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Especialización en Ortodoncia

Stability of nonsurgical treatments in anterior open bite: narrative review

Trabajo de titulación previo a la obtención del título de Especialista en Ortodoncia

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Resumen

La estabilidad de los tratamientos en ortodoncia depende de varios factores como: el patrón esqueletal, tipo movimiento realizado, protocolo de retención y control de hábitos. Esto sugiere que la estabilidad de la corrección de la mordida abierta anterior en pacientes adultos no está exenta de este fenómeno, presentando una alta tasa de recidiva principalmente en el primer año postratamiento.

El propósito de esta revisión fue comparar la estabilidad entre las diferentes alternativas de tratamiento ortodóncico no quirúrgico para corregir esta maloclusión en pacientes adultos. Se realizó una búsqueda sobre el tema en diferentes bases digitales de datos como: LILACS, MEDLINE, Google Académico, Scopus, ScienceDirect, JCU Library's One Search y PubMed. A los artículos obtenidos se les aplicó criterios de selección dándonos cuarenta artículos con diferentes enfoques terapéuticos no quirúrgicos para analizar en nuestro estudio. Esto nos permite indicar que se mantiene la sobremordida positiva a largo plazo tras corregir la mordida abierta anterior con el anclaje esquelético debido a la intrusión efectiva de los molares acompañada con cambios significativos en el perfil de los tejidos blandos y el patrón esquelético.

Palabras clave: mordida abierta anterior, estabilidad, recidiva, seguimiento, posretención

Abstract

The stability of orthodontic treatments depends on several factors, for example, skeletal pattern, type of movement performed, retention protocol, and habit control. It suggests that the stability of anterior open bite correction in adult patients is not exempt from this phenomenon, presenting a high relapse rate mainly in the first post-treatment year.

This review aimed to compare the stability between different non-surgical orthodontic treatment alternatives to correct this malocclusion in adult patients. A search was carried out in digital databases on this subject, such as: LILACS, MEDLINE, Google Scholar, Scopus, ScienceDirect, JCU Library's One Search and PubMed. Selection criteria were applied to the articles obtained, giving us forty articles with different non-surgical therapeutic approaches to analyze in our study. It allows us to indicate that positive overbite is maintained in the long term after correction of anterior open bite with skeletal anchorage due to effective intrusion of the molars and significant changes in the soft tissue profile and skeletal pattern.

Key words: anterior open bite, stability, relapse, follow-up, post-retention

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Introduction

Anterior open bite (AOB) is the absence of vertical overbite of the upper incisors over the lower incisors [1,2] while the posterior teeth occlude. [3, 4] Its prevalence ranges from 1.5% - 11% and varies between ethnic groups, age, and dentition. [1,5]

It can hinder correct chewing, pronunciation of phonemes, and even the aesthetics and self-esteem of the patient. [2,5-8]

Therapeutic options to correct anterior open bite include: surgical (orthognathic surgery), non-surgical (myofunctional therapy, orthodontic treatment), [1,9,10] or a combination of both. [11-13]

The literature reports good results with both surgical and non-surgical treatments to correct this malocclusion. [1] However, it had a great tendency to relapse due to its multifactorial etiology in the first year of retention; [1, 14, 15] therefore, maintaining a proper overbite in the long term is a challenge [7] in adult patients with skeletal anterior open bite. [1]

Clinicians to close anterior open bite with non-surgical orthodontic alternatives combine molar intrusion and incisor extrusion to achieve counterclockwise rotation of the occlusal and mandibular planes. [1,11] However, there are few studies with long-term follow-up on this subject. With this background, our study aimed to compare the stability of different non-surgical alternatives to treat this malocclusion, the results of which will serve as a guide for the clinician when choosing a therapeutic option.

Materials and methods

A literature search was carried out in the digital databases: LILACS, MEDLINE, Google Scholar, Scopus, ScienceDirect, JCU Library's One Search and PubMed limited between 2017-2022 using MeSH terms: ("anterior open bite") AND ("stability" OR "relapse "OR "follow up" OR "post - retention").

The initial search resulted in 2,406 articles by two researchers working independently, who selected full manuscripts in English, Spanish, and Portuguese related to non-surgical orthodontic treatment with or without extractions to correct anterior open bite in the permanent dentition with post-retention follow-up data of at least 12 months. We excluded unavailable articles, studies that included subjects with craniofacial syndromes, and studies with a post-retention follow-up of less than one year or duplicates.

