

## Original Research Article

# Correlation between clinical grading of adenoid or tonsil hypertrophy and adenoid or tonsil volume post adenotonsillectomy: a prospective cohort study

Daniel D. Kokong<sup>1\*</sup>, Adeyi A. Adoga<sup>1</sup>, Ishaku Turaki<sup>1</sup>, Nuhu D. Maan<sup>1</sup>,  
John P. Yaro<sup>1</sup>, Emmanuel Innocent<sup>2</sup>

<sup>1</sup>Department of ENT, Head and Neck Surgery, <sup>2</sup>Department of Histopathology, College of Health Sciences, University of Jos, Jos, Plateau State, Nigeria

**Received:** 29 December 2019

**Accepted:** 29 February 2020

### \*Correspondence:

Dr. Daniel D. Kokong,

E-mail: dankokong@yahoo.com

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## ABSTRACT

**Background:** Measuring adenoid or tonsil volume in surgically removed specimens is likely the most accurate method for quantifying adenotonsillar hypertrophy severity which may predict the extent of surgery to curtail post tonsillectomy haemorrhage a potential lethal complication.

**Methods:** All patients with adenoid or tonsil hypertrophy were graded clinically while the objective grading by volumetric saline displacement in accordance with Archimedes' principle; between August 1, 2017 to July 31, 2019 at the Jos University Teaching Hospital, Plateau State, Nigeria. Data analysis was by the SPSS version 21.0 Chicago IL, USA.

**Results:** The study had 96 participants with a M:F=1.7:1. Age range was 9 months to 51 years, median was 3 yrs, mean was 9.5 yrs±15.5 yrs with 83 (86.5%) who were ≤18 yrs. Main features of this study, no. of patients in snoring was 83 (86.5%), nasal obstruction 71 (74.0%), rhinorrhoea 32 (33.3%), noisy breathing 23 (24.0%), dysphagia- 18 (18.8%), mouth breathing 18 (18.8%). Grading of this study was 78 (81.2%) were Brodsky grade III & IV while 72 (75.0%) had ANR of ≥0.5. Blood loss was range 10 ml to 250 ml, median 35 ml, mean 52.7±46.9 ml while 51 (63.0%) had blood loss of ≤50 ml. Volume of surgical specimen of adenoid; range 0.20-4.50 ml, mean 1.56±0.83 ml while tonsil; (Rt)-range 1.00-12.50 ml, mean 3.18±1.97 ml. There was a positive correlation between adenoid or tonsil grade and volume at 99% CI; (r)=0.409, (p=0.000) and grade (mean) 3.11±0.78, volume (mean) 3.18±1.96.

**Conclusions:** This study establishes a positive correlation between clinical grading of adenoid or tonsil and volume with a certain level of accuracy which may predict extent of surgery to avoid post tonsillectomy hemorrhage, a life-threatening/lethal complication from excessive, partial or suboptimal surgery commonly.

**Keywords:** Adenoid or tonsil, Grading or volume, Correlation, Surgical, Accuracy

## INTRODUCTION

Adenoidal or tonsillar hypertrophy are a frequent source of anxiety for parents and doubt for general practitioners.<sup>1,2</sup> Adenotonsillar hypertrophy is the major determinant of obstructive sleep apnea (OSA) in children. Untreated OSA is associated with adverse cardiovascular,

neurocognitive, and somatic growth consequences. Removing the tonsils and adenoids is widely recognized as the most effective first-line therapy for childhood sleep apnea.<sup>3-7</sup>

It is important to effectively communicate adenoid or tonsillar size for outcomes studies as the overall

effectiveness of an adenotonsillectomy is only about 80% in reducing the apnea-hypopnea index. Subjective tonsillar size based on the Brodsky rating system corresponds to objective tonsillar volume reported by several scholars which explains our current utility of the Brodsky's criteria that has been in use for almost three decades and that for adenoids by Fujioka et al for four decades.<sup>8-11</sup> Nevertheless, controversies still exist about the value and/or significance of such measure methods. This way, Gray's anatomy states that "the size of the projection of the medial border of the tonsil into the pharynx is not a true indication of the size of the organ".<sup>12</sup>

