ORIGINAL ARTICLES

Clinical Efficacy and Polysomnography of Adenotonsillectomy in the Treatment of Sleep-Related Respiratory Disorders in Children

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Introduction: If sleep-related breathing disorders in children are not treated quickly, they may be harmful to the child's future development. The best diagnostic test is polysomnography, since clinical assessments alone are not enough. Adenotonsillectomy is the most effective and widespread treatment for such disorders.
Objective: To assess clinical data on sleep-related breathing disorders, particularly in relation to behaviour and neurocognition, their long-term resolution with surgery and correlation with PSG data.
Method: Prospective study with 73 children between 3 and 11 years of age, attending a special clinic for sleep-related breathing disorders. A medical history questionnaire was given to the parents, which included questions on the child's sleep patterns, respiratory disorders and behavioural and neurocognitive changes, and a polysomnography was carried out. Cases requiring surgery were monitored after 9 months by means of a further questionnaire and a follow-up polysomnography.
Results: Of the 73 children tested, 100 % snore, 87.5 % display objective apnoeas and 89 % suffer from nasal congestion. Drowsiness during the day was reported in only 28 %. Over 50 % of cases report aggressiveness or hyperactivity, while 41 % have concentration difficulties. In 61 of the 73 cases (83.6 %) given a pre-operative polysomnography, the mean apnoea-hypopnoea index was 6.44 (4.44). Post-operative follow-up is available for 44 cases, 29 of them with polysomnography. The resolution of clinical symptoms is highly satisfactory in these cases, but 5 patients (17.2 %) still have an apnoea-hypopnoea index of more than 3.
Conclusions: Adenotonsillectomy is effective in curing the majority of sleep-related respiratory disorder symptoms in children. However, a significant percentage of cases display a persistent polysomnographic change. Long-term post-operative monitoring is recommended in such cases.

Key words: Sleep-related breathing disorders. Behavioural and neurocognitive changes. Polysomnography.

Efectividad clínica y polisomnográfica de la adenamigdalectomía en el tratamiento de los trastornos respiratorios del sueño en los niños
Introducción: Si los trastornos respiratorios del sueño en los niños no se tratan precozmente pueden ser nocivos para la ulterior evolución del individuo. La prueba diagnóstica por excelencia es la polisomnografía y las evaluaciones exclusivamente clínicas no son suficientes. La adenamigdalectomía es el tratamiento más extendido y eficaz de estos trastornos.
Objetivo: Valorar los datos clínicos de los trastornos respiratorios del sueño, en especial los referentes a conducta y neurocognitivos, y su resolución a largo plazo con la cirugía y su relación con los datos de la polisomnografía.
Material y método: Estudio prospectivo de 73 niños, de entre 3 y 11 años de edad, que acuden con una clínica compatible con trastornos respiratorios del sueño. Se realiza un cuestionario clínico a los padres, que incluye preguntas sobre el sueño, sus problemas respiratorios y alteraciones de conducta y neurocognitivas y un estudio polisomnográfico. Los casos sometidos a cirugía son controlados a los 9 meses mediante un nuevo cuestionario y una nueva polisomnografía.
Resultados: De los 73 niños analizados, el 100 % son roncadores, el 87,5 % presenta apneas observadas y el 89 %, obstrucción nasal. Únicamente refiere somnolencia diurna el 28 %. Más del 50 % de los casos refieren agresividad o hiperactividad y el 41 %, dificultades en la concentración. En 61 de los 73 casos se ha practicado polisomnografía preoperatoria (83,6 %). La media del índice de apnea-hipopnea preoperatorio ha sido de 6,44 ± 4,44. Se dispone de control postoperatorio en 44 casos, 29 con polisomnografía. La resolución de los síntomas clínicos es muy satisfactoria en es-

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tos casos, pero 5 (17,2 %) pacientes siguen con un índice de apnea-hipopnea > 3.
Conclusiones: La adenamigdalectomía es eficaz en la resolución de la mayoría de los síntomas de trastornos respiratorios del sueño en niños. Sin embargo, un porcentaje significativo de casos presenta una persistencia de la alteración polisomnográfica. Por ello se recomienda un seguimiento a largo plazo de estos casos después de la cirugía.

