EFFECT OF THERAPEUTIC EXTRACTION OF FIRST AND SECOND PREMOLAR ON MANDIBULAR PLANE ANGLE – A SYSTEMATIC REVIEW

**Deepika J Nair, BDS[1] , Parvathy Ghosh, MDS[2] , Sapna Varma N.K, MDS[3]
, Ajith V.V,MDS[4], Devu Radhakrishnan Pillai, MDS[5]**

[1] Post Graduate Student, [2] Assistant Professor,
[3] Professor and Head of Department,
[4] Professor,
Orthodontics and Dentofacial Orthopedics, Amrita School of Dentistry, Kochi, Kerala, India,
[5]Consultant Orthodontist, Kuwait.
Corresponding Author
Dr. Parvathy Ghosh
Assistant Professor
Orthodontics and Dentofacial Orthopedics, Amrita School of Dentistry
Kochi, Kerala, India - 682041
Email: parvathyghosh08@gmail.com
Phone: +91 0484 2858901; +91 9633457499

Running Title: Premolar extraction and mandibular plane angle

ABSTRACT
Objective: A systematic review of the existing literature was done to evaluate the effects of therapeutic extraction of first and second premolar on mandibular plane angle and in turn on the vertical facial dimension.

Methods: Electronic database searches (MEDLINE, EBSCO host and Google Scholar) of published literature were performed with no publication date or language restrictions followed by manual searches for eligible studies. Extraction of data was done independently and in duplicate by two authors. Risk of bias was assessed using Cochrane's tool, ROBINS-I (Risk of bias in non-randomized studies – of interventions).

Results: Only four studies, 2 prospective and 2 retrospective, satisfied the eligibility criteria and were included in the current systematic review. All selected studies had a first and second premolar extraction group. The parameters evaluated were Sella-Nasion/Mandibular plane (SN/MP angle), lower anterior facial height (LAFH), total anterior facial height (TAFH) and lower anterior facial height ratio (LAFH/TAFH). The pretreatment and post treatment measurements in the included studies showed no statistical significance to suggest a decrease in mandibular plane angle after premolar extraction.

Conclusion: With the limited data that was assessed, it can be concluded that extraction of premolars regardless of it being first or second does not cause any anterior mandibular rotation. Since there was no reduction in mandibular plane angle and vertical facial dimensions, the wedge effect hypothesis has been proved wrong.

Key words: Bicuspid, tooth extraction, vertical dimension.

INTRODUCTION

Therapeutic extraction of premolars and its effects on treatment outcome has been acontroversial topic since the very beginning. In the early 1800s maxillary premolar extraction was routinely done to treat Class II division I malocclusions (1). Isaac B. Davenport in 1887 lectured against this, stating "extractions caused a loss of important organs."(2) In 1892, Kingsley described the use of a headgear to depress and drive the incisors distally after extracting the maxillary first premolars. However, he did not advocate if further, in line with other stalwarts of the time. E.H. Angle believed that a full complement of teeth and a normal occlusion should be present for the mouth and related structures to be in best harmony (1). Calvin Case restored therapeutic extractions by 1893 with an explanation that arch expansion though creates space for correction of malalignment the long-term stability and esthetics will not be satisfactory (1). Raymond Begg, Charles Tweed and Robert H.W. Strang had the greatest influence on extraction philosophy in the midcentury (1, 3). Mandible can rotate in clockwise or anti-clockwise direction (4). Clockwise rotation occurs when the posterior vertical growth exceeds condylar growth. When this happens pogonion cannot cope up with the forward growth of the upper face causing the mandibular plane to become steeper. Anti-clockwise rotation occurs due to more condylar growth than combined vertical growth and results in a forward movement of pogonion causing an increase in the facial angle. This "flattening" of the mandibular plane tends to increase the vertical overbite and makes retention and vertical overbite correction more difficult. Anterior dental height holds the key to overbite correction. In open bite cases the primary objective is to prevent an increase in dental height anteriorly. The degree of vertical overbite is determined by the association between horizontal and vertical growth. So, any change in mandibular plane angle causing an increase or decrease in vertical facial height is crucial (5). Facial types were described by Schudy as 'hypodivergent' and 'hyperdivergent'. He proposed an extraction treatment for hyperdivergent patients and a non- extraction treatment for patients with hypodivergent facial type. Many believe that premolar extraction causes no change in growth

