

ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE SCHOOL OF MEDICINE DEPARTMENT OF ANESTHESIOLOGY, CRITICAL CARE AND PAIN MEDICINE

A research thesis on Perioperative Adverse Events and Outcomes of Rigid Bronchoscopy for pediatric Foreign Body Aspiration Removal at Tikur Anbessa Specialized Hospital: A Prospective Observational Study from September 1, 2025 to January 30, 2026

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ABSTRACT

Background: Foreign body Aspiration is a life threatening emergency situation among pediatric age group worldwide. Prompt diagnosis and removal are critical; however, the procedure itself carries significant anesthetic and surgical risks.

Objective: This study aims to comprehensively determine Perioperative Adverse Events and Outcomes of Rigid Bronchoscopy for pediatric Foreign Body Aspiration Removal at Tikur Anbessa Specialized Hospital: under a Prospective Observational Study in the study period.

Materials and Methods

Institution-based prospective observational study was done on 56 patients who had confirmed or suspected FBA with census sampling method, standardized and structured questionnaires were used. The collected data was cleared and entered to SPSS version 27. Descriptive and chi square test analysis was done.

Result: Thirty five (62.5%) had complications, hypoxia was the leading(58.9%), which has moderate improvement compared to 2020 study in TASH (85%) but still the incidence of hypoxia is higher compared to other developed countries. The independent predictors of intraoperative complication were number of broncoscopic retrievals more than 3 (AOR: 9.52, 95%CI: 2.65-34.2, P= 0.001) followed by preoperative oxygen requirement (AOR: 6.18, 95% CI: 1.48 – 25.90, p=0.011 and preoperative pulmonary infection (AOR: 5.12 95% CI: 1.15-22.85, P=0.032). Eight patients were admitted to ICU intubated. The independent predictor of ICU admission were the occurrence of post op complications (AOR: 11.45, 95% CI: 2.51-52.4, P=0.002), followed by preoperative pulmonary infection (AOR: 6.12, 95% CI (1.35 – 27.80), P=0.018.

Conclusion: Bronchoscopic foreign body aspiration removal remains high risk procedure which is associated with frequent intraoperative adverse events. Success rate of FBAR was good and no deaths recorded despite higher intraoperative adverse events. The commonest intraoperative complication was hypoxia.

Number of broncoscopic attempts more than 3 times followed by preoperative oxygen requirement and preoperative pulmonary infections were the strongest independent predictors of the occurrence of intraoperative adverse events.

The ICU admission rate was higher. The independent predictors of ICU admission were the occurrence of post op complications followed by preoperative pulmonary infection.

Keywords-Foreign body Aspiration, FBA Removal, Bronchoscopy, hypoxia, adverse event, outcome

ACRONYMS

ACCPM – Anesthesiology, Critical Care and Pain Medicine

AE – Adverse events

ASA - American society of Anesthesiologists

DOS - Duration of surgery

DOA -Duration of anesthesia

ETB - Ethiopian Birr

FBA - Foreign Body Aspirations

FBAR – Foreign Body Aspiration Removal

TB FBA – Trachea -bronchial Foreign Body Aspiration

GC - Gregorian calendar

PACU - Post Anesthetic Care Unit

PICU - Pediatric Intensive Care Unit

EOR - Emergency Operating Room

SPSS - Statistical Package for the Social Sciences

TASH - Tikur Anbessa Specialized Hospital

1. INTRODUCTION

1.1 Background

Foreign body aspiration (FBA) is a critical pediatric emergency and one of the leading causes of accidental morbidity and mortality in young children(1). Globally, up to 80% of tracheobronchial foreign body aspiration cases occur in children under three years of age due to their developmental tendency to explore objects orally and their limited protective airway reflexes.

The Global Burden of Disease (GBD) study highlights that thousands of children die each year from airway foreign bodies, and even more suffer long-term disability from delayed diagnosis or complications [8, 9]. The burden is most pronounced in Southeast Asia, North Africa, and Sub-Saharan Africa, where limited awareness, late referrals, and resource constraints compound the risk. If not promptly diagnosed and managed, FBA can result in severe complications such as asphyxia, pneumonia, atelectasis, bronchiectasis, and death(2, 3).

Rigid bronchoscopy remains the gold standard for both diagnosis and removal of aspirated foreign bodies in children. While the procedure is generally life-saving, it is not without risk(3). Reported adverse events include hypoxia, laryngospasm, bronchospasm, bradycardia, arrhythmias, mucosal injury, bleeding, and, rarely, pneumothorax or cardiac arrest(3). Mortality rates during bronchoscopy are low in developed countries, averaging (1)around 0.4%, largely due to the availability of skilled personnel, advanced equipment, and established perioperative protocols(1). Despite these improvements globally, outcomes remain more challenging in low- and middle-income countries, where delayed presentation, limited resources, and shortage of experienced providers increase the risk of complications(1).

In Ethiopia, Tikur Anbessa Specialized Hospital (TASH) serves as the largest referral center for pediatric emergencies, including foreign body aspiration. However, systematic data on the magnitude and types of adverse events associated with FBA removal in this setting are not adequate.

1.2 Statement of the Problem

Foreign body aspiration and its removal remain an important cause of pediatric morbidity and mortality. Rigid bronchoscopy is the gold standard for both the diagnosis and removal of aspirated foreign bodies. Despite its effectiveness, the procedure is associated with a range of perioperative adverse events, including hypoxia, laryngospasm, bronchospasm, airway trauma, bleeding, and, in severe cases, cardiopulmonary arrest. Although most complications during bronchoscopy are minor, major complications and death are still occurring (1). The incidence of these complications varies widely across studies, with reported rates influenced by factors such as patient age, duration of aspiration, presence of pulmonary infection, type and location of the foreign body, and perioperative anesthetic management.

Globally, improvements in anesthesia, surgical training, and equipment have reduced the mortality of FBA from nearly 50% in the early 20th century to less than 1% today [3]. However, outcomes remain worse in low- and middle-income countries due to delayed presentation, limited resources, and shortages of trained personnel [11]. In western countries, mortality rates during the procedure are estimated to 0.42 %(1).

At Tikur Anbessa Specialized Hospital, the largest tertiary referral center in Ethiopia, rigid bronchoscopy is routinely performed for suspected FBA. Despite the high case volume, there is limited systematically collected evidence on the magnitude of perioperative adverse events, associated risk factors, and patient outcomes the incidence of complications (both minor and major,) remains higher as a prospective study done by Dr. Netsanet on 2020. This discrepancy may reflect limited number of experienced surgeons and anesthesiologists, limited center with broncoscopy, late presentation, lack of protocols, as many procedures are conducted by residents.

In addition, while general anesthesia is the standard approach, there is no consensus on the optimal ventilation technique-whether spontaneous, controlled, or assisted ventilation during bronchoscopy in children. These gaps in knowledge and practice increase the risk of preventable adverse events and poor outcome

1.3 Significance of the Study

Despite the clinical and public health importance of FBA, the magnitude of adverse events from the study which was done five years back at TASH was higher than any other researches This study is significant as it addresses an important gap in evidence regarding the perioperative management and outcomes of pediatric patients undergoing rigid bronchoscopy for foreign body aspiration (FBA) removal in a resource-limited setting. Although rigid bronchoscopy is the standard of care, the procedure is associated with potentially serious perioperative adverse events, and there is limited prospective data from Ethiopia to guide clinical practice.

The findings of this study will provide valuable information on the magnitude and types of perioperative adverse events associated with rigid bronchoscopy in children.