After reviewing the content of articles, those that did not fit the search requirements were eliminated, leaving forty eligible manuscripts (Table I) that include: five case series, twenty - nine case reports, four systematic reviews, and two systematic reviews and meta-analysis.

Description of the state of knowledge

Anterior open bite

Anterior open bite (AOB) is the absence of vertical overbite of the incisors, [1,2,16] resulting from a poor relationship between posterior and anterior facial height. [17]

Its multifactorial etiology [1] involves skeletal anomalies, dentoalveolar anomalies, respiratory disorders, neurological conditions, and abnormal habits. [2,8,9, 11, 14, 18, 19-23]

This malocclusion can be dental or skeletal. [1]

The dental anterior open bite is the product of a habit, it manifests from canine to canine, protruded and protruded incisors, and proinclined incisors [16] with normal skeletal relationships. [6,8,17]

In contrast, in skeletal anterior open bite, there are occlusal contacts only in molars due to the excess of maxillary posterior dentoalveolar vertical growth. [6] In cephalometry, an increased angle of the occlusal, gonial, and mandibular planes is present, as well as increased lower anterior facial height, mandibular retrusion, a short mandibular ramus, divergent maxillary and mandibular occlusal plane, steep anterior cranial base, difficulty of the labial seal, and a short mandibular ramus, divergent maxillary and mandibular occlusal plane, pronounced anterior cranial base, and the difficulty of the labial seal. [1,8,9,17,22]

A proper diagnosis will guide us in choosing the precise therapeutic approach to correct anterior open bite [7,11,13] depending on its clinical variation. [21]

Treatment protocols for an anterior open bite to divide into:

- Non-surgical therapies: myofunctional therapy, preventive treatment, orthodontic treatment with or without extractions aimed at molar intrusion or incisor extrusion. [2, 7,21,23-25]

- Surgical: Orthodontic treatment with orthognathic surgery (Le Fort I or bimaxillary osteotomy). [26,27]

Stability of anterior open bite correction

When choosing an orthodontic treatment alternative for anterior open bite, the patient's medical history, the severity of malocclusion, and dental and gingival exposure should be considered. [21]

Non-surgical alternatives are based on extrusion and retro inclination of the anterior teeth or intrusion of the posterior teeth [11,17,20] to correct occlusal plane inclination through the use of temporary anchorage devices (TADs), [2,16,28,29] bite blocks, [1, 30] chin rest, [31-33] high traction, [34] multiple edge archwire technique (MEAW), [20, 35,36] application of reverse curve archwires with short intermaxillary elastics for bite closure, [10,20, 37] or aligners. [38,39]

Adult patients are more susceptible to recurrence of anterior open bite after completion of active orthodontic treatment [21]; it occurs mainly in the first year after appliance removal. [1,8,23,28,40]

Recurrence manifests with reduced as an overbite, eruption of molars, upper jaw and mandibular rotation opening, and increased lower facial height. [41]

The stability of anterior open bite correction depends on the severity of the initial malocclusion, the patient's age, the treatment modality (with or without extractions or orthognathic surgery), and the abnormal tongue position. [6,11,21,28,42] In addition, for the maintenance of the positive overbite in the post-retention period, the retention protocol [4, 25] covering the type of retention and the retention regimen employed is crucial whether it is full-time (use at all times except when brushing teeth and eating), part-time (at night) or other (indicated by the clinician according to the case) to avoid the occurrence of relapse. [4] It coincides with Almeida et al. [18] who considered these aspects to achieve stable outcomes without significant changes at seven years of follow-up. [18]

In growing patients, correction of anterior open bite is a challenge due to residual growth, [8,17] especially in those with a divergent growth pattern [43]; for this reason, orthodontic treatments seek to provoke the anterior growing of the dentoalveolar complex [22,32,46,47] and control the posterior vertical growth to avoid reopening of the bite. [4,8,17,43] However, this does not guarantee the stability of the results as they may require a second phase of orthodontics therapy, as indicated by Lv et al. [8]

