BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 21, Issue 3

DOI: 10.58240/1829006X-2025.3-178

CASE REPORT

THE IMPORTANCE OF A MULTIDISCIPLINARY APPROACH TO METABOLIC SYNDROMES IN CHILDREN WITH OSAS. A CASE REPORT

Sabina Saccomanno[1], Melania Evangelista[2], Licia Coceani Paskay[3], Eleonora Luciani[4], Martina Serenelli[5], Elena Tessarolo[5], Valerio Brunetti[6]

[1.]Researcher at the Department of life Science, Health and Health Professions Link university Italy, Rome, Italy

[2.]Medical Director of the NESMOS Department, Faculty of Medicine e Psychology, Sapienza University of Rome-Regional Sleep Disorders Center at Sant' Andrea Hospital Rome, Italy

[3.] Private Practice at Academy of Orofacial Myofunctional Therapy (AOMT), Pacific Palisades, CA 90272, USA

[4.]Private practice, Rome, Italy

[5.]Students of the Dental School at the Polytechnic University of Marche, Italy (you need to put the city as well)

[6.]Adjunct Professor at Policlinico Universitario A. Gemelli IRCS, Rome, Italy

*Corresponding Authors: Sabina Saccomanno, Researcher at the Dental School, Unicamillus University,00131 Rome, Italy- e-mail s.saccomanno@unilink.it

Received: *Feb. 16, 2025;* ***Accepted:*** *Mar.7. 2025;* ***Published:*** *Mar. 20, 2025*

ABSTRACT

Objective: OSAS is currently a relatively frequent multifactorial sleep disorder often associated with metabolic dysfunction. This case study highlights the importance of creating a collaboration team of different specialists such as a pediatrician, a dentist, a sleep specialist, an otolaryngologist and a speech therapist, which, in this case, was essential to promote an early and comprehensive diagnosis, not only to limit and to prevent complications, but for a better therapeutic management of the symptoms.

Case review: A 10-year-old girl who came in for orthodontic treatment was found to have signs and symptoms of metabolic disorders including obesity, obstructive sleep apnea, breathing issues, transmissive hypoacusis and orofacial dysfunctions. She was previously treated orthodontically without resolution of any symptoms. At that point, instead of a "serial" approach, the girl was evaluated and then treated by a team of professionals who addressed together her various metabolic, functional and structural issues.

Results: The integrated program of palatal expansion and myofunctional therapy, in particular, made it possible to intervene on the skeletal structure and on the muscular function of this patient by promoting nasal respiration, a balanced mastication, adequate mobility and muscle tone of the orofacial complex and of the oropharynx. The improvement of the metabolic status was associated with better breathing and important weight loss.

Conclusion: A multidisciplinary approach seems to be the best strategy for solving cases of MetS (metabolic syndromes) and concomitant OSAS in children. A key role is played by the orthodontist and the pediatrician, by being able to intercept cases of OSAS in children and in adolescent and by being able to intervene directly on some components such as palatal contraction.

Keywords: metabolic syndrome, OSAS, rapid expander, myofunctional therapy, approach multidisciplinary

INTRODUCTION

Children can be impacted by a wide range of sleep disordered breathing (SDB), from upper airways respiratory syndrome (UARS) to obstructive sleep apnea syndrome (OSAS).[1] Results from recent studies have shown that obstructive sleep apnea syndrome (OSAS) is significantly associated with metabolic complications such as obesity, increased insulin values, increased cholesterol and triglycerides in the blood as well as an increased risk of developing cardiovascular disease.[2-4]

Pediatric OSAS is defined as a multifactorial disorder that occurs during sleep, characterized by a prolonged and/or intermittent partial obstruction

of the upper airways that alters the normal ventilation, oxygen saturation and sleep architecture.[2] The severity of the condition is defined by the number of apneas and hypopneas per hour of sleep (Apnea - Hypopnea Index: AHI).
Complications of OSAS in pediatric age can be divided into three categories:

1) *Neurocognitive (*excessive daytime sleepiness, reduced quality of life, aggressive behavior, poor school performance, depression, attention deficit, and hyperactivity);
2) *Cardiovascular(*systemic hypertension, absence of decreased blood pressure during sleep, left ventricular dysfunction, pulmonary hypertension, altered heart rate, autonomic nervous system dysfunction)*;*
3) *Metabolic* (increased reactive C protein, insulin resistance, hypercholesterolemia, increased transaminases, reduced insulin-like growth factor, reduced or altered secretion of growth hormones).[3]

