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STABILITY AFTER INTRUSION & AUTOROTATION OF MANDIBULAR POSTERIOR TEETH :A META- ANALYSIS

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ABSTRACT

Background:Intrusion of teeth is one of the orthodontic movement treatment used to treat the alignment. **Aim:** To assess & evaluate the scientific literature & compile current state of evidence for stability of PTI & AOM by MA. **Material & Method:** In our meta analysis we have assessed past scientific literature upto 8 in number which were full filling the inclusion criteria for know about stability of teeth after PTI treatment in 3 different groups i.e. miniscrew, miniplate and both with the help of MPA, FH, OB, UMPP.**Result:**For MPA-EV, groups 1 & 2 showed positive outcomes that regarding stability on the other hand, group 3, favored relapse rather than stability. For FH-EV, group 1 & 2 showed the steadiness while group 3 showed relapse rather than stability. For OB-EV, groups 1 & 2 had more variation ($\chi^2=78.59$, $\chi^2 = 3.98$) and reliable data ($I^2 = 96\%$ and 75% respectively), but group 3 shown lower variation ($\chi^2 = 1.39$) and inconsistent data ($I^2 = 28\%$) and UMPP-EV, group 2 & 3 exhibited greater variation ($\chi^2 = 2.09$, $\chi^2 = 4.75$) and conflicting data ($I^2 = 52\%$ and 79% respectively), whereas group 1 demonstrated less variation ($\chi^2 = 1.76$) and consistent data ($I^2 = 0\%$) in relation to OB. **Conclusion:** Relapse does occur but still treatment outcome remains stable even after 1 year of follow-up. Stability can be improved for PTI with proper retention protocol.

Keywords: PTI, AOM, MA, FH, OB, UMPP, MPA, relapse, stability, alignment.

INTRODUCTION

Intrusion of the teeth is one of main fundamental treatment modality in many cases while doing orthodontic corrections. Therefore, whenever an orthodontist apply intrusion procedure against any tooth the equal extrusive force is experienced by the remaining teeth. Hence, this process could be classified both for anterior & posterior, according to the results achieved i.e. true intrusion or absolute intrusion, relative intrusion and pseudointrusion. [1,3] Furthermore, in our research we are basically focusing about posterior intrusion, which eventually causes autorotation of mandible, therefore we have considered relative and true intrusion but not pseudointrusion. A study has shown that, 1mm of posterior teeth intrusion leads to 2mm of bite closure.[4] Various studies have been conducted by Kuroda et al [5,6], Sugawara et al [7,8,9] & Beak et al [9,8,10] concluded that relapse invariably occur irrespective of intrusion technique in posterior teeth used. Furthermore, every study conducted to date mentioned different values for relapse of intruded teeth. This is because they have taken follow-up at different time intervals & for different sample sizes. Hence, there is a need for studies with long term follow up & longer sample sizes. According to a studies “meta-analysis(MA) is a quantitative, formal, epidemiological study design used to systematically assess previous research studies to drive conclusions about the body of the research”. [11,12]

Hence, we have decided to evaluate the stability of posterior teeth intrusion & autorotation of mandible by MA.

REVIEW OF LITERATURE

Hakami Z. (2016) [4] “compiled and summarized the existing molar intrusive techniques and appliances, considering their advantages, disadvantages, and potential clinical effectiveness. They stated that molar intrusion has always been a complex and difficult treatment modality. Patients with open bites or those with over-erupted molar teeth can benefit from its use.”

Alsafadi A, Alabdullah M, Saltaji H, Abdo A, Youssef M (2016) [13] “conducted a systematic review on the impact of molar intrusion using temporary anchorage devices in patients with an anterior open bite. The goal was to find out how molar intrusion affects the shape of the face and the movement of the lower jaw during open-bite treatment of permanent teeth with the help of a comprehensive analysis of public data upto September 2015.”

Wang XD, Zhang JN, Liu DW, Lei FF, Liu WT, Song Y et al (2017) [14] “presented a case report on the use of miniscrew-assisted vertical control to correct a severe high angle with mandibular retrusion and a gummy smile in an adult. The patient's diagnosis indicated a skeletal Class II skull base with a mild anterior open bite, a protrusive maxilla, and a backwardly rotated mandible.”

Pinzan-Vercelino CR, Bramante FS, de Araújo Gurgel J, Vergani EC, de Souza Gregório R. (2017) [15] “conducted a study of 57-year-old woman underwent treatment for a maxillary molar supra eruption. The procedure involved the placement of buttons on the buccal and palatal surfaces of the molars, along with the use of 2 mini-implants and elastomeric chains. The intrusion was successfully accomplished within a span of 5 months.”

Al-Dhubhani MK. (2018) [16] “conducted a comprehensive review of the existing scientific evidence on the stability of AOB correction in patients who have undergone posterior tooth intrusion using TADs. Further conducted a thorough search of electronic databases and specific orthodontic journals. Various studies were collected that examined the stability of AOB correction through the use of different types of TADs, including RCTs, n-RCTs, and retrospective studies (RTSs). These studies specifically focused on the intrusion of maxillary, mandibular posterior teeth, or both. Both reviewers actively participated in the process of data extraction and analysis, resolving any disagreements through discussion. Three RTSs and one

NRCT were identified. There was a lack of substantial scientific evidence when evaluating the risk of bias in the studies involved, as no related randomized controlled trials were identified. Despite the relapse of overbite after debonding, it is worth noting that all 95 participants in the studies managed to maintain a positive overbite. The relapse of the overbite could not be solely attributed to the posterior tooth intrusion relapse. There is limited scientific evidence to support the long-term stability of correcting the AOB by intruding posterior teeth using TAD”.

Deng J, Yan-Ang, Wang X, Jing, Ding Y, Zhou Y (2018) [17] “evaluated the long-term stability of vertical control in hyperdivergent patients who were treated with transient anchorage devices. The sample consisted of 20 hyperdivergent patients who did not have an anterior gaping bite. The temporary anchorage devices were employed to intrude on the upper incisor and molars in order to maintain vertical control. Prior to treatment, immediately following treatment, and during retention, lateral cephalograms were implemented. After treatment, the upper molars and incisors intruded by 1.33 mm and 1.41 mm, respectively ($P < 0.05$). U6-PP increased by 0.11 mm and 0.23 mm during the first and second phases of retention, respectively ($P > 0.05$). U1-PP exhibited a significant extrusion of 1.2 mm during the first stage ($P < 0.05$), which increased by 0.68 mm during the second stage ($P > 0.05$). The mandibular plane angle (MP-SN) experienced a relapse of 0.510 and 0.420 during the first and second phases of retention, respectively, and decreased by 2.58 degrees following treatment ($P > 0.05$). There were no substantial alterations in soft tissue, with the exception of an increase in the length of the upper mandible during the second stage ($P < 0.05$). Following treatment with vertical intrusion, it is possible to successfully treat maxillary anterior and posterior intrusions, counterclockwise rotation of the mandibular plane, and enhanced profiles. Intruded molars and incisors both exhibited some extrusion during the first stage of retention (less than three years), and molars had superior long-term stability than incisors. The therapeutic effects were consistent during the second stage of retention, which lasted from three to six years, with the exception of a slight increase in the length of the upper lip. The mandibular plane, which was rotated, maintained its stability throughout the retention period.”

