Outcome of Adenotonsillectomy for Sleep and Breathing Difficulties in Nigerian Children with Obstructive Adenotonsillar Enlargement

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Abstract The aim of this study was to examine improvements or otherwise, in sleep disturbance and breathing difficulties after adenotonsillectomy (AT) for chronic upper airway obstruction in children. In a prospective clinical study and tertiary referral center setting, the study population included consecutive children aged 1.5 through 12 years who underwent AT for chronic upper airway obstruction due to adenotonsillar enlargement, without any history of previous AT. The validated “Symptomatology score” (SS) parameters were used to grade the symptoms before and after AT. The extent of improvement of the symptoms after surgery were estimated by a standardized response mean (SRM). The study included 59 children, 40 of whom were males (68%). Their ages ranged from 1.5 to 12 years with a mean of 3.3 years and 63% were <4 years. The results showed that tonsillar size was correlated significantly with a high preoperative SS ($P \leq 0.001$). The mean preoperative SS for the study population was 7.2, whereas the mean postoperative SS was 1.7. This change was highly significant ($P < 0.001$). The symptom domain with the greatest change in mean score was snoring, which improved by 2 points with SRM of 2.2. The changes in total score and in the scores for

each symptom domain were highly significant ($P < 0.002$). We concluded that adenotonsillectomy is associated with remarkable improvement in breathing difficulties and sleep disturbances in children with obstructive adenotonsillar hypertrophy regardless of the condition whether it is mild or severe.

Keywords Airway obstruction · Adenoids · Obstructive breathing · Snoring · Child · Adenotonsillectomy

Introduction

Adenoidectomy and adenotonsillectomy (AT) are surgical therapies commonly applied in the relief of chronic upper airway obstruction in the presence of adenotonsillar hypertrophy in children. Such obstructive episodes often manifest as sleep-disordered breathing (SDB), physical suffering, and daytime problems in children [1–6]. SDB has been recognized as a spectrum of sleep-related breathing disturbances with severity ranging from mild obstruction of upper airway producing snoring primarily, through increased upper airway resistance with obstructive hypoventilation, to continuous episodes of complete upper airway obstruction producing obstructive sleep apnea syndrome (OSAS) [2–4, 7]. Apart from snoring, other manifestations of obstructive adenotonsillar hypertrophy include mouth breathing, apneic pulses during sleep, difficulty in breathing, restless sleep, frequent awakening, failure to thrive, and behavioral disturbance [2, 4, 7–10].

Although polysomnography performed overnight in a laboratory setting is considered the gold standard for evaluation of OSAS, it is expensive, time-consuming, and not widely available for evaluation of SDB in children

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[1, 9–13]. The ‘Symptomatology score’ (SS) and other graded clinical assessments have been validated against roentgenographic ratings of upper airway obstruction by adenoid vegetations, and shown to be simple, reliable and easy-to-use tools in evaluating the obstructive impact of adenoid vegetations in children [14–16].

This present study was designed to examine improvements or otherwise, in breathing difficulties and sleep disturbance after AT in children with obstructive adenotonsillar hypertrophy using validated ‘symptomatology score’ (SS) parameter.

Materials and Methods

Participants

Children aged 1.5 through 12 years who were undergoing adenotonsillectomy (AT) for breathing difficulties and/or sleep disturbances were recruited from the otolaryngology clinics of a tertiary referral health institution and private practice offices of the authors from April 2004 through February 2007. Children were included if their symptoms had lasted for at least 3 months. The symptoms included snoring, mouth breathing, struggling to breath during sleep, and apneic pauses. Exclusion criteria considered were: those with previous adenoidectomy, those whose primary reason for AT was recurrent infections, those with craniofacial anomalies, nasal septal deviation, and sickle cell disease.

Ethical consideration

The study protocol was approved by the institutional ethical review committee. Informed consent was obtained from the parents or legal guardians.