As a result I decided to conduct this study to know the recent incidence of adverse events outcomes of FBAR in TASH, considering that the findings will help to

Quantify the burden and types of intraoperative and postoperative complications and compare with the previous studies

Identify the major risk factors

Guide improvements in training, equipment availability, and the anesthesia practice

Inform institutional protocols and potential national guidelines

Finally, this research aims to reduce morbidity and mortality from pediatric FBA in Ethiopia by generating evidence- based recommendations for safer and more effective care.

2. LITERATURE REVIEW

Foreign body aspiration (FBA) is a major pediatric emergency that continues to cause significant morbidity and mortality worldwide. Children, particularly those younger than three years, are at greatest risk due to their tendency to place small objects in the mouth and their immature airway protective reflexes(1, 2) . Emergency rigid tracheobronchoscopy and forceps removal of aspirated foreign bodies under general anesthesia and with meticulous perioperative monitoring is a safe and effective procedure with no mortality (2, 4). Even in suspected aspiration or chronic bronchopulmonary infections, liberal use of endoscopy is recommended(4). Inhaled foreign bodies may lodge anywhere along the airway, but most are found in the bronchi. The severity of presentation depends on the location, size, and nature of the aspirated material(1) .

Complications of FBA and Removal

While rigid bronchoscopy is regarded as the gold standard for removal, it carries inherent risks(1). Reported intraoperative complications include hypoxemia, laryngospasm, bronchospasm, arrhythmias, bleeding, airway edema, and rarely pneumothorax or cardiac arrest [3, 4]. Postoperative complications include stridor, respiratory distress, and prolonged oxygen requirements(1).

In a review of 12,979 cases, Fidkowski et al. reported a mortality rate of 0.42% during bronchoscopy, with most complications being minor and reversible(1), Similarly, Hasdiraz et al., in a large Turkish series of 1,035 cases, found an overall complication rate of 13.4%, though major complications were rare. Hypoxemia as the Leading Adverse Event- Hypoxemia is the most common intraoperative adverse event during bronchoscopy for FBA(5). A prospective Indian study of 71 children reported desaturation in 25% of patients [7]. In another meta-analysis of five studies done in China involving 423 children, desaturation occurred in both spontaneous and controlled ventilation groups, with no statistically significant difference between techniques (1). Risk factors for intraoperative hypoxemia include younger age, prolonged procedure(5) (1) duration, pre-existing pneumonia, and type of foreign body aspirated (1, 5). Jet ventilation with intermittent apnea technique prevents hypoxemia(5, 6). Muscle relaxation, if necessary can be achieved by using succinylcholine by bolus or intermittent

doses or non-depolarizing relaxants; shorter acting agents (e.g. mivacurium or atracurium) may be used, to avoid prolonged neuromuscular blockade at the end of a short duration bronchoscopy(6). Use of muscle relaxation requires controlled ventilation, prevents coughing, trauma and facilitates removal of foreign bodies through the vocal cord(6). Other Adverse Events -Other adverse events include laryngospasm, bronchospasm, and airway trauma(5). In the same Indian study, airway mucosal bleeding was observed in 19%, airway edema in 8%, and bronchospasm in 2.8% [7]. A Pakistani series of 81 children found laryngospasm in 16%, laryngeal edema in 13.6%, and mucosal bleeding in 7.4% [1]. Rare but serious complications such as pneumothorax and cardiac arrest have also been reported [6, 10].

Global and Regional Trends-Globally, improvements in anesthesia, surgical training, and equipment have reduced the mortality of FBA from nearly 50% in the early 20th century to less than 1% today [3]. However, outcomes remain worse in low- and middle-income countries due to delayed presentation, limited resources, and shortages of trained personnel [11]. In a large retrospective study from Northwestern China involving 2,000 children, there were 15 deaths, and mortality was higher among younger patients and those presenting with severe airway obstruction [12, 37].

African experience- Several studies from Africa a similar pattern: children under five year's old, peanut or seed aspiration as the leading causes, and high rates of late presentation. Egyptian series show complication rates approaching 20% from 3000 cases when bronchoscopy is delayed for more than 24 to72hrs [33, 39]. The Nigerian study was a 5-year retrospective review of 24 patients who were confirmed to have tracheobronchial foreign bodies. From 24 patients 22 had delayed presentation had higher complications and mortality (2 cases died) (22, 2334). From Ghanaian hospital study, 40 cases 20% of them had complications mainly due to delayed diagnosis (40). In South Africa, late referral from peripheral centers and socioeconomic barriers remain major challenges, with pneumonia and hypoxia as common squeal [22, 23, and 34].

Local Context-In Ethiopia, FBA is an established challenge. Published data on adverse events related to FBA removal are scarce. In a retrospective study done on 2017 at TASH from the total of 150 FBA patients 68(46%) developed complications, from these

44(64.7%) were aspiration pneumonia, 12(17.6%) and 8(11.8%) of patients developed minimal bleeding and upper air way obstruction respectively (20). In another study done at TASH in 2020, a total of 60 FBA cases were studied. FBA removal was successful in 56 patients (36). The commonest adverse event was desaturation in 51 patients (85%) followed by one lung ventilation54 (75%), persistent hypoxia34 (56.7%), airway mucosal bleeding34 (56.7%), laryngospasm 14(23.3%), airway or laryngeal edema 13(21.7%), bradycardia 9(15%), esophageal intubation 5(8.3%) and inadequate depth of anesthesia 2(3.3%). There were two cases of tracheobronchial fistula with tension pneumothorax. Among the study participants 7 patients needed PICU admission. There was no death. Mode of ventilation, duration of surgery, surgeon's experience, and occurrence of adverse events such as laryngeal edema, persistent hypoxia and bradycardia had stastically significant association with PICU admission (36). From this study, FBA was successfully removed in 87.9% of patients and the remaining 7(12.3%) had no FBA which was a similar finding as Pakistan's where successfully extracted FB were 71(87.7%) and no foreign bodies were detected in the remaining 10(12,3%) patients(36).

Work from Tikur Anbessa Specialized Hospital has shown that many children present only after prolonged symptoms, often days after the initial aspiration [24, 25]. Early studies by Melaku et al. [26] documented the spectrum of airway and digestive tract foreign bodies in Addis Ababa. Subsequent work by Bekele [27] and Tadesse [28] highlighted diagnostic delays, lack of adequate equipment, and significant perioperative risks another study at TASH was showing that the magnitude of adverse events were higher than any other researches. The incidences of serious tracheobronchial trauma with bronco-pleural fistula were 2(3.3%). This observed proportion was higher, than other results and even large scale studies and reviews showed, but the confidence interval was wide due to small sample size.

3. OBJECTIVES OF THE STUDY

3.1. General objective

To assess the Perioperative Adverse Events and Outcomes of Rigid Bronchoscopy for pediatric Foreign Body Aspiration Removal at Tikur Anbessa Specialized Hospital: under A Prospective Observational Study in the study period

3.2. Specific objectives

To determine the magnitude of intraoperative adverse events occurring during foreign body aspiration removal in the pediatric age group at TASH.

To identify factors associated with the occurrence of perioperative adverse events during foreign body aspiration removal.

To assess the postoperative complications, disposition and overall outcomes of children undergoing foreign body aspiration removal.

To determine the proportion of patients requiring postoperative mechanical ventilation following foreign body aspiration removal.

4. METHODOLOGY

4.1 Study design

An institutional-based prospective observational study was done

4.2 Study Area and period

The study was done the emergency operating rooms of Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia, from September 1, 2025 to January 30, 2026.

TASH is Ethiopia's largest teaching and referral hospital, serving patients from across the country. It provides a wide range of surgical and medical specialties, with the exception of transplantation surgery. The hospital has three major operating theater complexes dedicated to elective procedures, comprising a total of 14 operating rooms.