AIM

To assess & evaluate the scientific literature & compile current state of evidence for stability of PTI & AOM by MA.

MATERIAL & METHOD

In our study we have involve steps like formulation of problem, literature search, selected studies, identifying & coding study characteristics, analyze the selected studies and report meta-analytic findings.

FORMULATION OF PROBLEM

we have conducted & collected on literature related to the stability of treatment outcome was not much discussed in orthodontics. Therefore, there is a need for strong evidence regarding stability. During clinical practice, patients, as well as clinicians, prefer intrusion of posterior teeth over orthognathic surgery for correction of vertical problems. Maintaining the position of intruded teeth after completion of treatment is challenging in clinics.

LITERATURE SEARCH

For the purpose of meta-analysis, searching for scientific literature articles and reviews is necessary. Based on the study topic, a search protocol was made to obtain primary and secondary keywords (Table 1).

SR NO	PRIMARY KEY WORD	SECONDARY KEY WORD
1	Posterior teeth intrusion	Skeletal open bite, Dental open bite, Gummy smile, clockwise rotated maxilla and mandible, increase anterior facial height, TAD, Mini screw, Mini plate, Mini implant, headgear, posterior bite block, bite block with spring, bite block with a magnet.
2	Intrusion of molar	
3	Autorotation of mandible	
4	Stability of posterior teeth intrusion	
5	Stability of autorotation of mandible	

TABLE 1: SEARCH STRATEGY

We have used PICO protocol for searching articles .

- P= Population :** Patient requiring posterior teeth intrusion (open bite, gummy smile, clockwiserotated maxilla & mandible , increase anterior facial height , etc.)
- I= Intervention :** Intrusion of posterior teeth
- C= Comparion :** Patient with intrusion & without intrusion
- O= Outcome :** a. Stability of posterior teeth intrusion
b. Autorotation of mandible

Scientific literature, articles & reviews were searched using following keywords individually & by combing with Boolean operator.

SELECTED STUDIES

Listed below are inclusion & exclusion criteria for our study.

Inclusion Criteria

1. No gender specification
2. No age limit specification.
3. Electronic database regarding orthodontic treatment completed for each patient.
4. Electronic database in which clinical evaluation of posterior intrusion and its stability performed in patients (at least 1 clinical evaluation after completion of treatment, imaging evaluation (Lateral cephalogram, tomogram, magnetic resonant imaging, etc.)
5. Data containing studies like case series, survey, retrospective studies including only post-treatment evaluation with or without control, case-control, cohort studies and randomized clinical trials.
6. Case reports and opinion papers.
7. Literature must be in the English language

Exclusion Criteria

1. Studies dealing with incomplete orthodontic therapy and/or orthognathic surgery.
2. To avoid multi publication bias (in which the same study is reported by different authors under different titles or in different journals), we are choosing 1 representative article from the independent report.
3. Patients presenting craniofacial pathologies, syndrome, cleft lip and/or palate.

IDENTIFY & CODING STUDY CHARACTERISTIC

An independent quality assessment of the included studies was performed according to a modified Newcastle-Ottawa scale by 2 investigators. In areas of disagreement, a third investigator was consulted, and consensus was obtained after discussion.

ANALZING THE STUDIES SELECTED

Parameters used for meta- analysis are:-

1. Overbite
2. Mandibular Plane
3. Upper Molar to palatal plane
4. Facial height

We have calculated relapse, and calculating relapse indirectly proved the stability. Less relapse increases the stability of the treatment. This ultimately determined whether the treatment favored stability or not.

ASSESSMENT OF BIAS IN INDIVIDUAL STUDY & ACROSS STUDIES

The assessment of heterogeneity was done using the χ^2 based Q statistic method and the I² index. However, it is important to note that the Q statistic may not be very sensitive to detecting heterogeneity(HG). Therefore, a more substantial HG among the studies was considered when the I² index reached 50%. A chi-square test was also performed to assess heterogeneity. Calculations were conducted using the Comprehensive MA software (RevMan5). When analyzing each study, we utilized the RevMan5 software provided by Cochrane to assess the risk of bias. The software conveniently offered predefined biases in drop-down menus for the 6 domains. We have evaluated following fields which include randomized sequence generation (selection bias), allocation concealment (selection bias), blinding of participants & personnel (performance bias), blinding of outcome assessors (detection bias), incomplete outcome data addressed (attrition bias), selective outcome reporting (reporting bias) & other bias.

Furthermore, risk of bias of included trials were assessed using:-

1. **Low risk of bias** : Green colour coded
2. **Unclear risk of bias**: Yellow colour coded
3. **High risk of bias**: Red colour coded

This risk of bias is displayed next to each forest plot of each study with colour-coding of green as low risk, yellow as unclear & red as high risk.

REPORTING MA FINDING

The data was summarized using a forest plot and a funnel plot. The chi-square test of homogeneity and the chi-square test were performed to assess the heterogeneity of the studies included. The random-effects model incorporated the variability among articles in estimating the accuracy of summary estimates by considering a distribution of the true parameter being estimated across studies, instead of assuming a single true parameter value. The 95% confidence interval values were calculated to indicate the accuracy of the combined means.

The changes occurred were evaluated for the following 3 groups:-

1. Miniscrew- group 1
2. Miniplate- group 2
3. Both – group 3

The changes due to posterior teeth intrusion were evaluated in 2 different categories:-

1. Mandibular plane angle (MPA)
2. Facial height(FH)

The dental changes were evaluated based on changes seen in following cephalometric parameters:-