Study Protocol

On attending the clinic, a detailed medical history (from parents/caregivers) and physical examination were performed. When parents/caregivers were unsure of their observations, they were asked to further observe their children at daytime and during sleep over a period of 1 week and then the history were retaken. Children were diagnosed clinically as having obstructive adenotonsillar enlargement by a history of snoring, apneic pauses during sleep, and struggling to breath; and by a physical examination documenting hypertrophic tonsils and/or adenoids. Adenoid hypertrophy was confirmed using X-ray of post-nasal space (Fig. 1a). Other symptoms evaluated were: mouth breathing, nasal discharge, and daytime hypersomnolence. Data were obtained on the following parameters: age, sex, presenting symptoms, and tonsillar size.

Fig. 1 **a** Plain radiograph of the nasopharynx of a patient showing marked narrowing of the nasopharyngeal airway (*black arrow*), occasioned by the lobulated soft tissue shadow of grossly enlarged adenoid vegetation. **b** Plain radiograph of the nasopharynx after 6 week of AT, showing marked improvement of the airway

‘The symptomatology scores’ [14] were generated using set of questions designed to grade the severity of the most typical symptoms of adenotonsillar hypertrophy that indicated breathing and sleep disturbances. The following numeric values were assigned to snoring and mouth breathing: 0—absent, 1—occasionally during sleep, 2—regularly during sleep, 3—regularly during sleep and daytime. Obstructive breathing during sleep was assigned the following values: 0—absent, 1—occasionally, 2—<5 episodes, 3—≥5 episodes. The domains of nasal discharge and daytime hypersomnolence were assigned the following values: 0—never, 1—occasionally, and 2—regularly. The SS represents the sum of the individual domain scores. These were recorded prior to, and at least, 10 weeks after AT for each child. The maximum score any child had was thus 13. The SS of less than 6 suggested ‘mild’ airway obstruction, scores between 6 and 9 were considered suggestive of

‘moderate’ obstruction, whereas scores of more than 9 suggested ‘severe’ obstruction.

Clinical Signs

The palatine tonsils were clinically graded on a scale from 1 to 4 as follows: Grade 1 tonsils confined to the tonsillar pillars; grade 2 tonsils extend just outside the pillars; grade 3 tonsils extended outside the pillars but did not meet in the midline; grade 4 tonsils met in the midline [17]. Tonsils graded 3 and 4 were considered enlarged in this study.

Outcome Measures

The effectiveness of adenotonsillectomy for the relief of sleep disturbances, breathing difficulties, and physical suffering in these children was evaluated using a measure of the change in the SS after AT. The ‘SS change score’ was calculated by subtracting the postoperative mean total and mean domain SS scores from the corresponding pre-operative values. Change scores range from -3.0 to 3.0 , with negative numbers indicating deterioration and positive numbers indicating improvement. The standardized response mean (SRM), defined as the change score/standard deviation of the change score, was used to estimate the extent of improvement of the symptoms after surgery. The 95% confidence intervals (95% CI) for the difference in total and domain scores were also calculated.

Radiological evidence of improvement in airway obstruction after AT were assessed by comparing the pre-operative and post-operative ‘adenoid nasopharyngeal ratio’ (AN ratio) measurements derived from lateral soft tissue X-ray of the nasopharynx, as was earlier described [14].

Treatment Protocol

Adenotonsillectomy was recommended after reviewing individual histories, physical findings, and X-ray of post nasal space. No sleep studies were performed before surgery. Adenoidectomy was carried out by curettage of the adenoid vegetations under direct vision via oral access, whereas tonsillectomy was carried out by the traditional dissection technique. Surgeries were carried out under general anesthesia with oro-trachea intubation to secure the airways. None of the children had any significant pre- or post-operative anesthetic complications. All the patients were observed postoperatively in the recovery room with electrocardiographic and pulse oximetry monitoring. They were discharged home on the next day but were followed up at 2, 6, and 10 weeks.

Statistical Analysis

Statistical analysis was performed with SPSS® Windows version 15.0. P values < 0.05 were considered statistically significant.

Results

Sixty-nine children were initially included in the study, of whom 6 were lost to follow-up and 4 did not undergo surgical therapy. As a consequence, the study population included 59 children. Forty of the children (68%) were male. The mean age of the children at the time of inclusion in the study was 3.3 years, and the range was 1.5–12 years. Sixty-three percent were aged < 4 years. The mean interval between surgery and the post-operative evaluation was 78 days.