The evaluation of the adenoid or tonsil size is valuable in clinical work, which is a major factor for the upper airway obstruction in obstructive sleep apnea or hypopnea syndrome (OSAHS) patients, as removal of large tonsils can significantly widen a relatively narrow pharynx. Thus, tonsil size is now commonly accepted as a predictive factor for successful surgical outcome. Several methods and examinations have been employed for evaluating the tonsil size. The Brodsky scale which is widely used in physical examination is a classical method. It is simple to perform and costs little. However, its accuracy may be influenced by several subjective and objective factors theoretically, such as embedded tonsils or excessive oropharyngeal tissues. Clinically, it has been reported that the tonsil grading may not reflect real tonsil volume, which may be underestimated or overestimated by subjective grading scale due to the embedded tonsils or excessive oropharyngeal tissues, leading to surgical chances missing or over-treatment.<sup>13-16</sup>

Measuring adenoid or tonsil volume in surgically removed specimens is likely the most accurate method for quantifying adenotonsillar hypertrophy severity which would determine the extent of surgery to avoid devastating complications associated with excessive, partial or suboptimal surgery leading to primary post tonsillectomy hemorrhage (PTH) which informed this study.<sup>17,18</sup>

## **METHODS**

### **Study design**

This was a prospective study.

### **Setting**

The Jos University Teaching Hospital, Jos, Plateau State, Nigeria between August 1, 2017 to July 31, 2019, a public academic tertiary health institution.

### **Eligibility criteria**

In accordance with the clinical practice guideline compendium of American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) 1995 cases with

bleeding or coagulation defects, malignancies and gross craniofacial anomalies were excluded.<sup>19</sup>

### **Sample size**

All consecutive patients who met the inclusion criteria within the period for the study.

### **Study selection**

Convenient sampling.

### **Diagnostic criteria**

Clinical symptoms or risk factors, clinical grading of Tonsillar enlargement by Brodsky where grade 0=surgically absent tonsillar fossae, grade 1=0-25% oropharyngeal obstruction, grade 2=25-50%, grade 3=50-75%, grade 4=75-100% while adenoidal size by Fujioka et al from X-ray cephalometry or adenoid nasopharyngeal ratio (ANR), re-enforced by mirror examination intra-operatively in accordance with Cassano et al classification as follows; grade 1- adenoid tissue fills less than 25% of vertical height of choana; grade 2-adenoid tissue fills 25-50% of choana; grade 3- adenoid tissue fills 50-75% of choana and grade 4- adenoid tissue fills 75-100% of choana reinforced by peri-operative mirror examination.<sup>10,11,20</sup> All confirmed by histopathologic reports.

### **Data items**

Biodata, diagnosis, indication for adenoidectomy or tonsillectomy or adeno-tonsillectomy, investigations: full blood count, U/ E/ Cr, clotting profile (prothrombin time ratio or international normalized ratio (INR)), blood group or cross match for the at risk/Surgeon's preference, electrocardiography (ECG), X-ray post nasal space, CXR-AP. The patients' fitness for surgery was assessed using the American Society of Anaesthesiology (ASA) criteria by the anaesthesiologist (ASA I or II considered fit for surgery). All operations were under general anaesthesia via orotracheal intubation with the use of propofol or halothane. All were administered peri-operative intravenous augmentin (GSK) and etamsylate sodium (dicynone) which acts at capillary bed and promote platelet aggregation. We used also soaked gauze in 1-2% xylocaine in 1:1000 adrenaline prepared in 1:200,000 dilution for surgical hemostasis. The surgical technique was the cold steel dissection tonsillectomy and adenoidectomy by the Beckmann adenoid curette. Use of monopolar diathermy for coagulation of bleeders as appropriate while duration of procedure was defined as first incision to completion of operation/ securing hemostasis, any bleeding thereafter was categorized as PTH. Estimated blood loss (EBL) obtained by counting used pieces of blood soaked gauze (one square inch soaked gauze=10 ml of blood) or estimated blood volume in receiving bottle on completion of surgery is final volume in the bottle less irrigation fluid already

predetermined (150 ml).<sup>21</sup> Volume of adenoid or tonsil surgical specimen was by Archimedes principle.<sup>22</sup> The Surgeons were the consultants and specialist registrars-under supervision. Finally, observed complications and final outcome were noted.

