

Open bite and atypical swallowing: orthodontic treatment, speech therapy or both? A literature review



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Abstract

Aim The cause-effect relationship between anterior open bite and atypical swallowing, two frequently associated conditions, is currently not completely understood. These conditions are often accompanied by speech disorders and represent a problem for both young patients and untreated adult patients. Treatment of these complex cases may be orthodontic, logopedic therapy or both. The purpose of this review is to compare the various types of treatment to determine their effectiveness in improving skeletal condition, normalisation of muscle activity, and temporal stability.

Methods The present systematic review was conducted following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. In order to find the most appropriate articles for inclusion, an electronic and manual search was performed using PubMed and The Cochrane Library on May 23, 2021. No language restrictions or time limits were applied. Only human studies describing cases of patients in the developmental stage of dentition, i.e., deciduous dentition or mixed dentition with an anterior open bite related to a type of swallowing with tongue interposition between the arches, undergoing three different types of treatment (orthodontic only, myofunctional/logopedic only, combined) were included.

Results After careful analysis of the articles identified from the electronic and manual searches, 9 studies met the eligibility criteria. This review was written following a three-section structure, corresponding to three different types of treatment: orthodontic treatment, myofunctional treatment/logopaedic exercises, and combined treatment. Information analysed for each study included: number of participants, age of patients and stage of dentition, type of treatment used, duration of treatment and results of the study.

Conclusions The most effective treatment in cases of anterior open bite associated with atypical swallowing is a combination of the traditional orthodontic therapy and myofunctional therapy. Further studies are needed to devise an effective and universal logopaedic protocol to be followed in these cases.

KEYWORDS Open bite; Atypical swallowing; Orthodontic treatment; Myofunctional treatment; Speech therapy.

Introduction

Open bite is defined as an alteration in the vertical relationship of the maxillary and mandibular dental arches, characterised

by a lack of contact between antagonistic teeth [Subtelny and Sakuda, 1964]. In almost all cases this condition involves the anterior teeth, particularly the incisors, while more rarely it involves the posterior sectors of the dental arches. The aetiology of this condition remains uncertain but it is believed to be multifactorial and dependent on both intrinsic and extrinsic aetiological factors of environmental nature. Environmental factors include variations in dental eruption or alveolar growth, disproportionate neuromuscular growth, tongue malfunction, and/or oral bad oral habits [Cayley et al., 2000a].

Very frequently, open bite is strongly related to the interposition of the tongue between the teeth during swallowing [Maciel et al., 2005]; the latter condition occurs during infancy (infantile swallowing), as it is a physiological characteristic of sucking, but it can also occur during the transition between deciduous and permanent teeth. Infantile swallowing in a patient with permanent teeth constitutes a non physiologic condition called atypical swallowing. The type of swallowing, in fact, should change through different stages in life: from infantile to mixed swallowing and finally to adult swallowing. Very often there is a period in which infantile and adult swallowing tend to overlap, characterised by fewer infantile acts, called mixed or transitional swallowing. Generally, however, infantile swallowing tends to prevail until the age of 6 years, by which time it is considered normal [Farronato, 2013].

Mixed swallowing is characterised by the appearance of the deciduous dentition, which prevents the tongue from interposing itself between the dental arches and forces it against the palate, and by the onset of positive pressure in the mouth. Adult swallowing, on the other hand, is determined by the retroincisive position of the tongue in the region of the papilla with formation of a negative pressure of the oropharyngeal tract [Farronato, 2013].

Sometimes a type of swallowing characterised by the interposition of the tongue between the arches is associated with the so-called "lispings", that is an altered sibilant production. The aetiology of this type of swallowing is uncertain, as in the case of anterior open bite (AOB), although genetic, functional and pathological factors seem to be involved [Cayley et al., 2000a; Saccomanno et al., 2012a].

