GRADUATION PROJECT

Degree in Dentistry

Orthopedic treatment for anterior open bite in growing patients

Madrid, academic year 2022/2023

Identification number: 167

SUMMARY

ABSTRACT

Introduction: anterior open bite in young kids has always been a challenge for orthodontists in their treatment plan, specially the skeletal AOB since it is the one that deteriorates face structures and leads to functional disability. In order to fix this problem the study reviews different appliances that can be used in these patients and their effects on the AOB closure trying to find the most effective one and have a look and new appliances. **Objectives:** to evaluate effects of the appliances used in the treatment of the AOB, find most new appliances and the most effective ones. **Materials and Methods**: 46 articles from medline, pubmed and 6 books have been used, the PRISMA scheme is used to sort articles in two steps. The including and excluding criteria specified. **Results:** the review of McNamara Rapid Maxillary Expander (fixed), Hawley (removable), Quadhelix (fixed), Klammt (removable) and Froggy Mouth (removable) showed that RME remain to be effective in expansion of the palate prior to closure of AOB, Hawley removable appliance didn't show a lot of evidence regarding AOB closure, Quadhelix is mainly used for correction of the alveolodental AOB, the Klammt appliance is effective with a lot of advantageous side effects for the patient despite being removable, and Froggy Mouth is an effective appliance on young kids with trouble habits that lead to AOB skeletal pattern, the Froggy helped kids to change the muscular pattern and gradually eliminated the habit and has lead to AOB closure. **Conclusion:** there is not the most effective appliance but Klammt has shown to be very effective for the correction of the AOB closure and mandible pronation that will lead to equilibrated development and Froggy Mouth helped kids to get rid of habits at the earliest stages.

Introducción: la mordida abierta anterior (MAA) en niños pequeños siempre ha sido un reto para los ortodoncistas en su plan de tratamiento, especialmente la MAA esquelética ya que es la que deteriora las estructuras faciales y provoca la incapacidad funcional. Para solucionar este problema el estudio revisa diferentes aparatos que se pueden utilizar en estos pacientes y sus efectos sobre el cierre de la MAA tratando de encontrar el más efectivo y además revisar los aparatos más nuevos. **Objetivos:** evaluar los efectos de los aparatos usados en tratamiento de MAA, encontrar más nuevos aparatos y unos más efectivos. **Materiales y Métodos:** Se han utilizado 46 artículos de medline, pubmed y 6 libros, se utiliza el esquema PRISMA para clasificar los artículos en dos pasos. Los criterios de inclusión y exclusión están especificados**.** **Resultados:** la revisión de McNamara Rapid Maxillary Expander RME (fijo), Hawley (removible), Quadhelix (fijo), Klammt (removible) y Froggy Mouth (removible) mostró que RME sigue siendo efectivo en la expansión del paladar antes del cierre de MAA, el aparato removible de Hawley no mostró mucha evidencia con respecto al cierre de la MAA, Quadhelix se usa principalmente para la corrección de la AOB alveolodental, el aparato de Klammt es efectivo con muchos efectos secundarios ventajosos para el paciente a pesar de ser removible, y Froggy Mouth es un aparato efectivo en niños pequeños con hábitos problemáticos que peora al patrón esquelético, Froggy ayudó a los niños a cambiar el patrón muscular y gradualmente eliminó el hábito y condujo al cierre de AOB. **Conclusión**: no existe el aparato más efectivo pero Klammt ha demostrado de ser muy efectivo para la corrección del cierre de la AOB y la pronación mandibular que conducirá a un desarrollo equilibrado y Froggy Mouth ayudó a los niños a deshacerse de los hábitos en las etapas más tempranas.

Keywords: anterior open bite, treatment open bite, appliances, orthopedics, review

1. INTRODUCTION:

1.1. Definition:

The pathology called an anterior open bite (AOB) or apertognathia is defined as a lack of contact between superior and inferior anterior incisors, that remain without occlusion during maximum intercuspidation (1). It leads to aesthetic and functional disability (including eating and talking problems) (2) as shown in Figure 1.

Figure 1. Anterior Open Bite in mixed dentition, intraoral photos of anterior view, lateral view, superior and inferior view. AOB is present in lateral and central incisors, whereas the canines and molars are in contact (3).

The occlusion is only presented in the premolar and/or molar regions, whereas some anterior teeth do not contact (4) or all anterior part of the dental arch remains open (5). We can surely say that the treatment of Anterior Open Bite is still a challenge for professionals due to its instability, patients' compliance problems and relapses in correction (6).

1.2. Justification and background:

This review is done to have a new look at the current problem and analyse the devices that are used in the treatment of it. Since the outcome of the treatment always depends on the compliance of the patient, age, type of the anterior open bite and the clinical case severity. The answer would be for seeking for new appliances, its effectiveness and analysing the problem. In addition, the background of this problem is reviewed in the prevalence, classification and etiology part of this work presented below.

1.3. Prevalence:

The frequency of AOB is still as high as almost 16.52% overall in children and adolescents in European Union countries (7), which are numbers of concern. The prevalence does slightly varies depending on the continent and studies conducted, being 19.38% in South America according to the most recent metanalysis conducted (8) and 12.1% to the one made in year 2014 (9).

Talking in overall regarding the problem, the prevalence of anterior open bite is around 22% of females and 17% of males. It also varies around 18-21% in the primary dentition, and around 14% in the mixed dentition (5-9). Analysing this, we can say the prevalence is not high in total, but still should be taken into consideration for all professionals.

1.4. Etiology:

Anterior Open Bite is a combination of several problems that can be presented individually or simultaneously. Those problems can be intrinsic (hereditary) or extrinsic (environmental) (11) and skeletal or dental (4). The skeletal and dental AOB will be reviewed in the classification part of this work.

Knowing the right etiology of the problem or habit is always a key factor in the right treatment approach for each patient in the clinical practice, since harmful oral habits can lead to the development of hyper divergence in the profile of the young patient (2).

Intrinsic problems of the AOB include dental development such as teeth location, anomalies of them, interruption in the shape and form (4), dental pathology itself as amelogenesis imperfecta or pathology of dental buds. Amelogenesis imperfecta is a genetic pathology appearing at the young age, characterised by lack of enamel structure and can be associated with syndromes (12). The teeth present hypersensitivity, which is highly disturbing sensation, so therefore patients tend to avoid closing teeth and get them to contact, which with time leads to skeletal AOB (13).

It also includes osseous pathology related to the bones only (1), nasal obstruction due to formed polyps (11) that is related to inadequate tongue position and lead to oral respiration in short future. Anomalous deglutition that leads to AOB is showed in Figure 2. Additionally to that, muscular hypotonicity, and vertical morphogenetic growing such

as dolicocephalic facial pattern are also intrinsic risk factors, even so in some articles it is (15) mentioned that facial growth pattern is not associated with anterior open bite directly.