**Data collection process**

A proforma for data collection was utilized.

**Risk of bias**

Minimized as cases were consecutively enrolled from established diagnostic criteria.

**Results synthesis**

Data were extracted from the proforma, coded, entered into a spread sheet and subjected to statistical analysis by a Statistician or data analyst.

**Data analysis**

We utilized SPSS version 21.0 Chicago, IL, USA.

Analysis commenced with descriptive statistics; associations or relationship were established with the correlation coefficient(r) at 99% CI (two-tailed) with p value ≤0.01 as significant while Linear regression analysis with (r<sup>2</sup>) or β-coefficient at 99% CI with p value ≤0.01 as significant were used to establish predictors. Correlation of 0.90 to 1 corresponds to a very high degree of correlation, 0.70 to 0.90 -high, 0.50 to 0.70 -moderate, 0.30 to 0.50 - low and below 0.30 considered very low. The Pearson’s Chi square (χ<sup>2</sup>) statistics at 95% confidence interval were used to confirm association between tonsil grade and volume (p≤0.05 regarded as significant).

Findings displayed in simple descriptive format, tables, figures while interpretation/inference made through discussion.

**Ethical clearance**

Obtained from the Institutional Health Research Ethical Committee (HREC) with reference no: JUTH/DCS/ADM/127/XXIX/1528; the study observed the Helsinki declaration.

**RESULTS**

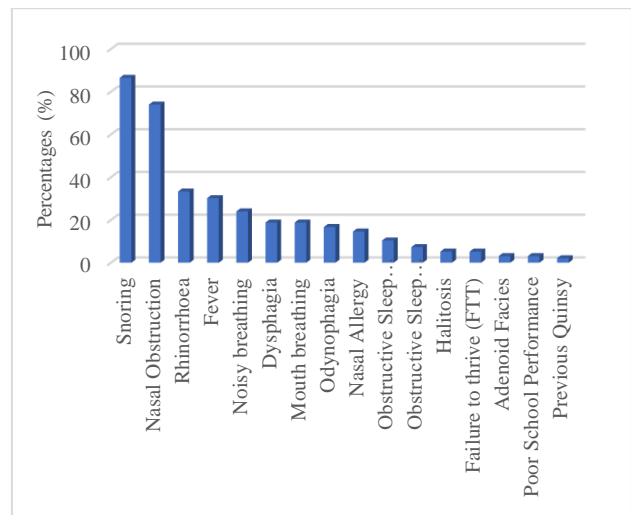
There were 96 participants, representing 60.4% of ENT major operations (159) within the study period with 61 (63.5%) males and 35 (36.5%) females; (M:F=1.7:1). Age range was 9 months-51 years, median was 3.0 yrs, mean was 9.5±15.5 years. A total of 83 (86.5%) were children ≤18 years with two peaks; 0-4 years was 61 (63.5%) and 5-9 years was 16 (16.7%) (Table 1).

Clinical features were snoring-83 (86.5%), nasal obstruction-71 (74.0%) rhinorrhea 32 (33.3%), fever 29 (30.2%), noisy breathing 23 (24.0%), dysphagia 18 (18.8), mouth breathing 18 (18.8%), odynophagia 16 (16.7%), nasal allergy 14 (14.6%), OSA 10 (10.4%), OSAS 7 (7.3%), halitosis 5 (5.2%), failure to thrive 5 (5.2), adenoid facies- 3 (3.1%), poor school performance 3 (3.1%), previous quinsy 2 (2.1%) (Figure 1).