Some studies confirm that in individuals with OSAS, the risk of metabolic dysfunction is six to nine times higher than in a subject without OSAS. Although the exact mechanism responsible is still unknown, it seems that the fragmentation of sleep and intermittent hypoxyemia, typical of OSAS[5] can cause pathophysiological alterations that, interacting with those of metabolic syndrome (MetS) [4-7] would be able to cause or perpetuate the progression of metabolic damage.
For this reason, other studies consider the OSAS as a further component of MetS.[8,9]
The *prevalent* phenotypes in children with OSAS are three:

1) The *common phenotype is called adenoids*, characterized by adenotonsillary hypertrophy, dark circles under the eyes, oral respiration, low tongue posture, by dental-skeletal malocclusion and by a skinny body;
2) The *adult phenotype of an obese child*, not so much related to adenotonsillar disease as related to excessive body fat.
3) *The syndromic phenotype*, which includes micro-retrognathia associated with genetic syndromes such as Pierre Robin's, or patients with true macroglossia of the tongue, common in syndromes such as Down's.[10,11]

The incidence of OSAS in pediatric age is higher in children between two and six years, in association with the presence of adenoids and hypertrophic tonsils and in adolescents, with close relation to weight gain.[3] These two periods coincide with those in which the orthodontists intervene on the young patients to carry out first interceptive therapy and then therapy with fixed appliances. The orthodontists are a key figure in the diagnosis and early treatment of OSAS, as they able to identify and intervene directly on some anatomic components involved in the pathophysiology of this respiratory disorder, such as a narrow palate and mandibular retrusion.[12-14]
OSAS are a relatively frequent condition and knowing how to recognize symptoms in addition to encouraging early detection, reduces the risk of , significant complications.[15,17]

Every orthodontist should introduce during the first visit a questionnaire validated for pediatric OSAS, to be filled out by parents, and create a team of experts with whom to interface for the care management of each case, including the evaluation of the lingual frenum.[18,19]

Children suspected of having OSAS should be sent to perform a nocturnal polysomnography (PSG), the gold standard for the diagnosis of this condition.[20]
The therapeutic solutions to pediatric OSAS require a multidisciplinary approach: the main therapeutic tools are represented by pharmacological options, surgery (usually adenotonsillectomy), orthodontics, and myofunctional /speech therapy.
With regards to orthodontic therapy, many studies have reported that use of the rapid palatal expansion (RPE), in growing patients with transverse contraction of the maxilla, leads to an increase in the total volume of the upper airways and therefore, of the nasal airflow.[21]
RPE devices are able to reduce AHI in children with OSAS by providing an appropriate therapeutic alternative.[22]
Although Nasal Continuous Positive Airway Pressure (CPAP) devices can offer good results in subjects with MetS and concurrent OSAS, given its effectiveness in reducing individual pathophysiological alterations of OSAS even in young children, it is not recommended as a first therapeutic choice due to the significant compliance it requires.
The management of metabolic syndromes encourages the reduction of excess weight based on behavioral changes on both eating habits and physical

Sabina Saccomanno, Melania Evangelista, Licia Coceani Paskay, Eleonora Luciani, Martina Serenelli, Elena Tessarolo, Valerio Brunetti.The importance of a multidisciplinary approach to metabolic syndrome in children with OSAS.A Case Report.Bulletin of Stomatology and Maxillofacial Surgery.2025;21(3).178-188. doi:10.58240/1829006X-2025.3-178

activity in order to achieve a balance between caloric consumption and intake, thus reducing fat mass and keeping/increasing muscular mass.

For behavioral therapy to be successful, families must be involved and be supportive as much as possible. In the event of unsuccessful outcomes of the behavioral approach, in children or adolescents with severe obesity and associated co-morbidity, pharmacological solutions or bariatric surgery should be considered.[23-25]

The following Case Report highlighted that, in the case of this particular child suffering from OSAS, the improvement of the respiratory system facilitated the resolution of most of the concurrent metabolic alterations, suggesting a possible causal and reciprocal interconnection between the two pathologies.

In this regard, there are many studies that suggest the relationship between non optimal respiration and consequent adaptations of metabolic processes, such as those involving secretion of insulin and the regulation of glucose.[26-27]

REPORT OF A CASE

Information about the patient A.P. she was born on July 2008 by preterm birth at 32 + 4 weeks. Her weight at birth was 1.9 kg (4.2 lbs) and since birth she presented high bilirubin, muscular hypotonia, difficulty in sucking and feeding, poor reactivity to stimuli and the absence of crying ("silent newborn").