Palabras clave: Trastornos respiratorios del sueño. Alteraciones de conducta y neurocognitivas. Polisomnografía.

INTRODUCTION

The obstruction of the upper airways (UA) in children may manifest itself during sleep as either complete or partial obstructive sleep apnoea.[1] When discussing this paediatric pathology, it would be correct to speak of sleep-related breathing disorders (SBD), as this definition describes a range of clinical conditions including obstructive apnoea, the increased resistance of upper airways syndrome and obstructive hypopnoea syndrome.[1]

It is known that there are considerable differences between SBD in adults and children, leading to consideration of the latter not just as a simple form of the adult case, but as an independent syndrome.[1,2] However, what they do have in common is that any delay in diagnosis and treatment can be very harmful to the development of the individual.[3-9]

The diagnostic test par excellence for paediatric SBD is a nocturnal polysomnography (PSG).[3] All attempts to use case histories, physical examinations or diagnostic shortcuts have proved futile for the correct evaluation of these disorders.[3,10]

Adenotonsillectomy is the most widespread and effective treatment in nearly three quarters of cases.[3,11,12] This surgery, without going into the mode used, achieves normalization of the nocturnal respiratory problems and daytime symptoms, and the reversal or stoppage, in many cases, of eventual complications.[2,3,13]

Despite the efficacy of this treatment, a higher incidence of respiratory complications in the immediate post-operative period has been reported.[3,14,15] There may also be reproduction of symptoms after puberty or the persistence of residual symptoms after surgery.[16-18]

It is therefore recommended that children operated on should continue to be evaluated both clinically and polysomnographically.[18-20] On the other hand, even accepting that effective treatment produces immediate normalization of the respiratory disturbances during sleep, the reversibility of the associated morbidity may not occur or may not be complete.[21]

This publication reviews, on a prospective basis, personal experience in the treatment of children with SBD using adenotonsillectomy and the long-term clinical and polysomnographic course.

MATERIAL AND METHOD

This is a prospective study started in February 2005 and concluded in October 2007. All children between 2 and 11 years attending the otolaryngology out-patients' clinic with clinical manifestations compatible with SBD were invited to be included in this study.

This is a preliminary study that will serve as a basis for further prospective analysis which will seek to verify an assessment of behavioural and neurocognitive disorders secondary to SBD. This second study has already begun in our hospital and has been approved by the Clinical Trials Committee.

All patients who agreed to participate in this study were interviewed through a questionnaire given to the parents which included questions about the sleeping habits of the children, their breathing problems and any behavioural and neurocognitive abnormalities. These questionnaires were filled in during the first consultation and, if appropriate, 9 months after surgery. The parents were assured, in writing, of the confidentiality of their responses.

The questions posed in the questionnaires covered 3 general aspects. Some related to the sleep-related breathing difficulties: snoring, evaluated from 0 to 10 using a visual analogue scale (VAS), nasal breathing difficulties, apnoeas observed and daytime sleepiness. The second part referred to the quality of sleep and included questions about nocturnal enuresis, restless sleep, profuse sweating during sleep, bruxism, painful legs, night terrors, and sleepwalking. Finally, the third block referred to changes in behaviour and awareness. The questions probed whether the children, compared with other children of the same age and environment, presented problems of aggressiveness, hyperactivity, delays in language, memory and concentration and also what level of educational achievement (high, normal, or low) the parents place would assign to them.

In addition, a complete otolaryngological exploration was performed, including, in most cases, a flexible endoscopy of the UA.

All patients who agreed were subjected to a complete PSG prior to surgery and again 9 months later. A recording lasting 8 h in length was made and the mother was allowed to stay in a bed next to the child. The recording was made under the child's normal circumstances, after having dinner at the usual time and without medication to induce sleep. Brain activity was analyzed using surface electrodes placed in both rolandic areas with unipolar leads. An electromyography was obtained with the application of contact electrodes in the sub-maxillary region.