**Table 1: Age distribution of patients with obstructive adenotonsillar disease (n=96).**

S. no.	Age (years)	frequency	Percentage (%)
1	0-4	61	63.5
2	5-9	16	16.7
3	10-14	3	3.1
4	15-19	3	3.1
5	20-24	1	1.1
6	25-29	2	2.1
7	30-34	3	3.1
8	35-39	2	2.1
9	≥40	5	5.2
<b>Total</b>		96	100.0

M:F=61:35=1.7:1



**Figure 1: Clinical features of obstructive adenotonsillar disease.**

**Clinical grade**

Forty three (44.8%) were Brodsky grade III, 35(36.4%) were grade IV and 16 (16.7%) were grade II while 72(75.0%) had adenoid-nasopharyngeal cavity ratio (ANR) of ≥0.5 equivalent of grades III and IV (Table 2).

Main indications, obstructive adenotonsillar disease 72 (75.0%) and chronic hypertrophic tonsillitis 20 (20.8%).

Abnormal ECG findings were seen in 27 (28.1%) which were cases of myocardial infarction, cor-pulmonale, heart block, cardiomegaly and cardiac arrhythmias.

**Table 2: Adenoid or tonsil grade distribution (n=96).**

Grade	Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1	2	2.1	2.1
	2	16	16.7	18.8
	3	43	44.8	63.6
	4	35	36.4	100.0
	Total	96	100.0	100.0

NB: grades 1-4 also described as 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> degrees adenoid or tonsil size respectively.

**Table 3: Summary of descriptive statistics of the main variables.**

	Minimum	Maximum	Mean	Std. deviation
Clotting profile (INR)	0.52	2.68	1.22	0.24
Clotting profile (PTR)	0.58	1.92	1.21	0.22
Estimated blood loss (ml)	10.00	250.00	52.71	49.60
Adenoid vol	0.20	4.50	1.56	0.83
Tonsil vol (right)	1.00	12.50	3.18	1.97
Tonsil vol (left)	0.80	11.00	2.96	1.55

NB: twenty-eight (29.2%) had INR >1.3, median blood loss= 35.00 ml, PTR= Prothrombin time ratio.

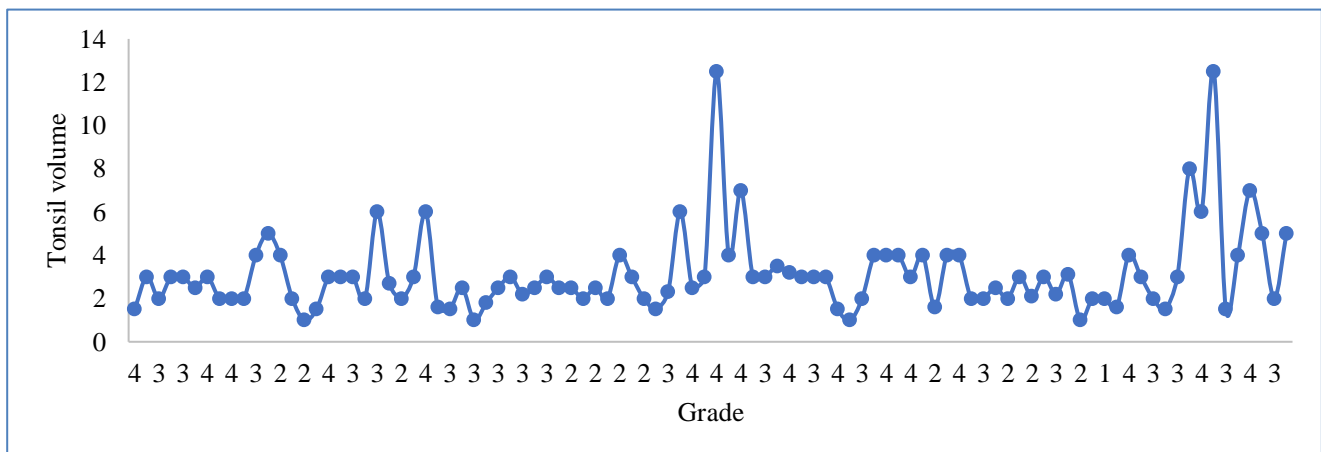
**Table 4: Relationship between adenoid or tonsil grade and volume of surgical specimen (n=96).**

Grade	Tonsil vol (right)				Total
	1.0-1.9	2.0-2.9	3.0-3.9	4 and above	
1	2	-	-	-	2
2	3	10	0	3	16
3	6	17	15	5	43
4	4	2	10	19	35
Total	15	29	25	27	96

NB: Adenoid or tonsil grade equates the volume of surgical specimen with certain level of accuracy as: grade 1=1.0-1.9 ml, grade 2=2.0-2.9 ml, grade 3=3.0-3.9 ml, grade 4= 4.0 ml or more.

