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Extraction versus non-extraction orthodontic treatment: a systematic review and meta-analysis

Karim Gamal Elias[a] **; Gautham Sivamurthy**[b]**; David R. Bearn**[c]

[a] Orthodontist, Cairo, Egypt; and former postgraduate student, Orthodontics, School of Dentistry, University of Dundee, Dundee, United Kingdom

[b] Clinical Lecturer and Honorary Consultant in Orthodontics, School of Dentistry, University of Dundee, Dundee, United Kingdom

[c] Honorary Professor of Orthodontics, School of Dentistry, University of Dundee, Dundee; and Consultant in Orthodontics, NHS Fife, United Kingdom

Corresponding Author: Karim Gamal Elias, School of Dentistry, University of Dundee, Dundee, United Kingdom

E-mail: kgnelias@outlook.com

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ABSTRACT

Objectives: To compare four first premolar extraction and non-extraction treatment effects on intra-arch width, profile, treatment duration, occlusal outcomes, smile aesthetics and stability.

Materials and Methods: Electronic search of literature to June 2nd, 2023 was conducted, using health science databases with additional search of grey literature, unpublished material and hand searching, for studies reporting non-surgical patients with fixed appliances regarding sixteen sub outcomes. Data extraction utilized customized forms, quality assessed with ROBINS-I and Cochrane RoB 2. GRADE assessed certainty of evidence.

Results: Thirty (29 RS, 1 RCT) studies were included. Random effect meta-analysis (95%CI) demonstrated maxillary (MD -2.03mm;[-2.97, -1.09];P<0.0001) and mandibular inter-first molar width decrease (MD -2.00mm;[-2.71, -1.30];P<0.00001) with four first premolar extraction. Mandibular intercanine width increase (MD 0.68mm;[0.36, 0.99];P<0.0001) and shorter treatment duration (MD 0.36years;[0.10, 0.62];P=0.007) in non-extraction group. Narrative synthesis included three and five studies for upper and lower lips-E plane, respectively. For ABO-OGS and maxillary/mandibular anterior alignment (Little's Irregularity Index) each included two studies with inconclusive evidence. No eligible studies for UK PAR score. Class I subgroup/sensitivity analyses favoured same results. Prediction interval indicated no significant difference for all outcomes.

Conclusions: Four first premolar extraction results in maxillary and mandibular inter-first molar width decrease and retraction of upper/lower lips. Non-extraction treatment results in mandibular intercanine width increase and shorter treatment duration. No significant difference between the two groups regarding maxillary intercanine width, US PAR score and posttreatment smile aesthetics. Further high-quality focused research recommended.

KEY WORDS: Orthodontic extractions; Arch width; Profile; Treatment outcomes; Smile aesthetics; Stability

INTRODUCTION

The longest running debate in orthodontics, spanning more than a century, has been the effects of extraction and non-extraction treatment[1]. The main concern with extraction treatment has been the possible deleterious effect on facial profile and the main concern with non-extraction treatment being post-treatment stability[2]. Edward Angle's philosophy of preserving the full complement of teeth argued that extraction of teeth would cause an imbalance in facial harmony, and abnormal function due to the change in arch width and form[3]. Unlike many of Angle's disciples, Calvin Case opposed this philosophy and defended the extraction of teeth in treating malocclusion to avoid later relapse[4]. However it was not until the 1940s, when more members of the orthodontic fraternity (including Charles H. Tweed and Raymond Begg) also supported an extraction treatment approach, that it became a generally accepted option[5,6].

Since then the pendulum has swung between extraction and non-extraction treatment, reporting a peak extraction rate of 76% in 1968[7] declining to 17.6% in 2005[8] among University of North Carolina patients, whereas at the University of São Paulo, non-extraction treatment continued with an upward trend from 14.29% (1973-1977) to 54.55 % (2003- 2007)[9].

Orthodontic literature has discussed this conundrum, with conflicting results. Bowman and Johnston[10]examined the effects on facial profile and concluded from a sample of 120 patients that extraction treatment had positive results for patients who had initial protrusion relative to E plane, but it was detrimental for those who had retrusive lips before starting treatment. Boley et al.[11]studied profiles of 50 patients and concluded that no difference was found between the two groups as facial profile measurements (Holdaway H-line) were within normal limits. Konstantonis[12]attributed change in extraction patients' soft tissue profile to greater incisor retraction, which can be controlled during treatment planning with less retraction mechanics and more mesialization of posterior segments. These effects are more pronounced in patients with thin lips or high lip strain.

Little et al.[13]concluded that extraction does not guarantee long term stability and Rossouw et al.[14]reported no significant difference in stability between extraction and non-extraction groups, with similar amounts of relapse.

The literature has previously reported premolar extraction compared to non-extraction treatment focused on limited outcomes[12,15–23].A recently published scoping review[24]outlined the weaknesses of published evidence across the breadth of the current literature but did not include any quantitative evaluation of the available data. This systematic review is therefore focused on four first premolar extraction, a broad range of outcomes and quantitative analysis, providing the orthodontist with the evidence required to inform clinical decisions.

The aim of this systematic review was to compare four first premolar extraction and non-extraction treatment effects on arch form, (maxillary and mandibular intercanine width and first molar width), profile changes (upper and lower lip prominence to E-plane), treatment duration, occlusal outcomes (end treatment UK and US weighted PAR scores, ABO-OGS score), posttreatment smile aesthetics (aesthetic score, maxillary intercanine width/smile width, visible dentition width/smile width, maxillary intercanine width/visible dentition width) and posttreatment changes of maxillary and mandibular anterior alignment (Little's Irregularity Index) to provide orthodontists with the best data available.

MATERIALS AND METHODS

This review was prepared in accordance with the PRISMA 2020 statement and the Cochrane Handbook for Systematic Reviews of Interventions.(PROSPERO:CRD42021254523)

Eligibility criteria are in Table 1. Electronic databases were searched until June 2nd 2023 without restrictions regarding publication year, study design, or language with additional searching of grey literature, unpublished literature and hand searching of reference lists of included and excluded studies comparing premolar extraction to non-extraction treatment. Search strategies and publication date range of the search are in Table 2.

The articles resulting from the search were added to Zotero (version 6.0.26). Duplicates were identified and removed. Articles were manually checked during screening and further duplicates found and removed. Articles were first checked and excluded by title, with the resultant articles screened by their abstract and then full text articles checked for eligibility.

If there was difficulty encountered in getting the full text of an article, soft copies were obtained from the [redacted]. No contact was made with authors.

Non-English studies without English version were translated using Google translate. Sample size and all reported data were checked and values were revised and recalculated whenever raw data provided to ensure quality of included data.

Two reviewers undertook study selection and data extraction in duplicate using a customized data extraction form (Appendix 1 and 2) prepared by the third reviewer. When there was disagreement, discussion with the third reviewer reached the final decision.

Due to the ethical challenges in undertaking comparative prospective and randomized clinical trials in this subject area retrospective studies were included. ROBINS-I tool was used to assess the quality of observational (prospective and retrospective) studies, with each outcome being individually judged. Cochrane RoB 2 tool was used for randomized trials.

Where appropriate continuous data, with sample size, mean value and standard deviation were available RevMan (version 5.4.1) was used for quantitative synthesis and narrative synthesis reported when meta-analysis was not possible. Confidence interval (95%) with mean difference was used with significance level $P<0.05$. I^2 statistic for random effects model meta-analysis was calculated using Comprehensive Meta-Analysis software (version 3.0). Prediction interval (95%) with mean difference, used to describe the distribution of true effect sizes, was calculated using an Excel spreadsheet (Microsoft Corporation, Redmond, Washington) based on formulas by Borenstein et al[25,26].

Outcome measures and time points of assessment are presented in Table 1. Studies reporting female and male subgroups were combined into a single group using RevMan. Random effects model meta-analysis was used because of the amount of heterogeneity due to the difference in populations and study design. Heterogeneity was assessed by assessing overlap of the confidence intervals on Forest plots and I^2 statistic with threshold for interpretation as described in the Cochrane Handbook.

Subgroup and sensitivity analyses were carried out, to deal with possible sources of heterogeneity of including different malocclusion classes together and differences in outcome measures to isolate their influence.

Publication bias was addressed by including unpublished literature. When more than 10 studies pooled together for an outcome in the meta-analysis, publication bias was identified through a funnel plot. GRADE was used to assess certainty of evidence for each outcome.

RESULTS

Study Selection and Characteristics

The search of databases (including grey literature and hand searching) identified 2652 articles. Removal of duplicates and exclusion by title (Appendix 3) and screening by abstracts (Appendix 4), resulted in a total of 383 articles (Appendix 5).

Thirty (29 RS[27–55],1 RCT[56]) studies were included with some studies including multiple outcomes. Twenty-four[27,29–33,35,36,38–44,46–51,54–56]were included in meta-analysis, of which one thesis[47]and two non-English articles in Chinese[54]and Korean[42]were included (Table 3). Narrative synthesis included three studies[31,45,53]for UL- E plane, five studies[31,34,37,45,53]for LL- E plane, two studies[28,52]for ABO-OGS, and two studies[32,33]for maxillary and mandibular anterior alignment (LII), (Table 4). Figure 1 shows the process of study identification and selection.

Risk of Bias within Studies

The included RCT[56]was judged as being of high risk of bias (Figure 2). For retrospective studies, twenty-three were of serious risk [28–33,35–41,43,45–50,53–55]and six of moderate risk of bias[27,34,42,44,51,52](Table 5) (Appendix 6).

Synthesis of Results

Results of meta-analyses, prediction interval, subgroup and sensitivity analyses are presented in Table 6 with values rounded to two decimal places.

Arch width

- **Intercanine Width (Figure 3)**

Nine retrospective studies[27,31,39,42,44,47,49,51,54] and one RCT[56] reported no statistically significant difference between four first premolar extraction and non-extraction treatment in maxillary intercanine width (MD 0.02mm; total 95% CI [-0.38, 0.43]; I^2 =0%; P=0.91) with significant increase in mandibular intercanine width (MD 0.68mm; 95% CI [0.36, 0.99]; I^2 =0%; P<0.0001) in non-extraction group.

- **Intermolar Width (Figure 4)**

Eight retrospective studies[27,31,39,42,44,47,49,51] and one RCT[56] reported significant decrease in maxillary (MD -2.03mm; total 95% CI [-2.97, -1.09]; I^2 =0%; P<0.0001) and mandibular inter-first molar width (MD -2.00mm; total 95% CI [-2.71, -1.30]; I^2 =5.32%; P<0.00001) with four first premolar extraction.

Profile

Three studies[31,45,53] were included for UL- E plane and five studies[31,34,37,45,53] for LL- E plane with vote counting indicating retraction of upper and lower lips with four first premolar extraction.

Choi et al.[31] compared 15 four first premolar extraction (UL- E plane:-1.61±1.62, LL- E plane:-3.13±1.97) with 17 non-extraction (UL- E plane:-0.07±0.89, LL- E plane:-0.15±0.70) Class I and II female patients and found significant retraction of upper and lower lips in extraction group.

In an equally divided sample of 20 Class I patients, Freitas et al., 2019[34], reported no significant difference between four first premolar extraction (LL- E plane:-0.2±3.7) and non-extraction (LL- E plane:-0.05±1.9) treatment.

Hassan et al.,[37] reported no significant difference between four first premolar extraction (LL- E plane:-2.15±3.38) and non-extraction (LL- E plane:-0.83±2.75) treatment in a sample of 60 Class I and II Pakistani females.

Konstantonis, 2012[45] compared 30 four first premolar extraction (UL- E plane:-2.75±1.5, LL- E plane:-3.34±1.75) with 32 non-extraction (UL- E plane:-0.68±1.89, LL- E plane:0.67±2.24) borderline Class I patients and found significant retraction of upper and lower lips in extraction group.

Xu et al.,[53] compared 13 four first premolar extraction (UL- E plane:- –1.0±1.9, LL- E plane: –2.6±1.9) with 12 non-extraction (UL- E plane: –0.9±2.4, LL- E plane: –0.4±3.4) borderline Chinese population of different malocclusion and found significant retraction of lower lip in extraction group with no difference regarding upper lip retraction.

Treatment Duration (Figure 5)

Eight retrospective studies[29,30,32,33,36,46,47,55] and one RCT[56] reported shorter treatment duration in non-extraction group (MD 0.36years; total 95% CI [0.10, 0.62]; I^2 =3.18%; P=0.007) compared to four first premolar extraction group.

Occlusal outcomes

- **PAR Score**

No eligible studies were found for UK weighted PAR score. Three retrospective studies[33,38,41] reported no statistically significant difference between four first premolar extraction and non-extraction treatment with US weighted PAR score. (MD 0.33; total 95% CI [-0.21, 0.87]; I^2 =0%; P=0.23). (Figure 6)

- **ABO- OGS**

Two retrospective studies were included with inconclusive evidence. Anthopoulou et al.[28] compared 25 four first premolar extraction (total score: 27.04±6.30) with 30 non-extraction (total

score: 29.07±7.11) Class I borderline patients and found no statistically significant difference between the two groups.

In 40 Class I borderline patients, Vaidya et al.[52] reported lower scores for four first premolar extraction group (total score: 22.0±2.29), when compared to non-extraction (total score: 26.8±5.18).

Smile Aesthetics (Figure 7)

Four retrospective studies[40,43,48,50] for aesthetic score (MD -0.09; total 95% CI [-0.24, 0.05]; I^2 =0%; P=0.21) and four retrospective studies[35,40,43,50] for maxillary intercanine width/smile width (MD 0.01; total 95% CI [-0.00, 0.02]; I^2 =0%; P=0.12), visible dentition width/smile width (MD -0.00; total 95% CI [-0.01, 0.01]; I^2 =0%; P=0.81) and maxillary intercanine width/visible dentition width (MD 0.00; total 95% CI [-0.02, 0.02]; I^2 =0%; P=0.94) reported no statistically significant difference between four first premolar extraction and non-extraction treatment.

Stability

Two retrospective studies were included with inconclusive evidence. Francisconi et al.[32] compared 40 four first premolar extraction (maxillary Little index:0.89±1.48, mandibular Little index:1.64±1.75) with 44 non-extraction (maxillary Little index:1.64±1.37, mandibular Little index:1.36±1.33) patients of different malocclusions and found greater maxillary crowding relapse in non-extraction group and no significant difference between the two treatment groups for mandibular crowding relapse.

Freitas et al.[33] compared 97 four first premolar extraction (maxillary Little index:1.30±1.75, mandibular Little index:1.93±2.06) with 58 non-extraction (maxillary Little index: 1.66±1.42, mandibular Little index:1.40±1.18) patients with no significant difference between the two groups regarding maxillary crowding relapse and more mandibular crowding relapse in the extraction group.

Prediction Interval

Prediction interval, the range that in 95% of all populations the true effect size will fall within, was wider than 95% confidence intervals, but with no significant difference, for all outcomes.

Subgroup Analysis

Class I subgroup analyses of maxillary and mandibular intercanine width (Figure 3), maxillary and mandibular inter-first molar width (Figure 4) and treatment duration (Figure 5) favored the same results as the main analyses.

Sensitivity Analysis

For arch width, sensitivity analysis excluded three studies[27,47,56], where measurement of intercanine (Figure 8) and intermolar (Figure 9) width was from the most labial aspect of buccal surfaces of teeth instead of canine tips and mesiobuccal cusp tips. Sensitivity analysis excluded two studies[30,32], for treatment duration, reporting the use of extraoral appliances, related to patient compliance (Figure 5) and two studies[35,48] for smile aesthetics (Figure 10), where it was not clear whether included data were end treatment or posttreatment.

Risk of Bias across Studies

No funnel plot generated, as no more than ten studies were included in meta-analyses.

Quality of Evidence

GRADE evidence profile was completed for all outcomes (Table 7). No separate grading was undertaken for subgroup/ sensitivity analyses.

DISCUSSION

This review,only included studies with four first premolar extraction compared to non-extraction treatment to control heterogeneity, with the inclusion of grey literature, non-English studies and published theses to reduce reporting bias. However, eligible studies were of high level of bias except six studies of moderate risk of bias.

Eligibility criteria were set to reduce confounding variables related to effects due to different treatment approaches. For all outcomes, studies included were limited to non-surgical patients with fixed appliances with no adjunctive procedures. Studies reporting the use of functional appliances or extra-oral appliances were excluded for profile.

Confounding variables were further controlled by exclusion of studies with incomplete data reporting to avoid imputations and studies with more than one error in sample size or treatment data, for greater consistency. However this may have resulted in smaller sample sizes with a potential source of bias[57] as not all studies provided raw data for recalculation. However, no study included in quantitative synthesis reported any error in outcomes of interest, and excluded studies are included in supplementary material with reason for their exclusions if needed for future analysis.

Ideally, age of subjects included would have been limited to 13 years of age or older for arch width[58] and 15 years of age or younger for profile changes[59] to exclude growth effects, where significant increase in maxillary and mandibular intercanine and intermolar width occurring due to growth, between 3 and 13 years of age and significant upper and lower lip retraction in relation to E-plane between 15 and 25 years of age. However, it was not possible to include an age threshold criterion based on these limits, as raw age data was not provided and only mean age reported, a confounding variable of broad age range, increasing indirectness of the results.

There is conflicting evidence in the literature regarding arch width changes, with meta-analysis showing significant increase in mandibular intercanine width in non-extraction group and no difference regarding maxillary intercanine width. A possible explanation might be related to greater variability in maxillary archfrom whereas lower archform is more influenced by the soft tissue environment meaning that the need to generate space for alignment in non-extraction treatment leads to mandibular archwidth changes while lower archform is maintained in extraction treatment. The

movement of posterior teeth mesially into narrower areas of the dental arch is the cause for maxillary and mandibular intermolar width decrease in extraction group[44].

The reported results of profile changes, ABO-OGS and stability should be carefully interpreted because of the imprecision of the results due to small sample sizes. Where two studies were included, no meta-analysis was undertaken as with two studies and in the presence of heterogeneity, confidence intervals based on normal quantiles are not recommended[60].

For profile changes, the current narrative synthesis indicated retraction of upper and lower lips relative to E-plane with four first premolar extraction matching the findings of the meta-analysis by Konstantonis et al.,[12]. However, as ethnic differences were reported, indicating potential additional confounding factors for this outcome, no meta-analysis was undertaken.

Four first premolar extraction took on average 0.36 years longer to complete treatment in comparison to non-extraction treatment, which might be reasonable to assume as it allows for the time to complete space closure in extraction treatment, although it could also be related to more complex cases being treated with extractions. This difference is one of clinical significance for both clinicians and patients. The evidence for this finding was graded as low certainty in comparison with most other outcomes which were very low certainty.

Conflicting results on occlusal outcomes were reported in this review. No eligible studies were found for UK weighted PAR score and no significant difference reported with US weighted PAR score. However, It should be noted that end treatment data were pooled and not percentage improvement for ease of comparison with ABO-OGS.

The results of this review on smile aesthetics indicated no difference between the two treatment approaches in four different smile parameters. However, Işiksal et al.[40]stated that inadequate torque expression can affect smile aesthetics regardless of treatment modality.

There was no clear consensus whether four first premolar extraction or non-extraction treatment would provide greater post treatment stability as only two studies were included with conflicting results.

In summary, this review found low certainty evidence for a clinically significant difference in treatment duration, however there are debatable clinical implications of differences found in arch width changes and no differences in occlusal outcomes and smile parameters. The decision whether to extract or not is very situational. Ruellas et al.,[61] stated that clinicians should be aware of factors such as compliance, tooth-arch discrepancy, cephalometric discrepancy, facial profile, growth, anteroposterior relationships, dental asymmetry, and pathologies in decision making.

In the context of existing data, more robust evidence for changes in outcome between extraction and non-extraction treatment approaches is still needed. However, this is an almost impossible aim as one of the reasons for the lack of RCTs on this topic is ethical and patient recruitment dilemmas of randomizing these treatments. Alternatively, high quality observational studies may be most appropriate and a suggested protocol has been made available recently[24].

Limitations

- Studies included in quantitative synthesis were retrospective in nature except one prospective randomized trial with high level of bias. The limitation due to the decision to include observational studies has been discussed in a Cochrane review[62] with little evidence for significant effect estimate differences between observational studies and RCTs. However, it is important to consider the level of heterogeneity in meta-analyses of RCTs or observational studies with control for confounding in observational studies.
- There is a possible source of bias due to exclusion of studies with incomplete data set reporting but exclusion provides greater confidence in results rather than imputation, with the same for studies with more than one error in sample size or treatment data.
- As malocclusion classes were not studied individually, this baseline characteristic caused an increase in heterogeneity when studies were included for the meta-analysis. Clinical heterogeneity was controlled by limiting the intervention group to four first premolar extractions only and subgroup analyses were carried out, where possible.
- As different ages were pooled on the same estimative, without a sub-group analysis, this baseline characteristic caused an increase in the degree of indirectness of the results.
- A possible source of heterogeneity might be considered regarding aesthetic score, being a subjective parameter and assessed in different studies by different raters and then combined together for meta-analysis, being reported as observational bias in a meta-analysis[17] comparing premolar extraction to non-extraction treatment.
- Retention regimen might be a confounding factor related to stability while poor oral hygiene, poor patient compliance, experience of the operator are factors related to treatment duration[63].
- There is an imprecision up to ±0.1, in recalculated data of included studies, which may affect the results.
- Non-English studies, were translated using Google translate, which might present a possible source of inaccuracy.
- GRADE does not allow inclusion of multiple study designs per outcome, a recognised limitation of GRADEpro. For outcomes reporting RCT and observational studies, changing study design in certainty assessment did not affect overall certainty.

CONCLUSIONS

- Low level evidence indicates clinically significant shorter treatment duration in non-extraction group compared to four first premolar extraction.
- Low level evidence indicates mandibular intercanine width increase with non-extraction treatment and mandibular inter-first molar width decrease in four first premolar extraction group.
- Very low evidence indicates no significant difference in maxillary intercanine width between the two groups and decrease of maxillary inter-first molar width with four first premolar extraction.
- Very low level evidence indicates retraction of upper and lower lips- E-plane in four first premolar extraction group.
- Very low level evidence indicates no significant regarding US PAR score and posttreatment smile aesthetics.

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CONFLICT OF INTEREST

None declared.

SUPPLEMENTAL DATA

Appendices 1-6 are available online.