Around the first month of life, she started to exhibit respiratory difficulties due to bronchiolitis, bronchospasm, rhinitis with fever, airways obstructions caused by milk and mucus requiring pediatric suctioning. A.P. received antihistamines, cortisone, antibiotics and bronchodilators. Her initial nutrition and hydration involved the use of a syringe, receiving donkey's milk and fruit compote during her second years of life to facilitate swallowing and weight gain. However, her growth in the first year was still below the reference percentiles. (Saccomanno & Paskay, 2021) She endured numerous hospitalizations and ER visits due to viral and bacterial infections, fever, breathing and eating problems. She continued to exhibit a widespread developmental delay and slow growth throughout her second year of life. A polysomnography revealed that she was suffering from a mild- moderate OSA as well. She would get tired easily while chewing so she ate only soft foods.

Between age 3 to 4, A.P. increased her weight and improved her respiratory pattern but by then she presented with an ogival palate and a persistent facial dysmorphism. She was evaluated by an endocrinologist, a cardiologist, a hematologist, an orthopedist, an ENT and a neurologist. The findings confirmed neuromuscular and fine motor control delay; a chronic adenotonsillar hypertrophy and inflammation requiring tonsillectomy/ adenoidectomy (TA) and remodeling of the lower turbinate at age 4; a high-positioned diaphragm that restricted deep breathing; metabolic syndrome with dyslipidemia, increased level of platelets and hypothyroidism; a distended, globular abdomen; marked valgus knees ("knock-knees") and postural lordosis.

At age 5, A.P. was diagnosed with bilateral transmissive hearing loss, with bilateral endotympanic effusion. At age 6, her polysomnography indicated oxygen desaturation within normal limits but she suffered breathing crisis nevertheless. Her first palatal expansion did not significantly improve her breathing nor her metabolic situation.

At age 7 she was fitted with hearing aids. However, her transmissive hearing loss exceeded 60% and the hearing aids did not provide a meaningful audiological gain. She continued to have significant breathing issues for which treatments were only symptomatic. Her body weight and BMI increased above normal range for her age, even on a 1000 kcal/day diet. Her sleep apnea episodes increased with the increasing of her weight, with sleep frequently interrupted by apnea episodes, without relief from nebulizers, cortisone sprays and bronchodilators. Myofunctional therapy was attempted for one month, but suspended as her respiratory and audiological status became critical.

By age 8, A.P. was experiencing headaches, exhaustion, chronic fatigue, light sensitivity, poor academic performance, overall apathy and intolerance for crowded or noisy places. However, she received a medical advice inviting her to play sports or physical activities and she chose Latin American dance attending the activity biweekly.

By age 10 her breathing issues were unmanageable, the dysfunction at the level of the middle ear was markedly worse with recurrent infections, she presented an atypical swallowing, a class II malocclusion in mixed dentition, an upper maxillary contraction and an open bite.

She was 10 years of age when she was enrolled in a multidisciplinary plan, with RPE and myofunctional therapy twice a week.

Figure 1. Extraoral photos of the face and the profile at age 8.

Part 1. Summary of A.P.'s medical history and main complaints or reasons for consultation

At the time of the first visit in our office, (Sept 2016), the patient was in treatment with an ENT for respiratory problems and wore hearing aids due to bilateral transmissive hypoacusia.

—The *symptoms reported by parents were:* Night snoring, chronic fatigue, apathy, headache, poor school performance, hypersensitivity to light, noise and crowded environments.

—The *OSAS symptoms complained by the patient were:* Sleep interrupted and daytime fatigue.

—A *subjective clinical evaluation* (questionnaire) was filled in by A.P.'s parents, the result of which confirmed the pathological findings of her sleep disorders.

Part 2. Summary of relevant and recent medical history

- *Drug therapy:* The patient has been receiving therapy with cortisone, bronchodilators and broad-spectrum antibiotics for problems such as bronchiolitis, bronchospasm and upper airway infections, occurring frequently since her fifteenth day of life.
- *Comorbidities:* The patient has other coexisting conditions such as: dyslipidemia, childhood obesity and transmissive deafness.
- *Predisposing factors:* Prematurity (32 + 4 weeks); an ogival palate; mouth breathing; Being overweight, with a BMI (Body Mass Index) of 26.74.
- *Further screening and diagnosis.* Polysomnographic findings indicated obstructive sleep apnoea (OSAS) with mild AHI index for pediatric age. Apneas and hypopneas associated with phasic hemoglobin desaturations were noted. Some central apnoea episodes were also reported.

Diagnostic Evaluation before treatment

Table 1. AHI: Apnea/hypopnea index (No. events / hour), with oxygen saturation well below average.

