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Effects of adenotonsillectomy on neurocognitive and behavioural function in pediatric obstructive sleep apnea syndrome

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Abstract. *Effects of adenotonsillectomy on neurocognitive and behavioural function in pediatric obstructive sleep apnea syndrome. Objectives:* Aim of this study is to verify the presence of neurocognitive, neurobehavioral or sleep disturbances in children affected by adenotonsillar hypertrophy (ATH) and Obstructive Sleep Apnea Syndrome (OSAS) and verify their improvement after Adeno-Tonsillectomy (AT).
Methods: Eighty children suffering from adenotonsillar hypertrophy and OSAS were recruited for AT in the ENT Department of the University of Palermo. All the children underwent clinical evaluation, including rhinofibroscopy for grading the obstruction due to the adenotonsillar hypertrophy (before and 6 months after surgery), and polysomnography and 6 months after surgery. Two different rating scales were administered to the parents, the Sleep Disturbance Scale for Children (SDSC) for the evaluation of sleep disturbance and the subscales B and C of the Conners' Parent Rating Scale Revisited (CPRS-R) for the evaluation of behavioral disturbances (before and 6 months after surgery).
Results: Children's mean age was 5.3 + 1.6 years with a percentage of 59.2% for male and 40.8% for female. All patients showed adenotonsillar hypertrophy grade III-IV. Polisomnography showed the presence of moderate OSAS in 72.6% of the children and severe in 27.2%.
In the preoperative evaluation all the children had pathological values in the CPRS-R, regarding the cognitive and inattention subscale (B) and the hyperactivity subscale (C). In the SDSC results were also pathological, with variables depending on the subscales. After AT, CPRS-R evidenced a statistically significant improvement in scores for all children. Even SDSC scale postoperatively showed a statistically significant improvement in the scores of each subscale.
Conclusion: Adenotonsillar hypertrophy is the most frequent cause of snoring and OSAS in children. OSAS in children is a frequent cause of sleep disorders and daytime behavioral changes. AT in children improve significantly both OSAS and behavioral disturbances.

Introduction

Obstructive sleep apnea syndrome (OSAS) is a breathing disorder characterized by prolonged partial upper airway obstruction (hypopnea) and/or intermittent complete obstruction (apnea) causing hypoxia and frequent arousals, that disrupts normal ventilation during sleep and normal sleep patterns.[1,2] OSAS should be differentiated from Primary Snoring (PS), that is usually a benign disease characterized only by loud breathing, that frequently disappears when children grow up. Brunetti et al described in children population a PS prevalence of 4.9% respect to 1.8 % of OSAS.[3] In children, adenotonsillar hypertrophy (ATH) is the first cause of OSAS, because the enlargement of lymphoid tissues, reduces the airway space, increasing the airflow resistance, often causing an upper airway obstruction during sleep.[4] Also, other anatomical factors can influence the presence of OSAS: craniofacial anomalies (retrognathia and micrognathia), obesity[5] and neurocognitive disease. According to the American Thoracic Society and the American Academy of Pediatrics, the main symptoms of OSAS caused by ATH include habitual nightly snoring, disturbed sleep and neurocognitive and behavioral problems.[1,2,4] In particular, these children present neurobehavioral disorders such as attention deficit and hyperactivity, disabilities in learning and in daily attitudes due to the excessive sleepiness. However, some authors have shown that the behavioral and cognitive consequences of sleep-disordered breathing (SDB) are also present in children with referred snoring.[6]

Several questionnaires to assess the cognitive-behavioral disorders in children have been devised. Sleep Disturbance Scale for Children (SDSC) and Conners' Parent Rating Scale Revisited (CPRS-R) are commonly used to assess respectively the sleep disturbances and the behavioral problems and child personality.[7,8]

The aims of this study were to verify the presence of neurocognitive, neurobehavioral or sleep disturbances in children with ATH and OSAS and their improvement after AT.

Materials and methods

This prospective study was conducted on children suffering from adenotonsillar hypertrophy observed in the ENT Department of the University of Palermo between 01 November 2013 and 31 October 2014. The inclusion criteria of the study were adenotonsillar hypertrophy and OSAS. During this period a total of 116 children that experienced adenotonsillectomy were recruited for the study, 80 patients suffering from OSAS.

