IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 12 Ver. VI (Dec. 2017), PP 84-89
www.iosrjournals.org

The Efficiency of Different Molar Intrusion Methods in The Treatment of Anterior Open Bite:A Systematic Review

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Abstract
Objectives: *to perform a systematic review to evaluate the effectiveness of different molar intrusion methods used in the treatment of anterior open bite patients, to explore the changes that occur in the vertical facial morphology and mandibular rotation.*
Search methods: Electronic databases were searched up to April, 2016 in (CENTRAL-Cochrane register of controlled trials, PubMed and LILACS). Grey literature was also searched electronically through Google Scholar. Hand searching was done in the central library in Cairo University and the Cairo Dental Journal (CDJ) as well as high impact factor journals in the field (AJODO, EJO and The Angle Orthodontist). Language was restricted to English.
Results: *Twenty articles were eligible for the descriptive analysis, but only 4 were eligible for the quantitative analysis. Quality assessment of the included articles showed moderate to high quality. Meta-analysis using the fixed effect model .*
Conclusion: *A significant improvement in overbite was found in Frankel-4 appliance group about 2 mm greater than the control group. A significant improvement in overbite was found in MPBB group about 1 mm greater than the SPBB group. There is no enough evidence in the orthodontic literature regarding to the most efficient molar intrusion method used for anterior open bite treatment in adults.*

Date of Submission: 01-12-2017 Date of acceptance: 14-12-2017

I. Introduction

The term anterior open bite (AOB) was defined scientifically for the first time by ―Caravelli in 1842, as the lack of incisal contact between anterior teeth in centric relation.[1] It may occur with an underlying Class I,II or III skeletal pattern. AOB cause many problems as it can make speech, swallowinig, mastication and aesthetics difficult.[2]AOB develops because of interaction of many etiologic factors which may be hereditary or environmental in nature or combination of them; environmental etiology may be variation in dental eruption and alveolar growth, abnormality in neuromuscular functions of tongue, oral habits or both. Also nasopharyngeal airway obstruction or enlarged lymphatic tissue, lead to oral respiration which cause the mandible to posture inferiorly with the tongue protruded and resting in the oral floor and this situation induce dental and skeletal modifications similar to those caused by thumb sucking.[3]Skeletal open bite differs from dental open bite, as it involves the morphology and position of maxilla or the mandible or both. Skeletal open bite characterized by one or more of the following; increased lower anterior facial height, decreased posterior facial height, excessive gonial angle, excessive maxillary mandibular plane angle, small ramus and body of the mandible and inadequate lip seal. Dental open bite patients are characterized by normal craniofacial pattern, proclined incisors, undererupted teeth, normal or slight excessive molar height and thumb or finger sucking habits.[4]

Anterior open bite ―AOB is one of the most difficult malocclusion to treat orthodontically. Without proper diagnosis, identification and elimination of etiologic factors treatment stability of anterior open bite will have poor prognosis. When treatment plan is made it should consider patient‘s age, dental and skeletal discrepancies, as treatment of AOB ranged from observation or simple control to complex surgical procedure.[5] Dental open bite is usually self corrected or respond to conventional orthodontic treatment, while skeletal open bite require combination of orthognathic and orthodontic treatment to achieve a stable occlusion, improved function and acceptable esthetics.[4]

Treatment of AOB in growing patients could be done by preventing passive eruption of posterior teeth, using orthopedic functional appliances, while treatment in adult patients is very challenging, as treatment is done either by molar intrusion or incisor extrusion. Anterior incisor extrusion showed many drawbacks, because

it left the skeletal component of deformity unchanged and in such cases patients usually had shorter roots and less facial bone support of anterior teeth, leading to compromised esthetic.[6] Traditional orthodontic treatment often cannot intrude the molars especially in adults, before introducing temporary anchorage devices. The only treatment option to obtain counterclockwise of the mandible to close AOB was surgical impaction of the posterior segment of maxilla.[7]Favorable growth pattern in patients with a hyperdivergent phenotype include an increase in the posterior facial height, a forward mandibular rotation and enhanced condylar growth. Therefore, control of the vertical dimension is considered the most important factor in the treatment of AOB, and molar intrusion is the primary objective to achieve those treatment goals.[8]

Since there is a difference in the methods used for molar intrusion in the treatment of AOB in the growing and adult patients , the question of which method is the most efficient was not answered before and the conflict in the literature could not produce a definite answer. A systematic review has been chosen to resolve this conflict aiming to provide clinicians with the most efficient methods used in the treatment of AOB in the growing and adult patients.