Figure 2. Skeletal AOB with protruded maxillary incisors and maxillary compression caused by anomalous deglutition, intraoral superior and lateral right view (16).

Extrinsic factors that lead to AOB include deleterious oral habits such as sucking habits, for example pacifier/finger sucking that deteriorate the equilibrium in the pressure of the mouth (17) showed in Figure 3, that is directly proportional to development of apertognathia (15,18).

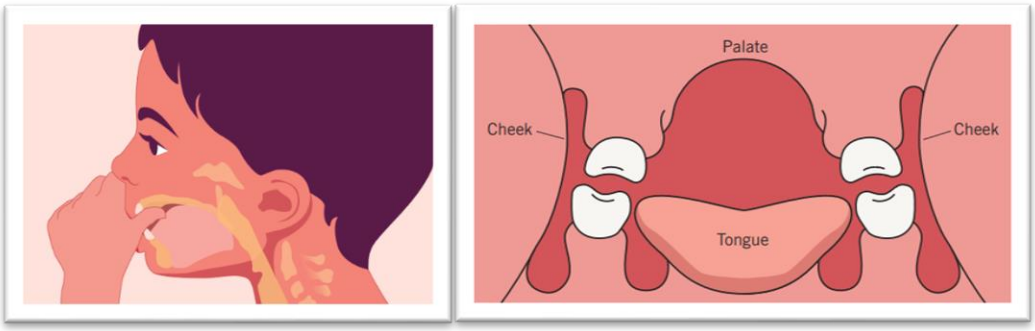


Figure 3. We can see here how uneven pressure can lead to changes on dentofacial development. During the finger sucking, the tongue is positioned downwards and the pressure doesn't reach the palate (19).

It is found that the use of pacifier for more than 36 months increases the prevalence of AOB in young kids (10). If the habit stops before the complete eruption of the permanent incisors in patients with normal proportions, mesocephalic pattern and no dental or osseous pathologies, most of the AOB resolve spontaneously without any concomitant consequences (4) after stimuli removal. Nevertheless, some authors believe that it is

impossible to make the deteriorating habit to disappear forever and that patient can start with deteriorating habit again, which will lead to AOB reappearance and relapse (20).

1.5. Classification:

Anterior Open Bite is classified into two categories, one of which is Skeletal one, an example is shown in Figure 4 with intraoral view, orthopantomography and cephalometry following Steiner analysis and alveolodental type, where example is shown in Figure 5 with intraoral view, orthopantomography and cephalometry. Following these images, it is possible to see clear difference at the level of the bones and facial development.

The dentoalveolar open bite is dental anterior open bite that affect only some teeth and does not carry the problem related to the development of the bones (21). It is normally due to lingually displaced maxillary central or lateral incisors, the erupt lingually due to the bud position or the lack of space for the permanent incisors (4),(22). Dental open bite does not present any craniofacial concomitant anomalies or pathologies. The osseous vertical relation is correct, and the problem the professional must deal with is exclusively alveolodental. Dental open bites are considered as a consequence of the inhibitory action over the eruption of the incisors such as finger or pacifiers (1).

Skeletal open bite, which is considered more complex, is an often event in young kids (4), (22). When a finger or pacifier is located anteriorly between teeth, presenting an inhibitory action, mandible is positioned downwards to hold it, therefore tongue goes down too. It is also placed down during mouth breathing when the nasal obstruction (intrinsic) is present, for the patient to get air and breath, since nose block doesn't allow to. This impedes vertical equilibrium of the jaws and pressure of the oral cavity. The disruption of the pressures balance at the level of the cheeks, palate and tongue alters the shape of the maxillary arch, leading to lack of occlusion in anterior area (18,22,23).