The main operating theater, located within TASH, houses 11 surgical tables, including two tables designated for emergency procedures (one on the 3rd floor and another on the 4th floor). In addition, there are separate operating rooms for obstetrics and orthopedics.

The main emergency operating rooms (EOR) handle all urgent surgical cases except obstetrics, neurosurgery, urology, and orthopedic emergencies, which are performed in their respective specialty theaters.

Pediatric emergency surgeries, including rigid bronchoscopy for foreign body removal, are performed in the main EOR. These procedures are carried out collaboratively by pediatric surgeons (and their residents) together with anesthesiologists and anesthesiology residents, who provide perioperative anesthesia care.

The hospital also has a four-bed Pediatric Intensive Care Unit (PICU), managed by pediatric intensivists, where critically ill children and those requiring postoperative intensive monitoring, including mechanical ventilation, are admitted.

4.3. Population

4.3.1 Source population

All pediatric patients (aged 0–14 years) who came to EOR of TASH during the study period

4.3.2 Study population

All pediatric patients who came with FBA within the study period who met the inclusion criteria.

4.4. Eligibility criteria

4.4.1. Inclusion criteria

Children aged 0–14 years for whom bronchoscopy was done for suspected or confirmed foreign body aspiration.

Patients whose caregivers gave informed consent to participate in the study.

4.4.2. Exclusion criteria

1. Pediatric Patients with FBA who were intubated and were on mechanical ventilation and admitted to ICU pre procedurally.

2. Pediatric patients who had rigid bronchoscope procedure for other indication than suspect of foreign body aspiration

3. Patients whose guardians/parents refused consent for participation.

4.5. Sample size determination and procedure

4.5.1 Sample size determination

Census sampling method was employed.

To determine the sample size, single proportion formula was used.

$$n = \frac{(Z\alpha/2)2\ p\ (1-p)}{d2}$$

$$n = \frac{(1.96)^2\ (0.85)\ (1-0.85)}{(0.05)^2} = 0.4898/0.0025=196$$

Where: n = desired sample size

z = z value at 95% confidence interval (CI)

p = complication rate during foreign-body aspiration removal was 85% from Tikur Anbessa (AAU thesis, 2020**)** — prospective review of FBA cases

d = margin of error=0.05

Since the total cases seen during the previous study was 60 which is <10000

Using the reduction formula Nf = no/ (1+ (no)/N= 196/(1+196/60)=49 and adding 10% probability of non-respondents, n= 54.

Since the study was conducted over a fixed period of months, which was similar to the 2020 study that included 60 cases, all pediatric cases that underwent bronchoscopic FBAR for confirmed or suspected FBA in the study period were included.

4.5.2 Sampling procedures

Institutional based census sampling was used.

4.6 variables of the study

4.6.1 Dependent variable

Primary dependent variables: Occurrence of perioperative adverse events

(Secondary: Type of event, outcome (ICU admission, ward admissions, discharge, death)

4.6.2 Independent variable

Socio -demographic variable: age, sex

Patient factor: ASA status, co-existing diseases or co morbidities, type of foreign body aspiration, duration of initial presentation after FBA

Procedural factors:, type of ventilation (controlled, spontaneous or both), number of bronchoscope attempts, duration of surgery, duration of anesthesia, airosilization with Lidocaine before the procedure one lung ventilation, inadequate depth of anesthesia and the experience of the surgeon and a anesthesia provider .

4.7. Operational definitions

1. Pediatric patients: all patients less than 14 years of age.

2. Adverse Event Any untoward, unintended clinical occurrence that happens during or after foreign body aspiration removal, which is temporally associated with the procedure, regardless of direct causal relationship.

3. Magnitude of Adverse Events The proportion (%) of pediatric patients undergoing foreign body aspiration removal who develop one or more adverse events Magnitude=Number of patients with ≥1 adverse event/Total number of patients undergoi ng removal×100

4. Type of ventilation is the ventilation that we use during general anesthesia. It can be

a. Spontaneous ventilation is natural breathing where a patient controls their own respiratory rate, timing, and depth, using their diaphragm to create negative pressure to move air in and out without assistance

b. Assisted ventilation is patient is not on muscle relaxants but needs clinician assistance on breathing

c. Controlled ventilation a patient is on muscle relaxation and need clinician or machine full support of ventilation

d. Controlled ventilation without relaxant a patient is not on muscle relaxation and need clinician or machine full support of ventilation

5. Duration of anesthesia is defined as the time period from the transfer of the patient to the operating room and put on monitors to the transfer of the patient to PACU or ICU.

6. Duration of surgery is defined as the time period from the initial introduction of the rigid bronchoscope tip in to the patient's mouth to the final removal of the bronchoscope from the vocal cords.

7. Laryngospasm is the closure of the vocal cords that obstructs ventilation of the lungs, and it may also be identified clinically by the treating physician whenever it requires intervention.

8. Bronchospasm is defined as a prolonged expiratory phase accompanied by wheezing and desaturation which can also defined by the managing physician diagnosis with any need of intervention.

9. Bradycardia is defined as a resting heart rate of below the base line of beats per minute according to age of the patients. < 1 years old <105 beat/ min, 1 - 5 years old <85 beat / min, 6 – 10 years < 70 beat / mi n, >=12 years old <60 beat/min for more than 15 seconds either with ECG or stereoscope.

10. Desaturation / Hypoxia is defined as a SpO2 level of 94% or below for more than 15 sec.

11. Aspiration is entrance of foreign body or material or fluid in to trachea -bronchial tree which can also done by physician diagnosis with any need of intervention

12. Mucosal bleeding is defined as the presence of bleeding associated with the bronchoscope procedure.

13. Persistent Hypoxia (clinical emergency hypoxia) is defined as SPO2 level of less than 90% for greater than or equal to 30 sec

14. Serious trauma to trachea -bronchial tree is defined as major air way trauma like pneumo -thorax, pneumo -mediastinum and surgical emphysema which can also done by physician diagnosis with any need of intervention .

15. Monitor interruption – defined as any interruption of monitors from continuous ASA standard monitor. Monitor interruption after looking the presence of adverse events like

the patients is desaturation and bradycardia considered as presence of those adverse events if the interruption last more than 15 sec.

16. Duration of hospital stay – from the time procedure will be done for FBA to the time the patient is discharged to home in hr. or days.

17. Cardiac arrest is defined as absent of pulse in carotid artery for > or = to 10 sec.

18. Mortality-death that occurs during surgery or hospital stay until the patient is discharged

4.8 Data collection procedure and questioner development

Data collection tool : To differentiate those patient with intra operative adverse events during FBAR , Structured standardized observational data collection tool Were prepared from different published research papers and were tested on 5% of cases and refined before use.

Data was collected in the study period by assigned EOR attaching residents for all pediatric foreign body aspiration patients who fulfill inclusion criteria after training was given by the principal investigator.

Transfer of data were started by filling the questionnaires as soon as the patient came to EOR or as soon as it was feasible and completed when the patient discharged or expired. Anesthetic chart and the surgeons´ notes were reviewed for completeness of questioners for each patient.

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4.9. Data quality controls

.Completeness of data collection was monitored and checked by the principal investigator. All filled questionnaires were checked for completeness and consistency during data management, storage and analysis

4.10. Data analysis technique

All completed questionnaires were coded.

Development of data entry templates, data cleaning, processing, analysis and the overall data management was done by the principal investigator using Epic data and the Statistical Package for Social Sciences (SPSS) software.Descriptive frequencies and percentages were done

Bi-variate correlation method was used with Chi square for 2 by 2 cross tabulation ,Fishers Exact test for count less than 5 expected count in the sample and Kendall's Tau Coefficient for non - parametric or non -uniform continuous samples to determine which independent variables was associated with dependent variable. Multi variable regression model was used for those p – value <0.2 from bi-variate analysis and clinically significant variables. Finally from multiple regression model $p<0.05$was considered statistically significant AOR and 95% confidence interval were used during reporting.

