

Integrating occlusion, vision, and posture: a multidisciplinary approach to paediatric malocclusion



E. Bardellini¹, M. G. Gulino¹, S. Pini²,
S. Fontana³, M. Febbrari⁴, A. Majorana¹

¹Department of Surgical and Medical Specialties, Radiological Sciences and Public Health, School of Pediatric Dentistry, University of Brescia, Brescia, Italy

²Pediatric Ophthalmology, Fondazione Poliambulanza Istituto Ospedaliero, Brescia, Italy

³Central Laboratory of Chemical Analysis, ASST Spedali Civili di Brescia, Brescia, Italy

⁴Private practitioner, via del Gallo 15, 25128 Brescia, Italy

DOI 10.23804/ejpd.2025.2385

email: elena.bardellini@unibs.it

Abstract

This case report presents a comprehensive postural evaluation of a 9-year-old paediatric patient with unilateral right crossbite and an associated visual defect. Postural assessments were performed using a vertical laser line (VLL) and a baropodometric-stabilometric platform, revealing significant postural alterations, including cervical extension, increased dorsal kyphosis, pelvic rotation, and an asymmetrical distribution of plantar load. The Romberg test indicated a visual system dysfunction, confirmed by ophthalmologic and orthoptic examinations, which identified mild myopic astigmatism and convergence insufficiency. The patient underwent two years of treatment with the Mouth Slow Balance (MSB) functional appliance, combined with corrective lenses and orthoptic exercises. Post-treatment evaluations demonstrated substantial improvements, including correction of the crossbite, normalization of visual function, improved head and body posture, and balanced plantar load distribution. The Romberg Index returned to physiological values, confirming restored visual influence on postural control. This case underscores the importance of a multidisciplinary approach involving dental, postural, and ophthalmologic evaluations in addressing occlusal and visual dysfunctions. Early identification and intervention can prevent compensatory postural adaptations, optimise craniofacial growth, and enhance the overall quality of life in paediatric patients.

KEYWORDS Unilateral crossbite, Postural assessment, Oculomotor dysfunction, Functional appliance therapy, Multidisciplinary treatment.

Introduction

The stomatognathic system is a complex anatomical-functional system comprising tissues and organs located in the oral and cranial cavities. Dental malocclusion is not merely a dysfunctional relationship between the upper and lower jaw; rather, it is an anomaly involving various functional systems, including the temporomandibular joints, masticatory and facial muscles, suprahoid muscles, alveolar processes, teeth, tongue, vestibule, and vascular-nerve elements. Consequently, dental-mandibular disharmony is often associated with a functional issue that, if left untreated in early childhood, may lead to imbalances in maxillofacial, facial, and cranial structures [Gianni, 1980].

Crossbite (or lateral reverse bite) is a dental-skeletal discrepancy characterised by an imbalance between the transverse dimensions of the upper and lower jaw. This condition can manifest as unilateral (right or left) or bilateral crossbite, often resulting in

mandibular displacement. Unilateral crossbite may lead to lateral deviation of the chin, causing facial asymmetry, misalignment of jaw midlines and, ultimately, imbalance in temporomandibular joints and masticatory muscles [Ishizaki et al., 2010; Saccomanno et al; 2012]. The recent National Posturology Guidelines officially recognise the correlation between mandibular occlusion and body posture, defining posture as “the position adopted by various parts of the body in relation to the environment and gravitational field” [Italian Ministry of Health, 2017]. Given that “the structures of the human body change, adapt, and relate to the surrounding environment,” and that posturology likens the human figure to the balance of forces in an “inverted pendulum” [Preuschoft, 2004], postural diagnostic evaluation is recommended to follow a cranio-caudal approach. Therefore, ocular, vestibular, and oral sensory receptors emerge as primary anatomical structures in posture regulation; their close anatomical correlations explain functional interactions [Zieliński et al., 2021]. Various studies have identified correlations between the eyes and masticatory muscles [Ciavarella et al., 2012], binocular function and lateral mandibular deviations [Monaco et al., 2004], and even ocular motility, astigmatism, and crossbite [Monaco et al., 2011]. Visual or postural alterations of the eyes and/or occlusal dysfunctions can result in postural adaptations [Bardellini et al., 2019; Bardellini et al., 2022; Guaglio, 2013], highlighting the need for appropriate diagnostic tools. This case report presents a comprehensive postural evaluation of a paediatric patient with malocclusion and an associated visual defect. Given the complex interplay between posture, occlusal health, and visual function, early identification of imbalances in these systems is essential for effective intervention. Malocclusion and visual defects can both contribute to compensatory postural adjustments, which, if left unaddressed, may lead to persistent issues impacting the patient’s overall quality of life [Bardellini et al., 2019; Bardellini et al., 2022; Guaglio, 2013]. This case highlights the potential of a multidisciplinary approach—encompassing dental and ophthalmologic evaluations—to address these interconnected factors and optimise the patient’s postural and functional outcomes.