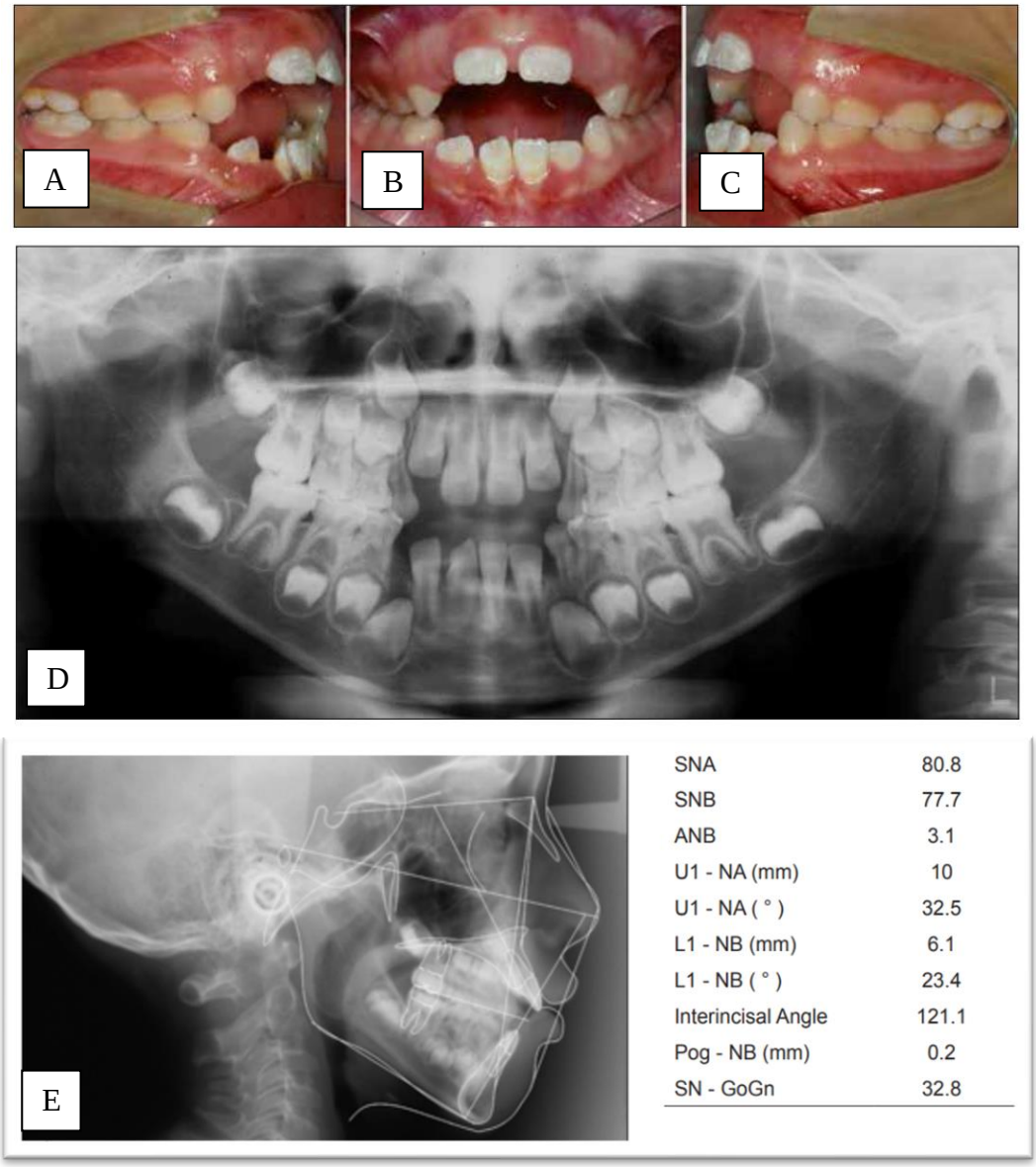


Figure 4. Shows a complete diagnostics of a clinical case of the growing patient. A-B-C shows intraoral photographs of the patient in the mixed dentition with severe skeletal anterior open bite and divergent growth of the maxilla. D presents orthopantomography of the same patient. On the image E the cephalometry is shown with results interpretation regarding Steiner analysis with initial results of the patient, normal results and results at the end of the treatment conducted with palatal crib (24).

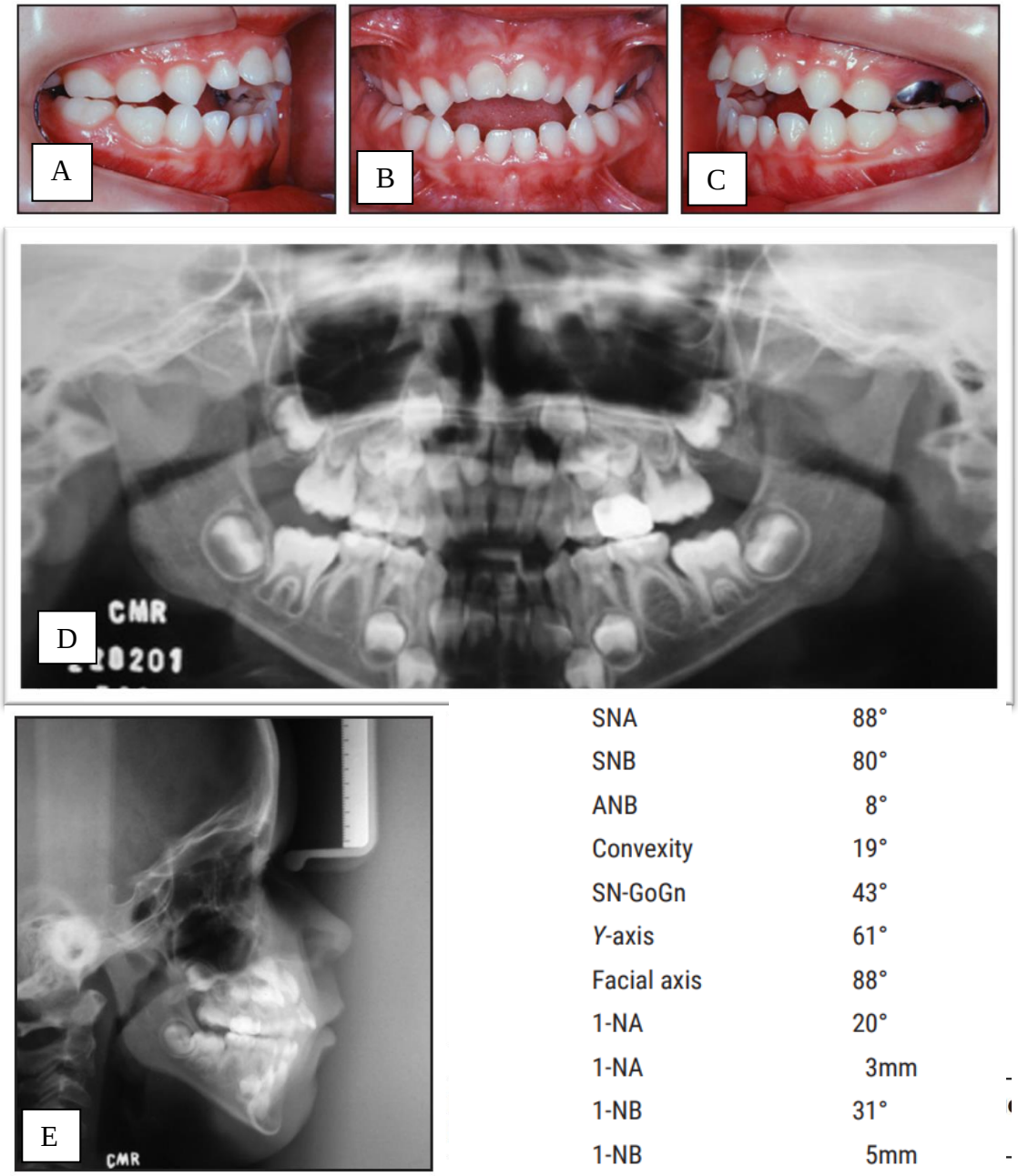


Figure 5. A complete diagnostics of the growing 5-years old patient. The A-B-C show intraoral photos of the patient with pacifier-sucking habit, a dentoalveolar anterior open bite in upper and lower incisors and posterior open bite unilaterally left. The orthopantomography is presented at D image and cephalogram with measurements is shown at the E image (25).

Regarding formation of the divergent maxilla, it happens when the thumb is placed between anterior incisors, the tongue is at the low position. Therefore, the pressure by the tongue against the palate of the upper posterior teeth is significantly decreased, leading to compressed maxilla. Meanwhile, pressure of the cheeks on the teeth is

increased. This is due to buccinator contraction during sucking process. The palate tends to get narrower, obtaining the shape of the V in the maxilla (4).

1.6. Therapeutic options:

The therapeutic options are divided according to classification and etiology of each case of the patient. We should always be aware of what the appliance looks like, what are the fragments and segments included in it, and also how it can be modified according to the patients' needs.

This means that nature of AOB relied on the type of oral habit and soft tissues would make orthodontist chose different treatment approach (26). Options for therapy for AOB would include removable and fixed appliances, or both after each other. Since skeletal AOB is aften a consequence of a compressed maxilla, it is clear enough that our first approach in these kids is the appliance that will expand the maxilla to obtain the space (27).

From the fixed ones we have McNamara Rapid Palatal Expander that is used since a long time with centralised along the palatal suture jack screw for expansion of skeletal compressed maxilla that can be applied to bands or incorporated into appliance (28) as it is shown in Figure 6. It is big in size, heavy and massive, therefore more difficult to clean and take care of for young patients. It includes acrylic segments covering occlusal surfaces of posterior teeth in a shape of the bite blocks surrounded by metallic band and fixed to the teeth. McNamara should be activated rapidly, which is why in very small kids it can be disadvantage, causing some face distortion and changing soft tissues position extra orally, but nevertheless it is very effective and fast-acting appliance, if activated carefully and on time (4,29).

