Original Research Article

Stability of skeletal open bite correction in adult patients by molar intrusion: A meta analysis

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A B S T R A C T

Objective: To review and compile literature to check the post retention stability of skeletal open bite correction by molar intrusion.

Search Method: Articles were searched in Electronic database of English literature i.e. PubMed, Cochrane Library, Embase and google scholar.

Search Criteria: Titles and abstracts of potential articles with inclusion criteria were examined and included based on consensus agreement.

Data Collection and Analysis: Abstracts of articles having characteristics that were uncertain were examined, with full article retrieval if necessary. The reference list of the retrieved articles were also searched.

Result: On comparing the mean post treatment and post retention of overbite derived from their respected forest plot graphs, there was 32 percent relapse in the overbite correction.

Conclusion: This study states that skeletal open bite patients treated with molar intrusion have 68 % stability, whereas the intruded molar have a 95% stability.

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1. Introduction

Anterior open bite (AOB) malocclusion is the lack of vertical overlap or contact between the maxillary and mandibular incisors and is of multifactorial etiology. [1]

Skeletal anterior open bite is a discrepancy in the vertical plane of space effecting the jaw bases with a prevalence of 1.5% to 11% varying amongst ethnic groups. [2] Clinical Signs and symptoms of skeletal open bite being speech problems, unattractive smile, and difficulty biting food with front teeth., anterior open bite, lisping, increased lower anterior facial height.

Diagnosis of skeletal open bite requires precise clinical examination and cephalometric analysis.

Lateral cephalogram is one of the most common accessory diagnostic aid in diagnosing & treatment planning. Common cephalometric variables associated with skeletal open bite are: Skeletal parameters - decreased mandibular, increased mandibular plane angle, vertical downward position of maxilla and mandible in relation to cranial base, cranial cant of occlusal plane and increased anti inclination angle. Dental parameters - absence of overbite, increased molar distance from the palatal plane/mandibular plane.

Various modalities for treating skeletal open bite have been proposed which include surgical methods and non-surgical method. Surgical Treatment modalities for correcting skeletal open are invasive in nature and need not be always performed unless the skeletal malocclusion is severe in extent. Other treatment modalities for correcting

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open bites include reducing the posterior dentoalveolar height by applying intrusive forces to posterior teeth with Temporary Anchorage Devices. Posterior bite blocks can also be used to correct anterior open bites. [3,4] Bite blocks augmented with magnetic augmentation [5–7] or springs [8] have also been used. Multi-loop edgewise arch wire techniques can be used. [9,10]

Open bite is considered a malocclusion that still defies correction, especially in terms of stability. One might expect even more relapse and greater problems in treating open-bite malocclusions in adults. [11,12] Growth in the vertical dimension is the last to cease, making corrections more prone to relapse. Correcting a skeletal open bite by molar intrusion has been found to be promising. However correcting a skeletal discrepancy by dentoalveolar means can be challenging from post retention point of view.

Clockwise rotation of the lower jaw is a result of more vertical growth at the molar region than at the mandibular condyles. [13] The rotations of the mandible can be affected by the dentoalveolar region hence if we alter the position of the molars in the vertical dimension, we can affect the current position of the mandible.

In this review, we compiled evidence from the articles on the long-term stability of the major therapeutic interventions for correcting anterior open bite.

The aim of this study is a systematic search for eligible publications and to conduct a meta-analysis regarding (1) Efficiency (2) Stability (3) Overall treatment time (4) Effectiveness of skeletal open bite treated with molar intrusion in adult patients.

2. Materials and Methods

2.1. Protocol and registration

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed to ensure transparency and comprehensiveness in this systematic review.

This review was registered a priori in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42022329184).

An in–vitro study was done to identify and review the orthodontic literature with regard to the efficiency, effectiveness, and stability of skeletal open bite correction in adult patients by molar intrusion.

2.2. Eligibility criteria

The selection criteria according to *PICOS* was applied for this review are as presented inTable 1.

2.3. Information sources, search strategy, and study selection

Electronic databases were searched, no limitation was put on the year of study publication. Cochrane Central Register of Controlled Trials (Central), PubMed, Embase and Google Scholar were searched.

Hand screening of all journals that were found to be relevent and reference list of included articles was done as a part of additional search.

The search strategy used a set of keywords designed specifically taking into account the wants and needs of the inclusion criteria of the study. The search strategies are given in detail in Figure 1.

The keywords used are as follows:- Skeletal openbite OR skeletal open bite AND molar intrusion OR intrusion of molars AND stability OR reliability NOT surgically treatment NOT surgically corrected NOT corrected by surgery NOT by extrusion of incisors.

The article search, inclusion of study, method, assessment of quality, and data extraction were done by two reviewers individually and in duplicate .These reviewers were not blinded to the concerned authors. The results were revised by the second and fourth authors.

Eligible articles were assessed in 2 phases. Only titles and abstracts were screened in the first phase. In the second phase assessment of full text was conducted for final eligibility. The articles which did not meet 1 or more of the inclusion criteria, were excluded.

