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Oxygen Saturation Improvement after Adenotonsillectomy in Children

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Abstract: The goal of this study was to establish whether adenotonsillectomy is effective on the severity of oxygen desaturation or improve oxygen saturation in children with sleep breathing disorders. Thirty-two children, aged 4-7 years, with clinical indication for adenotonsillectomy were enrolled in a non-controlled clinical trial. Pre- and postoperative nocturnal oxygen saturation monitoring was done and oxygen desaturation index as well as desaturation events were analyzed using Wilcoxon and paired Student's t-tests. Snoring was the most prevalent (87.5%) complaint before operation. The study revealed a significant improvement in the postoperative oxygen desaturation index (1.60±3.22) compared with the preoperative oxygen desaturation index (3.98±4.93) ($p<0.01$). Oxygen desaturation events at the level of oxygen saturation 85-89% was significantly improved after operation ($p<0.01$). No significant differences were seen in the desaturation events at the levels of oxygen saturation lower than 85%. Nocturnal oxygen saturation improves mildly after adenotonsillectomy in children with sleep breathing disorders.

Key words: Tonsillectomy, oximetry, desaturation event, sleep disorder, obstructive sleep apnea

INTRODUCTION

Arterial oxygen saturation monitoring has established to be a useful method in diagnosing a variety of respiratory disorders and today it is a common and essential monitoring used to evaluate patients either undergoing surgery or other procedures (Gries and Brooks, 1996). Many researchers used pulse oximeters for the evaluation of Sleep Breathing Disorders (SBD), diagnosis of Obstructive Sleep Apnea (OSA), as well as evaluation the effect of adenotonsillectomy on improving OSA (Vazquez *et al*., 2000; Urschitz *et al*., 2003; Arrarte *et al*., 2007). Nocturnal Oximetry (NO) appears to be a substitution method to reduce the number of polysomnography (PSG) for evaluating OSA. Chiner *et al*. (1999) concluded that NO in patients with suspected Sleep Apnea Syndrome (SAS) or Sleep Apnea Hypopnea Syndrome (SAHS) and normal spirometric values permits the institution of therapeutic measure in their patients (Chiner *et al*., 1999).

Many studies evaluated the effect of adenotonsillectomy on quality of life, sleep, breathing and behavior in children with OSA (Mitchell and Kelly, 2004; Constantin *et al*., 2007). Mitchell and Kelly evaluated the outcome of adenotonsillectomy for severe OSA in 29 children using pre and postoperative PSG. Improvement in Respiratory Distress Index (RDI), (63.9 compared to 14.2) was seen after operation. They recommended postoperative PSG to identify those patients who may require additional therapy to improve their quality of life after operation (Mitchell and Kelly, 2004).

A few studies focused on the effect of adenotonsillectomy on nocturnal hypoxemia (Arrarte *et al*., 2007; Stradling *et al*., 1990). A non controlled clinical trial was performed to evaluate the effect of adenotonsillectomy on oxygen saturation in 31 children with SBD, aged 2-10 years scheduled for operation. The main oximetric variable was Oxygen Desaturation Index (ODI) which was defined as the total number of desaturation >4% from the baseline divided by the number of hours and percentage of desaturation below 95 and 90%. Significant differences were seen between ODI before and after surgical treatment. (1.63 preoperatively in comparison with 0.65 postoperatively $p<0.001$) (Arrarte *et al*., 2007).

It seems that pulse oximetry is a reliable alternative method for evaluating the patients who undergo adenotonsillectomy pre- and postoperatively. Previous studies focused on oximetric finding such as ODI and some other data, but we believe that the severity and the levels of desaturation as well as their improvement after adenotonsillectomy have not been reported so far. We

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therefore decided to examine the effect of adenotonsillectomy on oxygen saturation and it's efficacy on the severity of desaturation in children with adenotonsillar hypertrophy.