Radiographs of the nasopharynx were obtained pre-operatively in all the patients, and during 4–10 week post-operative period in 13 children. The pre-surgery AN ratio was 0.76 ± 0.08 , while the post-surgery value was 0.33 ± 0.10 . Although the number of post-surgery X-rays was few, the difference was significant ($t = 13.3$; $P < 0.001$).

The total SS and symptom domain scores before and after adenotonsillectomy for upper airway obstruction are presented in Table 1. The total score and the scores for all symptom domains showed significant improvement after surgery. The mean total SS score before surgery was 7.2 and after surgery, 1.7. The mean change in total SS score was 5.5 points (SRM 2.2). A decrease in total SS score of up to four points was noted in 41 children (69%), and a decrease greater than two points were noted in 49 children (83%). Four children recorded zero change, while a change of only 1 point was noted in one child. Both the zero and 1-point changes were noted only in the group of children with pre-surgery SS score suggestive of mild obstruction.

The symptom domain with the greatest change in mean score was snoring, which improved by 2.0 (SRM 2.2). The second greatest mean change was in the symptom domain of mouth breathing, which improved by 1.7 points (SRM 1.7). The smallest mean change was in the domain of daytime somnolence, which improved by 0.3 points (SRM 0.5). These differences in pre- and post-operative total SS scores and symptom domain scores are highly significant ($P < 0.0001$). The significance for daytime somnolence was however relatively less ($P < 0.002$).

On the symptom scale, all the symptoms of 28 children disappeared within 2 weeks of surgery. Others continued to have some minor symptoms. Most of these children still snore irregularly on some nights. The snoring was thought to be lighter, however, and they were more alert in the daytime. None had any need for additional treatment.

Table 1 Mean SS before and after adenotonsillectomy for symptom domains

Symptom domains	Pre-surgery mean score	Post-surgery mean score	Change score ^a (95% CI)	SD of change score	SRM
Total SS	7.2	1.7	5.5 (4.3–5.3)	2.4	2.3
Snoring	2.5	0.5	2.0 (1.8–2.2)	0.9	2.2
Mouth breathing	2.1	0.4	1.7 (1.4–1.9)	1.0	1.7
Apneic pulses	1.3	0.3	1.0 (0.8–1.3)	0.9	1.1
Nasal discharge	0.9	0.4	0.6 (0.4–0.8)	0.8	0.8
Daytime hypersomnolence	0.4	0.1	0.3 (0.1–0.4)	0.6	0.5

N = 59

CI confidence interval, *SD* standard deviation, *SRM* standardized response mean (change score/standard deviation of the change score)

^a Pre-surgery mean minus post-surgery mean; change score was significant ($P = <0.001$ for total SS and symptoms domains except daytime somnolence with P value = 0.003)

Table 2 Change in SS after AT for the Grades of SDB

Grades of SDB (Pre-surgery score)	No of patients	Mean SS		Change ratio ^a
		Pre-surgery	Post-surgery	
Mild (<6)	20	3.7	1.5	2.5
Moderate (6 = 9)	25	6.8	1.6	4.3
Severe (10–13)	14	11.0	2.2	5.0

N = 59

^a Pre-surgery mean score/Post-surgery mean score

Table 2 gives the change in SS after surgery for groups of children classified on the basis of the pre-surgery score as having either mild, or moderate, or severe obstruction. Pre-operatively, 24% of the children had SS higher than nine indicating severe obstruction, showed the most improvement (change ratio of 5.0). Children (42%) with a score of nine or lower but six or higher (moderate obstruction) showed an intermediate level of improvement (change ratio of 4.3), and those with a score lower than six (mild obstruction) showed the least improvement (change ratio of 2.5).