2.4. Data collection process and data items

Two reviewers performed data extraction independently and in duplicate. Standardized data extraction sheets were used to perform data extraction.

This included the following items: methods (duration, and treatment comparison), participants (sample size, age, and gender), general information and study setting orthodontic aspects (malocclusion characteristics, type of movement, appliance characteristics and biomechanics,),intervention (type of interventions, intervention site, and technical aspects of interventions),frequency of orthodontic adjustments, and follow-up duration, and outcomes , data of interest, methods of outcome measurements, and statistical significance of reported differences, and follow-up duration.

2.5. Risk of bias (ROB) and quality assessment in individual studies

ROBINS-1[14] tool was used for quality assessment of the studies (Table 2). Seven components of bias were evaluated: (1)] confounding bias , (2) Bias due to Inclusion of participants, (3) Bias due to classification of interventions (4) Bias arising from deviating from intended interventions/methods, (5) Bias due to loss of data, (6) Bias due to outcome measurements and (7) Bias due to reported result selection. For each included study, an overall assessment of bias (high, unclear, low) was made. Having at least one component was regarded as having an overall high ROB and that particular study/studies were excluded from the meta-analysis.

2.6. ROB across studies

Standard forest plot/ funnel plots would be drawn using three specific parameters (overbite in mm, U6 -pp and SN MP Angle) for the studies that would be included in the meta-analysis.

2.7. Summary measures and synthesis of results

Otherwise, the results were qualitatively summarized. Chi-square test was used to explore Statistical heterogeneity with the I2 index, corresponding to less, moderate, and extremely high heterogeneity, with values of 25 percent, 5 percent, and 75 percent respectively. I2 test specified that the fixed-effects model and the random-effects model have to be applied to studies with more than 50% heterogeneity or 50% heterogeneity, respectively.
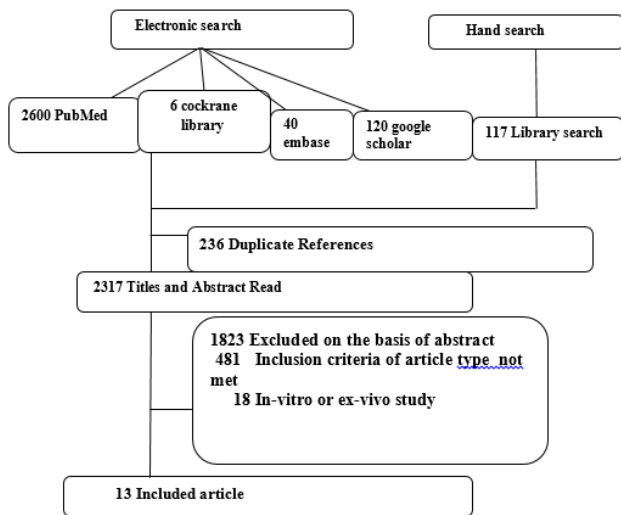
2.8. Additional analysis

Figure 1: Search strategy
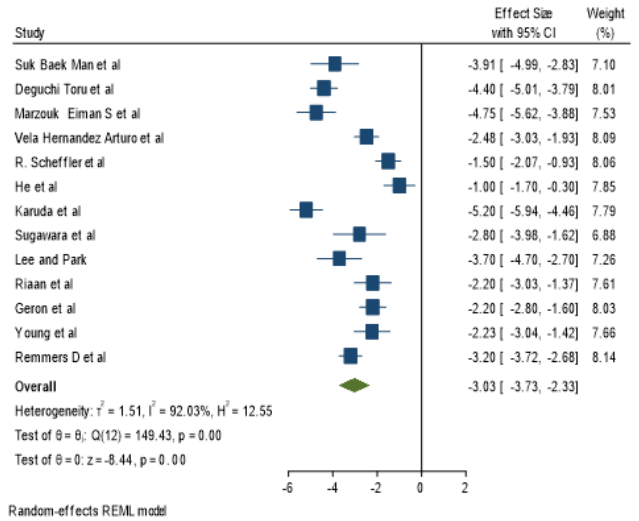
Figure 2: Forest plot graph depicting pooled mean and individual pretreatment overbite (mm) values of the articles included The estimated overall effect size is -3.03 with a 95% C I of (-3,73,-2.33) Study 6 has maximum effect size.Study 7 has minimum effect size Study 13 has maximum weight age and study 8 has minimum weight age. Higher the effect size with minimum standard deviation leads to more weight age.