pattern. Various studies found that no change occurs in facial height and mandibular plane angle with premolar extractions (6-9). However, a few found an increase in mandibular plane angle causing an increase in vertical facial height (10, 11). Some studies have also suggested a decrease in mandibular plane angle following premolar extraction resulting in bite deepening (12, 13). The effect is commonly explained by molars moving into the premolar extraction sites, which causes the mandibular plane to rotate anteriorly. The 'wedge effect' hypothesizes that, the extraction of all premolars or molars and the resultant forward movement of the posterior teeth leads to an anti-clockwise rotation of the mandible which maintains or increases the overbite. Even though this theory is widely accepted, it is not evidence based. Hence, the objective of the current review was to search systematically the existing literature and to assess the effects of therapeutic extraction of first and second premolar on mandibular plane angle and in turn on the vertical facial dimension.

MATERIALS AND METHODS

This systematic review was conducted according to the standards of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). There was no funding for this study and ethical approval was not requested as only previously published data was included in the review.

I. Criteria for selection of studies

Inclusion criteria Only the articles which fulfilled the following criteria in the five domains of a study were selected.

1. Design – Randomized control trial, non-randomized control trial, quasi-randomized control trial, prospective study and retrospective studies having control groups.

2. Subjects – Any age group and gender with any skeletal/dental malocclusion.

3. Intervention – Patients who underwent fixed appliance therapy in both arches. Comparison between therapeutic extraction of first and second premolar within the same study.

4. Documentation – Availability of pre- and post-treatment cephalometric values.

5. Outcome - Only hard tissue changes, (Effect on mandibular plane angle and vertical dimension of face) Exclusion criteria Studies with the following characteristics in the same five domains were not included

1. Design – Case report, animal studies, In-vitro studies, systematic review, and literature review.

2. Subjects- Less than 15 subjects.

3. Intervention- Orthognathic surgery along with orthodontic treatment, extraction of first or second mandibular premolar for reasons other than orthodontic treatment, functional, orthopedic or expansion appliances during treatment.

4. Documentation- Methods other than cephalometrics.

5. Outcome – Soft tissue changes.

II. Search strategy

Considering the differences in syntax rules and controlled vocabulary for each database, detailed search strategies were developed. Initially basic search was carried out after which the Medical Subject Headings (MeSH) terms were identified. Following this, advanced searches with appropriate key terms and Boolean operators were performed. Database search strategy has been summarized in Table 1. The databases included were Medline, EBSCO host and Google Scholar. The search aimed at identifying all relevant studies with no publication date or language barriers. Subject was restricted to dentistry or orthodontics according to the option availability in the database. To obtain additional studies the references of eligible studies were searched manually.

III. Selection of studies

Selection of studies for the review was conducted independently and in duplicate by the first two authors. They were not blinded to the identity of the authors, their institutions, or their research findings. The selection procedure included title-reading, abstract-reading and full-text-reading stages. Studies that were not eligible were excluded. Full texts were assessed by both these authors independently for inclusion in the review. Disagreements were charted and later resolved during discussions between the authors.

IV. Data collection and management

Two authors performed data collection separately and together. All disagreements were settled by re-evaluating the identified studies until a consensus was reached.

Table 1: Database Search Strategy

Medline/Pubmed/Scopus

First premolar AND extraction AND vertical changes

Second premolar AND extraction AND vertical changes

First premolar AND extraction AND vertical dimension

Second premolar AND extraction AND vertical dimension

First premolar AND extraction AND facial height

Second premolar AND extraction AND facial height

First premolar OR second premolar AND extraction AND mandibular plane [ti]

Google scholar

First premolar AND extraction AND vertical changes [ti]

Second premolar AND extraction AND vertical changes [ti]

First premolar AND extraction AND vertical dimension [ti]

V. Analysis of reporting bias

Bias in reporting occurs when the reporting of investigation findings is influenced by the nature or direction of the findings themselves. This systematic review strived to reduce potential reporting biases, including multiple (duplicate reports), publication and language bias by conducting a sensitive and accurate search of many sources with no publication date or language restrictions.

VI. Quality assessment

ROBINS-I (Risk of bias in non-randomized studies – of interventions) tool was used to assess quality of included studies (14). Two authors evaluated the studies individually and then compared their conclusions. All disagreements were settled after discussion.

