COLLEGE OF MEDICINE AND HEALTH SCIENCES

MANAGEMENT OF CHILDREN WITH COR PULMONALE SECONDARY TO HYPERTROPHY OF ADENOIDS/TONSILS IN LIMITED RESOURCE SETTING

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2021

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

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Registration Number: 10100342

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of ENT, Head and Neck Surgery in the College of Medicine and Health Sciences

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Kigali, September 2021

DECLARATION

I Dr. HAKIZIMANA Aristote declare that this dissertation titled" Management of children with cor pulmonale secondary to hypertrophy of adenoids/tonsils in limited resource setting" is the result of my own work and has not been submitted for any other degree at the University of Rwanda or any other institution.

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ABSTRACT

Background: In pediatrics, cor pulmonale due to adenoidal and tonsillar hypertrophy is uncommon. The major mode of management is adenoidectomy with or without tonsillectomy, however in a limited resource setting, managing the few cases diagnosed can be difficult.

Objectives: This study aimed to evaluate the perioperative management and outcomes among patients with cor pulmonale secondary to adenotonsillar hypertrophy at CHUK.

Patients and method: The study is observational prospective and descriptive. It was conducted at CHUK from September 2019 to August 2021. It includes patients with cor pulmonale secondary to adenoids/tonsils hypertrophy who underwent surgery at UTHK. Perioperative management and outcomes were recorded.

Results: In this study, 32 patients were enrolled of which 87.5% were males with ages ranging from 9 months to 5 years. Among the participants, 21 had cor Pulmonale of which 66% started treatment of cor pulmonale before surgery. The median preoperative oxygen saturation in this study was 95% ranging from 65% to 99% on room air. Consideration anesthesia medications, 100% of patients were induced on halothane with oxygen, 1 to 2 mcg/kg of fentanyl, 2-3mg/kg of Propofol before the intubation. analgesia was Fentanly100 %, paracetamol75 %, diclofenac 60%.

Postoperatively, 29 patients(91%) were extubated immediately after surgery of which 4 had respiratory failure, 2 had pulmonary edema; 3 patients were kept intubated after surgery. 7 patients continued oxygenotherapy, additional 5 patients were managed by Lasix postoperatively. 81.3% of patients were admitted and monitored in the general ward; 4 needed HDU. 1 patient extubated himself while he was being transported to PICU and he was observed in HDU. Only 2 patients were admitted to PICU, no death was encountered.

Conclusion: Patients with cor pulmonale secondary to adenotonsillar hypertrophy can be safely managed by adenoidectomy/tonsillectomy and monitored intensively in the general ward or HDU. Good preoperative preparation and assessment plus better anesthesia consideration intraoperatively improves outcome and reduces the need for a PICU bed.

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LIST OF ABBREVIATIONS

ATS: Adenotonsillectomy

CHUK: Centre Hospitalier Universitaire de Kigali

ENT: Ear Nose Throat

OPD: Outpatient department

PICU: Pediatric Intensive Care Unit

ABG: Arterial Blood Gases

PCO2: Partial Pressure of carbon dioxide

HIV: Human Immunodeficiency Virus

OSA: Obstructive Sleep Apnea

RVH: Right Ventricular Hypertrophy

UTHK: University teaching Hospital Kigali

RMH: Rwanda Military Hospital

KFH: King Faisal Hospital

ACKNOWLEDGEMENTS

First of all, my gratitude goes to my supervisor, **Dr.Françoise NIZEYIMANA** to have accepted to supervise this dissertation. Thank you for your continuous support, encouragement, and patience.

Dr. Isaie NCOGOZA, my supervisor, has always been a wonderful help with his extensive knowledge in ENT surgery and his ability to answer queries in a precise manner. I'd also like to thank him for his commitment to helping develop the University of Rwanda's postgraduate program in ENT, Head & Neck Surgery.

Special appreciation to the ENT team doctors at CHUK, RMH, and KFH, who guided me through my ENT training journey with their guidance and wonderful examples. You've all been excellent role models for me. I learned a lot of stuff from you in several disciplines that will help me throughout my life.

I'd like to express my gratitude to all of my colleagues, surgical personnel, medical students, and nurses. Their assistance has been much appreciated on numerous occasions.

Last but not least, I want to express my gratitude to my family and friends for their unwavering support throughout the years.

Thank you for everything!

DEDICATION

I would like to dedicate this work to my beloved wife ***Gabrielle ISHIMWE*** *and my uncle* ***Isaac NGENDAHIMANA, my parents,*** *for their love, support, and sacrifice of family time; and to all of the children who benefited from surgery from this study.*

CHAPTER ONE: INTRODUCTION

1.1. Background

Since 1965 Menarche et al observed cor pulmonale in pediatric patients with chronic upper airways obstruction due to hypertrophied tonsils/adenoids, other few cases have been identified worldwide(1–3). In developed countries with good health systems and sufficient primary care physicians, cor pulmonale secondary to upper airway blockage from hypertrophied adenoids is rarely found in their population(4–6). However, In developing countries, many factors contribute to the occurrence of cor pulmonale from OSA due to hypertrophy of tonsils/adenoids such as poor access to health facilities all over the country, few medical professionals, and lack of knowledge among primary care physicians, with delays in the referral of patients with adenotonsillar hypertrophy(7,8).

In Africa cases of cor pulmonale have been identified(9–11). In East Africa, few cases of cor pulmonale secondary to hypertrophied tonsils/adenoids and their management have been reported in the literature(12). Surgical management of patients with cor pulmonale caused by hypertrophy of adenoids/tonsils is the challenge especially in a limited resource setting, but studies showed that good preoperative preparation and management has to be taken into account. intraoperatively anaethesia medication and advanced airway intervention along with a short time of surgery, have to be done with caution(1,12–15).