II. Material And Methods

This systematic review was conducted according to the preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 checklist. This review was registered on the International Prospective Register of Systematic Reviews (PROSPERO) on 30 March 2015 and the registration number was : CRD42015017938.

2.1 Search strategy

Electronic search was done up to April 30, 2016. It was conducted in the following databases: PubMed, Cochrane (Central Cochrane registers of controlled trials), LILACS. The literature searches used the following Medical Subject Headings (MeSH) terms: Anterior open bite, Orthodontic, Molar intrusion, Rapid molar intruder, High pull headgear, Posterior bite block, orthopedic appliance, Magnetic bite block, mini screw, mini plate, Skeletal anchorage device.

2.2 Focused question

1. What is the most efficient methods for molar intrusion in the treatment of anterior open bite?
2. ***Selection criteria (PICO question: population, intervention, comparison, outcome)***
3. The following eligibility criteria were used to determine eligible reports for this systematic review:
4. Population: Orthodontic patients with anterior open bite.
5. Intervention : Any intervention used for molar intrusion .
6. Comparator(s)/Control: Comparative group subjects with anterior open-bite either treated or non-treated subjects.

2.3Outcome: Angular and linear measurements used to

Assess The Vertical Changes Of The Mandible: overbiteand maxillary and mandibular plane angle (MMA); mandibular plane angle (MPA) between Go-Gn or Me- Go and reference plane (FH or SN); lower anterior facial height (LAFH), the distance between anterior nasal spine ANS and point Me; Jarabak ratio, the ratio between posterior facial height (PFH) and anterior facial height (AFH); Y-axis angle, the angle between Sell- Nasion (SN) and Sell-Gnathion (S-Gn); the distance between lower first molar (L1) and mandibular plane; and the distance between upper first molar U6 and the reference plane, either palatal plane or horizontal plane.Study design: Randomized and non-randomized controlled clinical trials, clinical trials (prospective and retrospective), and case series studies. Excluded articles included case reports with ≤8 subjects, animalstudies, review articles, abstracts, and discussions.

III. Study Selection

The titles and abstracts of all articles obtained through the electronic searches were screened independently bytwo reviewers (AmrMostafa and AbdelRahmanNassim). Since it cannot rely on abstracts to get enough information about the results of posterior teeth intrusion on the facial structure, no attempt at this stage was made to identify studies that did not mention the effect of molar intrusion on facial morphology and mandibular rotation. After obtaining a sufficient number of abstracts, full articles were retrieved for the final selection process. The reference list of the articles that have been retrieved was checked out for additional studies that may have been missed in the initial searches. A consensus was reached among the assessors about the articles that met the eligibility criteria.

IV. Data Collection And Analysis

Data was extracted in duplicate by two reviewers (AMand AN) on the following items: year of publication, study design, materials, method measurements, age, sample size, treatment period, force applied, amount of reduction of open bite, mandibular rotation obtained, improvement of facial morphology gained, side effects, and author's conclusions, among others.

V. Risk Of Bias In Individual Studies

1. The risk of bias of included trials was assessed twice. The first assessment process done by the Cochrane Collaboration's tool,[9]. For assessing risk of bias for randomized clinical trials and the methodological index for nRCTs (MINORS)[10].
2. Two reviewers (AM and AN) performed the evaluations, and in cases of disagreement, consensus was reached after discussion.
3. Methodological quality was done for each article without blinding to the authors.

VI. Data Synthesis

We planned to perform a meta-analysis if both quality and quantity of the information retrieved from the finally selected studies justified a meaningful statistical combination.

VII. Results

The electronic search and hand searching from PubMed,CENTRAL-Cochrane register of controlled trials, LILACS and Google scholar resulted in a pooled number of hits with a total of 5,590 citations.A total of 5,204 titles were screened after removal of a total of 386 citations for the reason of duplication. Thirty citations were removed as internal duplicates from Google Scholar alone, while 356 was removed as external duplicates across the databases.A total of 4,078 titles were eliminated due to irrelevance to the review question.The number of citations that required reading of abstract were 1126. Out of these 1126 abstract, 1087 studies were excluded for reasons of methodological irrelevance such as case report, narrative reviews and litter to the editors. Other reasons for exclusion after reading the abstracts was the age group, type of interventions and different outcomes.Thirty nine full texts were then attempted to be retrieved. After the successful retrieval of twenty full texts, data extraction was commenced.(Fig1)Finally four studies are included in meta-analysis.Correction of AOB (Overbite) – (Is-Ii in mm) (Analysis 1.1 & 1.2) :

