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ORIGINAL ARTICLE

Routine Electrocardiography Request in Adenoidectomy: Is it necessary?

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Abstract To evaluate the relevance of routine electrocardiographic request in pre-operative work-up of children undergoing adenoidectomy. This is a two year prospective study of children with obstructive adenoid that had adenoidectomy. This is a tertiary hospital based study at the Otorhinolaryngology Department of University College Hospital, Ibadan. Children ($\leq$12 years) with clinical and radiological evidence of an obstructive adenoid were investigated. Information obtained with an interviewer assisted questionnaire included the biodata, clinical presentation of the patients, ECG findings, echocardiographic findings, cardiothoracic ratio, palatal airway and ratio of adenoid diameter to the nasopharyngeal diameter. The adenoid volume was measured after adenoidectomy. The results were analyzed using SPSS version 14 and level of statistical significance was $P < 0.05$. There were seventy four patients; 45 (60.8%) males and 29 (39.2%) females with a mean age of 38.35 months, S.D $\pm$ 30.32 (range 5–144 months). All the patients presented with mouth breathing and recurrent mucopurulent rhinorrhea. Mild snoring was detected in 18 (25%) patients, moderate snoring in 39 (54.17%) patients and severe snoring in 15 (20.83%) patients. Mild apnea was observed in 55 (74.32%) patients and moderate in 19 (25.68%) patients. Only seven (9.46%) patients had abnormal electrocardiographic findings but their ejection fraction on echocardiography ranged from 63 to 72% with a mean value of 68.17%, S.D $\pm$ 3.22. Cardiac complications of enlarged obstructive adenoid appear not to be common. Routine preoperative electrocardiography should therefore be restricted to only the high risk patients.

Keywords Children · Electrocardiography · Obstructive adenoid

Introduction

Nasal obstruction in children is a common clinical presentation to the paediatricians and paediatric Otorhinolaryngologists. An enlarged, obstructive adenoid has been implicated in some of the cases [1]. Adenoids are lymphoid tissues located at the postnasal space and their surgical removal is simply referred to as adenoidectomy. An enlarged adenoid is a common cause of obstructive sleep apnea syndrome, which is an absolute indication for adenoidectomy. Obstructive sleep apnea syndrome is clinically diagnosed when there is snoring, excessive daytime somnolence, restlessness and cessation of breath for at least five times, each episode lasting for at least 10 s in an hour of sleep. The situation is usually worse when accompanied by enlarged tonsils. In a neglected, long standing situation, this could result in hypoxia, pulmonary hypertension, right ventricular hypertrophy and cor-pulmonale [2]. Other indications for adenoidectomy include failure to thrive, recurrent or persistent middle ear effusion and recurrent or chronic sinusitis [3–5].

The possibility of cardiac complications from an obstructive adenoid usually necessitates the routine

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preoperative electrocardiographic and/or echocardiographic evaluation of these children by surgeons and anesthetists. However, is this routine request really necessary in all children undergoing adenoidectomy? This study was therefore designed to find out the relevance of routine pre-operative electrocardiography in adenoidectomy and to determine the association between the degree of nasal obstruction and the electrocardiographic findings.

Materials and Methods

Study Design

This was a two-year prospective study of children that had adenoidectomy for obstructive adenoid. Ethical approval was obtained to conduct the study from University of Ibadan/University College Hospital Ibadan ethical review board. Written informed consent was obtained from the patients' caregivers.

Setting/Study Location

It was a hospital based study at the Otorhinolaryngology Department of University College Hospital, Ibadan.

Sampling Criteria/Technique

All Children ($\leq$12 years) with clinical and radiological evidences of an obstructive adenoid who had adenoidectomy during the study period participated in the study.

Study Period

October 2006–October 2008.

Data Sources and Collection Procedure/Technique

Information obtained with an interviewer assisted questionnaire included the biodata and clinical information on the symptomatology of obstructive adenoidal enlargement which included duration of symptoms, presence of recurrent or persistent mucopurulent rhinorrhea, mouth breathing, snoring, restless sleep, frequent waking-up at night (at least three times due to respiratory discomfort or distress), obstructive breathing during sleep, ear discharge, reduced hearing and failure to thrive. The snoring was classified mild if present only on supine position but not every night; moderate if present every night but diminished or disappeared with change in position and severe if present every night but never changed with position.