Eye movements were explored by 2 electrodes placed in the upper angle of the left eye and at the lower angle of the right eye. The respiratory graph was obtained by nasal and oral thermal resistance and thoracic and abdominal mercury bands. Oxygen saturation throughout the night was registered with a pulsoxymetry reading. The examination was complemented with the recording of body movements through the application of 2 electrodes on the anterior tibial muscle. The recording was at a speed of 30 s per page. The study was assessed using the criteria of the *Manual of* *standardized terminology, techniques and scoring system for sleep stages in human subjects* by Rechtschaffen and Kales.

The cases that met criteria for surgery by physical examination, questioning and/or PSG were informed of the surgical indication of tonsillectomy. The surgical indication was based on compliance with at least 2 of the following criteria: apnoeas observed by the parents every night associated with snoring, tonsil hypertrophy in Friedman's grades 3 or 4,[22] and apnoea-hypopnoea index (AHI) ≥3 in the PSG. In cases where only the clinical or polysomnographic criterion was met, a follow-up consultation was suggested. The cases with obvious tonsil hypertrophy, but who did not meet the other 2 criteria, were not candidates for surgery or follow-up at our centre.

The technique performed was traditional tonsillectomy, using bilateral tonsil dissection under general anaesthesia. Adenoidectomy was associated in all cases except for 3 in whom, for different reasons, this procedure had already been carried out. Patients were admitted for the post-operative night and were not usually treated with antibiotics in the post-operative period, except if they had a history of recurrent tonsil infections.

Two groups were analyzed for the purposes of this study. The first included all the cases that came to the clinic with compatible signs of SBD, filled out the questionnaire and were examined. In this group, the clinical respiratory disorders were evaluated along with their quality of sleep and behavioural and neurocognitive disorders, as well as the relationship of these to the PSG parameters.

The second, smaller group included all cases subjected to tonsillectomy with or without adenoidectomy for whom we have clinical follow-up 9 months later. This group enabled analysis of the results of the clinical and polysomnographic effectiveness of the treatment applied.

Statistical Analysis

The statistical analysis was carried out with using SPSS 15.0 software.

The first section shows the summary of the descriptive statistics which, for the qualitative variables, shows the average (standard deviation) and, for the quantitative variables, shows the frequency and percentages of cases with symptoms.

The procedure in all the sections for comparisons and relations between variables has been as follows: for comparisons between clinical signs and PSG and also for the relationships between behavioural and neurocognitive clinical signs and symptoms of SBD and PSG in the total pre-operative group (n=74), a non-parametric Mann-Whitney *U* test was carried out when there was a qualitative and a quantitative variable, except for the school performance variable, the only one with 3 groups and for which the Kruskal-Wallis H test was conducted instead.

Spearman's correlation coefficient was calculated for 2 quantitative variables (normal distribution did not occur in either, as verified through a Kolmogorov-Smirnov test) and for 2 qualitative variables Fisher's exact χ^2 test was calculated according to the frequency of the groups. The same tests have been used to compare the group of patients operated on (n=44). A *P* value less than .05 was considered significant for all tests.

RESULTS

Description of the Population

The sample in the first group comprises 73 children with ages ranging between 2 and 11 (average, 4.56 [1.97]) years. The proportion of males to females was 40 (54.8%) to 32 (45.2%).

Pre-operative PSG was performed in 61 of the 73 cases (83.6%). The average AHI was 6.44 (4.44).

Pre-operative Results

Pre-operative Symptoms

The descriptions of all symptoms, grouped into the 3 blocks referred to previously, are given in Table 1.