The data obtained from four studies, based on the similarity in the intervention there were two meta analysis had obtained for this outcome. Haydar and Enacar (1992)[11]and Erbay et.al (1995)[12]were pooled to compare the effect of Frankel-4 appliance versus control group on overbite. A sample of 31 who had treated with Frankel-4 appliance was compared to a sample of 30 who acted as a control with no intervention. The overall effect showed a significant improvement about 1.99 mm of overbite (P<0.00001) in Frankel-4 appliance group than control group (MD 1.99; 95% CI -2.62 to -1.44) as shown in (Figure 2). The test of heterogeneity showed no heterogeneity (I2=3 %).The data obtained from the other two studies. Kuster and Ingervall (1992)[13]and Doshi and Bhad-Patil (2010)[14], were pooled to compare the effect of Magnetic PBB versus Spring PBB on overbite. A sample of 21 samples who had treated with Magnetic PBB were compared to a sample of 32 who were treated with Spring PBB. The pooled estimate showed a significant improvement about 1.03 mm of overbite (P=0.0007) in the Magnetic PBB group compared to the Spring PBB group by a (MD -1.03; 95% CI -1.63 to -0.43) as shown in (Figure 3). No heterogeneity was detected (I2= 0%).

Mandibular Plane angle (MPA) – (PP-GoMe) in ° (Analysis 2.1):

The data obtained from two studies, based on the similarity in the intervention there were two meta analysis had obtained for this outcome. Haydar and Enacar (1992)[11]and Erbay et.al (1995)[12]were pooled to compare the effect of Frankel-4 appliance versus control in changes of Mandibular Plane Angle. A total of 31 samples who had treated with Frankel-4 appliance were compared to a sample of 30 who acted as a control with no intervention. The pooled estimate showed no significant difference (P=0.60) between the two interventions with mean difference of (MD -0.86; 95% CI - 4.07 to 2.36 as shown in (Figure 4). The test for the heterogeneity showed high level of heterogeneity (I2= 96%) , so this meta analysis might be taken into consideration.Maxillary Molar Intrusion (U6-PP) in- mm (Analysis 3.1) & (Analysis 3.2): The data obtained from four studies, based on the similarity in the intervention there were two meta analysis had obtained for this outcome. Haydar and Enacar (1992)[11]and Erbay et.al (1995)[12]were pooled to compare the effect of Frankel-4 appliance versus control on maxillary molar intrusion. A total of 31 samples who had treated with Frankel-4 appliance were compared to a sample of 30 who acted as a control with no intervention. The pooled estimate showed no significant difference (P=0.09) between the two interventions with mean difference of (MD-0.49; 95% CI -1.06 to 0.07) as shown in (Figure 5). The test for the heterogeneity showed no heterogeneity (I2= 15%).

The data obtained from the other two studies**.** Kuster and Ingervall (1992)[13]and Doshi and Bhad-Patil (2010)[14], were pooled to compare the effect of Magnetic PBB versus Spring PBB on maxillary molar intrusion. A total sample of 21 who had treated with Magnetic PBB were compared to a sample of 32 who were treated with Spring PBB. The pooled estimate showed a significant (P=0.40) maxillary molar intrusion about 1.1 mm in the Magnetic PBB group more than the Spring PBB group by (MD 1.11; 95% CI -1.72 to -0.51) as shown in (Figure 6). No heterogeneity was detected (I2= 0%).

VIII. Discussion

The orthodontic treatment of anterior open bite is not only for the sake of the function of the dentition, but also for the overall improvement of the facial esthetic that was shown to have an impact on self-esteem and quality of life for both adult and young persons. The debate of how to treat anterior open bite is still present in the orthodontic literature, as the different interventions have many questions concerning the efficieny of the methods,stability of the treatment and the time needed for the treatment. According to our knowledge there were four systematic reviews were conducted for the treatment of anterior open bite. Three systematic reviews Cozza et.al (2005)[3], Oliveira et.al (2007)[2]and Feres et.al (2015)[15]conducted for early treatment of anterior open bite in the growing patients and one systematic review (Alsafadi et.al (2016),[16]) for anterior open bite treatment in the adult patients and this review has been published at 23 March 2016 after we registered our systematic review on (PROSPERO), but they were not able to report a definite result. The limitation of Cozzaet.al(2005),[3]was due to many studies have been published later after 2005 which may change the results. Oliveira et.al (2014),[2]included only randomized controlled trials neglecting the non-randomized clinical trials and cohort studies. Feres et.al (2015),[15]included only orthopedic appliances and neglected the temporary anchorage devices in their inclusion criteria of intervention. Alsafadi et.al (2016)[16] has been done for the treatment of anterior open bite with temporary anchorage device, but they included only adult population. Also they not able to conduct clear results due to the weak evidence in this field.This systematic review has been conducted without any age limitation to include both growing and adult populations in the same review .he objective of this systematic was not achieved regarding the treatment of adults due to lack of evidence and lack of well conducted studies as we found only one prospective cohort study (Deguchi et.al (2011),[17]) with adult sample which did not include in the quantitative analysis.