Swallowing with tongue interposition between the arches and anterior open bite are frequently associated but, despite many investigations, the relationship between the two is not fully understood. In fact, it is unclear what is the cause and what is the effect between the two conditions. According to the prevailing opinion, it is more likely that the open bite itself causes the infantile swallowing pattern than vice versa [Proffit

et al., 2007; Kikyo et al., 1999]. In fact, along these lines, there is a belief that during swallowing, the tongue presses on the anterior teeth for too short a period of time to determine an influence on the eruption of the anterior teeth, and thus on the formation of the anterior open bite [Proffit et al., 2007; Mason, 2011]. For these authors, it is the tongue that, when pushed forward during the physiological swallowing movement, causes incorrect swallowing. In contrast, other studies argue that it is infantile swallowing that is an important factor underlying the aetiology of the anterior open bite [Peng et al., 2003; Kasparaviciene et al., 2014; Dixi and Shetty, 2013; Begnoni et al., 2020]. From this, it can be assumed that tongue-push swallowing is a contributing factor to the relapse of the results achievable with traditional orthodontic treatment and should therefore be controlled during treatment and restraint periods [Yashiro and Takada, 1999].

The diagnosis of atypical swallowing is based on the medical history through the investigation of the presence of bad habits, the examination of the oro-facial district during which the resting position of the tongue and the position of the mandible during swallowing are investigated (in fact, atypical swallowing is characterised by the absence of muscular contraction which, under normal conditions, can be perceived by placing a hand between the temporalis and the masseter and by the absence of occlusal contact) and the intraoral functional examination. During this moment of diagnosis, the position of the tongue during swallowing, the possible presence of contraction of the muscles (buccinator, orbicularis, and menton) and the position of the lips during swallowing should be observed [Farronato, 2013]. Finally, radiographs and complementary examinations, such as palatograms or electropalatography (EPG) [Cayley et al., 2000a; Farronato et al., 2020; Leonardi et al., 2021; Maspero et al., 2020], are also useful for diagnosis.

Speech therapy in association with oral myofunctional therapy, corrects the position of the tongue during swallowing, speech and in habitual position. Orthodontic appliances, on the other hand, restore the correct relationship between the two dental arches. The devices used can be distinguished into two large groups: restrictors and stimulators. The first ones have the only purpose of stopping the incorrect function from damaging the occlusion through appropriate "physical barriers" such as grids and shields. The latter, which are nowadays the predominant choice, actively help myofunctional therapy and correct function. The latter include lingual function stimulators and lingual elevators. Sometimes, if the condition of interposition of the tongue between the dental arches during swallowing persists for a long time, it may be necessary to combine orthodontic treatment with surgical treatment [Celli et al., 2014].

Considering the strong association with speech disorders, the purpose of this study is to emphasize the need for a multidisciplinary treatment of these conditions with the interaction of orthodontists, surgeons and speech therapists [Cayley et al., 2000a; Maspero et al., 2014; Farronato et al., 2012a].

Materials and methods

This systematic review was conducted following the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) guidelines.

Eligibility criteria

The inclusion criteria that were applied were as follows:

1. Study design: clinical trials, randomised controlled trials (RCTs), controlled clinical trials (CCTs), and case reports.
2. Participants: patients in the developmental stage of dentition, i.e., deciduous dentition (up to 6 years) or mixed dentition (6–12 years).
3. Interventions: treatment modalities used to correct cases of anterior open bite related to swallowing with tongue interposition between the arches, with related speech problems.
4. Comparison: between the various types of treatment (only orthodontic, only speech therapy, combined).
5. Outcome: the primary outcome was improvement in skeletal condition and normalisation of muscular activity, with respect to the treatment applied.

Search strategy

An electronic search was conducted via PubMed, Scopus, The Cochrane Library, Open Grey, and LILACS on May 23, 2021, by means of the following search strategy: "(tongue thrusting OR tongue thrust* OR tongue position OR tongue posit* OR swallow OR swallowing OR swallow* OR swallowing pattern OR swallow* pattern OR open bite OR anterior open bite) AND (orthodontic treatment OR orthodontic* treat* OR orthodontic manag* OR orthodontic management OR orthodontic therapy OR orthodontic* therap* OR orofacial muscle treatment OR orofac* muscle treat* OR orofacial muscle therapy OR orofac* muscle therap* OR speech therapy OR logopedic) AND (deciduous dentition OR deciduous dent* OR primary dentition OR primary dent* OR early mixed dentition OR early mixed dent* OR late mixed dentition OR late mixed dent* OR mixed dentition OR mixed dent*)". A manual search of reference lists of retrieved articles was also conducted for full-text review. No language restrictions or time limits were applied. In addition, only human studies were considered. References from the different databases, before being evaluated, were entered into the EndnoteWeb@ application in order to identify duplicates and proceed with their elimination. At this point, titles and abstracts were first reviewed and then the full-text review of relevant articles was considered for inclusion. Screening of abstracts and full-text manuscripts was performed independently by two authors.