On the other hand, in patients without growth, it is difficult to influence the skeletal development of the face; for this reason, the ideal is an orthodontic-surgical treatment [6,10,21,23] to improve occlusion, function, and facial esthetics. [8, 19,22,43] Although, it is possible to perform

a camouflage to reduce the skeletal problem [17,20,44] through the intrusion of molars [19,21] or extrusion of incisors [23] to correct the inclination of the occlusal plane through the use of temporary anchorage devices (TADs: mini-implants or mini-plates), [1,14,28] which allow obtaining dental movement without adverse effects, without depending on the patient and with more predictable results. [2]

Among the temporary anchorage devices, we have the mini-plates, whose placement requires a surgical procedure for the fix with bone screws at the zygomatic level; [28] it allows accelerating molar intrusion and wears greater orthodontic forces than mini - implants. [28] Marzouk y Kassem [48] state that the force required to intrude molars is 150 gr, and at the premolar level is 75 gr to achieve an average molar intrusion of 3.04 mm with an overbite closure of 6.93 mm. [48] In addition, they point out that L-shaped mini-plates are the most effective, consecutive by those combined with acrylic plates or transpalatal bar appliances. [28] They also indicate that the use with or without acrylic plates, transpalatal bar appliances, lingual arch, or bite blocks in posterior teeth; [28] these attachments aim to accelerate molar intrusion to close the open bite. [21,28,49,50,51,52] Additionally, Marzouk y Kassem [53] emphasize that with mini-plates, in addition to optimal bite closure, the patient's soft profile improves. [53]

On the other hand, mini - implants are the most commonly used anchorage devices in the orthodontic clinic, [2] and their placement is less invasive [19] than orthognathic surgery. [11, 22, 28] By applying forces of 50 - 100gr (biologically tolerable) through these devices, [2,6,10,28,34,40,54,55] an effective and stable molar intrusion is obtained to treat the dental or skeletal anterior open bite [8,11,22] whose achieved dento - skeletal changes (mandibular rotation and increased overbite) allow the bite closure obtained to compensate for the minor dental relapse observed post - retention. [2,23]

Other treatment alternatives include posterior build-ups, [1] the MEAW technique (multiloop edgewise archwire technique), [35] or the application of nickel-titanium curved archwires with short intermaxillary elastics [43] with or without extractions, but it requires a longer treatment time. [8, 10,17,18,20, 28]

Posterior build-ups produce a molar intrusion less than that obtained with TADs, [1] similar to that generated with 1.5 mm thick aligners, which gives a molar intrusion of 1 mm. [14]

In the MEAW technique, the occlusal plane inclination is modified by posterior intrusion and anterior extrusion. [11,20,35,56] Challenges include patient cooperation in the utilization of intermaxillary elastics, correct construction of loops, and adequate clinician training. [11,20,56]

Instead of this technique, an upper accentuated curve and lower reverse curve combined with elastics [20] are used to reduce chair time and soft tissue irritation. [57]

Vertical intermaxillary elastics require constant use so that the force used to correct the overjet is greater than the intrusion force used in the arches. [56] When using elastics in Class II or Class III, there is a risk of extrusion of molars, which limits mandibular advancement. [57]

In addition, when correcting anterior open bite with extractions, the clinicians should try to close the spaces without loss of anchorage of the molars and control the anterior vertical dimension, ideally with a sectional mechanics to have vertical and torque control. [1,10,17]

According to Gónzalez et al. [28] there is no consensus on whether the non-surgical or surgical option is the most stable for correcting anterior open bite in adult patients. [28]

On the contrary, Cruz et al. [20] mention that there is a 75% stability of the results when treating with conventional orthodontic therapies [20] while with orthognathic surgery, there is a 75 - 100% stability to correct skeletal MAA, [17, 18,48] being Lefort I maxillary surgery the most stable, [6,41] but the dentoalveolar compensation realized (extrusion in the anterior region and intrusion in the posterior zone) should be taken into account to maintain the positive overbite in the long term. [41]

Discussion

The success of orthodontic treatment, in most cases, is linked to anchorage planning; [58,59,60] similarly, in non-surgical treatment of anterior open bite, the aim is to achieve this anchorage through extraoral or intraoral devices to achieve bite closure. [2,61-64]