Case report

A 9-year-old patient in mixed dentition underwent dental and postural evaluation. The patient had good health except for recurrent headaches.

Diagnosis

Assessment of dental occlusion

The assessment of dental occlusion was carried out after



FIG. 1 Intraoral frontal (A) and lateral (B) photographs of the patient, showing evidence of a unilateral right crossbite with mandibular lateral deviation. The patient is positioned on the postural assessment station with a vertical laser line (VLL), observed in right lateral view. Notable features include cervical extension with forward head posture, accentuated dorsal kyphosis, pelvic anteroversion, and right knee flexion (C). Graph produced by the baropodometric-stabilometric platform (Biopostural System®) showing evidence of bilateral 3rd-degree hollow foot (D), along with visualization of load asymmetry (E) between the left foot (57.1% of body weight) and the right foot (42.9% of body weight).

performing plastic models, panoramic radiograph and lateral telerradiography for the cephalometric analysis (Ortho TP®). The dental examination revealed a unilateral right crossbite with mandibular lateral deviation (Fig. 1A-B). Cephalometric measurements indicated a normoskeletal structure.

Postural assessment with vertical laser line (VLL)

The Biopostural System® postural station (CE-0124) was used for postural assessment. The patient stood behind a vertical laser line in an upright posture, with feet positioned at a 30-degree angle, arms relaxed at the sides, and gaze directed at the horizon. Postural tone and body alignment were analysed through a postural trace based on specific landmarks (Fig. 2) [Hasegawa et al., 2017; Rocabado, 1983].

The VLL postural examination revealed cervical extension with forward head posture, an increase in dorsal kyphosis, anterior pelvic tilt, and right knee flexion (Fig. 1C).

Postural assessment with Baropodometric-stabilometric platform The Biopostural System® (CE-0124) was used for static and dynamic assessment of foot support, consisting of dedicated acquisition software interfaced with a baropodometric - stabilometric platform. This platform, equipped with 1600 force sensors and resistive technology for high-frequency data acquisition, is referred to as baropodometric when evaluating foot support type (normal, high arch, or flat) and as stabilometric when measuring a subject's postural control by quantifying oscillations and mean displacement of the center of pressure over a specified time period. The platform enables postural assessment, distinguishing through specific tests the contributions of various determinants (occlusal, visual, vestibulo-auditory, musculoskeletal, articular, connective-visceral, and emotional) to the postural

system [Avagnina et al., 2003; Rosário, 2014]. The postural evaluation on the baropodometric-stabilometric platform revealed bilateral 3rd-degree hollow foot (Fig. 1D) with a significant load discrepancy between the left and right foot: 57.1% on the left and 42.9% on the right (Fig. 1E). A Romberg test was also conducted on the platform to determine the independent contribution of the visual system to postural balance in relation to proprioceptive, vestibular, and occlusal systems. The test measures the oscillation area of the center of pressure with eyes alternately open and closed. With eyes open, the visual, vestibular, proprioceptive, and occlusal systems collectively influence the center of pressure oscillations. When eyes are closed, the visual system is excluded from postural control. The platform's computer system compares the two measured areas under both conditions, generating a Romberg Index or Quotient.

A Romberg Index below 100 indicates "postural blindness," suggesting the need for further visual investigation. An Index above 250 suggests proprioceptive or vestibular or occlusal issues. Values between 100 and 250 are considered within the normal range [Wu and Lee, 2015]. The Romberg test yielded an Index of 73.33 (Fig. 3) indicating a potential visual issue and prompting a recommendation for ophthalmological and orthoptic evaluations.

Ophthalmological and orthoptic examination

An ophthalmological examination, prompted by the postural assessment, identified mild myopic astigmatism and ocular convergence deficit with exophoria of the right eye.