RESULTS

Description of studies

The flow chart (PRISMA statement) describing the selection of studies is given in Figure 1. A total of 589 studies were identified at the start through electronic search of databases. Additional 14 records were identified through a manual search. After removal of duplicates and application of study selection criteria, 177 studies were selected for further screening. During title and abstract reading stage 21 articles by reviewer 1 and 14 articles by reviewer 2 were selected for full text reading. From these 36 articles, 17 were further excluded on a combined evaluation. Reasons for the same have been mentioned in the flow diagram. As a result, only 4 articles have been included in this systematic review. Of these four articles, the studies by Aynur Aras and Kim et al were prospective whereas studies by Al-Nimri and Yating et al were retrospective (15-18). These studies evaluated the effects of therapeutic extraction of first and second premolar on mandibular plane angle and facial height under the same study setting. A summary of the main characteristics is given in Table 2.

Figure 1. The flow chart showing the method of selection of studies
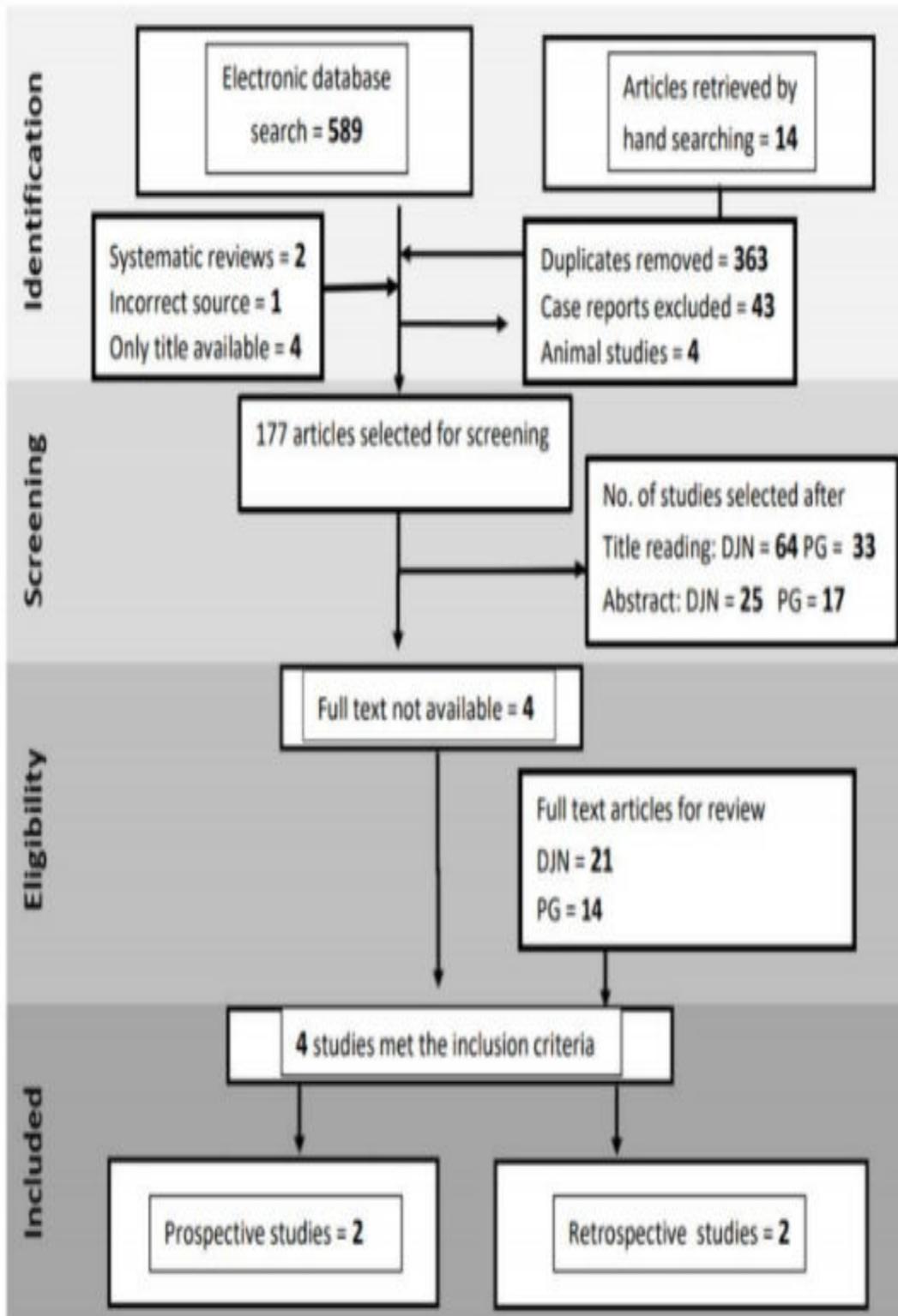
Table 2: Main characteristics of the included studies