Figure 3: Forest plot graph depicting pooled mean and individual pretreatment SN MP angle values of the articles included. Inference The estimated overall effect size is 40.81 with a 95% C I of (37.90,43.73). Study 3 has maximum effect size . 11 has minimum effect size. Study 5 has maximum weightage and study 4 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage
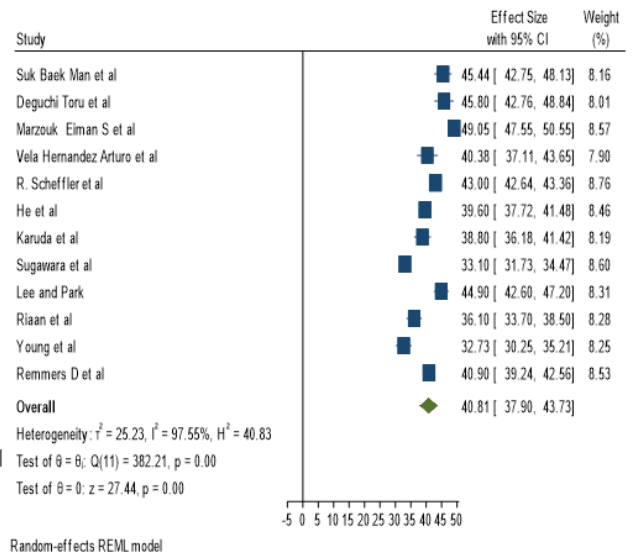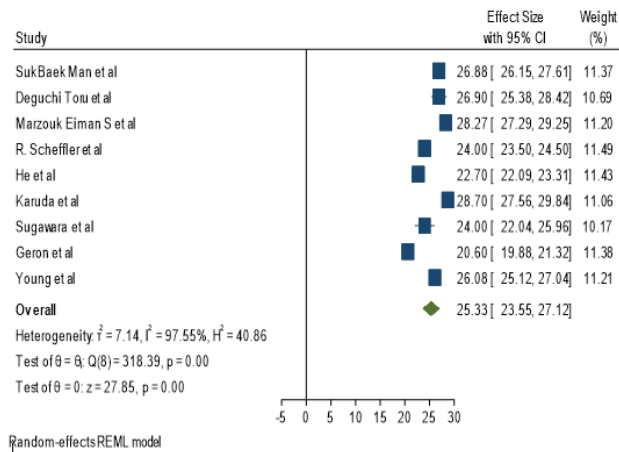
Table 1: Eligibility criteria used for study selection

Category	Inclusion criteria	Exclusion criteria
Study design	MRCT, Pre-post studies	Case report
Participants	Healthy male and female patients, aged 18 years and above having skeletal open bite	Unhealthy male and female patients, aged below 18 years having dentoalveolar open bite
Intervention	Molar Intrusion	Extrusion of incisors, Surgical correction
Control	Extrusion of incisors, Surgical correction or conventional orthodontic therapy	Molar Intrusion
Outcome measures	Primary outcomes-Stability of the skeletal open bite (OB in mm)(in percentage) treated with molar intrusion Secondary outcome-Whether the relapse in the overbite is Skeletal or dentoalveolar in nature	
Others	English articles in which the studies have been performed on Human being	Non English articles in which the studies have been performed on Human being/Animals

Table 2: Assessment of ROB for the included studies

S. No	Study	Pre-intervention		At intervention	Post-intervention			
		Bias due to confounding	Bias in selection of participants into the study	Bias inclassifica on of inter- ventions	Bias due todeviations from intended interventions	Bias due to missing data	Bias in measu- rement of outcomes	Bias in selection of the reported result
1	Suk Baek Man et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
2	Deguchi Toru et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
3	Marzo uk Eiman S et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
4	Vela Hernandez Arturo et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
5	R. Scheffler et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
6	He et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
7	Karuda et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
8	Sugawara et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
9	Lee and Park	LOW	LOW	LOW	LOW	LOW	LOW	LOW
10	Riaan et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
11	Young et al	UNCLEAR	LOW	LOW	LOW	LOW	LOW	LOW
12	Remmers D et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW
13	Geron et al	LOW	LOW	LOW	LOW	LOW	LOW	LOW

Table 3: The search engines that were searched, the keywords that were used and the final article/s that were included

S. No	Search engines		Results	Final
1	Central (The Cochrane Library)	Skeletal openbite OR skeletal open bite AND molar intrusion OR intrusion of molars AND stability OR reliability NOT surgically treatment NOT surgically corrected NOT corrected by surgery NOT by extrusion of incisors	6	1
2	Embase	Same as above	40	4
3	PubMed	Same as above	2600	7
4	Google Scholar	Same as above	120	1

Figure 4: Forest plot graph depicting pooled mean and individual pretreatment U6-PP (mm) values of the articles included.Inference The estimated overall effect size is 25.33 with a 95% C I of (23.55,27.12).Study 3 has maximum effect size.Study 8 has minimum effect size .Study 4 has maximum weightage and study 7 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage

3. Result

3.1. Study selection and characteristics

2883 articles were found using electronic search and hand search, out of which 566 were duplicates and were excluded. 2317 articles remained and their titles and abstracts were read. On the basis of abstract, 1823 articles were excluded. On the basis of inclusion criteria 450 articles were excluded.6 articles were found to be ex vivo studies and were excluded.