**Table 5: Pearson chi-square ( $\chi^2$ ) tests at 95% CI of adenoid or tonsil grade vs volume of surgical specimen.**

	Value	df	Asymp sig. (2-sided)
Pearson chi-square	64.039 <sup>a</sup>	38	0.005
Likelihood ratio	71.490	38	0.001
Linear-by-linear association	15.244	1	0.000
N of valid cases	96		



**Figure 2: Relationship between tonsil grade and volume of surgical specimen.**

NB: Grade equated volume of surgical specimen with certain level of accuracy.

**Coagulation studies**

The INR was used range 0.52-2.68, mean 1.22±0.24 and 28 (29.2%) had abnormal INR ≥1.3. Blood loss of range 10 to 250 ml, median 35 ml, mean 52.7±46.9 ml. Overall, 5.2% experienced a maximum blood loss of 200-250 ml from which 3.1% had Primary PTH from tonsil remnant.

**Surgical specimen (vol)**

Adenoid vol was range 0.20-4.50, mean 1.56±0.83 ml while tonsil volume; right: range; 1.00 to 12.50 ml, mean 3.18±1.97 ml and left-range; 0.80 to 11.00 ml, mean 2.96±1.55 ml. The right tonsil was frequently larger than the left (Table 3).

**Surgery duration**

Range 20 to 120 mins, median 55 mins, mean 61.5±28.6 mins. Overall, 73 (76.0%) had the procedure within 60 mins.

Correlation of adenoid or tonsil grade and volume of surgical specimen: grade equated the volume with a certain accuracy; Pearson correlation coefficient at 99%

CI:  $r=0.409$ ,  $p=0.000$  while the Pearson's Chi Square( $\chi^2$ ) statistics at 95% CI to confirm association; Pearson ( $\chi^2$ ) value=64.039,  $p=0.005$  while the Linear-by-Linear association value=15.244;  $p=0.000$  (Table 4 and 5).

Relationship between adenoid or tonsil grade and vol of surgical specimen (Figure 2).

**Correlation statistics**

Grade (mean) was 3.11±0.78, volume (mean) was 3.18±1.96. Correlation coefficient at 99% CI (two-tailed); ( $r$ )=0.409, ( $p$ )=0.000 while regression analysis 99% CI; beta coefficient (standardized regression coefficient)  $\beta=0.409$ ,  $p=0.000$ . NB: When there is only one predictor variable in a model, then beta is equivalent to the correlation coefficient 'r' between the predictor and the criterion variable. The grade predicted the volume with a certain level of accuracy as; grade I corresponded to 1 ml, grade II was 2 ml, grade III=3 ml and grade IV=4 ml and above (Table 6 and 7).

On hospital stay, 82 (85.4%) were discharged within 72 hours, while 14 (14.6%) were discharged by the 5th post-operative day while 94.8% had complete resolution of symptoms with no mortality.

**Table 6: Correlation analysis of adenoid or tonsil grade vs volume of surgical specimen.**

Descriptive statistics	Mean	Std. deviation	N
Grade	3.1146	0.77961	96
Tonsil (vol) (right)	3.1837	1.96867	96
<b>Correlation</b>		Grade	Tonsil (right)
Grade	Pearson correlation	1	0.409**
	Sig. (2-tailed)		0.000
	N	96	96
Tonsil (vol) (right)	Pearson correlation	0.409**	1
	Sig. (2-tailed)	0.000	
	N	96	96

\*\* . Correlation is significant at the 0.01 level (2-tailed).