Treatment and post-treatment assessment

The patient underwent a two-year treatment with the Mouth Slow Balance (MSB) device (Fig. 4), an advanced functional

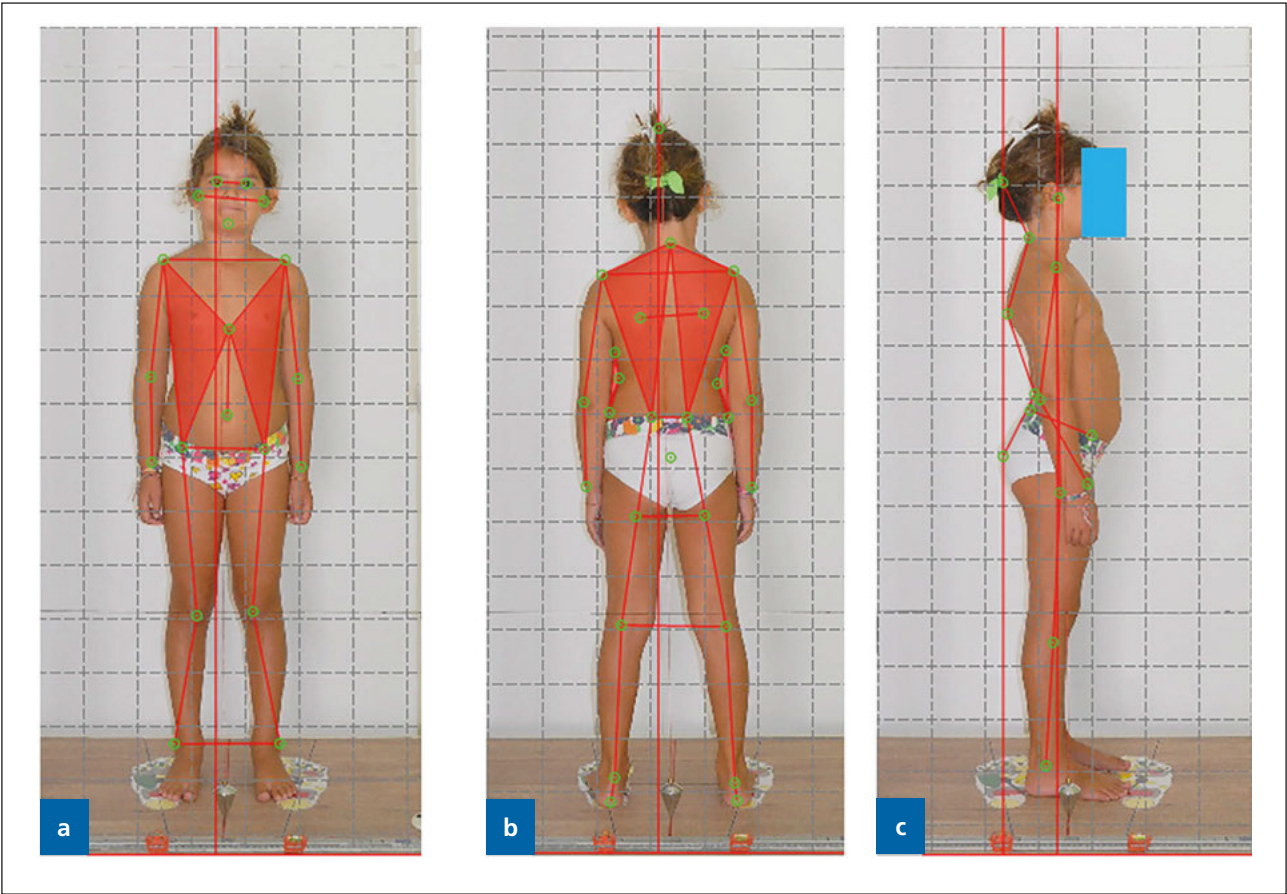


FIG 2 Patient positioned on the Biopostural System® postural station for postural assessment with a vertical laser line (VLL). The postural trace (orange lines and areas) is defined based on anatomical landmarks (green dots), identified on images of the patient acquired in frontal (A), posterior (B) and right lateral (C) views.