Hand search was also on the reference lists of the retrieved full articles. The complete search and data retrieval was independently performed by at least 1 investigator. In case, there was any confusion, a second investigator was called**.**

44 randomized controlled trials were included for the qualitative analysis. Only 13 studies were included in the quantitative synthesis. 31 studies included in the qualitative synthesis were case reports.
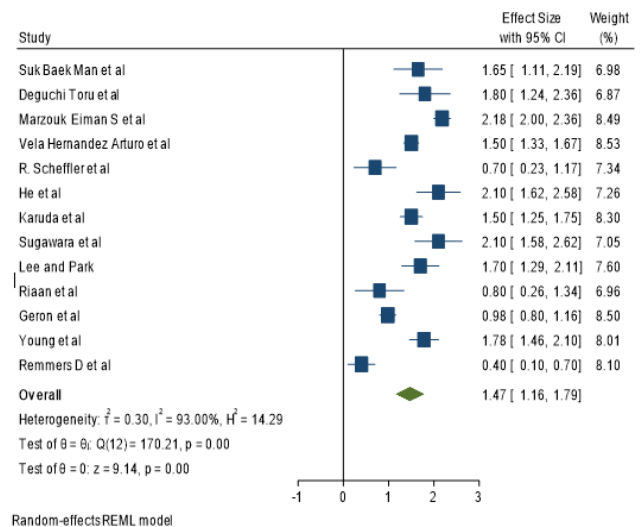

Figure 5: Forest plot graph depicting pooled mean and individual post treatment overbite (mm) values of the articles included Inference The estimated overall effect size is 1.47 with a 95% C I of (1.16,1.79).Study 3 has maximum effect size. Study 12 has minimum effect size.Study 13 has maximum weightage and study 8 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage.

3.2. Study characteristics and ROB within studies

Titles and Abstracts of potential articles for inclusion criteria were examined; the articles were included based on consensus agreement.

The articles that were included are as follows: - Suk Baek Man et al,[15] Deguchi Toru et al.,[16] Marzo uk Eiman S et al,[17] Vela Hernandez Arturo et al,[18] R. Scheffler et al.,[19] He et al,[20] Karuda et al[21] Sugawara et al,[22] Lee and Park,[23] Riaan et al,[24] Young et al,[25] Remmers D et al,[26] Geron et al.[27]

The characteristics of all the included studies are given in Table 3.

After compiling the articles to be included, articles were read and the data was abstracted onto custom data abstraction forms, which was pre-tested and piloted on 2 studies of each type. Abstracts of articles were examined,

Table 4: Characteristics of Included studies

Study	T1 (n)	Age T1 (y)	SD (y)	SN-MP T1 (degree)	SN-MP SD T1	OB T1 (mm)	OB SD T1	U6-PP T1 (mm)	U6-PP SD T1	OB T2 (mm)	OB SD T2	SN-MP T2 (degree)	SN-MP SD T2	U6-PP T2 (mm)	U6-PP SD T2	F/U time T3 (y)	OB T3 (mm)	OB SD T3	SN-MP T3 (degree)	SN-MP SD T3	U6-PP T3 (mm)	U6-PP SD T3
Remmers D et al	52	17.1	1.3	40.9	6.1	-3.2	1.9	26.08	2.51	0.4	1.1	40.6	6.3	25.42	2.62	5	0.2	1.8	40.3	6.8	26.15	2.56
Young et al	29	26	1	32.73	6.45	−2.23	2.1			1.78	0.84	32.58	5.61			2	1.53	1.09	33.45	5.06		
Geron et al	39	27.23	6.38			-2.2	1.9	20.6	2.3	0.98	0.57			17.7	2.4	2	0.91	0.4			18.57	
Riaan et al	16	13.1		36.1	4.9	-2.2	1.7			0.8	1.1	34.9	5.3			1	0.56	1.1	35.26	1.1		
Lee and Park	11	18		44.9	3.9	-3.7	1.7			1.7	0.7	42.9	4.5			1.54	0.7	0.7	43	4.8		
Sugawara et al	9	19		33.1	2.1	-2.8	1.8	24	3	2.1	0.8	31.7	2.4	25	2.8	1	1.2	0.8	32.2	3	25.1	2.5
Karuda et al	23	21.6	7.3	38.8	6.4	-5.2	1.8	28.7	2.8	1.5	0.6	35.5	6.9	26.4	2.4	2	1.5	0.6	35.5	6.9	26.4	2.4
He et al	20	20.6	4	39.6	4.3	-1	1.6	22.7	1.4	2.1	1.1	40.1	4.3	22.9	1.4	1	2	1.1	40.1	4.3	22.9	1.4
R. Scheffler et al	30	24.1	10.7	43	1	-1.5	1.6	24	1.4	0.7	1.3	42	1	21.7	1.1	2	0.3	1.1	42	0.8	22.3	1.2
Vela Hernández Arturo et al	31	26.6	4.9	40.38	9.29	-2.48	1.57			1.5	0.47	39.19	8.98			2.8	0.94	0.57	39.36	9.04		
Marzouk Eiman S et al	26	33		49.05	3.9	-4.75	2.27	28.27	2.55	2.18	0.48	46.91	3.89	25.23	2.14	4	1.41	0.39	47.43	3.93	25.64	2.17
Deguchi Toru et al	15	24.3	5.9	45.8	6	-4.4	1.2	26.9	3	1.8	1.1	42.2	6.7	24.6	2.5	2	1	0.9	43.8	6.5	25.1	2.8
Suk Baek Man et al	9	23.7	26.41	45.44	4.11	-3.91	1.65	26.88	1.12	1.65	0.82	43.41	4.41	24.5	1.64	4	0.45	1.09	43.98	4.76	24.94	1.68