**Table 7: Regression analysis of adenoid or tonsil grade and volume of surgical specimen.**

Variables entered or removed <sup>b</sup>						
Model		Variables entered	Variables removed	Method		
Dimension0	1	Grade <sup>a</sup>	-	Enter		
a. All requested variables entered. b. Dependent variable: tonsil vol (right)						
Model summary						
Model	R	R square	Adjusted R square	Std. error of the estimate		
Dimension0	1	0.409 <sup>a</sup>	0.168	0.158	1.80618	
a. Predictors: (constant), grade						
ANOVA <sup>b</sup>						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	59.080	1	59.080	18.110	0.000 <sup>a</sup>
	Residual	293.606	90	3.262		
	Total	352.686	91			
a. Predictors: (constant), grade, b. Dependent variable: tonsil vol (right)						

Continued.

Coefficients <sup>a</sup>						
Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.380	0.858		-0.442	0.659
	Grade	1.127	0.265	0.409	4.256	0.000

a. Dependent variable: tonsil vol (right)

## DISCUSSION

The incidence of adenoidectomy, tonsillectomy or both of 60.4% in our series confirms the frequency of the operation in oto-laryngological practice as reported by several scholars with a male preponderance with no clear scientific basis.<sup>23-25</sup> Unfortunately, these procedures are performed as first line surgical operations in the paediatric population who are the susceptible age-group for obstructive adenoidal and or tonsillar disease which are located amongst the highly vascularized and difficult for surgical access regions of the upper aerodigestive tract.<sup>26,27</sup> This was confirmed in this cohort where 86.5% were  $\leq 18$  years who were majorly  $\leq 4$  years with 63.5%; the age-group with up to 4-5 risks of developing serious to life-threatening airway and post tonsillectomy bleeding complications of the procedure.<sup>26,28</sup>

We recorded 81.2% of our cohort with grades III and IV adenoid/tonsil hypertrophy who had adenoidectomy, tonsillectomy or both as similarly reported by other researchers.<sup>29,30</sup> The 1<sup>st</sup> and second degrees hypertrophy are often reserved for conservative medical treatment as first line therapy while 3<sup>rd</sup> and 4<sup>th</sup> degrees have surgery as 1<sup>st</sup> line therapy. However, in medical treatment failure where obstructive additive effects persist in grade I or II adenoid/tonsil hypertrophy, we offered them surgery which has also been reported.<sup>20,21</sup>

Knowing the size of the tonsil/or adenoid and relationship to the surrounding structures before surgery is very important in terms of the success of the procedure. Usually, clinical classifications are often made according to the transverse extension of the tonsil toward the centre of the oropharynx, however; the depth in the lateral aspect and inferior extension toward the hypopharynx are not easily assessed due to the size or position of the tongue and tongue root/base in certain individuals.<sup>26,31</sup> Researchers therefore developed different methods of accurate volume assessments including the trans-cervical ultrasonographic method, the calculation method based on a formula, the Cavalieri, the Ellipsoid and the Archimedes' principle methods; which the latter had been proven to be the most accurate<sup>26,31-33</sup> this informed our choice of the method. Having knowledge of the adenoid/tonsil size/volume would assist the surgeon to predict the extent of surgery to avoid excessive, partial or suboptimal surgery leaving behind remnants with PTH as consequences for both.<sup>21,34</sup> Primary PTH usually occurs within the first 6 to 8 hrs which constitutes over 80% of primary PTH and is more dangerous due to the risk of

aspiration, laryngospasm and low amount continuous bleeding/swallowing, usually not immediately evident as patients are yet to recover fully from GA, with a subsequent circulatory collapse.<sup>35-37</sup> Furthermore, much of the mortality in tonsillectomy is directly/indirectly associated with primary PTH Windfuhr et al in a meta-analysis cited several lethal outcomes including a case of fatal hemorrhage from adenoidectomy in a 5-year old female in an attempt to remove adenoidal remnant secondary to a suspected nasopharyngeal arterial anomaly or over curettage despite 10 units of blood transfusion.<sup>18,38</sup> Another meta-analysis reported 71 published court verdicts after adeno-tonsillectomy with over 60% from PTH and its consequences.<sup>39</sup> Datta et al proposed an endoscopic grading system post adenoidectomy into; complete removal when adenoid tissue left is  $< 20\%$ , partial removal-when adenoid tissue left behind is between 20%-50% and sub-optimal-greater the 50% adenoidal tissue left behind.<sup>40</sup>