Pre-surgery Total Ss Score in Relation to Age, Sex, and Tonsillar Size

To examine factors that might be associated with a high pre-surgery total SS, correlation was tested for age as well as tonsillar size with the pre-surgery mean SS. Also the age, gender, and tonsillar size were used as covariates for ANOVA. There was small but significant inverse correlation between age and pre-surgery mean SS ($r = -0.35$;

Table 3 Pre-surgery mean total SS in relation to age, sex, and tonsillar size

	Number of patients	Pre-surgery mean score
Age		
1–3 years	37	7.8 ± 2.7
4–6 years	17	6.4 ± 2.7
>6years	5	5.8 ± 3.3
Sex		
Male	40	7.4 ± 2.9
Female	19	6.8 ± 2.7
Tonsillar Size (grade)		
Small (1 and 2)	34	5.6 ± 1.9
Large (3)	8	8.8 ± 2.9
Huge (4)	17	9.7 ± 2.1

N = 59

ANOVA tests: age, sex, and tonsillar size ($F = 2.4$; $P = 0.11$, $F = 0.65$; $P = 0.42$, and $F = 23.5$; $P < 0.001$ respectively)

$P = 0.006$). The correlation between large tonsillar size and a high preoperative SS was highly significant ($r = 0.61$; $P = < 0.001$). Table 3 portrayed the pre-surgery mean SS among the age groups, sex, and grades of tonsillar size. ANOVA test indicated that no significant differences existed among the age groups as well as the gender groups of the children regarding pre-surgery mean scores ($P = 0.11$ and 0.42 respectively). Regarding the tonsillar size, children who had moderately and grossly enlarged tonsils (grades 3 and 4 respectively) recorded significantly higher mean preoperative SS ($P < 0.0001$) than children with small tonsils (grade 1 and 2).

Discussion

Our study population of 59 children demonstrated that caregivers report an improvement in sleep disturbance, physical suffering, and daytime problems in their children after adenotonsillectomy for chronic upper airway obstruction resulting from adenotonsillar enlargement. Improvements of the obstructive symptoms as measured by reductions in scores for the 5 symptom domains postoperatively are dramatic regardless of the severity of upper airway obstruction. The symptom with the most significant improvement was snoring. The symptom with the least improvement was daytime hypersomnolence. Although we demonstrated significant improvements in obstructive symptoms in most of the children after AT, few of them however continued to mouth breath and even snore, despite having demonstrated significant improvement of the airway after AT which were confirmed by a post-operative X-ray of the nasopharynx (Fig. 1b). Other causes of airway

obstruction such as nasal allergy and infection which might account for persistence of the symptoms were not assessed for this study.

Previous studies have shown improvements in the quality of life in children who underwent AT for sleep-disordered breathing. In a study that evaluated the changes in the quality of life of 60 children aged 3–12 years after AT for obstructive sleep apnea, marked improvement was reported in the domains of sleep disturbance, physical symptoms, emotional symptoms, and daytime functioning. The improvement was reported to occur regardless of severity of the obstructive sleep apnea [6]. Another study that used OSA-18 survey and the Child Behavior Checklist to evaluate changes in behavior and quality of life after adenotonsillectomy in 64 children with sleep-disordered breathing, also reported improvement in the child behavior and quality of life after AT [10]. The child's clinical history and the presence of hypertrophic tonsils and adenoids were used as selection criteria for surgery. Significant change scores were found for the domains of sleep disturbance, caregiver concerns, and physical symptoms after AT [10]. Nieminen et al. [18] used polysomnographic parameter to select 24 children for AT from a pool of 58 children and reported that all children benefited clinically from the operation. All the symptoms of 16 children disappeared. Five children continued to have some minor symptoms. None had any need for additional treatment. On the symptom scale, they reported that the median score for the children operated on dropped from 12 (range, 7–15) to 1 (range, 0–6). The mean OSA score was reported to have changed significantly from 3.4 to –3.1. It was further observed that it was only one child with a postoperative OSA score greater than continued to snore on most nights. The snoring was thought to be lighter, however, and he was more alert in the daytime. The remaining 4 children that underwent AT continued to snore irregularly [18]. The results of the present study agree with the results of Nieminen et al. [18] and confirm that caregivers report a significant improvement in obstructive problems of their children after they undergo adenotonsillectomy.