Diagnostic parameters	Values
AHI	4,6 events/h
AHI supine	4,1 events/h
ODI	14,0
Nadir O2	80%
Medium SaO2	66%
CT 95	0.30%

Diagnostic Evaluation after treatment

Table 2. AHI: Apnea/hypopnea index (No. events / hour), with oxygen saturation well below the average.

Diagnostic parameters	Values
AHI	4,6 events/h
AHI supine	4,1 events/h
ODI	14,0
Nadir O2	80%
Media SaO2	66%
CT 95	0.30%

Sabina Saccomanno, Melania Evangelista, Licia Coceani Paskay, Eleonora Luciani, Martina Serenelli, Elena Tessarolo, Valerio Brunetti.The importance of a multidisciplinary approach to metabolic syndrome in children with OSAS.A Case Report.Bulletin of Stomatology and Maxillofacial Surgery.2025;21(3).178-188. doi:10.58240/1829006X-2025.3-178

- Clinical evaluation - anatomical, functional and aesthetic findings
- Type of respiration: mostly oral;
- Type of swallowing: dysfunctional with anterior lingual thrust;
- Face and profile analysis: oval - shaped face and short neck-chin distance;
- The lip seal is present but the perioral muscles are hypofunctioning;
- The palatine vault: It has a transverse restriction "ogival" morphology;
- Tongue: mildly hypotonic within a reduced intraoral space
- Tonsils and adenoids: surgically removed (in 2010 and 2014)
- Mild overall muscular hypotonia

Radiographic evaluation - dental and orthodontic
Orthopantomography. Permanent teething. Presence of all third molar gems (1.8-2.8-3.8-4.8). Second molars present (1.7-2.7-3.7-4.7) but not yet erupted in the arches.

Figure 2. Orthopantomography

-ray latero-lateral findings. Skeletal class II.. Hypodevelopment of the mandible and of the maxillary complex. Hyperdivergent skeletal growth. Restricted airway, low lingual posture.

Figure 3. Lateral X-ray teleradiography and cephalometric analysis

Figure 4. Lateral X-ray cephalometric analysis

Objective clinical examination of the malocclusion. The observation of the upper arch confirmed the transversal contraction of the palatine vault, the presence of an interincisive diastema, the persistence of a deciduous right canine (5.3) while the presence of crowding was noticed in the lower arch. The assessment of the occlusal arches identified a normal overjet (2 mm), a normal overbite (1 mm), the presence of a class II dental ratio and a bilateral open bite, possibly facilitated on the right by the lack of exfoliation of 5.3 and on the left side by an atypical swallowing.

Sabina Saccomanno, Melania Evangelista, Licia Coceani Paskay, Eleonora Luciani, Martina Serenelli, Elena Tessarolo, Valerio Brunetti.The importance of a multidisciplinary approach to metabolic syndrome in children with OSAS.A Case Report.Bulletin of Stomatology and Maxillofacial Surgery.2025;21(3).178-188. doi:10.58240/1829006X-2025.3-178

Treatment plan

The treatment plan comprised several stages:

- Rapid expansion of the palate associated with myofunctional therapy to expand the palate: a RPE device was used and followed this protocol: one activation per day (¼ turn/day) for one month (0.2 mm each activation, 30 days). At the same time, A.P. began myofunctional therapy, lasting 4 months.
- Myofunctional therapy associated with fixed orthodontic therapy, following the expansion of the palate. The myofunctional therapy was reprogrammed to adapt to the new intraoral environment with daily exercises to home and once a week with a speech therapist.
- Behavioral therapy. Changes in lifestyle were implemented, interesting both eating habits and physical activity and emotional support.

Clinical Procedures

*Instructions on device and complication management: t*he parents were informed about the difficulty of swallowing in the first days of application, difficulty in speech articulation, feeling of tension at the level of the teeth, possible headache, nasal discharge (rhinorrhagia), and interincisal diastema.

Instructions on precautions to be taken: parents were told how to activate the device; how to perform an accurate daily hygiene using pipe cleaners and hydropulsator Waterpick®); brushing her teeth after every meal; foods to avoid (filamentous or excessively crunchy foods).

Orthodontic follow-up: a checkup every week for a month, then once monthly.

Parents' report on symptoms: after fifteen days of RPE activation, the parents reported that their girl was more rested and did not snore anymore.

Girl's report on her symptoms: at each activation she reported having leaked cerumen from the ears, nasal discharge and bruises under the nose and on the cheeks.

As mentioned, the first 2 weeks of therapy were characterized by reported dental pain and at the level of the base of the nose, initial difficulty of chewing and opening of the interincisive diastema. However, after the fifteen days of activation, she reported improvement in chewing and swallowing, with transition from a liquid and semi-solid diet to integration of all food textures.