1. Overbite (OB)
2. Upper Molar to palatal plane(UMPP)

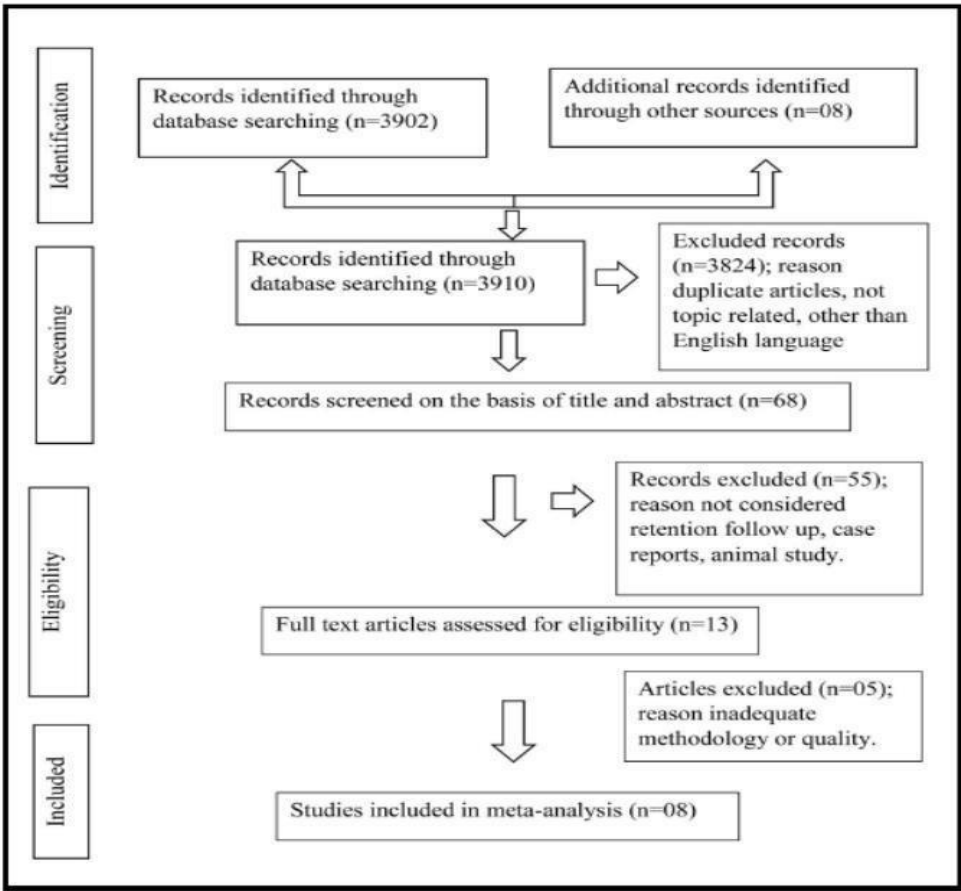
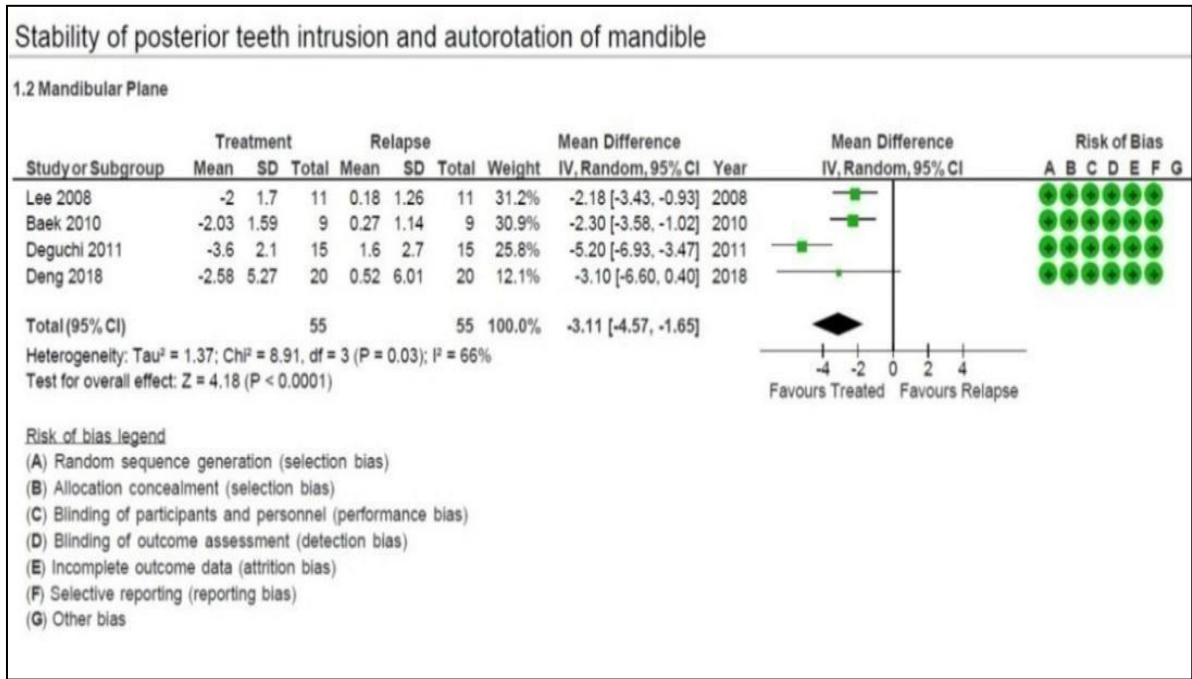


FIGURE 1: PRISMA FLOW CHART

RESULT

1. MINISCREW

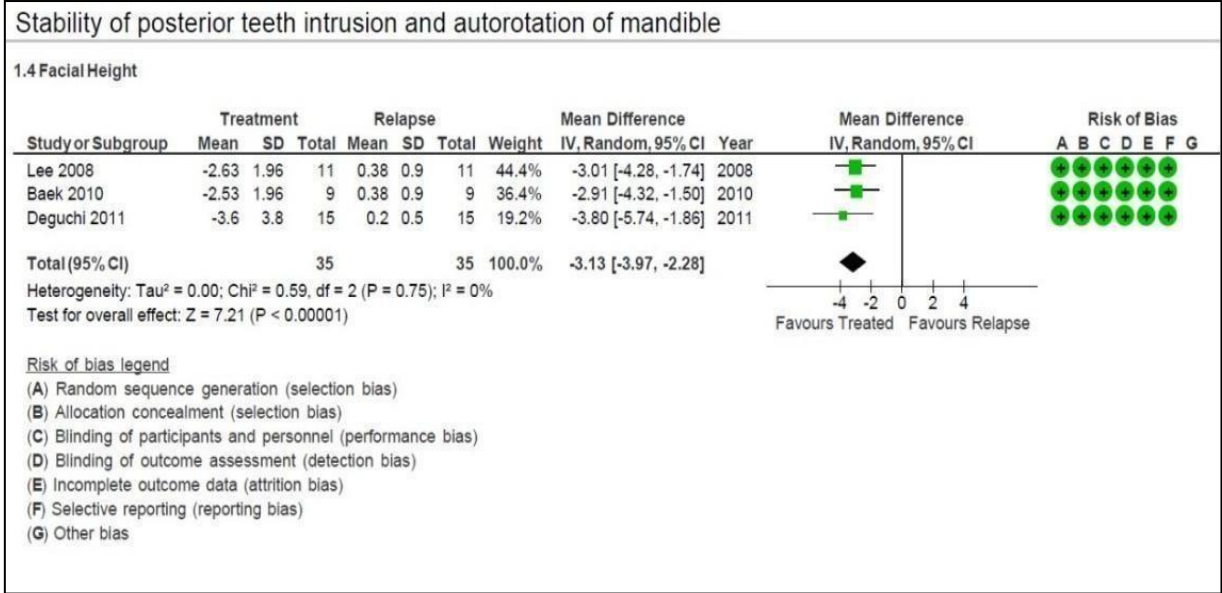
We found that , all studies which showed low risk of bias were denoted by green color i.e. low risk of selection bias, performance bias, detection bias, attrition bias, and reporting bias Diamond not crossing the line of the null effect denotes that pooled data favoured treatment