All the children underwent a clinical evaluation, including rhinofibroscopy of the upper airways for grading the obstruction due to tonsils and adenoids. Hypertrophy of pharyngeal tonsils was classified according to Brodsky grading scale[9]: Grade 0 Tonsillectomy, Grade 1 Tonsils that occupy <25% of the mesopharyngeal space, Grade 2 Tonsils that occupy between 25 and 50% of the mesopharyngeal space, Grade 3 Tonsils that occupy between 50 and 75% of the mesopharyngeal space, Grade 4 Tonsils that occupy more than 75 % of the mesopharyngeal space. Adenoid tissues were classified in scores of obstruction according to Cassano classes of obstructions[10]: Grade 1 obstruction < 25 % of the coanal space, Grade 2 obstruction between 25 and 50 % of the coanal space, Grade 3 obstruction between 50 and 75 % of the coanal space, Grade 4 adenoids occupying more than 75 % of coanal space.

Polysomnography was performed to assess the presence of SDB. According to polysomnographic findings in childhood, the Apnoea-Hypopnea Index (AHI) was defined as the pathological grade minimum (AHI 1-3), mild (AHI 3-5), moderate (AHI 5-10) and severe (AHI >10). An obstructive apnoic event in a child is scored when peak signal excursions drop by ≥ 90% of pre-event baseline using an oronasal thermal sensor, a duration > 2 missed breaths in association with either ≥ 3% oxygen desaturation or an arousal.[11] Six months after surgery, the presence of residual SDB was assessed by overnight pulse oximetry considered as a respiratory event of an oxygen desaturation ≥ 3%. For the evaluation of the sleep and behavioral disorders two scales were administered to the parents, the Sleep Disturbance Scale for Children (SDSC)[9] for the evaluation of sleep disturbance and the CPRS-R scale[7] for the evaluation of behavioral disturbances (before and 6 months after surgery).

The SDSC, recognized to be reproducible, valid, capable of distinguishing six groups of sleep disorders, is an instrument to assess a variety of behavioral patterns relating to children's sleep.

SDSC is a 26-items questionnaire composed of six subscales with different scores (Tab. 1): Disorders of initiating and maintaining sleep (DIMS) 7 items, sleep-disordered breathing (SDB) 3 items, disorder of arousal (DA) 3 items, sleep-wake transition disorders (SWTD) 6 items, disorders of excessive somnolence (DOES) 5 items, sleep hyperydrosis (SHY) 2 items. Each item has 5 potential answers with "never" assigned 1 point, "occasionally" 2 points, "sometimes" 3 points, "often" 4 points and "always" 5 points, with a total score ranging from 26 to 130. Therefore, the high risk of SDB is defined as a score ≥ 52 while the low risk of SDB is defined as a score < 52. This leads to a total score ranging from 26 indicating no disturbance to 130 indicating the worst patients.

The CPRS-R is a parent-report measure designed to assess children's problem behaviors over the previous month; it has become a useful tool for assessing treatment outcomes in children with ADHD and can provide behavior-specific outcome measures (e.g., hyperactivity/impulsivity). Of overall 14 subscales, the children underwent 'B' subscale to assess 'cognitive and inattention' disorders, and 'C' ones to assess hyperactivity. Subscale B and C consist respectively of 12 and 9 items. Each item has 4 potential answers with "not true" assigned 0 points, "partially true" 1 points, "enough true" 2 points and "really true" 3 points. A final score ≥ 56 for each subscale is considered pathological.[7] (Tab. 2)

All the patients underwent AT under general anesthesia, according to the Italian guidelines in which OSAS, the presence of ATH is considered as a primary indication for Adeno-Tonsillectomy (AT).[12] Parents gave their informed consent for