Apnoeas observed have been evaluated in 72 of the 73 cases, since in one case the parents did not know if their child had respiratory interruptions during the night. Of these 72 cases, 37 (51.4%) observed respiratory interruptions

Table 1. Description of Symptoms in Pre-operative Sleep-Disordered Breathing (SBD) (n=73)[a]

	Symptom	*Cases, No. (%)*
SBD clinical signs	Snoring (AVS average)	6.80 (1.97)
	Apnoeas observed[b]	63 (87.5)
	Nasal obstruction	65 (89)
	Daytime sleepiness	20 (28.4)
Sleep quality	Enuresis	31 (42.5)
	Agitated sleep	56 (76.7)
	Painful legs[c]	18 (34.6)
	Bruxism[c]	22 (42.3)
	Nocturnal terrors[c]	18 (34.6)
	Nocturnal sweating	48 (65.8)
	Sleepwalking	10 (13.7)
Behaviour and awareness	Aggressiveness	41 (56.2)
	Hyperactivity	39 (53.4)
	Speech delay	26 (35.6)
	Low school performance	14 (20.3)
	Concentration	30 (41.1)
	Memory	13 (17.8)

[a]AVS indicates analogue visual scale.
[b]Only 72 cases are taken into account, since in one of them, the parents did not know the answer.
[c]These 3 symptoms have only been evaluated in 52 of the 73 cases.

Table 2. Correlation Between the Intensity of the Snoring and the Nocturnal Apnoeas Observed[a]

Apnoeas Observed	*Intensity of Snoring According to AVS (n=72)*	
	Average (SD)	*Minimum-Maximum*
No (n=9)	5.44 (1.67)	3-8
Occasionally or always (n=63)	6.98 (1.89)	1-10

[a]AVS indicates analogue visual scale; SD, standard deviation.
P=.012.

occasionally depending on the circumstances, and 26 (36.1%) every night. Only 9 (12.2%) did not observe respiratory interruptions during the night in their children.

To evaluate the intensity of snoring, a VAS graded between 0 and 10 has been used. All cases snored with intensities between 1 and 10. The average pre-operative intensity was 6.80 (1.97).

With regard to the description of school performance, the parents were asked to grade the performance of their child compared with other students or related children of their own age as high, normal or low. In the 73 surveys, 14 (20.3%) cases placed their child at a low level of academic performance, versus 47 normal (64.4%), and 12 high (16.2%).

Correlations Between Clinical Signs of SBD and PSG

The mean snoring level, measured by AVS, was correlated against the percentage of apnoea cases observed and with the mean AHI. In addition, the correlation between the average number of cases with observed apnoeas and the mean AHI has also been calculated.

The results are presented in Table 2. The mean snoring level measured by AVS was significantly higher in cases where the parents observed nocturnal apnoeas (*P*=.012). However, there is no sign of any statistically significant correlation when assessing the relationship between the AHI values and the intensity of snoring graded by AVS or the presence or absence of apnoeas.

Correlation of Behaviour and Neurocognitive Clinical Signs With SBD Symptoms and PSG

The correlation of each of the 6 points in the questionnaire regarding behaviour and neurocognitive problems of the 73 children has been studied with respect to the average age, gender, presence of nasal obstruction, average intensity of snoring, presence of apnoeas observed and the mean AHI. The results are presented in Table 3. The most statistically significant results among these evaluations were as follows: the aggressiveness concept is more prevalent among younger children with greater intensity of snoring. Hyperactivity is more prevalent among boys. Delay in language acquisition is more common among younger boys. Concentration problems are noted more frequently among boys and, lastly, yet interestingly, memory alterations were more prevalent among children with the lowest AHI and also those with nasal obstruction.

In relation to school performance, evaluated subjectively by the parents, no statistically significant differences were found by analyzing the different parameters comparing the children with low, high, or normal performance. If we separate the 3 levels of performance, we can observe that girls have statistically significant higher performances and the cases with high performance are older than those with normal performance.

Post-operative Results

This second section includes a smaller group: all cases that underwent tonsillectomy with or without adenoidectomy for whom there is a clinical follow-up of 9 months. This group comprises 44 children, for whom pre-operative and post-operative PSG results are available in 29 cases.