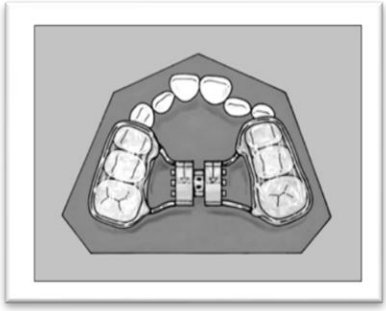


Figure 6. McNamara bonded appliances (28).

Mini-Screws and Modified Palatal Anchorage Plate is a new alternative treatment that appeared recently new on the market. They include titanium micro screws located intra orally. They are stable and direct action mechanisms, that do not depend on patients compliance (30) including anchorage that are placed lateral to the midpalate suture and can be quite invasive ways to solve problems, mainly used for more mature kids, but not the young ones (23).

One more appliance that could be complimentary or autonomous is fixed quad helix with rigid crib made of wire 0.9mm, used for palatal expansion and tongue interposition simultaneously. It impedes digital sucking and used in non-cooperative kids since it is fixed and not dependant on the patient´s compliance (31). This appliance consists of two bands cemented on first permanent molars and presents a prolonged wire with two active arms, pressing against palatal surface of the upper posterior teeth, as it is shown in Figure7. This is an alternative to maxillary expansion removable devices, since it helps to expand the arch, but in cases of dentoalveolar anterior open bite only, therefore using it in the skeletal anterior open bite is not convenient or advantageous (32).

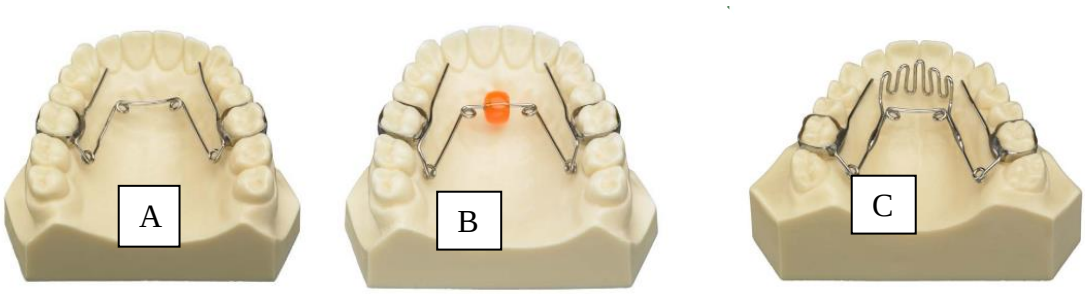


Figure 7. The image A represents a standard of the quadhelix, a regular one without any modification, whereas B is an image of the quadhelix with lingual pearl, and C is a quadhelix with palatal crib (33).

From removable ones we have Hawley removable appliance mainly used for dentoalveolar expansion and sometimes can be used for skeletal one, with optional pearl or crib, that are added modifications. There is also expansion screw that is

installed along the palatine suture and worn throughout the day, at least 16 hours. Can be combined with palatal crib for lingual disfunction treatment (34).

The Hawley is invented by Dr. Charles Hawley in 1919. Hawley plaque has Adam's clasp on the first molars and labial bow following 6 anterior teeth with 0.7 mm wire along them (35). The labial bow is used for retrusion of the incisors.

Another appliance that is effective for AOB and treatment of the molar class II division 1 is a Klammt removable appliance for correction of habits in skeletal pattern. It is bimaxillary apparat for mandibular retrognathism treatment and maxillary compression cases. (36) It regulates functions of the oral cavity, therefore improving the work of soft tissues by correcting malocclusion through varying muscle stimulation (21).

The Klammt appliance was developed simultaneously with famous Bionator Balters appliance, and became most functional appliance, made by George Klammt in 1955. It is used full time by the patient for higher effectiveness and best results due to balancing forces in the oral cavity (37). There are two variations of this appliances:

- One where acrylic block is flat, barely contacting posterior teeth.
- Another one, where acrylic pass-through interdental spaces of lingual surfaces of all posterior teeth.

Independent of what type of Klammt it is, the device itself consists of bilateral acrylics parts, upper and lower lip arches extended posteriorly, a palatal bow and upper and lower lip bows to control the movement of the anterior teeth and its aligning (38). The acrylic segments are in contact with palatal and lingual surfaces of both jaws and should be adapted to each patient to obtain space for functionality (21,39).

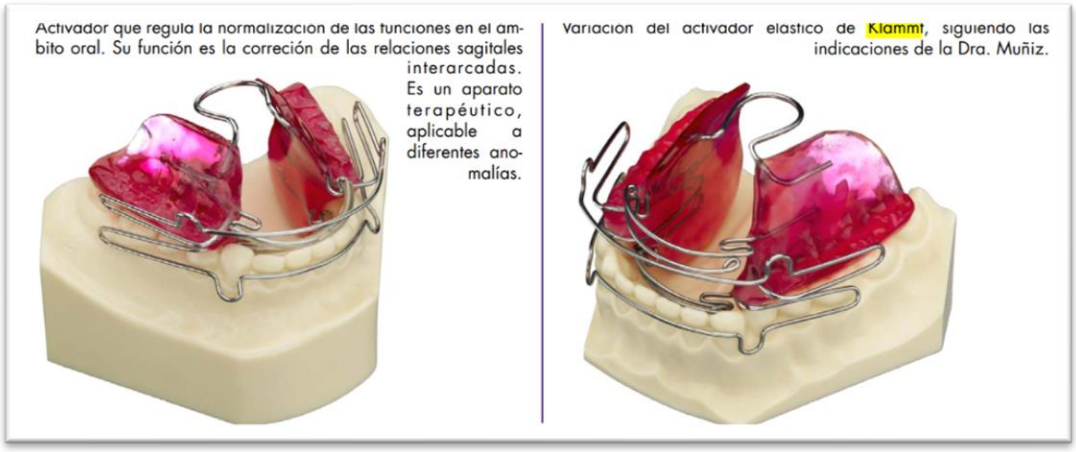


Figure 8. The indications and appearance of Klammt appliance where we can see acrylic segments and how wires are bended over, following the model (33).

One more removable device, a Froggy appliance that is new and not so much used yet, is mainly prescribed for very small kids of 3-4 years old with deteriorating habits (oral breathing, atypical deglutition), but there are 3 sized available: for 4-7, 8-11- and 12-years old children (40), which means that more studies on older kids are needed to prove and study effectiveness.

This device is made of flexible and soft plastic that is placed in the interlabial space, that is shown in Figure 9. This appliance should be used only for 15 minutes a day daily for 6 months approximately.

Muscles equilibrium therapy is the main base of functioning of this appliance.