Table 1
SDSC subscale mean values pre and post adenotonsillectomy

SDSC subscales	**Range**			**PRE-OP**	**POST-OP**	**t-test**
	Normal	Borderline	Pathologic	Mean Value (± SD)	Mean Value (± SD)	(P-value)
Disorders of initiating and maintaining sleep (DIMS)	0-10	11-16	17-26	20.9 (±2.7)	11.2 (±2.4)	0.001
Sleep disorded breathing (SDB)	0-3	4-6	7-11	12.4 (±1.8)	4 (±1)	0.001
Disorder of arousal (DA)	0-3	4-6	6-8	4.9 (±1.8)	3.5 (±0.7)	0.001
Sleep wake transition disorders (SWTD)	0-8	9-13	14-21	13.4 (±2.8)	8.1 (±0.7)	< 0.05
Disorders of excessive somnolence (DOES)	4-7	8-12	13-20	9.7 (±1.8)	7.8 (±1.6)	< 0.05
Sleep hyperydrosis (SHY)	1-2	3-6	7-10	4.8 (±1.9)	2.6 (±0.7)	0.001

Table 2
CPRS subscales mean values pre and post adenotonsillectomy

CPRS-R subscales	**Score**		**PRE-OP**	**POST-OP**	**t-Test** (P-value)
	Normal	Phatologic	Mean Value (± SD)	Mean Value (± SD)	
Cognitive and disattention disorders (B)	< 52	≥52	94.3 (±4.3)	53.9 (+2.2)	0.001
Hyperactivity (C)	< 52	≥52	89.9(±1.88)	49.3(+1.84)	0.001

the surgical procedure and for all performed tests. The local Ethics Committee approved of the study protocol.

Statistical Analysis

For the statistic analysis "Student's *t*-test", linear regression (*r*-value), following usual conditions of the application was performed; significance was set at 0.05.

Results

Out of a total of 116 children affected by adenotonsillar hypertrophy, 80 children suffering from OSAS were recruited for the study. The children's mean age was 5.3 ± 1.6 years, 59.2% male and 40.8% female. The anamnesis in these patients revealed the presence of sleep apnea and chronic snoring. Such night and day disturbances as nocturnal awakening, enuresis, and sleepiness, hyperactivity, aggressiveness, distraction, scarce school outcomes were also reported by parents during the anamnesis.

Clinical examination showed adenotonsillar hypertrophy in 100% of patients, with a pharyngeal tonsils hypertrophy grade III (15%)-IV (85%) and also adenoids hypertrophy grade III (20%)-IV (80%).

Polysomnography reported OSAS in 100% of cases and was defined as moderate in 34 (72.6%) and severe in 22 (27.2%). Six months after surgery polysomnography, proved normal in 79 (97.5%), highlighting a significant postoperative improvement. Only 2 children (2.5%) showed the persistence of pathological desaturation events in polysomnography, evidencing persistent OSAS, although with a reduction of AHI, probably due to the presence of obesity.

Before AT, all children presented pathological scores on CPRS-R scale with a mean value of 94.26 (± 4.33) in cognitive and disattention disorders subscale (B) and 89.9 (± 1.88) in hyperactivity subscale (C). CPRS-R scale performed six months post surgery evidenced a statistically significant improvement (p=0.001) for all the children with a mean value of 53.9 (± 2.2) in cognitive and disattention disorders subscale (B) and 49.3 (±

Table 3
SDSC subscale pre and post operative results

SDSC subscales	PRE-OP (80 Pz)			POST-OP (80 Pz)		
	Normal	Borderline	Pathologic	Normal	Borderline	Phatologic
Disorders of initiating and maintaining sleep (DIMS)	0	3	77	29	51	0
Sleep disorded breathing (SDB)	0	0	80	30	49	1
Disorder of arousal (DA)	20	35	25	52	28	0
Sleep wake transition disorders (SWTD)	0	47	33	57	43	0
Disorders of excessive somnolence (DOES)	5	12	63	42	38	0
Sleep hyperydrosis (SHY)	7	55	18	42	38	0

Table 4
CPRS-R pre and post operative results

CPRS-R subscales	PRE-OP (80 Pz)		POST-OP (80 Pz)	
	Normal	Phatologic	Normal	Phatologic
Cognitive and disattention disorders (B)	0	80	59	21
Hyperactivity (C)	0	80	80	0