MATERIALS AND METHODS

After approval of the project which was obtained from research committee of Shahrekord University of Medical Sciences the study was done during a 6 month period in 2007. Children aged 4-7 years with known OSA whose problems were established previously using a standardized questionnaire in a sleep breathing disorders clinic and with adenotosillar hypertrophy based on clinical evidence and lateral neck X-ray enrolled in this study. Children with sleep disturbance who had complained of: (a) chronic or recurrent nasopharyngeal or tonsillar infection (more than 6 per year), (b) snoring, (c) chronic sinusitis, (d) nasal obstruction with speech and adenotonsillar hypertrophy were included in this study. A total number of 32 patients with known OSA were selected at the outpatient clinic of otorhinolaryngology at Kashani hospital in Shahrekord, Iran.

Indication for adenotosillectomy was based on recurrent tonsillitis, chronic sinusitis, adenotonsillar hyperplasia resistant to medical treatment and finding adenoid hypertrophy on lateral neck radiograph and bilateral tonsillar hyperplasia which was found by otolaryngologist in a special outpatient clinic. Exclusion criteria were: age less than 4 and more than 7 years, anatomical abnormality of oropharynge, any pulmonary disease and those needed adenoidectomy without tonsillectomy, as well as any disease situations that can cause nocturnal oxyhemoglobin desaturation, such as sickle cell disease. Also the patients whose removed adenoids or tonsils size were not correlated with those appreciated on clinical examination were excluded from the study.

After local ethic committee approval, consent release forms were completed and signed by the parents. The patients who recruited in the study were programmed for evaluating pulse oximetry 48-72 h before and 3-4 weeks after operation. All of the necessary preoperative laboratory tests and X-ray was done the day before operation. For each child two questionnaire sheets were recorded pre- and postoperatively by the same parent.

For this study we used a NONIN Oximeter model 2500 A, which has a memory up to 72 h. Oximetric monitoring either preoperatively or postoperatively was performed by a trained physician at home with the help of the children's parents, using portable NONIN oximeter which has some merits such as easy portable and usable as well as it's software for analyzing the data by the computer. Validity of the test was approved if the duration of oximetric monitoring was 6 h or more and if the oxygen saturation data was reliable and compatible with pulse rate according to the pulse rate variable recorded in the memory of NONIN pulse oximeter. Oximetric monitoring was closely observed by the same physician towards omitting any situation conflicting the oxymetric monitoring.

The variables studied were: pulse rate, average low SpO_2, Oxygen Desaturation Index (ODI) which was defined as the total number desaturation >4% divided by the number of hours and desaturation events (decrease oxygen saturation less than 90% for a duration ≥10 sec) which was divided to four levels less than 90% with an interval of 5% (70-90%). Desaturation allocated events were performed for evaluating the severity of desaturation in the study.

After inducing anesthesia with fentanyl 2 μg kg^{-1}, sodium thiopental 5 mg kg^{-1} and atracurium 0.5 mg kg^{-1}, patients were intubated orally and adenotonsillectomy was performed by the same surgeon. After surgery the patients were closely monitored for any probable bleeding and complication for at least 24 h. Thereafter, they were evaluated in a four-week period.

Pre and postoperative oximetric variables were analyzed using paired Student t-test or Wilcoxon test. Depend on variables; correlation between variables was considered using Pearson correlation test. The data were analyzed statistically with SPSS version 15.0 package for windows.

RESULTS AND DISCUSSION

All of 32 patients enrolled in this study underwent pre- and postoperative oximetry and completed the study and had adenoid hypertrophy on X-ray imaging and bilateral tonsillar hyperplasia on clinical evaluation by the same otorinolaryngologist. The mean age was 5.45±0.96 years. Twenty one patients (66.6%) were male and 11 patients (34.4%) were female. Patients' clinical complaints were as follows: snoring (87.5%), fatigue (28.1%), enuresis (25.0%), daily sleepiness (21.9%) and irritability (15.6%) (Table 1). The duration of operations was not more than 30 min and neither bleeding nor complication was seen after operation.