At the end of the palatal expansion and after a cycle of myofunctional therapy, the following objectives were achieved: reaching a correct, physiological morphology of the palate and habitual nasal breathing, bilateral alternating chewing and the integration of all food consistencies into the diet, including foods of solid consistency.

Follow-up of *PSG/PG with diagnosis from a sleep doctor.* Snoring phases and sporadic breathing breaks were observed within normal limits.

DISCUSSION

Recent data show that OSA is associated with a pattern of metabolic changes, similar to that of obesity, due to the production of oxygen free radicals (Reactive Oxygen Species - ROS), caused by hypoxemia. That would increase the deleterious effects of systemic inflammation on adipose tissue and metabolic components associated with vascular disease and diabetes, thus exacerbating the metabolic complications related to obesity.

Children with OSAS have higher levels of blood pressure, reactive C protein, insulinemia, as well as a higher prevalence of left ventricle hypertrophy, demonstrating that OSAS considerably increase the risk of developing severe chronic cardiovascular and metabolic complications. In pediatric patients with OSAS and concomitant MetS, early diagnosis and intervention ensure that these serious consequences are limited.

The following case study wanted to demonstrate the key role played by the recovery of the respiratory, swallowing and chewing functions to restore the proper metabolic balance in a growing patient.

To summarize the therapeutic plan, it was carried out in several stages and included the participation of numerous professional figures. During the first phase, therapy included both the expansion of the palate thanks to the use of a RPE device that allowed to obtain a significant) transverse increase of 6 mm, and the myofunctional re-education in order to restore the neurophysiological nasal respiration, encourage bilateral alternating chewing, and the intake of regular solid foods, thus replacing the girl's exclusive nutrition with liquid and semi-solid foods consistency. As a result of the expansion of the palate, the patient was able to remove hearing aids, confirming the findings of some studies which indicate that restoring the correct size of the upper jaw allows an

Sabina Saccomanno, Melania Evangelista, Licia Coceani Paskay, Eleonora Luciani, Martina Serenelli, Elena Tessarolo, Valerio Brunetti.The importance of a multidisciplinary approach to metabolic syndrome in children with OSAS.A Case Report.Bulletin of Stomatology and Maxillofacial Surgery.2025;21(3).178-188. doi:10.58240/1829006X-2025.3-178

improvement of transmissive hearing loss in patients.During the second phase of the therapy plan, the girl continued myofunctional re-education to eliminate dysfunctional swallowing and then began fixed orthodontic therapy to correct her class II.

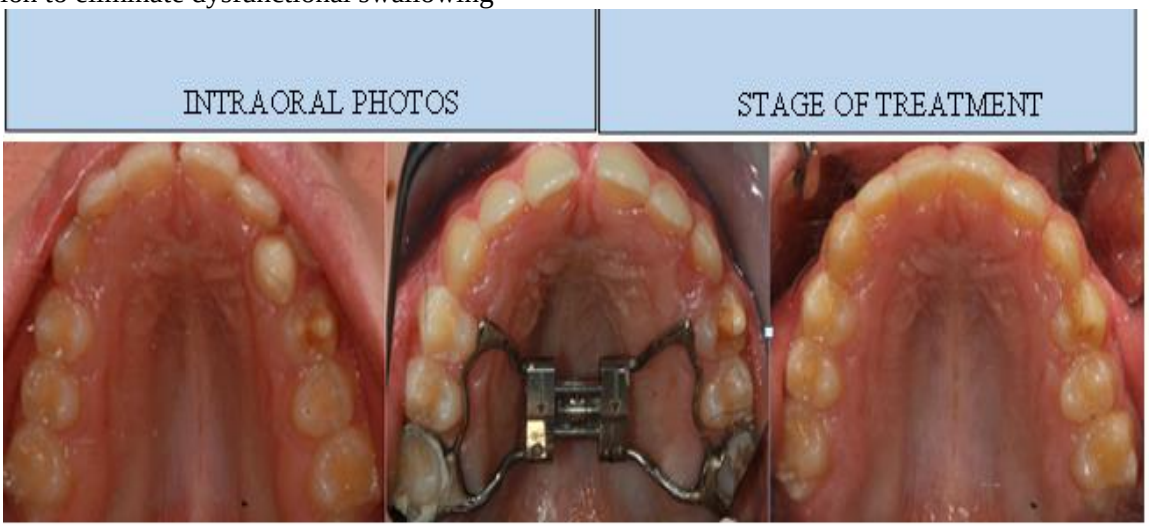

Figure 5a Before the treatment Intraoral occlusal photo of the upper arch prior to palatal expansion,note the presence of ogival type palate (2018)

Figure 5b During treatment Occlusal intraoral photo of the upper arch with R.E.P mounted

Figure 5c After treatment Occlusal intraoral photo of the upper arch following the palatal expansion

The other important therapeutic strategy was the increase in energy expenditure: a regular and aerobic physical activity favored the reduction of insulin resistance and fat mass, in particular abdominal fat, as well as decreasing pressure values.
However, further studies are needed to define the real impact of the correction of chronic hypoxemia on metabolic parameters.