The literature shows that these non-surgical treatments have good results, [6, 26,37,39,65,66] during extrusion care must be taken with the aesthetics of the smile when correcting the overbite, since this movement is more unstable than molar intrusion, [2,21,67] and this last mentioned movement is more difficult to achieve due to the volume of the roots and difficulty to control the extrusion of the teeth that serve as anchorage while seeking dental intrusion. [2, 21,63]

For this reason, to achieve these movements without adverse effects, temporary anchorage devices, including mini-plates and mini-implants are considered more effective [68,69] than other therapeutic alternatives to get more predictable movements [2] and with minimal cooperation from the patient. [22,28, 70-73]

In the studies that analyzed the stability of molar intrusion with mini-implants to correct an anterior open bite, we found a systematic review and meta-analysis by Gonzalez et al. [28]

where they indicate that, at one-year post-treatment, there is a recurrence of 10-30% with similar results to cases with orthognathic surgery. [28] In addition, they quantified the relapse at the level of the lower first molar as 27.2% and 30.3% for the mandibular second molar, which clinically manifests itself with molar extrusion. [28] On the contrary, the systematic review by Malara et al. [22] reported that at a one-year follow-up of open bite correction with TADs, molars were extruded from 10% to 21.74%, accompanied by a gradual decrease in overbite between -0.8 to -0.99 mm. [22]

When analyzing the evidence on the stability of molar intrusion performed with mini-plates, we found that Uslu et al. [74] reported a case treated with mini-plates and transpalatal bar with ten years follow-up where the overbite obtained remained stable thanks to the use of occlusal stops on the mandibular molars and myofunctional therapy.[74] While, Marzouk and Kassem[48] stated that the recurrence of molar intrusion with these devices, in the first year was 10.2% and 13.37% in four years; [48] on the other hand, the relapse of overbite at one - year was 8.19% and at four years 11.8%.[48] On the other hand, Al-Dhubhani [23] in his systematic review indicate that there is a recidive of overbite from 0.3 to 1.2 mm and of posterior intrusion from 0.3 to 0.5 mm at one year after post-treatment and at 4 years of follow-up they observed a relapse of molar intrusion of 11.2%.[23]

It is worth mentioning that according to Marzouk and Kassem [53] analyzed the changes in the soft profile with this therapeutic finding a non-significant four years recurrence rate of 20.2-31.1%.[53]

Regarding the stability of treatments with extractions vs. without extractions, Gonzalez et al. [28] report that there are studies in which the recurrence of orthodontic treatments with extractions is 25.8%, while in cases treated without extractions, it is 38.1%.[28] On the other hand, the systematic review by Foosiri and Changsiripun [24] indicates that in patients with premolar extractions, the mean stability rate was 93.53% with a recurrence of 0. 42 mm (not significant) compared to those without extractions where the mean stability rate was 73.68% with a significant relapse of 1.05 mm. [24]

There are also reports of cases where the results were stable. For example, Shirasaki et al. [10] report a patient with anterior open bite Class II, treated with premolar extractions with sectional arches and mini - implants with stable results up to four and a half years post-treatment. [10] Likewise, Santo [17] reported a case of premolar extractions with excellent results and great stability two years post-treatment. [17]

Among the possible reasons for relapse in treatments with or without extractions in an anterior open bite are changed in molar intrusion, incisor extrusion, and abnormal tongue position. [2,22] In contrast, Gu et al. [4] concluded that stability in the case of extractions is associated with the smaller initial inclination of the lower incisors. [4]

There is little evidence of stability with other therapeutic alternatives in adult patients, but results give us a superficial knowledge of these options. For example, Vela et al. [1] indicate that they obtained molar intrusion of 1 mm with bite blocks in Class I patients with anterior open bite, at 32 months follow-up presented a recurrence of 0.1 mm in the maxillary molar intrusion. [1]

In contrast, treatment with aligners or lingual appliances seeks controlled upper and lower molar intrusion simultaneously incisor extrusion occurs. [7, 14,75] A case report of anterior open bite class I, with aligners and micro-osteoperforations, achieved molar intrusion without root resorption; at one-year post-retention, a relapse in lateral incisor intrusion of 0.2 mm was observed. [14]

Another study indicates that the stability of the anterior open bite corrected with the MEAW technique in patients without growth is 90% and with growth in 94.4% due to the dentoalveolar changes and the rotational modification of the mandible. [20] In addition, they note that for every millimeter of reduction in second molar height (intrusion), there is a 2.13 mm increase in overbite leading to bite closure. [20]