We found significant differences between ODI ($p<0.01$), basal SpO_2 ($p<0.05$), desaturation events

Table 1: Patients' symptoms before and after adenotonsillectomy (n = 32)

	Preoperative		Postoperative	
Symptoms	Yes	No	Yes	No
Snoring	28 (87.5)	4 (12.5)	3 (9.3)	29 (90.7)
Fatigue	9 (28.1)	23 (71.9)	3 (9.3)	29 (90.7)
Enuresis	8 (25.0)	24 (75.0)	2 (6.3)	30 (93.7)
Daily sleepiness	7 (21.9)	25 (78.1)	3 (9.3)	29 (90.7)
Irritability	5 (15.6)	27 (84.4)	3 (9.3)	29 (90.7)

Data are presented as frequency (percent)

Table 2: Comparison between pulse oximetric findings, before and after adenotonsillectomy

Pulse Oximetry-Derived Variable	Preoperative	Postoperatove	CI 95[a]	p-value
Basal SpO2 (%)	93.60±1.37	94.26±1.64	-1.18; -0.14	0.014[b]
Desaturation events (<90%)	23.31±33.62	9.78±20.72	5.52; 21.53	0.002[b]
Average low SpO2 (%)	89.87±1.61	90.97±1.56	-1.57; -0.61	<0.001[b]
Average low SpO2 (<90%)	86.85±1.87	87.81±1.01	-1.88; -0.04	0.041[b]
Oxygen desaturation index (>4%)	3.98±4.93	1.60±3.22	1.11; 3.64	0.001[b]
Desaturation events (SpO2 85-89%)	19.47±27.18	8.09±13.09	5.38; 17.36	0.001[b]
Pulse rate (bpm)	82.75±15.53	78.50±13.77	-3.88; 12.38	0.295
Monitoring duration (min)	362.63±111.36	353.70±83.74	-38.88; 45.75	0.705
Desaturation events (SpO2 80-84%)	2.66±6.39	1.34±5.94	-1.43; 4.05	0.337
Desaturation events (SpO2 75-79%)	0.81±2.72	0.47±2.65	-1.02; 1.70	0.611

Data are presented as Mean±SD. Desaturation events: Desaturation period in the range mentioned with at least 10 sec duration. [a]Confidence interval 95% (Paired-Samples t-test), [b]Significant p-value (p<0.5)

(p<0.01) and average low SpO2 (p<0.01) as well as desaturation events at the level of SpO2 between 85%-89% before and after operation. There were no significant differences between duration of monitoring, pulse rate and desaturation events lower than 85% (Table 2).

Pearson correlation showed that strong correlation was existed between ODI and desaturation events ranged 85%-89% pre- and postoperatively (R = 0.90; R = 0.97) (Fig. 1).

Based on Wilcoxon test, Fig. 2 shows significant ODI differences and significant desaturation events differences in male (p<0.01) and female children (p<0.05), after operation.

Although nocturnal oximetry (NO) has been used for the diagnosis and evaluation of SAHS in many studies (Urschitz *et al*., 2005; Chiner *et al*., 1999; Nixon *et al*., 2004; Urschitz *et al*., 2003), on the other hand a few studies focused on the role of NO before and after adenotonsillectomy in children suffered from sleep breathing disorders related to adenotonsillar hypertrophy (Mitchell and Kelly, 2004; Netzer *et al*., 2001; Saito *et al*., 2007; Arrarte *et al*., 2007). However, limited studies evaluated the effect of adenotonsillectomy on nocturnal oxygen saturation in children (Stradling *et al*., 1990; Arrarte *et al*., 2007).

The result of the present study agrees in part with previous finding of Arrarte *et al*. (2007), who studied on 31 children with suspected SBD and clinical indication for adenotonsillectomy. Twenty seven patients completed that study and all of the patients noticed an improvement of symptoms after operation except in two cases in which the children still continued to snore at night which was paralleled with their high postoperative ODI. The mean preoperative ODI was 1.63 and the mean postoperative ODI was 0.65 which was significant in differences. Percentage of saturation times below 95 and 90% was the other characteristic of Arrarte (2007) study which was significant after adenotonsillectomy.