Despite that adenotonsillectomy is the recommended treatment option in the management of adenotonsillar hypertrophy with cor pulmonale(16,17), there is no specific protocol or guideline available regarding perioperative management to monitor respiratory status among patients suffering from cor pulmonale as a result of obstructive sleep apnea caused by adenotonsillar hypertrophy(13,17). The reported incidence of respiratory complications after surgery in pediatric patients with obstructive sleep apnea was 6.4-27% which can vary according to the age of the patient, severity, and comorbidities(18).

In Rwanda, no study has been done yet on the management of the patient with cor pulmonale. Because there are few PICU beds and ventilator machines in a limited resource setting as ours in CHUK, pediatric patients who may require PICU admission postoperatively may be delayed. This study is designed to evaluate the management of cor pulmonale caused by adenoids/tonsils hypertrophy in the limited resource setting as untreated Cor pulmonale secondary to severe

obstructive sleep apnea may result in severe morbidities associated with pulmonary odema, congestive heart failure even death(19–22).

1.2. Literature review

1.2.1. Adenotonsillar hypertrophy: Developmental anatomy and pathophysiology

Adenoids, tubal, palatine, and lingual tonsils make up the Waldeyer's Pirogov ring. The roof and posterior nasopharyngeal wall contain adenoids tissue. Between the anterior and posterior pillars lie both palatine tonsils. Adenotonsillar hypertrophy is the most common cause of obstructive sleep apnea(23,24). Tonsils in this study relate to palatine tonsils.

Adenotonsillar hypertrophy is a prevalent condition in infants all over the world (23). From birth to the age of 12, lymphoid tissue in the upper airways increases, then gradually shrinks throughout adulthood and adolescence (24). The growth of adenoids in the upper airways in normal children is proportional to the somatic growth of surrounding tissues (25). This explains why normal children's airways stay stable even when sleeping. Any change in this symmetrical growth pattern will result in abnormalities, therefore adenoids or tonsils hypertrophy is pathological in certain groups of children (26). Obstructive sleep apnea is most commonly caused by adenotonsillar hypertrophy in children aged 2 to 8. The commonest presentation of children with adenotonsillar hypertrophy includes difficult breathing during sleep, snoring, night sweats, and disturbed sleep (19,24,27).

1.2.2. Diagnosis of adenoids and tonsils hypertrophy

Children with adenotonsillar hypertrophy will commonly present with difficulty in breathing, snoring with apneic episodes during sleep, night sweats. Consistent mouth breathing and nasal blockage during the day, daytime hypersomnolence, and restlessness are characteristics of daytime symptoms(7,8,19,24,28,29). Polysomnography remains the gold standard for the diagnosis of obstructive sleep apnea (OSA) (19,29,30) but it is not available in our setting.

Ear Nose Throat physical exam, postnasal X-ray, nasal endoscopy can be utilized to assess the size of tonsils and adenoids (7,15,19,23,24,30). Adenoids examination by using nasal endoscopy is made in our setting and tonsils are graded using Brodisky score. Note Flexible endoscopy is the gold standard diagnostic tool of adenoid hypertrophy among other different modalities of

diagnosis. The Brodsky scale for tonsils grading was used in this dissertation as it is the most accurate among the other grading scales available worldwide (31–33).

The following tables represent adenoids graded by Clement et al. (31).

Table 1: Assessment of adenoids size

Grade	Description
Grade 1	Adenoids occupy 1/3rd of a vertical portion of the choanae
Grade 2	Adenoids occupying from 1/3rd to 2/3rd of the choanae
Grade 3	Adenoids occupying from 2/3rd to near blockage of choanae
Grade 4	Complete choanae obstruction

Table 2: Brodsky scale grading of tonsil size

Grade	Airway,%
1	< 25
2	25-50
3	51-75
4	>75

1.2.3. Complications of adenotonsillar hypertrophy

Chronic adenoid hypertrophy or adenotonsillar hypertrophy results in chronic upper airways obstruction which may progress to pulmonary hypertension and Cor pulomonale(12,15,19,20,34).

1.2.4. Pathophysiology of Cor pulmonale

Persistent upper airways obstruction due to hypertrophy of tonsils and adenoids results in chronic alveolar hypoventilation (21). The abnormal ventilation and perfusion of lungs cause arterial hypoxemia with hypercapnia-induced respiratory acidosis which progressively leads to vasoconstriction of pulmonary vessels, therefore the capillary permeability is increased (19). In the meantime, the vasoconstricted pulmonary arteries undergo remodeling and hypertrophy of the smooth muscular layer which can progress to myocardial hypertrophy, dilatation of the right ventricle, heart failure, and cor pulmonale. There is also evidence that hypercapnia causes

bronchoconstriction, hence ventilation effort causes a large swing in intrathoracic pressure resulting in pulmonary oedema (19–21,35).

Adenoidectomy with or without tonsillectomy reverse these cardiopulmonary complications with normalization of findings on echocardiography (9,11,34,36). The purpose of this research is designed to evaluate the management of children with cor pulmonale secondary to adenoids/tonsils hypertrophy in a limited resource setting.

1.2.5. Clinical manifestation and sociodemography

Adenotonsillar hypertrophy causes persistent upper airway obstruction resulting in hypoxemia and respiratory acidosis which can result in vascular resistance alteration, increase vascular resistance, pulmonary hypertension, and cor pulmonale (10,19,24,37). Pediatric patients with cor pulmonale have been presented with specific characteristics including excessive daytime somnolence, failure to thrive, heavy, younger age snoring and disrupted nocturnal sleep, abnormal weight for age (weight loss or high BMI >30kg/m2), large tonsils or adenoids followed by repetitive respiratory infections; high arousal index associated with lower oxygen saturation and events of bradycardia during sleep has been observed on PSG(30,38).

Some sociodemographic factors like household income, insurance status, easy access to health facilities, and limited knowledge of primary care physicians may influence health compliance and outcomes for children with OSA(39,40). Delays in referral have been observed in children who were previously presenting history suggesting partial or complete upper airways obstruction: nocturnal snoring, retractions, and constant partial obstruction) leading to cor pulmonale in such children(8). It mostly affects children of younger age (41,42).