Taking into account that 80% of relapse occur in the first year of post-treatment, it is necessary to use an indefinite retention protocol. [23,28,48]

In cases of anterior open bite with alteration of the tongue at rest, the patient should have used a customized retainer plus myofunctional therapy. [9, 19]

Among the different types of retainers, we have: circumferential with or without habit control, fixed, removable (acetate or circumferential), or a combination of lower fixed and upper removable retainers. [13,17,19,20]

The information analyzed allows us to affirm that this subject still requires more studies that incorporate a large group of patients and with medium and long-term follow-up to know how many cases presented stability and if there is an influence of the retainers to maintain the results. In addition, there remains doubt about the patients that relapsed, if they were retreated with a different therapeutic alternative (surgical or non-surgical).

Conclusions

In the present review, we reached the following conclusions:

1. All non-surgical alternatives seek bite closure by molar intrusion, incisor extrusion, or both. It should be noted that these movements with skeletal anchorage are produced without adverse effects and in a controlled manner.
2. In adult patients with anterior open bite (dental or skeletal), treated with skeletal anchorage devices, the molar intrusion obtained was similar to that produced by surgical orthodontic treatment.
3. Anterior open bite correction is more stable in patients treated with molar intrusion using skeletal anchorage due to effective molar intrusion accompanied by significant changes in soft tissue profile and skeletal pattern.
4. The relapse of molar intrusion after the utilization of skeletal anchorage in the first year was 10 - 30 %.
5. Recurrence occurs in 80% during the first-year post-treatment, but it is progressive in the future in any therapeutic alternative used; therefore, more effective retention protocols should be maintained in the long-term post-treatment taking into account the type of retainer, habit control, and myofunctional therapy according to the case.

Due to the limited evidence of the articles and their heterogeneity in this review, the conclusions are an appreciation of the stability of the therapeutic options analyzed. However, randomized controlled clinical studies with large samples and long-term follow-ups are necessary for a more accurate notion of the stability of the different non-surgical alternatives in adult patients to compare and reach a consensus on this issue.

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Appendices

Table N° 1. Selected articles

No	**TITLE**	**AUTHOR, YEAR**	**JOURNAL**	**TYPE OF STUDY**	**TREATMENT ALTERNATIVE**	**FOLLOW-UP POST-TREATMENT TIME (MONTHS/YEARS)**
1	Stability of anterior open bite correction treated with posterior teeth intrusion using temporary anchorage devices. A systematic review.	Al – Dhubhani M., 2018	Saudi Journal of Oral Sciences	Systematic review	Temporary anchorage devices (TAD's).	Between 1 and 4 years
2	Complex clinical case with Class III and open bite: stability after seven years.	Almeida et al.,2020	Dental Press Journal of Orthodontics	Case report	Premolars extraction, a Hyrax expander, intrusion mechanics and vertical elastics.	2 and 7 years
3	Long-term stability of a Class III malocclusion with severe anterior open bite and bilateral posterior crossbite in a hyperdivergent patient.	Antelo et al.,2020	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	1 phase: hyrax expander 2 phase: intermaxillary elastics.	4,5 years
4	Nonsurgical treatment and stability of an adult with a severe anterior open-bite malocclusion.	Cambiano et al.,2018	Journal of Orthodontic Science	Case report	Third molar extraction, posterior intrusion, anterior extrusion and intermaxillary elastics.	3 years
5	Eight-year stability of a severe skeletal anterior open bite with a hyperdivergent growth pattern treated with an edgewise appliance and chin cup therapy.	Cerci et al.,2021	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	High-pull chincup and an edgewise fixed appliance.	8 and 22 years
6	Clinical application of maxillary tissue bone-borne expander and biocreative reverse curve system in the orthodontic retreatment of severe anterior open bite with transverse discrepancy: A case report.	Choi et al.,2022	The Korean Journal of Orthodontics	Case report	Maxillary tissue bone -borne expander and biocreative reverse curve system.	4-year retention period
7	Extreme skeletal open bite correction with vertical elastics.	Cruz-Escalante et al.,2017	The Angle Orthodontist	Case report	First premolar extraction, anterior extrusion, Multiloop	2 years