Figure 9. Froggy appliance (40).

2. OBJECTIVES:

2.1. *General:* Evaluate the different effects of fixed and removable appliances for a skeletal anterior open bite in children.

2.2. *Secondary:*

Discover new appliances that are used in treatment of AOB.

Find the most effective appliance in the treatment of AOB.

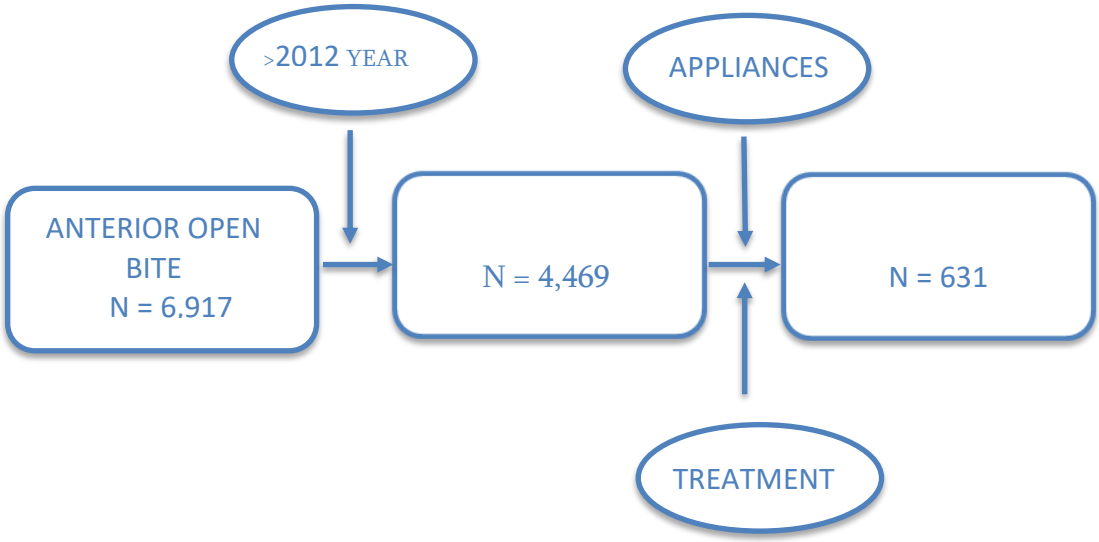
3. MATERIALS AND METHODS:

3.1. Research:

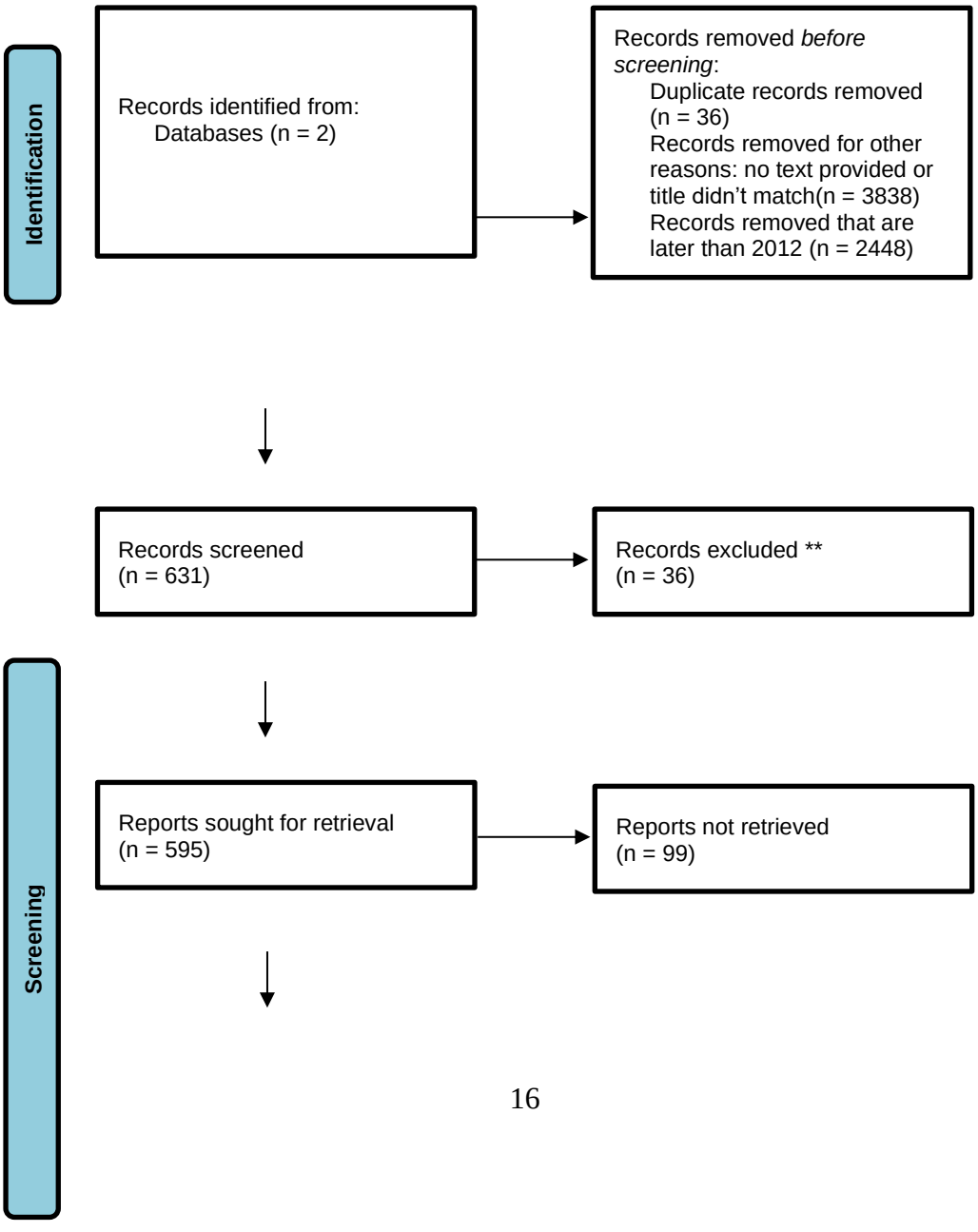
The scientific research of this review on the major online databases was based on the following keywords: anterior open bite, treatment open bite, appliances, orthopaedics, review. The search words used were “anterior open bite” OR/AND “treatment” AND/OR “appliances” NOT “adult”, not later than 2012. The databases used are Medline and Scopus. The total number of articles found is 6,917 from which at final the number of 46 was used only. Additionally, there was used 6 books of Orthodontics included in the reference.