Study selection based merely on the study design was not performed in this review. The literature previously compared the meta-analyses of nonrandomized comparative studies with that based solely on randomized clinical trials and it was shown that meta-analyses based on nonrandomized comparative studies is probably as good as randomized one (**Abraham *et al.*, (2010)[18]**). Also, information from different study designs can be combined together into a meta analysis, while taking into account the level of uncertainty associated with the estimates (**Sutton., (2002)[19])**.All included studies were found using same method for measuring outcomes by lateral cephalometric head films normally used as a standard diagnostic tool in our daily practice and all studies had been successfully attempted to standardize the measurement through the use of one cephalostat for lateral cephalometric radiograph in each study. In this review numerous measurements were used and this had led to a great heterogeneity in choosing the cephalometric outcome measurement to be pooled in this meta analysis, and thus not all the outcomes were pooled into a meta-analysis. Outcomes that were found to have a great benefit to the clinicians were reported both in a form of a forest plot and in a descriptive manner.

According to the results of this review, two linear cephalometric measurements and one angular measurement were included in meta-analyses. The two linear cephalometric measurements pooled, namely correction of anterior open bite (Is-Ii) mm and amount of maxillary molar intrusion (U6-PP) mm and one angular measurement; the changes in mandibular plane angle (ANS.PNS-GoMe)°.The overall quality of the included studies was found to be moderate, and thus, future research, with a well conducted methodology may alter the evidence in hand. For this reason, clinicians should be cautious when interpreting these results. Caution is also advised during the implementation of these findings with patients of different ethnicities and different orthodontic mechanics. Well conducted randomized clinical trials of large sample using CBCT instead of the 2D radiographic machines are recommended to increase the confidence in the available state of evidence regarding the most efficient intervention used for molar intrusion in the treatment of anterior open bite patients.

IX. Conclusion

Based on the limitation of our review on the most efficienct molar intrusion methods in the treatment of anterior open bite, it was concluded that:

1. A significant improvement in overbite was found in Frankel-4 appliance group about 2 mm greater than the control group due to vertical eruption of the upper and lower incisors and retraction of the upper incisors.
2. No significant difference was found regarding changes in the mandibular plane angle or maxillary molar intrusion between Frankel-4 appliance group and control group.

3. A significant improvement in overbite was found in Magnetic PBB group about 1 mm greater than the SPBB group.
4. A significant maxillary molar intrusion was found in Magnetic PBB group about 0.6 mm greater than the Spring PBB group.
5. There is no enough evidence in the orthodontic literature regarding to the most efficient molar intrusion method used for anterior open bite treatment in adults.