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FIGURE LEGENDS

Figure 1-PRISMA Flow Diagram

Figure 2-RoB (RCT)

Figure 3-Forest plot, maxillary and mandibular intercanine width

Figure 4-Forest plot, maxillary and mandibular intermolar width

Figure 5-Forest plot and sensitivity analysis, treatment duration

Figure 6-Forest plot, US weighted PAR score

Figure 7-Forest plot, smile aesthetics

Figure 8-Sensitivity analysis, maxillary and mandibular intercanine width

Figure 9-Sensitivity analysis, maxillary and mandibular intermolar width

Figure 10-Sensitivity analysis, smile aesthetics

Appendix 1- Data Extraction Form (RCT)

General Information	Notes
Title	Study identifier (the last name of first author + the year of the primary reference for the study
First author	
Author email & address	
Source of this article	
Methods	
Study design	
Total study duration	
Sequence generation	
Allocation sequence concealment	
Blinding	
Other concerns about bias	
Unit of allocation	
Participants	
Place	Hospital / City / Country
Inclusion criteria	
Exclusion criteria	
Age	
Sex	
Outcome measures	
Total number of patients recruited	
Total number of patients followed up	
Interventions:	
Total number of intervention groups	
Intervention for comparison group (if there is more than 1 group, it should be recorded one by one)	
Control group(s)	
Outcomes	
Outcome definition	
Outcomes and time points	
Unit of measurement	
What was measured at baseline? How was it measured? Is the tool validated (as stated in the article)?	
What was measured immediately after the intervention?	
When was the first follow-up? What was measured at the first follow-up?	
Analysis:	
Statistical technique used:	

Results:	
Number of participants allocated to each intervention group	
Outcome of interest: Arch width- Maxillary intercanine width	Sample size Missing participants Extraction Non-Extraction Pre-tx Mean (SD) End-tx Tx Change
Outcome of interest: Arch width- Mandibular intercanine width	Sample size Missing participants Extraction Non-Extraction Pre-tx Mean (SD) End-tx Tx Change
Outcome of interest: Arch width- Maxillary intermolar width	Sample size Missing participants Extraction Non-Extraction Pre-tx Mean (SD) End-tx Tx Change
Outcome of interest: Arch width- Mandibular intermolar width	Sample size Missing participants Extraction Non-Extraction Pre-tx Mean (SD) End-tx Tx Change
Outcome of interest: Treatment duration	Sample size Missing participants Extraction Non-Extraction Tx (years) Mean (SD)
Funding source	
Key conclusion of the study authors	
Miscellaneous comments from the study authors	
References to other relevant studies	
Correspondence required	
Miscellaneous comments by the review authors	
Type of fixed braces used	

Appendix 2- Data Extraction Form (Observational studies)

General Information	Notes
Title	Study identifier (the last name of first author + the year of the primary reference for the study)
First author	
Author email & address	
Source of this article	
Methods	
Study design	
Total study duration	
Participants	
Place	Hospital / City / Country
Inclusion criteria	
Exclusion criteria	
Age	
Sex	
Outcome measures	
Interventions:	
Total number of intervention groups	
Intervention for comparison group (if there is more than 1 group, it should be recorded one by one)	
Control group(s)	
Outcomes	
Outcome definition	
Outcomes and time points	
Unit of measurement	
What was measured at baseline? How was it measured? Is the tool validated?	
What was measured immediately after the intervention?	
When was the first follow-up? What was measured at the first follow-up?	
Analysis:	
Statistical technique used:	
Results:	
Number of participants allocated to each intervention group	

Outcome of interest: Arch width- Maxillary intercanine width	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Arch width- Mandibular intercanine width	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Arch width- Maxillary intermolar width	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Arch width- Mandibular intermolar width	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Profile- UL- E plane	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Profile- LL- E plane	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx Tx Change	Mean (SD)	
Outcome of interest: Occlusal outcomes- UK weighted PAR score	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx % Improvement	Mean (SD)	
Outcome of interest: Occlusal outcomes- US weighted PAR score	Sample size Missing participants		
		Extraction	Non-Extraction
	Pre-tx End-tx % Improvement	Mean (SD)	

Outcome of interest: Occlusal outcomes- ABO objective grading system	Sample size Missing participants Extraction Non-Extraction Alignment Mean (SD) Marginal ridges Buccolingual inclination Occlusal contacts Occlusal relationships Overjet Interproximal contacts Root angulation Total score
Outcome of interest: Treatment duration	Sample size Missing participants Extraction Non-Extraction Tx (years) Mean (SD)
Outcome of interest: Smile aesthetics- Aesthetic score	Sample size Missing participants Extraction Non-Extraction Post-tx Mean (SD)
Outcome of interest: Smile aesthetics- Maxillary intercanine width/smile width	Sample size Missing participants Extraction Non-Extraction Post-tx Mean (SD)
Outcome of interest: Smile aesthetics- Visible dentition width/smile width	Sample size Missing participants Extraction Non-Extraction Post-tx Mean (SD)
Outcome of interest: Smile aesthetics- Maxillary intercanine width/visible dentition width	Sample size Missing participants Extraction Non-Extraction Post-tx Mean (SD)
Outcome of interest: Stability- Maxillary anterior alignment (Little's Irregularity Index)	Sample size Missing participants Extraction Non-Extraction End-tx Mean (SD) Post-tx Post-tx Change
Outcome of interest: Stability- Mandibular anterior alignment (Little's Irregularity Index)	Sample size Missing participants Extraction Non-Extraction End-tx Mean (SD) Post-tx Post-tx Change
Funding source	
Key conclusion of the study authors	
Miscellaneous comments from the study authors	
References to other relevant studies	
Correspondence required	
Miscellaneous comments by the review authors	
Type of fixed braces used	

Appendix 3- Articles excluded by title

	Article/Reference
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452.	Xu B, Qin K. [The effect of extraction and non-extraction decompensation to bimaxillary orthognathic surgery in skeletal class III malocclusion]. *Hua Xi Kou Qiang Yi Xue Za Zhi = Huaxi Kouqiang Yixue Zazhi = West China Journal Of Stomatology*. 2012;30(2):143–7.
453.	Yamaguchi H, Naruse T, Sueishi K, et al. Long-term stability following surgical orthodontic treatment of mandibular prognathisms: investigation by means of lateral X-ray cephalogram. *Bull Tokyo Dent Coll*. 1996;37(4):167-175.
454.	Yang ST, Kim HK, Lim YS, Chang MS, Lee SP, Park YS. A three dimensional observation of palatal vault growth in children using mixed effect analysis: a 9 year longitudinal study. *Eur J Orthod*. 2013;35(6):832-840.
455.	Yasuda Y, Iijima M, Mizoguchi I. Camouflage treatment of severe skeletal Class III malocclusion with miniscrew anchorage. *Journal of the World Federation of Orthodontists.* 2014;3(3):137–44.
456.	Yavari J, Shrout MK, Russell CM, Haas AJ, Hamilton EH. Relapse in Angle Class II Division 1 Malocclusion treated by tandem mechanics without extraction of permanent teeth: A retrospective analysis. *Am J Orthod Dentofacial Orthop*. 2000;118(1):34-42.
457.	Yavuz MC, Sunar O, Buyuk SK, Kantarcı A. Comparison of piezocision and discision methods in orthodontic treatment. *Prog Orthod*. 2018;19(1):44.

458.	Yin K, Han E, Guo J, Yasumura T, Grauer D, Sameshima G. Evaluating the treatment effectiveness and efficiency of Carriere Distalizer: a cephalometric and study model comparison of Class II appliances. *Prog Orthod*. 2019;20(1):24.
459.	Yordanova, Greta, Martin Mladenov, and Gergana Gurgurova. 'Combining the action of the pendulum appliance with rapid palatal expansion'. *Journal of IMAB* 2017;23(4):1752-7.
460.	Yoshida, M, M Seiryu, A Mayama, T Takano-Yamamoto, and I Mizoguchl. 'Class III Malocclusion with Traumatic Unilateral Maxillary Central Incisor Loss Treated Using Orthodontic Miniscrews: A Case Report'. *Australasian Orthodontic Journal*. 2022;38(2):329-47.
461.	Yu, Yi-Li, Guo-Hua Tang, Fang-Fang Gong, Lin-Ling Chen, and Yu-Fen Qian. '[A comparison of rapid palatal expansion and Damon appliance on non-extraction correction of dental crowding].' *Shanghai kou qiang yi xue* 2008;17(3):237–42.
462.	Zawawi KH. Patients' acceptance of corticotomy-assisted orthodontics. *Patient Preference And Adherence*. 2015;9:1153–8.
463.	Zhang, Dong-ping, Jun Liu, Yang Liu, Na Sun, and Ji-cui Yi. '[Influence of self-ligating and conventional brackets on dental arch width in non-extraction treatment: a meta-analysis].' *Shanghai kou qiang yi xue.* 2014;23(3):367-372
464.	Zhang Hua, DU Yue-ying. Hard tissue changes between extraction- and nonextraction-group in patients with skeletal Class III malocclusion by orthognathic treatment. *China Journal of Oral & Maxillofacial Surgery*. 2011;9(4):323–6.
465.	Zhang J-N, Chen S, Zhong C, Yu F-Y, Lu H-P. Retreatment of a skeletal Class II postpubescent patient with a convex facial profile and temporomandibular disorders. *Australasian Orthodontic Journal*. 2019;35(2):218–28.
466.	Zhang W, Yan C-J, Li L. [Clinical research for non-extraction treatment of maxillary mild-to-moderate crowding with Damon technology]. *Shanghai Kou Qiang Yi Xue*. 2017;26(6):610–614.
467.	Zhang Y, Cai P. Association between alveolar bone height changes in mandibular incisors and three-dimensional tooth movement in non-extraction orthodontic treatment with Invisalign. *Orthod Craniofac Res*. 2023;26(1):91-99.
468.	Zhou, Yan-Heng, Yan-Nan Sun, Wei Hu, and Min-Kui Fu. '[Application of Straight Wire Appliance for Pre- and Post-Surgical Orthodontics]'. *Zhonghua Kou Qiang Yi Xue Za Zhi = Zhonghua Kouqiang Yixue Zazhi = Chinese Journal of Stomatology*.2004;39(6):509-12.
469.	Zimmer B, Gaida S, Dathe H. Compensation of skeletal Class III malocclusion by isolated extraction of mandibular teeth: Part 2: Skeletal, dentoalveolar and soft tissue parameters in comparison with nonextraction Class III therapies. *J Orofac Orthop*. 2016;77(2):119–28.
470.	Zou B, Zhou Y, Lowe AA, Li H, Pliska B. Changes in anteroposterior position and inclination of the maxillary incisors after surgical-orthodontic treatment of skeletal class III malocclusions. *Journal Of Cranio-Maxillofacial Surgery*. 2015;43(10):1986-1993.

Appendix 4- Articles excluded by abstract

	Article/Reference	Reason for exclusion/ Study design
1.	Akin N. Change in the soft tissue profile during and after orthodontic treatment. *J Marmara Univ Dent Fac*. 1993;1(4):347-353.	No outcomes of interest Prospective study
2.	Ali US, Sukhia RH, Fida M. Effect of class II extractions and functional appliance treatment on smile esthetics. *Dent Med Probl*. 2020;57(2):157-163.	No outcomes of interest Retrospective study
3.	Alsafadi K, Vahdettin L. Gender Specific Changes in Palatal Height and Volume Following Extraction and Non-Extraction Orthodontic Treatment: A 3-Dimensional Computed Tomography Evaluation. *Journal Of Medical Imaging And Health Informatics*. 2020;10(1):256–60.	No outcomes of interest Retrospective study
4.	Anuwongnukroh N, Dechkunakorn S, Kunakornporamut K, Tua-Ngam P. Dental arch changes in postretention in Class II division 1 extraction cases. *Int Orthod*. 2017;15(2):208-220.	Study only reported extraction group Retrospective study
5.	Ardani I G, Kannayyah D, Triwardhani A. "Correlation of Maxillary and Mandibular Arch Form and Tooth Size Ratio in Ethnic Javanese Malocclusion Patient." *Journal of International Oral Health.* 2019;11(2):75-9.	No outcomes of interest Retrospective study
6.	Atik E, Akarsu-Guven B, Kocadereli I. Soft tissue effects of three different Class II/1-camouflage treatment strategies. Weichteileffekte dreier unterschiedlicher Strategien zur Klasse II/1-Camouflage-Behandlung. *J Orofac Orthop*. 2017;78(2):153-165.	No outcomes of interest Retrospective study
7.	Barrer JG, Ghafari J. Silhouette profiles in the assessment of facial esthetics: a comparison of cases treated with various orthodontic appliances. *Am J Orthod*. 1985;87(5):385-391..	Study only reported non-extraction group Retrospective study
8.	Battagel JM. The use of tensor analysis to investigate facial changes in treated class II division 1 malocclusions. *Eur J Orthod*. 1996;18(1):41-54.	No outcomes of interest Retrospective study
9.	Bavbek NC, Türköz Ç, Tuncer BB, Tuncer C, Ulusoy Ç. Termoplastik pekiştirme apareylerinin transversal boyutların stabilitesinin korunmasındaki etkinliklerinin değerlendirilmesi: Efficacy of thermoplastic retainers on maintaining the stability of transversal dimensions. *Acta Odontologica Turcica*. 2019;36(2):41–6.	Study only reported non-extraction group Retrospective study
10.	Booij JW, Serafin M, Fastuca R, Kuijpers-Jagtman AM, Caprioglio A. Skeletal, Dental and Soft Tissue Cephalometric Changes after Orthodontic Treatment of Dental Class II Malocclusion with Maxillary First Molar or First Premolar Extractions. *J Clin Med*. 2022;11(11):3170.	No outcomes of interest Retrospective study
11.	Cabrera Mde C, Cabrera CA, de Freitas KM, Janson G, de Freitas MR. Lateral open bite: treatment and stability. *Am J Orthod Dentofacial Orthop*. 2010;137(5):701-711.	Case report
12.	Cheney EA. Extraction and nonextraction in identical twins. *Am J Orthod*. 1949;35(5):351-363.	Case report

13.	Fontes FPH, Bellini-Pereira SA, Aliaga-Del-Castillo A, et al. Comparison of the dentoskeletal and soft tissue changes with the cervical headgear and Jones Jig followed by fixed appliances in Class II malocclusion patients: A retrospective study. *Int Orthod*. 2020;18(3):424-435.	No outcomes of interest Retrospective study
14.	Freitas KM, de Freitas MR, Henriques JF, Pinzan A, Janson G. Postretention relapse of mandibular anterior crowding in patients treated without mandibular premolar extraction. *Am J Orthod Dentofacial Orthop*. 2004;125(4):480-487.	Study only reported non-extraction group Retrospective study
15.	Freitas KMS, Massaro C, Miranda F, de Freitas MR, Janson G, Garib D. Occlusal changes in orthodontically treated subjects 40 years after treatment and comparison with untreated control subjects. *Am J Orthod Dentofacial Orthop*. 2021;160(5):671-685.	Study only reported extraction group Retrospective study
16.	Fudalej P, Artun J. Mandibular growth rotation effects on postretention stability of mandibular incisor alignment. *Angle Orthod*. 2007;77(2):199-205.	No outcomes of interest Retrospective study
17.	Goldstein BJ, Veitz-Keenan A. Extraction or non-extraction treatment for Class II division 2 malocclusion?. *Evid Based Dent*. 2018;19(3):88-89.	Systematic review
18.	Halimi A, Zaoui F. Influence des extractions des prémolaires sur la dimension de l'arcade mandibulaire: etude clinique auprès de 30 cas [Influence of premolar extraction on the dimensions of the lower dental arch: clinical study of 30 cases]. *Odontostomatol Trop*. 2007;30(119):22-28.	Study only reported extraction group Retrospective study
19.	Hamamci, N, A Akkurt, M Dogru, I Veli, and O Hamamci. 'The Effects of Extraction and Non-Extraction Treatment on RME Applied Patients'. *Turkish Journal Of Orthodontics* 2010;23(1):49-60	No outcomes of interest Retrospective study
20.	Horn AJ, Thiers-Jegou I. Class II deep bite faces: one-phase or two-phase treatment?. *World J Orthod*. 2005;6(2):171-179.	Case report
21.	Huang L, Artun J. Is the postretention relapse of maxillary and mandibular incisor alignment related?. *Am J Orthod Dentofacial Orthop*. 2001;120(1):9-19.	No outcomes of interest Retrospective study
22.	Janson G, Silva LNBC, Valerio MV, Laranjeira V, Niederberger A, Garib D. Treatment Time of Class II Malocclusion, with and without Mandibular Crowding, Treated with Four Premolar Extractions: A Retrospective Study. *Turk J Orthod*. 2021;34(2):122-126.	Study only reported extraction group Retrospective study
23.	Janson G, Branco NC, Morais JF, Freitas MR. Smile attractiveness in patients with Class II division 1 subdivision malocclusions treated with different tooth extraction protocols. *Eur J Orthod*. 2014;36(1):1-8.	Study only reported extraction group Retrospective study
24.	Janson G, Branco NC, Fernandes TM, Sathler R, Garib D, Lauris JR. Influence of orthodontic treatment, midline position, buccal corridor and smile arc on smile attractiveness. *Angle Orthod*. 2011;81(1):153-161.	Systematic review
25.	Janson G, Janson M, Nakamura A, de Freitas MR, Henriques JF, Pinzan A. Influence of cephalometric characteristics on the occlusal success rate of Class II malocclusions treated with 2- and 4-premolar extraction protocols. *Am J Orthod Dentofacial Orthop*. 2008;133(6):861-868.	Study only reported extraction group Retrospective study
26.	Janson G, Niederberger A, Garib DG, Caldas W. Root resorption in Class II malocclusion treatment with Class II elastics. *Am J Orthod Dentofacial Orthop*. 2016;150(4):585-591.	Study only reported non-extraction group Retrospective study

27.	Janson G, Maria FR, Barros SE, Freitas MR, Henriques JF. Orthodontic treatment time in 2- and 4-premolar-extraction protocols. *Am J Orthod Dentofacial Orthop*. 2006;129(5):666-671.	Study only reported extraction group Retrospective study
28.	Janson G, Valarelli FP, Beltrão RT, de Freitas MR, Henriques JF. Stability of anterior open-bite extraction and nonextraction treatment in the permanent dentition. *Am J Orthod Dentofacial Orthop*. 2006;129(6):768-774.	No outcomes of interest Retrospective study
29.	Jimenez-Gayosso S, Lara-Carrillo E, Lopez-Gonzalez S, Scougall-Vilchis R, Escoffie-Ramirez M, Herandez-Martinez C, et al. Changes In The Dental Arches Before And After Orthodontic Treatment With Extractions Of First Premolars Analyzed With The Ortho Studio (R) Maestro 3d Scanner. *Acta Bioclinica*. 2021;11(21):16–28.	Study only reported extraction group Retrospective study
30.	Jonsson T, Karlsson KO, Ragnarsson B, Magnusson TE. Long-term development of malocclusion traits in orthodontically treated and untreated subjects. *Am J Orthod Dentofacial Orthop*. 2010;138(3):277-284.	No outcomes of interest Retrospective study
31.	Kang HK, Guo J, Kaczynski R, Liu C, Zhou Z. Effects of maxillary incisor inclination on dentoalveolar changes in class II division 1 and 2 non-extraction treatment for Caucasian children - A retrospective study using CBCT. *Int Orthod*. 2021;19(1):51-59.	No outcomes of interest Retrospective study
32.	Karaman A, Güdük Z, Genc E. Evaluation of pharyngeal airway dimensions and cephalometric changes after premolar extraction and nonextraction orthodontic treatment in adolescent and adult patients. *J Stomatol Oral Maxillofac Surg*. 2023;124(1):101275.	No outcomes of interest Retrospective study
33.	Kau CH, Durning P, Richmond S, Miotti FA, Harzer W. Extractions as a form of interception in the developing dentition: a randomized controlled trial. *J Orthod*. 2004;31(2):107-114.	No outcomes of interest RCT
34.	Kau CH, Bakos K, Lamani E. Quantifying changes in incisor inclination before and after orthodontic treatment in class I, II, and III malocclusions. *J World Fed Orthod*. 2020;9(4):170-174.	Study only reported non-extraction group Retrospective study
35.	LaHaye MB, Buschang PH, Alexander RG, Boley JC. Orthodontic treatment changes of chin position in Class II Division 1 patients. *Am J Orthod Dentofacial Orthop*. 2006;130(6):732-741.	No outcomes of interest Retrospective study
36.	Maniewicz Wins S, Antonarakis GS, Kiliaridis S. Predictive factors of sagittal stability after treatment of Class II malocclusions. *Angle Orthod*. 2016;86(6):1033-1041.	Systematic review
37.	Pazera C, Gkantidis N. Palatal rugae positional changes during orthodontic treatment of growing patients. *Orthod Craniofac Res*. 2021;24(3):351-359.	No outcomes of interest Retrospective study
38.	Pousti, M., M. Basafa, M. R. Sabaghi, and A. Ghabel. 'Lip Position and Arch Width Changes in Class I Patients after Orthodontic Treatment with Four Premolars Extracted'. *Journal of Dentistry* 2007;8(1):37-45.	Study only reported extraction group Retrospective study
39.	Rathod AB, Araujo E, Vaden JL, Behrents RG, Oliver DR. Extraction vs no treatment: Long-term facial profile changes. *Am J Orthod Dentofacial Orthop*. 2015;147(5):596-603..	Study only reported extraction group Retrospective study