FOREST PLOT 1.1: MPA

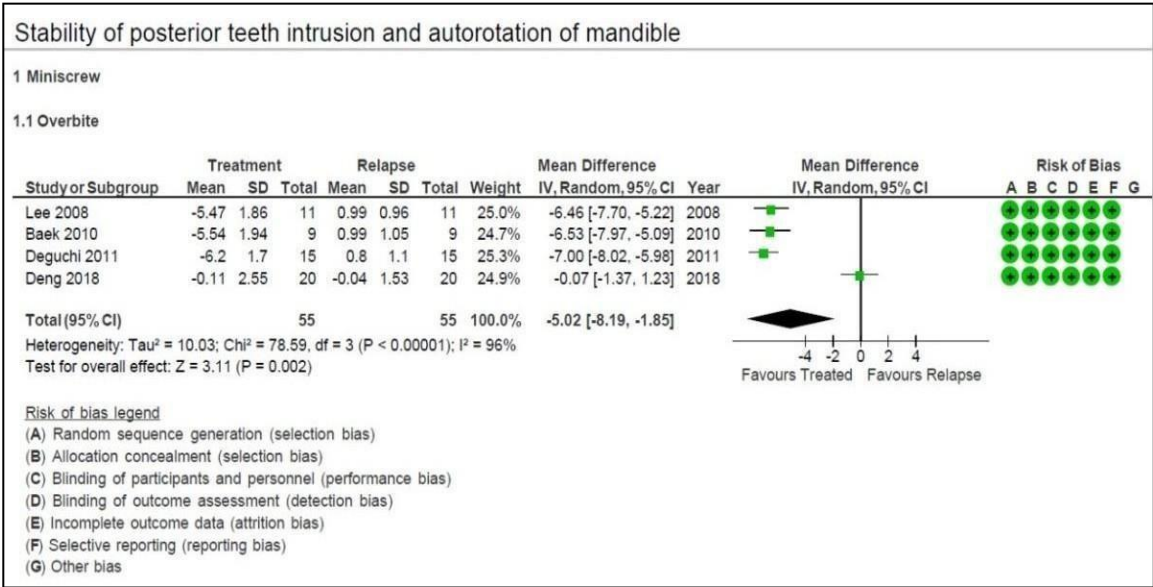
Forest plot 1.1 showed that, pooled estimate as – 3.11mm [95%CI: -4.57, -1.65]. Heterogeneity was evaluated by $I^2 = 66\%$, which means studies were inconsistent ($I^2 > 50$)i.e.this MA considered studies that were not from same population.Three studies showed statistical significant stability but only one study (Deng 2018) did not showed statistically significant

stability of posterior teeth intrusion(PTI) and autorotation of mandible(AOM). Thus, evaluation showed significant stability.



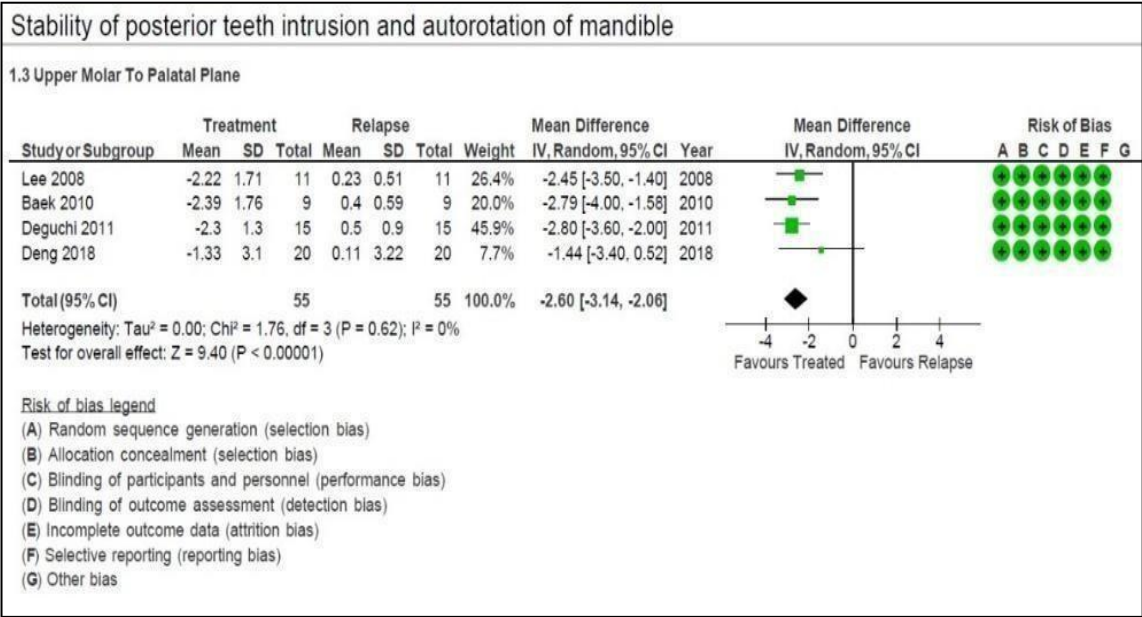
FOREST PLOT 1.2: FH

Forest plot 1.2 showed that, pooled estimate as – 3.13 mm [95%CI: -3.97, -2.28]. Heterogeneity was evaluated by $I^2 = 0\%$, which means studies were consistent ($I^2 < 50$)i.e.this MA considered studies that were not from same population.All three studies showed statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability.



FOREST PLOT 1.3: OB

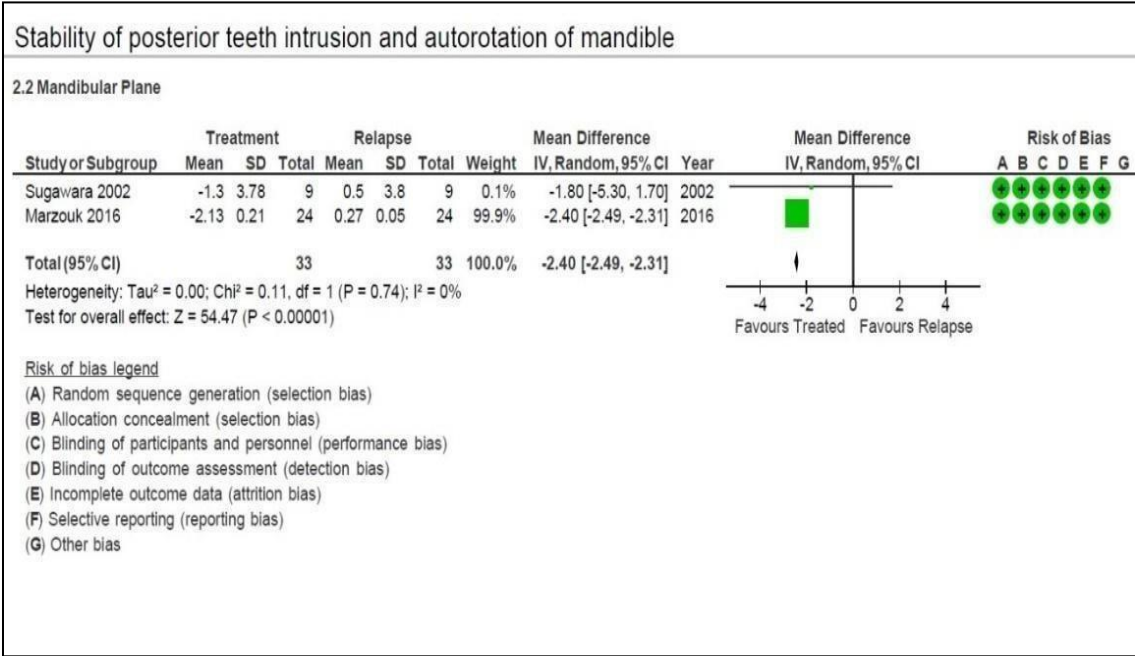
Forest plot 1.3 showed that, pooled estimated as -5.02mm [95%CI: -8.19, -1.85]. Heterogeneity was evaluated by $I^2 = 96\%$, which meant the studies were inconsistent ($I^2 > 50\%$) i.e. MA considered studies that were not from the same population.Three studies showed statistical significant stability but only one study (Deng 2018) did not showed statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability



FOREST PLOT 1.4: UMPP

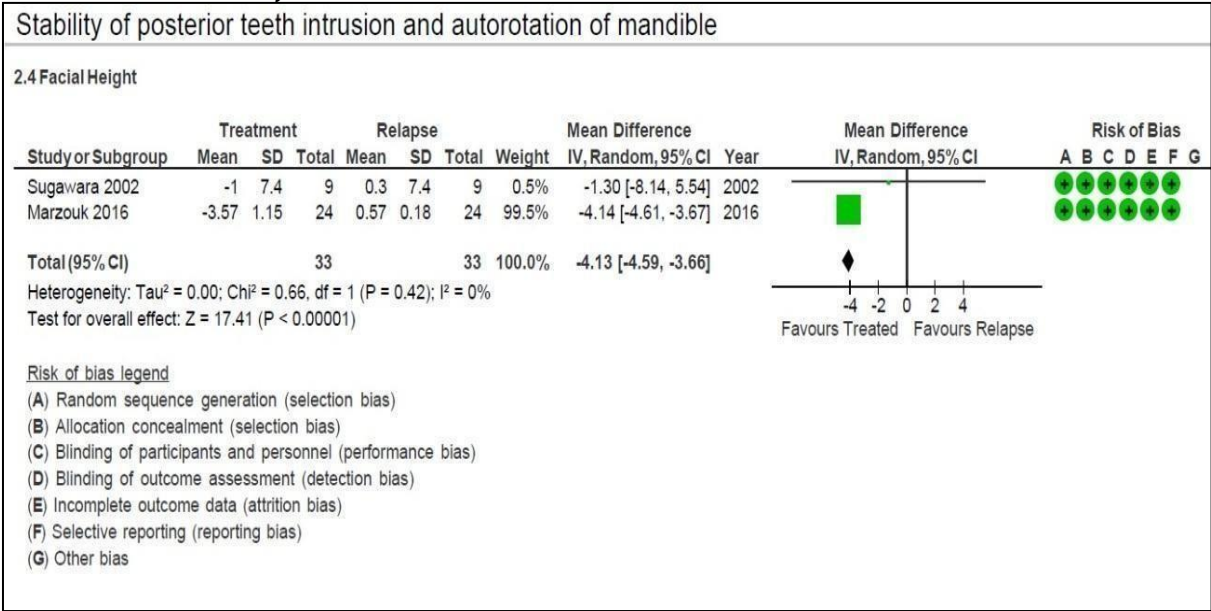
Forest plot 1.4 showed that, pooled estimate as -2.60 mm [95%CI: -3.14 , -2.06]. Heterogeneity was evaluated by $I^2 = 0\%$, which meant the studies were consistent ($I^2 < 50\%$) i.e. MA considered studies that were not from the same population. Three studies showed statistical significant stability but only one study (Deng 2018) did not showed statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability.

2. MINIPLATE



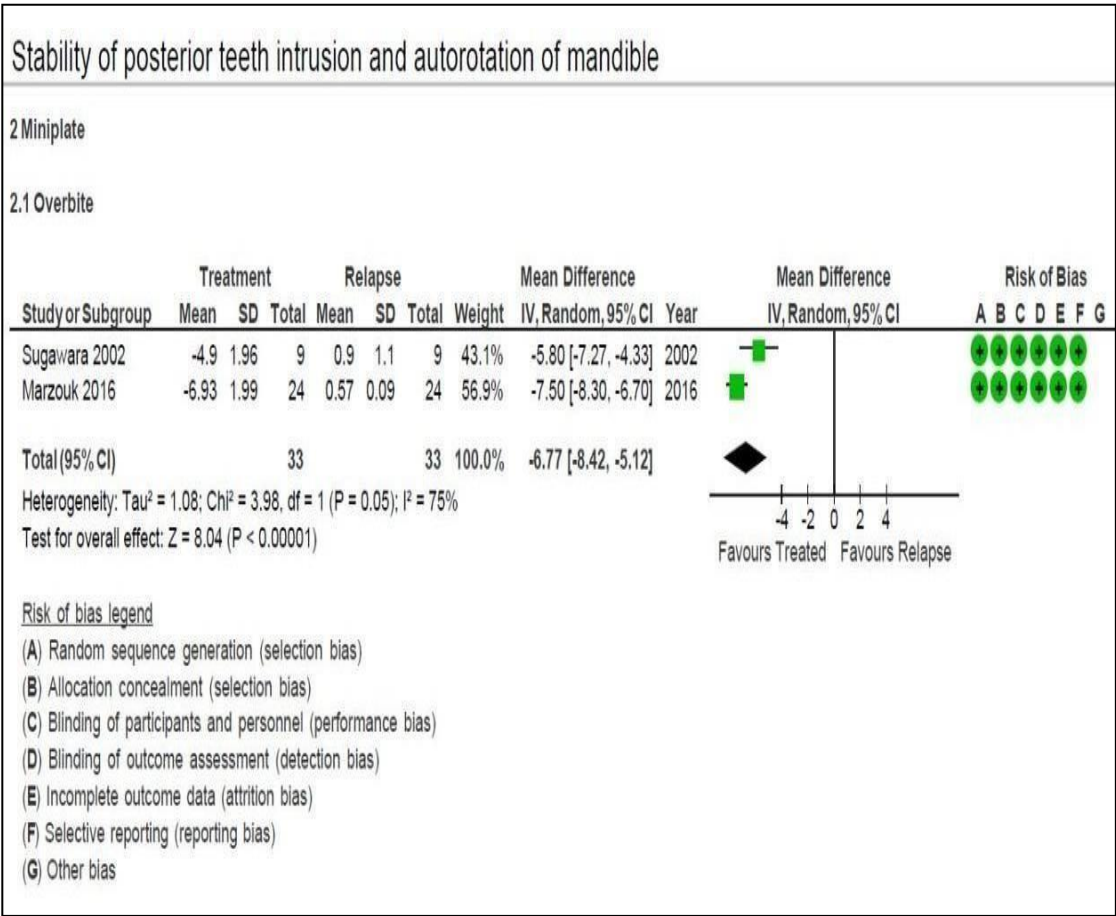
FOREST PLOT 2.1: MPA

Forest plot 2.1 showed that, pooled estimate as -2.40 mm [95%CI: -2.49 , -2.31]. Heterogeneity was evaluated by $I^2 = 0\%$, which meant the studies were consistent ($I^2 < 50\%$) i.e. MA considered studies that were not from the same population. One study (Marzouk 2016) showed statistically significant stability but another study (Sugawara 2002) did not show statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability.