Data collection process

The process of extracting data from the studies included in the review was performed by two authors and confirmed by a third. Two reviewers independently completed the initial selection of titles and abstracts of all included papers, excluding articles with titles and abstracts that were not relevant to the research question and did not meet the inclusion criteria. If there was insufficient information in the title or abstract to decide whether to exclude or include it from the search, the full article was read and then a decision was made regarding inclusion or exclusion. The reference lists of each eligible article were manually reviewed to select articles that were more relevant to the search. The final list was reported to the knowledge of a third reviewer. To avoid double counting of reports from the same study and thus reduce selection bias, it was decided to consider only the last published report.

Data collection was performed using a spreadsheet that was updated from time to time. The information collected for each study was organised into a table; the data entered within it were then divided into six categories: number of participants, patient age and stage of dentition, type of treatment used, duration of treatment, and study results.

Results

Search details.

The electronic search identified 307 articles, whereas records for 4 articles were identified after manual search of the included full-text evaluation studies. After initial screening consisting of title reading and subsequent removal of duplicates, 84 articles remained for further evaluation. After a more thorough analysis based on full-text reading, 9 studies were deemed eligible for inclusion in the review (Fig. 1).

Characteristics of the included studies are shown in Table 1.

Study design

The sample sizes of the various studies ranged from 1 to 130 children; however, only one study recruited more than 100 children.

Participant ages ranged from 4 to 14 years. Most studies considered children in the mixed dentition period.

The interventions reported in the studies were: orthodontic appliances, myofunctional treatment/speech therapy exercises, a combination of the two treatments.

Discussion

Several different treatment approaches can be found in the literature regarding the early treatment of anterior open bite [Rosa et al., 2019]. Specifically, three different types of treatment were presented in the following review: orthodontic only, myofunctional/speech therapy only, and combined.

Orthodontic treatment

Orthodontic treatment for the early correction of the anterior open bite include functional appliances, either fixed or removable type, having the objective of correcting and limiting excessive vertical skeletal growth and removing the mechanical factors that maintain the open bite i.e., as in the case of interposition of the tongue between the arches during swallowing [Farronato et al., 2012b; Lanteri et al., 2020].

Among the selected studies, 5 studies examined treatment with orthodontic therapy alone based on the use of spurs

bonded to the lingual surface of maxillary and/or mandibular incisors, and/or fixed or removable palatal grids. These would contribute to the elimination of tongue interference in the open bite space that would eventually act toward the intended correction of the anterior open bite. Treatment in all 5 cases lasted from 6 to 23 months, and the results obtained were also comparable. It turned out that, in some cases, a type of orthodontic treatment only allows to correct the anterior open bite and therefore to solve the skeletal problem but not to eliminate definitively the bad habit of the patient. In fact, in this way there is the risk of recurrence that put the patient in front of the need to undergo again an orthodontic treatment.

Functional treatment

A further treatment modality for the anterior open bite is represented by orofacial myofunctional therapy (OMT), whose purpose is to harmonise orofacial functions by establishing a new physiological swallowing pattern and to eliminate factors that interfere with the normal development of the dental arches. This type of therapy aims to make the patient aware of the incorrectness of the tongue and thus allows him to learn a physiological myofunctional behavior. It is well known that a correct myofunctional protocol must adapt to the needs of each patient and its success depends above all on the compliance of both child and parents.

Insufficient attention is given to this treatment modality in the literature. There is also a lack of evidence defining the ideal age to begin this type of treatment and more research is needed in this regard. From the studies found and presented in this review, it was found that OMT can positively influence tongue behaviour, both at rest and during the swallowing mechanism, although it does not appear to significantly influence treatment alone [Van Dyck et al., 2016]. An idea also shared by Cayley et al., who, although they demonstrated that normal swallowing function resumes after OMT in subjects with anterior open bite, also demonstrated that only a partial reduction of anterior open bite is present from cephalometric tracings [Cayley et al., 2000b].