A complete ear, nose and throat examination was performed on all the patients and the tonsils were graded during oropharyngeal examination using Brodsky grading method [6]. Grade 1+ meant tonsils were completely in the tonsillar fossa and barely seen behind the anterior pillars; Grade 2+ meant tonsils were visible behind the anterior pillars; Grade 3+ meant tonsils extended ¾ of the way to the midline and Grade 4+ meant that the tonsils touched each other and were completely obstructing the airway [6].

A lateral post-nasal space radiograph was obtained in an erect position with the neck extended and the mouth opened in order to visualize the shadow of the adenoid. The palatal airway was evaluated as described by Bitar [7]. The degree of nasopharyngeal obstruction was determined by assessing the ratio of adenoid shadow diameter to the nasopharyngeal diameter. This was considered mild if <50% of the palatal airway was obstructed, moderate if $\geq$50% was obstructed but not up to 100% and severe obstruction if there was complete nasopharyngeal obstruction and no air column was seen on the postnasal space radiogram.

The cardiothoracic ratio was determined from the antero-posterior view of plain chest radiograph.

Electrocardiography (ECG) was carried out on all the patients and the parameters measured on the ECG included the heart rate, rhythm, characteristics of P, QRS, and T waves and presence of evidence of atrial hypertrophy, ventricular hypertrophy and axis deviation. The tracings were analyzed and reported by a pediatric cardiologist. All the patients with abnormal ECG findings had echocardiography done before surgery. The parameters measured on echocardiography included left atrium (LA) dimension, right ventricle (RV) dimension, left ventricle end diastolic diameter (LVEDD), left ventricle end systolic diameter (LVESD), Interventricular septum (IVS) dimension, deceleration time (DT), fibre shortening (FS), Isovolumic relaxation time (IRT), peak late ventricular filling velocity (VA), peak early ventricular filling velocity (VE), posterior wall (PW) dimension and ejection fraction. ECG was repeated after 6 months in the patients with abnormal preoperative electrocardiographic findings.

Their arterial oxygen saturation (SaO_2) was measured with pulse oximeter prior to surgery and according to the SaO_2 levels, apnea was classified as follows; mild if a SaO_2 level is $\geq$85%, moderate if a SaO_2 level is between 65 and 84% and severe if SaO_2 level is $\leq$64%.

All adenoidectomies were performed using Negus adenoid curette under indirect visualization with a post-nasal space mirror. In addition, tonsillectomy was also performed in twenty six (35.14%) patients. The adenoid volume was measured after adenoidectomy. This was done by pouring water into an improvised test tube up to 10 ml measurement level. The curetted or removed adenoid tissue was then dropped into the tube and the volume of water displaced was observed. The average of the values observed by three individuals was recorded.

Data Analysis

The results were tabulated and statistically analyzed using statistical package for social sciences (SPSS) version 14. The association between age at surgery and adenoid volume was tested using the Pearson correlation coefficient. The association between the palatal airway and adenoid volume was also tested using the Pearson correlation coefficient. Chi Square test was used to study the association between the degree of nasal obstruction using the palatal airway and electrocardiographic (ECG) findings. ANOVA was used to study if the electrocardiographic findings differed according to the adenoid volume, duration of symptoms and the degree of nasal obstruction using the palatal airway. Level of significance was determined at $P < 0.05$, two-tailed level at 95% confidence interval and correlation coefficient (r).