Figure 6a,b. Extraoral and intraoral photos (2016), after failed palatal expansion and surgical therapy.

Figure 7 a,b,c,d. Extraoral and intraoral frontal photographies. Evolution over time from 2018 to 2019.

Figure 8a,b. Extraoral and intraoral photos (2019*),* post expansion and myofunctional therapy

FOLLOW-UP AND RESULTS

The benefits of multidisciplinary treatment gradually emerged in the treatment of A.P. Her respiratory appearance and efficiency improved; blood count stabilized (the hematocrit went from 43.3 to 41.9; the platelets from 508 to 426; the white blood cells from 25.73 to 7.23; the neutrophil granulocytes from 21.81 to 4.48; and the monocytes from 1.34 to 0.55). (Table 3).

Her weight decreased by 6 kg, her waist circumference decreased by 7 cm, and, according to her mother, she grew considerably in height. Her hearing aids were removed following the last audiological evaluation in which her

auditory threshold was optimal.
The quality of her sleep improved and a polysomnography performed after treatment documented the resolution of sleep apneas.
The girl was able to stop taking the medications related to the upper airways issues right after the first phase of palatal expansion and myofunctional therapy.
Fixed orthodontics continued as the third phase of therapy.

Table 3. Parameters

Parameters	Pre-treatment	Post-treatment
Body weight	• Overweight (BMI increased: 26,74)	• Loss of 6 kg • Reduction of waist circumference of 17 cm • Reported Considerable growth in height
Audiometric examination	• Bilateral medium-severe transmissive hypoacusia (requiring hearing aids)	• Auditory threshold within normal limits (removal of hearing aids)
Polysomnography (PSG)	• Obstructive sleep apnea (OSAs) with mild AHI for pediatric age	• Improvement of sleep quality reportedly
Blood tests	• Altered blood values • hematocrit 43.3 • platelets 508 • white blood cells 25.73 neutrophil granulocytes 21.81 • monocytes 1.34	• Normal blood values • hematocrit 41.9 • platelets 426 • white blood cells 7.23 • neutrophil granulocytes 4.48 • monocytes 0.55
Psychophysical ability	• Chronic asthenia, apathy, cefalea, poor school performance, • hypersensitivity to light, noise and crowded environments.	• Improvement of mood, school performance and physical activities. Reportedly more sociable.
Palatal transverse width	• Ogival palate	• Transverse increase of the palate 6 mm
Respiration	• Prevalent oral respiration	• Exclusive nasal respiration
Swallowing and chewing	• Dysfunctional swallowing with anterior lingual thrust associated with masticatory difficulty (prevalent intake of liquid or semi-liquid food)	• Correct and functional swallowing and chewing (food intake of any consistency)

CONCLUSIONS

The following case study wanted to demonstrate the key role played by the recovery of the respiratory, swallowing and chewing functions, along with the structural changes brought by orthodontics, to restore the proper metabolic balance in a growing patient. The integrated multidisciplinary treatment produced health benefits for A.P., who in the past already underwent a palatal expansion in two stages without significant results, as the altered orofacial functions were not corrected, along with the structural changes. Thanks to this multidisciplinary treatment, the girl re-learned to breathe exclusively with her nose and to chew her foods with all textures, allowing an improvement and optimization in orofacial and oropharyngeal muscle tone and mobility.

The new integrated program of palatal expansion and myofunctional therapy, building on top of the intervention of other professionals (neurologist, orthopedist, internist etc.) and encouraging a meaningful physical activity (in the case of this patient she learned to love dancing), made it possible to act synergistically on both orofacial structures and functions as well as positively impacting the whole body.[28-31]

DECLARATIONS

Funding: This research received no external funding.

Ethical Approval

Institutional Review Board Statement: The study was conducted at one clinical center in conformity with the Good Clinical Practice Guidelines, following the recommendations of the World Medical Association Declaration of Helsinki ethical principles for medical research involving human subjects, as revised in Fortaleza (2013). The patient included in this work was treated in a private dental practice with written consensus.