4.11. Ethical consideration

The thesis was reviewed and approved by the research and ethics committee of department of Anesthesiology, critical care and pain medicine, AAU. The nature and purpose of the study was told to family member or to legal guardian of the patient to be included in the study and written informed consent was taken from family or legal guardian. The questioner did not include names, addresses or other identifying information about the study participant.

4.12 Dissemination of the Study

The findings of this study were presented to the department of ACCPM in the presence of anesthesiologists, resident, researchers, and relevant college officials. Following the presentation, the final report will be submitted to a reputable peer reviewed journal for publication in a similar context.

5. RESULTS

5.1 socio-demographic factors

56 patients were included in the study. Males were 37(66.1%) and females were 19(33.9). The lowest age was 5 months and the highest age was 168 months. The mean age was 52.2 months.

5.2 Descriptive analysis

41 patients (73.2 %) arrived to the hospital lately after 24 hrs. and 15 patients (26.8%) before 24hrs. The most common reason for delayed presentation was referral from another hospital (38 patients) 67.9%, followed by family were not aware of FBA (10.7%). 10 patients (17.9) had no delay. 54 patients (96.4%) were ASA I and 2 patients were ASA II. Fasting /NPO/ duration of most patients (54) was more than 6 hr., only 2 patients had NPO of less than 6hr.Two had coexisting medical illness, one was known asthmatic and the other had hyperactive airway disease.

33 patients (58.9%) were not on respiratory distress; only 23 patients were on distress. 17 patients (30.4%) had aspiration pneumonia. 30 patients (53.6%) were not on oxygen therapy before the procedure, while 26 patients (46.4%) were requiring oxygen. From those who needed oxygen 21 patients were on nasal cannula and 5 patients were on facemask.

43 cases (76.8%) were done by anesthesiology and pediatric surgery residents followed by 10 cases by anesthesiologist and pediatric surgeon. 32cases (57.1%) were done at night time as urgent/ emergent cases, whereas 24 cases were done at day time as urgent/emergent cases.

Regarding induction of anesthesia, it was a combination of the following drugs, propofol (100%), fentanyl (92%) and isoflurane (16.1%) respectively. Suxamethonium was given for 2 patients for induction. The maintenance anesthetic drugs were propofol (98.2%), isoflurane (67.9%) and ketamine (12.9%). Pre-operative air way lidocaine aerosolization was done for most of the patients 53 (94.6%). Mode of ventilation for most of patients was controlled ventilation without muscle relaxant 50 patients (89.3%), followed by controlled ventilation with muscle relaxant 5 patients (8.9%). One patient was done with

spontaneous mode of ventilation. For most of patients number of bronchoscopic procedures at different times were two times (41.1%), followed by 3 times (32%).Most of the foreign bodies were removed with ≤ 3 attempts. In 8 patients foreign body was removed with single attempt. And the maximum attempt to remove a FB was 6.

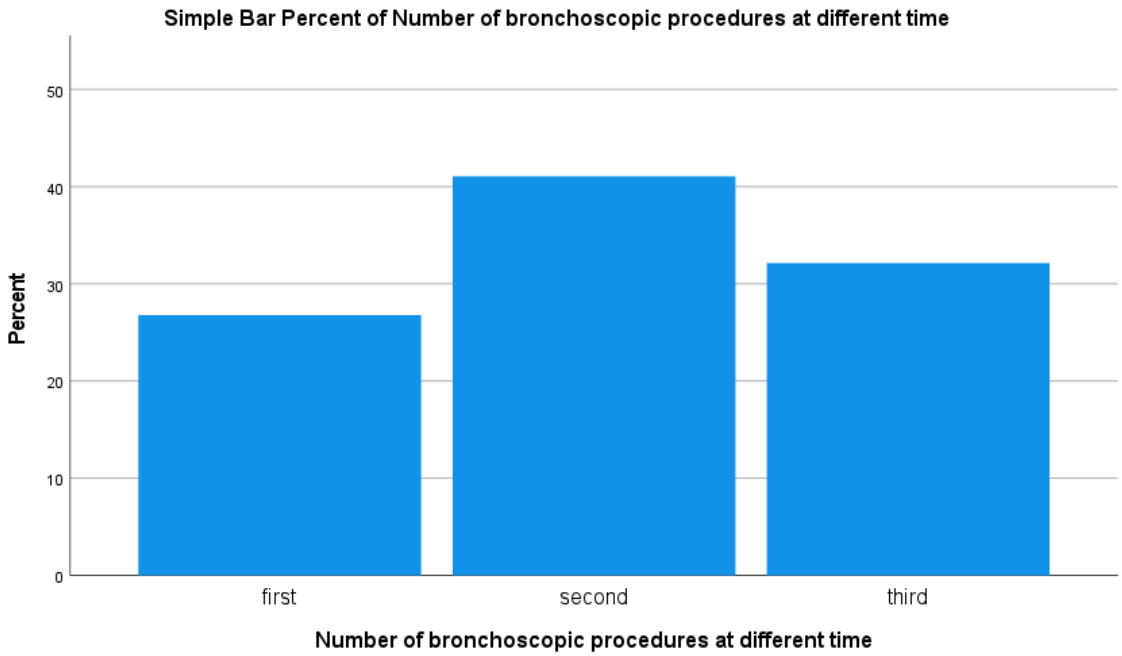

Figure 1; number of bronchoscopys at different time

FBAR was done successfully for 54 patients. One patient had repeat bronchoscopy after 1st day bronchoscopy was cancelled because of intraoperative instability (hypoxia, bradycardia, bilateral pneumothorax and cardiac arrest) no foreign body was found on one patient.

There were 8 monitor interruptions during the procedure all were due to pulsoxymetry disconnection. The mean DOS and DOA were 31.9 and 54.8minutes. The Maximum and minimum durations were 10-70 and 20-120 minutes. Most procedures were done within 20-40 minutes and most anesthesia durations were within 30-60minutes. The most common site of foreign body impaction was the right main bronchus (73.2%), followed by the left main bronchus (12.5%) and trachea (10.7%). This is expected because the right bronchus is wider and more vertical.

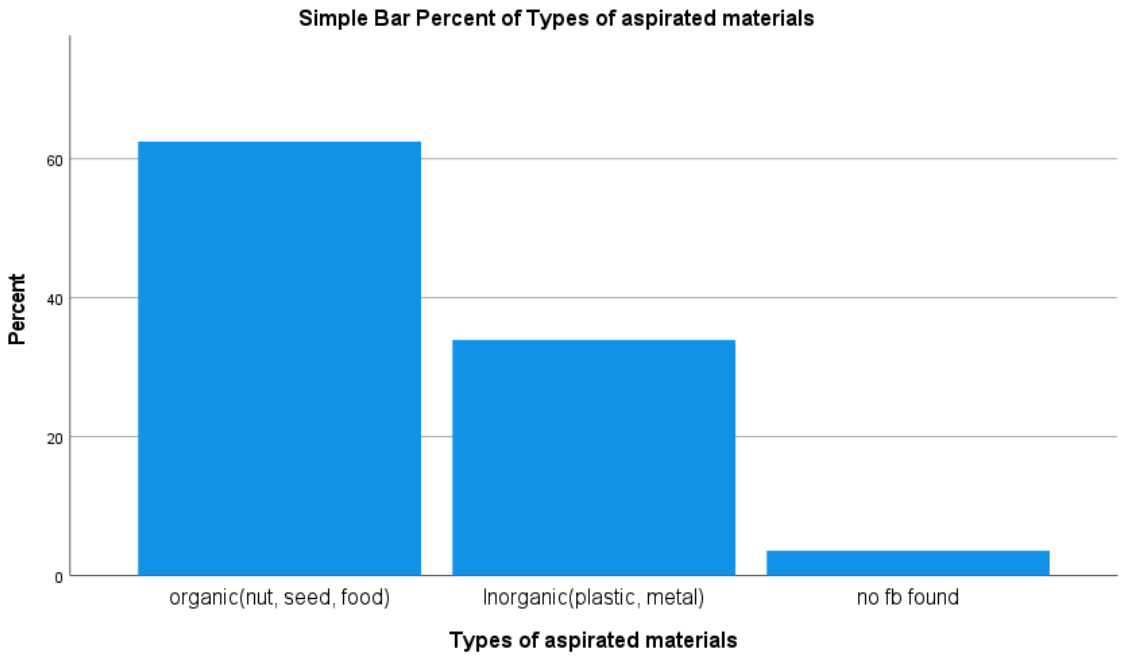

Figure 2;Type of aspirated material

Cont...