Results

Seventy four patients had adenoidectomy; 45 (60.8%) males and 29 (39.2%) females with a sex ratio of 3:2 (M:F). Their ages ranged from 5 months to 144 months with a mean age of 38.35 months S.D ± 30.32. Fifty-one (68.92%) of these patients were ≤36 months old. The duration of symptoms ranged from 3 to 132 months. The symptoms seen in the patients are presented in Table 1. Twenty six (35.14%) of these patients had associated enlarged tonsils on oropharyngeal examination (Brodsky grade 2+ in 14 [18.92%] patients and Brodsky grade 3+ in 12 [16.22%] patients). The remaining forty eight (64.86%) patients had Brodsky grade 1+ tonsils. Mild snoring was detected in 18 (25%) patients, moderate snoring in 39 (54.17%) patients and severe snoring in 15 (20.83%) patients. Mild apnea was observed in 55 (74.32%) patients and moderate in 19 (25.68%) patients. There was no patient with observed severe apnea. The indications for adenoidectomy were obstructive sleep apnea syndrome with persistent mucopurulent rhinorrhea in 58 (78.38%) patients, recurrent otitis media in 11 (14.86%), and failure to thrive in 5 (6.76%).

The cardiothoracic ratio ranged from 0.41 to 0.63 with a mean value of 0.51, S.D ± 0.07. The adenoid–nasopharyngeal diameter ratio ranged from 0.71 to 1 with a mean of 0.85. The nasopharyngeal obstruction was mild in 6 (8.1%), moderate in 45 (60.8%) and severe in 23 (31.1%). Seven (9.46%) patients had abnormal ECG findings of which three patients had isolated right ventricular hypertrophy, one patient had right atria hypertrophy and another had right axis deviation and the remaining two patients had bilateral ventricular hypertrophy. All these seven patients had moderate apnea. The remaining patients had normal ECG findings. All the patients with abnormal ECG findings had echocardiography done before surgery but no functional abnormality (systolic or diastolic dysfunction) was detected. The results of the echocardiography are presented in Table 2. The ejection fraction (EF) ranged from 63 to 72% with a mean value of 68.17%, S.D ± 3.22; the peak late ventricular filling velocity (VA) ranged from 0.65 to 0.71 with a mean value of 0.67 ± 0.4 and the peak early ventricular filling velocity (VE) ranged from 1.04 to 1.12 with a mean value of 1.07 ± 1.2.

Table 1 Symptomatology of obstructive adenoid

Symptoms	Frequency	Percentage
Recurrent mucopurulent nasal discharge	73	98.6
Mouth breathing	71	95.9
Snoring	72	97.3
Noisy breathing	44	59.5
Cessation of breath during sleep	47	63.5
Nasal blockage	73	98.6
Recurrent cough	45	60.8
Excessive day time somnolence	8	10.8
Restlessness during sleep	21	28.4
Recurrent ear discharge	6	8.1
Impairment of hearing	4	5.4
Failure to grow like other children	3	4.1
Recurrent otalgia	7	9.5
Inability to speak	3	4.1

Note: All the patients presented with more than one symptom

The volume of adenoid measured after removal ranged from 1 ml to 4 ml with an average of 2.19 ml, S.D ± 0.76. Six months post operatively, a repeat electrocardiography was performed on five patients but there was persistent of the initial ECG finding in three patients while only in two patients was the ECG findings considered normal (Table 2). The remaining two patients were lost to follow up.

The adenoid volume significantly correlated with the age of patient at surgery ($P < 0.05$, $P = 0.000$; $r = 0.8208$). There was also a significant correlation between ratio of adenoid diameter to nasopharyngeal diameter and the palatal airway ($P < 0.0001$; $r = 0.8172$) but no statistically significant correlation existed between the palatal airway and the adenoid volume ($P = 0.553$, $r = 0.0660$). Electrocardiographic (ECG) findings did not correlate significantly with age at surgery ($P = 0.598$; $r = 0.0682$), palatal airway ($P = 0.695$; $r = 0.0789$) or adenoid volume ($P = 0.143$; $r = 0.3542$). However, there was a correlation between the ECG and duration of symptoms ($P < 0.001$).