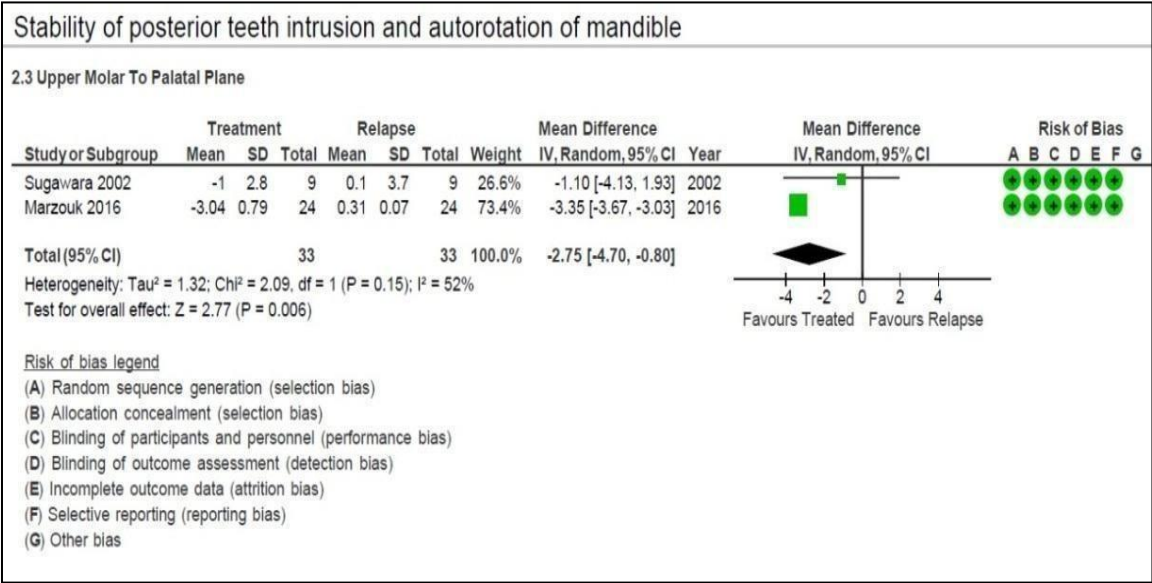
FOREST PLOT 2.2: FH

Forest plot 2.2 showed that, pooled estimate as -4.13 mm [95% CI -4.59, -3.66]. Heterogeneity was evaluated by $I^2 = 0\%$, which meant the studies were consistent ($I^2 < 50\%$) i.e. MA considered studies that were not from the same population. One study (Marzouk 2016) showed statistically significant stability but another study (Sugawara2002) did not show statistically significant stability of PTI and AOM. Diamond not crossing the line of the null effect denotes that pooled data favoured treatment. Thus, evaluation showed significant stability.



FOREST PLOT 2.3: OB

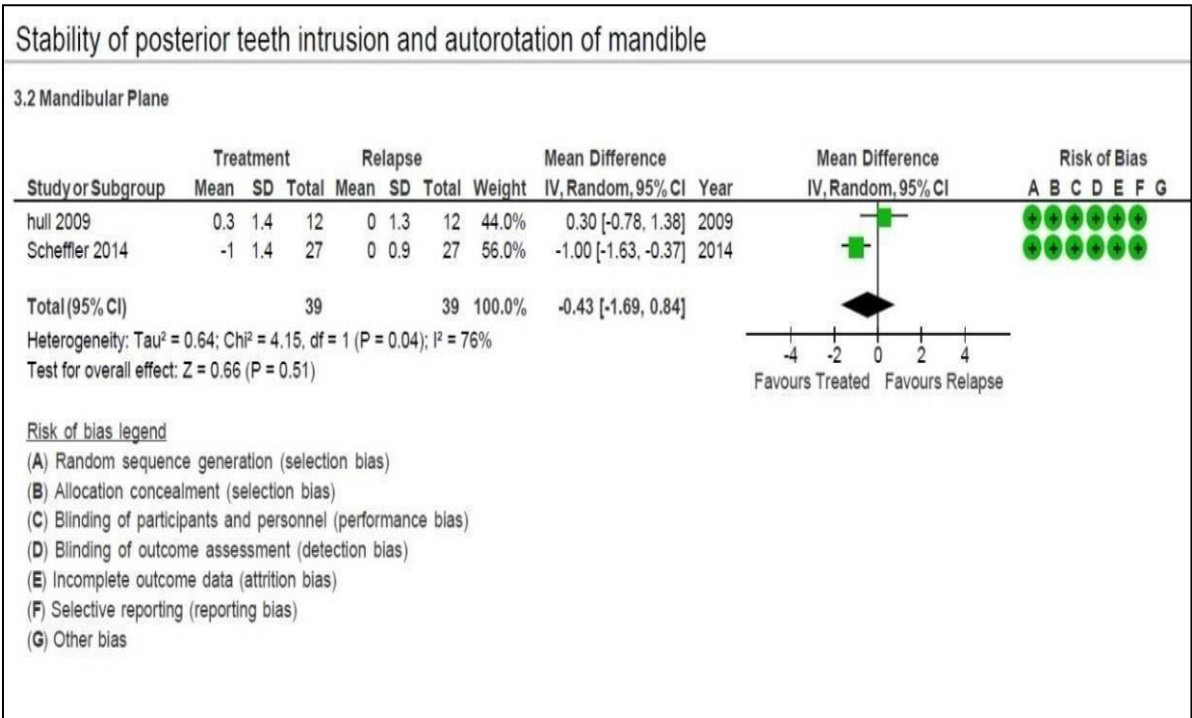
Forest plot 2.3 showed that, pooled estimate as – 6.77 mm [95%CI: -8.42, -5.12]. Heterogeneity was evaluated by $I^2 = 75\%$, which meant the studies were inconsistent ($I^2 > 50\%$) i.e. MA considered studies that were not from the same population. Both studies showed statistically significant stability of PTI and AOM. In the pooled data, included studies. Thus, evaluation showed significant stability.