Table 5: illustrates the percentage ofstability and relapse derived from the overall difference between posttreatment (T2) and post retention (T3) values of overbite (mm) which wereobtained from the forest plot graphs

Post treatment Overbite (mm)	Post retention Overbite (mm)	Difference	Percentage of Stability	Percentage Of Relapse	Significance
1.47	1	0.47	68%	32%	P<0.002

Table 6: illustrates the percentage of stability and relapse derived from the overall difference between post treatment (T2) and post retention (T3) values of overbite (mm) which were obtained from the forest plot graphs

Post treatment SN MP Angle (degree)	Post retention SN MP Angle (degree)	Difference	Percentage of Stability	Percentage of relapse	Significance
39.33	39.66	0.33	99%	1%	p=0.065

Table 7: illustrates the percentage of stability and relapse derived from the overall difference between post treatment (T2) and post retention (T3) values of SN MP angle which were obtained from the forest plot graphs

Post treatment SN MP Angle (degree)	Post retention SN MP Angle (degree)	Difference	Percentage of Stability	Percentage of relapse	Significance
39.33	39.66	0.33	99%	1%	p=0.065

Table 8: illustrates the percentage of stability and relapse derived from the overall difference between post treatment (T2) and post retention (T3) values of U6 PP (mm) which were obtained from the forest plot graphs

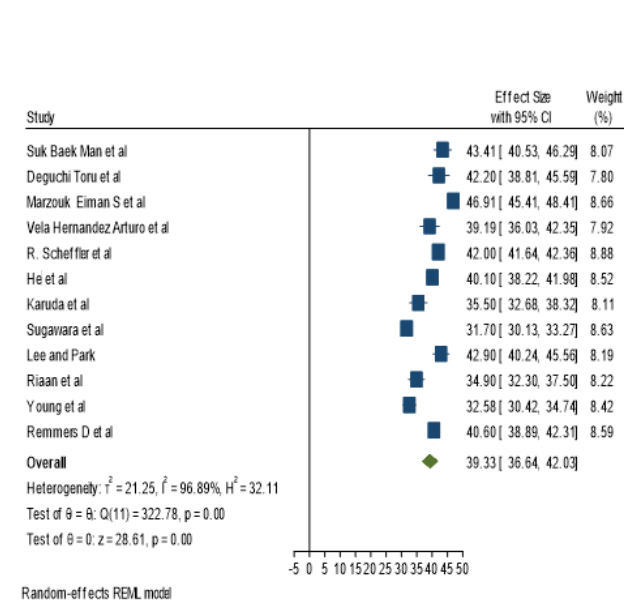| Post treatment U6 PP (mm)	Post retention U6 PP (mm)	Difference	Percentage of Stability	Percentage of Relapse	Significance
23.69	24.76	1.07	95%	5%	p<0.0024

Figure 6: Forest plot graph depicting pooled mean and individual post treatment SN MP angle values of the articles included Inference The estimated overall effect size is 39.33 with a 95% C I of (36.64,42.03) Study 3 has maximum effect size .Study 8 has minimum effect size .Study 5 has maximum weightage and study 2 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage.
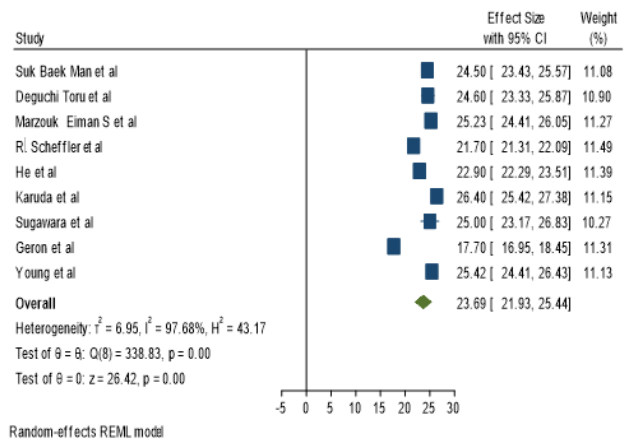

Figure 7: Forest plot graph depicting pooled mean and individual post treatment U6-PP (mm) values of the articles included. Inference The estimated overall effect size is 23.69 with a 95% C I of (21.93, 25.44) Study 3 has maximum effect size Study 8 has minimum effect size Study 4 has maximum weightage and study 7 has minimum weightage. Higher the effect size with minimum standard deviation leads more to weightage.

with the full article retrieved if necessary.