FIG 3 Romberg test, performed with open eyes ("occhi aperti", left side) and closed eyes ("occhi chiusi", right side). The Romberg index is 73.33% before treatment. Translation of the Italian terms: asse X= axis X; asse Y= axis Y; lunghezza (mm)= length (mm) ; area (mm²) = area (mm²); velocità= speed ; velocità L/L= lateral/longitudinal speed; velocità A/P= anterior/posterior speed; accelerazione A/P= anterior/posterior acceleration; rapporto L/S =length/ surface ratio

appliance derived from the Bionator, customised based on an individualised bite and a dynamic-functional squaring approach, as previously described in our study [Bardellini et al., 2019]. The MSB device was activated monthly, progressively achieving correction of the right lateral crossbite (Fig. 5A-B). In addition to the MSB treatment, corrective glasses were prescribed to address myopic astigmatism, along with orthoptic exercises aimed at

improving accommodation, convergence, and binocular vision fusion. Following treatment, a postural analysis with the Vertical Laser Line (VLL), conducted with both corrective glasses and the MSB device in place, demonstrated improved head positioning, realignment of the cervical spine, reduced dorsal kyphosis, corrected pelvic rotation, and decreased compensatory stress at the right knee (Fig. 5C). Assessment on the baropodometric-stabilometric platform indicated persistence of bilateral 3rd-degree hollow foot (Fig. 5D); however, there was a notable improvement in pressure load distribution, now approaching physiological values, with 50.8% on the left foot and 49.2% on the right (Fig. 5E). Additionally, the Romberg test yielded an Index of 105.89, within the physiological range, suggesting normalisation of the visual system's influence on overall postural control (Fig. 6).

Discussion and conclusion

This case report suggests that postural assessment on a stabilometric baropodometric platform, performed as part of a dental examination for malocclusion, can reveal underlying potential visual issues, which require ophthalmological confirmation. Correcting both visual and dental factors—through visual exercises and functional orthodontic appliances—can lead to significant improvements in postural stability. Posture is a complex system influenced by multiple interconnected factors, making a multidisciplinary approach essential. Addressing both occlusal and visual aspects is particularly valuable during paediatric development, when cranial and facial structures are still adaptable

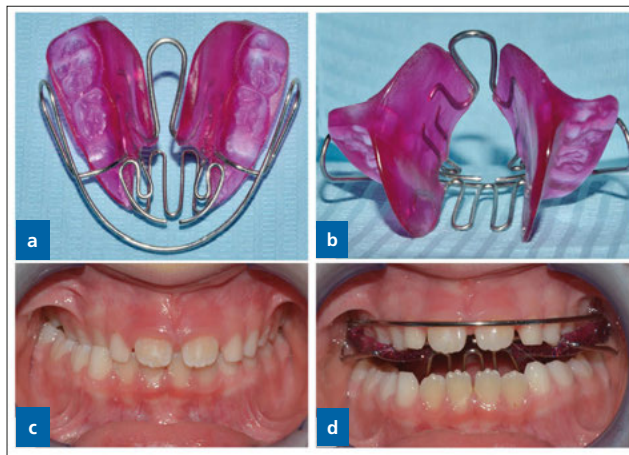


FIG 4 Functional orthopaedic device Mouth Slow Balance (MSB) Class I, shown in bottom view (A) and rear view (B), along with intra-oral photographs of a unilateral right crossbite, without (C) and with (D) the MSB.