Degrees of Resolution of the Clinical Signs

The first analysis carried out is the percentage of resolution of symptoms 9 months after surgery. These results are shown in Table 4.

For a better assessment of the snoring symptom, the intensity of the reduction after surgery has been evaluated. If we consider the difference between the variable of snoring intensity before and after surgery, we can see that in 79.5% of cases the intensity was reduced by 5 points or more, and only 20.5% show a decrease of less than 5 points. The mean reduction was 5.91 (2.18) (Table 5).

Degrees of Resolution of the PSG

If we define an AHI of 3 as the polysomnography cut-off, it can be observed that before the surgery only 3 patients (10.3%) had an AHI below that figure. In the post-operative recordings, 24 (82.8%) of the 29 cases had an AHI <3.

The mean AHI was 7.32 (4.61) before surgery and it decreased to 1.52 (2.09) 9 months after the procedure. There was a reduction of 79.2% on average and clearly the differences in AHI before and after surgery were statistically significant (*P*<.05).

In total, therefore, 5 patients (17.2%) failed to resolve their polysomnographic alteration since their post-operative AHI were ≥3. The 5 cases solved the nasal obstruction problems and significantly reduced the intensity of snoring. Two (40%) of the 5 cases reported persistence of nocturnal apnoeas.

These 5 cases have been analyzed and compared with the 24 in whom the AHI was reduced to below 3. The previous mean AHI shows no statistical difference when compared with the 5 unresolved cases (7.42) and the 24 resolved ones (7.29). No other factor analyzed, such as age or gender or the intensity of snoring, offers significant differences between the polysomnographically resolved group and those unresolved. This is probably closely tied to the low number and asymmetry of the 2 groups.

Comparative Analysis of the Symptoms With Regard to their Resolution

A statistical analysis of each symptom was carried out by comparing the group of children in whom the symptom was resolved with the group in whom it was not. For each

Table 3. Correlation Between Behaviour and Neurocognitive Clinical Signs and Other Clinical Parameters and PSG[a]

			No		*Yes*	*P*
Aggressiveness	Average intensity of snoring		6.28 (1.70)		7.22 (1.98)	.025
	Cases with apnoeas[b]		29 (46)		34 (54)	.364
	AHI average		6.49 (4.96)		6.39 (4.11)	.912
	Age average		5.28 (1.99)		4.33 (2.01)	.017
	Boys		15 (37.5)		25 (62.5)	.168
	Girls		17 (51.5)		16 (48.5)	
	Nasal obstruction		29 (44.6)		36 (55.4)	.503
Hyperactivity	Average intensity of snoring		6.41 (1.74)		7.15 (2.01)	.076
	Cases with apnoeas		30 (47.6)		33 (52.4)	.572
	AHI average		6.93 (4.59)		6.06 (4.35)	.232
	Age average		5.04 (1.95)		4.49 (2.11)	.218
	Boys		14 (35)		26 (65)	.025
	Girls		20 (60.6)		13 (39.4)	
	Nasal obstruction		32 (49.2)		33 (50.8)	.180
Speech delay	Average intensity of snoring		6.55 (2.06)		7.27 (1.54)	.140
	Cases with apnoeas		41 (65.1)		22 (34.9)	.620
	AHI average		6.63 (4.40)		6.09 (4.57)	.363
	Age average		4.92 (1.84)		4.36 (2.36)	.048
	Boys		21 (52.5)		19 (47.5)	.017
	Girls		26 (78.8)		7 (21.2)	
	Nasal obstruction		41 (63.1)		24 (36.9)	.405
		Low		*Normal*	*High*	*P*
School performance	Average intensity of snoring	6.35 (1.55)		7.23 (1.73)	5.67 (2.46)	.052
	Cases with apnoeas	11 (17.5)		43 (68.3)	9 (14.2)	.287
	AHI average	5.60 (4.32)		6.31 (3.97)	7.89 (5.99)	.499
	Age average	5.14 (2.41)		4.11 (1.75)	5.67 (1.72)	.009
	Boys	9 (22.5)		29 (72.5)	2 (5)	.015
	Girls	5 (15.2)		18 (54.5)	10 (30.39)	
	Nasal obstruction	12 (18.5)		43 (62.2)	10 (15.3)	.654
			No		*Yes*	*P*
Concentration	Average intensity of snoring		6.53 (1.98)		7.20 (1.77)	.177
	Cases with apnoeas		38 (60.3)		25 (39.7)	.529
	AHI average		6.81 (4.55)		5.93 (4.31)	.246
	Age average		4.91 (1.85)		4.46 (2.28)	.138
	Boys		19 (47.5)		21 (52.5)	.025
	Girls		24 (72.7)		9 (27.3)	
	Nasal obstruction		40 (61.5)		25 (38.5)	.178
Memory	Average intensity of snoring		6.78 (1.90)		7.61 (1.85)	.095
	Cases with apnoeas		51 (81)		12 (19)	.486
	AHI average		7.06 (4.66)		3.91 (1.94)	.005
	Average age		4.71 (1.89)		5.33 (1.89)	.491
	Boys		30 (75)		10 (25)	.070
	Girls		30 (90)		3 (9.1)	
	Nasal obstruction		56 (86.2)		9 (13.8)	.029