Author Year Study design	Main objective	First premolar extraction group (E4)		2nd premolar extraction group (E5)		Malocclusion Skeletal pattern	Mandibular plane	Facial height	Mesial migration of mandibular molars
		Intervention Sample size Gender Age -mean± S.D	Treatment	Intervention Sample size Gender Age -mean± S.D	Treatment				
Aynur Aras (2002) Prospective	Determine vertical changes	Extraction of mandibular first premolar 15 6 M, 9 F 14.85 ± 1.05	Straight wire appliance Space closure with coil springs on a continuous arch wire Use of class II or III elastics	Extraction of mandibular 2nd premolar 9 3 M, 6 F 15.04 ± 1.20	Straight wire appliance Space closure with coil springs on a continuous arch wire Use of class II or III elastics	Skeletal open bite (only anterior teeth E4; extending till premolars E5 Class I or II molar relationship	Mandibular plane angle (Sn- GoGN)	LAFH TAFH LAFH/TA FH	LM to Gn horizontal. Horizontal distance from bisection of occlusal surface of L6 to perpendicular to mandibular plane at Gnathion.
Tae-Kyung Kim et al (2005) Prospective	Changes in facial vertical dimension	Extraction of maxillary and mandibular first premolar 27 6 M, 21 F 15.6 ± 3.9	Pre-adjusted edgewise appliance with a 0.022" slot and closing loop mechanics.	Extraction of maxillary and mandibular 2nd premolar 27 6 M, 21 F 16.2 ± 4.0 y	Pre-adjusted edgewise appliance with a 0.022" slot and closing loop mechanics.	Class I hyper divergent cases	SN to mandibular plane angle (SN-MP) FH to mandibular plane angle (FH-MP) MMA	LAFH TAFH LAFH/TA FH	Superimposition by structural method. L1E – Mandibular central incisor edge. LM – Mesial contact point of mandibular first molar
Kazem S. Al-Nimri (2006) Retrospective	Change in facial vertical dimension	Extraction of mandibular first premolar n=26 16 M, 10 F 13.2 ± 1.5	Pre-adjusted edge-wise appliances Roth prescription slot size 0.022×0.028 Space closure 0.019×0.025" SS arch wire	Extraction of mandibular 2nd premolar 26 16 M, 10 F 13.4 ± 1.4	Pre-adjusted edge-wise appliances Roth prescription slot size 0.022×0.028 Space closure 0.019×0.025 " SS arch wire	Class II Division I malocclusion	Mandibular plane angle (Go-Me) to FH plane Maxillary-mandibular plane angle (ANS-PNS AND Me-Pog line)	TAFH LAFH PFH LAFH/TA FH PFH/TAF H	Superimposition on corpus axis (Xi point to protuberance menti at suprapogonion. LIE to N-Pog (distance from mandibular incisor tip to nasion-
Yating Wang et al (2013) Retrospective	Determine vertical changes	Extraction of maxillary and mandibular first premolars 46 24 M, 22 F	Straight wire appliance with 0.022" slot Space closure 0.019×0.025" SS arch wire Niti closing springs Class II elastics	Extraction of maxillary first and mandibular 2nd premolars 41 21 M, 26 F	Straight wire appliance with 0.022" slot Space closure 0.019×0.025 " SS arch wire Niti closing springs Class II elastics	Angles class I molar relationship	Mandibular plane angle (SN- Go-Me)	LAFH LAFH/TA FH	L1 to Pterygoid vertical (perpendicular to SN plane through Ptm) L6 to Pterygoid vertical

S.D – Standard Deviation; M – Male; F – Female;; Sn-GoGn – Sella- Gonian-Gnathion; LAFH – Lower anterior facial height; TAFH – Total anterior facial height; LAFH/TAFH – Lower anterior facial height ratio; LM – Mesial contact point of first molar; L6 – Lower molar; L1 – Lower central incisor; MP – Mandibular plane; FH – Frankfort Horizontal plane; L1E – Mandibular central incisor edge; MMA – Maxillo-mandibular plane angle; Me – Menton; PFH – Posterior facial height; ANS – Anterior nasal spine; PNS – Posterior nasal spine

Quality assessment

No study was labeled "low" relating to confounding, because all known important confounding domains were duly measured but not fully managed in any case. Reliability and validity of measurement of important domains were sufficient. Studies by Yating et al and Aynur Aras were regarded as problematic due to limited information about selection of participants and measurement of outcome. These were assessed as 'serious' risk of bias. Studies by Kim et al and Al-Nimri were graded as 'moderate' risk for bias. Risk of bias assessment has been summarized in Table 3.