40.	Silli, Silvia. 'Original-Patientenpräsentation Des Austrian Board of Orthodontists (ABO)'. Kieferorthopädie: Die Zeitschrift Für Die Praxis, 2022;36(4): 403–12.	Case report
41.	Sims AP, Springate SD. Stability of the lower labial segment following orthodontic treatment--a comparison of treatment with Andresen and Begg appliances. *Br J Orthod*. 1995;22(1):13-21.	No outcomes of interest Retrospective study
42.	Sobhi Afshar M, Ebadifar A. Dimensional changes of dental arch following non-extraction orthodontic treatment. *Caspian Journal of Dental Research*. 2016;5(1):29-35.	Study only reported non-extraction group Retrospective study
43.	Sobral MC, Habib FA de L, Matzenbacher L. Conservative compensatory Angle Class III malocclusion treatment. *Dental press j orthod* (Impr). 2012;17(6):137–45.	Case report
44.	Tauheed S, Shaikh A, Fida M. Microaesthetics of The Smile: Extraction vs. Non-extraction. *J Coll Physicians Surg Pak*. 2012;22(4):230-234.	No outcomes of interest Retrospective study
45.	Vaden JL, Williams RA, Goforth RL. Class II correction: Extraction or nonextraction?. *Am J Orthod Dentofacial Orthop*. 2018;154(6):860-876.	Case report
46.	Xu L, Huang XH, Lin S. [Investigation on the effects of different brackets on the three-dimensional direction of the arch in the non reduction treatment]. *Shanghai Kou Qiang Yi Xue*. 2018;27(2):176-180.	No outcomes of interest RCT
47.	Yang IH, Nahm DS, Baek SH. Which hard and soft tissue factors relate with the amount of buccal corridor space during smiling? *Angle Orthod*. 2008;78(1):5-11	No outcomes of interest Retrospective study
48.	Zuroff JP, Chen SH, Shapiro PA, Little RM, Joondeph DR, Huang GJ. Orthodontic treatment of anterior open-bite malocclusion: stability 10 years postretention. *Am J Orthod Dentofacial Orthop*. 2010;137(3):302.e1-303.	No outcomes of interest Retrospective study
49.	**刘 超峰**, 许 艳华, **易 春**艳, **刘 彦**. Andrews**六要素用于正畸病例数字化**资料的临床回顾性研究 [Clinical retrospective study on the digital data of orthodontic cases by Andrews six elements]. *Hua Xi Kou Qiang Yi Xue Za Zhi*. 2022;40(2):183-188.	No outcomes of interest Retrospective study

Appendix 5- Articles excluded by full text

	Article/Reference	Reason for exclusion/ Study design
1.	Abdelhafez RS, Talib AA, Al-Taani DS. The effect of orthodontic treatment on the periodontium and soft tissue esthetics in adult patients. *Clin Exp Dent Res*. 2022;8(1):410-420.	No outcomes of interest Retrospective study
2.	Abei Y, Nelson S, Amberman BD, Hans MG. Comparing orthodontic treatment outcome between orthodontists and general dentists with the ABO index. *Am J Orthod Dentofacial Orthop*. 2004;126(5):544-548.	No outcomes of interest Retrospective study
3.	Ackerman JL, Proffit WR. Soft tissue limitations in orthodontics: treatment planning guidelines. *Angle Orthod*. 1997;67(5):327-336.	Narrative review
4.	Aggarwal, Isha, Adarsh Deep Kharel, Sanjay Mittal, Mandeep K. Bhullar, and Tanzin Palkit. 'Evaluation of Treatment Changes in the Maxillary Intercanine and Intermolar Width in Patients with Various Malocclusions: A Study Model Analysis'. *Dental Journal of Advance Studies.* 2021; 9(1): 43–47.	No outcomes of interest Retrospective study
5.	Ahmed A, Fida M, Sukhia RH. Cephalometric predictors for optimal soft tissue profile outcome in adult Asian class I subjects treated via extraction and non-extraction. A retrospective study. *Int Orthod*. 2021;19(4):641-651.	Different or incomplete data set (not reporting mean treatment changes for profile) Retrospective study
6.	Akinci Cansunar H, Uysal T. Comparison of orthodontic treatment outcomes in nonextraction, 2 maxillary premolar extraction, and 4 premolar extraction protocols with the American Board of Orthodontics objective grading system. *Am J Orthod Dentofacial Orthop*. 2014;145(5):595-602.	Study did not identify which premolars were extracted Retrospective study
7.	Aktas B, Celebi F, Bicakci AA. The effect of orthodontist change on treatment duration and outcomes. *Am J Orthod Dentofacial Orthop*. 2022;161(1):e80-e86.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
8.	Akyalcin S, Erdinc AE, Dincer B, Nanda RS. Do long-term changes in relative maxillary arch width affect buccal-corridor ratios in extraction and nonextraction treatment?. *Am J Orthod Dentofacial Orthop*. 2011;139(3):356-361.	No outcomes of interest Retrospective study
9.	Akyalçin S, Hazar S, Güneri P, Gögüs S, Erdinç AM. Extraction versus non-extraction: evaluation by digital subtraction radiography. *Eur J Orthod*. 2007;29(6):639-647.	No outcomes of interest Retrospective study

10.	Akyalcin S, Misner K, English JD, Alexander WG, Alexander JM, Gallerano R. Smile esthetics: Evaluation of long-term changes in the transverse dimension. *Korean J Orthod*. 2017;47(2):100-107.	Study did not mention the number of extracted first premolars Retrospective study
11.	Al Senani Y, Al Shammery AJ, Al Nafea A, Al Absi N, Al Kadhi O, Al-Shammery D. Influence of Fixed Orthodontic Therapy on Pharyngeal Airway Dimensions after Correction of Class-I, -II and -III Skeletal Profiles in Adolescents. *Int J Environ Res Public Health*. 2021;18(2):517.	No outcomes of interest Retrospective study
12.	Al-Attar A, Nissan L, Almuzian M, Abid M. Effect of mini-implant facilitated micro-osteoperforations on the alignment of mandibular anterior crowding: A randomised controlled clinical trial [published online ahead of print, 2022 May 15]. *J Orthod*. 2022;14653125221099038.	Study only reported non-extraction group RCT
13.	Al-Ibrahim HM, Hajeer MY, Burhan AS, Haj Hamed Y, Alkhouri I, Zinah E. Assessment of Dentoalveolar Changes Following Leveling and Alignment of Severely Crowded Upper Anterior Teeth Using Self-Ligating Brackets Alone or With Flapless Piezocision Compared to Traditional Brackets: A Randomized Controlled Clinical Trial. *Cureus*. 2023;15(3):e35733.	No outcomes of interest RCT
14.	Alex, A., K. Shashidhar, M.N. Kuttappa, K.U.S. Nayak, S.K. Menta, and A. Anushree. 'Comparative Analysis of Mandibular Changes after Orthodontic Treatment with and without Extraction of Four Premolars: A Digital Cephalometric Study'. *Acta Marisiensis - Seria Medica.* 2022; 68(2): 61–67.	No outcomes of interest Retrospective study
15.	Ali B, Jeelani W, Shaikh A, Quadeer TA, Khan JA. Identification of Orthodontic Extraction Predictors in End-On Class II Malocclusion. *Journal of the Pakistan Dental Association*. 2021;30(3):178–82.	No outcomes of interest Retrospective study
16.	Ali B, Shaikh A, Fida M. Factors affecting treatment decisions for Class I malocclusions. *Am J Orthod Dentofacial Orthop*. 2018;154(2):234-237.	No outcomes of interest Retrospective study
17.	Alqerban A, Alaskar A, Alnatheer M, Samran A, Alqhtani N, Koppolu P. Differences in hard and soft tissue profile after orthodontic treatment with and without extraction. *Niger J Clin Pract*. 2022;25(3):325-335.	Study did not identify which premolars were extracted Retrospective study
18.	Alqerban A, Jacobs R, van Keirsbilck PJ, et al. The effect of using CBCT in the diagnosis of canine impaction and its impact on the orthodontic treatment outcome. *J Orthod Sci*. 2014;3(2):34-40.	No outcomes of interest Retrospective study
19.	Alsaggaf DH, Afify AR, Zawawi KH, Alsulaimani FF. Factors influencing the orthodontic treatment plan in Class II malocclusion. *Am J Orthod Dentofacial Orthop*. 2022;161(6):829-837.e1.	Electronic survey
20.	Alshayea, EI, HO AlBalbeesi, A Almutairi, M Alshenaifi, N AlAgil, and S Bin Huraib. Radiographic Evaluation of External Apical Root Resorption After Orthodontic Treatment: A Study of Contributing Factors, *J Res Med Dent Sci,* 2020;8(5): 101-109	No outcomes of interest Retrospective study
21.	Amin, Bushra, Sadia Naureen, Hameed Ullah Jan, and Tariq Hameed and Umer Hameed. 'Comparison of Intermolar Arch Width Before and After Alignment Phase of Orthodontic Treatment in Class Ii Div 1 Patients'. *Pakistan Oral & Dental Journal*, 2021;41(4), 200-204	No outcomes of interest Cross sectional study

22.	Anderson TG. Extraction vs. nonextraction. *J Am Dent Assoc*. 1999;130(11):1560.	Narrative review
23.	Andrén A, Naraghi S, Mohlin BO, Kjellberg H. Pattern and amount of change after orthodontic correction of upper front teeth 7 years postretention. *Angle Orthod*. 2010;80(4):432-437	No comparison between extraction and non-extraction groups Retrospective study
24.	Angst C, Eliades T, Papageorgiou SN. Stability of occlusal outcome during long-term retention: the time-dependent variation of the American Board of Orthodontics index. *Eur J Orthod*. 2021;43(1):1-7.	Study did not identify which premolars were extracted Retrospective study
25.	Anjum Z, Pervez H, Naveed A. analysis of orthodontic treatment by par index in Pakistan. *Indo American Journal of Pharmaceutical Sciences*. 2019;6(6):12174–6.	No comparison between extraction and non-extraction groups Retrospective study
26.	Aoki, M, K Soma, and F Miura. '[Dental Arch Form Achieved by Orthodontic Treatment]'. *Nihon Kyosei Shika Gakkai Zasshi = The Journal of Japan Orthodontic Society* 1988;47(4):780-795	Report not retrieved
27.	Artun J, Garol JD, Little RM. Long-term stability of mandibular incisors following successful treatment of Class II, Division 1, malocclusions. *Angle Orthod*. 1996;66(3):229-238.	Study did not identify which premolars were extracted Retrospective study
28.	Atik E, Coşkuner HG, Taner T. Comparison of orthodontic treatment with different premolar extraction modalities in terms of soft tissue profile. *Cumhuriyet Dental Journal*. 2019;22(4):390–401.	Different treatment group (expansion with quadhelix) Retrospective study
29.	Aydemir, H, O Nebioglu-Dalci, AT Altug, and U Toygar-Memikoglu. 'The Effects of Tooth Extraction and Nonextraction on the Soft Tissue Profile in Patients With Class II Division 2 Malocclusion'. *Turkish J Orthod*. 2014;27(2): 63–69.	No outcomes of interest Retrospective study
30.	Azizi F, Extiari A, Imani MM. Tooth alignment and pain experience with A-NiTi versus Cu-NiTi: a randomized clinical trial. *BMC Oral Health*. 2021;21(1):431.	No outcomes of interest RCT
31.	Baluta J, Lavelle CL. An analysis of dental arch form. *Eur J Orthod*. 1987;9(2):165-171.	Study reported different premolar extraction pattern (extraction of maxillary first premolars) Retrospective study

32.	Basciftci FA, Uysal T, Buyukerkmen A, Demir A. The influence of extraction treatment on Holdaway soft-tissue measurements. *Angle Orthod*. 2004;74(2):167-173.	No outcomes of interest Retrospective study
33.	Basciftci FA, Usumez S. Effects of extraction and nonextraction treatment on class I and class II subjects. *Angle Orthod*. 2003;73(1):36-42.	Study did not identify which premolars were extracted Retrospective study
34.	Battagel JM. Identification of the relapsing Class III face: Chernoff faces in orthodontics. *Br J Orthod*. 1993;20(3):193-202.	No comparison between extraction and non-extraction groups Retrospective study
35.	Battagel JM. Predictors of relapse in orthodontically-treated Class III malocclusions. *Br J Orthod*. 1994;21(1):1-13.	No outcomes of interest Retrospective study
36.	Battagel JM. Chernoff faces: an orthodontic application. *Br J Orthod*. 1995;22(2):135-144.	No comparison between extraction and non-extraction groups Retrospective study
37.	Battagel JM, Orton HS. Class III malocclusion: a comparison of extraction and non-extraction techniques. *Eur J Orthod*. 1991;13(3):212-222.	No outcomes of interest Retrospective study
38.	Baumrind S, Korn EL, Boyd RL, Maxwell R. The decision to extract: Part 1--Interclinician agreement. *Am J Orthod Dentofacial Orthop*. 1996;109(3):297-309.	No outcomes of interest Prospective study
39.	Baumrind S. Unbiased quantitative testing of conventional orthodontic beliefs. *Seminars In Orthodontics*. 1998;4(1):3–16.	Study did not identify which teeth were extracted Retrospective study
40.	Beattie JR, Paquette DE, Johnston LE Jr. The functional impact of extraction and nonextraction treatments: a long-term comparison in patients with "borderline," equally susceptible Class II malocclusions. *Am J Orthod Dentofacial Orthop*. 1994;105(5):444-449.	No outcomes of interest Retrospective study
41.	BeGole EA, Fox DL, Sadowsky C. Analysis of change in arch form with premolar expansion. *Am J Orthod Dentofacial Orthop*. 1998;113(3):307-315.	Study did not identify which teeth were extracted Retrospective study
42.	Bherwani, AK, and M Fida. Morphological characteristics affecting extraction decision in class ii division 1 malocclusion in females. *Journal of the College of Physicians and Surgeons--pakistan: JCPSP*. 2007;17(8):486-9.	Report not retrieved

43.	Bhupali NR, Singh SP, Verma S, Kumar V, Verma RK. Long term stability of treatment outcome after fixed orthodontic treatment with or without premolar extraction. *Orthodontic Waves*. 2019;78(1):26–32.	Study did not identify which premolars were extracted Retrospective study
44.	Birkeland K, Bøe OE, Wisth PJ. Subjective assessment of dental and psychosocial effects of orthodontic treatment. *J Orofac Orthop*. 1997;58(1):44-61.	No outcomes of interest Retrospective study
45.	Birkeland K, Furevik J, Bøe OE, Wisth PJ. Evaluation of treatment and post-treatment changes by the PAR Index. *Eur J Orthod*. 1997;19(3):279-288.	Study did not identify which teeth were extracted Retrospective study
46.	Bishara SE, Cummins DM, Jakobsen JR, Zaher AR. Dentofacial and soft tissue changes in Class II, division 1 cases treated with and without extractions. *Am J Orthod Dentofacial Orthop*. 1995;107(1):28-37.	Low internal consistency (mean treatment changes L1:MP extraction males pretreatment/ retention- NAPog non-extraction males in tables) Retrospective study
47.	Bishara SE. Mandibular changes in persons with untreated and treated Class II division 1 malocclusion. *Am J Orthod Dentofacial Orthop*. 1998;113(6):661-673.	Duplicate publication (Bishara et al., 1995)
48.	Bishara SE, Bayati P, Zaher AR, Jakobsen JR. Comparisons of the dental arch changes in patients with Class II, division 1 malocclusions: extraction vs nonextraction treatments. *Angle Orthod*. 1994;64(5):351-358.	Low internal consistency (sample size) Retrospective study
49.	Bishara SE, Chadha JM, Potter RB. Stability of intercanine width, overbite, and overjet correction. *American Journal Of Orthodontics*. 1973;63(6):588–95.	Study only reported extraction group Retrospective study
50.	Bishara SE, Cummins DM, Jakobsen JR. The morphologic basis for the extraction decision in Class II, division 1 malocclusions: a comparative study. *Am J Orthod Dentofacial Orthop*. 1995;107(2):129-135.	Duplicate publication (Bishara et al., 1995)
51.	Bishara SE, Cummins DM, Zaher AR. Treatment and posttreatment changes in patients with Class II, Division 1 malocclusion after extraction and nonextraction treatment. *Am J Orthod Dentofacial Orthop*. 1997;111(1):18-27.	Low internal consistency (sample size) Retrospective study
52.	Bishara SE, Jakobsen JR. Profile changes in patients treated with and without extractions: assessments by lay people. *Am J Orthod Dentofacial Orthop*. 1997;112(6):639-644.	No outcomes of interest Retrospective study

53.	Bishara SE, Jakobsen JR, Hession TJ, Treder JE. Soft tissue profile changes from 5 to 45 years of age. *Am J Orthod Dentofacial Orthop*. 1998;114(6):698-706.	No outcomes of interest Retrospective study
54.	Bishara SE, Ortho D, Jakobsen JR, Angelakis D. Posttreatment changes in male and female patients: a comparative study. *Am J Orthod Dentofacial Orthop*. 1996;110(6):624-629.	No outcomes of interest Retrospective study
55.	Bishara SE, Zaher AR, Cummins DM, Jakobsen JR. Effects of orthodontic treatment on the growth of individuals with Class II division 1 malocclusion. *Angle Orthod*. 1994;64(3):221-230.	Duplicate publication (Bishara et al., 1995)
56.	Bjering, R., Sandvik, L., Midtbø, M., & Vandevska-Radunovic, V. (2017). Stability of anterior tooth alignment 10 years out of retention. *Journal of Orofacial Orthopedics / Fortschritte Der Kieferorthopädie*, 78(4), 275–283	No comparison between extraction and non-extraction groups Retrospective study
57.	Boley JC, Pontier JP, Smith S, Fulbright M. Facial changes in extraction and nonextraction patients. *Angle Orthod*. 1998;68(6):539-546	No outcomes of interest Retrospective study
58.	Boley JC. Serial extraction revisited: 30 years in retrospect. *Am J Orthod Dentofacial Orthop*. 2002;121(6):575-577.	Narrative review
59.	Bombonatti R, Aliaga-Del Castillo A, Bombonatti JFS, Garib D, Tompson B, Janson G. Cephalometric and occlusal changes of Class III malocclusion treated with or without extractions. *Dental Press J Orthod*. 2020;25(4):24-32.	Study did not identify which premolars were extracted Retrospective study
60.	Bourne CO, Philip J. Extraction versus non-extraction treatment of bimaxillary proclination [abstract]. *West Indian med j*. 2001;50(Suppl 7):44–44.	Abstract only
61.	Bowman SJ. More than lip service: facial esthetics in orthodontics. *J Am Dent Assoc*. 1999;130(8):1173-1181.	Narrative review
62.	Bowman SJ. Facial aesthetics in orthodontics. *Aust Orthod J*. 2001;17(1):17-26.	Narrative review
63.	Bowman SJ, Johnston LE Jr. The esthetic impact of extraction and nonextraction treatments on Caucasian patients. *Angle Orthod*. 2000;70(1):3-10.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
64.	Bowman SJ. The Social Six Redux. Is That Really All There Is? *Pesquisa Brasileira Em Odontopediatria E Clinica Integrada*. 2010;10(2):309–16.	Narrative review
65.	Bradley TG. Changes in orthodontic treatment modalities in the past 20 years: exploring the link between technology and scientific evidence. *J Ir Dent Assoc*. 2013;59(2):91-94.	Narrative review
66.	Bramante MA. Controversies in orthodontics. *Dent Clin North Am*. 1990;34(1):91-102.	Narrative review

67.	Bravo LA, Canut JA, Pascual A, Bravo B. Comparison of the changes in facial profile after orthodontic treatment, with and without extractions. *Br J Orthod*. 1997;24(1):25-34.	Study did not identify which premolars were extracted Retrospective study
68.	Brignardello-Petersen R. Very low certainty evidence suggests small benefits of tooth extraction compared with nonextraction in patients undergoing orthodontic fixed appliance treatment. *Journal Of The American Dental Association*. 2018;149(10):E137.	Narrative review
69.	Burashed H. Changes in the Vertical Dimension After Orthodontic Treatment in Response to Different Premolar Extraction Patterns. *Cureus*. 2023;15(5):e38893. Published 2023 May 11.	No outcomes of interest Retrospective study
70.	Burrow SJ. The Impact of Extractions on Facial and Smile Aesthetics. *Seminars in Orthodontics*. 2012;18(3):202–9.	Narrative review
71.	Burstone, C., M. P. Filleul, and V. Pigeot. '[Stability of orthodontic treatment of occlusal asymmetry].*' L' Orthodontie francaise*. 2000;71(3):197-205	Narrative review
72.	Buschang PH, Fretty K, Campbell PM. Can commonly used profile planes be used to evaluate changes in lower lip position? *Angle Orthod*. 2011;81(4):557-563.	Study reported different premolar extraction pattern (bilateral, unilateral and four premolar extraction) Retrospective study
73.	Carapezza LJ. Extraction vs. nonextraction. A second opinion. *Journal of the American Dental Association* (1939). 1999;130(11):1560.	Narrative review
74.	Carrero, Gladys, and Lia Belandria. "Retainers used during the containment phase in orthodontics." *Acta Bioclinica*. 2017 Jan 1;7(13):202-+.	Narrative review
75.	Celebi, F, and S Akbulut. 'Investigation of the Relationship between Mesiodistal Crown Diameters and Tooth Extraction Decisions in Orthodontic Patients'. *Journal Of Research In Medical And Dental Science*, 2019;7(3): 144–49.	No outcomes of interest Retrospective study
76.	Chang NY, Cho JH, Lee YM, Kang KH. Comparison of Soft Tissue Changes between Adolescents and Adults in Class II Malocclusion Treatment. *Journal of Oral Medicine and Pain.* 2009;34(3):277-94.	Low internal consistency (mean treatment changes dental/ soft tissue variables adolescent extraction and non-extraction group) Retrospective study
77.	Chang YI, Shin SJ. The morphologic characteristics of Class I, non-extraction patients. *Korean J Orthod*. 1998;28(3):343-51.	No outcomes of interest Retrospective study
78.	Chang Q, Zhang D, Ren L. The effect of tooth extraction and nonextraction treatment on the soft tissue profile of the subjects with border-line Angle classII division 1 malocclusion. *Journal of Practical Stomatology*. 2015 (4):577-9.	Report not retrieved