[a]AHI indicates apnoea-hypopnoea index.
[b]The cases with no observed apnoeas are compared against those reporting occasional or constant apnoeas.

Tabla 4. *Resolution of Symptoms After Adenotonsil Surgery (n=44)*[a]

Symptom		*Pre-surgery*	*Post-surgery*	*Percentage Resolution*
Sleep-disordered breathing clinic	Snoring (AVS average)	6.70 (1.84)	0.80 (1.62)	85.1% decrease of the average
	Apnoeas observed[b]	39 (90.7%)	5 (11.4%)	34 (87.2%)
	Nasal obstruction	40 (90.9%)	0	40 (100%)
	Daytime sleepiness	10 (22.7%)	0	10 (100%)
Sleep quality	Enuresis	19 (43.2%)	4 (9.1%)	15 (79%)
	Agitated sleep	37 (84.1%)	8 (18.2%)	29 (78.4%)
	Painful legs[c]	10 (33.3%)	0	10 (100%)
	Bruxismc	16 (53.3%)	7 (23.3%)	9 (56.3%)
	Nocturnal terrors[c]	13 (43.3%)	8 (26.7%)	5 (38.5%)
	Nocturnal sweating	28 (67.6%)	9 (20.5%)	19 (67.9%)
	Sleepwalking	8 (18.2%)	5 (11.4%)	3 (37.5)
Behaviour and awareness	Aggressiveness	27 (61.4%)	4 (9.1%)	23 (85.2%)
	Hyperactivity	28 (63.6%)	6 (13.6%)	22 (78.6%)
	Speech delay	18 (40.9%)	5 (11.4%)	7 (58.3%)
	School performance[d]	12 (27.3%)	5 (11.4%)	16 (76.2%)
	Concentration	21 (47.7%)	5 (11.4%)	16 (76.2%)
	Memory	11 (25%)	1 (2.3%)	10 (90.1%)

[a]AVS indicates analogue visual scale.
[b]Apnoeas observed always or occasionally.
[c]For these 3 symptoms there is information for only 30 of the 44 cases.
[d]Cases of low school performance.

symptom, the average age, gender and mean pre-operative AHI was analyzed.

Statistically significant differences were only found in the mean pre-operative AHI between the cases who showed resolution of bruxism and those who did not. The cases in which bruxism was resolved had a higher AHI. The rest of the comparisons carried out for each of the symptoms did not offer any statistically significant results.

The analysis of the snoring symptom, measured by AVS, was done with the variable of the difference in the intensity of snoring before and after surgery. There is a significant relationship with age (correlation coefficient, –0.511; a 99% significant correlation); the older the child, the less the decline in the intensity of snoring.