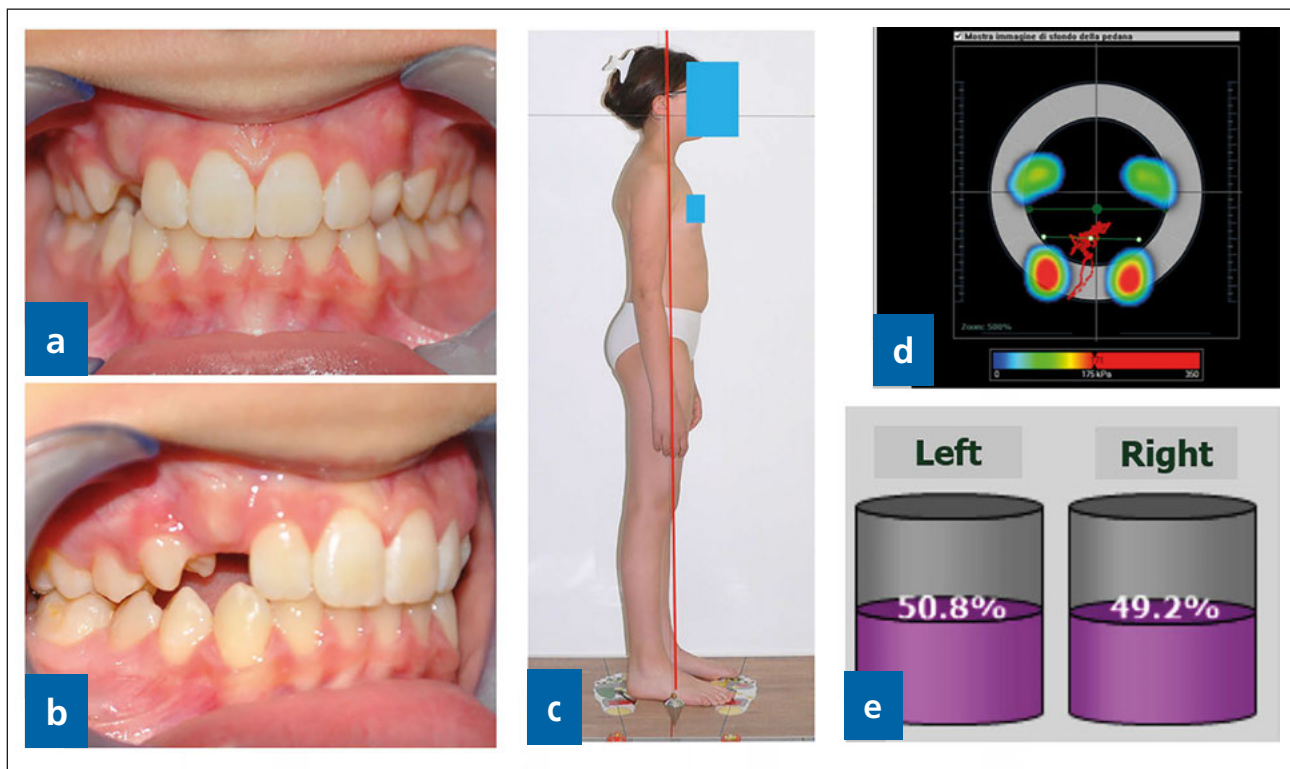


FIG 5 Intraoral frontal (A) and lateral (B) photographs of the patient, showing correction of the unilateral right crossbite. Patient wearing corrective glasses and the functional orthopedic device (MSB) on the Biopostural System® postural station for assessment with the vertical laser line (VLL), right lateral view. Notable features include head repositioning, realignment of the cervical spine, reduction of dorsal kyphosis, restoration of proper lumbar lordosis, correction of pelvic alignment, and decreased compensatory stress on the right knee (C). Graph produced by the baropodometric-stabilometric platform, demonstrating evidence of bilateral 3rd-degree hollow foot (D) and showing the physiological distribution of pressure loads (E) between the left foot (50.8%) and the right foot (49.2%).