1.84) in hyperactivity subscale (C) (Tab.2, Tab.4). As for SDSC questionnaire, the results were variable depending on the subscales: DIMS results pathological in 96.25% (77/80) and borderline in 3.75% (3/80); SDB results pathological in all children with a mean score of 12.41 (± 1.77); SWTD results 58.75% (47/80) borderline and 41.25% (33/80) pathological. DOES results pathological in 78.75% (63/80), borderline in 15% (12/80), normal in 6.25% (5/80). DA results normal in 25% (20/80), borderline in 43.75% (35/80), and pathological in 31.25% (25/80). SHY results normal in 8,75% (7/80) of the cohort, borderline in 68.75% (55/80) and pathological in 22.5% (18/80). SDSC After surgery showed: DIMS subscale normal in 36.25% of children and borderline in 63.75% (p=0.001); SDB subscale normal in 37.5% of children, borderline in 61.25% and pathological in 1.25% with a statistically significant reduction respect initial values (p= 0.001). Also DA subscale resulted borderline in 35% and normal in 65% with a statistically significant improvement (p=0.001). SWTD and DOES subscales resulted significantly improved ($p < 0.05$) respectively, the first normal in 71,25% and borderline in 53,75%, the second normal in 52,5% and borderline in 47,5%. In SHY subscale also resulted a statistically significant improvement with borderline values in 47.5% and normal in 52.5% (Tab.1, Tab.3).

Discussion

Obstructive sleep apnea in children is associated with increased risk of multiple morbidities, these can occur several years before diagnosis. The American Academy of Pediatrics (AAP) recommends adenotonsillectomy as a first-line treatment for children with OSAS associated with adenotonsillar hypertrophy. Many techniques have been developed recently to make this surgery quick and safe.[13] Obstructive respiratory diseases in children are mainly due to severe adenotonsillar hypertrophy, about 80% of children benefit from surgery. A severe adenotonsillar hypertrophy could be the only cause responsible for the nocturnal breathing obstruction.[14] Comorbidities associated with increased risk of OSAS and increased risk of persistence of obstructive disease after adenotonsillectomy include craniofacial anomalies, neuromuscular disorder, obesity and should be considered in the treatment of children's sleep disorder.[15] Children with OSAS have higher

prevalence of behavioral problems, especially for externalizing hyperactive-type behaviors[16], and behavioral sleep problems such as refusal to go to bed, early waking, difficulty in sleeping, nightmares, getting up after being put to bed, waking during the night or getting up after a few hours. These disorders may impact negatively on the life quality of children and their family and may increase the risk of special educational needs in school-aged children. A prospective cohort study, based on parental report and behavioral problems questionnaire, shows that persistent loud snoring at the ages of two and three years, is associated with increased risk of hyperactivity, inattention, and depression at three years of age.[17] There is no clear association between attention deficit hyperactivity disorder (ADHD) and sleep-disordered breathing in children (SDB). Findings in literature argue both for and against an association between ADHD and SDB.[18]

Several authors have found, an improvement in scores related to cognitive, behavioral and sleep problems in children with OSAS after adenotonsillectomy. Horiuchi et al. administered ROCF (scale of visuospatial construction) and RAVLT (used to assess verbal learning and memory).[19] They found scores improved after treatment. Such improvement could be related indirectly to short-term memory and attention capacity, most frequently impaired in patients with OSAS. The improvement in several cognitive tests was shown by Friedman, Lie, and Chervin.[20-22] They found behavioral improvement in children after adenotonsillectomy when compared with control group through the CPRS-R rating questionnaire and a memory scale.

In our study, SDSC score shows, values compatible with an altered pattern of sleep before adenotonsillectomy. Values of DIMS, SDB, SWTD are borderline or pathologic in the whole cluster. DOES is normal in only 6.25 % of children. DA and SHY score are normal in 25% and 8.75% of children respectively. Parents of our little patients reported typical sleep behavior problems such as refusal to go to bed, to fall asleep, waking up, nightmares, clonus, and movements during the night. There are few reports of the refusal to wake up, daily sleepiness and sleep attacks. These findings are consistent with the typical clinical presentation of OSAS in children, in contrast with adulthood, where daily sleepiness is the main symptom. Even though only in 15% DOES score is normal. Nightmare, hyperhidrosis and extremely restless sleep are attributed by neurophysiologists to subcortical arousals, brain hypoxemia, and orthosympathetic nervous system activation. Only a few patients, according to DA and SHY are free of these symptoms. Six months after adenotonsillectomy there was an improvement in the SDSC score globally considered and in the single sub-scores. DIMS showed the most important improvement with a percentage of 36.25% of normal and 63.75% of borderline after surgery. Caregivers of children reported a better sleep in terms of time and quality which showed that most of OSAS cases in children are responsive to adenotonsillectomy.

