyst and excision of cyst (Table 1).

Five of the cases had the Fogarty catheter placed through the ETT and remaining five had the catheter placed by the side of the tube for lung isolation. The median number of attempts required for lung isolation was 2 (range of 1 to 4) and time required for proper catheter placement was 5 to 18 minutes. There were 4 episodes of desaturation in

Table 1. Demographic characteristics of the patients, diagnosis and surgical procedure

Case No.	Age (years)	Sex	Weight (kg)	Diagnosis	Surgical procedure
1	7	M	13	Destroyed lung with bronchiectasis	Rt. Pneumonectomy
2	11	M	33	Hydatid Cyst	Rt. Enucleation
3	7	M	17	Thoracic Cyst	Rt. Enucleation
4	8	F	17	Hydatid Cyst	Rt. Enucleation
5	7	M	13	Broncogenic Cyst	Rt. Cyst Excision
6	5	F	15	Hydatid Cyst	Rt. Enucleation
7	5	M	13	Hydatid Cyst	Rt. Enucleation
8	8	M	21	Lung Carcinoma	Rt. Lobectomy
9	11	M	24	Cystic bronchiectasis	Lt. Pneumonectomy
10	4	M	9	Hydatid Cyst	Lt. Enucleation

three patients which were successfully managed by manual ventilation using 100% oxygen. Quality of lung isolation was good to excellent (grade 4-5) as per the feedback of operating surgeons (Table 2).

Table 2: Details of lung isolation

Case No.	Size of endotracheal tube (ETT) (in mm ID)	Size of Fogarty catheter (Fr)	Method of Fogarty placement	No. of attempts for catheter placement	Time consumed for catheter placement (mins)	Complications during catheter placement	Surgeon's feedback about quality of lung isolation
1	5.5	5	Through ETT	2	6	None	Good
2	6.0	6	By the side of ETT	1	5	None	Good
3	5.5	5	Through ETT	2	7	None	Excellent
4	5.5	5	Through ETT	2	5	None	Good
5	5.0	5	By the side of ETT	3	12	1 episode of desaturation	Excellent
6	5.0	5	By the side of ETT	2	8	None	Good
7	5.0	4	Through ETT	3	14	2 episodes of desaturation	Good
8	5.5	5	By the side of ETT	1	5	None	Good
9	6.5	6	Through ETT	3	17	1 episode of desaturation	Good
10	4.5	4	By the side of ETT	4	18	None	Good

When the two methods of lung isolation (through or by the side of ETT) were compared, number of attempts and time consumed for proper catheter placement were similar. The median number of attempts was 2, with the average time consumption of 9.8 minutes when lung isolation was done through the endotracheal tube. When lung isolation was done by the side of the tube, the median number of attempts was 2 with the average time consumption of 9.6 minutes. The median number of attempts for isolation of right lung was 2 with the average time consumption of 7.75 minutes. For the left sided lung isolation, the mean number of attempts was 3.5 times and the average time consumed for isolation was 17.50 minutes which was longer than for right sided isolation (median number of attempts was 2 times and average time consumed for isolation was 7.75 minutes).

Similarly, in patients who had desaturation during the procedure, median number of attempts was more (3 attempts for patients with desaturation and 2 attempts for those without desaturation) and average time consumed for lung isolation was longer (14.33 minutes for patients with desaturation and 7.71 minutes for those without desaturation). The duration of use of Fogarty catheter was 45 minutes to 2 hours. As we studied only 10 patients, we did not perform a formal statistical analysis.

Discussion

In this study, lung isolation was accomplished successfully with 4-6 Fr Fogarty embolectomy

catheters in 10 children undergoing lung resection for hydatid cyst enucleation, lung carcinoma, pneumonectomy and lobectomy. The findings were similar to the study by Camci et al.[10]. Left sided lung isolation needed more time compared with the right one as observed in a study by El-Agatyet al.[11]. However, lung isolation was completed within 20 minutes of induction as observed in the study by Camci et al.[10]. The number of attempts was more for left lung isolation but the episodes of desaturation were similar in both sides. Regarding the technique of placement of Fogarty catheter placed through or beside ETT, there was no difference in view of duration of successful lung isolation and number of attempts. Success of lung isolation graded by the surgeons was good to excellent quality as reported in El-Agaty et al study[11].

Fogarty catheter tip position should ideally be confirmed by Fiberoptic Bronchoscope (FOB). In our study, this was confirmed by C-arm fluoroscopy due to unavailability of appropriate sized FOB. In a resource limited setup like ours, appropriate sized DLT and FOB are usually unavailable and DLTs are more costly than Fogarty catheter. So, we chose to study the safety and feasibility of Fogarty embolectomy catheter for OLV in children. There were 4 episodes of desaturation which was successfully managed. Similar episodes of desaturation were observed in other studies[8,10].

The study has several limitations. Only 10 patients were enrolled in the study and the study was conducted in a single centre. The cuff pressure of Fogarty catheter was not measured. Only the episodes of desaturation were noted and were documented as possible complication of the procedure. Multicentred studies involving larger patient population may justify the results of this case series.

Conclusions

Isolation of lung in the pediatric age group has always been a challenge for anesthesiologists. Appropriate sized DLT and pediatric FOB are not easily available in resource limited settings. In such conditions, Fogarty catheter can be a reasonable option. Our case series revealed safety and feasibility of fluoroscopy guided use of Fogarty embolectomy catheter for OLV in children. Further studies may justify the findings.

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