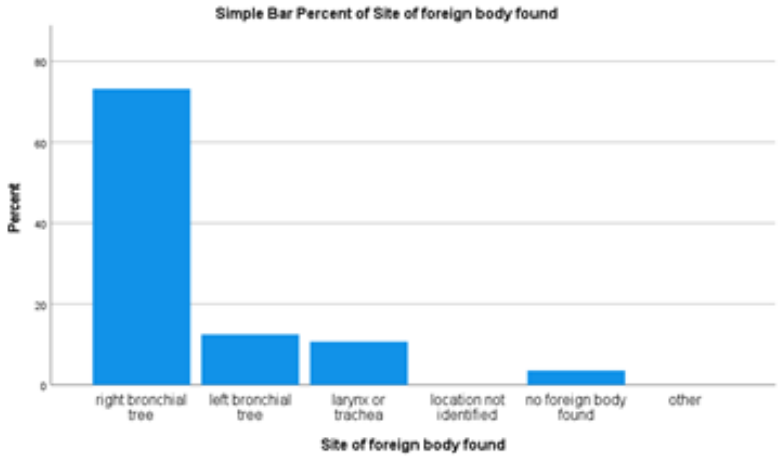

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Figure 3;site of foreign body found

62.5 % of aspirated foreign bodies were organic. One patient was rescoped on another day and FB was removed.

(62.5%) of patients had intraoperative complications, hypoxia was the leading (58.9%), persistent hypoxia for >2min (8.9%), airway edema (8.9%), laryngospasm and bronchospasm (5.4%) each, 02 pneumothorax (3.6%), one patient had bradycardia and cardiac arrest (1.8%) 2ry to persistent hypoxia 2ry to bilateral pneumothorax. Atropine and One cycle of CPR was done and ROSC was achieved, bilateral chest tube was inserted and the procedure was done on another day after the patient was stabilized. There was another patient who had intraoperative pneumothorax for which right side chest tube was inserted and transferred to PICU for monitoring. Duration of hypoxia was 1-5 min in 17 patients, <1 min in 12 patients.

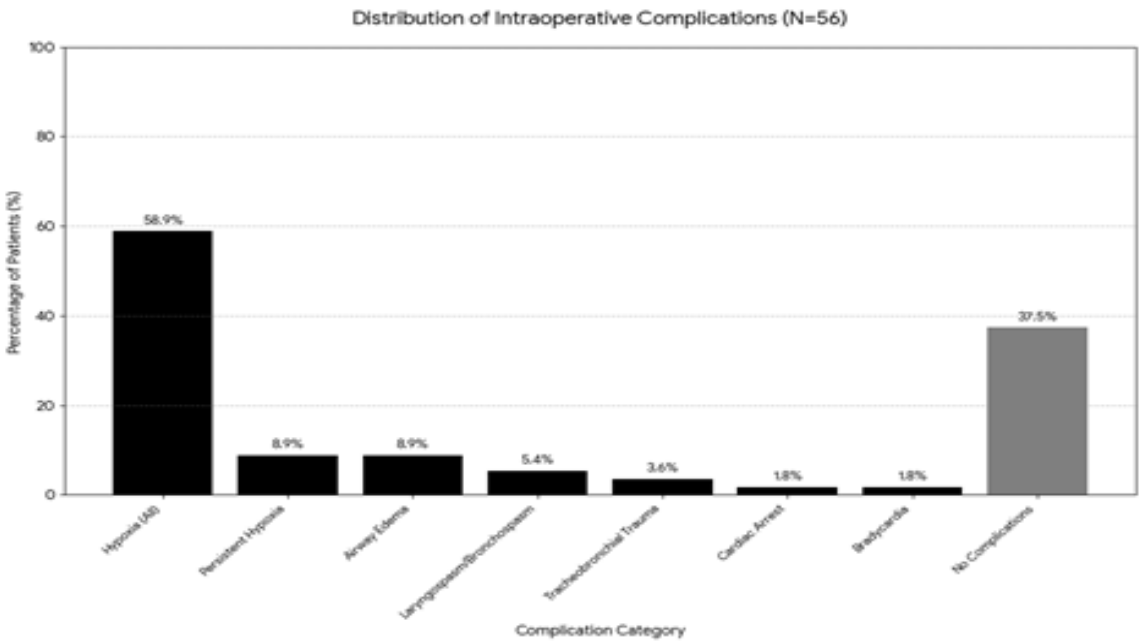

Figure 4;distribution of intraoperative complications

Most hypoxias occurred during scoping of right main bronchus. Most hypoxias were managed by two lung ventilation mainly, followed by increasing depth of anesthesia and bronchodilators.

7 patients had postop complications. These complications were hypoxia, laryngospasm, laryngeal edema and pulmonary infections. Most patients (83.9%) were stable, transferred to PACU then to wards. From a total of 56 patients, 8 patients (14%) were transferred to PICU (intubated). 57.1%) of patients were discharged after 2-3 days of hospital stay. 21.4% stayed for less than 24hrs, 21.4% stayed >3days. No patient has died during this study period.

5.3 Association factors analysis

The dependent variables such as intraoperative complications, intra operative desaturation (hypoxia), persistent hypoxia, laryngospasm, laryngeal edema, bradycardia, and procedural outcome were assessed with independent variables using chi-square test and fisher exact test

From the analysis preoperative oxygen therapy (p=0.019), the presence of pulmonary infection prior to the procedure (p=0.020) and the number of bronchoscopy's (p=0.037) had significant association with the occurrence of intraoperative complications

There was no strong statistical association between the occurrence of intraoperative complication and whether the procedure was done by senior or resident, the mode of mechanical ventilation, duration of surgery and the type of aspirated foreign body; even though it is known they have strong clinical association.