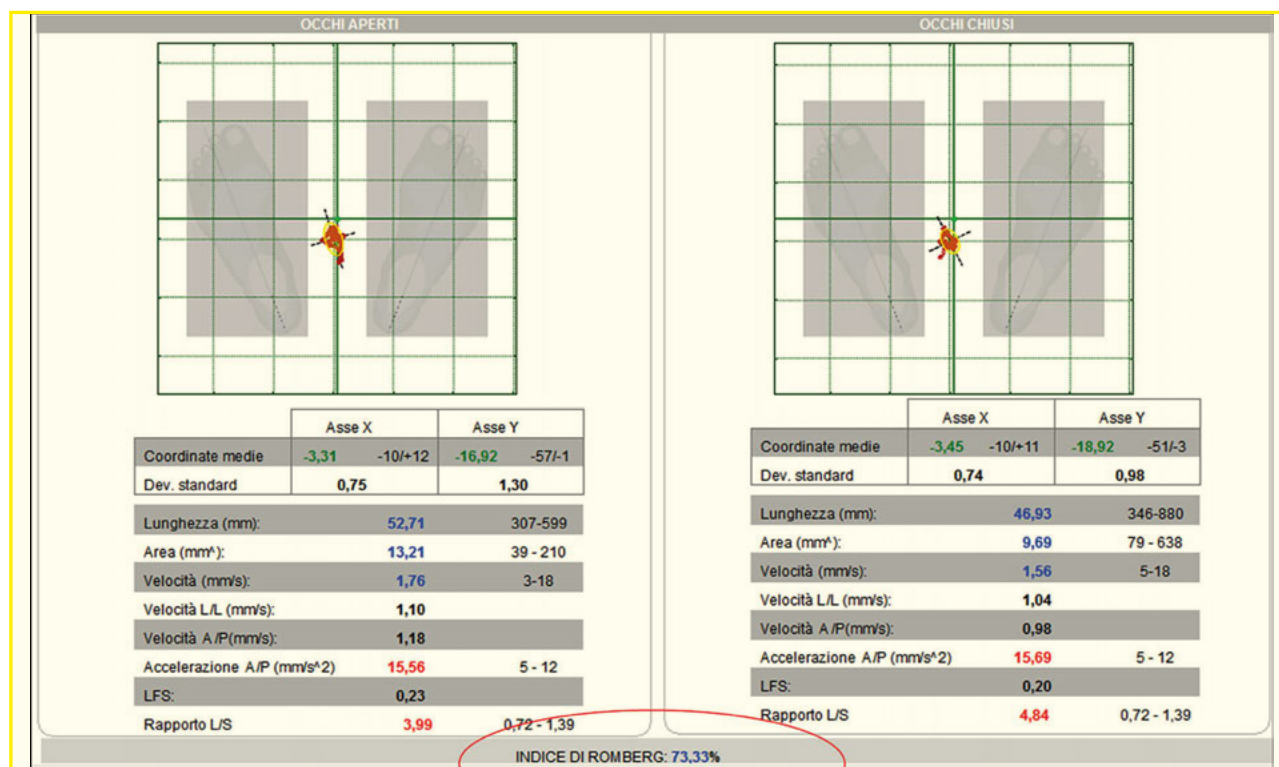


FIG 6 Romberg test, performed with open eyes (“occhi aperti”, left side) and closed eyes (“occhi chiusi”, right side). The Romberg index is 105.89 % after treatment. Translation of the Italian terms: asse X= axis X; asse Y= axis Y; lunghezza (mm)= length (mm); area (mm²) = area (mm²); velocità= speed; velocità L/L= lateral/longitudinal speed; velocità A/P= anterior/posterior speed; accelerazione A/P= anterior/posterior acceleration; rapporto L/S =length/ surface ratio.

[Bardellini et al., 2019; Bardellini et al., 2022; Guaglio, 2013]. Visual or occlusal dysfunctions can contribute to compensatory postural adaptations, potentially leading to symptoms such as headaches, as observed in this patient’s medical history. The use of the Mouth Slow Balance (MSB) appliance facilitated targeted occlusal correction while preserving oral hygiene and ensuring high compliance. The MSB’s elastic design and minimal interference with swallowing and speech allowed the patient to maintain daily activities, including school and sports, without disruption [Bardellini et al., 2019; Bardellini et al., 2022]. This combined approach successfully re-established optimal posture from head to toe, demonstrating the importance of collaboration among paediatric healthcare providers—including paediatricians, dentists, ophthalmologists, orthoptists, and optometrists. Dentists play a critical role in the early identification and referral of patients with complex postural issues linked to both occlusion and vision. By recognising signs of potential postural imbalances during routine examinations, dentists can facilitate timely referrals for specialised assessments, enabling a multidisciplinary approach. This model can lead to more effective, early-stage interventions, contributing to improved long-term postural and overall health outcomes [Rosário, 2014; Wu and Lee, 2015; Maagard et al., 2021].

Acknowledgments

A special thanks to Angelo Vannella for the development of the Clinical Software for Orthodontics and Posturology of the Biopostural System®. (CE-0124).