1.2.6. Preoperative investigation and preparation

Unlikely, cor pulmonale will be failed to be diagnosed before surgery; a history of snoring and mouth breathing associated with neurobehavioral change is sensitive; videotapes, audiotapes with pulse oximetry can be helpful. Preoperative complete ENT exam, a loud P2 (tricuspid regurgitation) contribute to the diagnosis. Preoperative assessment includes blood workup, nasopharyngeal endoscopy/lateral skull radiography for nasal patency and adenoid size, tonsils size grade by using Brodsky score. Overnight polysomnography with ECG, Echocardiography, cardiac catheterization is mandatory in diagnosis (14,43–46). Evaluation of pulmonary functions

and chest x-ray is not recommended in patients with OSA preoperatively (47). Medications like furosemide, Aldactone, digoxin for patients having cor pulmonale with heart failure, or pulmonary edema, if given preoperatively improve outcomes and minimize cardiorespiratory complications postoperatively (1,12,14).

1.2.7. Intraoperative management and anaesthesia consideration

Intraoperatively, there is no consensus among anesthetic management of pediatric patients with cor pulmonale due to hypertrophy of adenoids/tonsils; the use of sedative premedication is discouraged; opioids and sedative sparing anesthesia are not recommended but if used you have to be careful in titration with extreme vigilance(13,14). The consideration goes to advanced airway management and maintains the perfusion pressure, avoid to increase pulmonary vascular resistance (12).

Emergence from anesthesia post adenoidectomy with/without tonsillectomy children with cor pulmonale is a challenge: extubate after full recovery of muscle strength, advanced airway interventions, avoid triggers of vasoconstriction to reduce the peripheral vascular resistance, quicker surgery to avoid long exposure to anaesthesia medications, consider CPAP in the case is needed(13,48). Teamwork is needed while extubating those children as it is done during intubation and close monitoring postoperative during the night(49).

1.2.8. Management of postoperative complications

Postoperative respiratory problems in children with obstructive sleep apnea have been observed in 6.4-27%, this can vary according to the age of the patient, severity, and comorbidities(18). Even though Adenoidectomy/tonsillectomy is the most acceptable treatment for adenoids and tonsils causing cor pulmonale, there is no established specific protocol or guidelines regarding perioperative management to monitor postoperative respiratory status in patients having cor pulmonale due to obstructive sleep apnea caused by adenotonsillar hypertrophy (13,17).

Upper airway edema, nausea, vomiting, and pain characterize the early postoperative period, which may be managed by opioid-sparing analgesia, adjuncts like dexamethasone, ondansetron, paracetamol, ibuprofen, or diclofenac(13,49–53). PSG monitoring can be continued on a patient with persisted OSA even after surgery; in some severe cases, congestive heart failure and

respiratory compromise can persist and may need assisted ventilation, CPAP, or oxygenation for a while (43,48,50,54–57).

Negative pressure pulmonary Oedema or postobstructive pulmonary oedema is a common complication following laryngospasm post adenoidectomy; and the management range from simple oxygen delivered by a nasal cannula, mask, or CPAP with mask or event mechanical intubation in a good setting along with medications delivery like IV furosemide, dexamethasone, salbutamol with restriction of iv fluids(22,58–62). However in a limited resource setting without ventilator machines, negative pressure pulmonary oedema can be treated with proper monitoring with pulse oximetry,oxygenotherapy with rebreather mask, iv furosemide(63).

In a study done by Orval E. Brown et al 1988 at the University of Texas Southwest Medical center,11 children with cor pulmonale secondary to hypertrophy of tonsils and adenoids were identified during 10 years. Patients had a variety of symptoms, including an irregular EKG, chest radiography, hypoxia, and right heart failure in which 10 were managed by tonsillectomy and or adenoidectomy alone: 40% of patients did well postoperatively and they were monitored in general wards with careful observation. 70% had preoperative elevated PCO2 in which 14% had respiratory arrest 36hours postoperative which was resolved after mechanical ventilation for 2 days. 40% of patients with preoperative elevated PCO2, their postoperative management included intubation and mechanical ventilation for 1–5 days to get their ABG back to normal (17).

C. Hunt et al in 1982 found 22 children with OSA in their study, of which 55% were having signs and symptoms of cor pulmonale confirmed by ECG with echocardiography with evidence of RVH. In each patient, the symptoms improved postoperative and cardiomegaly improved after surgically treating OSA(8). Bruce D.Edison et al. at Chicago 2015; identified 2 cases with tonsilloadenoid hypertrophy resulting in cor pulmonale. They were management with adenotonsillectomy and they have been extubated immediately postoperatively without any complication (1). Pi Chang Lee et al in Taiwan 2012 at the National Yang-Ming University and Taipei General hospital during 7 years, 30 patients with obstructive sleep apnea were identified of which 17% were having cor pulmonale. All patients underwent adenotonsillectomy

successfully, symptoms improved without any complication and pulmonary hypertension decreased dramatically after surgery(30).

In a study done at Harare Central Hospital,1988 throughout 9months,15 patients with a history of OSA presented at the hospital for adenotonsillectomy. Among them,6 (40%) were found to have signs of cor pulmonale.ECG and echocardiography were done for diagnosis, the operation was done urgently. The induction was done with halothane and oxygen or halothane and nitrous oxide in oxygen with no premedication given before. The intubation was done when the patient was spontaneously breathing. After intubation, the monitoring continued with assisted ventilation on T piece by monitoring the patient with ECG and precordial stethoscope. No analgesia or opioids are given before the operation and postoperatively. The symptoms resolved in all patients after the operation,1(16%) patient was kept intubated for 2 days.No respiratory failure was observed in others perioperatively(14).