FOREST PLOT 2.4: UMPP

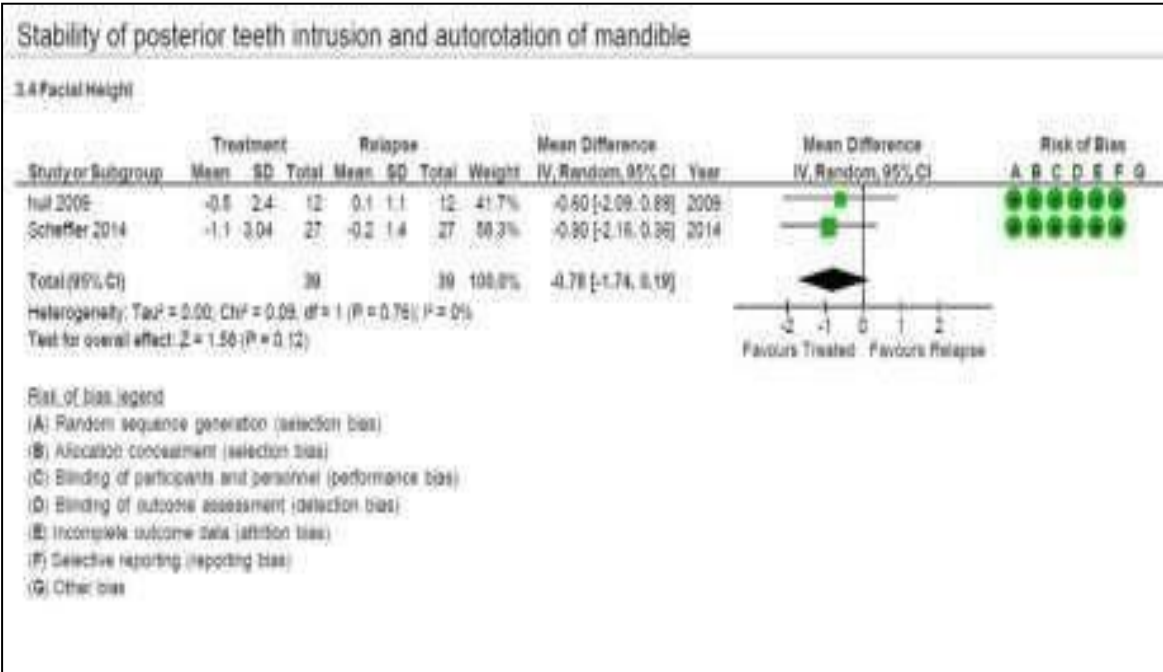
Forest plot 2.4 showed that, pooled estimate – 2.75 mm [95%CI: -4.70, -0.80]. Heterogeneity was evaluated by $I^2 = 52\%$, which meant the studies were inconsistent ($I^2 > 50\%$) i.e. MA considered studies that were not from the same population. One study (Marzouk 2016) showed statistically significant stability but another study (Sugawara 2002) did not show statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability.

3. BOTH



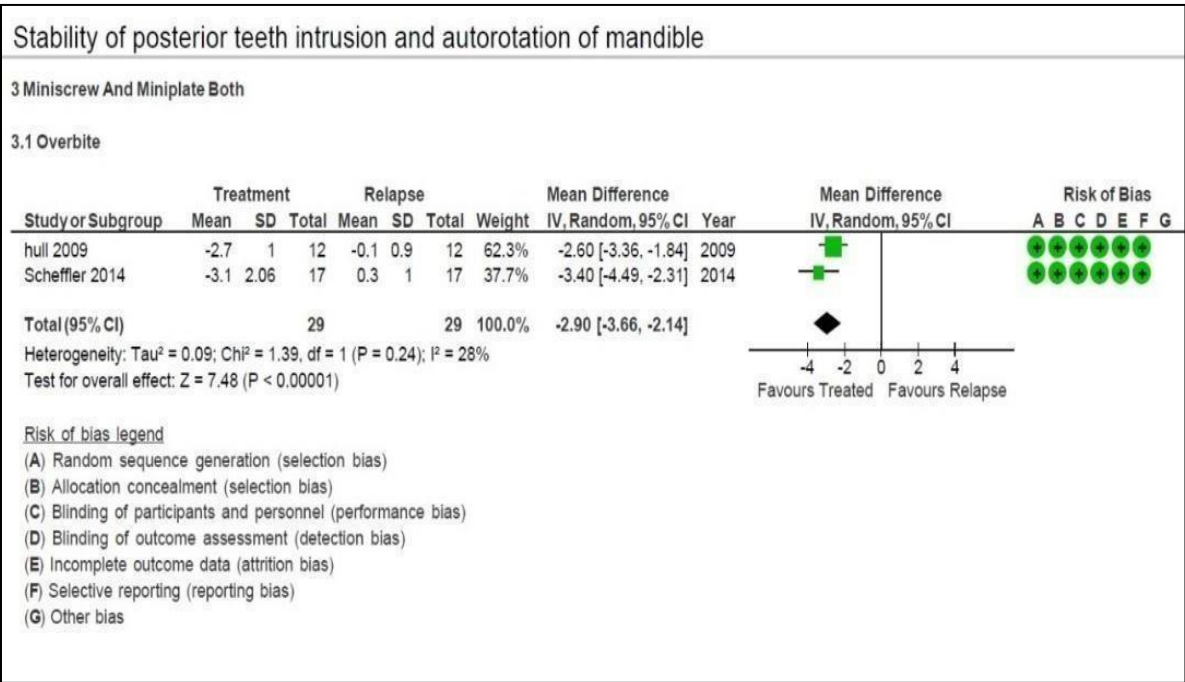
FOREST PLOT 3.1: MPA

Forest plot 3.1 showed that, pooled estimate as -0.43mm [95% CI -1.69, 0.84]. Heterogeneity was evaluated by $I^2 = 76\%$, which meant the studies were consistent ($I^2 > 50\%$) i.e. MA considered studies that were not from the same population. One study (Hull 2009) did not show statistically significant stability, but another study (Scheffler 2014) showed statistically significant stability of PTI and AOM. Diamonds crossing the line of the null effect that denotes pooled data favored relapse. Thus, evaluation did not showed significant stability.