All of 32 children in our study completed the study. The mean pre- and postoperative ODI was 3.98 and 1.60, respectively. Moreover, basal SpO_2 and average low

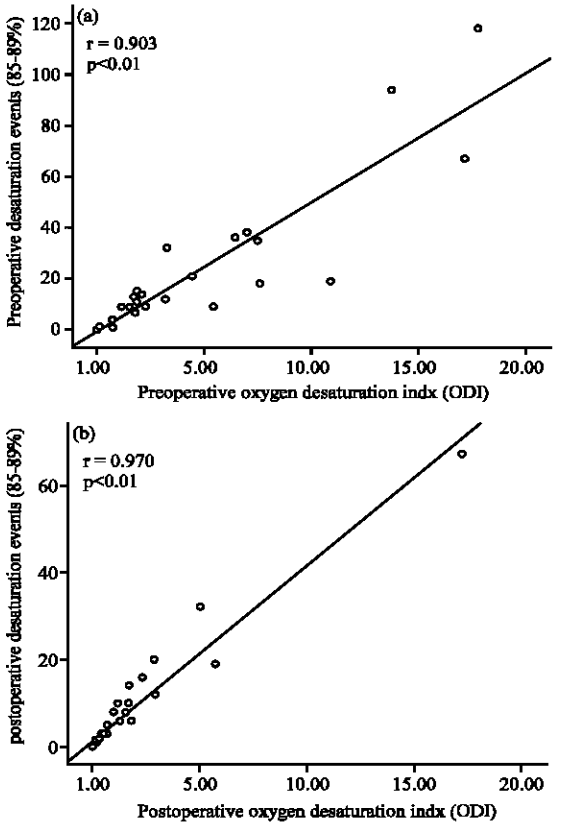

Fig. 1: Correlation between (a) preoperative ODI and preoperative desaturation events at the oxygen saturation level 85-89% (r = 0.903) and (b) postoperative ODI and postoperative desaturation events at the oxygen saturation level 85-89% (r = 0.970)

SpO_2 were improved significantly after operation. Although three children remained snoring after operation, their ODI had similar improvement.

As we believe, evaluation of the severity of desaturation below 90% which is the lowest endpoint in normal children according to the study of Gries *et al*. (1996) may be affected after operation, we therefore

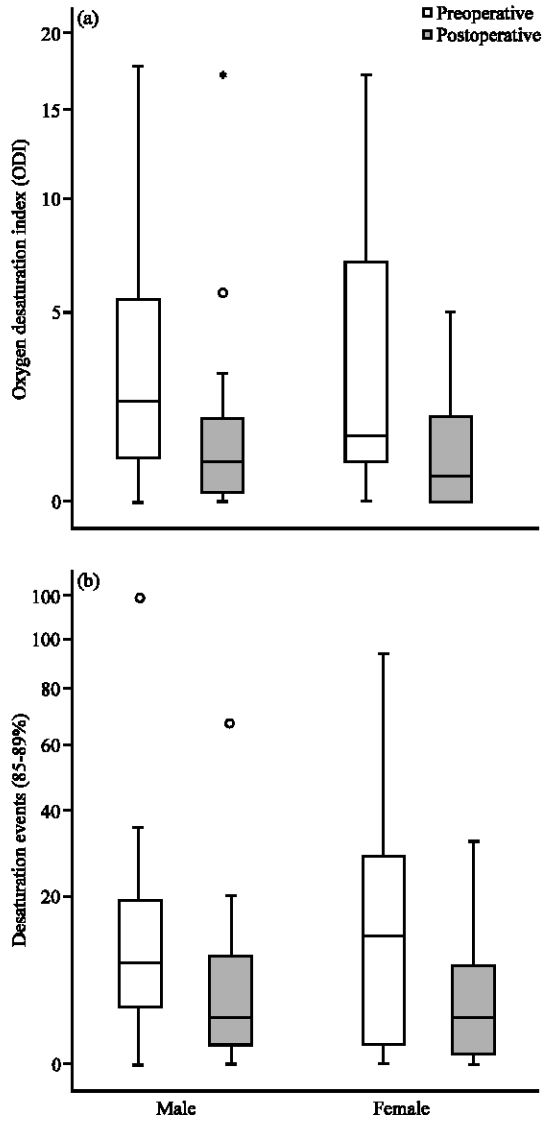

Fig. 2: (a, b) Preoperative and postoperative ODI and desaturation events at the oxygen saturation level 85-89%, in different sexes. ODI and desaturation events improved in both male and female children after adenotonsillectomy (*p<0.01). No significant differences were seen between sexes