A ten-year review (2004-2014) done by Collin Oduro et al in Ghana, 9 cases with chronic cor pulmonale in which 55% were having adenotonsillar hypertrophy. All cases received furosemide and spironolactone as a treatment for heart failure. All patients with adenoid hypertrophy underwent adenoidectomy, no one of them was kept on mechanical ventilation postoperatively (9). In 2016 R Kabyemera et al in Tanzania in a case review, the patient was treated with furosemide, Aldactone, and oxygenotherapy 18 days before surgery, he was operated on and didn't need a PICU bed, he was discharged on day 2 postoperatively(12). To my knowledge, there is no study done here in Rwanda showing the management and outcomes for a patient with cor pulmonale due to adenotonsillar hypertrophy.

1.3. Justification of study

Worldwide few cases of cor pulmonale with adenoids hypertrophy were reported, adenoidectomy being the mainstay of treatment for those patients but some of them come in severe critical conditions (example: heart failure,) which require preoperative optimization but the immediate postoperative management and disposition are still controversial. Globally, there is no protocol available showing the perioperative management of those few pediatrics patients with cor pulmonale due to hypertrophy of adenoids/tonsils.

In developed countries with regular medical follow up most pediatric patients rarely develop cor pulmonale, from the few cases identified they advise postoperative close monitoring of those patients mechanically ventilated in the intensive care unit to prevent the risk of respiratory failure.

Adenoid hypertrophy leading to cor pulmonale needs management in a limited resource setting. The surgery of patients with cor pulmonale due to adenotonsillar hypertrophy was delayed and some cases died from respiratory failure while still waiting for the availability of PICU beds in CHUK settings.

The majority of adenotonsillar diseases are referred to the University Teaching Hospital of Kigali (CHUK for both ENT and anesthesia services). The hospital's pediatric department has a total of 86 beds (including surgical) for pediatric cases,7 beds in HDU with only 3 PICU beds almost busy all the time and this leads to delays in the surgical management of cases with Cor pulmonale due to lack of postoperative destination. This study was designed to assess if, by adequate preoperative assessment and preparations, children with cor pulmonare can be safely operated on in CHUK setting with the shortage of PICU beds, pediatric ventilators, and lack of pre-established protocols.

CHAPTER TWO: RESEARCH METHODOLOGY

2.1. Research question

Can we safely manage children with cor pulmonare in CHUK setting with the shortage of PICU beds?

2.2. Objectives

2.2.1. General objectives

To evaluate the perioperative management and outcomes of the patients with cor pulmonale due to hypertrophy of adenoids/tonsils at CHUK.

2.2.2. Specific objective

- To determine preoperative workup for patients with cor pulmonale
- To describe per-operative management considerations for patients with cor pulmonale
- To describe immediate post adenotonsillectomy disposition and outcomes of patients with cor pulmonale.

2.3. Study design

The study was a cross-sectional, prospective, descriptive study.

2.4. Study setting

The research was conducted at the University Teaching Hospital of Kigali (CHUK).

2.5. Study period

This study was conducted within a period of two years from September 2019 to August 2021.

2.6. Study population

The study population was considered pediatric patients ranging age from 0-15 years old with cor pulmonale due to adenotonsillar hypertrophy who underwent tonsillectomy with or without adenoidectomy during the study period at CHUK.

2.7. Sample size

The sample size was the cases encountered during 2 years of the study period from September 2019 to August 2021.

2.8. Inclusion criteria

Patients sonographically confirmed cor pulmonale or pulmonary hypertension due to adenoid and tonsillar hypertrophy. However, the cor pulmonale was confirmed by heart ultrasound done by a pediatric cardiologist, adenoids were confirmed by flexible endoscopy and tonsils by using the Brodsky scale(64).

2.9. Exclusion criteria

All children with:

- ✓ Neurological abnormalities
- ✓ Craniofacial abnormality or genetic disorders e.g. Down syndrome
- ✓ Pathologies causing airway obstructions e.g. nasal masses deviated nasal septum
- ✓ Known cardiac diseases /chronic lung diseases.
- ✓ Refusal to grant a written consent

2.10. Data collection

Data were collected by a senior ENT resident or ENT surgeon using a pre-established questionnaire and the consent was signed by the parent of the guardian before filling in the questionnaire. For 32 participants obtained, the important information was collected: Preoperatively patients demographic data; operative factors analyzed include the presence of obstructive sleep apnea, adenoids size and tonsils size, cardiology consultation, and echocardiographic findings, blood workup. Intraoperative anesthesia and surgical consideration were recorded then immediate postoperative disposition, management of postoperative complications, and outcomes were recorded.

2.11. Data analysis

Data entry was recorded using Epidata 3.1 software. The data processing and statistical analyses were performed using SPSS 25.0. Comparison of categorical variables was performed using the chi-square test with the limit of significance $p = 0.05$. Microsoft Word and PowerPoint were useful in the draft, final writing, and presentation of this study.

2.12. Ethical consideration

This study was carried out after approval given by the Department of ENT, Head and Neck Surgery, Department of anesthesia, the CMHS Institutional Review Board at the University of Rwanda (Approval note: No 282/CMHS IRB/2020). Patients who were enrolled in the study are those who their parents or caretaker have given their written informed consent. A parent or guardian was requested to consent. All data collected were treated with confidentiality.

CHAPTER THREE: RESULTS

3.1. Sociodemographic characteristics

The majority of our participants were male at 87.5% and 72% were from the rural area, and 94% of participants used community-based health insurance, and 97% were from the low-income population. The participants' ages ranged from 9 months to 5 years with a mean age of 20 months. Table 3 provides more information.

Table 3: Sociodemographic characteristics of study participants

Characteristics	Number	%
Age in months		
Median (Min-Max)	20.0 (9-60)	
Gender of participant		
Male	28	87.5
Female	4	12.5
Residence		
Rural	23	71.9
Urban	9	28.1
Economic category (Ubudehe)		
Class I-III	31	96.9
Class IV-V	1	3.1
Insurance		
CBHI	30	93.8
Private insurance	2	6.3

3.2. Preoperative clinical information

The totality of patients had chest deformity, snoring, the difficulty of breathing, and disturbed sleep. Seventy-eight percent of participants had night sweats. Eighty-four percent of the participants received antihistamines, 50% received nasal decongestants, 56% of them were given nasal steroids and almost nineteen percent were given antibiotics when consulted health facilities for the complaints. Find more details in table 4 below.