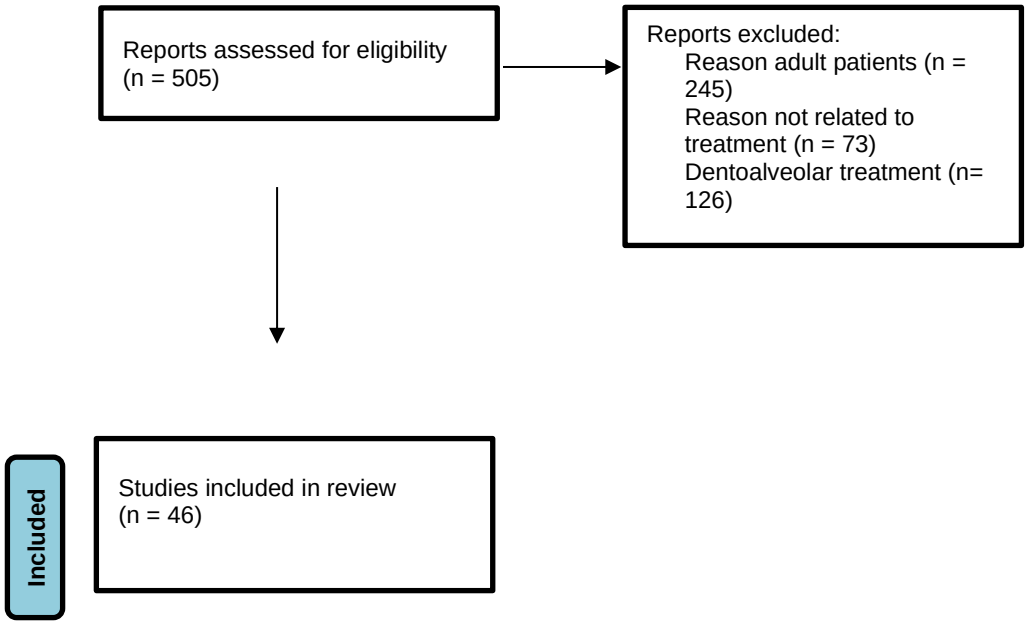
The studies included in this review focus on etiology of AOB, comparing different appliances in the treatment, and the use of removable and fixed appliances for an anterior open bite. No restrictions were applied for publication type, the languages used were English, Spanish, and French.

3.2. Schematic Research and Criteria:



Scheme 1. The first step of selection.





Scheme 2. The second step of selection, PRISMA flow chart.

First step of articles sorting presents a scheme of initial articles research showed in Scheme 1. Typing a "anterior open bite" presented 6.917 articles. With the use of filter of published works of later than 2012 year the articles decreased up to 4.469. Adding OR/AND "treatment" OR/AND "appliances" got the final of 631 articles.

The second step of sorting of articles and selection was done using PRISMA flowchart table presented in Scheme 2.

Including criteria of the review:

- articles not later than 2012,
- growing patients only,
- treatment with appliances,
- fixed and removable orthopaedic appliances,
- articles focused on skeletal AOB.

Excluding criteria of the review:

- the reports not related to anterior open bite treatment,
- duplicates,
- reports of minor academic significance,
- studies not published in scientific conferences,
- adult patients' studies,
- dentoalveolar AOB.

4. RESULTS:

4.1. Results regarding overall use of myofunctional appliances:

Regarding oral functional appliances that can be used it say that it can correct tongue behaviour therefore deteriorating habits and AOB itself. And that it is preferably should be done as soon as possible to avoid irreversible consequences (4,23,41–43). The AOB correction can be fixed on the short-term and long-term.

4.2. Results regarding McNamara Maxillary Expansion (or Rapid Maxillary Expansion) or RME compared with Palatal Crib and Quadhelix:

This is the heading appliance for expansion of the maxilla prior to closure of AOB. It can be used as initial approach, followed by another functional appliance, used to correct overbite and aesthetics (42).

If we talk about post treatment stability, the use of Maxillary Expansion prior to palatal crib appliance has similar results as palatal crib solitary for closure of AOB, but the treatment with expansion priorly takes less time (27).

While comparing Maxillary Expansion + Bite Blocks and Quadhelix + crib no significant differences were found, since maxillary expansion device, obviously, lead to higher expansion than Quadhelix fixed appliance (42).

4.3. Results regarding quadhelix appliance:

Quadhelix with crib remove sucking habits and expand maxilla itself, together with reduction on intermaxillary diversion and overall approximately 2.5mm increase in overbite but with the same effectiveness as trans palatal bar combined to gear pull and lip bumper (43).

4.4. Irrelevant results regarding mini-screws and crib:

Mini-Screws and Modified Palatal Anchorage Plate have shown to be effective in AOB correction and aesthetics for teenagers or adolescents, but not for very young kids (23). The success of expansion of maxilla and decrease of AOB through mini-screw was 92% after wearing appliance approximately for 2 years and 2 months (46). Regarding minis crew supported palatal crib that is quite invasive it is evaluated that if we compare it to conventional palatal crib, the amount of AOB closure is similar (3) so both appliances are valid(41). And it does remain to be effective as a treatment of anterior open bite (47).

4.5. Results regarding Klammt Appliance:

Klammt removable appliance gives efficient results for vertical growth control (21) and early malocclusion (48). The Klammt appliance in addition to correcting anterior open bite improves sagittal relationship of maxilla with mandible up to SNA 83, SNB 82 and ANB 3° (39).

It also influences the tongue to get back to palate and reducing AOB by increased pressure over palate, that therefore increases overbite. The use of this appliance stimulate face muscles and transversal expansion that improves arch also (38). In addition to all mentioned, it ameliorates mandibular length, retract the upper incisors and align anterior teeth, detrudes lower ones and improves aesthetics of the face and also, for example, lip interposition habit disappears, leading to higher lips tonicity (21).

4.6. Results regarding Froggy Appliance:

Froggy removable appliance has shown to be effective in small growing children with oral breathing and atypical deglutition, for correction of AOB, after wearing it for 6 months every day during 15 mins for considerable clinical results (40). Using Froggy

Mouth leads to formation of the new swallowing mechanism, showing improving in Figure 10 (49). After six months the success rate is average to 82.5% if patient presents good compliance, in addition to that a correct swallowing pattern is obtained, lip incompetence eliminates and facial mimics improves (50).

It helps to recover normal oral functions and promote harmonic growth, together with reducing dental problems. It is a good choice for very young children, since it provides muscular correction of atypical deglutition, and should be used when kid's neuronal activity is at hight point, as watching a movie (51).

This can be considered as a new therapeutic approach, nevertheless we need more evidence and clinical results to support this statement, since not a lot of studies have been conducted (51).

Table 1. Brief explanation of data collected with references, treatment provided, sample size, results, conclusion, and study type.