Although PSG is considered the gold standard for evaluation of OSAS, for select patients PSG testing may not be necessary prior to AT. There are no clinical practice guidelines regarding the use of PSG and candidacy for AT [2]. Most otolaryngologists make decisions or recommendations based on medical history that is suggestive of SDB, as well as on physical examination demonstrating adenoid and/or tonsillar hypertrophy [2, 8–10]. However, predictive accuracy of clinically suspected OSAS may be as low as 30% when PSG testing was performed as well [13, 19]. Unlike polysomnography that measures derangements in physiologic parameters during sleep in obstructive children, the SS, like other health-related clinical surveys,

focuses on the physical problems and functional limitations consequent on upper airway obstruction as reported by caregivers. A number of Studies [2, 8, 10, 12] using various clinical parameters have demonstrated that adenotonsillectomy results in marked improvement in quality of life, not only in children who have OSAS documented by polysomnography, but also in those clinically diagnosed as having SDB without confirmation by polysomnography.

When we classified the severity of airway obstruction of the children in our study on the basis of the preoperative mean SS, there was a consistent relationship between severity of the problems and the extent of improvement as reported by the caregivers. We found that the higher the preoperative SS score, the greater the reduction in mean scores after AT in all the three categories measured by the SS. Group 1 had the lowest mean preoperative score, 5 or lower, and had the smallest room for improvement. Our findings are in agreement with other reported work that evaluated the changes in sleep disturbance after AT in children for SDB [2], and changes in quality of life in children after AT for OSAS [6]. Different clinical parameters were however employed in the above studies (Pediatric Sleep Questionnaire and OSA-18 quality of life survey respectively).

The SS clinical parameter utilized in our study was validated previously against radiologic assessment and was shown to reliably evaluate the degree of airway obstruction in children with obstructive adenoid vegetations [14]–[16]. It is an easy-to-use tool to assess the impact of airway obstruction on sleep disturbance, physical suffering, and daytime problems of the children as perceived by the caregivers, before and after AT. The grading of the symptoms reflected a progressive increase in the clinical severity of upper airway obstruction. For instance, when considering snoring, obstruction that led to nighttime as well as daytime noisy breathing was considered more severe than obstruction that caused noisy breathing only during sleep. The same consideration was similarly applied in the case of mouth-breathing. The scores assigned were based on the history obtained from the parents or legal guardian. When parents were unsure of their observations, they were asked to observe their children at intermittent intervals during the daytime and during sleep, over a period of 1 week, and the history was then retaken. Previous studies documented reliability of graded symptoms and signs in predicting the degree of upper airway obstruction in children with adenoid hypertrophy [13–15].

Our study shows that AT is associated with dramatic improvements in sleep and breathing in children suffering from SDB as a result of adenotonsillar hypertrophy even when the condition is mild.

In this study, large tonsillar size was a predictor of a high preoperative SS which is suggestive of a severe

obstruction. The change in SS was equally correlated with preoperative tonsillar size. This is consistent with the findings of previous studies [11, 12, 18]. In one of the studies [11], it was reported that large tonsillar size was correlated significantly with a high preoperative apnea/hypopnea index on polysomnography. Equally, Nieminen et al. [18] reported that 93% of children with OSA had large tonsils compared with 68% with primary snoring and only 3% of controls. Sohn et al. [12] used OSA-18 clinical parameter to evaluate effectiveness of adenoidectomy and tonsillectomy for SDB in children, and reported that mean OSA-18 change score showed significant correlation with tonsil size as well as adenoid size.

To assess the importance of age and sex on the outcome of adenotonsillectomy for upper airway obstruction, children in the study population were divided into three groups for analysis: 1–3; 4–6; and 6–12 year olds. No significant difference was found in the preoperative mean SS in children from these different age groups. The majority of children (88%) in the study were within the age of 6 years. Indeed, none of the children was over 12. This reflects the peak incidence of adenotonsillar obstruction in the 4–6 year age group [20]. However, despite the relatively large overall study population, the absence of differences between age groups may simply be a reflection of the small number of older children included in this study.

The present study, to our knowledge, is the first prospective study to show objective improvements in sleep disturbances, breathing difficulties and physical suffering in children after adenotonsillectomy. However, this study suffered from the limitation relatively short follow-up duration as it is not known whether improvements are maintained long-term. In spite of these limitations, the present study demonstrated resolution or remarkable improvement in snoring, mouth breathing, obstructive breathing during sleep, nasal discharge, and daytime hypersomnolence, after an AT in children with obstructive adenotonsillar hypertrophy regardless of whether the condition was mild or severe.

Conflict of interest None.

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