Table 4: Clinical information on the evolution of adenotonsillar disease

Characteristics	Number	%
Signs and Symptoms		
Chest deformity	32	100
Snoring	32	100
Difficult of breathing	32	100
Disturbed sleep	32	100
Night sweats	25	78.1
Oxygen dependency		
Yes	7	21.9
No	25	78.1

3.3. Pre-operative clinical findings

Among 32 participants, the majority had mild disease severity where 15 (75%) participants had mild pulmonary hypertension while 4 (20%) were having severe pulmonary hypertension .21 patients were found to have also cor pulmonale, 14 (66%) of them started treatment of cor pulmonale. The median preoperative oxygen saturation for the patients who were recruited in the study was 95% ranging from 65% to 99%, the median rate of respiration was 31 cycles per minute with the median heart rate was 128 beats per minute.

Table 5: Pre-operative clinical findings

Variables	N	%
Pulmonary hypertension		
Mild	15	75.0
Moderate	1	5.0
Severe	4	20.0
Cor pulmonale		
Mild	14	66.7
Moderate	4	19.0

Severe	3	14.3
Started treatment of cor pulmonale		
Yes	14	66.7
No	7	33.3
Medications		
Sildenafil only	7	50.0
Sildenafil and Aldactone	3	21.4
Lasix, Aldactone, and sildenafil	3	21.4
Aldactone only	1	7.1
Vital signs		
Oxygen saturation [Median (Min-Max)]	95 (65-99) %	
≤90%	8	25
>90%	24	75
Respiratory rate [Median (Min-Max)]	31.0 (22-52)	
Heart rate [Median (Min-Max)]	128 (40-156]	

3.4. Intraoperative management and anesthesia consideration

Seventy-two percent (23 the patients) underwent both adenoidectomy and tonsillectomy and 75% of the operations lasted 30 minutes to one hour. Considering the anesthesia medications, all patients received a low dose of fentanyl 1mcg/kg, propofol 2-4mg/kg, and high dose dexamethasone 0.5mg/kg, four patients out of thirty-two received ketamine, and 100% patients received halothane.

Table 6: Intraoperative management and anesthesia considerations

Variable	N	%
Type of operation		
Adenoidectomy	9	28.1
Adenoidectomy and tonsillectomy	23	71.9
Duration of surgery		

>30 min	8	25.0
30 min-1 hour	24	75.0
Anesthesia medications		
Fentanyl (low dose)	32	100.0
Dexamethasone	32	100.0
Propofol	32	100.0
Halothane	32	100.0
Suxamethonium	2	6.3
Veculonium	1	3.1
Ketamine	1	3.1

3.5. Postoperative outcomes and management for the study participants

Three patients required mechanical ventilation in the postoperative period(note that one has self extubated during his transport to PIC U then he was monitored in HDU without reintubation), among 29 extubated patients four had respiratory failure and 2 patients had post obstructive pulmonary edema post-surgery. Two patients who were not extubated have been admitted to PICU. Among extubated postoperatively 4 patients have been admitted in HDU, and the remaining 26 patients were admitted to the general ward during the postoperative period. Seven patients were put on oxygenotherapy after surgery, ten (31%) patients received sildenafil and five patients received Lasix treatment after surgery, the majority 66% received dexamethasone postoperatively,75% were given paracetamol, one required adrenaline nebulization. No death was encountered during our study. Find more details in Tables 7and 8 below.

Table 7: Postoperative outcomes and disposition for the study participants

Variable	N	%
Post-operative mechanical ventilation		
Yes	3	9.4
No	29	90.6
Respiratory failure		
Yes	4	12.5
No	28	87.5

Pulmonary edema		
Yes	2	6.3
No	30	93.8
Disposition after surgery		
General ward	26	81.3
HDU	4	12.5
PICU	2	6.3
Hospital stay Median[(min-max)]	**3(2-6)**	
≤3 days	25	78.1
>3 days	7	21.9
Improved symptoms		
Yes	32	100.0

Table 8: Postoperative management among participants

Variable	N	%
Postoperative management		
Lasix	5	15.6
Sildenafil	10	31.3
Oxygenotherapy	7	21.9
Other medications		
Paracetamol	24	75.0
Dexamethasone	21	65.6
Diclofenac	19	59.4
Ondensetron	5	15.6
Atropine	1	3.1
Adrenaline nebulization	1	3.1

3.6. Factors associated with poor operation outcome

There was a statistically significant association between poor outcome and patient's preoperative oxygen saturation where patients with low oxygen saturation (<90%) were 11 times more likely to have poor outcomes compared to a patient with oxygen saturation >90% (OR=11.0; 95% CI: 1.48-81.6; p=0.019). Patients who did not start medications for cor pulmonale were 1.7 times more likely to have a poor outcome than those who started treatment (OR=1.71; 95% CI: 0.6-11.06; p=0.571). No statistically significant difference was seen between the outcome of operation and type of operation. Find more details in Table 9 below.

Table 9: Factors associated with postoperative outcome

Predictors	Poor surgery outcome		OR (95% CI)	P-value
	Yes	No		
Duration of surgery				
≤30 min	1 (12.5%)	7 (87.5%)	Ref	
30 min-1 hr	5 (20.8%)	19 (79.2%)	1.84 (0.18-18.66)	0.605
Pulmonary hypertension				
Mild	1 (6.7%)	14 (93.3%)	Ref	
Moderate	0 (0.0%)	1 (100%)		
Severe	2 (50.0%)	2 (50%)	14.00 (0.83-235.08)	0.487
Cor pulmonale				
Mild	1 (7.1%)	13 (92.9%)	Ref	
Moderate	2 (50.0%)	2 (50.0%)	6.50 (0.28-151.12)	0.244
Severe	1 (33.3%)	2 (66.7%)	1.10 (0.02-11.09)	0.661
Started treatment of cor pulmonale				
Yes	2 (14.3%)	12 (85.7%)	Ref	
No	4 (22.2%)	14 (77.8%)	1.71 (0.26-11.06)	0.571
Oxygen saturation				
<90%	4 (50.0%)	4 (50.0%)	11.00 (1.48-81.60)	0.019
>90%	2 (8.3%)	22 (91.7%)	ref	

Ref: reference group

CHAPTER FOUR: DISCUSSIONS

This study was conducted at Kigali University Teaching Hospital which receives most of the patients presenting severe obstructive sleep apnea from all around the country.