Thirteen studies were identified in the search forest plot graphs were plot for each parameter allowing extraction of mean OB, SN –MP angle and U6-PP angle for the pre intervention condition (T1), the post treatment result after therapeutic intervention (T2), and long-term stability
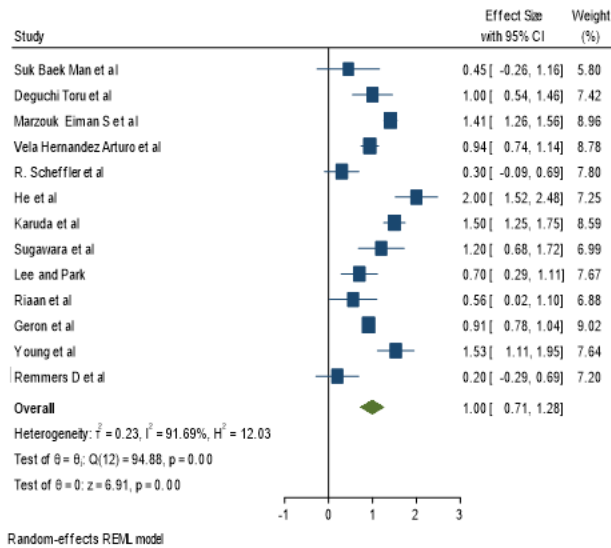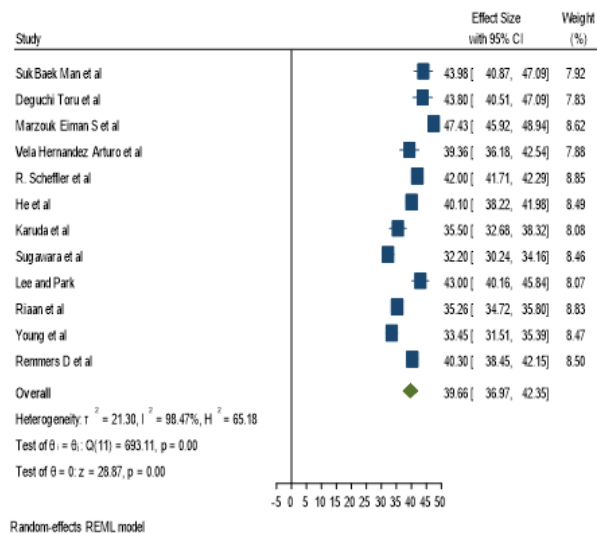
Figure 8: Forest plot graph depicting pooled mean and individual post retention overbite (mm) values of the articles included Inference The estimated overall effect size is 1 with a 95% C I of (0.71, 1.28). Study 6 has maximum effect size. Study 13 has minimum effect size. Study 11 has maximum weightage and study 1 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage.

Figure 9: Forest plot graph depicting pooled mean and individual post retention SN MP angle values of the articles included Inference The estimated overall effect size is 39.66 with a 95% C I of (36.97, 42.35) .Study 3 has maximum effect size. Study 8 has minimum effect size .Study 5 has maximum weightage and study 2 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage
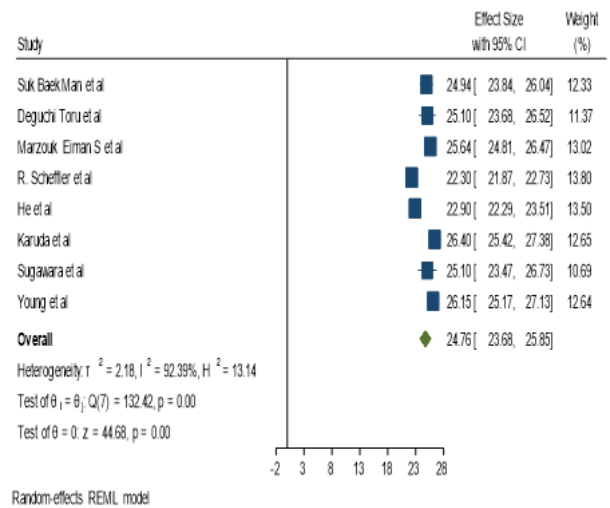

Figure 10: Forest plot graph depicting pooled mean and individual post retention U6-PP (mm) values of the articles included. Inference The estimated overall effect size is 24.76 with a 95% C I of (23.68, 25.85). Study 6 has maximum effect size. Study 4 has minimum effect size. Study 9 has maximum weightage and study 8 has minimum weightage. Higher the effect size with minimum standard deviation leads to more weightage

follow-up (T3) These data were pooled to enable the primary evaluation of long-term s nonsurgical open-bite treatment outcomes by molar intrusion.

ROB within studies are given in Table 2.