Author, year, reference	Treatment and sample	Results	Conclusion	Study Type
Ahmed S. F and co. 2022 (3)	N=26. Mini-screw palatal crib and conventional palatal crib group.	AOB closure 3.97 +- 1.44 mm in the Mini-screw group and 3.97 +- 0.89 mm in the Conventional group.	Both appliances used showed similar effect in the closure of AOB.	A randomized Clinical Trial.
Bhopal MP and co. 2021 (41)	N=40.	Myo group had tongue pressure of 44.3 changed to 51.4 and control	Oral Myofunctional Appliances improve	Case control study.

	Myofunctional appliances and control.	group 38.5 at the end 44.5.	tongue strength, tongue posture at rest and position.	
Kook YA, 2015, (23)	N=1. Mini-Screw.	Positive overbite in 1 year.	Successful on young teenagers.	Case Report.
Paoloni V and co. 2021 (42)	N=30. Rapid Palatal Expansion + Bite Blocks, another with Quad helix.	Rapid Maxillary expander had slightly higher maxillary transverse dimension at the end.	Maxillary Expander showed more positive changes regarding AOB.	Controlled Clinical Study.
Mucedero M and co, 2017 **(43)**	N=22 Group 1 quadhelix, group 2 transpalatal arch + pull gear + lip bumper and group 3 control.	Both experimental groups showed reduction of the palatal plane and a greater increase in overbite.	Both protocols were equally effective in correcting the anterior open bite.	Prospective Study.

Tunes Teixeira RA, 2022 (27)	N=25. Expansion prior to Palatal Crib group and only Palatal Group.	Similar changes in both.	Similar stability but PC group treatment was faster.	Prospective Study.
Kobayashi, 2014 (46)	N=137. Mini-Screw.	92% success rate.	Mainly indicated for adolescents and adults.	Prospective Study.
Feres MR and co, 2016 (47)	N=12. (Articles)	Crib Therapy showed to be affective for overbite.	Crib Therapy is effective for short time.	Systematic Review

Inamassu-Lemes SM, 2016 (21)	N=16. Klammt appliance.	Increased lower anterior facial height, mandibular length, clockwise rotation of the mandible, retrusion and verticalization of the upper incisors.	Klammt is indicated in Class II malocclusion, mandibular deficiency, increased overbite, proclined upper incisors, verticalized lower incisors.	Prospective Study
Mora IA 2017 (48)	N=20. Klammt appliance.	Cephalometric variations of statistical significance.	Effectiveness of appliance is verified.	Quasi-experimental study, RCT
Lino FM and co, 2015 (38)	N=1.	Interacts with muscle system and improves development of oral structures, changing jaw position.	Beneficial to use in open bite and class II patients.	Case report.
Fellus P 2015 (49)	N=40. Froggy Mouth.	Clinical correction was achieved, lip strength increased.	Froggy Mouth is effective in young children.	Prospective Study

Quinzi V and co, 2020 (50)	N=40. Froggy Mouth.	Correction of atypical swallowing.	Demonstrated short-term efficacy.	Prospective study.
Di Vecchio S and co. 2019 (51)	Froggy Mouth.	Corrected Atypical Swallowing clinically.	Provided to be a new myofunctional therapy appliance for atypical swallowing.	Retrospective Study
Manzini P 2020 (40)	N=6 Froggy Mouth	Corrected atypical swallowing pattern.	Oral normal functions restored.	Case Series

Figure 10. A) AOB provoked by pacifier use. B) Improvement after pacifier was removed. C) Result after using Froggy Mouth. D) Occlusion 3 years later with no other treatment provided (49).

5. DISCUSSION:

This review is aimed to pay attention to the solving of the skeletal anterior open bite using various appliances as soon as possible and at the best moment for patient, to avoid functional and aesthetic complications in adult life. We can see that there are a lot of different methods, protocols, and treatment plans to follow with the aim to close the AOB. Nevertheless, all appliances reviewed in this work have led to a closure of the anterior open bite, improvement of aesthetics and functionality for the patient. The question was the time, the cooperation of the patient and the complexity of the case.

The results indicate that, first, the treatment approach is individual to each patient and habit-aimed exclusively for each one (4,23,39,41–45). The treatment or elimination of the habit are the actions that should be taken early in the life of the growing patient. Relying on results and the articles reviewed, it is possible to state that this review supports the fact that both intrinsic and extrinsic factors should be carefully analysed, and appliance should be chosen regarding on the etiology of the problem, age of the patient and compliance showed as it is presented in the opinion of the Proffit (4).

Therefore, relying on the review results, for a youngest kid's category under 6 years old with an oral breathing or deteriorating habit of atypical deglutition that involves incorrect oral habits, froggy mouth showed to be the less invasive, most comfortable, and not depending that much on compliance in contrast to Klammt appliance (38) that is directly dependent of it and current use of the device intraorally. It comes from the fact that time wear should be up to 15 minutes daily for Froggy (51) and 12 hours for Klammt (21), which is normally is not a troublesome task for parents to control in case of Froggy.

Klammt directly applies forces on teeth whereas Froggy improves balance of the oral muscles, improving its functional aspect. It makes dentoalveolar changes due to muscular functional movements being changed. Since forces of Klammt are of direct

action it can be said that if we need to move teeth wires can be used to control the individual movement of teeth.

In contrast to say it can be said that Forggy Mouth doesn't have wires therefore does not have control over teeth and works on the neuromuscular balance functions, improving patient's anterior open bite.

Regarding Froggy appliance we can say that results therefore present an effort-effectiveness indirect relation since higher results are obtained with a low amount of effort (40). The froggy appliance would be considered not invasive at all, since its approach is exclusively to change muscles equilibrium. In addition, it should be mentioned, that Klammt appliance is bigger, heavier, and more uncomfortable for young patients, whereas Froggy is smaller, lighter, and more flexible in its appearance and use.

Following the topic it should be added that Klammt removable appliance has a great and positive influence on the tongue movement, which is the most important muscle in the AOB development (38).

If we compare Maxillary Expander and Klammt we can say that Klammt has more control over the retrusion of the anterior upper incisors and its alignment (36) due to presence of the upper and lower labial bow, as it is showed in the introduction part. This labial bow therefore has led to decreased overbite, which is exactly the aim of the treatment and target of this review. In despite, Maxillary McNamara expander doesn't have this labial bow wire located, therefore no retrusion is presented while wearing it.

McNamara makes skeletal expansion of the maxillary arch, whereas Klammt is the one that is making dentoalveolar arch changes. If a crib or a pearl for tongue position is added to McNamara, we can consider that both work on the functional position of the tongue of the patient. If the open bite of the growing patient is too severe and location of crib/pearl would be too uncomfortable, it can be considered to close anterior open bite first and afterwards expand maxilla with McNamara and pearl to maintain tongue.

Hawley appliance also has a labial bow located. Despite the fact that the Hawley retainer is not as effective at maintaining incisors and retaining them (52), we can say that there's still effect of retrusion on incisors, since Hawley also has labial bow and can retain incisors. Regarding the closure of the AOB there is not a lot of information provided in the work, therefore it is not valid enough to say it can be effective enough for correction of AOB or not. More reviews and evidence should be provided to make a proper conclusion.