The majority of patients in this study were male with 87.5%(28) and 12.5% females(4). A similar finding was found in Ghana th with 8 (89%)patients were males and 11% were females (9). Similar findings were reported in Nigeria, in the US, and in Taiwan(10,30,34), findings with 71.6% males and 28.4% of females in Nigeria

The reason for males being predominant in patients with adenoids/tonsils hypertrophy with obstructive sleep apnea is not clear, but there are facts that females reach their maximum nasopharyngeal depth and adenoid area earlier than males do as shown in a study done at Child Research Council in Denver, USA by (65) this could explain why female develop less obstructive symptoms than the male of the same age.

The current study found that the age of participants ranges from 9month up to 5 years with a mean age of 20months. Similar findings were found in the UK(41)and Zimbabwe (14). Cor pulmonale is manifested in younger age who relatively have big adenoids/tonsils compared with their airway size but also poor immunity which causes frequent attacks of upper respiratory infection as postulate by Pi Chang Lee et al. in their study in 2012(30). This is also justified by various studies(42).

This study found that 31(97%) patients were coming from low-income families. The study done at Johns Hopkins University by V Harris et al. (66) and the one by Mary Jane et al. USA(34) report the same findings. . In our study, this is explained by poor access to health facilities or shortage of specialists in public facilities in the countryside in Rwanda, their insurance status, not forgetting the poor awareness of OSA among primary health providers in our country.

In the current study, 23(73%) patients large number were from the rural areas (and 28% from the urban area. Similar findings have been noted in the USA(39,67). In Rwanda, this is mainly due to a lack of health knowledge threatening conditions or due to lack of access to pediatricians or otolaryngologists in a rural area not forgetting the delay of transfer from primary healthcare providers. Being far from hospitals influences the delay in management or the condition is not

recognized by primary health providers, however, in developed country cases are found in the region with few medical centers and not having the means to access health care.

In this study, preoperative echocardiography was performed for all patients by a pediatric cardiologist as the main investigation for diagnosis. It revealed the presence of right ventricular hypertrophy in 21(65.6%) participants and only pulmonary hypertension in 34.3%. The flexible endoscopy was done in all patients. The study done in Taiwan(30) showed 17% having cor pulmonale, in Zimbabwe, 23% were having cor pulmonale: in these studies patients were among all patients presented with OSA in their settings whereas in our study we took only patients with OSA confirmed for cardiopulmonary change by echo cardiac evaluation. The same preoperative assessment is used in other studies worldwide(2,9,14,35). However, other investigations are used in developed settings; namely cardiac catheterization, Arterial Blood Gases, and Polysomnography (30,34–36,41,50,68). Like in this study, worldwide studies done previously showed the same preoperative preparations with echocardiography, EKG, together with physical cardiac examinations have been used preoperatively(14,43–45). Based on other studies worldwide, echocardiography with other modalities used in this study is standard and acceptable in making the diagnosis of cor pulmonale.

In this study participants diagnosed with cor pulmonale about 14(66.7%) patients were given medications as a part of treatment which improves postoperative outcomes: - 50% received sildenafil only, 21.4% received sildenafil and Lasix plus Aldactone,7.1% received Aldactone only. The same preparation was done in Ghana(9) Other studies report treating cor pulmonale with diuretics, digoxin some days before surgery(1,9,14). These medications decreased the severity of symptoms and it has been the core part of good preoperative preparation in our study.

In a study done in Zimbabwe, 100% of patients with cor pulmonale with congestive heart failure were all treated with digoxin and furosemide by pediatricians before surgery to improve the outcomes(14), and the study done at Northwestern University USA,100%patients with congestive heart failure and cor pulmonale were managed with diuretics preoperatively(1). From the report in Tanzania, furosemide, Aldactone and oxygen were the therapy give preoperatively(12).

In the literature there exist a limited series number of patients diagnosed for cor pulmonale secondary to adenotonsillar hypertrophy; in previously reported studies, none is specific or has given guidelines about the anesthetic/surgical management of this condition(5,69). In the current study, induction was done by a low dose of fentanyl (1-2mcg/kg) as analgesia, halothane, and propofol (2-3mcg/kg) as hypnotics before intubation. Adjuvant Dexamethasone was given to all patients, paracetamol in 24(75%) participants and diclofenac in19 patients(59.4%).

In the study done In Zimbabwe, the same approach was used but no analgesics were given preoperatively and no opioid analgesia was given postoperatively. A study done in Cincinnati Children's Hospital Medical Center USA found and discourage giving opioids to patients with severe OSA because of their depressive effect on the respiratory center(13). Other reports recommend halving doses of opioids while giving anesthesia to patients with severe OSA and give opioid-sparing analgesics and adjuncts as dexamethasone, paracetamol, ketamine(13,53).

In the current study 29 of the participants(90.6%) have been extubated immediately after surgery and monitored in PACU of which 4 patients (12.5%)patients had episodic hypoxemia, 2 patients(6.3%) developed postobstructive pulmonary oedema. 3 (9%) patients remained intubated in PACU. The same findings have been found in Zimbabwe where 16% were previously known comorbidity remained intubated(14), in the USA 36% extubated with 63% needed mechanical ventilation(5). During our study patients with cor pulmonale and heart failure which was not managed before surgery had poor outcomes. In a developed setting they wait for ABG normalization to extubate which is not regularly monitored postoperatively in our setting.