3.3. Results of individual studies

To calculate or primary outcome i.e. Stability of overbite correction, overbite (in mm) was taken as a parameter. This parameter was fond in all 13 articles

To find out whether the reason for relapse was skeletal or dental in nature, SN-MP angle and U6-PP (in mm) were taken. The former was found in 12 out of 13 articles and latter was found in 9 out of 13 articlesFigure 2,Figure 3 and Figure 4 F tells us the overall mean Pretreatment overbite (in mm), Pretreatment SN MP Angle and Pretreatment U6-PP plane (in mm). Figure 5,Figure 6 and Figure 7 tells us the overall mean Post treatment overbite (in mm), Post treatment SN MP Angle and Post treatment U6-PP plane (in mm).

Figure 8, Figure 9 and Figure 10 tells us the overall mean Post retention overbite (in mm), Post retention SN MP Angle and Post retention U6-PP plane (in mm).

3.4. Synthesis of results

On comparing pretreatment and post treatment values of overbite mean which was derived from their respective forest plot graphs (Figure 2 and Figure 5), significant

amount of correction in overbite was found.

On comparing pretreatment and post treatment values of SN MP angle mean which was derived from their respective forest plot graphs (Figure 3 and Figure 6), significant amount of reduction in the angle was found.

The reason behind this was due to intrusion of the molars, this in turn leads to autorotation of the mandible in the anti-clockwise direction leading to a decrease in SN MP angle.

On comparing pretreatment and post treatment values of U6 –PP (in mm) which was derived from their respective forest plot graphs (Figure 4 and Figure 7), significant amount of reduction in the parameter was found was found, indicating that the molars were intruded.

On comparing post treatment(1.47mm) and post retention(1 mm) values of overbite which was derived from their respective forest plot graphs (Figure 5 and Figure 8), significant amount of relapse was found.

To find out the cause of relapse, two more parameters were taken.

On comparing post treatment(39.33 degree) and post retention values(39.66 degrees) of SN MP angle which was derived from their respective forest plot graphs (Figure 6 and Figure 9), non-significant amount of relapse was found.

On comparing post treatment (23.69 mm) and post retention(24.76 mm) values of U6 PP (mm) which was derived from their respective forest plot graphs (Figure 7 and Figure 10), significant amount of relapse was found.

3.5. Rob across studies

The risk of bias across studies were low

4. Discussion

4.1. Summary of evidence

The different post retention time periods and absence of U6-pp values among the studies has led to increased level of heterogeneity. Nevertheless, this uncontrolled sample represents the best evidence to date and could serve as a starting point for future studies with more rigorous designs

According to Table 4 significant change in Post retention Overbite (in mm) compared to post treatment Overbite (in mm) indicates the nature of the corrected overbite was subject to relapse.

According to Table 5 no significant change in Post retention SN MP Angle compared to Post treatment SN MP Angle indicates that no residual disproportionate growth in the vertical dimension was left in the patient which would

have been responsible for relapse. According to Table 6, significant change in U6 pp indicates the nature of the relapse to be of dentoalveolar origin.

According to Tables 4, 5 and 6 this study shows that skeletal open bite patients treated with molar intrusion have 68 % stability which is supported by Table 4. Whereas the molar which was intruded have a 95% stability which is supported by table 6. The findings confirm that there was no residual growth left in the patients and the relapse was dentoalveolar in nature as confirmed by Table 5 and Table 6. Other studies in the past have concluded that correction of skeletal open bite has a relapse rate of approximately 25% to 30%. However they do not specify the relapse rate of skeletal open bite treated with different treatment modalities separately. Although a previous meta analysis was conducted which elaborated the overall stability of skeletal open bite, the nature of relapse, it been skeletal or dentoalveolar in nature has not been commented upon.

This study has attempted to rule out the reason of relapse to be dentoalveolar in nature and not skeletal. No Disproportionate residual growth was responsible for the bite to relapse as indicated by there been no significant change in the mean SN-MP angle of post treatment from that of post retention. This study was also aimed to co relate the rate of overbite relapse with that of the amount of relapse in molar intrusion. There are limitations to this analysis, mostly due to the low level of evidence of the included studies.

Of particular interest is clinical decision-making for borderline patients, such as older adolescents with AOB or adults with mild to moderate open bite

5. Limitations

Several shortcomings were observed because of the lack of adequate randomization methods, absence of outcome assessment blinding.