79.	Chaqués-Asensi J. [The extraction-non extraction dilemma: a case in the border]. *L' Orthodontie francaise*. 2017;88(1):3–13.	Case report
80.	Cheng HC, Wang YC. Effect of nonextraction and extraction orthodontic treatments on smile esthetics for different malocclusions. *Am J Orthod Dentofacial Orthop*. 2018;153(1):81-86.	Study did not identify which teeth were extracted Retrospective study
81.	Cho HK, Kim JC. Dentofacial Changes in Class I Cases Treated With and Without Extraction. *Korean J Phys Anthropol.* 1996;9(1):45-54.	Report not retrieved
82.	Cho WT, Yu DH. A study on the changes of the soft tissue profile following orthodontic treatment by digital subtraction method. *Korean J Orthod*. 1997;27(3):411-20.	No outcomes of interest Retrospective study
83.	Choi WC, Kim TW. The long-term stability of the lower incisor axis in Class II division 2 malocclusions. *Korean J Orthod*. 2004;34(6):497-505.	No outcomes of interest Retrospective study
84.	Chou, Byron, David Dang, Adrienne Joy, David Chambers, Joorok Park, and Heesoo Oh. 'Changes in Cephalometric Measurements in Adult Patients Following Orthodontic Treatment with Premolar Extractions versus Non-Extraction', 2018.	Abstract only
85.	Chung CH, Tadlock LP, Barone N, et al. Common errors observed at the American Board of Orthodontics clinical examination. *Am J Orthod Dentofacial Orthop*. 2017;152(2):139-142.	Narrative review
86.	Cotrin P, Gambardela-Tkacz CM, Moura W, et al. Anterior tooth alignment and arch dimensions changes: 37-year follow-up in patients treated with and without premolar extraction. *Am J Orthod Dentofacial Orthop*. 2020;158(4):e5-e15.	Low internal consistency (sex distribution extraction group- treatment duration non-extraction group methodology/ table) Retrospective study
87.	Cotrin P, Gambardela-Tkacz CM, Moura W, et al. Long-term occlusal changes and patient satisfaction in patients treated with and without extractions: 37 years after treatment. *Am J Orthod Dentofacial Orthop*. 2020;158(4):e17-e27.	Low internal consistency (sex distribution extraction group- Age T1 non-extraction group methodology/ table) Retrospective study
88.	Cotrin P, Freitas KMS, Freitas MR, Valarelli FP, Cançado RH, Janson G. Evaluation of the influence of mandibular third molars on mandibular anterior crowding relapse. *Acta Odontol Scand*. 2020;78(4):297-302.	No outcomes of interest Retrospective study
89.	Cousins AJ, Lewis HG, Viader PH. Changes in orthodontic treatment patterns within one orthodontic practice over a 15 year period. *Br J Orthod*. 1981;8(1):11-14.	No outcomes of interest Retrospective study

90.	Cummins DM, Bishara SE, Jakobsen JR. A computer assisted photogrammetric analysis of soft tissue changes after orthodontic treatment. Part II: Results. *Am J Orthod Dentofacial Orthop*. 1995;108(1):38-47.	No outcomes of interest Retrospective study
91.	Dai F, Yu J, Chen G, Xu T, Jiang R. Changes in buccal facial depth of female patients after extraction and nonextraction orthodontic treatments: A preliminary study. *Korean J Orthod*. 2018;48(3):172-181	Different or incomplete data set (not reporting SD for arch width changes-treatment duration in months) Prospective study
92.	Davidovitch M, Konstantarakis E, Athanasios V, Sella-Tunis T. Effects of Class II elastics during growth on the functional occlusal plane according to skeletal pattern and extraction vs nonextraction. *Angle Orthod*. 2023;93(1):19-25.	No outcomes of interest Retrospective study
93.	Davis LM, BeGole EA. Evaluation of orthodontic relapse using the cubic spline function. *Am J Orthod Dentofacial Orthop*. 1998; 113(3):300-306.	Study did not identify which premolars were extracted Retrospective study
94.	de Freitas MR, Beltrão RT, Janson G, Henriques JF, Chiqueto K. Evaluation of root resorption after open bite treatment with and without extractions. *Am J Orthod Dentofacial Orthop*. 2007;132(2):143.e15-143.e1.43E22.	No outcomes of interest Retrospective study
95.	de la Cruz A, Sampson P, Little RM, Artun J, Shapiro PA. Long-term changes in arch form after orthodontic treatment and retention. *Am J Orthod Dentofacial Orthop*. 1995;107(5):518-530.	Study only reported extraction group Retrospective study
96.	Deguchi T, Honjo T, Fukunaga T, Miyawaki S, Roberts WE, Takano-Yamamoto T. Clinical assessment of orthodontic outcomes with the peer assessment rating, discrepancy index, objective grading system, and comprehensive clinical assessment. *Am J Orthod Dentofacial Orthop*. 2005;127(4):434-443.	No outcomes of interest Retrospective study
97.	Demir A, Uysal T, Sari Z, Basciftci FA. Effects of camouflage treatment on dentofacial structures in Class II division 1 mandibular retrognathic patients. *Eur J Orthod*. 2005;27(5):524-531.	Study reported different premolar extraction pattern (extraction of maxillary premolars) Retrospective study
98.	Devanna, R, NH Felemban, Y Althomali, and P Gupta. 'Determination of Combination Factor as an Aid in Orthodontic Treatment Planning in Western Region of Saudi Arabian Young Male Population-A Retrospective Cephalometric Study'. *Journal of Clinical & Diagnostic Research*. 2021;15(3):17-20.	No outcomes of interest Retrospective study

99.	Di Giovanni T, Vogiatzi T, Koretsi V, Walsh T, Silikas N, Papageorgiou SN. Effect of orthodontic extraction of mandibular premolars on third molar angulation after treatment with fixed appliances : A cross-sectional study [published online ahead of print, 2023 Mar 31]. Auswirkungen der kieferorthopädischen Extraktion von Unterkieferprämolaren auf die Angulation der dritten Molaren nach Behandlung mit festsitzenden Apparaturen : Eine Querschnittsstudie [published online ahead of print, 2023 Mar 31]. *J Orofac Orthop*. 2023;10.1007/s00056-023-00465-3.	Study reported different premolar extraction pattern (extraction of mandibular premolars) Retrospective study
100.	DiBiase AT, Sandler PJ. Does orthodontics damage faces? *Dent Update*. 2001;28(2):98-104.	Narrative review
101.	Dong, Zuo-ying, Dong-xu Liu, Tie-jun Wang, and Li Liu. Changes in arch width after extraction and nonextraction treatment. *Shanghai Kou Qiang Yi Xue.* 2007;16(4):355-357.	Report not retrieved
102.	Dore, D, K Daniel, C Rankine, J Chadha, and D Gardiner. "Extraction versus Nonextraction: Orthodontic Stability Study Seven Years Postretention." *Journal of dental research* 75, no. SI (1996): 3362.	Abstract only
103.	Ebadifar A, Shafazand MH, Seifi M. Arch dimensional changes following orthodontic treatment with extraction of four first premolars. *Journal Of Oral Health And Oral Epidemiology*. 2016;5(2):84–9.	Study only reported extraction group Retrospective study
104.	El Shehawy TO, Hussein FA, Ei Awady AA. Outcome of photodynamic therapy on orthodontic leveling and alignment of mandibular anterior segment: A controlled clinical trial. *Photodiagnosis Photodyn Ther*. 2020;31:101903.	Study only reported non-extraction group RCT
105.	Emmanouilidis, Georgios. 'Perceived Facial Profile and Smile Changes of Class I Extraction and Non-Extraction Patients Following Treatment with Fixed Orthodontic Appliances', Aristotle University of Thessaloniki; 2019. No. GRI-2019-25135.	Different or incomplete data set (100 mm VAS) Retrospective study
106.	Erdinc AE, Nanda RS, Dandajena TC. Profile changes of patients treated with and without premolar extractions. *Am J Orthod Dentofacial Orthop*. 2007;132(3):324-331.	No outcomes of interest Retrospective study
107.	Erdinc AE, Nanda RS, Işiksal E. Relapse of anterior crowding in patients treated with extraction and nonextraction of premolars. *Am J Orthod Dentofacial Orthop*. 2006;129(6):775-784.	Low internal consistency (treatment duration extraction/ non-extraction) Retrospective study
108.	Evans RD. 3-D facial changes as a result of orthodontic treatment. *British Dental Journal*. 2002;192(2):94-94.	Abstract only
109.	Faisal SS, Sakrani MH, Rizvi BE, Siddique H. Change in arch width after extraction and non extraction treatment. *ASH & KMDC*. 2014 ;19(1):32-6.	Different or incomplete data set (not reporting mean treatment changes for arch width) Retrospective study

110.	Fan Y, Liu Z, Chen G, et al. Quantification and visualization of the tooth extraction effects on face with spatially dense geometric morphometrics [published online ahead of print, 2022 Jun 25]. *Orthod Craniofac Res*. 2022;10.1111/ocr.12597.	No outcomes of interest Retrospective study
111.	Farhadian N, Miresmaeili A, Soltani M. Comparison of Extraction and Non-extraction Orthodontic Treatment using the Objective Grading System. *Front Dent.* 2005;91–5.	Study did not identify which premolars were extracted Retrospective study
112.	Faruqui S, Fida M, Shaikh A. Factors Affecting Treatment Duration - A Dilemma In Orthodontics. *J Ayub Med Coll Abbottabad*. 2018;30(1):16-21.	No outcomes of interest Retrospective study
113.	Finnöy JP, Wisth PJ, Böe OE. Changes in soft tissue profile during and after orthodontic treatment. *Eur J Orthod*. 1987;9(1):68-78.	Study did not identify which premolars were extracted Retrospective study
114.	Fisher MA, Wenger RM, Hans MG. Pretreatment characteristics associated with orthodontic treatment duration. *Am J Orthod Dentofacial Orthop*. 2010;137(2):178-186.	No outcomes of interest Retrospective study
115.	Fleming PS, Springate SD, Chate RA. Myths and realities in orthodontics. *Br Dent J*. 2015;218(3):105-110.	Narrative review
116.	Franchi L, Baccetti T, Camporesi M, Lupoli M. Maxillary arch changes during leveling and aligning with fixed appliances and low-friction ligatures. *Am J Orthod Dentofacial Orthop*. 2006;130(1):88-91.	Study only reported non-extraction group Retrospective study
117.	Fujino T, Rokusha Y, Yamaguchi K, Kawata T. [Variations of profile related to extraction and non-extraction in the treatment of the crowded dental arch]. *Nihon Kyosei Shika Gakkai zasshi = The journal of Japan Orthodontic Society*. 1986;45(3):496-502.	Report not retrieved
118.	Gao J, Wang X, Qin Z, et al. Profiles of facial soft tissue changes during and after orthodontic treatment in female adults. *BMC Oral Health*. 2022;22(1):257. Published 2022 Jun 26.	No outcomes of interest Retrospective study
119.	Gardner SD, Chaconas SJ. Posttreatment and postretention changes following orthodontic therapy. *Angle Orthod*. 1976;46(2):151-161.	Different treatment group (expansion with inner bow- headgear) Retrospective study
120.	Gebeile-Chauty S. Les boîtiers autoligaturants constituent-ils une alternative avantageuse dans les approches non extractionnistes?: Are self ligating brackets an advantageous alternative in non extraction approach? *Revue d'Orthopédie Dento-Faciale.* 2014;48(3):241–8.	Narrative review
121.	Germeç D, Taner TU. Effects of extraction and nonextraction therapy with air-rotor stripping on facial esthetics in postadolescent borderline patients. *Am J Orthod Dentofacial Orthop*. 2008;133(4):539-549.	Different treatment group (non-extraction with IPR) RCT

122.	Germec-Cakan D, Taner TU, Akan S. Arch-width and perimeter changes in patients with borderline Class I malocclusion treated with extractions or without extractions with air-rotor stripping. *Am J Orthod Dentofacial Orthop*. 2010;137(6):734.e1-735.	Different treatment group (non-extraction with IPR) RCT
123.	Gianelly A. Evidence-based therapy: an orthodontic dilemma. *Am J Orthod Dentofacial Orthop*. 2006;129(5):596-598.	Narrative review
124.	Gianelly AA. Crowding: timing of treatment. *Angle Orthod*. 1994;64(6):415-418.	Narrative review
125.	Gianelly AA. Arch width after extraction and nonextraction treatment. *Am J Orthod Dentofacial Orthop*. 2003;123(1):25-28.	Low internal consistency (mean and SD- pre-tx/post-tx) Retrospective study
126.	Goergiakaki I, Papadopoulos M a., Ioannidou-Marathiotou I. Evaluation of orthodontica treatment outcome of Angle Class II, division 1 malocclusion by means of the PAR index. *Hellenic Orthodontic Review*. 2003;6(1):27–44.	Study did not identify which premolars were extracted Retrospective study
127.	Golwalkar SA, Shetty V. Arch widths after extraction and nonextraction treatment in class I patients. *J Contemp Dent Pract*. 2013;14(2):312-315.	Study did not mention the number of extracted first premolars Retrospective study
128.	González-Gil-de-Bernabé P, Bellot-Arcís C, Montiel-Company JM, Gandía-Franco JL. Evaluation of treatment outcomes in a 3 years post-graduate orthodontic program using the peer assessment rating (par). *Journal of clinical and experimental dentistry*. 2014;6(4):e364-e368.	Study did not identify which teeth were extracted Retrospective study
129.	Greer, Preston, Josh Knowles, Jeryl D. English, Wick G. Alexander, J. Moody, and Sercan Akyalcin Alexander. 'LONG-TERM DENTAL ARCH CHANGES IN EXTRACTION AND NON-EXTRACTION PATIENTS USING THREE-DIMENSIONAL (3D) DIGITAL MODELS'. EMBRACING NOVEL TECHNOLOGIES IN DENTISTRY AND ORTHODONTICS 2019;1001:61.	No outcomes of interest Retrospective study
130.	Guirro WJ, Freitas KM, Janson G, de Freitas MR, Quaglio CL. Maxillary anterior alignment stability in Class I and Class II malocclusions treated with or without extraction. *Angle Orthod*. 2016;86(1):3-9.	Low internal consistency (sample size- sex distribution) Retrospective study
131.	Gupta, Deepak Kumar, Sanjeev Verma, and Puneet Sharma. 'Assessment of Third Molar Angulation and Eruption in Extraction vs Non Extraction Treatment'. *JIDA: Journal of Indian Dental Association* 2018;12(4): 12–17..	Study did not mention the number of extracted first premolars Retrospective study

132.	Hagler BL, Lupini J, Johnston LE Jr. Long-term comparison of extraction and nonextraction alternatives in matched samples of African American patients. *Am J Orthod Dentofacial Orthop*. 1998;114(4):393-403.	Study did not identify which premolars were extracted Retrospective study
133.	Han H, Cha KS. A study of the variances in pre-and post-treatment dental arch shapes in extraction and non-extraction cases. *Korean J Orthod*. 1991;21(1):223-38.	Study did not mention the number of extracted first premolars Retrospective study
134.	Hannapel ED, Johnston Jr LE. Extraction vs. non-extraction: PAR-score reduction as a function of initial susceptibility. *Prog. Orthod.* 2002:3:17-21	Study did not mention the number of extracted first premolars Retrospective study
135.	Hashim HA, Dweik YG, Al-Hussain H. An odontometric study of arch dimensions among Qatari population sample with different malocclusions. *International Journal of Orthodontic Rehabilitation.* 2018;9(3):93-100	No outcomes of interest Retrospective study
136.	Hassan M, Ibrahim S, Salama A. Changes in Smile Proportions Concomitant to Extraction and Non- Extraction Orthodontia (A Comparative Study). *Al-Azhar Dental Journal for Girls*. 2017;4(2):111–20.	Study did not identify which teeth were extracted Retrospective study
137.	Hayasaki SM, Castanha Henriques JF, Janson G, de Freitas MR. Influence of extraction and nonextraction orthodontic treatment in Japanese-Brazilians with class I and class II division 1 malocclusions. *Am J Orthod Dentofacial Orthop*. 2005;127(1):30-36.	Different data set (not reporting SD for treatment duration) Retrospective study
138.	Hazar S, Akyalçin S, Boyacioğlu H. Soft tissue profile changes in Anatolian Turkish girls and boys following orthodontic treatment with and without extractions. *Turkish Journal of Medical Sciences*. 2004;34(3):171-8.	Different or Incomplete data set (not reporting mean treatment changes/ SD for profile) Retrospective study
139.	Heiser W, Niederwanger A, Bancher B, Bittermann G, Neunteufel N, Kulmer S. Three-dimensional dental arch and palatal form changes after extraction and nonextraction treatment. Part 1. Arch length and area. *Am J Orthod Dentofacial Orthop*. 2004;126(1):71-81.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study

140.	Heiser W, Niederwanger A, Bancher B, Bittermann G, Neunteufel N, Kulmer S. Three-dimensional dental arch and palatal form changes after extraction and nonextraction treatment. Part 3. Transversal and sagittal palatal form. *Am J Orthod Dentofacial Orthop*. 2004;126(1):91-99.	No outcomes of interest Retrospective study
141.	Heiser W, Richter M, Niederwanger A, Neunteufel N, Kulmer S. Association of the canine guidance angle with maxillary and mandibular intercanine widths and anterior alignment relapse: Extraction vs nonextraction treatment. *Am J Orthod Dentofacial Orthop*. 2008;133(5):669-680.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
142.	Hellekant M, Lagerström L, Gleerup A. Overbite and overjet correction in a Class II, division 1 sample treated with Edgewise therapy. *Eur J Orthod*. 1989;11(2):91-106.	Different or incomplete data set (not reporting mean treatment changes for arch width) Retrospective study
143.	Helmholdt RD. Extraction vs. nonextraction. And a third. *J Am Dent Assoc*. 1999;130(11):1560-1562.	Narrative review
144.	Herzog C, Konstantonis D, Konstantoni N, Eliades T. Arch-width changes in extraction vs nonextraction treatments in matched Class I borderline malocclusions. *Am J Orthod Dentofacial Orthop*. 2017;151(4):735-743.	Different or incomplete data set (not reporting SD for arch width changes) Retrospective study
145.	Hockley A, Weinstein M, Borislow AJ, Braitman LE. Photos vs silhouettes for evaluation of African American profile esthetics. *Am J Orthod Dentofacial Orthop*. 2012;141(2):161-168.	No outcomes of interest Retrospective study
146.	Hodgkinson D, Firth FA, Farella M. Effect of incisor retraction on facial aesthetics. *J Orthod*. 2019;46(1_suppl):49-53.	Narrative review
147.	Hosseinzadeh-Nik T, Eftekhari A, Shahroudi AS, Kharrazifard MJ. Changes of the Mandible after Orthodontic Treatment with and without Extraction of Four Premolars. *J Dent (Tehran)*. 2016;13(3):199-206.	No outcomes of interest Retrospective study
148.	Hoybjerg AJ, Currier GF, Kadioglu O. Evaluation of 3 retention protocols using the American Board of Orthodontics cast and radiograph evaluation. *Am J Orthod Dentofacial Orthop*. 2013;144(1):16-22.	No comparison between extraction and non-extraction groups Retrospective study

149.	Iftikhar A, Mushtaq N. Mandibular Intercanine Width in Pre and Mid Orthodontic Treatment in Extraction and Non-Extraction Cases. *Pakistan Orthodontic Journal*. 2021;13(2):67-71.	Study reported different premolar extraction pattern (extraction of mandibular first premolars) Prospective study
150.	Iida Y, Deguchi ST, Kageyama T. Chin cup treatment outcomes in skeletal Class III dolicho- versus nondolichofacial patients. *Angle Orthod*. 2005;75(4):576-583.	No comparison between extraction and non-extraction groups Retrospective study
151.	Ileri Z, Basciftci FA, Malkoc S, Ramoglu SI. Comparison of the outcomes of the lower incisor extraction, premolar extraction and non-extraction treatments. *Eur J Orthod*. 2012;34(6):681-685.	Low internal consistency (PAR percentage calculation) Retrospective study
152.	Irfan S, Fida M. Comparison of soft and hard tissue changes between symmetric and asymmetric extraction patterns in patients undergoing orthodontic extractions. *Dent Med Probl*. 2019;56(3):257-263.	Study only reported extraction group Retrospective study
153.	Isik F, Nalbantgil D, Tabakoglu C, Sayinsu K, Arun T. The Evaluation of Smile Esthetics Following Extraction and Non-extraction Orthodontic Therapies. *Turkish Journal Of Orthodontics*. 2005;18(3):243–51.	Study did not identify which premolars were extracted Retrospective study
154.	Ismail SF, Moss JP, Hennessy R. Three-dimensional assessment of the effects of extraction and nonextraction orthodontic treatment on the face. *Am J Orthod Dentofacial Orthop*. 2002;121(3):244-256.	No outcomes of interest Prospective study
155.	Ismail HA. The use of peer assessment rating index to compare treatment outcome in extraction versus non-extraction treatment. *Egypt Orthod J*. 2007;32:67–81.	Study did not mention the number of extracted first premolars Retrospective study
156.	Ismail SF, Moss JP. The three-dimensional effects of orthodontic treatment on the facial soft tissues--a preliminary study. *Br Dent J*. 2002;192(2):104-108.	No outcomes of interest Prospective study
157.	Jahanbin A, Hasanzadeh N, Khaki S, Shafaee H. Comparison of self-ligating Damon3 and conventional MBT brackets regarding alignment efficiency and pain experience: A randomized clinical trial. *J Dent Res Dent Clin Dent Prospects*. 2019;13(4):281-288.	No outcomes of interest RCT

158.	James RD. A comparative study of facial profiles in extraction and nonextraction treatment. *Am J Orthod Dentofacial Orthop*. 1998;114(3):265-276.	Different or incomplete data set (not reporting SD for mean treatment changes- profile) Retrospective study
159.	Janoševic PN, Janoševic ML, Filipovic GL, Stošic MD, Buric MV, Stojanovic DK, et al. Extraction and non-extraction therapy in class II/1 patients [Ekstrakciona i neekstrakciona terapija pacijenata sa malokluzijom II-1 klase]. *Acta Stomatologica Naissi*. 2014;30(69):1348–61.	Case report
160.	Janson G, Rizzo M, Laranjeira V, Garib DG, Valarelli FP. Posterior teeth angulation in non-extraction and extraction treatment of anterior open-bite patients. *Prog Orthod*. 2017;18(1):13.	No outcomes of interest Retrospective study
161.	Janson G, Dutra dos Santos PB, Garib DG, Francisconi MF, Baldo T de O, Barros SE. Interlabial gap behavior with time. *Journal Of The World Federation Of Orthodontists*. 2013;2(4):E175–9.	No outcomes of interest Retrospective study
162.	Janson G, Valarelli DP, Valarelli FP, de Freitas MR. Treatment times of Class II malocclusion: four premolar and non-extraction protocols. *Eur J Orthod*. 2012;34(2):182-187.	Low internal consistency (initial age non extraction group- treatment time SD extraction group methodology/ tables) Retrospective study
163.	Janson G, Junqueira CH, Mendes LM, Garib DG. Influence of premolar extractions on long-term adult facial aesthetics and apparent age. *Eur J Orthod*. 2016;38(3):272-280.	No outcomes of interest Retrospective study
164.	Janson G, Rizzo M, Valerio MV, Oyonarte R, Garib D. Stability of first and second premolars extraction space closure. *Am J Orthod Dentofacial Orthop*. 2022;162(3):367-373.	No outcomes of interest Retrospective study
165.	Jena AK, Mohapatra M, Sharan J, Patro BK. Temporary deterioration of oral health-related quality of life (OHRQoL) in nonextraction and extraction modalities of comprehensive orthodontic treatment in adolescents. *Angle Orthod*. 2020;90(4):578-586.	Different or incomplete data set (treatment duration in months) Retrospective study
166.	Jeon H, Lee SJ, Kim TW, Donatelli RE. Three-dimensional analysis of lip and perioral soft tissue changes after debonding of labial brackets. *Orthodontics & Craniofacial Research*. 2013;16(2):65–74.	No outcomes of interest Retrospective study