Table 5.1 Bi-variate Analysis of Factors Associated with Intraoperative Complications

Variable (Sub-category)	Complication: Yes (n=35)	Complication: No (n=21)	Odds Ratio(95% CI)	P-value
Age (months) (Mean ± SD)	44.57 ± 42.89	64.95 ± 42.65		0.090
Weight (kg) (Mean ± SD)	14.61 ± 7.79	18.67 ± 7.11		0.08
Number of retrieval attempts	3.09 ± 1.27	2.57 ± 1.43		0.168

(Mean ± SD)				
Duration of surgery (min) (Mean ± SD)	31.86 ± 13.34	32.14 ± 14.37		0.940
Sex-female	12 (63.2%)	7 (36.8%)		1.000
- Male	23 (62.2%)	14 (37.8%)		
Aspirated material type-inorganic	9 (47.4%)	10 (52.6%)		0.204
- None	1 (50.0%)	1 (50.0%)		
- Organic	25 (71.4%)	10 (28.6%)		
Site of FBA	4 (66.7%)	2 (33.3%)		0.240
- Left	2 (28.6%)	5 (71.4%)		
- None	1 (50.0%)	1 (50.0%)		
- Right	28 (68.3%)	13 (31.7%)		
Duration of aspiration<24hr	28 (68.3%)	13 (31.7%)		0.243
- > 24 hours	7 (46.7%)	8 (53.3%)		
Preoperative oxygen therapy-no	14 (46.7%)	16 (53.3%)	1.0 (Reference)	0.019
- Yes	21 (80.8%)	5 (19.2%)	4.8 (1.4 – 16.4)	
Preoperative pulmonary infection-no	20 (51.3%)	19 (48.7%)	1.0(reference)	0.020
- Yes	15 (88.2%)	2 (11.8%)	7.1(1.4-35.2)	
Number of bronchoscopic procedures-1st	6 (40.0%)	9 (60.0%)		0.037

- 2nd time	14 (60.9%)	9 (39.1%)		
- 3rd time	15 (83.3%)	3 (16.7%)		

Table 5.2 Multiple Logistic Regression: analysis of Predictors of intraoperative Complications

Predictor Variable	**Adjusted Odds Ratio (AOR)**	**95% Confidence Interval (CI)**	**p-value**
Number of Retrieval Attempts ($>3 attempts)	**9.52**	(2.65 – 34.20)	**0.001***
Preoperative Oxygen Requirement (Yes)	**6.18**	(1.48 – 25.90)	**0.011***
Preoperative Pulmonary Infection (Yes)	**5.12**	(1.15 – 22.85)	**0.032***

Note: Statistically significant at $p < 0.05$. Reference categories: <3 attempts, No oxygen requirement, and No infection.

Multiple regression analysis models were used for those variables whose p value was less than 0.2. Three variables with lowest p value were taken.

As seen from table 5.2 the independent predictors of intraoperative complication were number of broncoscopic retrievals more than 3 (AOR: 9.52, 95%CI: 2.65-34.2, P= 0.001) followed by preoperative oxygen requirement (AOR: 6.18, 95% CI: 1.48 – 25.90, p=0.011 and preoperative pulmonary infection (AOR: 5.12 95% CI: 1.15-22.85, P=0.032). This shows mechanical airway trauma and prolonged manipulation causes airway injury and edema. In addition the presence of pulmonary infection likely causes

reduced FRC, increased airway reactivity make them to have complications regardless of other factors.

Table 5.3 Bi-variate analysis of factors association with intraoperative hypoxia

Variable	Hypoxia: Yes (n=33)	Hypoxia: No (n=23)	Odds Ratio(95% CI)	P-value
Age (Mean ± SD)	43.64 ± 42.36	64.52 ± 43.19		0.077
Weight (Mean ± SD)	14.58 ± 7.93	18.35 ± 7.03		0.072
Retrieval attempt (Mean ± SD)	3.15 ± 1.25	2.52 ± 1.41		0.085
Aspirated material –organic	24 (68.6%)	11 (31.4%)		0.163
- Inorganic	8 (42.1%)	11 (57.9%)		
- None	1 (50.0%)	1 (50.0%)		
Aspiration duration >24hr	6 (40.0%)	9 (60.0%)		0.151
- < 24 hours	27 (65.9%)	14 (34.1%)		
Preoperative oxygen therapy- yes	20 (76.9%)	6 (23.1%)	4.36(1.36-19.8)	0.023
- No	13 (43.3%)	17 (56.7%)	1.0	
Pulmonary infection- yes	14 (82.4%)	3 (17.6%)	4.91(1.2-19.8)	0.040
- No	19 (48.7%)	20 (51.3%)	1.0	
Bronchoscopic procedure-1st	5 (33.3%)	10 (66.7%)		0.034
- 2nd time	14 (60.9%)	9 (39.1%)		
- 3rd time	14 (77.8%)	4 (22.2%)		

As shown on table 5.2 patients who required preoperative oxygen therapy and who had pulmonary infection (p=0.023 and=0.04) had strong stastical association to intraoperative

hypoxia. Hypoxia risk was higher with increased number of bronchoscopic procedures (p=0.034). It was higher in 3rd procedure which may suggest repeated attempts may cause airway edema and reactivity

Table 5.4 Bi-variate association of post-operative complication and the risk factors

Associated Factor	Post-op Cpx: YES (n=7)	Post-op Cpx: NO (n=49)	P-value
Intraoperative Complication			0.076†
- Yes	6(85.7%)	29(59.2%)	
- No	1(14.3%)	20(40.8%)	
Number of Procedures			0.155
- 1st Attempt	0(0.0%)	15(100%)	
- 3rd Attempt	5(71.4%)	13(26.5%)	
Pulmonary Infection			0.227
- Yes	5(71.4%)	12(24.5%)	
- No	2(28.6%)	37(75.5%)	
† Approaching statistical significance due to small "Yes" group size.			

From the analysis result Because of the small sample size and fewer yes responses the statistical association results are >0.05.But clinically the occurrence of intraoperative

complications, preoperative pulmonary infections and increased bronchoscopic attempts are strong predictors of postoperative complications.

Table 5.5 Bi-variate association of patient disposition and risk factors

Factor	ICU / High-Level Care (n=8)	Ward / Discharge (n=47)	P-value
Post-operative Complication			<0.001
- Yes	5 (71.4%)	2 (28.6%)	
- No	3 (6.1%)	45 (93.9%)	
Pulmonary Infection			0.011
- Yes	6 (35.3%)	11 (64.7%)	
- No	2 (5.1%)	36 (94.9%)	
Preoperative Oxygen Therapy			0.031
- Yes	7 (26.9%)	19 (73.1%)	
- No	1 (3.3%)	28 (96.7%)	
Intraoperative Complication			0.04
- Yes	8 (22.9%)	26 (74.3%)	
- No	0 (0.0%)	21 (100%)	
Bronchoscopic Procedure			0.155

- 1st time	0 (0.0%)	15 (100%)	
- 2nd time	3 (13.0%)	19 (82.6%)	
- 3rd time	5 (27.8%)	13 (72.2%)	

As seen from the table factors which has significant association for ICU admission were postoperative complications, preoperative pulmonary infections, preoperative oxygen requirement and patients who had intraoperative complications.

Table 5.6 Multiple Logistic Regression: analysis of Predictors of ICU admission

Predictor Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	p-value
Post-operative Complication	11.45	(2.50 – 52.40)	0.002*
Pulmonary Infection	6.12	(1.35 – 27.80)	0.018*
Preoperative Oxygen Therapy	4.3	(0.95 – 19.40)	0.058

As seen from this table of multiple regression analysis the independent predictor of ICU admission were the occurrence of post op complications (AOR: 11.45, 95% CI: 2.51-52.4, P=0.002), followed by preoperative pulmonary infection (AOR: 6.12, 95% CI (1.35 – 27.80), P=0.018

6. DISCUSSIONS

The findings of this prospective study show the incidence of intraoperative complications, hypoxia is the commonest. The overall success rate of FBAR was high.

FBA was common in males (66.1%) which is consistent with the findings of the previous studies .The average ages were 4 years and 4months slightly higher than other studies which was 3years and below.

A significant proportion of patients (73.2%) presented more than 24 hours after aspiration, with referral from other healthcare facilities being the main cause of delay. Delayed presentation is a known risk factor for complications, as it increases the likelihood of airway inflammation, infection, and distal migration of the foreign body. Delay was slightly lower than the TASH 2020 thesis (80%) but higher than other African studies like Egypt and was a major predictor for the occurrence of intraoperative complications in many large scale studies.