During this study among 32 participants,2 (6.3%) needed a PICU bed with mechanical ventilation postoperatively,94% were monitored in the general ward(81.3%) or HDU(12.5%). Patients who presented with cor pulmonale and congestive heart failure who didn't receive treatment some days before surgery had poor outcomes. Various studies were done in the USA, Ghana, Tanzania, which showed that good preoperative preparation leads to better outcomes for all patients with cor pulmonale minimizing postoperative mechanical intubation(1,9,12,70).

In this present study 4(12.5%)patients had episodic hypoxemia which was managed by oxygenotherapy by nasal plong or facial mask, immediate postoperatively,2 patients(6.3%) developed postobstructive pulmonary oedema together with one patient who developed pulmonary edema on day 2 postoperatively they were management by oxygenotherapy by facial

mask plus Lasix and they were monitored either in general ward or HDU. For some patients with moderate or severe pulmonary hypertension, sildenafil was continued. The same method was used in the study done in a limited-resource setting in Ghana(63) The aim was to avoid postoperative ventilation support as we have a shortage of PICU beds in our hospital.

Some medications were found helpful during this study in the management of upper airways oedema and postoperative pain where our patients were managed by iv dexamethasone 21(65%), diclofenac 17(59%), paracetamol 24(75%) ondansetron 5(15.6%) as it has been recommended in other studies(55). Many studies encourage using supplement oxygen, dexamethasone, Lasix, and use noninvasive methods to reduce the need for intubation(60,62,71).

This study has been done with a lack of ventilators, PICU beds, postoperatively complications were closely monitored in the general ward or HDU with proper medications, and a better outcome has been achieved.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATION

5.1. Conclusions

The following are the conclusions from the current study:

- Low-income populations with poor access to health facilities are more likely to develop cor pulmonale caused by adenotonsillar hypertrophy.
- Before surgery, a pediatric child with severe obstructive sleep apnea must have a cardiology consultation and a heart ultrasound.
- A good preoperative preparation, a good anesthesia plan, and skilled anesthesia and ENT surgical team are all essential for a successful outcome.
- Patients with cor pulmonale secondary to adenoids/tonsils without other comorbidities can be safely operated without a PICU bed.

5.2. Recommendations

The following recommendations are formulated:

- **To the Rwanda Ministry of Health**
  - Increase awareness of obstructive sleep apnea among health care providers all over the country and know the right time to consult or to refer patients to otorhinolaryngologists to avoid cardiopulmonary complications of adenotonsillar hypertrophy
  - Increase the number of ENT surgeons and anaesthesiologists in district hospitals and avail the materials for good practice.
- **To clinical staff CHUK(ENT, ANAESTHESIA, PEDIATRICS)**
  - Ensure that children below 2 years with severe obstructive sleep apnea on adenoid hypertrophy mandate a cardiology consultation and echocardiography.
  - Pediatric patients with RVH without other obvious causes need otorhinolaryngologist consultation for adenoids screening as a cause of nasopharyngeal obstruction
  - Cardiac failure must first be treated medically, as this improves outcomes and reduces the need for a PICU bed.
  - Postoperatively patients with cor pulmonale have to be observed and monitored closely at least for 3 days.
  - Establish a protocol regarding the proper management of children with cor pulmonale due to adenoids tonsils hypertrophy.

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APPENDICES

Appendix 1. Data collection tool

Questionnaire

I. information Demographic

- **Patient ID**
- **Age**
- **Sex: male ☐ female ☐**
- **Weight:**
- **residence: rural ☐ urban ☐**
- **Ubudehe category: class I-III ☐ class IV-V ☐**
- **Level of education/Guardian …….**
- **Insurance……**

II. Clinical information

1. Presenting symptoms

a. Snoring
b. Difficulty in breathing
c. Disturbed sleep
d. Night sweat
e. Others

2. Duration of symptoms

a. < 6months
b. 6-12 months
c. > 1year

3. Have you visited a health service for this complaint?

a) No
b) Yes

4. If yes, which level? Health centre only

a. Health centre and DH?

b. DH only
c. Private facility only
d. Public and private facilities
e. Not applicable

5. How many times in all have you visited another health facility?

a. …….
b. Not applicable

5. When is the first time you sought treatment at a health facility?

a. 1 year ago
b. 6-12 months ago
c. 1-6 months ago
d. < a month ago
e. Not applicable

6. What treatment were you given?

a. Nasal decongestant
b. Nasal steroid
c. Antihistamine
d. Others……
e. Not applicable

7. Why did you decide to seek treatment at CHUK (in full)

- I was given a referral because I asked for it
- I was given a referral because I was getting worse
- I was given a referral because I was not improving
- I decide to come without a referral note

PREOPERATIVE ASSESSMENT

1. **Vitals**

   SpO2:…….

   RR:……..

HR:……..

T:……

2. **Is the patient oxygen dependent**

   Yes Non

   If yes how many litters of oxygen per min given ……

3. **Physical finding:**

   Adenoid size(flexible nasoendoscopy grade):

   Tonsils size(Brodsky grade):

4. **Cardiac u/s findings**

   a. **Pulmonary hypertension**

   b. **Cor pulmonale: mild ☐ moderate☐ severe**

5. **Have you started any treatment for cor pulmonary**

   Yes Non

   If yes specify :……

5.Premedication given?

NO ☐

If yes specify……

<u>Intraoperative</u>

Induction:

Analgesics:

Fentanyl low dose☐ normal dose☐

Ketamine low dose☐ normal dose ☐ Others……

Not applicable ☐

Hypnotics : Propofol ☐

Halothane ☐

Ketamine ☐

Other…….

Muscle relaxant: Suxamethonium

Vecuronium

Other ……..