Combined treatment

In order to maintain the result obtained through orthodontic

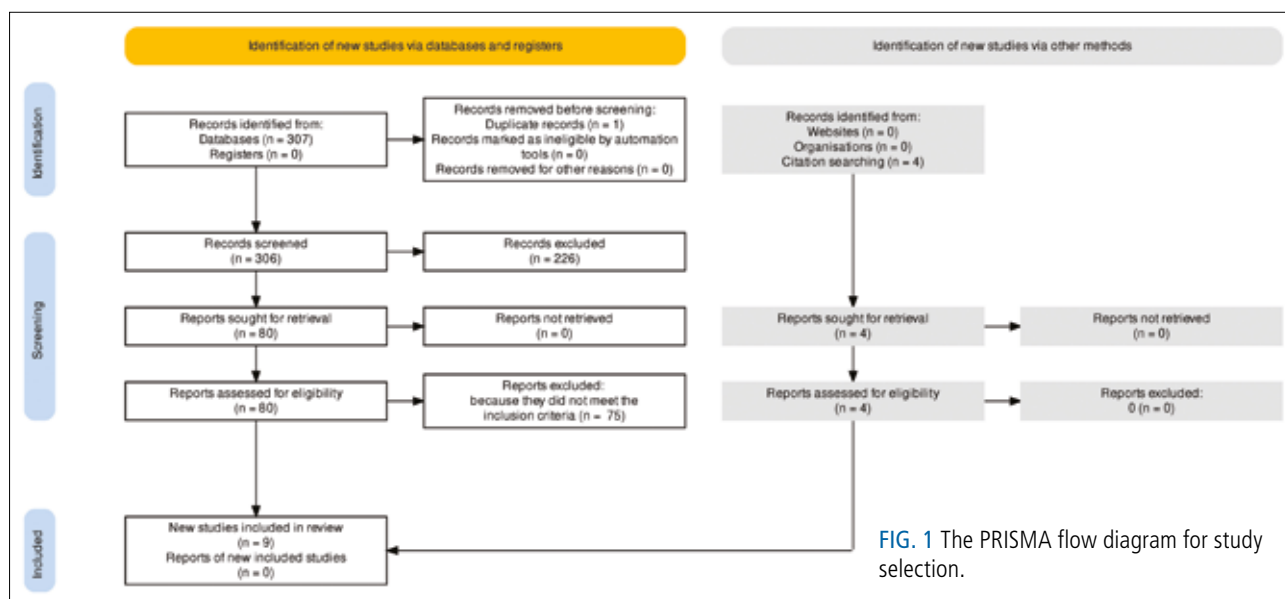


FIG. 1 The PRISMA flow diagram for study selection.