Most of the cases 43(76.8%) were done by anesthesiology and pediatric surgery residents at night as urgent/emergent case. Despite this, success rate of FBAR was better (95%) compared to the previous study in TASH (87.9%).This suggests improvements in perioperative management and skills.

The most common site of FBA was at the right main bronchus (73.2%) higher than the previous study in TASH which was 64.3%. This is expected because the right bronchus is wider and more vertical. Aspiration of organic foreign bodies is still higher 62.5%.

The most commonly used induction drugs were a combination of propofol (100%), fentanyl (92%) and isoflurane (16.1%) respectively and controlled mode of ventilation without relaxant was use for most cases. But in TASH 2020 study the commonly used mode of ventilation was spontaneous/ assisted mode. This study finding was similar to most standard studies even though there is a different practice from different institutions depending on the case. Studies, including those from Egypt (2021) and Turkey (2025**)**, favor propofol due to its rapid onset and superior suppression of airway reflexes compared to older inhalational techniques Several large-scale Chinese meta-analyses, increasingly supports controlled ventilation.

The mean DOS and DOA were 31.9, SD 13.6 and 54.8 SD 23.5 minutes respectively. This is lower than the TASH 2020 study but moderately higher compared to study of Pakistan or Indians study.

Regarding complications 62.5% of the patients had intraoperative complications, hypoxia was the leading(58.9%), which has moderate improvement compared to 2020 study in TASH (85%) but still the incidence of hypoxia is higher compared to other developed countries such as a prospective Indian study of 71 children reported desaturation in 25% of patients.).Other intraoperative complications were persistent hypoxia for >2min (8.9%), airway edema (8.9%), laryngospasm and bronchospasm (5.4%).There were 02(3%) serious tracheobronchial traumas similar to the previous TASH study ,but this observed proportion was higher, than other results and even large scale studies and reviews , but the confidence interval was wide due to small sample size.

There was one cardiac arrest , but no cardiac arrest on previous TASH study.

From multiple regression analysis the independent predictors of intraoperative complication were number of broncoscopic retrievals more than 3 (AOR: 9.52, 95%CI: 2.65-34.2, P= 0.001) followed by preoperative oxygen requirement (AOR: 6.18, 95% CI: 1.48 – 25.90, p=0.011 and preoperative pulmonary infection (AOR: 5.12 95% CI: 1.15-22.85, P=0.032). This finding is consistent with both Turkish large scale studies and Chines meta-analysis both findings show procedural duration and repeated instrumentation were the most significant predictors of hypoxia and laryngeal edema

Unlike the TASH 2020 study, there was no strong statistical association between the occurrence of intraoperative complication and whether the procedure was done by senior or resident, the mode of mechanical ventilation, duration of surgery and the type of aspirated foreign body; even though it is known they have strong clinical and stastical association in other studies.

Patients who required preoperative oxygen therapy and who had pulmonary infection (p=0.023 and=0.04) had strong statistical association to intraoperative hypoxia. Hypoxia risk was higher with increased number of bronchoscopic procedures (p=0.034). It was

higher in 3rd procedure which may suggest repeated attempts may cause airway edema and reactivity

Post-operative complications occur in 8 patients all were admitted to ICU intubated. It was higher in those who had already experienced intraoperative complications (p=0.076) and those undergoing their third bronchoscopic procedure (p=0.157). Preoperative pulmonary infection also showed a clinical trend toward increased post-operative morbidity. The independent predictor of ICU admission were the occurrence of post op complications (AOR: 11.45, 95% CI: 2.51-52.4, P=0.002), followed by preoperative pulmonary infection. The rates of ICU admissions are closely related to Ghana and Egypt studies which show higher ICU admission rates. The predictors of ICU admission for those studies were also delayed presentation, pulmonary infection and multiple bronchoscopic attempts. There was no death during the study period similar to the 2020 TASH study, whereas the African and developed countries, studies show mortality was 1-2% and 0.4% from previous studies.

7. LIMITATIONS OF THE STUDY

The shortage of time and fund decreases the number of cases that can included in the study which may change this research findings.

The other limitation was the study was not multi center (done only at TASH) due to time and fund shortage. Even though majority of FBA cases are done at this hospital. Including other hospitals may change the result and can be more representative.

Due to small sample size it was difficult to do stastical association for some variables like association of persistent hypoxia to risk factors even though they have strong clinical association.

8. STRENGTH OF THE STUDY

This prospective research studied at this hospital showed the recent trends of complications and outcomes of FBA compared to the previous national and global studies The questionnaires were adopted and modified from different studies .All eligible participants were included in the study.The study was prospective study design which reduces recall biases.

The use of multi variable logistic regression enabled identification independent predictors of intraoperative complications and ICU admissions, strengthening the validity of the finding.

The study tried to address the factors affecting the patient from preoperative, intraoperative to post-operative conditions.

9. CONCLUSSION

Bronchoscopic foreign body aspiration removal remains high risk procedure which is associated with frequent intraoperative adverse events. Success rate of FBAR was good and no deaths recorded despite higher intraoperative adverse events. The commonest intraoperative complication was hypoxia.

Number of broncoscopic attempts more than 3 times followed by preoperative oxygen requirement and preoperative pulmonary infections were the strongest independent predictors of the occurrence of intraoperative adverse events.

The ICU admission rate was higher. The independent predictors of ICU admission were the occurrence of post op complications followed by preoperative pulmonary infection. This suggests early referral, stabilization and reduce broncoscopic attempts may improve the surgical outcomes.

10. RECOMMENDATION

I recommend the researchers to do on this area in multi center for a long period to get nationwide and representative result.

For TASH, improve liaisons communications for early referrals to decrease delays which have still clinical associations for the occurrence of complications.

For ACCPM and pediatric surgery departments to give simulation based trainings to decrease intraoperative complications and decrees number of bronchoscopies.

For FMOH to focus to expand FBAR at regional hospitals by providing bronchoscopies, trained human resources to improve quality of services and delays.

For regional health bureaus to work closely with FMOH to expand the service and early report when there is shortage of bronchoscopy or physician. Facilitate trainings and strengthen referral pathways to avoid delays. Give continuous Health Education on Foreign body aspiration prevention methods and its risks for the community integrated with health Education Program

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ANNEX –– questioner/observational tools

My name is Assefa Bassie (MD) I am a final year resident in Addis Ababa University College of Medicine and Health Sciences School of medicine department of anesthesiology, critical care and pain medicine. I am going to do my thesis on Perioperative Adverse Events and Outcomes of Rigid Bronchoscopy for pediatric Foreign Body Aspiration Removal at Tikur Anbessa Specialized Hospital: A Prospective Observational Study from September 1, 2025 to January 30, 2026

Would you give me informed consent?

Signature _____

Instructions: Please complete the following form by filling in the blanks or checking the appropriate boxes.