167.	Jeong M, Ryu YK. The study of arch dimensional changes before and after orthodontic treatment in Angle Class I malocclusion cases. *Korean J Orthod*. 1990;20(1):183-195.	Study did not mention the number of extracted first premolars Retrospective study
168.	Jerrold L, Chay C, Accornero M. The extraction of teeth: Part 1 diagnostic and treatment considerations. *Seminars in Orthodontics*. 2019;25(4):309–17.	Narrative review
169.	Jiang RP, McDonald JP, Fu MK. Root resorption before and after orthodontic treatment: a clinical study of contributory factors. *Eur J Orthod*. 2010;32(6):693-697.	No outcomes of interest Retrospective study
170.	Jiang R, Zhang D, Fu M. [A factors study of root resorption after orthodontic treatment]. *Zhonghua kou qiang yi xue za zhi = Zhonghua kouqiang yixue zazhi = Chinese journal of stomatology*. 2003;38(6):455-457.	No outcomes of interest Retrospective study
171.	Jo SY, Bayome M, Park J, Lim HJ, Kook YA, Han SH. Comparison of treatment effects between four premolar extraction and total arch distalization using the modified C-palatal plate. *Korean J Orthod*. 2018;48(4):224-235.	No outcomes of interest Retrospective study
172.	Johnston LE Jr. A comparative analysis of Class II treatments: a retrospective/prospective alternative. *Clin Orthod Res*. 1998;1(2):142-146.	Narrative review
173.	Jonsson T, Magnusson TE. Crowding and spacing in the dental arches: long-term development in treated and untreated subjects. *Am J Orthod Dentofacial Orthop*. 2010;138(4):384.e1-384.e7.	No outcomes of interest Retrospective study
174.	Kahl-Nieke B. The role of extraction in stability of orthodontic treatment. *J Orofac Orthop*. 1996;57(5):272-287.	Narrative review
175.	Kahl-Nieke B, Fischbach H, Schwarze CW. Treatment and postretention changes in dental arch width dimensions--a long-term evaluation of influencing cofactors. *Am J Orthod Dentofacial Orthop*. 1996;109(4):368-378.	Study did not identify which premolars were extracted Retrospective study
176.	Kamal AT, Shaikh A, Fida M. Occlusal Outcome Of Non-Extraction And All First Premolars Extraction Treatment In Patients With Class-I Malocclusion. *J Ayub Med Coll Abbottabad*. 2016;28(4):664-668.	Low internal consistency (PAR percentage calculation) Retrospective study
177.	Kamal AT, Shaikh A, Fida M. Improvement in Peer Assessment Rating scores after nonextraction, premolar extraction, and mandibular incisor extraction treatments in patients with Class I malocclusion. *Am J Orthod Dentofacial Orthop*. 2017;151(4):685-690.	Low internal consistency (PAR percentage calculation) Retrospective study
178.	Kandasamy S, Woods M. Is orthodontic treatment without premolar extractions always non-extraction treatment? *Australian Dental Journal*. 2005;50(3):146–51.	Narrative review

179.	Kantharaju VH, Shivaprakash G, Shamnur N. The Relationship between Posttreatment Smile Esthetics and the ABO Objective Grading System: Class I Extraction versus Non-Extraction Cases. *Turk J Orthod*. 2020;34(1):39-45.	Study did not identify which premolars were extracted Retrospective study
180.	Katsaros C. Profile changes following extraction vs. nonextraction orthodontic treatment in a pair of identical twins. *Journal Of Orofacial Orthopedics = Fortschritte Der Kieferorthopadie : Organ/Official Journal Deutsche Gesellschaft Fur Kieferorthopadie*. 1996;57(1):56–9.	Case report
181.	Katsaros C, Ripplinger B, Högel A, Berg R. The influence of extraction versus non-extraction orthodontic treatment on the soft tissue profile. *J Orofac Orthop*. 1996;57(6):354-365.	Study did not identify which premolars were extracted Retrospective study
182.	Keerthana P, Chitra P. Alleviation of Lower Anterior Crowding with Super- Elastic and Heat-Activated NiTi Wires: A Prospective Clinical Trial. *Turk J Orthod*. 2021;34(2):127-135.	Study only reported non-extraction group Prospective study
183.	Keser Eİ, Ciğer S, Kaya D. Changes in Soft-tissue Profile After Extraction and Non-extraction Openbite Treatment. Hacettepe Dişhekimliği Fakültesi Derg(Clinical Dentistry and Research). 2009;33(1):21–30.	Low internal consistency (mean treatment changes, inconsistent convention of signs) Retrospective study
184.	Khan M, Fida M. Soft tissue profile response in extraction versus non-extraction orthodontic treatment. *J Coll Physicians Surg Pak.* 2010;20(7):454–9.	Study did not identify which premolars were extracted Retrospective study
185.	Khanam, S. R. ., Ghosh, R. ., Hassan, G. S. ., & Hossain, M. . Maxillary dental arch width changes by extraction and non-extraction orthodontic treatment among angle's class I malocclusion patients. *Update Dental College Journal*, 2022:12(2), 24–26.	Study did not mention the number of extracted first premolars Retrospective study
186.	Kim, B., J.W. Shin, C. Hong, A.Y. Pyo, U.-B. Baik, Y.H. Kim, and H.S. Chae. The Lower Lip Profile Change During Total Distalization of the Mandibular Dentition. *Open Dentistry Journal* 2023;17(1):1-7	No outcomes of interest Retrospective study
187.	Kim YH. A comparative cephalometric study of Class II, Division 1 nonextraction and extraction cases. *Angle Orthod*. 1979;49(2):77-84.	No outcomes of interest Retrospective study

188.	Kirschneck C, Proff P, Reicheneder C, Lippold C. Short-term effects of systematic premolar extraction on lip profile, vertical dimension and cephalometric parameters in borderline patients for extraction therapy--a retrospective cohort study. *Clin Oral Investig*. 2016;20(4):865-874.	Different treatment group (treatment with functional orthopaedic appliances) Retrospective study
189.	Kiyamehr Z, Razeghinejad MH, Rahbar M, Oskouei SG, Vafaei A. Factors Affecting the Duration of Fixed Orthodontic Treatment in Patients Treated in a University Department between 2016 and 2020. *Maedica (Bucur)*. 2022;17(2):380-386.	No outcomes of interest Retrospective study
190.	Kocadereli I. Changes in soft tissue profile after orthodontic treatment with and without extractions. *Am J Orthod Dentofacial Orthop*. 2002;122(1):67-72.	Low internal consistency (mean treatment changes NLA non-extraction group- LL- E plane extraction group) Retrospective study
191.	Kochenborger, C, V Dias, FL Martinelli, RR Luiz, and MTD Araujo. 'Is It Possible to Distinguish between Extraction and Nonextraction Treatments Using Facial Images of Adolescents with Skeletal Class II Malocclusion?' *Journal of the World Federation of Orthodontists*, 2015;4(2):52-56.	No outcomes of interest Retrospective study
192.	Kompacher A, Wendl B, Pichelmayer M, Weiland F. Therapeutic Decision in Class I Borderline Cases: Extraction vs. Non-Extraction. *Informationen Aus Orthodontie & Kieferorthopaedie*. 2013;47(2):80-85.	Narrative review
193.	Konstantonis D, Anthopoulou C, Makou M. Extraction decision and identification of treatment predictors in Class I malocclusions. *Prog Orthod*. 2013;14:47.	No outcomes of interest Retrospective study
194.	Krause F. Correlation of linear horizontal + vertical changes in bony + soft tissue profile in class 2 division 1 cases coincident with treatment byextraction + non-extraction techniques. *American Journal Of Orthodontics And Dentofacial Orthopedics*. 1964;50(2):146-.	Abstract only
195.	Krusinskiene V, Kiuttu P, Julku J, Silvola AS, Kantomaa T, Pirttiniemi P. A randomized controlled study of early headgear treatment on occlusal stability--a 13 year follow-up. *Eur J Orthod*. 2008;30(4):418-424.	No outcomes of interest RCT
196.	Kuftinec MM, Stom D. Effect of edgewise treatment and retention on manidbular incisors. *Am J Orthod*. 1975;68(3):316-322.	Different or incomplete data set (not reporting mean treatment changes for arch width/ treatment duration in months) Retrospective study

197.	Kumari M, Fida M. Vertical facial and dental arch dimensional changes in extraction vs. non-extraction orthodontic treatment. *J Coll Physicians Surg Pak*. 2010;20(1):17-21.	Different or incomplete data set (not reporting mean treatment changes for arch width) Retrospective study
198.	Kusnoto J, Evans CA, BeGole EA, Obrez A. Orthodontic correction of transverse arch asymmetries. *Am J Orthod Dentofacial Orthop*. 2002;121(1):38-45.	Study did not identify which teeth were extracted Retrospective study
199.	Lang G, Alfter G, Göz G, Lang GH. Retention and stability--taking various treatment parameters into account. *Journal of Orofacial Orthopedics = Fortschritte der Kieferorthopadie : Organ/official journal Deutsche Gesellschaft fur Kieferorthopadie*. 2002;63(1):26-41.	No comparison between extraction and non-extraction groups Retrospective study
200.	Lapointe ST. Long-term dental arch changes following orthodontic treatment [Master's Thesis]. 2006. https://central.bac-lac.gc.ca/.item?id=MR22538&op=pdf&app=Library&is_thesis=1&oclc_number=435870167	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
201.	Le AT. An assessment of orthodontic treatment outcomes: A comparison of PAR and ABO grading methods [M.S.]. Available from: https://www.proquest.com/docview/304968445/abstract/84CAD7C53BD04859PQ/1	Study reported different premolar extraction pattern (first and second premolar extractions in the same group) Retrospective study
202.	Lee WC. Model analysis in orthodontic treatment changes of the maxillary dental arch. *Korean J Orthod*. 1974;4(1):41-8.	Different or incomplete data set (not reporting mean treatment changes for arch width) Retrospective study
203.	Leon-Salazar R, Janson G, Henriques JF, Leon-Salazar V. Influence of initial occlusal severity on time and efficiency of Class I malocclusion treatment carried out with and without premolar extractions. *Dental Press J Orthod*. 2014;19(4):38-49.	Study did not identify which premolars were extracted Retrospective study

204.	Li Q, Zheng Z, Bai D, Pang G. [A retrospective study of morphologic basis for the extraction decision in Class II, division 1 malocclusion]. *Hua xi kou qiang yi xue za zhi = Huaxi kouqiang yixue zazhi = West China journal of stomatology*. 1999;17(4):341-343.	Report not retrieved
205.	Lieberman, Myron A., and Esther Gazit. 'Facial Profile as Affected by Extraction or Non-Extraction Decisions'. *Quintessence International* 1982;13(4):447-54.	Narrative review
206.	Lim HJ, Ko KT, Hwang HS. Esthetic impact of premolar extraction and nonextraction treatments on Korean borderline patients. *Am J Orthod Dentofacial Orthop*. 2008;133(4):524-531.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
207.	Lim HW, Park JH, Park HH, Lee SJ. Time series analysis of patients seeking orthodontic treatment at Seoul National University Dental Hospital over the past decade. *Korean J Orthod*. 2017;47(5):298-305.	No outcomes of interest Retrospective study
208.	Lin PT, Woods MG. Lip curve changes in males with premolar extraction or nonextraction treatment. *Aust Orthod J.* 2004;20(2):71-86.	Different or incomplete data set (treatment duration in months) Retrospective study
209.	Lin Y, Zhong P-P, Zhang D-Q. [Investigation of the possible factors related to root resorption during orthodontic treatment in adolescents]. *Shanghai kou qiang yi xue = Shanghai journal of stomatology*. 2007;16(1):24-27.	Report not retrieved
210.	Little RA, Spary DJ. The effect of conventional versus figure-of-eight module ligation on mandibular incisor alignment: a randomised controlled trial. *J Orthod*. 2017;44(4):231-240.	Study did not identify which teeth were extracted RCT
211.	Little RM. Stability and relapse of dental arch alignment. *Br J Orthod*. 1990;17(3):235-241.	Narrative review
212.	Little RM. Stability and relapse of mandibular anterior alignment: University of Washington studies. *Semin Orthod*. 1999;5(3):191-204.	Narrative review
213.	Liu X, Jumanjiang M, Cao Y, LI Z, MA C. Effect of orthodontic extraction treatment and non-extraction treatment on esthetical smile. *Chinese Journal of Medical Aesthetics and Cosmetology* 2008;14(3):184-186	Report not retrieved
214.	Liu ZY, Yu J, Dai FF, Jiang RP, Xu TM. Three-dimensional changes in lip vermilion morphology of adult female patients after extraction and non-extraction orthodontic treatment. *Korean J Orthod*. 2019;49(4):222-234.	Different or incomplete data set (treatment duration in months) Retrospective study
215.	Liu Y, Huang W, Xu TM. Long-term changes of hard-tissue in borderline cases with extraction vs. nonextraction treatment. *Beijing Da Xue Xue Bao Yi Xue Ban*. 2008;40(6):633-638.	No outcomes of interest Retrospective study

216.	Lo FD, Hunter WS. Changes in nasolabial angle related to maxillary incisor retraction. *Am J Orthod*. 1982;82(5):384-391.	No outcomes of interest Retrospective study
217.	Loke S. Evaluation Of Orthodontic Treatment Outcome: A Self-Audit Using The Peer Assessment Rating (PAR) Index. *Dent J Malays*. 2010; 31(1): 25- 34.	Study reported different premolar extraction pattern (two and four premolar extraction in the same group) Retrospective study
218.	Luppanapornlarp S, Johnston LE Jr. The effects of premolar-extraction: a long-term comparison of outcomes in "clear-cut" extraction and nonextraction Class II patients. *Angle Orthod*. 1993;63(4):257-272.	Study did not identify which premolars were extracted Retrospective study
219.	Maaz M, Fida M. Comparison of treatment outcomes as assessed by 3 indexes in subjects with Class I malocclusion treated by 3 different methods: A cross-sectional study. *Am J Orthod Dentofacial Orthop*. 2022;161(4):537-541.	Study did not identify which premolars were extracted Retrospective study
220.	Maaz M, Fida M. Dental, skeletal, and soft-tissue changes in adult orthodontic patients treated with premolar extraction and nonextraction: A cross-sectional study. *Am J Orthod Dentofacial Orthop*. 2022;162(3):360-366.	Different or incomplete data set (median and range for ABO- OGS) Retrospective study
221.	Mahmoudzadeh M, Mirzaei H, Farhadian M, Mollabashi V, Khosravi M. Comparison of anterior crowding relapse tendency in patients treated with incisor extraction, premolar extraction, and nonextraction treatment. *Journal of the World Federation of Orthodontists*. 2018;7(2):61–5.	Study did not identify which premolars were extracted Retrospective study
222.	Mahmoudzadeh M, Akbarzadeh M, Karami S. Panel Perception of Profile Attractiveness after Prediction of Orthodontic Treatment (Ext Vs Non Ext). *Journal Of Research In Medical And Dental Science*. 2018;6(1):107–12.	No outcomes of interest Retrospective study
223.	Mahtani AA. INTERMOLAR AND INTERCANINE WIDTH CHANGES FOLLOWING ORTHODONTIC TREATMENT WITH MAXILLARY AND MANDIBULAR FIRST PREMOLAR EXTRACTIONS IN DIFFERENT FACIAL PATTERNS. *PalArch's Journal of Archaeology of Egypt / Egyptology* 2020;17(7):1287-97.	Study only reported extraction group Retrospective study
224.	Maina DM. Facial changes in extraction and nonextraction patients. *Angle Orthod*. 1999;69(6):485-487.	Narrative review
225.	Major P, Kamelchuk L, Nebbe B, Petrikowski G, Glover K. Condyle displacement associated with premolar extraction and nonextraction orthodontic treatment of Class I malocclusion. *Am J Orthod Dentofacial Orthop*. 1997;112(4):435-440.	No outcomes of interest Retrospective study

226.	Makhbul MZM, Hassan WNW. Lower Dental Arch Widths Changes Following Fixed Orthodontic Treatment. *Annals of Dentistry University of Malaya.* 2018 ;25(1):17–22.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
227.	Männchen R, Serafin M, Fastuca R, Caprioglio A. Does Early Treatment Improve Clinical Outcome of Class II Patients? A Retrospective Study. *Children (Basel)*. 2022;9(2):232. Published 2022	No outcomes of interest Retrospective study
228.	Mejia-Maidl M, Evans CA. Soft tissue facial considerations and orthodontic treatment. *Seminars in Orthodontics*. 2000;6(1):3–20.	Narrative review
229.	Mendes LM, Janson G, Zingaretti Junqueira-Mendes CH, Garib DG. Long-term profile attractiveness in Class II Division 1 malocclusion patients treated with and without extractions. *Am J Orthod Dentofacial Orthop*. 2019;155(3):362-371.	No outcomes of interest Retrospective study
230.	Mew JR. Extraction vs. nonextraction. *Journal of the American Dental Association* (1939). 1999;130(12):1695–6.	Narrative review
231.	Meyer AH, Woods MG, Manton DJ. Maxillary arch width and buccal corridor changes with orthodontic treatment. Part 1: differences between premolar extraction and nonextraction treatment outcomes. *Am J Orthod Dentofacial Orthop*. 2014;145(2):207-216.	Study did not identify which premolars were extracted Retrospective study
232.	Meyer AH, Woods MG, Manton DJ. Maxillary arch width and buccal corridor changes with orthodontic treatment. Part 2: attractiveness of the frontal facial smile in extraction and nonextraction outcomes. *Am J Orthod Dentofacial Orthop*. 2014;145(3):296-304.	Study did not identify which premolars were extracted Retrospective study
233.	Milutinović J, Stamenković Z, Zelić K, Marinković N, Nedeljković N. Soft tissue profile changes during treatment of patients with Class II malocclusion. *Srpski arhiv za celokupno lekarstvo*. 2022;150(5-6):261-266.	Different treatment group (treatment with functional orthopaedic appliances) Retrospective study
234.	Mislik B, Konstantonis D, Katsadouris A, Eliades T. University clinic and private practice treatment outcomes in Class I extraction and nonextraction patients: A comparative study with the American Board of Orthodontics Objective Grading System. *Am J Orthod Dentofacial Orthop*. 2016;149(2):253-258.	No comparison between extraction and non-extraction groups Retrospective study
235.	Misner KG. Effects of long-term changes in dental width measurements on the traverse dimension of the smile [Doctoral dissertation]. 2014 https://www.proquest.com/docview/1611961710/abstract/D5A9144D07E54718PQ/1	Study did not identify which premolars were extracted Retrospective study

236.	Miyake H, Ryu T, Himuro T. Effects on the dental arch form using a preadjusted appliance with premolar extraction in Class I crowding. *Angle Orthod*. 2008;78(6):1043-1049.	No outcomes of interest Retrospective study
237.	Miyazaki H, Motegi E, Yatabe K, Isshiki Y. Occlusal stability after extraction orthodontic therapy in adult and adolescent patients. *Am J Orthod Dentofacial Orthop*. 1998;114(5):530-537.	Study only reported extraction group Retrospective study
238.	Monica U, Yerraginnela S, Venreddy S, Mamillapalli PK, Khan SI, Gopinathan PA. Effect of Orthodontic Treatment on Pharyngeal Airway and adjacent Soft Tissues: A Lateral Cephalogram-Based Retrospective Study. *DOAJ*. 2023;35(1):93-6.	No outcomes of interest Retrospective study
239.	Moseling KP, Woods MG. Lip curve changes in females with premolar extraction or nonextraction treatment. *Angle Orthod*. 2004;74(1):51-62.	Different or incomplete data set (treatment duration in months) Retrospective study
240.	Motamedi AK, Dadgar S, Teimouri F, Aslani F. Stability of changes in mandibular intermolar and intercuspid distances following orthodontic treatment. *Dent Res J (Isfahan)*. 2015;12(1):71-75.	Different or incomplete data set (study not reporting mean treatment changes for arch width) Retrospective study
241.	Muñoz Morente, R. J, and M Ferrer Molina. 'Extracción frente a no extracción: efecto en la estética del perfil'. Ortod. esp. (Ed. impr.) 44, no. 4 (October 2004): 269–78.	Report not retrieved
242.	Myser SA, Campbell PM, Boley J, Buschang PH. Long-term stability: postretention changes of the mandibular anterior teeth. *Am J Orthod Dentofacial Orthop*. 2013;144(3):420-429.	Study did not identify which teeth were extracted Retrospective study
243.	Nagani NI, Ahmed I. Effectiveness of Two Types of Fixed Lingual Retainers in Preventing Mandibular Incisor Relapse. *J Coll Physicians Surg Pak*. 2020;30(3):282-286.	No outcomes of interest RCT
244.	Negreiros PO, Freitas KMS, Pinzan-Vercelino CRM, Janson G, Freitas MR. Smile attractiveness in cases treated with self-ligating and conventional appliances with and without rapid maxillary expansion. *Orthod Craniofac Res*. 2020;23(4):413-418	Study only reported non-extraction group Retrospective study