Table 3: Risk of bias in the included studies

Title of Study/Author/Year	Bias due to confounding	Bias in participants selection	Bias in intervention classification	Bias due to deviation from intended studies	Bias due to missing data	Bias in outcome measurement	Bias in reported result selection	Overall bias
Vertical changes following orthodontic extraction treatment in skeletal open bite subjects - Aynur Aras (2002)	Moderate	Moderate	Moderate	No information	Low	Moderate	Moderate	Serious
First or second premolar extraction effects on facial vertical dimension - Tae-Kyung Kim et al (2005)	Moderate	Moderate	Low	Low	Low	Moderate	Low	Moderate
Vertical changes in Class II Division 1 malocclusion after premolar extractions - Kazem S. Al-Nimri (2006)	Moderate	Moderate	Moderate	Low	Low	Moderate	Low	Moderate
Vertical changes in Class I malocclusion between two different extraction patterns - Yating Wang et al (2013)	Moderate	Moderate	Moderate	Low	Low	Moderate	Moderate	Serious

Effects of first premolar extraction

Differences in the pre-treatment facial vertical dimension (FVD) between first premolar extraction group (E4) and second premolar extraction group (E5) were analyzed. In the study by Kim et al, statistically significant differences were noted in Sella-Nasion/Mandibular plane angle (SN/MP), (P<0.05). No differences were seen in other parameters that measured FVD between groups E4 and E5. Facial height in group E4 increased significantly post treatment (P<0 .05), but no statistically significant differences were noted in angular and proportional measurements.

But mandibular plane angle remained nearly constant in group E4 in the study by Aynur Aras. Lower anterior and total anterior facial height showed the largest increase in E4 group. Extrusion of mandibular molars was the largest in group E4. Here, no significant changes were observed in mandibular plane angle and lower anterior facial height ratio suggesting rotation of the mandible.

Al-Nimri noted that the mean value of total anterior facial height (TAFH) and lower anterior facial height (LAFH) after treatment increased in both the groups. In group E4, there was no change in the mandibular plane angle. The average increase in the LAFH here was 4.2 mm and the mandibular molars protracted by 2.9 mm during the course of treatment. The difference in protraction of mandibular molars between E4 and E5 group was statistically significant.

In the study by Yating et al, SN-MP angle decreased significantly in Group E4. Facial height parameters increased after treatment in both groups (P<0.001). Remarkable differences between groups were not noted.

Effects of second premolar extraction

Kim et al found the mesial movement of maxillary and mandibular molars was more in Group E5 than in group E4 (P<0.05). Group E5 showed an increase in anterior facial height (P<0.05). Angular and proportional measurements were similar to that in group E4 showing no statistically significant changes. Unlike E4, E5 group did not present any difference in FVD.

In the study by Aynur Aras, in group E5, significant changes were noted in mandibular plane angle, which indicated a forward mandibular rotation. The mandibular plane angle decreased in group E5 and E6 with maximum reduction in group E6. Extrusion of mandibular molars was indistinguishable in groups E5 and E6. An increase in LAFH and TAFH was noted in group E5. The least increase was noted in group E6.

Al-Nimri, though reports an average reduction of 0.88 in the MP and MM angles in group E5, the change was not statistically significant (P>0.05). The PFH/TFAFH ratio showed a significant increase of 1.0%, (P<0.05). An average increase of 3.8 mm in the LAFH was seen in E5 group which again was not significant. Here, the mandibular molars were protracted by 4.7 mm.

In the study by Yating et al, SN-MP increased slightly in Group E5. Increase in facial height was seen after treatment in both groups (P<0.001).

Effect on vertical dimension of the face

No significant differences were reported in the facial vertical measurements between first and second premolar extraction groups by Kim et al as well as by Al-Nimri. But, Aynur Aras showed

that extraction of second premolars lead to closing rotation of mandible leading to reduced vertical facial height.