Discussion

Adenoidectomy is a surgical procedure that is commonly performed by pediatric surgeons or otorhinolaryngologists

Table 2 Pre- and post-operative electrocardiographic and echocardiographic findings in the patients with abnormal electrocardiogram

		Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7
ECG report	Heart rate	107	96	134	112	132	123	106
	Abnormality	BVH	RVH	RAD	RVH	RVH	BVH	RAH
Post-operative ECG	6 months postoperatively	BVH	NA	Normal	NA	RVH	BVH	Normal
EchoG findings	LA (cm)	2.8	2.6	2.7	2.8	2.4	2.7	2.9
	RV (cm)	1.8	1.6	1.6	1.7	1.4	1.5	1.9
	LVEDD (cm)	3.8	3.5	3.7	3.8	3.4	3.9	3.8
	LVESD (cm)	2.3	2.5	2.4	2.4	2.6	2.5	2.2
	IVS (mm)	7.4	6.9	6.7	7.1	7.2	7.6	6.8
	DT (ms)	181	173	151	175	169	179	162
	FS (%)	39	37	35	37	38	38	36
	IRT (ms)	76	68	66	71	73	77	69
	PW (mm)	7.1	6.8	6.7	6.9	7.0	7.3	6.6

Abbreviations: *ECG* electrocardiography, *EchoG* Echocardiography, *RVH* right ventricular hypertrophy, *RAH* right atria hypertrophy, *BVH* bilateral ventricular hypertrophy, *RAD* right axis deviation, *NA* not available

to remove adenoid tissue causing nasal obstruction in children. This may reduce the morbidity such as failure to thrive, persistent otitis media and also, mortality rate associated with it. Cardiac complications in a neglected obstructive adenoid are the most dreaded and electrocardiography is usually performed to screen for these during patient's evaluation. Polysomnography is recognized as the most useful laboratory test to assess the presence and severity of sleep related breathing disorder [8, 9] but this was not performed in this study because of fund. However, the SaO_2 levels of the patients were measured with oximeter. It has been reported that oximetry can have sensitivity as high as 100% and specificity as high as 98% [10] hence good at monitoring the degree of blood oxygen saturation.

We evaluated seventy four children with obstructive adenoid who underwent adenoidectomy in our series. Fifty-one (68.92%) of these patients were $\leq$36 months old and nearly 95% of these patients were under 6 years of age, though not surprising as adenoid tissue usually undergoes fibrosis from repeated inflammation and would have shrunken above this age. Also above this age, nasopharynx is usually rapidly developed while adenoid tissue maintains its size or becomes shrunken due to repeated inflammation and fibrosis.

The symptomatology of obstructive adenoids reported in our series (Table 1) is similar to the findings in previous similar studies [5, 11]. Most of our patients presented with mouth breathing, recurrent mucopurulent nasal discharge and snoring. These symptoms have been linked with obstructive adenoids in children, but they are not really specific for the condition, as some other rhinologic conditions in children could present with similar symptoms [11]. Bitar et al. devised a validated and reliable clinical score for identifying children that will require adenoidectomy [7]. However, it is our practice to consider our patients for adenoidectomy if the adenoid is obstructing more than 67% of the nasopharyngeal airway on lateral plain postnasal space radiograph.

Although, 97% of the patients presented with snoring out of which 21% were considered severe, none of these patients were observed to have severe apnea. Obstructive sleep apnea syndrome (OSAS) usually occurs when a patent upper airway is not maintained during sleep. OSAS was an indication for adenoidectomy in all these patients although associated with other complications like failure to thrive, otitis media and persistent rhinorrhea. Otitis media with effusion can result in conductive hearing loss thereby impairing the child language development and education. Also, persistent nasal discharge in a child may turn him or her to a social abuse among his or her mate in school. Adenoidectomy will definitely prevent these complications due to obstructive adenoid thereby promoting the child's development. However, when adenoidectomy is not performed, the obstructive adenoid can obstruct air flow from the upper airway to the lower airway during sleep leading to distortion of blood gases and resulting in hypercapnia and hypoxemia. Hypercapnia is a potent stimulus of respiration. Chronic hypoxemia may cause polycythemia, growth failure, increased pulmonary and systemic hypertension, right-sided heart failure, cardiac arrhythmias or even death [2, 12]. Five (6.76%) of these patients had associated failure to thrive.