Conflicts of Interest: The authors declare no conflicts of interest.

REFERENCES

1.Dayyat E, Kheirandish-Gozal L, Gozal D. Childhood Obstructive Sleep Apnea: One or Two Distinct Disease Entities? Sleep Med Clin. 2007 Sep;2(3):433-444. doi: 10.1016/j.jsmc.2007.05.004.

2.Pirelli P, Fiaschetti V, Fanucci E, Giancotti A, Condo' R, Saccomanno S, Mampieri G. Cone beam CT evaluation of skeletal and nasomaxillary complex volume changes after rapid maxillary expansion in OSA children. Sleep Med. 2021;86:81-89. doi: 10.1016/j.sleep.2021.08.011.

3.Saccomanno S, Antonini G, D'Alatri L, D'Angelantonio M, Fiorita A, Deli R. Patients treated with orthodontic-myofunctional therapeutic protocol. Eur J Paediatr Dent. 2012 ;13(3):241-3.

4.Saccomanno S, Antonini G, D'Alatri L, D'Angeloantonio M, Fiorita A, Deli R. Case report of patients treated with an orthodontic and myofunctional protocol. European Journal of Paediatric Dentistry 2014; 15:184-186

5.Gelb M, Montrose J, Paglia L, Saccomanno S, Quinzi V, Marzo G. Myofunctional therapy Part 2: Prevention of dentofacial disorders. Eur J Paediatr Dent.2021;22(2):163-167.doi: 10.23804/ejpd.2021.22.02.15

6.Quinzi V., Saccomanno S., Jewel Manenti R., Giancaspro S., Coceani Paskay L., and Marzo G. Efficacy of Rapid Maxillary Expansion with or without Previous Adenotonsillectomy for Pediatric Obstructive Sleep Apnea Syndrome Based on Polysomnographic Data: A Systematic Review and Meta-Analysis *Appl. Sci.* **2020**;*10*;6485; doi:10.3390/app10186485

7.New Trends in myofunctional Therapy occlusion, muscles and posture. Edi Ermes 2020 ;18-24

8.Saccomanno S.,Martini C, D'alatri L, Farina S, Grippaudo C.A specific protocol of myo-functional therapy in children with Down syndrome. A pilot study Eur J Pediatric Dent 2018; 19(3)243- 246.doi 10.23804/ejpd.2018.19.03.14

9.Saccomanno S, Greco F, D'Alatri L, De Corso E, Pandolfini M, Sergi B, Pirronti T, Deli R. Role of 3D-CT for orthodontic and ENT evaluation in Goldenhar syndrome. Acta Otorhinolaryngol Ital. 2014;34(4):283-7.

10.Camacho M, Chang ET, Song SA, Abdullatif J, Zaghi S, Pirelli P, Certal V, Guilleminault C. Rapid maxillary expansion for pediatric obstructive sleep apnea: A systematic review and meta-analysis. Laryngoscope.2017;127(7):1712-1719.doi: 10.1002/lary.26352.

11.Memè, L., Saccomanno, S., Strappa, E.M., Sampalmieri, F., Bambini, F., Gallusi, G. Oral Appliances for Severe Positional Obstructive Sleep Apnea Syndrome: A Case Report.Applied Sciences