Table 4: Interventions and outcomes of included studies

Author/ Year/Design	INTERVENTION	Results Mean ± SD of T1 – T0 difference	Effect on Vertical dimension of the face
Aynur Aras (2002) Prospective	Group 1 (n=15) (Extraction of first premolar) (E4) Group 2 (n=9) (Extraction of second premolar) (E5) (Extraction of first molar) (E6) (n=8)	MPA (Sn – GoGn) (P =0.474) E4 = 0.2 ± 3.16 E5 = 1.06 ± 2.04 LAFH (ANS – Me) (P = 0.623) E4 = -3.6 ± 6.93 E5 = -2.3 ± 4.65 TAFH (N – Me) (P = 0.642) E4 = -5.4 ± 7.62 E5 = -4 ± 5.95 LAFH /TAFH (%) (P = 0.736) E4 = -0.35 ± 2.64 E5 = -0.02 ± 1.52	-Extraction of first premolar does not cause any change in vertical dimension. -Extraction of second premolars and first molar led to closing rotation of mandible and thus reduced vertical facial height in patients with skeletal open bite.
Tae-Kyung Kim et al (2005) Prospective	Group 1 (n=27) (Extraction of first premolar) (E4) Group 2 (n=27) (Extraction of second premolar) (E5)	Sn – MPA (P = 0.475) E4 = 0.56 ± 1.70 E5 = 0.26 ± 1.35 FH - MPA (P = 0.584) E4 = 0.13 ± 1.81 E5 = 0.39 ± 1.66 LAFH (ANS – Me) (P = 0.353) E4 = 2.06 ± 2.39 E5 = 2.65 ± 2.24 TAFH (N – Me) (P = 0.915) E4 = 3.44 ± 3.06 E5 = 3.35 ± 3.14 LAFH /TAFH (%) (P = 0.097)** E4 = 0.17 ± 1.07 E5 = 0.62 ± 0.88	-Extraction of first or second premolars showed no decrease in facial vertical dimension. -The lower facial height ratio was statistically different in group E5, but the amount of increase was too small to have clinical significance.
Kazem S. Al-Nimri (2006) Retrospective	Group 1 (n=26) (Extraction of first premolar) (E4) Group 2 (n=26) (Extraction of second premolar) (E5)	MPA (Sn – GoGn) (P = 0.483) E4 = -0.3 ± 0.5 E5 = -0.8 ± 0.5 LAFH (ANS – Me) (P = 0.160) E4 = 4.2 ± 0.4 E5 = 3.8 ± 0.4 TAFH (N – Me) (P = 0.184) E4 = -7.5 ± 1.5 E5 = 6.0 ± 1.5 LAFH /TAFH (%) (P = 0.426)	-No significant difference in the facial vertical growth between first and second premolar extraction groups.
Yating Wang et al (2013) Retrospective	Group 1 (n=47) (Extraction of second premolar) (E5) Group 2 (n=46) (Extraction of first premolar) (E4)	Sn – MPA (P = 0.017)** E4 = -0.18 ± 1.51 E5 = 0.30 ± 1.55 LAFH (ANS – Me) (P = 0.624) E4 = 5.74 ± 1.96 E5 = 1.41 ± 2.67 LAFH / TAFH (%) (P = 0.506) E4 = -0.06 ± 0.70 E5 = 0.76 ± 0.92	-The MP-SN angle showed a statistically significant increase slightly in E5 group and decrease in E4 group. This less than 1° decrease was clinically insignificant. -Wedge effects were balanced by extrusion of posterior teeth as well as residual growth potential.

T1- Post treatment time; T0 – Pre- treatment time; E4 – First premolar extraction group; E5 – Second premolar extraction group; S.D – Standard Deviation; n = Number of subjects; M – Male; F – Female; y – Years; Sn-GoGn – Sella- Gonian-Gnathion; P = Statistical significance(P value); LAFH – Lower anterior facial height; TAFH – Total anterior facial height; LAFH/TAFH – Lower anterior facial height ratio; N – Nasion; MP – Mandibular plane; Me – Menton; ANS – Anterior nasal spine; ** Statistically significant.

Yating et al, also noted no significant vertical changes with extraction of both first and second premolars and here the wedge effects were compensated by extrusion of posterior teeth and residual growth potential. The comparison of pre and post treatment parameters that assess vertical facial height and mandibular plane angle of the four included studies, their mean values and standard deviations have been summarized in Table 4.