					Edgewise Archwire (MEAW) appliance.	
8	Treatment of adult patient with hyperdivergent retrognathic phenotype and anterior open bite: report of a case with non-surgical orthodontic approach.	Santo MD Jr.,2020	Dental Press Journal of Orthodontics	Case report	Extractions of upper / lower first premolars.	2 years
9	Evaluation of Long-term Stability of Vertical Control in Hyperdivergent Patients Treated with Temporary Anchorage Devices.	Deng et al.,2018	Current Medical Science	Case series	Premolar extraction, mini-implants.	3 and 6 years
10	Stability of anterior open bite in permanent dentition treated using extraction or non-extraction methods: A systematic review and meta-analysis of each method.	Foosiri P, Changsiripun C.,2019	Orthodontic Waves	Systematic review and meta-analysis	Extractions and non-extractions.	1 year
11	Camouflage of a high-angle skeletal Class II open-bite malocclusion in an adult after mini-implant failure during treatment: an update.	Franzotti et al.,2021	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	High-pull headgear therapy.	7 years
12	Nonsurgical correction of a severe anterior open bite with mandibular molar intrusion using mini-implants and the multiloop edgewise archwire technique.	Freitas et al.,2018	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	Mini-implants and multiloop edgewise archwire technique.	50 months
13	Treatment of skeletal Class II open bite with the triple intrusion system.	Gökalp et al.,2018	Journal of Clinical Orthodontics	Case report	Multipurpose implants* (MPIs), posterior maxillary cap splints, and palatal mini-implants.	4 years
14	Stability of anterior open bite treatment with molar intrusion using	González et al.,2020	Progress in Orthodontics	Systematic review and meta-analysis	Temporary anchorage devices (TAD's).	2.5 years

	skeletal anchorage: a systematic review and metaanalysis.					
15	Simplifying the approach of open bite treatment with aligners and selective micro-osteoperforations: An adult case report.	Greco et al.,2020	International Orthodontics	Case report	Aligners and selective micro-osteoperforations.	3 years
16	Nonsurgical treatment of a hyperdivergent skeletal Class III patient with mini-screw–assisted mandibular dentition distalization and flattening of the occlusal plane.	He et al.,2022	The Angle Orthodontist	Case report	Mini- implants.	26 months
17	Orthodontic treatment of open bite involved in diffuse hypercementosis.	Hichijo et al.,2020	The Journal of the American dental Association (JADA)	Case report	Mini- implants.	1 year
18	Nonsurgical correction of a Class III skeletal anterior open-bite malocclusion using multiple microscrew implants and digital profile prediction.	Kim DH, Sung SJ.,2018	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	Extraction of the third molars, maxillary molar intrusion, and total distalization of the mandibular dentition with multiple mini-implants.	3 years
19	Lingual treatment of an adult patient with an iatrogenic class II anterior open bite: Report of a case with a non-surgical orthodontic approach.	Le Keux F, Frapier L.,2021	International Orthodontics	Case report	Lingual appliance.	3 years
20	Severe open bite with mandibular asymmetry treated using micro-implant anchorage.	Liao et al.,2017	Australasian Orthodontic Journal	Case report	Occlusal splint, mini-implants.	2 years
21	Intrusion of upper molars with mini-implants for open bite correction is effective? A systematic review.	Lira et al.,2018	Brazilian Dental Science	Systematic review	Mini-implants.	3 years