Not applicable

Adjuvants: Dexamethasone

Other ……

Operation done

a. **Adenoidectomy**
b. **Adenoidectomy +tonsillectomy**
c. **Tonsillectomy**
d. **Others**

Duration of surgery

a) **>30 min**
b) **30min-1hr**
c) **>1hr**

Postoperative mechanical ventilation :yes ☐

No ☐

Period between Date of diagnosis and date of surgery

a. Less than week
b. Week – month
c. More than month

III. Postoperative

1. **Period required for recovering from anesthesia**
   a. **< 30 min**
   b. **30min – hour**
   c. **>hour**
   d. **Not applicable**

2. Postoperative complication
    a. Respiratory failure
    b. Pulmonary oedema
    c. Bleeding
    d. Fever
    e. Forgotten pack

Others……

3. Postoperative disposition:
    a. General ward
    b. HDU
    c. PICU
4. Postoperative consideration
    a. Symptoms improved
    b. Medications: Lasix
        Sildenafil
        Oxygenotheray
        Others…
    c. Hospital stay:
5. Postoperative discharge day:

    Describe special consideration if any……
    ……

Appendix 2: Informed consent

Title of the study: Cor pulmonale secondary to adenoid/tonsils hypertrophy: perioperative management and outcomes

Explanation to the patient(English version)

I am Dr Aristote HAKIZIMANA a senior resident in ENT- Head and Neck Surgery at University of Rwanda, Faculty of Medicine. I am conducting a study in Rwanda Referral Hospitals for the degree of Master of Medicine in ENT-Head and Neck Surgery. My study is aimed to evaluate postoperative management and outcomes of cor pulmonale secondary to adenoid/tonsils hypertrophy at CHUK.

During the study, the parent/guardian of the child will sign the consent form before the surgical procedure. The questionnaire will be filled by one of the ENT staff at CHUK where the study is being conducted. This will be done before the surgical procedure, perioperatively, during admission to ward and the day of the postoperative discharge.

No direct benefit and no risks for the participant but the result of this study may be used to benefit other patients in future.

All information obtained from this study will be handled in a confidential manner and be used for only research purposes.

If you have question about the study, please feel free to contact Dr Aristote HAKIZIMANA, Phone: +250 788 700 577 and E-mail: **hakaristo@gmail.com**.

If you agree to be included in this evaluation, please sign the section below.

CONSENT FORM

I……confirm that the purpose of this study and my role have been well explained to me by Dr…….....
I agree to the conditions explained and give consent to be included for……. who is my dependant by virtue of being a minor or unable to consent.

Names of the parent/attendant……...

Signature…… Date……/……./…..…….

Name of the Witness……..

Signature…….. ……Date……/……/……...

Researcher's names……

Researcher's signature…… Date…../……. /……..

IBISOBANURO NO KWEMERA UBUSHAKASHATSI (Kinyarwanda version)

Umutwe w'ubushakashatsi

"Cor pulmonale secondary to adenoid/tonsils hypertrophy: perioperative management and outcomes"

Ibisobanuro

Aristote HAKIZMANA, ukora ubu bushakashatsi, ni umuganga wiga muri Kaminuza Nkuru y'u Rwanda ishami ry'Ubuvuzi, aho ategurirwa kuba inzobere mu kuvura no kubaga Amatwi, Amazuru, Umuhogo, umutwe n'ijosi (ENT, Head & Neck Surgery).

Arakora ubu bushakashatsi areba ubuvuzi bukorwa n'icyo butanga nyuma yo kubaga abana bafite indwara z,umutima zatewe na anjine(adenotonsillar hypertrophy)mu bitaro bya CHUK. Ubushakashatsi ni kimwe mu bisabwa ngo urangiza amasomo ahabwe impamyabushobozi y'inzobere mu kuvura no kubaga Amatwi, Amazuru, Umuhogo, umutwe n'ijosi (Mmed in ENT, Head and Neck Surgery).

Muri ubu bushakashatsi,uwujuje ibyangombwa byo kugirango abagwe angine(adeno/tonsillectomy) zateye uburwayi bw'umutima, asobanurirwa iby'icyo gikorwa hanyuma agasinya urupapuro rwemeza ko yinjiye mu bushakashatsi ku bushake. Urupapuro ruriho ibizibandwaho mubushakashatsi(questionnaire) ruruzuzwa mbere yo kubagwa, igihe cyo kubagwa,igihe umurwayi avuye mu kinya, ari mubitaro ndetse n'igihe asezerewe mu bitaro. Iyo agize ikibazo ari mu rugo asabwa kugaruka bitaba ibyo agasabwa kugaruka ku bitaro yabagiweho nyuma y'ibyumweru bibiri muri controle.

Mu kujya muri ubu bushakashatsi ntakiguzi cyangwa inyungu yihariye umuntu ku giti cye akuramo; ariko ibizavamo bizafasha abandi barwayi mu gihe kizaza.Hakoreshwa inomero mu mwanya w'amazina y'umurwayi; kandi amakuru yose avuye ku murwayi akabikanwa ibanga.

Ibizava muri ubu bushakashatsi ntibizakoreshwa kuzindi nyungu zitari iz'ubushakashatsi kandi mu kubitangaza nta na hamwe hazagaragazwa amazina y'ababukoreweho.

Inyigo y'ubu bushakashatsi yasuzumwe inemezwa na Komisiyo y'ubushakashatsi muri Kaminuza y'u Rwanda (Research commission).

Kubibazo cyangwa ibindi bisobanuro, baza:
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Niba wemeye kwinjira mu bushakashatsi dusinyire ku rupapuro rukurikira.

Kwemera kwinjira mu bushakashatsi ku bushake

Njyewe ……, (imyaka……) nemeye ko nahawe ibisobanuro birambuye na Dr……kuri ubu bushakashatsi mpabwa n'umwanya wo gusobanuza. Mu gusinya, nemeye kubushake bwanjye ntagahato ko ubu bushakashatsi bukorerwa kuri…..……..... (imyaka……) mpagarariye. (Isano……..)

Amazina y'umubyeyi/Umuhagarariye……...
Umukono…….……itariki……/……/…….

Amazina y'ukora ubushakashatsi/Umuhagarariye……
Umukono…….……itariki……/……/…….

Amazina y'undi wabibonye: …….
Umukono…… itariki……/……/……...