The Klammt appliance, through reviews, achieved highly significant results, which is exactly the target of this work. Apart from solving the main problem presented, this appliance improves a variety of other aspects that should be taken into consideration. Those unexpected results include the ability of the appliance to lead to maxillary dentoalveolar transversal expansion of the growing patients as it has been mentioned (36). This is of vital importance, since skeletal anterior open bite is recurrently the consequences of underdeveloped, therefore compressed maxillary arch. It is mentioned that Klammt appliance restored the pressure over the palate by the tongue (36) action which means that pressure is a stimulus for the development of the compressed maxilla, leading to it natural expansion. Once the maxilla is properly expanded, the occlusion correction will take place using acrylic segments inside the appliance.

This data, accordingly, contributes to the clearer understanding of the problem underneath of the AOB, which is physiological changes upon the eroded habit pattern. This means that physiological problem should be solved priorly to physical change, which is an anterior open bite.

Apart from that, these results matter, since there is existing evidence that showed: Klammt appliance does improve relationship between skeletal bases of maxilla and mandible. The Klammt appliances improves mandibular length (36), so these results mean that if the mandible growths forward, it will lead to equilibrium of the jaws together with pressure balance and the anterior open bite will improve.

Nevertheless, we should note that McNamara Maxillary Expansion appliances do not depend on the compliance of the patient. Similarly, to quadhelix which is also fixed

appliance and palatal screws, the results expected might be faster, than the ones with removable appliances since the patient is not capable to avoid wearing them.

Mini screw anchorage plate devices haven't been reviewed in this work in that much details, as other appliances did, since mainly and in overall it is preferred for adult patients or mature adolescents (30). What is needed to be noted that these results do not fit with the theory of treating skeletal anterior open bite in growing patients, therefore are not valid or reliable for this review.

Following the current topic, we should consider possible alternative explanations to the problem which are presented in this work such as reviewing wider variety of appliances of different appearance and use methods and protocols, and myotherapy which can be effective in very small kids.

Additionally, it should be noted that these results matter because the continuous improving and combination of the devised should be a motivation into seeking for something as effective as light, comfortable, easy to use and compliance-free for patient. It means that reviewing devises presented in articles and results obtained build on existing evidence of continuous study and renewal.

What hasn't been reviewed into this article is the ways to prevent this problem so no treatment would be required. There's also no information provided on the muscular therapy, which can also be used to treat initial AOB at the stage of its appearance. Getting back to the topic if we compare it to removable appliance, it can be said that the fixed shows a better impact on the incisors repositioning in total and shorter treatment span since it does not depend on the compliance of the patient.

This review provides a new insight into the relationship between Froggy appliance and muscular therapy. To argue this position, we should say that the number of articles is not high enough to make any proper and clear solution, therefore we need more research and evidence for further discussion. Nevertheless, it should be noted that Froggy appliance is shown to be very compelling in the few studies reviewed.

These results should be considered when planning how to treat any minor growing patient who is attending orthodontists' office with skeletal anterior open bite, provoked by either intrinsic or extrinsic factors.

To add, it is important to bear in mind that anterior open bite affects the psycho-social performance and environment, effecting the quality of life in a functional and aesthetic way, affecting phonetics, mastication, respiration and changing physical appearance of the individual.

6. LIMITATIONS OF THE WORK:

Nevertheless, the limitations of the studies should be reviewed also as it will present the validity and reliability of the review. The generalizability of the results is limited by lack of physical evidence, since it is only review of the results obtained from another studies, articles, and books and no trial or meta-analysis was conducted to verify those results and its real validity.

Although, the reliability of these data is impacted by the digital sources used, that include the articles and books from the library of the university provided. Therefore, it means that there are more alternative sources of information with different results and varying level of evidence that can be obtained at other libraries and universities provided resources.

Due to the lack of data provided in articles, the results cannot confirm how different appliances change the patient's profile at the end of the treatment, since not in all the studies cephalograms are provided. Between those that analyse the changes in profile the Froggy Mouth is most efficient because it showed the achieving of lips seal (49), compared with other appliances.

In addition, only few articles reviewed evolution of the patient throughout the years therefore no proper follow up was conducted in majority of the sources used.

The methodological choices were constrained by choosing articles directly related to the topic and treatment of the highlighted problem. It is beyond the scope of this study to

evaluate the long-term efficacy of Froggy mouth since data is provided only based on short-term.

Further recommendation for this review and following reviews is to wider the range of databases and resources. It is therefore convenient to focus on different articles than the one reviewed here and encounter new ways of combining appliances to achieve anterior open bite closure.

Avenues for further studies or analyses should include works more focused on Froggy Appliance in a long-term and more analysis about overbite decrease using the Klammt. Regarding Froggy Appliance the investigation on more older kids of different age categories should be conducted to evaluate the effectiveness. By the fact that it acts on growing muscles we can say that it can also be used in kids up to 11-12 years old, but no studies are done to confirm this point.

7. CONCLUSION:

According to the review since the objective of the work is to evaluate the different effects of fixed and removable appliances for a skeletal anterior open bite in children, it can be said that:

- McNamara Rapid Maxillary Expander remain to be efficient in the expansion of the maxilla prior to the AOB correction, after the expansion of realised, the removable or fixed appliance can be used to correct the occlusion and lack of contact.

- Quadhelix is more preferably should be used for dentoalveolar AOB correction.

- Klammt showed a range of positive effects on the AOB closure and skeletal growth of the patient, improving the mandible length, retracting incisors, and recovering teeth contacts.

- Froggy Appliance is shown to be effective in deleterious habits that provoke anterior open bite, and the appliance improves the habit.

The effects of the appliances presented include increase of the overbite in the AOB and its consequent closure. To conclude on the secondary objective about discovery of new appliances that are used in treatment of AOB it should be said that.

- The freshest appliance is Froggy mouth and is used at the earliest stages in very small kids.

Regarding the objective to find the most effective appliance in the treatment of AOB it should be evaluated that there is no most effective appliance that could be used on the patient, since all appliances reviewed gave approximately and significantly similar results, sometimes varying only in the length of the treatment period.

Conclusion is this work was useful to understand etiology, formation of the anterior open bite and treatment, it helped to find ambiguous ways to solve it. To conclude we can say that the use of appliances for correction of AOB and proper intervention of orthopaedics is essential to solve the AOB.

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ANNEXES.

ANNEXE 1. PICO EVALUATION.

PICO	
P	AOB IN CHILDREN
I	ORTHOPAEDIC APPLIANCES

C	SURGERY/ADULT PATIENTS
O	CLOSE AOB

ANNEXE 2. ARTICLES USED PAGE 1.