SDSC questionnaire is, in our opinion, a useful tool because it makes it possible to assess a variety of behavioral patterns related to children's sleep, from the beginning of the awakening. The administration requires between 10 and 15 minutes. It is standardized, reproducible, clear, easily understood and applied. Conners' Parent Rating Scale Revisited (CPRS-R) is an instrument for screening and assessing behavioral problems in children between 3 and 17 years of age (in the Italian version). In our opinion, it is a useful and effective parent rating scale for assessing psychosocial disturbances in children with disruptive behavior problems, which are often related to OSAS. It is widely used for the evaluation of ADHD disorder, but subscales can have a much wider field of application such as conduct problems, cognitive, family, emotional, self-control, anxiety inconvenience.

Before surgery, children presented pathological result for CPRS-R considering cognitive and disattention/disorder (B) items (mean value 94,3) and hyperactivity items (mean value 89,9). Six months after adenotonsillectomy children scored much better in both analyzed areas. Another time, this test, demonstrated the benefits that adenotonsillectomy could determine in children with OSAS. CPRS-R provides a reliable, accurate, and relatively brief measure of caregivers perceptions of children's behavior, and in our case, provide a useful measure for monitoring the positive effects of adenotonsillectomy over time.[23]

Conclusion

The Sleep Disturbance Scale for Children (SDSC) and Conners' Parent Rating Scale Revisited

(CPRS-R) results, good instruments to assess the presence of neurocognitive, neurobehavioral or sleep disturbances associated with OSAS. This in combination with clinical history, accurate physical examinations and instrumental tests are absolutely necessary to diagnose or rule out OSAS in children. Was evident in light of the polysomnographic results that AT in children is a good treatment for OSAS. Furthermore, there was a significant improvement of the neurocognitive, neurobehavioral and sleep disturbances after surgery. Demonstrating the efficacy of AT in the treatment of the neurocognitive disorders associated with OSAS in children.