245.	Nevárez PS, Justus R, Ondarza-Rovira R, López SG.. 'Comparative Analysis of the Intercanine Width of the Lower Dental Arch in Patients with Extraction and Non-Extraction Treatment of First Premolar Extractions'. *Revista Mexicana de Ortodoncia* 2023;8(4):225-35	Study reported different premolar extraction pattern (extraction of mandibular premolars) Retrospective study
246.	Olteanu, Cristian, Andreea Pop, Brigitta Boicioc, Manuela Chibelean, Alexandrina Muntean, Grigore Ioan Vlad, and Mariana Păcurar. 'Factorii Care Influenţează Durata Tratamentului Ortodontic: FACTORS INFLUENCING THE DURATION OFORTHODONTIC TREATMENT.' *Romanian Journal of Stomatology*. 2020;66(2): 110–15.	No outcomes of interest Retrospective study
247.	Omar Z, Short L, Banting DW, Saltaji H. Profile changes following extraction orthodontic treatment: A comparison of first versus second premolar extraction. *Int Orthod*. 2018;16(1):91-104.	Study only reported extraction group Retrospective study
248.	Oner S, Sarac M. Effect of Extraction and Nonextraction Treatment on Long Term Mandibular Incisors Stability. *Turkish Journal Of Orthodontics*. 2011;24(1):12-21.	Low internal consistency (sample size) Retrospective study
249.	Pan Y, Chen S, Shen L, Pei Y, Zhang Y, Xu T. Thickness change of masseter muscles and the surrounding soft tissues in female patients during orthodontic treatment: a retrospective study. *BMC Oral Health*. 2020;20(1):181.	Study did not identify which premolars were extracted Retrospective study
250.	Papageorgiou SN, Tilen R, Vandevska-Radunovic V, Eliades T. Occlusal outcome after orthodontic treatment with preadjusted straight-wire and standard edgewise appliances : A retrospective cohort study. Okklusales Ergebnis nach kieferorthopädischer Behandlung mit „straight-wire"- und „standard edgewise"-Apparaturen : Eine retrospektive Kohortenstudie. *J Orofac Orthop*. 2021;82(5):321-328.	No outcomes of interest Retrospective study
251.	Papagiannis A, Sallmann R, Papageorgiou SN, Eliades T, Konstantonis D. Palatal shape covariation in extraction versus nonextraction borderline patients: A geometric morphometric study [published online ahead of print, 2023 Mar 16]. *Am J Orthod Dentofacial Orthop*. 2023;S0889-5406(23)00099-9.	No outcomes of interest Retrospective study
252.	Paquette DE, Beattie JR, Johnston LE Jr. A long-term comparison of nonextraction and premolar extraction edgewise therapy in "borderline" Class II patients. *Am J Orthod Dentofacial Orthop*. 1992;102(1):1-14.	Study did not mention the number of extracted first premolars Retrospective study
253.	Park H, Boley JC, Alexander RA, Buschang PH. Age-related long-term posttreatment occlusal and arch changes. *Angle Orthod*. 2010;80(2):247-253.	Study did not identify which teeth were extracted Retrospective study
254.	Peck S. Extractions, retention and stability: the search for orthodontic truth. *Eur J Orthod*. 2017;39(2):109-115.	Narrative review

255.	Perkovic V, Alexander M, Greer P, Kamenar E, Anic-Milosevic S. Association between arch width changes and long-term stability 20 years after orthodontic treatment with and without extractions [published online ahead of print, 2023 Feb 6]. *Angle Orthod*. 2023;93(3):261-268.	Study did not identify which premolars were extracted Retrospective study
256.	Perkovic, Vjera, Ervin Kamenar, Lucija Petrac, and Sandra Anic Milosevic. 'Evaluation of Arch Widths as Predictors for Long Term Stability After Orthodontic Treatment with and Without Extractions: ISPITIVANJE ŠIRINE DENTALNIH LUKOVA KAO PREDIKTORA ZA DUGOTRAJNU STABILNOST NAKON ORTODONTSKE TERAPIJE SA I BEZ EKSTRAKCIJA.' *Acta Stomatologica Croatica* 2022;56(2):204–204.	Abstract only
257.	Popowich K, Flores-Mir C, Nebbe B, Heo G, Major PW. Comparison of Class I and Class II Treatment Duration Among Three Different Orthodontic Practices. *Semin Orthod*. 2006;12(1):52–9.	Study did not identify which premolars were extracted Retrospective study
258.	Popowich K, Nebbe B, Heo G, Glover KE, Major PW. Predictors for Class II treatment duration. *Am J Orthod Dentofacial Orthop*. 2005;127(3):293-300.	Study reported different premolar extraction pattern (two and four premolar extraction in the same group) Retrospective study
259.	Posen AL. The application of quantitative perioral assessment to orthodontic case analysis and treatment planning. *Angle Orthod*. 1976;46(2):118-143.	Narrative review
260.	Priyadarshini, Maitreye, and Purva Joneja. 'Williams Line and Rickett's E-Line: Retraced: An Endeavor to Untangle the Established Extraction vs Non-Extraction Dilemma'. *Baba Farid University Dental Journal*. 2022;12(1):28-33.	Study did not identify which teeth were extracted Retrospective study
261.	Pudyani PS, Hanimastuti Y. Profil jaringan lunak wajah kasus borderline maloklusi klas I pada perawatan ortodonti dengan dan tanpa pencabutan gigi (Facial soft tissue profile on borderline class I malocclusion in orthodontic treatment with or without teeth extraction). *Dental Journal (Majalah Kedokteran Gigi).* 2013;46(4):179-84.	Study reported different premolar extraction pattern (four second premolar extraction) Retrospective study
262.	Putrino, A., A. Impellizzeri, L. Pavese, E. Barbato, and G. Galluccio. 'Orthodontic Treatment and Third Molars Development: Longitudinal Study on Radiographs'. *Dental Cadmos.* 2019;87:558-70..	Report not retrieved
263.	Quaglio CL, de Freitas KM, de Freitas MR, Janson G, Henriques JF. Stability and relapse of maxillary anterior crowding treatment in class I and class II Division 1 malocclusions. *Am J Orthod Dentofacial Orthop*. 2011;139(6):768-774.	No comparison between extraction and non-extraction groups Retrospective study

264.	Ranjan, P. P., Shu, X. C., & Pratap, S. V. Assessment of pretreatment and post treatment arch-width changes in extraction and non extraction cases in a chinese patient population. *UJMDS* 2014;2(2): 103-107	Study did not mention the number of extracted first premolars Retrospective study
265.	Reddy P, Kharbanda OP, Duggal R, Parkash H. Skeletal and dental changes with nonextraction Begg mechanotherapy in patients with Class II Division 1 malocclusion. *Am J Orthod Dentofacial Orthop*. 2000;118(6):641-648.	Study only reported non-extraction group prospective study
266.	Remmers D, Van't Hullenaar RW, Bronkhorst EM, Bergé SJ, Katsaros C. Treatment results and long-term stability of anterior open bite malocclusion. *Orthod Craniofac Res*. 2008;11(1):32-42.	No comparison between extraction and non-extraction groups Retrospective study
267.	Rinchuse DJ, Busch LS, DiBagno D, Cozzani M. Extraction treatment, part 1: the extraction vs. nonextraction debate. *J Clin Orthod*. 2014;48(12):753-760.	Narrative review
268.	Rocha AD, Casteluci CEVF, Ferreira FPC, Conti AC, Almeida MR, Almeida-Pedrin RR. Esthetic perception of facial profile changes after extraction and nonextraction Class II treatment. *Braz Oral Res*. 2020;34:e003.	No outcomes of interest Retrospective study
269.	Rongo R, Nissen L, Leroy C, Michelotti A, Cattaneo PM, Cornelis MA. Three-dimensional soft tissue changes in orthodontic extraction and non-extraction patients: A prospective study. *Orthod Craniofac Res*. 2021;24 Suppl 2:181-192.	No outcomes of interest prospective study
270.	Rosa M. Orthodontic edentulous space closure in all malocclusions Outcome evaluation of facial and dental esthetics. *International Journal Of Esthetic Dentistry*. 2020;15(5, S):S14–31.	Narrative review
271.	Rosa M. Missing teeth in the smile area: space closure in all malocclusions looking for long term health, esthetics and function. *Seminars in Orthodontics*. 2020;26(1):52-60.	Narrative review
272.	Rosa M, Lucchi P, Ferrari S, Zachrisson BU, Caprioglio A. [Congenitally missing maxillary lateral incisors: long-term periodontal and functional evaluation after orthodontic space closure with first premolar intrusion and canine extrusion]. *Orthod Fr.* 2017;88(4):319-332.	No outcomes of interest Retrospective study
273.	Rosseto MC, Palma FM, Ferreira RI, Pinzan A, Vellini-Ferreira F. Comparative study of dental arch width in plaster models, photocopies and digitized images. *Braz Oral Res*. 2009;23(2):190-195.	No outcomes of interest Retrospective study
274.	Rossouw PE, Preston CB, Lombard C. A longitudinal evaluation of extraction versus nonextraction treatment with special reference to the posttreatment irregularity of the lower incisors. *Semin Orthod*. 1999;5(3):160-170.	Study did not identify which premolars were extracted Retrospective study
275.	Rossouw PE, Preston CB, Lombard CJ, Truter JW. A longitudinal evaluation of the anterior border of the dentition. *Am J Orthod Dentofacial Orthop*. 1993;104(2):146-152.	Study did not identify which teeth were extracted Retrospective study

276.	Rossouw, Paul Emile. 'A Longitudinal Study of the Stability of the Dentition Following Orthodontic Treatment'. PhD Thesis, Stellenbosch: Stellenbosch University, 1992.	Study did not identify which teeth were extracted Retrospective study
277.	Rukiah BA, Oeripto A, Harahap N. A Comparison of class I malocclusion treatment outcomes with and without extractions using an ABO grading system for dental casts and radiographs. *Dental Journal (Majalah Kedokteran Gigi*). 2017;50(3):144–8.	Study did not identify which teeth were extracted Retrospective study
278.	Rushing SE, Silberman SL, Meydrech EF, Tuncay OC. How dentists perceive the effects of orthodontic extraction on facial appearance. *J Am Dent Assoc*. 1995;126(6):769-772.	No outcomes of interest Retrospective study
279.	Sadowsky C, Sakols EI. Long-term assessment of orthodontic relapse. *Am J Orthod*. 1982;82(6):456-463.	No outcomes of interest Retrospective study
280.	Sadry S, Koru BE, Kayalar E. Analyzing the effects of tooth extraction on the lip in orthodontic treatment. *J Stomatol Oral Maxillofac Surg*. 2022;123(4):e126-e132.	No outcomes of interest Retrospective study
281.	Saelens NA, De Smit AA. Therapeutic changes in extraction versus non-extraction orthodontic treatment. *Eur J Orthod*. 1998;20(3):225-236.	Low internal consistency (treatment duration extraction/ non extraction) Retrospective study
282.	Salehi, Parisa, Hamid Reza Pakshir, and Seyed Ali Reza Hoseini. 'Evaluating the Stability of Open Bite Treatments and Its Predictive Factors in the Retention Phase during Permanent Dentition'. *Journal of Dentistry.* 2015;16(1): 22–29.	No outcomes of interest Retrospective study
283.	Santana, Lucas Garcia, Túlio Silva Pereira, Izabella Barbosa Fernandes, Margareth Maria Gomes de Souza, Saul Martins Paiva, Maria Leticia Ramos-Jorge, and Leandro Silva Marques. 'Impaction of Mandibular Third Molars after Orthodontic Treatment by the Edgewise Method: A Retrospective Study'. *Brazilian Oral Research*. 2020;24;34: e065	No outcomes of interest Retrospective study
284.	Schabel BJ, McNamara JA Jr, Franchi L, Baccetti T. Q-sort assessment vs visual analog scale in the evaluation of smile esthetics. *Am J Orthod Dentofacial Orthop*. 2009;135(4 Suppl):S61-S71.	No comparison between extraction and non-extraction groups Retrospective study
285.	Scott SH, Johnston LE Jr. The perceived impact of extraction and nonextraction treatments on matched samples of African American patients. *Am J Orthod Dentofacial Orthop*. 1999;116(3):352-360.	No outcomes of interest Retrospective study
286.	Seehra J, Al-Ali A, Pandis N, Cobourne MT. Space closure versus space opening for bilateral absent upper lateral incisors: what is the duration of orthodontic treatment?. *Eur J Orthod*. 2020;42(4):460-465.	No outcomes of interest Retrospective study

287.	Selwyn-Barnett BJ. Rationale of treatment for Class II division 2 malocclusion. *Br J Orthod*. 1991;18(3):173-181.	Narrative review
288.	Shafique HZ, Zaheer R, Jan A, et al. Vertical Skeletal Changes after Extraction and Nonextraction Orthodontic Treatment. *Eur J Dent*. 2023;17(1):227-233.	No outcomes of interest Retrospective study
289.	Shahrure B, Acar A. Evaluation of Risk Factors for Severe Apical Root Resorption in the Maxillary Incisors Following Fixed Orthodontic Treatment. *Turk J Orthod*. 2022;35(2):75-83.	No outcomes of interest Retrospective study
290.	Shannon KR, Nanda RS. Changes in the curve of Spee with treatment and at 2 years posttreatment. *Am J Orthod Dentofacial Orthop*. 2004;125(5):589-596.	Study did not identify which teeth were extracted Retrospective study
291.	Shapiro PA. Mandibular dental arch form and dimension. Treatment and postretention changes. *Am J Orthod*. 1974;66(1):58-70.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
292.	Shearn BN, Woods MG. An occlusal and cephalometric analysis of lower first and second premolar extraction effects. *Am J Orthod Dentofacial Orthop*. 2000;117(3):351-361.	Study only reported extraction group Retrospective study
293.	Shen LH, Xie TY, Jiang RP, et al. Measurement of three-dimensional changes in lip vermilion in adult female patients after orthodontic extraction: a retrospective longitudinal study. *Head Face Med*. 2021;17(1):9.	No outcomes of interest Retrospective study
294.	Shi X, Wu B, Cao D, et al. Effect of socioeconomic and malocclusion-related factors on duration of orthodontic treatment by fixed appliance: A retrospective study [published online ahead of print, 2023 Apr 10]. *Orthod Craniofac Res*. 2023;10.1111/ocr.12661.	Report not retrieved
295.	Shirvani A, Sadeghian S, Abbasi S. Prediction of lip response to orthodontic treatment using a multivariable regression model. *Dent Res J (Isfahan)*. 2016;13(1):38-45.	Low internal consistency (sample size- mean treatment changes, inconsistent convention of signs) Retrospective study
296.	Singh DP, Garg AK, Singh SP, Krishna Nayak US, Gupta M. Comparison of the dental arch changes in patients with different malocclusions. *Indian J Dent Res*. 2014;25(5):623-629.	Study only reported extraction group Retrospective study
297.	Singh GD, Maldonado L, Thind BS. Changes in the soft tissue facial profile following orthodontic extractions: a geometric morphometric study. *Funct Orthod*. 2004;22(1):34-40.	No outcomes of interest Retrospective study

298.	Skidmore KJ, Brook KJ, Thomson WM, Harding WJ. Factors influencing treatment time in orthodontic patients. *Am J Orthod Dentofacial Orthop*. 2006;129(2):230-238.	Study did not identify which teeth were extracted Retrospective study
299.	Smitha T, Vaswani V, Deepak V, Sheethal HS, Hema KN, Jain VK. Reliability of palatal rugae patterns in individual identification. *J Oral Maxillofac Pathol*. 2021;25(3):555.	No outcomes of interest Retrospective study
300.	Snow JI, Chung DD. Hispanic adolescent lip response to extraction and nonextraction orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 2023;163(1):68-78.	Different or incomplete data set (study reported median/ range for profile changes) Retrospective study
301.	Soheilifar S, Soheilifar S, Afrasiabi Z, Soheilifar S, Tapak L, Naghdi N. Prediction accuracy of Dolphin software for soft-tissue profile in Class I patients undergoing fixed orthodontic treatment. *J World Fed Orthod*. 2022;11(1):29-35.	No outcomes of interest Retrospective study
302.	Soheilifar S, Soheilifar S, Javanshir B, noorani A, Akbarzadeh M, Malekshoar M. Comparison of buccal corridor and dental arch width changes in extraction and non-extraction orthodontic treatment. *Sch. Acad. J. Biosci*., 2017; 5(1):21-28	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
303.	Soheilifar S, Soheilifar S, Ataei H, et al. Extraction versus non-extraction orthodontic treatment: Soft tissue profile changes in borderline class I patients. *Dent Med Probl*. 2020;57(3):275-283.	Study reported different premolar extraction pattern (four first and second premolar extraction in the same group) Retrospective study
304.	Sondhi A, Cleall JF, BeGole EA. Dimensional changes in the dental arches of orthodontically treated cases. *Am J Orthod*. 1980;77(1):60-74.	No outcomes of interest Retrospective study
305.	Stephens CK, Boley JC, Behrents RG, Alexander RG, Buschang PH. Long-term profile changes in extraction and nonextraction patients. *Am J Orthod Dentofacial Orthop*. 2005;128(4):450-457.	No outcomes of interest Retrospective study
306.	Stoner B. Vertical Control for the Class Ii Patient: The Key to Favorable Mandibular Change. Tweed Profile. 2013 Jan;12:7–19.	Case report

307.	Stuart DA. *Nonextraction and extraction facial profiles compared by trained dentists and lay evaluators* (Master's thesis).2004 https://mspace.lib.umanitoba.ca/bitstream/handle/1993/15763/Stuart_Nonextraction_and.pdf?sequence=1	Different or incomplete data set (not reporting mean treatment changes for profile) Retrospective study
308.	Takada K. Artificial intelligence expert systems with neural network machine learning may assist decision-making for extractions in orthodontic treatment planning. *J Evid Based Dent Pract*. 2016;16(3):190-192.	Narrative review
309.	Takada K, Yagi M, Horiguchi E. Computational formulation of orthodontic tooth-extraction decisions. Part I: to extract or not to extract. *Angle Orthod*. 2009;79(5):885-891.	No outcomes of interest Retrospective study
310.	Taner TU, Ciger S, El H, Germeç D, Es A. Evaluation of dental arch width and form changes after orthodontic treatment and retention with a new computerized method. *Am J Orthod Dentofacial Orthop*. 2004;126(4):464-476.	Study only reported non-extraction group Retrospective study
311.	Tawila, Sami. 'Upper Airway Dimensions in Adult African American Patients Treated with Four First Premolar Extraction'. PhD Thesis, State University of New York at Buffalo, 2019. https://www.proquest.com/dissertations-theses/upper-airway-dimensions-adult-african-american/docview/2244342816/se-2	Low internal consistency (mean treatment changes-more than one error-dental variables) Retrospective study
312.	Trecenti, M. F. S., de Miranda Ladewigb, V., Almeida-Pedrinb, R. R., Almeidac, M. R., & Contic, A. C. D. C. F. A Preferência Estética do Perfil de Indivíduos com Má-Oclusão de Classe II Tratados com e sem Extração. *J Health Sci*, 2018;20(3), 179-84.	Study reported different premolar extraction pattern (extraction maxillary first premolars) Retrospective study
313.	Türköz Ç, İşcan HN. Evaluation of extraction and non-extraction treatment effects by two different superimposition methods. *Eur J Orthod*. 2011;33(6):691-699.	No outcomes of interest Retrospective study
314.	Uhde MD, Sadowsky C, BeGole EA. Long-term stability of dental relationships after orthodontic treatment. *Angle Orthod*. 1983;53(3):240-252.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study
315.	Vaden JL, Kiser HE. Straight talk about extraction and nonextraction: a differential diagnostic decision. *Am J Orthod Dentofacial Orthop*. 1996;109(4):445-452.	Narrative review

316.	Valiathan M, El H, Hans MG, Palomo MJ. Effects of extraction versus non-extraction treatment on oropharyngeal airway volume. *Angle Orthod*. 2010;80(6):1068-1074.	Study did not identify which premolars were extracted Retrospective study
317.	Varghese, Alexander. 'Comparison of Dimensional Changes in the Dental Arch after Extraction and Non-Extraction Treatment', 2006. (Doctoral dissertation).	Low internal consistency (mean treatment changes maxillary intercanine width non-extraction group and maxillary intermolar width extraction group table/ results) Retrospective study
318.	Verma, Purva, and Ravindra Kumar Jain. 'Comparative Evaluation of Stability of Mandibular Anterior Crowding Correction Done with Two Different Treatment Protocols: A Retrospective Study'. *Journal of International Oral Health.* 2022;14(2):189–94.	No outcomes of interest Retrospective study
319.	Verma, Sneh Lata, V P Sharma, Pradeep Tandon, Gyan P Singh, and Kiran Sachan. 'Comparison of Esthetic Outcome after Extraction or Non-Extraction Orthodontic Treatment in Class II Division 1 Malocclusion Patients'. *Contemporary Clinical Dentistry* 2013;4(2): 206–12.	Different or incomplete data set (treatment duration in months) Retrospective study
320.	Verma SL, Sharma VP, Tandon P, Singh GP. The Impact of Extraction vs Nonextraction Treatment on Soft Tissue Profile in Borderline Class I Malocclusion: A Cephalometric Study. *Journal of Indian Orthodontic Society*. 2014;48(1):47-53.	Different or incomplete data set (treatment duration in months) Retrospective study
321.	Verma SL, Sharma VP, Singh GP, Sachan K. Comparative assessment of soft-tissue changes in Class II Division 1 patients following extraction and non-extraction treatment. *Dent Res J (Isfahan)*. 2013;10(6):764-771.	Different or incomplete data set (treatment duration in months) Retrospective study
322.	Vig PS, Weintraub JA, Brown C, Kowalski CJ. The duration of orthodontic treatment with and without extractions: a pilot study of five selected practices. *Am J Orthod Dentofacial Orthop*. 1990;97(1):45-51.	Study did not identify which teeth were extracted Retrospective study

323.	Virkkula T, Kantomaa T, Julku J, Pirttiniemi P. Long-term soft-tissue response to orthodontic treatment with early cervical headgear--a randomized study. *Am J Orthod Dentofacial Orthop*. 2009;135(5):586-596.	No comparison between extraction and non-extraction groups RCT
324.	Vu CQ, Roberts WE, Hartsfield JK Jr, Ofner S. Treatment complexity index for assessing the relationship of treatment duration and outcomes in a graduate orthodontics clinic. *Am J Orthod Dentofacial Orthop*. 2008;133(1):9.e1-9.e13.	Study did not identify which premolars were extracted Retrospective study
325.	Ward DE, Workman J, Brown R, Richmond S. Changes in arch width. A 20-year longitudinal study of orthodontic treatment. *Angle Orthod*. 2006;76(1):6-13.	No comparison between extraction and non-extraction groups Retrospective study
326.	Ward KT. The evaluation of soft-tissue changes in borderline extraction/nonextraction cases. *Am J Orthod Dentofacial Orthop*. 2001;120(2):225-.	Abstract only
327.	Weyrich C, Lisson JA. The effect of premolar extractions on incisor position and soft tissue profile in patients with Class II, Division 1 malocclusion. *J Orofac Orthop*. 2009;70(2):128-138.	Different treatment group (treatment with functional orthopaedic appliances) Retrospective study
328.	Wholley CJ, Woods MG. The effects of commonly prescribed premolar extraction sequences on the curvature of the upper and lower lips. *Angle Orthod*. 2003;73(4):386-395.	No outcomes of interest Retrospective study
329.	Willeit FJ, Cremonini F, Willeit P, et al. Stability of transverse dental arch dimension with passive self-ligating brackets: a 6-year follow-up study. *Prog Orthod*. 2022;23(1):1-8.	Study only reported non-extraction group Retrospective study
330.	Williams MO, White LW. A rationale for expansion. *World J Orthod*. 2005;6(4):406-410.	Narrative review
331.	Williams R, Hosila FJ. The effect of different extraction sites upon incisor retraction. *Am J Orthod*. 1976;69(4):388-410.	Different or incomplete data set (treatment duration in months) Retrospective study
332.	Windyasari O, Yusuf M. The Effect of Upper Incisor Anteroposterior Position Changes on the Lip Profile in Class I Malocclusion. *Proceedings Of The International Dental Conference Of Sumatera Utara 2017 (IDCSU 2017)*. 2018:215–8	No outcomes of interest Retrospective study
333.	Xie M, Lao K, Qin C, Qinqin MA, Shuixue MO. Impacts of orthodontic treatment with tooth extraction on the frontal view of facial soft tissue in adult fe-males with class II division 1 malocclusion. *Journal of Practical Stomatology*. 2016;32(3):368-71.	Report not retrieved