Studies	Participants	Average age dent. stage	Treatment	Duration (months)	Results
Slaviero et al. [2017]	n = 41	7–10 years, mixed	Palatal grid → G1, fixed → G2, removable	6	Correction of open bite, increased overbite with dentoalveolar changes especially in the front area
Canuto et al. [2016]	n = 68 G1: 20 patients treated with bonded lingual spurs (mean age 9.31 years) G2: 21 patients treated with conventional lingual spurs (mean age 9.22 years) G3 - control: 27 untreated subjects.	9.3 years, mixed	Lingual spurs bonded to the lingual surfaces of the upper and lower incisors	12	The two applications resulted in similar increases in overbite during early treatment of the open bite
Leite et al. [2016]	n = 39: control (n = 13), palatal grid (n = 13) and lingual spur (n = 13)	7.8–8.5 years, mixed	Palatal fixed grid, spurs glued on lingual surfaces of upper incisors	12	Grids and spurs are effective in treating AOB, advantage to grids in improving overbite
Condò et al. [2012]	n = 50 G1 (25) = 10 M, 15 F (age 4-7 years, mean 6.17), between last primary dentition and first mixed dentition G2 (25) = 12 M, 13 F (age 9.19 years), second mixed dentition		Orthodontic-paedodontic eruptive guidance device called Habit Corrector®	12	Device effective in correcting different aspects in the development of occlusion, such as overjet, overbite, open bite and molar relation
Nascimento et al. [2016]	n = 1 (F), AOB, thumb sucking and tongue interposition in rest position and during swallowing	6 years	Palatal spurs, removable maxillary grid	23	Abolition of bad habits. At 3-year follow-up, adequate alignment, normalised overbite and overjet, molar Class I. Treatment stability
Cayley et al. [2000 b]	n = 8 M, AOB with swallowing with tongue interposition between arches	9.08–11.75 years	Myofunctional therapy to re-educate the muscles of the tongue	-	Small differences in cephalometric measurements before and after therapy, some evidence of reduction in AOB. Partial success in improving tongue function during swallowing and reducing AOB
Maciel et al. [2005]	n = 130 (62 M, 68 F)	9.6 (8–12 years)	Orthodontic treatment, oro-miofunctional therapy	-	-
Van Dyck et al. [2016]	n = 22 (11 M, 11 F), AOB, and a visceral swallowing pattern	7.1–10.6 years	Myofunctional therapy (joint exercises to strengthen the front and middle part of the tongue muscles)	6	No significant improvement, OMT can positively affect language behavior, however
Albertini et al. [2015]	n = 1 (F), AOB, tongue thrust habit	14 years	Cycle of speech therapy pre orthodontic treatment continued even during subsequent orthodontic treatment + straightwire1 lingual technique with Ormco STb brackets * Light Lingual System, removable palatal acrylic plate with cutout at the retroincisive papilla to promote lingual retraining	16	Open bite corrected, crowding resolved, smile line harmonious

TABLE 1 Characteristics of included studies.

therapy, it is necessary for the patient to be re-educated in muscular terms so as to eliminate not only the skeletal problem, but also the patient's bad habit [Saccomanno et al., 2014]. In this way, the patient who has been taught the correct swallowing mechanism does not present the risk of recurrence. In order to clinically resolve the bite and ensure treatment stability, it is important for the patient to undergo a combination of orthodontic therapy and orofacial myofunctional therapy (OMT). This means that the open bite must be intercepted and treated both from the point of view of coordination of the various phases of swallowing and from a structural point of view. In fact, the act of swallowing is a very complex procedure that involves many muscular and skeletal structures, which is why it is necessary to coordinate them in order to ensure proper swallowing.

This type of combined approach is often overlooked. Currently, a multidisciplinary approach is advisable in which each figure cooperates for the complete resolution of the problem, ensuring long-term stability [Saccomanno et al., 2012b]. It also is essential to highlight the fact that, in order to obtain optimal results, good patient compliance with both

types of therapy is necessary [Saccomanno et al., 2012a].

The analysis of the results also showed the importance of the association of OMT with speech therapy, because in most studies speech disorders were highlighted. The logopedic treatment is able to suggest a series of myofunctional exercises, which the patient must perform regularly, aimed at correcting the incorrect attitudes of the tongue and atypical swallowing, not only speech defects. In fact, if performed by a qualified speech therapist, it can be considered an important supplement to the orthodontic treatment of patients with bad habits, including patients with tongue interposition between the dental arches [Di Vecchio et al., 2019]. This is what is claimed by Albertini et al. [2015], who reports the case of a patient who underwent treatment with lingual appliances in combination with speech therapy. Regarding speech therapy, the literature is scarce; in fact, most of the studies found are case reports and case series but there are no studies with a small sample of participants. It is still to be clarified whether OMT should be started before, concomitantly with, or after orthodontic treatment; orthodontists and speech therapists seem to

have different opinions on this matter [Van Dyck et al., 2016].

The literature does not provide a universal protocol to be followed in these cases. Therefore, further studies would be useful to establish guidelines.

Conclusions

The most effective treatment in cases of anterior open bite with tongue interposition between the arches seems to be the association of traditional orthodontic therapy with myofunctional therapy. The latter, in synergy with speech therapy, aims to establish a new neuromuscular pattern in order to correct the position of the muscles at rest and during swallowing. Further research is needed to establish a universal logopaedic protocol to be followed in these cases.

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