There was no radiologic evidence of cardiomegaly as the cardiothoracic ratio of all the patients in this series fell within the normal limits for the pediatric age group. One would have expected some degree of cardiac enlargement in these patients especially in cases with unilateral or bilateral ventricular hypertrophy if actually there was

associated peripheral vasoconstriction. The blood pressure of these patients was within normal limits for the age.

Electrocardiography was performed on all our patients and only seven (9.46%) had abnormal findings in the form of isolated right axis deviation, right atrial hypertrophy, right ventricular hypertrophy and biventricular hypertrophy. Echocardiography on these seven patients however showed evidence of good contractility and ejection fractions of between 63 and 72% with a mean value of 68.17%, S.D $\pm$ 3.22. The values were within normal limits and are satisfactory and safe for putting a patient under general anesthesia. However one patient (Patient 5 in Table 2), who had suffered from obstructive adenoid for 4 years, developed post-operative apneic attack after extubation and was re-intubated and managed in intensive care unit for more few hours. Therefore, in long standing cases of obstructive sleep apnea syndrome, post-operative extubation difficulty with apneic attack is a possibility and must be borne in mind during extubation of the patients postoperatively.

In this study, we found no statistically significant correlation between the palatal airway and the electrocardiographic findings ($P = 0.695$). This might be due to the fact that most of these patients mouth breath even during sleep; hence they do not have such degree of hypoxemia and hypercapnia that may result in the overt cardiac pathology that is expected. However, this reason may be insufficient as 63% of these patients have history of repeated cessation of breath during sleep. Perhaps, if there was a further delay in surgical intervention of adenoidectomy or adenotonsillectomy to relieve the upper airway obstruction, obvious cardiac pathology might develop which might grossly affect the cardiac function and structure. There was associated tonsillomegaly in twenty six (35.14%) patients. The combined adenotonsillomegaly would be expected to result in a more severe form of hypoxemia and hypercapnia with resultant cardiac disease. Two patients with Brodsky grade 2+ and another two patients with Brodsky grade 3+ had abnormal ECG finding.

Larger nasopharyngeal adenoid volume is expected to cause more significant obstruction with more severe cardiac pathology. There was no significant correlation between the adenoid volume and ECG findings ($P = 0.143$). This may be because the obstructive symptom of adenoid tissue is more of a factor of the small postnasal space rather than due to the adenoid volume or size. This emphasizes the importance of considering the degree of nasal obstruction (ratio of adenoid volume to nasopharyngeal volume) in causing symptoms rather than the adenoid size [13]. The duration of obstruction may also be very important in determining the degree of electrocardiographic abnormality seen ($P < 0.001$). When a patient with obstructive adenoid presents early and the obstruction is removed, he or she may not develop cardiac complication.

A repeat ECG on 5 patients who had initial preoperative abnormal ECG showed that there was a reversal of the ECG findings to normal in two patients while three patients had persistence of their preoperative ECG finding (Table 2). Two patients were lost to follow up. However, there was complete resolution of the clinical symptoms of snoring, restless sleeping and cessation of breath during sleep in the patients. Perhaps, more time may be required to see a complete reversal or disappearance of the cardiac pathology on ECG but unfortunately, further follow up of the patients was no longer possible. Mitchell RB in his pre- and postoperative polysomnographic evaluation of children who underwent adenoidectomy for obstructive sleep apnea (OSA) reported on persistence of OSA in some of his patients 6 months after surgery [9].

Conclusion

Cardiac complications and abnormal electrocardiographic findings that will prevent surgical intervention are not so common in patients with obstructive adenoid despite the degree of nasal obstruction in them. It is therefore necessary to carry out another study in future to find out the reason. Routine request of electrocardiography in the preoperative work-up of patients for adenoidectomy is not necessary as it will add to the treatment cost of the patients and may delay surgical intervention in some instances. This should be restricted only to the high risk patients and advice of cardiologist sought before surgery if abnormality is identified on the patient's ECG.

Key Message

Routine pre-operative electrocardiographic request for all children undergoing electrocardiography is not necessary. Each paediatric patient should however be considered based on their clinical presentation for the need for electrocardiography.

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