334.	Xie X, Wang L, Wang A. Artificial neural network modeling for deciding if extractions are necessary prior to orthodontic treatment. *Angle Orthod*. 2010;80(2):262-266.	No outcomes of interest Retrospective study
335.	Xu T, Liu Y, Huang W, Lin J. [Cephalometric comparison of soft-tissue morphology between extraction and non-extraction orthodontic treatment in borderline cases]. *Beijing da xue xue bao Yi xue ban = Journal of Peking University Health sciences*. 2004;36(6):650-654.	Duplicate publication (Xu el al., 2006) Retrospective study
336.	Xu T, Liu Y, Zhang H, Lin J. [Changes of profile prominence in borderline cases with extraction and non-extraction orthodontic treatment]. *Hua xi kou qiang yi xue za zhi = Huaxi kouqiang yixue zazhi = West China journal of stomatology*. 2004;22(5):384-386.	Report not retrieved
337.	Xu T, Liu Y, Huang W, Lin J. [Cephalometric comparison of hard-tissue morphology between extraction and non-extraction orthodontic treatment in borderline cases]. *Beijing da xue xue bao Yi xue ban = Journal of Peking University Health sciences*. 2003;35(6):654-658.	No outcomes of interest Retrospective study
338.	Xu T, Yang M, Huang W. [Comparison of extraction versus non-extraction orthodontic treatment results--a preliminary study]. *Hua xi kou qiang yi xue za zhi = Huaxi kouqiang yixue zazhi = West China journal of stomatology*. 2003;21(3):205-207.	Report not retrieved
339.	Yamaguchi K, Nanda RS. The effects of extraction and nonextraction treatment on the mandibular position. *Am J Orthod Dentofacial Orthop*. 1991;100(5):443-452.	No outcomes of interest Retrospective study
340.	Yamen T, Ulas O. Computed tomography evaluation of palatal form in the transversal and sagittal fabrication process and the effect of first molar and canine crown angulations. *Advanced Composites Letters*. 2019; 28:1-10	Study reported different premolar extraction pattern (extraction of maxillary first premolars) Retrospective study
341.	Yang CYM, Atsawasuwan P, Viana G, et al. Cone-beam computed tomography assessment of maxillary anterior alveolar bone remodelling in extraction and non-extraction orthodontic cases using stable extra-alveolar reference [published online ahead of print, 2022 Sep 14]. *Orthod Craniofac Res*. 2022;10.1111/ocr.12609.	Study reported different premolar extraction pattern (extraction of maxillary premolars) Retrospective study
342.	Yang M, Duan X, Lin Z. Extraction or Non-extraction: Another Ethical Dilemma. *Chinese Medical Ethics*. 1994;0(05):-	Report not retrieved
343.	Yashwant V, Ravi K., Arumugam E. Dimensional changes in the dental arches of orthodontically treated cases borderline patients treated with extraction and nonextraction modalities. *Dental Press Journal of Orthodontics*. 2016;21(4):50–9.	Study reported different premolar extraction pattern (first and second premolar extraction in the same group) Retrospective study

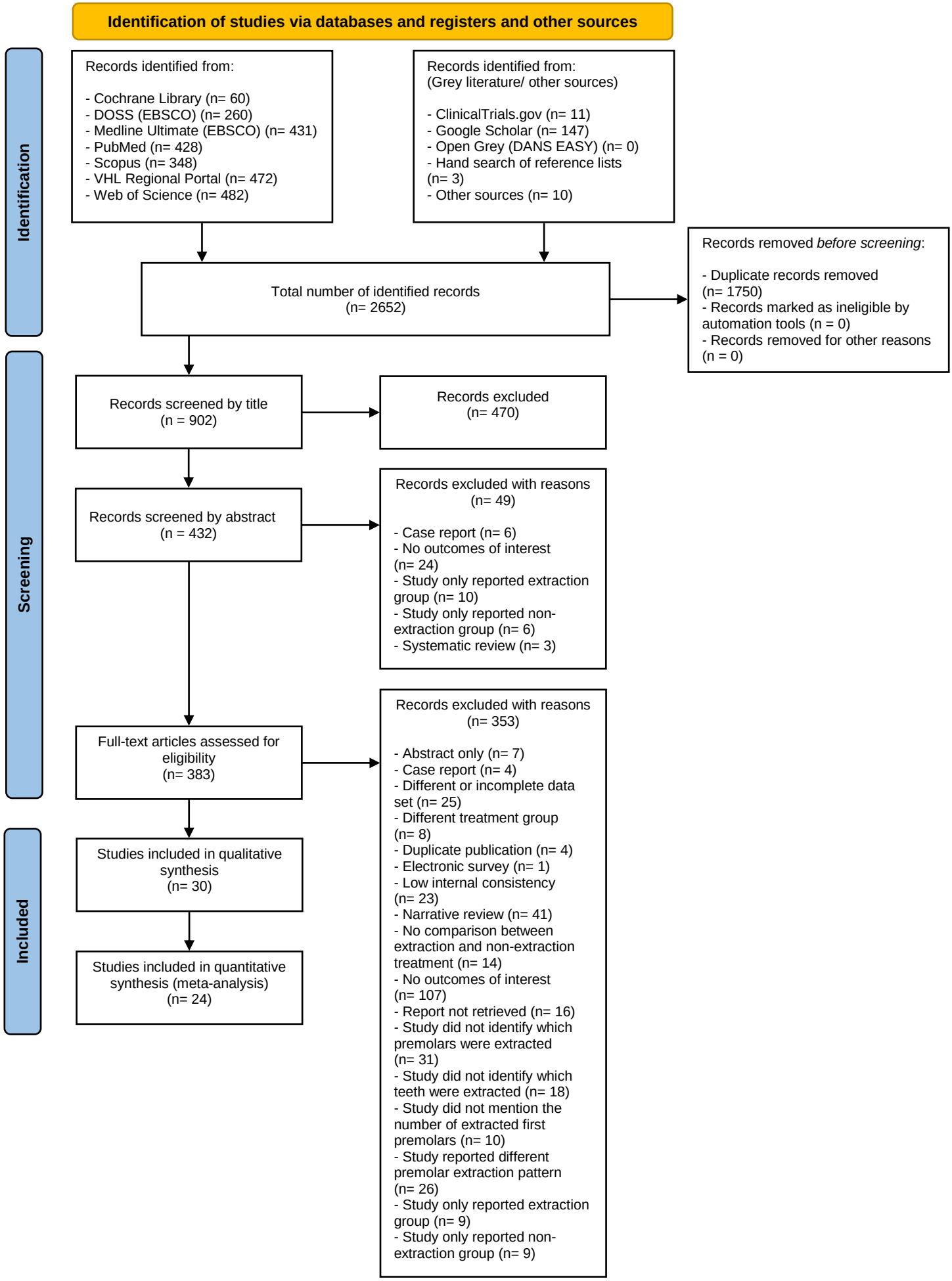
344.	Yavan MA, Güler S, Eğlenen MN, Karaca MN. A Comparison of the Effects of Extraction and Nonextraction Orthodontic Treatments on Cephalometric Parameters and Arch Widths. *Cumhuriyet Dental Journal*. 2021;24(1):47-56.	Low internal consistency (mean treatment changes UL/ LL- E plane) Retrospective study
345.	Yohana, N., S. Bahirrah, and Nazruddin. 'The Changing of Occlusal Plane Inclination in Class II Malocclusion'. *Dental Journal.* 2020; 53(3): 133–139	Study reported different premolar extraction pattern (extraction of maxillary first premolars) Retrospective study
346.	Yoshizumi J, Sueishi K. Post-treatment Stability in Angle Class III Cases. *Bull Tokyo Dent Coll*. 2016;57(1):29-35.	Study did not identify which teeth were extracted Retrospective study
347.	Young TM, Smith RJ. Effects of orthodontics on the facial profile: a comparison of changes during nonextraction and four premolar extraction treatment. *Am J Orthod Dentofacial Orthop*. 1993;103(5):452-458.	Different treatment group (treatment with functional orthopaedic appliances) Retrospective study
348.	Yu Z, Jiaqiang L, Weiting C, Wang Y, Zhen M, Ni Z. Stability of treatment with self-ligating brackets and conventional brackets in adolescents: a long-term follow-up retrospective study. *Head Face Med*. 2014;10:41. Published 2014 Sep 20.	Study only reported non-extraction group Retrospective study
349.	Zafarmand AH, Qamari A, Zafarmand MM. Mandibular incisor re-crowding: is it different in extraction and non-extraction cases?. *Oral Health Dent Manag*. 2014;13(3):669-674.	Different or incomplete data set (not reporting mean post treatment changes) Retrospective study
350.	Zafarmand AH, Zafarmand MM. Stability of Changes in Dental Arch Dimensions with Orthodontic Treatment:A Comparative Study between Extraction and Non-extraction Cases. 2015;(28).	Low internal consistency (treatment duration extraction/ post retention period non-extraction) Retrospective study

351.	Zhao J, Du S, Liu Y, Saif BS, Hou Y, Guo YC. Evaluation of the stability of the palatal rugae using the three-dimensional superimposition technique following orthodontic treatment. *J Dent*. 2022;119:104055.	No outcomes of interest Retrospective study
352.	Zhou, Qin, Jie Gao, Donghui Guo, Haolin Zhang, Xu Zhang, Wen Qin, and Zuolin Jin. Three Dimensional Quantitative Study of Soft Tissue Changes in Nasolabial Folds after Orthodontic Treatment in Female Adults. *BMC Oral Health* 2023;23(1):1-11	No outcomes of interest Retrospective study
353.	Zierhut EC, Joondeph DR, Artun J, Little RM. Long-term profile changes associated with successfully treated extraction and nonextraction Class II Division 1 malocclusions. *Angle Orthod*. 2000;70(3):208-219.	Low internal consistency (mean treatment changes UL/ LL- E plane non-extraction group) Retrospective study

Appendix 6- RoB judgment- ROBINS-I tool

Domains	Judgment	
Bias due to confounding	Low	Two or more examiners measuring outcomes of interest. (Examiner bias is a confounding factor)
	Moderate	Only one examiner measuring outcomes of interest.
	Serious	N/A
	Critical	N/A
	No information	No details whether, one or two examiners were measuring outcomes of interest.
Bias in selection of participants into the study	Low	Same number of subjects assigned to each treatment group with no difference in pretreatment malocclusion and reporting characteristics of included participants (mean age, sex distribution).
	Moderate	Same number of subjects assigned to each treatment group with no difference in pretreatment malocclusion but not reporting any of the characteristics of included participants (mean age, sex distribution).
	Serious	Difference in number of subjects assigned to each treatment group and/or no difference in pretreatment malocclusion reported.
	Critical	N/A
	No information	N/A
Bias in classification of interventions	Low	Intervention groups well defined. Studies clearly reporting four first premolar extraction and non-extraction treatment groups.
	Moderate	N/A
	Serious	N/A
	Critical	N/A
	No information	N/A
Bias due to deviations from intended interventions	Low	No risk of bias, as the effect of assignment to intervention is assessed.
	Moderate	N/A
	Serious	N/A
	Critical	N/A
	No information	N/A
Bias due to missing data	Low	No missing participants.
	Moderate	N/A
	Serious	N/A
	Critical	N/A
	No information	N/A
Bias in measurement of outcomes	Low	N/A
	Moderate	Methods of outcome assessment were comparable across groups but prone to biases due to lack of blind outcome assessment. (Examiners were aware of the intervention whether extraction or non-extraction treatment).
	Serious	Subjective parameters (aesthetic score).
	Critical	N/A
	No information	N/A
Bias in selection of the reported result	Low	Studies reporting pretreatment, end treatment and mean treatment changes for arch width and profile changes, PAR score (PAR components, pretreatment, end treatment and percentage improvement) and total ABO- OGS components, treatment duration (pretreatment age, end treatment age), posttreatment raw data for smile aesthetics and end treatment, posttreatment and mean posttreatment changes for stability.
	Moderate	N/A
	Serious	Studies not reporting complete data set.
	Critical	N/A
	No information	N/A
Overall bias	Low	Low risk of bias for all domains.
	Moderate	Study is judged to be at low or moderate risk of bias for all domains.
	Serious	Study is judged to be at serious risk of bias in at least one domain, but not at critical risk of bias in any domain.
	Critical	Study is judged to be at critical risk of bias in at least one domain.
	No information	N/A

PRISMA 2020 flow diagram

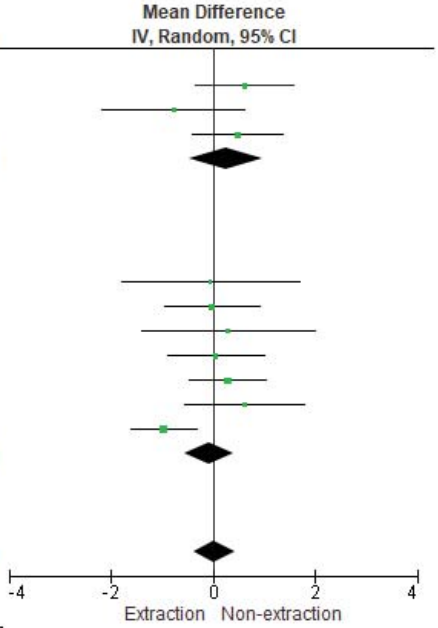


D1	D2	D3	D4	D5	Overall
-	!	+	!	+	-
D1 Randomization process was performed as follow: the first patient was placed into one of the two groups by the use of a coin toss and every following patient that was recruited was placed into every other group accordingly.					
D2 Deviations from the intended interventions: it is likely that carers and people delivering the interventions were aware of participants' assigned intervention.					
D3 Missing outcome data: Pre-tx, end-tx data and mean changes reported (mean and SD) for the two groups.					
D4 Measurement of the outcome: Assessment of the outcomes could have been influenced by knowledge of the intervention received.					
D5 Selection of the reported result: Maxillary and mandibular ICW and IMW width measurements were analyzed in accordance with a pre-specified plan and unlikely to have been selected from multiple outcomes/ analyses.					

De Almeida et al., 2011

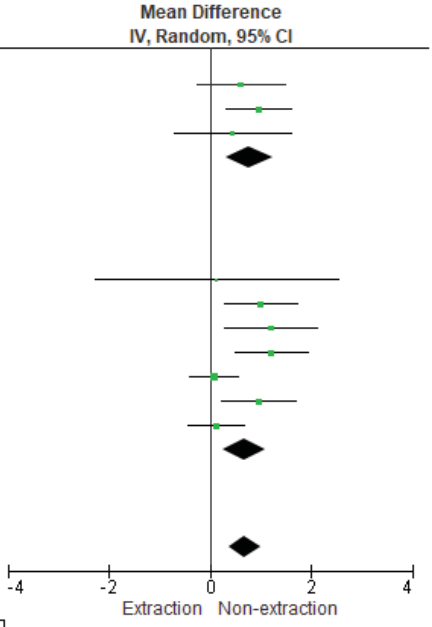
Maxillary intercanine width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.1.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	1.47	2.11	30	0.85	1.71	30	10.8%	0.62 [-0.35, 1.59]
De Almeida et al., 2011	1.09	2.36	21	1.86	2.21	20	6.4%	-0.77 [-2.17, 0.63]
Sumit and Ashima, 2010	0.44	1.76	25	-0.04	1.42	25	12.0%	0.48 [-0.41, 1.37]
Subtotal (95% CI)			**76**			**75**	**29.2%**	**0.26 [-0.46, 0.98]**
Heterogeneity: Tau² = 0.12; I² = 8.65%								
Test for overall effect: Z = 0.72 (P = 0.47)								
1.1.2 Different malocclusion classes								
Choi et al., 2020	-0.34	2.54	15	-0.29	2.47	17	4.5%	-0.05 [-1.79, 1.69]
Dong et al., 2007 (Article in Chinese)	1.26	1.26	25	1.28	2.03	25	11.3%	-0.02 [-0.96, 0.92]
Işık et al., 2005	1.72	3.95	27	1.42	2.74	42	4.7%	0.30 [-1.40, 2.00]
Jeon et al., 2007 (Article in Korean)	1.91	1.97	30	1.86	1.75	30	11.2%	0.05 [-0.89, 0.99]
Kim and Gianelly, 2003	0.84	1.16	30	0.55	1.78	30	14.2%	0.29 [-0.47, 1.05]
MacKriel, 2008 (Thesis)	1.84	1.68	26	1.22	2.55	26	8.4%	0.62 [-0.55, 1.79]
Oz et al., 2017	0.22	2.27	80	1.19	1.88	80	16.5%	-0.97 [-1.62, -0.32]
Subtotal (95% CI)			**233**			**250**	**70.8%**	**-0.07 [-0.56, 0.41]**
Heterogeneity: Tau² = 0.15; I² = 0%								
Test for overall effect: Z = 0.29 (P = 0.77)								
Total (95% CI)			**309**			**325**	**100.0%**	**0.02 [-0.38, 0.43]**
Heterogeneity: Tau² = 0.15; I² = 0%								
Test for overall effect: Z = 0.11 (P = 0.91)								
Total (95% PI)								**0.02 [-1.00, 1.04]**



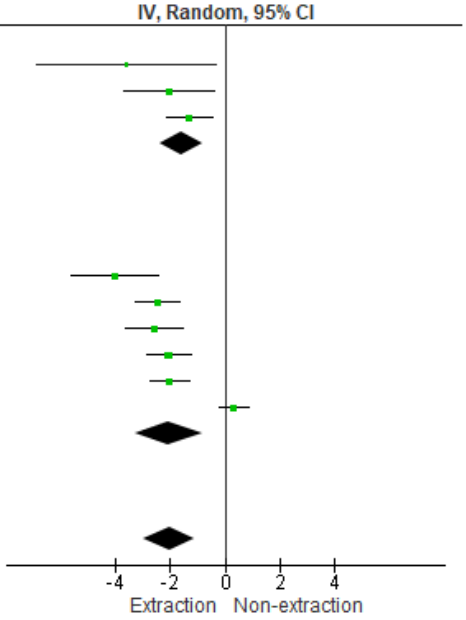
Mandibular intercanine width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	1.63	1.79	30	1.02	1.64	30	8.8%	0.61 [-0.26, 1.48]
De Almeida et al., 2011	1.48	0.88	21	0.52	1.17	20	12.7%	0.96 [0.32, 1.60]
Sumit and Ashima, 2010	1.18	1.73	25	0.73	2.4	25	5.7%	0.45 [-0.71, 1.61]
Subtotal (95% CI)			**76**			**75**	**27.2%**	**0.77 [0.31, 1.24]**
Heterogeneity: Tau² = 0.00; I² = 0%								
Test for overall effect: Z = 3.23 (P = 0.001)								
1.2.2 Different malocclusion classes								
Choi et al., 2020	-0.09	4.09	15	-0.22	2.61	17	1.6%	0.13 [-2.28, 2.54]
Dong et al., 2007 (Article in Chinese)	1.3	1.31	25	0.3	1.32	25	10.9%	1.00 [0.27, 1.73]
Işık et al., 2005	0.61	1.99	27	-0.6	1.71	42	8.2%	1.21 [0.30, 2.12]
Jeon et al., 2007 (Article in Korean)	1.95	1.52	30	0.73	1.37	30	10.9%	1.22 [0.49, 1.95]
Kim and Gianelly, 2003	0.51	1.12	30	0.43	0.79	30	16.1%	0.08 [-0.41, 0.57]
MacKriel, 2008 (Thesis)	2.07	1.58	26	1.11	1.06	26	10.9%	0.96 [0.23, 1.69]
Oz et al., 2017	0.61	1.97	80	0.49	1.68	80	14.2%	0.12 [-0.45, 0.69]
Subtotal (95% CI)			**233**			**250**	**72.8%**	**0.68 [0.25, 1.11]**
Heterogeneity: Tau² = 0.17; I² = 0%								
Test for overall effect: Z = 3.09 (P = 0.002)								
Total (95% CI)			**309**			**325**	**100.0%**	**0.68 [0.36, 0.99]**
Heterogeneity: Tau² = 0.10; I² = 0%								
Test for overall effect: Z = 4.24 (P < 0.0001)								
Total (95% PI)								**0.68 [-0.14, 1.50]**