defined four levels of desaturation under 90 with 5% interval. Our study revealed that only desaturation events in the range of oxygen saturation 85-89% may improve after operation and no changes occur when desaturation events are recorded under 85% oxygen saturation. This particular finding of this study differentiates our study from the other studies and we think further investigations are necessary to approve the result of this study.

The reliability of the main variable in our study at the saturation level of 85-89% is confirmed by strong correlation ($r>0.90$) before and after operation. These findings make unique our study from previous studies (Saito *et al*., 2007; Arrarte *et al*., 2007). The results indicate that nocturnal oxygen desaturation less than 85% may not improve in patients with adenotonsillar hypertrophy and remaining this question whether adenotonsillectomy improve any severity of sleep apnea disorders.

Although the study was consisted of more male children (21) than female (11), signs and symptoms were improved in both sexes after operation and either ODI or desaturation events (85-89%) changed significantly after adenotonsillectomy in male and female patients ($p<0.01$; $p<0.05$), respectively.

This study is different from the study of Minova *et al*., in which ODI was defined as the number of decrease in SpO_2 to <85% per hour for evaluating neonatal apnea. The reason for establishing this cut-off value was that SpO_2 rarely drops below 85% during non-pathologic periodic breathing (Minowa *et al*., 2003). Present decision to consider a cut-off value of 90% in evaluating the desaturation events is based on hemoglobin-oxygen dissociation curve and based on the study of Gries and his colleques who presented the lowest oxygen saturation of 90.7% in healthy normal 1-10 year population during sleep (Gries and Brooks, 1996). The SpO_2 of 70% which is considered as the lowest cut-off point in our study is based on the sensitivity of pulse oxymeter as well as oxygen saturation of 70% equivalent to a partial pressure of oxygen in arterial blood of approximately 40 mmHg.

Twenty one children (66.6%) were male and 11 children (34.4%) were female in this study with the mean age of 5.45 years. This is in part similar to at least two studies (Arrarte *et al*., 2007; Gislason and Benediktsdottir, 1995). However, the similarity with the above mentioned studies and the differences between our study and the other investigations (Redline *et al*., 1999; Ali *et al*., 1993), could be explained by the small size of sample as noted by Arrarte *et al*. (2007) as well as the kind of the study which was a non-controlled clinical trial.

The effect of the patients' movements on oxymetric data may show a false oxygen desaturation and could change the result of the study. We managed this common error either with comparing the oximetric data with the pulse rate as used in other studies (Brouillette *et al*., 2000; Arrarte *et al*., 2007) or by close observing the patients during oxymetric monitoring. However, we didn't find any true oxygen desaturation less than 75%.

The study has several disadvantages. We were not able to use PSG pre and postoperatively to compare the result with oxymetric finding, or to have a large sample

size in both sexes to evaluate more variables related to sleep breathing disorders. On the other hand we didn't evaluated OSA based on algorithm for evaluation of obstructive sleep apnea completely, as mentioned in a recent study (Muzumdar and Arens, 2008). We circumvented these limitations by choosing the known patients with OSA syndrome whose problems were established previously, using a standardized questionnaire to find patients with OSA requiring adenotonsillectomy (Brouilette *et al*., 1984).

Although this study has some limitations, it would be concluded that adenotonsillectomy has a potent beneficial effect on improving oxygen saturation in children with mild oxygen desaturation (ranged between 85-89% saturation) due to adenotonsillar hypertrophy, but not moderate or severe desaturation (below 85% saturation). More investigation is needed for further confirmation.

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