We perform clotting profile on all cases for adenotonsillectomy as our regular routine pre-operatively and further group /cross match at least a unit of fresh whole blood before the procedure in the event of a need for transfusion despite the argument for and against.<sup>41,42</sup> Our dictum is 'any circumstance that has a chance of occurrence, can happen on any index case no matter how infinitesimally small: better to over prepare than under prepare'.

For yet to be identified reasons, the right tonsil was found to be larger than the left in this cohort: right=12.5ml, mean  $3.18 \pm 1.97$  while left=11.0 ml, mean  $2.96 \pm 1.55$  ml similarly observed in a study.<sup>13</sup> This study recorded the largest tonsil and adenoid in literature with volumes of  $12.5 \pm 1.97$  ml and  $4.5 \pm 0.83$  respectively contrary to reports by Scholars outside Africa<sup>16,32</sup> which were by far less. This may be from delays from misdiagnosis as the continent of Africa suffers from dearth of ENT specialists or ignorance. The study consistently demonstrated a correlation between the subjective clinical grading with volume displacement grading by the Archimedes principle that has similarly been reported globally.<sup>13,16,17</sup> Furthermore, the degree of correlation was succinctly displayed in both diagrams/tabular forms where the grade was found to equate the volume by a certain level of accuracy, with a Pearson Coefficient correlation at 99% CI,  $r=0.409$ ,  $p$  value=0.000. Linear by Linear Association value 15.244,  $p=0.000$ . while regression analysis 99% CI yielded a  $\beta$  coefficient (standardized regression coefficient)  $\beta=0.409$ ,  $p=0.000$  which are all significant.

These are unprecedented findings which may serve as a guide to determine extent of surgery to curtail excessive or partial or sub-optimal removal.

On morbidity, however, this study recorded a case of brain injury from laryngospasm in a patient being managed for ENT allergy. The incidence of laryngospasm has been reported in the literature as high as 25% in patients undergoing tonsillectomy and adenoidectomy. Laryngospasm can rapidly result in hypoxaemia, bradycardia and cardiac arrest.<sup>43,44</sup> Patients with hypersensitivity of the airway from infective, inflammatory, or other irritation such as passive smoking, silent gastro-esophageal reflux have a 10-fold increase in the risk of laryngospasm. However, 94.8% had complete resolution of symptoms while the remaining with incomplete resolution were cases of Down's syndrome, nephrotic syndrome and cerebral palsy with no mortality.

## CONCLUSION

This study establishes a positive correlation between the clinical grading of adenoid/tonsil with volume assessment with a certain level of accuracy which may predict extent of surgery to avoid primary PTH, a life-threatening/lethal complication from excessive, partial or suboptimal surgery commonly.

## ACKNOWLEDGEMENTS

We appreciate the consultant staff whose patients were enrolled for the study and the Data analyst, Mr Kingsley Oparah for his expertise. The study is a version of that presented at the Biennial Delegates' meeting & Scientific conference of the Medical and Dental Consultants' Association of Nigeria held Monday 26-31/08/2019 at the Multipurpose hall, Steffan's Hotel, Jonah Jang Way, Rayfield, Jos, Plateau State, Nigeria. And also it is a version of that presented at the 27<sup>th</sup> Annual Scientific conference or Annual General Meeting of the Otolaryngological Society of Nigeria, held Wednesday 20<sup>th</sup>-22<sup>nd</sup> November, 2019 at Sheraton Hotel & Towers, Ikeja, Lagos, Nigeria.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Kokong DD, Adoga AA, Turaki I, Maan ND, Yaro JP, Innocent E. Correlation between clinical grading of adenoid or tonsil hypertrophy and adenoid or tonsil volume post adenotonsillectomy: a prospective cohort study. *Int J Otorhinolaryngol Head Neck Surg* 2020;6:598-605.