Part 1: Patient Identification & Socio-Demographic Factors

Questionnaire Number: _____

Age (in months): _____

Weight (kg): _____

Sex: ☐ Male ☐ Female

Preoperative Coexisting Medical Conditions:

☐ None

☐ Yes (Please specify: e.g., cardiovascular, respiratory, renal, etc.) _____

Part 2: Preoperative Patient-Related Factors

Pre-procedure Oxygen Therapy:

☐ No

☐ Yes (Please specify method: e.g., Nasal Cannula, Face Mask): _____

Pre-procedure Respiratory Distress: ☐ Yes ☐ No

Pre-procedure Pulmonary Infection:

☐ No

☐ Yes (Please specify: e.g., pneumonia, bronchitis): _____

Part 3: Anesthesia-Related Factors

ASA Physical Status Score: ☐ I ☐ II ☐ III ☐ IV

Fasting (NPO) Duration: ☐ > 6 hours ☐ < 6 hours

Anesthetic Agents Used:

Induction: ☐ Fentanyl ☐ Propofol ☐ Succinylcholine ☐ Isoflurane ☐ Halothane

Maintenance: ☐ Propofol ☐ Ketamine ☐ Isoflurane ☐ Halothane

Intraoperative Monitor Interruption:

☐ No

☐ Yes (Please specify reason): _____

Topical Lidocaine Aerosolization before Bronchoscopy: ☐ Yes ☐ No

Mode of Ventilation:

☐ Spontaneous (no muscle relaxant)

☐ Controlled (with muscle relaxant)

☐ Assisted (spontaneous with pressure support)

☐ Controlled (without muscle relaxant)

Part 4: Surgical & Procedural Factors

Number of Bronchoscopy Procedures at Different Times: ☐ 1st ☐ 2nd ☐ 3rd

Number of Retrieval Attempts in Current Procedure: _____

Duration of Surgery (minutes): [Time from bronchoscope insertion to removal from vocal cords] _____

Procedure Team:

☐ Anesthesiologist & Pediatric Surgeon

☐ Anesthesiology Resident & Pediatric Surgeon

☐ Anesthesiologist & Pediatric Surgery Resident

☐ Anesthesiology Resident & Pediatric Surgery Resident

☐ MSC / Anesthetist

Timing of Procedure:

☐ Urgent/Emergent (Night)

☐ Urgent/Emergent (Daytime)

☐ Elective, Stable (Night)

☐ Elective, Stable (Daytime)

Part 5: Foreign Body & Aspiration History

Duration of Aspiration Before Arrival:

☐ < 24 hours

☐ > 24 hours

Reason for Delay in Presentation:

☐ Referral from another hospital

☐ Family was not aware of FBA

☐ Patient was asymptomatic

☐ No delay

☐ other (Please specify): _____

Site of Foreign Body:

☐ Right Bronchial Tree

☐ Left Bronchial Tree

☐ Larynx or Trachea

☐ Location not identified

☐ No foreign body found

☐ Other (Please specify): _____

Type of Aspirated Material:

☐ Organic (e.g., nut, seed, and food): _____

☐ Inorganic (e.g., plastic, metal): _____

☐ No foreign body found

Part 6: Intraoperative Complications & Management

Any Intraoperative Complications? ☐ Yes ☐ No

If yes, please indicate all that apply below:

Type of Complication:

☐ Hypoxia (SpO_2 $\leq$ 94% for >15 sec)

☐ Airway Mucosal Bleeding

☐ Airway Edema (acute swelling / failed cuff leak test)

☐ Bradycardia (HR below age-specific threshold for >15 sec)

☐ Bronchospasm (wheezing, prolonged expiration, difficult ventilation)

☐ Laryngospasm (glottic closure obstructing ventilation)

☐ Aspiration (of gastric contents into airway)

☐ Persistent Hypoxemia (SpO_2 < 90% for >2 min)

☐ Nausea & Vomiting

☐ Serious Airway Trauma (e.g., pneumothorax, pneumomediastinum)

☐ Cardiac Arrest (absent pulse for ≥10 sec)

☐ Mortality (death during or within 7 days of procedure)

☐ other (Please specify): _____

Duration of Hypoxic Episode (if applicable):

☐ < 1 minute

☐ 1 - 5 minutes

☐ 6 - 10 minutes

☐ > 10 minutes

Context of Hypoxia (if applicable):

☐ Scope in Right Bronchus

☐ Scope in Left Bronchus

☐ Scope above Carina

☐ Esophageal Intubation

☐ Inadequate Anesthetic Depth

☐ Other (Please specify): _____

Intervention for Hypoxia (if applicable):

☐ Two-Lung Ventilation

☐ Increased Anesthetic Depth

☐ Administration of Muscle Relaxant

☐ Inhalational Bronchodilators

☐ Other (Please specify): _____

Total Duration of Anesthesia (minutes): [Time from first monitor application in OR to transfer to PACU/ICU] _____

Part 7: Postoperative Course & Outcome

Patient Transferred To:

☐ ICU (Intubated)

☐ ICU (Extubated)

☐ PACU, then to Ward

☐ PACU, then Discharged after 4 hours

Any Post-Procedural Complications? ☐ No ☐ Yes

If yes, please indicate all that apply:

☐ Hypoxia

☐ Laryngospasm

☐ Laryngeal Edema

☐ Pulmonary Infection

☐ other (Please specify): _____

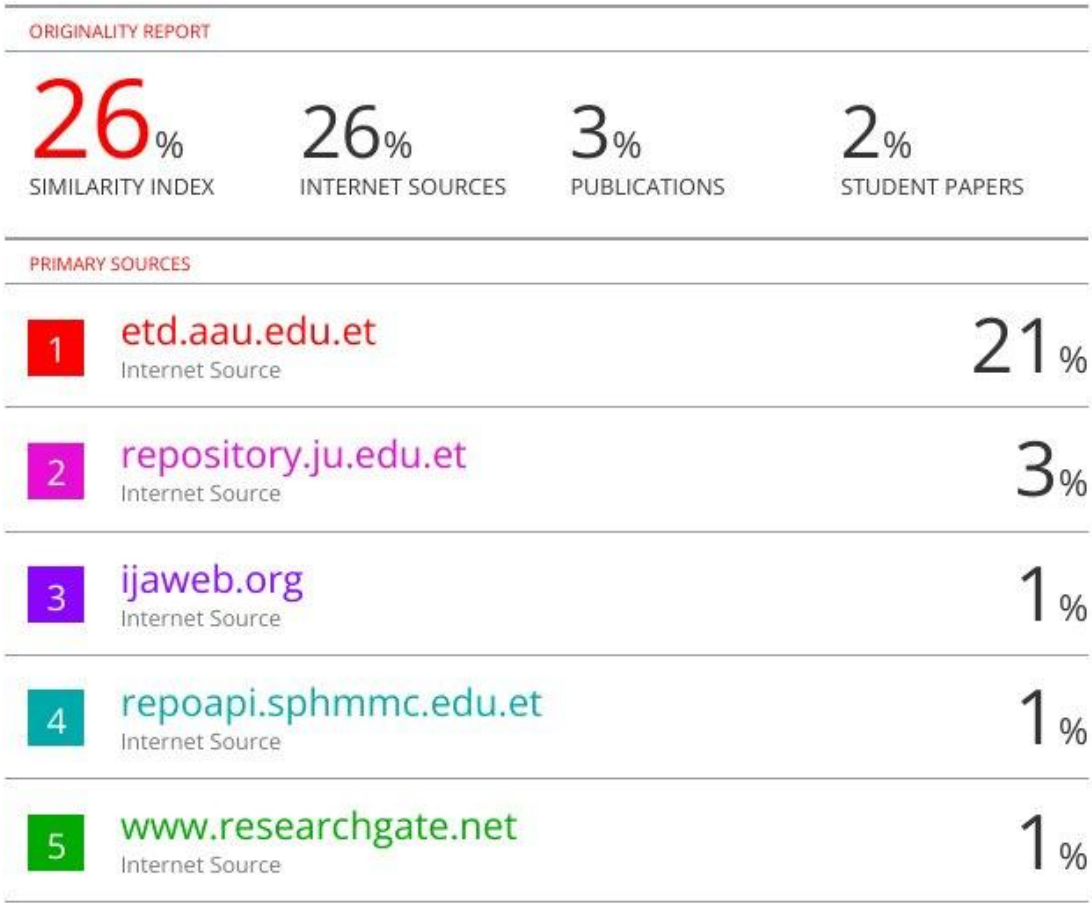
Length of Hospital Stay:

☐ Less than 24 hours

☐ 2 to 3 days

☐ Greater than 3 days

☐ Died



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