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Data and Analysis

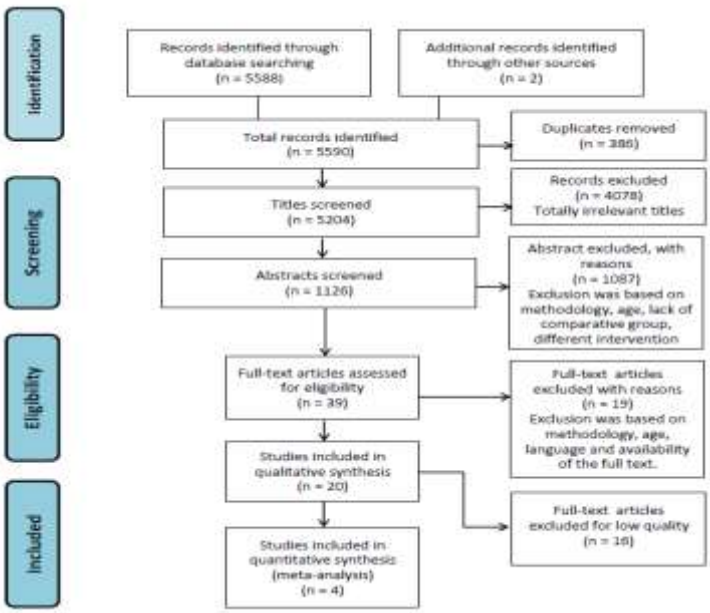


Figure (1) : PRISMA flow chart of the screening and inclusion process

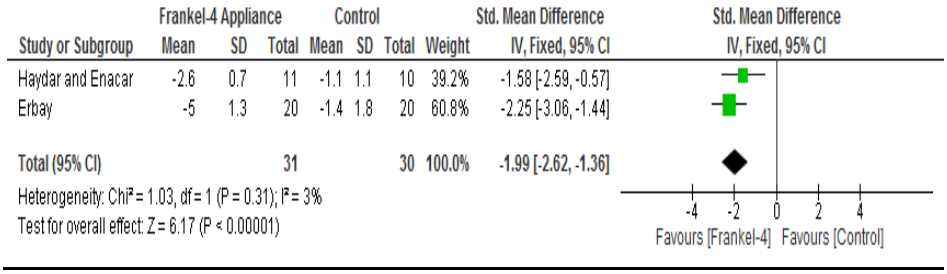
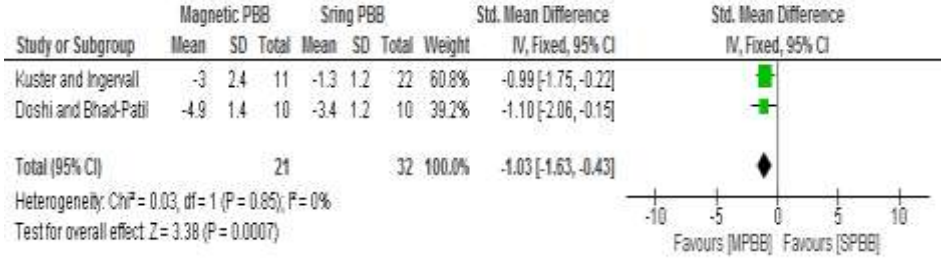


Figure (2) :Effect of FR-4 on Overbite



Figure(3): Effect of MPBB versus SPBB on Overbite

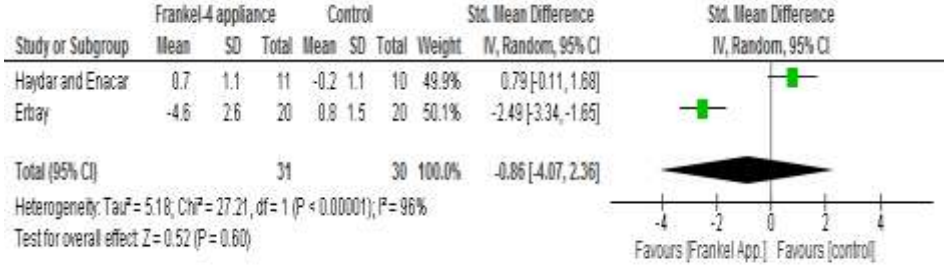


Figure (4) :Effect of FR-4 on MPA°

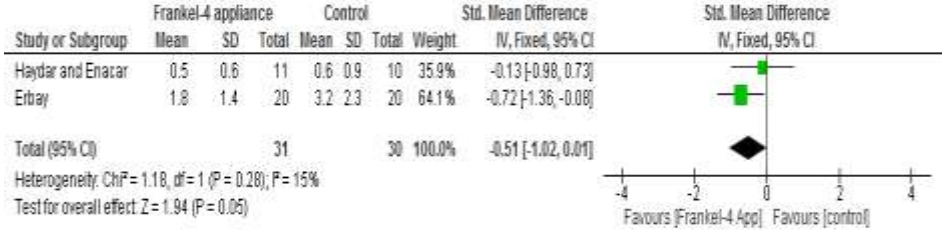


Figure (5) :Effect of FR-4 on Maxillary Molar Intrusion

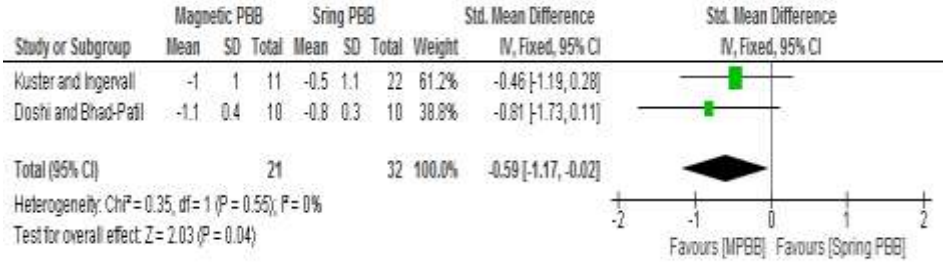


Figure (6) :Effect of MPBB versus SPBB on Maxillary Molar Intrusion

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