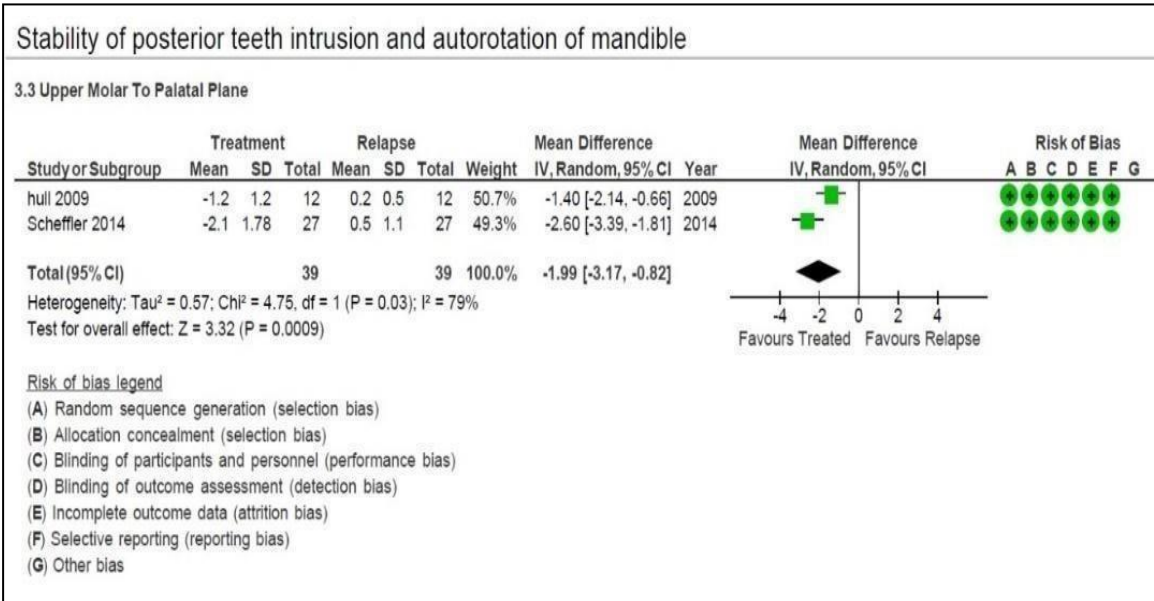
FOREST PLOT 3.2: FH

Forest plot 3.2 showed that, pooled estimate as -0.78 mm [95%CI: -1.74, 0.19].Heterogeneity was evaluated by $I^2 = 0\%$, which meant the studies were consistent ($I^2 < 50\%$) i.e. MA considered studies that were not from the same population. Both studies (hull 2009, Scheffler2014) did not show statistical significant stability of PTI and AOM. Diamond crossing the line of null effect denotes that pooled data favoured relapse.Thus, evaluation showed significant stability.



FOREST PLOT 3.3: OB

Forest plot 3.3 showed that, pooled estimate as – 2.90 mm [95%CI: -3.66, -2.14]. Both studies showed statistically significant stability. Heterogeneity was evaluated by $I^2 = 28\%$, which meant the studies were consistent ($I^2 < 50\%$) i.e. MA considered studies that were from the same population. Thus, evaluation showed significant stability.



FOREST PLOT 3.4: UMPP

Forest plot 3.4 showed that, pooled estimate as – 1.99 mm [95%CI: -3.17, -0.82]. Both studies showed statistically significant stability. Heterogeneity was evaluated by $I^2 = 79\%$, which meant the studies were inconsistent ($I^2 > 50\%$) i.e. MA considered studies that were from the same population. Both studies showed statistically significant stability of PTI and AOM. Thus, evaluation showed significant stability.

DISCUSSION

The success rate of PTI & AOM varied according to each study in all 8 articles, every author has considered a different definition of intrusion. Due to small sample size case reports were not included in this MA. In non-surgically treated adolescent, it was difficult to determine whether relapse of intruded teeth was due to poor growth pattern, residual habits or rebound of tooth position. However, adolescent patient showed relatively good record of success of orthodontic therapy. Several studies were conducted by McNamara (1977)[18], Carlson and Schneiderman (1983)[19], Altuna and Woodside (1985)[20], and Woods and Nanda (1988)[21] to investigate the impact of certain interventions on the eruption of posterior teeth in animals. Dellinger (1986)[22], Woodside and Linder-Aronson (1986)[23], Kalra et al. (1989)[24] & Kiliaridis et al. (1990)[25] conducted human studies that demonstrated the successful intrusion of posterior teeth. In their study, researchers utilized a magnetic bite block to facilitate the intrusion of posterior teeth. However, it is worth noting that the participants chosen for this study were individuals in the midst of their growth process. As individuals grow taller, the occlusion remains stable, making it challenging to accurately measure the amount of relapse. So, in this study only adult patients were included. Kalra et al. (1989)[17] showed that cemented magnetic bite-blocks improved mandibular development in patients with open bites after 4 months of treatment. They noticed a small rebound eruption of teeth, but the rest of the alterations were stable for magnetic bite block treatment for open bite-induced intrusion of posterior teeth.

MPA evaluation(EV)

The mandible was repositioned forward, anteriorly and upward due to the PTI, which is commonly referred to as AOM. Changes in the MPA occur as a result of AOM. By assessing

these changes, we can determine the extent of the shift in the vertical position of the posterior teeth. The angle exhibited minimal variation across all groups during the post-treatment phase. Notably, groups 1 and 2 demonstrated outcomes that supported the stability of the MP. Interestingly, among the three groups, group 3, which included miniscrew and miniplate, exhibited contrasting results that favored relapse rather than stability, in contrast to the other two groups. Group 1 and 3 exhibited greater variation ($\chi^2 = 8.91$, $\chi^2 = 4.15$) and inconclusive data ($I^2 = 66\%$ and 76% respectively), while group 2 demonstrated less variation ($\chi^2 = 0.11$) and consistent data ($I^2 = 0\%$) for overbite.

FH-EV

Changes in FH occur when the posterior teeth are repositioned inward, and it is important to consider this element when assessing stability. There were little changes in facial height seen in all groups over the post-treatment period. Group 1 and 2 exhibited results that confirmed the steadiness. All groups, including group 1, 2, and 3, showed minimal heterogeneity with chi-square values of 0.59, 0.66, and 0.09 respectively. The data in all groups were consistent, with I-squared values of 0% in each group. In contrast to the other two groups, group 3 had divergent outcomes that encouraged relapse rather than stability.

OB-EV

The modification in the OB that occurs during treatment and retention is just a manifestation of the changes in the vertical locations of the back teeth. It is important to assess this alteration while assessing the stability of the treatment. All the studies included in this meta-analysis demonstrated favorable results indicating the stability of overbite, as shown by forest plots 1.3, 2.3, and 3.3. There was a recurrence, although it was clinically inconsequential. Similarly, the combined findings of all studies likewise supported the notion that overbite stability is preferred over relapse. Groups 1 and 2 had more variation ($\chi^2 = 78.59$, $\chi^2 = 3.98$) and reliable data ($I^2 = 96\%$ and 75% respectively), but group 3 shown lower variation ($\chi^2 = 1.39$) and inconsistent data ($I^2 = 28\%$) regarding OB.

UMPP-EV

When examining the stability of posterior teeth intrusion, it is important to take into account the linear changes in the distance between the upper molar and the palatal plane. Once again, all the studies included in this meta-analysis consistently demonstrated results that support the stability of the upper molar to the palatal plane. Although there was a relapse, it was deemed clinically insignificant. Based on the combined findings of all the studies, it was found that the stability of the upper molar to palatal plane was preferred over the relapse. Group 2 and 3 exhibited greater variation ($\chi^2 = 2.09$, $\chi^2 = 4.75$) and conflicting data ($I^2 = 52\%$ and 79% respectively), whereas group 1 demonstrated less variation ($\chi^2 = 1.76$) and consistent data ($I^2 = 0\%$) in relation to overbite.

CONCLUSION

All pooled studies show that PTI & AOM has statistically significant stability. The analysis shows that among all intrusion methods, intrusion with miniscrew is the most effective procedure. The skeletal parameter, MPA & FH support the treatment over relapse. The dental parameter, OB & UMPP favor treatment over relapse, providing that PTI & AOM is a stable treatment. Relapse does occur but still treatment outcome remains stable even after 1 year of follow-up. Stability can be improved for PTI with proper retention protocol.

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