22	Long-term Follow-up and Treatment of a Patient with Severe Skeletal Open Bite Using Temporary Anchorage Devices.	Lv et al.,2018	Nigerian Journal of Clinical Practice	Case report	Premolar extraction, mini-implants.	2.5 years
23	Outcomes and Stability of Anterior Open Bite Treatment with Skeletal Anchorage in Non-Growing Patients and Adults Compared to the Results of Orthognathic Surgery Procedures: A Systematic Review.	Malara et al.,2021	Journal of Clinical Medicine	Systematic review	Mini-implants.	Between 1 and 3 years
24	Aesthetic and functional outcomes using a multiloop edgewise archwire for camouflage orthodontic treatment of a severe Class III open bite malocclusion.	Marañón-Vásquez et al.,2017	Journal of Orthodontics	Case report	Multiloop Edgewise Archwire technique.	2.5 years
25	Long-term stability of soft tissue changes in anterior open bite adults treated with zygomatic miniplate-anchored maxillary posterior intrusion.	Marzouk ES, Kassem HE, 2018	The Angle Orthodontist	Case series	Mini-plates.	4 years
26	Treatment of a twice-relapsed anterior open bite using temporary anchorage devices, myofunctional therapy, and fixed passive self-ligating appliances.	Miller JR., 2020	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	Myofunctional therapy, fixed appliances, and temporary anchorage.	1 year
27	Orthodontic treatment of acquired open bite accompanied with extreme mesially inclined mandibular molars.	Miyamoto et al.,2018	International Orthodontics	Case report	Extraction of maxillary first premolars.	2 years
28	Orthodontic treatment for a patient with anterior open bite and severe condylar resorption.	Moon et al.,2020	American Journal of Orthodontics and	Case report	First premolar extractions and temporary skeletal anchorage.	3 years

			Dentofacial Orthopedics			
29	Without mini-plates, mini-implants and surgery: treatment of severe anterior open bite in an adult patient - a case report.	Nascimiento LE.,2020	Revista Científica do CRO-RJ	Case report	Stepdown bends in the upper arches, anterior teeth extrusion with elastics.	1 year
30	Nonsurgical and nonprosthetic camouflage treatment of skeletal Class II open bite with bilaterally missing lower first molars.	Nguyen et al.,2019	The Angle Orthodontist	Case report	Upper premolar and second molar extraction.	16 months
31	Nonsurgical treatment of severe Class II malocclusion with anterior open bite using mini-implants and maxillary lateral incisor and mandibular first molar extractions.	Pithon MM.,2017	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	Maxillary expansion, extraction of atypical maxillary lateral incisors and mandibular first molars, intrusion of maxillary teeth with the aid of mini-implants.	2 years
32	Severe open bite correction and 5-mm mandibular arch distalization without skeletal anchorage: 4-year follow-up of a case of nonsurgical orthodontic treatment of adult skeletal class III malocclusion.	Ren et al.,2020	Chinese Journal of Dental Research	Case report	Extraction of four wisdom teeth, uprighting and distalization of the mandibular arch with molar intrusion using curved Niti wires with intermaxillary elastics.	4 years
33	Long-term stability in patients with counterclockwise growth pattern treated with molar intrusion using miniscrews.	Rosenberg et al.,2019	Sociedad argentina de ortodoncia	Case series	Mini-implants.	2 and 10 years
34	Correction of anterior open bite of varying severity using clear aligner therapy—A case series.	Sabouni et al.,2022	Clinical Case Reports	Case series	Clear aligner therapy.	1 year
35	Comprehensive approach to simultaneous molar intrusion and	Shirasaki et al.,2020	Dental Press Journal of Orthodontics	Case report	Maxillary first premolars extraction,	4.5 years

	canine retraction in the treatment of Class II anterior open bite using miniscrew anchorage.				sectional archwires, elastic chains and mini-implants.	
36	Multiloop edgewise archwire technique and denture frame analysis: a systematic review.	Tabancis et al.,2020	Head & Face Medicine	Systematic review	Multiloop Edgewise Archwire (MEAW).	2 years
37	Orthodontic treatment of a patient with maxillary lateral incisors with dens invaginatus: 6-year follow-up.	Thiesen et al.,2018	American Journal of Orthodontics and Dentofacial Orthopedics	Case report	Extraction of the maxillary lateral incisors and two mandibular premolars.	6 years
38	Stability Evaluation of Orthodontic Treatment of a Severe Open Bite Problem for an Adult by Maxillary Molar Intrusion Using Zygomatic Mini-Plates and Premolar Extractions: A 5 Year Follow Up Results.	Türkmen N, Marsan G.,2021	Sağlık Bilimlerinde İleri Araştırmalar Dergisi	Case report	First premolar extraction and mini-plates.	5 years
39	Treatment of anterior open-bite using zygomatic anchorage: a 10-year follow-up case report.	Uslu et al.,2020	Australasian Orthodontic Journal	Case report	Mini-plates.	10 years
40	Nonsurgical treatment of skeletal anterior open bite in adult patients: Posterior build-ups.	Vela et al.,2017	The Angle Orthodontist	Case series	Posterior build-ups.	32 months