DISCUSSION

Orthodontic treatment effects on vertical dimension of the face are of utmost importance to an Orthodontist. In patients with a hyperdivergent facial profile, Orthodontists attempt to decrease the facial height or maintain it. On the other hand, in patients who have a hypodivergent profile, the existing lower anterior facial height has to be maintained or increased. Several orthodontic techniques are available for the same of which premolar extractions have remained controversial. Premolar extractions are done in patients with a hyperdivergent profile because it is believed to cause mesialization of the molars and in turn an upward and forward displacement of the mandible causing a reduction in mandibular plane angle and thereby producing a reduced facial height. This concept is known as the wedge effect and still remains hypothesis without clear proof.

Many studies over a period of time found no difference in vertical dimension of the face with premolar extractions. (8,19-21). A few found a decrease in mandibular plane angle causing an anti-clockwise rotation of the mandible (12,13). On the other hand, Carter et al and Abu-Alhaija et al found a significant increase in facial height with extraction of premolars (10, 22). Apart from evaluating premolar extraction effects on vertical dimension of the face, this systematic review compared the effects caused by first and second premolar extraction on facial height. Very few studies were identified having two groups, one with extraction of first and the other with extraction of second premolar under the same study setting.

Four such studies have been included and all four studies assessed mandibular plane angle, lower anterior facial height, total facial height and the ratio between the two. Since the parameters are common among all the four studies and are reliable for evaluating changes in vertical dimension, comparison could be done and conclusions could be drawn. The studies by Kim et al, Yating et al and Al-Nimri did not support the wedge concept. They concluded that if the posterior teeth extrusion keeps pace with anterior facial height increase, the bite-closing effect due to movement of molars mesially can be nullified. Increased mesial movements can allow for more molar extrusion with appropriate treatment mechanics. The molars are extruded when the extraction space is closed and this appears to maintain or even increase the facial vertical dimension (16). The mandibular plane angle can also be maintained if mesial movement and extrusion of molars are balanced in a certain proportion (11).

Apart from extrusion of molars, residual growth potential also plays a major role in reversing the wedge effect (17,18). The presence of residual vertical growth can cause an increase in lower anterior facial height (23-25). Garlington and Logan observed a compensatory change in maxillary vertical growth that counteracted the counter-clockwise rotation of the mandible (26).

The present systematic review has analyzed only 4 studies with moderate risk of bias. This can be considered as a limitation. Further studies can be done including more data from literature having low risk of bias. Only one study supports the hypothesis that extraction of premolars causes anterior rotation of the mandible thereby reducing vertical dimension of the face (15). The other three studies did not show significant differences between the effects caused by first or second premolar extraction. The conclusions of these studies have been summarized in Table 5.

Table 5: Conclusions of included studies

Author Year Study design	CONCLUSIONS
Aynur Aras (2002) Prospective	- No significant mandibular rotational change was observed following orthodontic treatment with first premolar extractions in subjects with a skeletal open bite consisting of anterior teeth involvement only. - Within the appropriate indications, the extraction of the second premolars or the first molars led to a closing rotation of the mandible in skeletal anterior open bite extending to the posterior teeth.
Tae-Kyung Kim et al (2005) Prospective	- Regardless of maxillary and mandibular P1 or P2 extraction treatments, there was no decrease of FVD and no significant difference in FVD changes in the patients with a Class I malocclusion and hyper divergent facial type. -Therefore, the wedge effect concept that the bite is closed by extraction of P2 and forward movement of molars seems invalid.
Kazem S. Al-Nimri (2006) Retrospective	- Mandibular premolar extraction in Class II division 1 subjects was not associated with a significant reduction of the facial divergence measured by the MM angle and the MP angle. - Second premolar extraction was associated with more forward movement of the mandibular molars; there was no significant difference in the facial vertical growth between first and second premolars extraction groups.
Yating Wang et al (2013) Retrospective	- No significant vertical changes occurred after orthodontic treatment with 2 different extraction patterns; the hypothesized wedge effects due to mesial movement of posterior teeth might be balanced by the extrusion of posterior teeth as well as the residual growth potentials.

CONCLUSIONS

With the limited data that was analyzed it can be concluded that extraction of premolars regardless of it being first or second, does not cause a counter-clockwise rotation of

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the mandible. The wedge effect was not documented and there will be no reduction in mandibular plane angle and vertical facial dimensions. Therefore, extraction of premolars cannot be considered as an evidence-based treatment approach to reduce vertical facial height.

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