References

- Avagnina L, Eric Benguerbi E, Schmidt G. Diagnostica Biomeccanica con pedane di pressione. Timeo Editore, Bologna 2003. EAN: 9788886891370. ISBN: 8886891377.
- Bardellini E, Gulino MG, Fontana S, Amadori F, Febrari M, Majorana A. Can the Treatment of Dental

- Malocclusions Affect the Posture in Children? J Clin Pediatr Dent. 2022 May 1;46(3):241-248. doi: 10.17796/1053-4625-46.3.11. PMID: 35830640.
- Bardellini E, Gulino MG, Fontana S, Merlo J, Febrari M, Majorana A. Long-term evaluation of the efficacy on the podalic support and postural control of a new elastic functional orthopaedic device for the correction of Class III malocclusion. Eur J Paediatr Dent. 2019 Sep;20(3):199-203. doi: 10.23804/ejpd.2019.20.03.06. PMID: 31489818.
- Ciavarella D, Monsurò A, Padricelli G, Battista G, Laino L, Perillo L. Unilateral posterior crossbite in adolescents: surface electromyographic evaluation. Eur J Paediatr Dent. 2012 Mar;13(1):25-8. PMID: 22455524.
- Gianni E. La nuova ortognatodonzia. Vol.1. Piccin - Nuova Libreria, Padova 1980.
- Guaglio G. Bocca e Alta cervicale - Relazione sul profilo e sul piano frontale. Edizioni Martina, Bologna 2013.
- Hasegawa K, Okamoto M, Hatsushikano S, Shimoda H, Ono M, Homma T, Watanabe K. Standing sagittal alignment of the whole axial skeleton with reference to the gravity line in humans. J Anat. 2017 May;230(5):619-630. doi: 10.1111/joa.12586. Epub 2017 Jan 27. PMID: 28127750; PMCID: PMC5382592.
- Ishizaki K, Suzuki K, Mito T, Tanaka EM, Sato S. Morphologic, functional, and occlusal characterization of mandibular lateral displacement malocclusion. Am J Orthod Dentofacial Orthop. 2010 Apr;137(4): 454. e1-9. doi: 10.1016/j.ajodo.2009.10.031. PMID: 20362898.
- Italian Ministry of Health. National guidelines on the classification, assessment, and measurement of posture and related dysfunctions. Italy: Ministry of Health; 2017. Available at: https://www.salute.gov.it/imgs/C_17_pubblicazioni_2717_allegato.pdf
- Maagard ML, Nisted I, Bek T. Vergence Exercises for Six Weeks Induce Faster Recovery of Convergence Insufficiency Than Accommodation Exercises in School Children. Invest Ophthalmol Vis Sci. 2021 May 3;62(6):23. doi: 10.1167/iov.62.6.23. PMID: 34019649; PMCID: PMC8142715.
- Monaco A, Spadaro A, Sgolastra F, Petrucci A, D'Andrea PD, Gatto R. Prevalence of astigmatism in a paediatric population with malocclusions. Eur J Paediatr Dent. 2011 Jun;12(2):91-4. PMID: 21668278.
- Monaco A, Streni O, Marci MC, Sabetti L, Marzo G, Giannoni M. Relationship between mandibular deviation and ocular convergence. J Clin Pediatr Dent. 2004 Winter;28(2):135-8. doi: 10.17796/jcpd.28.2.mj731103m257134. PMID: 14969372.
- Preuschoft H. Mechanisms for the acquisition of habitual bipedality: are there biomechanical reasons for the acquisition of upright bipedal posture? J Anat. 2004 May;204(5):363-84. doi: 10.1111/j.0021-8782.2004.00303.x. PMID: 15198701; PMCID: PMC1571303.
- Rocabado M. Biomechanical relationship of the cranial, cervical, and hyoid regions. J Craniomandibular Pract. 1983 Jun-Aug;1(3):61-6. doi: 10.1080/07345410.1983.11677834. PMID: 6586872.
- Rosário JL. A review of the utilization of baropodometry in postural assessment. J Body Mov Ther. 2014 Apr;18(2):215-9. doi: 10.1016/j.jbmt.2013.05.016. Epub 2013 Jul 1. PMID: 24725789.
- 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 Sep;13(3):241-3. PMID: 22971265.
- Wu KT, Lee GS. Influences of monocular and binocular vision on postural stability. J Vestib Res. 2015;25(1):15-21. doi: 10.3233/VES-150540. PMID: 25882473.
- Zieliński G, Filipiak Z, Ginzst M, Matysik-Woźniak A, Rejdak R, Gawda P. The Organ of Vision and the Stomatognathic System-Review of Association Studies and Evidence-Based Discussion. Brain Sci. 2021 Dec 23;11(1):14. doi: 10.3390/brainsci12010014. PMID: 35053758; PMCID: PMC8773770.