6. Conclusion

1. This study states that skeletal open bite patients treated with molar intrusion have 68 % stability, whereas the intruded molar have a 95% stability.
2. As discussed previously the reason why the mandible's movement doesn't follow a 1:1 ratio is because of its cantilever like anatomy.[2]
3. No residual disproportionate growth in the vertical dimension was left in the patient which would have been responsible for relapse and the relapse was dentoalveolar in nature.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Nielsen IL. Vertical malocclusions: etiology, development,diagnosis and some aspects of treatment. *Angle Orthod*. 1991;61(4):247–60.
2. Sandler P, Madahar A, Murra A. Anterior open bite: aetiology and management. *Dent Update*. 2011;38(8):522–32.
3. Iscan HN, Sarisoy L. Comparison of the effects of passive posterior bite-blocks with different construction bites on the craniofacial and dentoalveolar structures. *Am J Orthod Dentofac Orthop*. 1997;112(2):112–71.
4. Proffit WR. St Louis:Mosby Year Book. and others, editor; 1993. p. 236–43.
5. Breunig A, Rokosi T. The treatment of open-bites using magnets. *Fortschr Kieferorthop*. 1992;53:179–86.
6. Dellinger EL. Active vertical corrector treatment-long-term follow-up of anterior open bite treated by the intrusion of posterior teeth. *Am J Orthod Dentofac Orthop*. 1996;110(2):145–54.
7. Noar JH, Shell N, Hunt NP. The performance of bonded magnets used in the treatment of anterior open bite. *Am J Orthod Dentofac Orthop*. 1996;109:549–56.
8. Kuster R, Ingervall B. The effect of treatment of skeletal open bite with two types of bite-blocks. *Eur J Orthod*. 1992;14(6):489–99.
9. Kim YH. Anterior openbite and its treatment with multiloop edgewise archwire. *Angle Orthod*. 1987;57(4):290–321.
10. Kim YH, Han UK, Lim DD, Serraon M. Stability of anterior open bite correction with multiloop edgewise archwire therapy: a cephalometric follow-up study. *Am J Orthod Dentofac Orthop*. 2000;118(1):43–54.
11. Dyer GS, Harris EF, Vaden JL. Age effects on orthodontic treatment: adolescents contrasted with adults. *Am J Orthod Dentofac Orthop*. 1991;100(6):523–53.
12. Nieke BK. Retention and stability considerations for adult patients. *Dent Clin North Am*. 1996;40(4):961–94.
13. Schudy FF. The rotation of the mandible resulting from growth: its implications in orthodontic treatment. *Angle Orthod*. 1965;35:36–50.
14. Sterne J, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. *BMJ*. 2016;12:355.
15. Baek M, Choi Y, Yu H, Lee K, Kwak J, Park Y. Long-term stability of anterior open-bite treatment by intrusion of maxillary posterior teeth. *Am J Orthod Dentofac Orthop*. 2010;138(4):396–7.
16. Deguchi T, Kurosaka H, Oikawa H, Kuroda S, Takahashi I, Yamashiro T. Comparison of orthodontic treatment outcomes in adults with skeletal open bite between conventional edgewise treatment and implant-anchored orthodontics. *Am J Orthod Dentofac Orthop*. 2011;139(4):60–8.
17. Marzouk E, Kassem H. Evaluation of long-term stability of skeletal anterior open bite correction in adults treated with maxillary posterior segment intrusion using zygomatic miniplates. *Am J Orthod Dentofac Orthop*. 2016;150(1):78–88.
18. Hernández AV, García RL, Sanz VG, Gallardo VP, Latorre FL. Nonsurgical treatment of skeletal anterior open bite in adult patients: Posterior build-ups. *Angle Orthod*. 2017;87(1):33–40.
19. Scheffler N, Proffit W, Phillips C. Outcomes and stability in patients with anterior open bite and long anterior face height treated with temporary anchorage devices and a maxillary intrusion splint. *Am J Orthod Dentofac Orthop*. 2014;146(5):594–602.
20. He S, Gao J, Wamalwa P, Wang Y, Zou S, Chen S. Camouflage treatment of skeletal Class III malocclusion with multiloop edgewise arch wire and modified Class III elastics by maxillary mini-implant anchorage. *Angle Orthod*. 2013;83(4):630–40.
21. Kuroda S, Sakai Y, Tamamura N, Deguchi T, Yamamoto TT. Treatment of severe anterior open bite with skeletal anchorage in adults: Comparison with orthognathic surgery outcomes. *Am J Orthod Dentofac Orthop*. 2007;132(5):599–605.
22. Sugawara J, Baik U, Umemori M, Takahashi I, Nagasaka H, Kawamura H. Treatment and posttreatment dentoalveolar changes following intrusion of mandibular molars with application of a skeletal anchorage system (SAS) for open bite correction. . *Int J Orthod Orthog Surg*. 2002;17(4):243–53.
23. Park Y, Lee H, Choi N, Kim D. Open Bite Correction by Intrusion of Posterior Teeth with Miniscrews. *The Angle Orthod*. 2008;78(4):699–710.
24. Foot R, Dalci O, Gonzales C, Tarraf N, Darendeliler M. The short-term skeleto-dental effects of a new spring for the intrusion of maxillary posterior teeth in open bite patients. *Prog Orthod*. 2014;15(1):56.
25. Kim Y, Han U, Lim D, Serraon M. Stability of anterior openbite correction with multiloop edgewise archwire therapy: A cephalometric follow-up study. *Am J Orthod Dentofac Orthop*. 2000;118(1):43–54.
26. Remmers D, Hullenaar RV, Bronkhorst E, Bergé S, Katsaros C. Treatment results and long-term stability of anterior open bite malocclusion. *Orthod Craniofac Res*. 2008;11(1):32–42.
27. Geron S, Wasserstein A, Geron Z. Stability of anterior open bite correction of adults treated with lingual appliances. *Eur J Orthod*. 2012;35(5):599–603.

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