DISCUSSION

Children have a number of anatomical and functional peculiarities in the UA along with maturity issues which differentiate them from adults from the point of view of the neurophysiology of sleep. Therefore, both the clinical signs and the physical, cognitive and maturity consequences of SBD differ in many respects from those that occur in adults.[1]

However, what they do have in common is that any delay in diagnosis and treatment can be very harmful for the further development of the individual.[3-9]

On the other hand, and despite the design of some of the questionnaires, including some adapted to different ages, with the aim of diagnosing children with SBD, it has been pointed out that case histories and physical examinations are not able to differentiate between primary snorers and children with nocturnal apnoeas.[3,10] Some cases with clear clinical signs have a normal PSG.

There are not much epidemiological data on the disease in children.[23-25] Well-conformed studies in adults are scarce and difficult to carry out and these difficulties increase in children, among other reasons, when trying to apply diagnostic criteria for adults.[2] The data that might be considered most reliable come from a review of the Technical Report on infant sleep apnoea published in 2002. It notes a prevalence of infant snoring between 3.2% and 12.1% and in terms of sleep apnoea, between 0.7% and 10.3%.[3]

Epidemiological data on the population analyzed in this study did not differ at all from those published. The mean age is 4.56 (1.97) years, with extremes between 2 and 11 years. The children were from 2 to 5 years of age in 74% of the cases. From the published series, we can extract that the peak of maximum involvement ranges from 2 to 5 years, coinciding with the age of maximum exuberance of Waldeyer lymphoid tissue. The gender ratio found in this study (55% male and 45% female) also coincides with that published in the literature, ie, scant gender differences, contrary to what is often seen in adults (a ratio of 3:1 in favour of males).[1]

One of the values of this study is the systematic use of PSG before and after surgery. Over 80% of children were subjected to the test before the adenotonsillectomy and in 66% cases this check-up was also carried out after surgery. There is considerable debate as to whether all children with clinical signs of SBD should undergo PSG, despite the fact that this test is the diagnostic standard.[3,26]

In 2006, Mitchell et al[27] published a work based on questionnaires sent to 105 paediatric otorhinolaryngologists. Only 10% of children undergoing adenotonsillectomy for obstructive sleep apnoea syndrome (OSAS) in the United States receive PSG and in 5% of them it is conducted after the surgical procedure. It is carried out systematically in cases of children under 1 year of age or with morbid obesity, craniofacial anomalies or neuromuscular diseases. This is despite the fact that the American Academy of Pediatrics recommends it for all of them.

If this examination provided reliable results, these percentages of utilization would probably increase. Only in half of the children who snored and in whom obstructive apnoea was suspected, was it confirmed by performing PSG.[1] The criteria used to evaluate an adult PSG are not valid in the case of children.

In assessing the symptoms, one of the differences we found regarding adults is that the questionnaire is aimed at parents and we have to rely on their acumen to guide the diagnosis and severity.[2] Neither this insight nor the case history alone are capable of differentiating the essential snorer from the child with nocturnal apnoea.[3,10]

The present study has used personal questionnaires aimed at parents, in which the symptoms were grouped into 3 blocks, those related to night and daytime breathing, those associated with sleep quality and, finally, those relating to behavioural and awareness disorders.

As expected, there was a high proportion of cases with snoring (100%), observed apnoea (88%), and nasal breathing difficulties (89%). However, as has been frequently noted, the symptom of excessive daytime sleepiness showed little prevalence, unlike in adults.[1,23,28,29] In this series, it was identified by only 28% of the respondents.

Regarding sleep quality, the presence of alterations is also significant in terms of the symptoms already pointed out by multiple authors.[28,29] Over 40% of the children reported nocturnal enuresis; 77% restless sleep; and 66% profuse sweating during sleep. Bruxism (teeth-grinding) was less frequently mentioned (42%), as were leg pain (35%), night terrors (35%), or sleepwalking (14%).