References

1. Standards and indications for cardiopulmonary sleep studies in children. American Thoracic Society. *Am J Respir Crit Care Med*.1996;153(2):866-878.
2. American Academy of Sleep Medicine. *International Classification of Sleep Disorders: Diagnostic and Coding Manual. 2.* American Academy of Sleep Medicine, Westchester: 2005.
3. Brunetti L, Bruni O, Cirignotta F, Cozza P, Donzelli G, Ferini Strambi L, Levrini L, Mondini S, Nespoli L, Nosetti L, Pagani J, Zucconi M. Gruppo di Studio Interdisciplinare Disturbi Respiratori nel Sonno.Guidelines for the diagnosis of childhood obstructive sleep apnea syndrome. *Minerva Pediatr.* 2004;56(3):239-953.
4. Velasco Suárez CT, Figueroa Turienzo JM, Len F, Mansilla E.Pulse oximetry recording in children with adenotonsillar hypertrophy: usefulness in the diagnosis of obstructive sleep apnea syndrome. *Arch Argent Pediatr.* 2013;111(3):196-201.
5. Lorusso F, Dispenza F, Saraniti C, Sireci F, Modica D.M, Gallina S. Sleep disordered breathing: evaluation of dynamic patterns of the upper airways in obese subjects. *Otorinolaringologia.* 2014;64:57-64.
6. Bhattacharjee R, Dayyat E, Kheirandish-Gozal L, Sans Capdevila O, Gozal D. Nocturnal polysomnographic characteristics of habitually snoring children initially referred to pediatric ENT or sleep clinics. *Sleep Med*. 2009;10(9):1031-1034.
7. Conners CK. *Conners' Rating Scales - Revised Techinical Manual.* Multi-Health Systems, New York:1997.
8. Bruni O, Ottaviano S, Guidetti V, Romoli M, Innocenzi M, Cortesi F, Giannotti F. The Sleep Disturbance Scale for Children (SDSC). Construction and validation of an instrument to evaluate sleep disturbances in childhood and adolescence. *J Sleep Res.* 1996,5(4):251-261.
9. Brodsky L. Modern assessment of tonsils and adenoids. *Pediatr Clin North Am.* 1989;36(6):1551-1569.
10. Cassano P, Gelardi M, Cassano M, Fiorella ML, Fiorella R. Adenoid tissue rhinopharyngeal obstruction grading based on fiberendoscopic findings: a novel approach to therapeutic management. *Int J Pediatr Otorhinolaryngol.* 2003;67(12):1303-1309.
11. Berry RB, Budhiraja R, Gottlieb DJ, Gozal D, Iber C, Kapur VK, Marcus CL, Mehra R, Parthasarathy S, Quan SF, Redline S, Strohl KP, Davidson Ward SL, Tangredi MM. American Academy of Sleep Medicine. Rules for scoring respiratory events in sleep: update of the 2007 AASM Manual for the Scoring of Sleep and Associated Events. Deliberations of the Sleep Apnea Definitions Task Force of the American Academy of Sleep Medicine. *J Clin Sleep Med*. 2012;8(5):597-619.
12. Bellussi LM, Marchisio P, Materia E, Passàli FM. Clinical guideline on adenotonsillectomy: the Italian experience. *Adv Otorhinolaryngol*. 2011;72:142-145.
13. Lorusso F, Gallina S, Modica DM, Di Salvo N, Riggio F. Bipolar Quantum Molecular Resonance versus Blunt Dissection tonsillectomy. *B-ENT*. 2015;11(2):101-108.
14. Chervin RD, Ruzicka DL, Giordani BJ, et al. Sleep-disordered breathing, behavior and cognition in children before and after adenotonsillectomy. *Pediatrics.* 2006;117(4):e769-e778.
15. Marcus CL, Brooks LJ, Draper KA, et al; American Academy of Pediatrics. Diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics.* 2012;130(3):576-584.
16. Rosen CL, Storfer-Isser A, Taylor HG, Kirchner HL, Emancipator JL, Redline S. Increased behavioral morbidity in school-aged children with sleep-disordered breathing. *Pediatrics.* 2004;114(6):1640-1648.
17. Blunden S, Lushington K, Lorenzen B, Martin J, Kennedy D. Neuropsychological and Psychosocial function in children with a History of snoring or behavioral sleep problems. *J Pediatr.* 2005;146(6):780-786.
18. Chervin RD, Hedger K, Dillon JE, Pituch KJ. Pediatric sleep questionnaire (PSQ): validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. *Sleep Med.* 2000;1(1):21-32.
19. Horiuchi F, Oka Y, Komori K, Tokui Y, Matsumoto T, Kawabe K, Ueno S. Effects of adenotonsillectomy on neurocognitive function in pediatric obstructive sleep apnea syndrome. *Case Rep Psychiatry.* 2014;2014:520215.
20. Friedman BC, Hendeles-Amitai A, Kozminsky E, Leiberman A, Friger M, Tarasiuk A, Tal A. Adenotonsillectomy improves neurocognitive function in children with obstructive sleep apnea syndrome. *Sleep.* 2003;26(8):999-1005.
21. Li HY, Huang YS, Chen NH, Fang TJ, Lee LA. Impact of adenotonsillectomy on behavior in children with sleep-disordered breathing. *Laryngoscope*. 2006;116(7):1142-1147.
22. Chervin RD, Ruzicka DL, Giordani BJ, Weatherly RA, Dillon JE, Hodges EK, Marcus CL, Guire KE. Sleep-disordered breathing, behavior, and cognition in children before and after adenotonsillectomy. *Pediatrics.* 2006;117(4):e769-778.
23. Conners CK, Sitarenios G, Parker JD, Epstein JN. The revised Conners' ParentRating Scale (CPRS-R): factor structure, reliability, and criterion validity. *J Abnorm Child Psychol.* 1998;26(4):257-268.

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