(Switzerland).2020;12(20);10570,
12.Dayyat E, Kheirandish-Gozal L, Gozal D. Childhood Obstructive Sleep Apnea: One or Two Distinct Disease Entities? Sleep Med Clin. 2007;2(3):433-444. doi: 10.1016/j.jsmc.2007.05.004.
13.Quinzi V., Saccomanno S., Jewel Manenti R., Giancaspro S., Coceani Paskay L., and Marzo G. Efficacy of Rapid Maxillary Expansion with or without Previous Adenotonsillectomy for Pediatric Obstructive Sleep Apnea Syndrome Based on Polysomnographic Data: A Systematic Review and Meta-Analysis *Appl. Sci.* **2020**;*10*;6485; doi:10.3390/app10186485
14.Quinzi, V; Nota, A; Caggiati, E; Saccomanno, S; Marzo, G; and Tecco. Short-Term Effects of a Myofunctional Appliance on Atypical Swallowing and lip Strength: A Prospective study Journal of clinicalMedicine.2020
15.Scoppa F., Saccomanno S., Bianco G., and Pirino A., Tongue Posture, Tongue Movements, Swallowing, and Cerebral Areas Activation: A Functional Magnetic Resonance Imaging Study *Appl. Sci.* **2020**, *10*, 6027; doi:10.3390/app10176027
16.Saccomanno S, Saran S, Paskay LC, Giannotta N, Mastrapasqua RF, Pirino A, Scoppa F. Malocclusion and Scoliosis: Is There a Correlation? J Pers Med. 2023 Aug 10;13(8):1249.doi:10.3390/jpm13081249..
17.Bambini, F., Pellecchia, M., Meme, L., Santarelli, A., Emanuelli, M., Procaccini, M., Lo Muzio,L. Anti-inflammatory cytokines in peri-implant soft tissues: A preliminary study on humans using cDNA microarray technology. European Journal of Inflammation.2007; 5 (3);121-127
18.New Trends in myofunctional Therapy occlusion, muscles and posture. Edi Ermes 2020 pag 18-24
19.Memè, L., Sartini, D., Pozzi, V., Emanuelli, M., Strappa, E.M., Bittarello, P., Bambini, F., Gallusi, G. Epithelial Biological Response to Machined Titanium vs. PVD Zirconium- Coated Titanium: An In Vitro Study.Materials,2020;15 (20);7250
20.Saccomanno S, Di Tullio A, D'Alatri L, Grippaudo Proposal for a myofunctional therapy protocol in case of altered lingual frenulum. A pilot study. C.Eur J Paediatr Dent. 2019 ;20(1):67-72. doi: 10.23804/ejpd.2019.20.01.13.
21.Briançon-Marjollet A, Weiszenstein M, Henri M, Thomas A, Godin-Ribuot D, Polak J. The impact of sleep disorders on glucose metabolism: endocrine and molecular mechanisms. Diabetology & metabolic syndrome 2015;7(1):1-16.
22.Strappa, E.M., Memè, L., Cerea, M., Roy, M., Bambini, F. Custom-made additively manufactured subperiosteal implant (2022) Minerva Dental and Oral Science.71(6);353-360
23.Tavares LF, Fonseca SC, Rosa MLG, Yokoo EM. Relationship between ultra-processed foods and metabolic syndrome in adolescents from a Brazilian Family Doctor Program. Public Health Nutr 2012;15(1):82-87.
24.Saccomanno,S; Deli,R; Dicintio,G; De Corso, E; Paludetti, G; Grippaudo, C Retrospective epidemiological study of mandibular rotational types in patients with orthodontical malocclusion. Acta otorhinolaryngol ital. 2018;38(2):160-165.doi: 10.14639/100x-1682
25.Lam JC, Mak JC, Ip MS. Obesity, obstructive sleep apnoea and metabolic syndrome. *Respirology*. 2012;17(2):223-236. doi:10.1111/j.1440-1843.2011. 02081
26.Buck LM, Dalci O, Darendeliler MA, Papageorgiou SN, Papadopoulou AK. Volumetric upper airway changes after rapid maxillary expansion: a systematic review and meta- analysis. Eur J Orthod 2017;39(5):463-473.
27.Bambini, F., De Stefano, C.A., Giannetti, L., Memè, L., Pellecchia, M. Influence of biphosphonates on the integration process of endos seousimplants evaluated using single photon emission computerize tomography (spect) [Article@Valutazione scintigrafica con metodica SPECT dell'effetto dei bifosfonati sul processo di osseointegrazioneimplantare].Minerva Stomatologica,2003;52(6);331-338
28.Botzer E. Quinzi V.Salvati S.E., Coceani Paskay L, Saccomanno S., Myofunctional therapy Part 3: Tongue functionand breastfeeding as precursor of oronasal functions Ejpd vol 22/3- 2021 163-165
29.Saccomanno S, Quinzi V, Albani A, D'Andrea N, Marzo G, Macchiarelli G. Utility of Teleorthodontics in Orthodontic Emergencies during the COVID-19 Pandemic: A Systematic Review. Healthcare (Basel). 202214;10(6):1108.doi:10.3390/healthcare10061108.
30.S. Saccomanno, A. Pirino, G. Bianco, L.C. Paskay, R. Mastrapasqua and F. Scoppa Does a short lingual frenulum affect body posture? Assessment of posture in the sagittal plane before and after laser frenulotomy: a pilot study. Journal of Biological Regulators & Homeostatic Agents.2021:35(3S1), 185-195

Sabina Saccomanno, Melania Evangelista, Licia Coceani Paskay, Eleonora Luciani, Martina Serenelli, Elena Tessarolo, Valerio Brunetti.The importance of a multidisciplinary approach to metabolic syndrome in children with OSAS.A Case Report.Bulletin of Stomatology and Maxillofacial Surgery.2025;21(3).178-188. doi:10.58240/1829006X-2025.3-178