Among the negative consequences of infant SBD, such as alterations in weight and height development or cardiovascular complications, we have focused here on behavioural changes and neurocognitive development. This issue should force us to diagnose the disease early to prevent its occurrence. According to the Technical Report from 2002, children with SBD have a 2.93-point higher risk than children who do not snore of suffering from hyperactivity, learning and behavioural problems.[3]

Table 5. Reduction in the Intensity of Snoring After Surgery

Difference[a]	*Frequency*	*Percentage*
1	1	2.3
2	3	6.8
3	0	0
4	5	11.4
5	15	34.1
6	3	6.8
7	3	6.8
8	8	18.2
9	5	11.4
10	1	2.3
Total	44	100

[a]Difference between the intensity of snoring before and after surgery.

The neurological syndrome most frequently found in children is known as attention deficit and hyperactivity disorder, which affects 35% of school-age children. There are many publications that link this syndrome with OSAS. These parameters are important since the ability to pay attention has an important role in learning and therefore in social and academic development.[30,31]

Literature is even more extensive in relation to neurocognitive disorders. The publications of various disorders in children with SBD, in connection with the field of knowledge, range from changes in general intelligence and memory to verbal intelligence and executive cognitive alterations. The rapid recognition and treatment of sleep disorders is very important, as they take place during a time of life, the first decade, of rapid neurocognitive development.[32-34]

This study shows significant numbers of neurocognitive and behavioural abnormalities. Aggressiveness has been reported by 56%, hyperactivity by 53%, language alterations by 36%, concentration problems by 41%, memory alterations by 18%, and below-average levels of academic performance by 20% of respondents. It is clear that these figures should be treated with caution because there is not a control group of non-snoring children available and the tools that have been used are very subjective.

The results of the attempt to correlate both SBD and the clinical signs of behavioural and neurocognitive disorders with the objective parameters, measured by PSG, only confirm this subjectivity.

No statistical correlation has been found between the intensity of snoring or the presence of observed apnoeas and AHI. The attempt to match each of the symptoms regarding behaviour and cognitive development has found no statistical relationship with the AHI value. The only correlations found relate to age or gender. This lack of correlation reinforces the idea that objective parameters are required for its evaluation.

Fortunately, we have an effective treatment and many publications show a significant resolution of many of these alterations with a simple adenotonsillectomy. This surgery, without going into the mode used, achieves the normalization of the nocturnal respiratory clinic, the daytime symptoms and the reversal, in many cases, of cardiovascular complications and delays in growth.[3,8,11,12]

The percentages of resolution observed in this study confirm these facts. The vast majority of symptoms, from the 3 categories presented here, achieve high levels of resolution. Apnoeas are reduced by 87% and 80% of cases reduce the intensity of snoring by 5 points or more.

Although some authors have reported that behaviour and neurocognitive alterations were more resistant to improvement with this surgery,[21] our results after 9 months indicate otherwise. Only language alterations show reductions below 60%.

With regard to the objective resolution of the SBD after surgery, 83% of cases were observed to reduce their AHI values below 3. The mean AHI was statistically significantly reduced from 7.32 to 1.52. However, in 5 patients (17.2%) the post-operative AHI values remained above 3. The analysis of these 5 cases did not find any parameters which could predict those cases with increased risk of persistence of SBD. It is likely that this attempt has failed because of the limited number of cases and the asymmetry of populations.

The reproduction of symptoms after puberty or else the persistence of residual symptoms after surgery have been estimated by some authors at up to 20%, a similar figure to that observed in this study.[16-18,35] It is therefore recommended that children operated on should continue to be evaluated both clinically and polysomnographically.[18-20]

In conclusion, SBD in children is accompanied by a series of specific clinical disorders and some of them with special significance in their development. The assessment of these changes has a high element of subjectivity, making it necessary to have tools for objective measurement available.

In this study, adenotonsillectomy has proved to be highly effective in resolving most of these symptoms. However, a significant percentage of cases show a persistence of polysomnographic alteration. Long-term monitoring of children intervened for SBD is therefore recommended. Whenever possible, and depending on available resources, it is advisable to carry out a PSG before and after surgery, although it is likely that the criteria used for its evaluation may need to be revised.

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