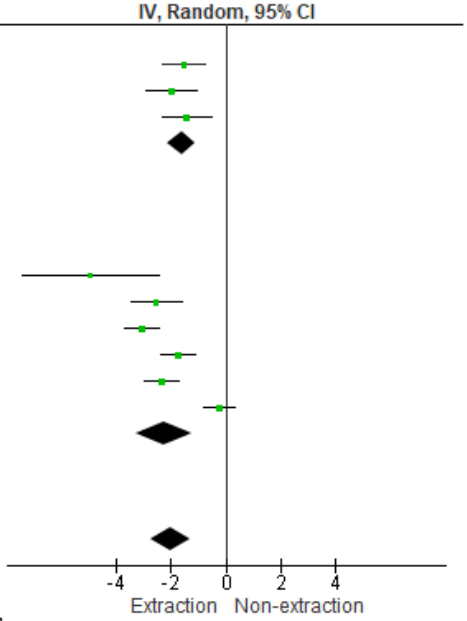
Maxillary intermolar width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	-2.14	8.9	30	1.45	2.25	30	5.1%	-3.59 [-6.87, -0.31]
De Almeida et al., 2011	-0.74	2.77	21	1.3	2.68	20	9.6%	-2.04 [-3.71, -0.37]
Sumit and Ashima, 2010	-1.3	1.76	25	0.01	1.21	25	12.5%	-1.31 [-2.15, -0.47]
Subtotal (95% CI)			**76**			**75**	**27.2%**	**-1.60 [-2.40, -0.80]**
Heterogeneity: Tau² = 0.05; I² = 0.32%								
Test for overall effect: Z = 3.93 (P < 0.0001)								
1.3.2 Different malocclusion classes								
Choi et al., 2020	-4.01	1.89	15	0.02	2.76	17	9.8%	-4.03 [-5.65, -2.41]
Işık et al., 2005	-0.88	1.66	27	1.58	1.62	42	12.6%	-2.46 [-3.26, -1.66]
Jeon et al., 2007 (Article in Korean)	-1.49	2	30	1.1	2.13	30	11.8%	-2.59 [-3.64, -1.54]
Kim and Gianelly, 2003	-0.53	1.39	30	1.53	1.75	30	12.6%	-2.06 [-2.86, -1.26]
MacKriel, 2008 (Thesis)	-1.79	1.57	26	0.23	1.13	26	12.7%	-2.02 [-2.76, -1.28]
Oz et al., 2017	0.81	1.35	80	0.5	2.04	80	13.3%	0.31 [-0.23, 0.85]
Subtotal (95% CI)			**208**			**225**	**72.8%**	**-2.06 [-3.29, -0.83]**
Heterogeneity: Tau² = 2.12; I² = 0%								
Test for overall effect: Z = 3.29 (P = 0.001)								
Total (95% CI)			**284**			**300**	**100.0%**	**-2.03 [-2.97, -1.09]**
Heterogeneity: Tau² = 1.64; I² = 0%								
Test for overall effect: Z = 4.25 (P < 0.0001)								
Total (95% PI)								**-2.03 [-5.26, 1.20]**



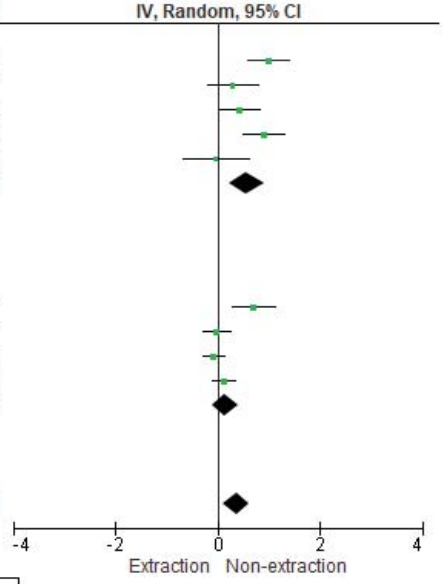
Mandibular intermolar width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.4.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	-0.93	1.29	30	0.59	1.8	30	11.7%	-1.52 [-2.31, -0.73]
De Almeida et al., 2011	-1.59	1.76	21	0.37	1.24	20	11.1%	-1.96 [-2.89, -1.03]
Sumit and Ashima, 2010	-1.33	1.87	25	0.1	1.34	25	11.2%	-1.43 [-2.33, -0.53]
Subtotal (95% CI)			**76**			**75**	**34.0%**	**-1.62 [-2.12, -1.12]**
Heterogeneity: Tau² = 0.00; I² = 0%								
Test for overall effect: Z = 6.34 (P < 0.00001)								
1.4.2 Different malocclusion classes								
Choi et al., 2020	-5.13	4.31	15	-0.2	2.63	17	5.0%	-4.93 [-7.44, -2.42]
Işık et al., 2005	-1.42	2.08	27	1.12	1.68	42	11.1%	-2.54 [-3.47, -1.61]
Jeon et al., 2007 (Article in Korean)	-2.39	1.28	30	0.68	1.23	30	12.4%	-3.07 [-3.71, -2.43]
Kim and Gianelly, 2003	-0.94	1.38	30	0.81	1.02	30	12.4%	-1.75 [-2.36, -1.14]
MacKriel, 2008 (Thesis)	-2.15	1.06	26	0.19	1.21	26	12.4%	-2.34 [-2.96, -1.72]
Oz et al., 2017	0.9	1.61	80	1.14	1.92	80	12.7%	-0.24 [-0.79, 0.31]
Subtotal (95% CI)			**208**			**225**	**66.0%**	**-2.24 [-3.27, -1.21]**
Heterogeneity: Tau² = 1.40; I² =14.33%								
Test for overall effect: Z = 4.26 (P < 0.0001)								
Total (95% CI)			**284**			**300**	**100.0%**	**-2.00 [-2.71, -1.30]**
Heterogeneity: Tau² = 0.94; I² = 5.32%								
Test for overall effect: Z = 5.56 (P < 0.00001)								
Total (95% PI)								**-2.00 [-4.44, 0.44]**



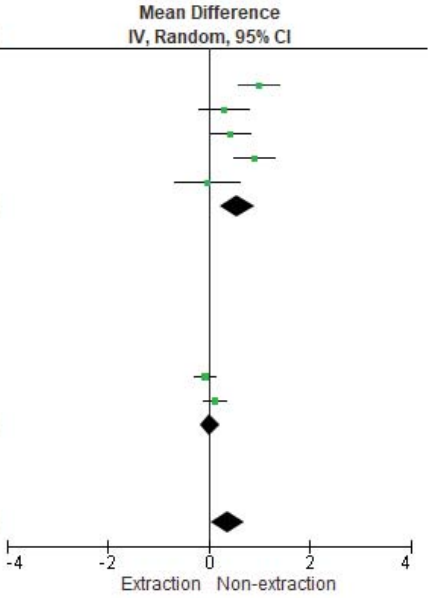
Treatment duration (years)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.5.1 Class I dental/ Skeletal								
Beit et al., 2017	2.79	1.16	41	1.8	0.65	42	10.9%	0.99 [0.58, 1.40]
De Almeida et al., 2011	2.7	0.6	21	2.4	1	20	9.5%	0.30 [-0.21, 0.81]
Gorucu-Coskuner et al., 2017	2.1	0.48	15	1.67	0.63	16	11.1%	0.43 [0.04, 0.82]
Kouli et al., 2019	2.59	1.03	34	1.68	0.65	34	10.8%	0.91 [0.50, 1.32]
Mahmood, 2009	2.47	1.12	20	2.5	1	20	7.7%	-0.03 [-0.69, 0.63]
Subtotal (95% CI)			**131**			**132**	**49.9%**	**0.57 [0.22, 0.91]**
Heterogeneity: Tau² = 0.10; I² = 7.79%								
Test for overall effect: Z = 3.21 (P = 0.001)								
1.5.2 Different malocclusion classes								
Bishara et al., 1995	2.9955	0.8952	44	2.3	1.1308	47	10.7%	0.70 [0.28, 1.11]
Francisconi et al., 2014	2.15	0.53	40	2.16	0.75	44	12.6%	-0.01 [-0.29, 0.27]
Freitas et al., 2013	2.09	0.58	97	2.16	0.71	58	13.4%	-0.07 [-0.29, 0.15]
MacKriel, 2008 (Thesis)	1.97	0.43	26	1.84	0.38	26	13.3%	0.13 [-0.09, 0.35]
Subtotal (95% CI)			**207**			**175**	**50.1%**	**0.14 [-0.11, 0.40]**
Heterogeneity: Tau² = 0.05; I² = 32.24%								
Test for overall effect: Z = 1.08 (P = 0.28)								
Total (95% CI)			**338**			**307**	**100.0%**	**0.36 [0.10, 0.62]**
Heterogeneity: Tau² = 0.12; I² = 3.18%								
Test for overall effect: Z = 2.69 (P = 0.007)								
Total (95% PI)								**0.36 [-0.52, 1.24]**



Sensitivity analysis (Treatment duration)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.5.1 Class I dental/ Skeletal								
Beit et al., 2017	2.79	1.16	41	1.8	0.65	42	14.3%	0.99 [0.58, 1.40]
De Almeida et al., 2011	2.7	0.6	21	2.4	1	20	12.6%	0.30 [-0.21, 0.81]
Gorucu-Coskuner et al., 2017	2.1	0.48	15	1.67	0.63	16	14.5%	0.43 [0.04, 0.82]
Kouli et al., 2019	2.59	1.03	34	1.68	0.65	34	14.2%	0.91 [0.50, 1.32]
Mahmood, 2009	2.47	1.12	20	2.5	1	20	10.3%	-0.03 [-0.69, 0.63]
Subtotal (95% CI)			**131**			**132**	**65.8%**	**0.57 [0.22, 0.91]**
1.5.2 Different malocclusion classes								
Bishara et al., 1995	2.9955	0.8952	44	2.3	1.1308	47	0.0%	0.70 [0.28, 1.11]
Francisconi et al., 2014	2.15	0.53	40	2.16	0.75	44	0.0%	-0.01 [-0.29, 0.27]
Freitas et al., 2013	2.09	0.58	97	2.16	0.71	58	17.1%	-0.07 [-0.29, 0.15]
MacKriel, 2008 (Thesis)	1.97	0.43	26	1.84	0.38	26	17.1%	0.13 [-0.09, 0.35]
Subtotal (95% CI)			**123**			**84**	**34.2%**	**0.03 [-0.17, 0.22]**
Total (95% CI)			**254**			**216**	**100.0%**	**0.38 [0.06, 0.69]**
Heterogeneity: Tau² = 0.14; I² = 0%								
Test for overall effect: Z = 2.33 (P = 0.02)								



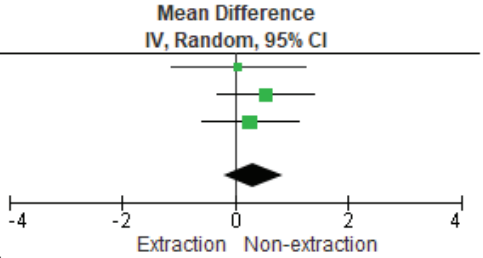
US weighted PAR score

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Freitas et al., 2013	4.11	3.07	97	4.05	3.91	58	20.7%	0.06 [-1.12, 1.24]
Holman et al., 1998	6.18	3.04	100	5.64	3.08	100	39.9%	0.54 [-0.31, 1.39]
Janson et al., 2015	2.26	1.57	30	2	1.8	30	39.3%	0.26 [-0.59, 1.11]
Total (95% CI)			**227**			**188**	**100.0%**	**0.33 [-0.21, 0.87]**

Heterogeneity: Tau² = 0.00; I² = 0%

Test for overall effect: Z = 1.21 (P = 0.23)

Total (95% PI) **0.33 [-3.17, 3.83]**

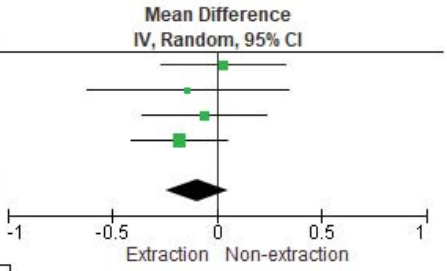


Aesthetic score

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Işiksal et al., 2006	3.15	0.46	25	3.12	0.6	25	24.6%	0.03 [-0.27, 0.33]
Johnson and Smith, 1995	2.93	1.03	30	3.07	0.86	30	9.4%	-0.14 [-0.62, 0.34]
Naik et al., 2014	3.01	0.4	15	3.07	0.42	15	25.1%	-0.06 [-0.35, 0.23]
Prasad et al., 2019	2.6	0.5188	40	2.78	0.5307	40	40.9%	-0.18 [-0.41, 0.05]
Total (95% CI)			**110**			**110**	**100.0%**	**-0.09 [-0.24, 0.05]**

Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: Z = 1.26 (P = 0.21)

Total (95% PI) **-0.09 [-0.40, 0.22]**

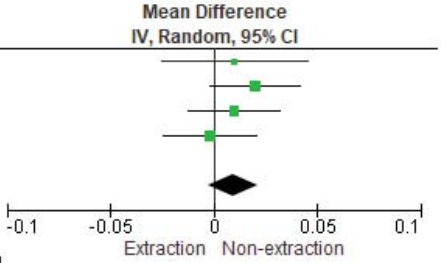


Maxillary intercanine width/smile width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.67	0.07	30	0.66	0.07	30	11.6%	0.01 [-0.03, 0.05]
Işiksal et al., 2006	0.72	0.03	25	0.7	0.047	25	30.3%	0.02 [-0.00, 0.04]
Johnson and Smith, 1995	0.72	0.044	30	0.71	0.044	30	29.2%	0.01 [-0.01, 0.03]
Prasad et al., 2019	0.6745	0.048	40	0.6762	0.0541	40	28.9%	-0.00 [-0.02, 0.02]
Total (95% CI)			**125**			**125**	**100.0%**	**0.01 [-0.00, 0.02]**

Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: Z = 1.57 (P = 0.12)

Total (95% PI) **0.01 [-0.01, 0.03]**

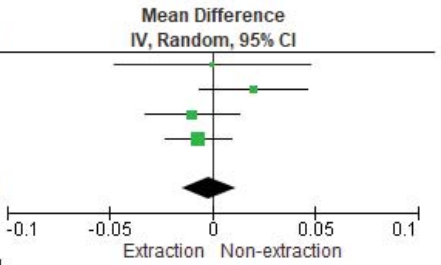


Visible dentition width/smile width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.84	0.12	30	0.84	0.06	30	6.9%	0.00 [-0.05, 0.05]
Işiksal et al., 2006	0.9	0.04	25	0.88	0.054	25	21.0%	0.02 [-0.01, 0.05]
Johnson and Smith, 1995	0.91	0.047	30	0.92	0.043	30	26.9%	-0.01 [-0.03, 0.01]
Prasad et al., 2019	0.8443	0.0382	40	0.8511	0.0367	40	45.1%	-0.01 [-0.02, 0.01]
Total (95% CI)			**125**			**125**	**100.0%**	**-0.00 [-0.01, 0.01]**

Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: Z = 0.24 (P = 0.81)

Total (95% PI) **-0.00 [-0.02, 0.02]**

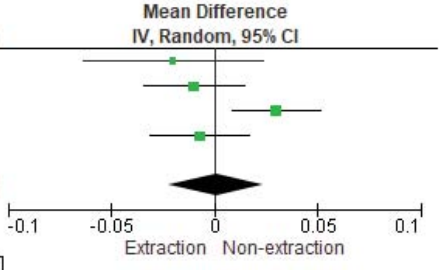


Maxillary intercanine width/visible dentition width

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.77	0.1	30	0.79	0.07	30	16.3%	-0.02 [-0.06, 0.02]
Işiksal et al., 2006	0.78	0.043	25	0.79	0.045	25	27.1%	-0.01 [-0.03, 0.01]
Johnson and Smith, 1995	0.8	0.05	30	0.77	0.032	30	29.3%	0.03 [0.01, 0.05]
Prasad et al., 2019	0.7882	0.0514	40	0.7951	0.0585	40	27.3%	-0.01 [-0.03, 0.02]
Total (95% CI)			**125**			**125**	**100.0%**	**0.00 [-0.02, 0.02]**

Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: Z = 0.08 (P = 0.94)

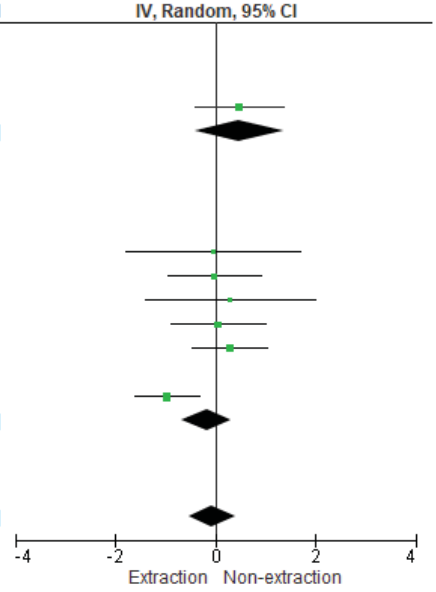
Total (95% PI) **0.00 [-0.04, 0.04]**



Sensitivity analysis (Maxillary intercanine width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.1.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	1.47	2.11	30	0.85	1.71	30	0.0%	0.62 [-0.35, 1.59]
De Almeida et al., 2011	1.09	2.36	21	1.86	2.21	20	0.0%	-0.77 [-2.17, 0.63]
Sumit and Ashima, 2010	0.44	1.76	25	-0.04	1.42	25	16.2%	0.48 [-0.41, 1.37]
Subtotal (95% CI)			**25**			**25**	**16.2%**	**0.48 [-0.41, 1.37]**
1.1.2 Different malocclusion classes								
Choi et al., 2020	-0.34	2.54	15	-0.29	2.47	17	6.1%	-0.05 [-1.79, 1.69]
Dong et al., 2007 (Article in Chinese)	1.26	1.26	25	1.28	2.03	25	15.2%	-0.02 [-0.96, 0.92]
Işık et al., 2005	1.72	3.95	27	1.42	2.74	42	6.3%	0.30 [-1.40, 2.00]
Jeon et al., 2007 (Article in Korean)	1.91	1.97	30	1.86	1.75	30	15.0%	0.05 [-0.89, 0.99]
Kim and Gianelly, 2003	0.84	1.16	30	0.55	1.78	30	19.1%	0.29 [-0.47, 1.05]
MacKriel, 2008 (Thesis)	1.84	1.68	26	1.22	2.55	26	0.0%	0.62 [-0.55, 1.79]
Oz et al., 2017	0.22	2.27	80	1.19	1.88	80	22.1%	-0.97 [-1.62, -0.32]
Subtotal (95% CI)			**207**			**224**	**83.8%**	**-0.17 [-0.67, 0.33]**
Total (95% CI)			**232**			**249**	**100.0%**	**-0.06 [-0.53, 0.41]**

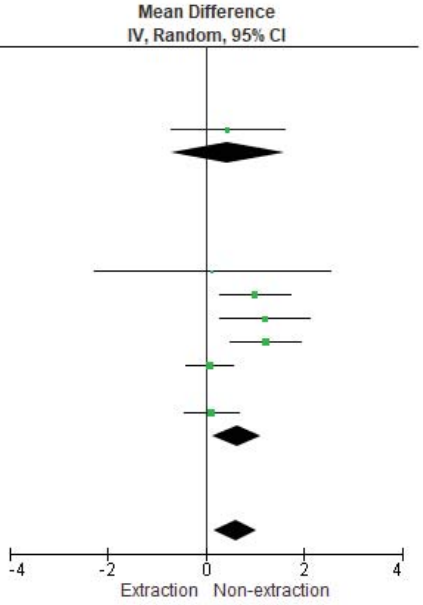
Heterogeneity: Tau² = 0.15; I² = 0%
Test for overall effect: Z = 0.26 (P = 0.80)



Sensitivity analysis (Mandibular intercanine width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	1.63	1.79	30	1.02	1.64	30	0.0%	0.61 [-0.26, 1.48]
De Almeida et al., 2011	1.48	0.88	21	0.52	1.17	20	0.0%	0.96 [0.32, 1.60]
Sumit and Ashima, 2010	1.18	1.73	25	0.73	2.4	25	9.6%	0.45 [-0.71, 1.61]
Subtotal (95% CI)			**25**			**25**	**9.6%**	**0.45 [-0.71, 1.61]**
1.2.2 Different malocclusion classes								
Choi et al., 2020	-0.09	4.09	15	-0.22	2.61	17	2.9%	0.13 [-2.28, 2.54]
Dong et al., 2007 (Article in Chinese)	1.3	1.31	25	0.3	1.32	25	16.4%	1.00 [0.27, 1.73]
Işık et al., 2005	0.61	1.99	27	-0.6	1.71	42	13.0%	1.21 [0.30, 2.12]
Jeon et al., 2007 (Article in Korean)	1.95	1.52	30	0.73	1.37	30	16.3%	1.22 [0.49, 1.95]
Kim and Gianelly, 2003	0.51	1.12	30	0.43	0.79	30	21.9%	0.08 [-0.41, 0.57]
MacKriel, 2008 (Thesis)	2.07	1.58	26	1.11	1.06	26	0.0%	0.96 [0.23, 1.69]
Oz et al., 2017	0.61	1.97	80	0.49	1.68	80	20.0%	0.12 [-0.45, 0.69]
Subtotal (95% CI)			**207**			**224**	**90.4%**	**0.63 [0.14, 1.12]**
Total (95% CI)			**232**			**249**	**100.0%**	**0.61 [0.17, 1.04]**

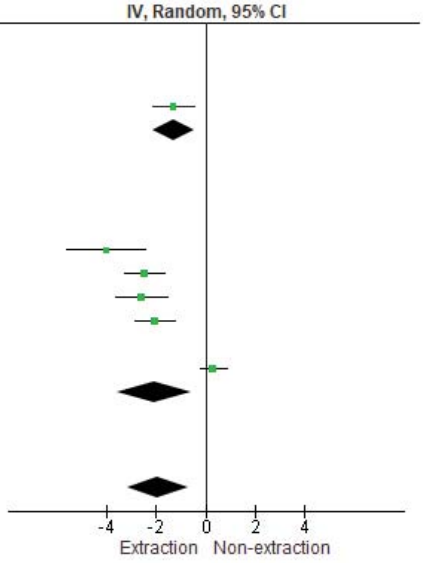
Heterogeneity: Tau² = 0.16; I² = 0%
Test for overall effect: Z = 2.74 (P = 0.006)



Sensitivity analysis (Maxillary intermolar width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.3.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	-2.14	8.9	30	1.45	2.25	30	0.0%	-3.59 [-6.87, -0.31]
De Almeida et al, 2011	-0.74	2.77	21	1.3	2.68	20	0.0%	-2.04 [-3.71, -0.37]
Sumit and Ashima, 2010	-1.3	1.76	25	0.01	1.21	25	17.1%	-1.31 [-2.15, -0.47]
Subtotal (95% CI)			**25**			**25**	**17.1%**	**-1.31 [-2.15, -0.47]**
1.3.2 Different malocclusion classes								
Choi et al., 2020	-4.01	1.89	15	0.02	2.76	17	14.0%	-4.03 [-5.65, -2.41]
Işık et al., 2005	-0.88	1.66	27	1.58	1.62	42	17.3%	-2.46 [-3.26, -1.66]
Jeon et al., 2007 (Article in Korean)	-1.49	2	30	1.1	2.13	30	16.4%	-2.59 [-3.64, -1.54]
Kim and Gianelly, 2003	-0.53	1.39	30	1.53	1.75	30	17.2%	-2.06 [-2.86, -1.26]
MacKriel, 2008 (Thesis)	-1.79	1.57	26	0.23	1.13	26	0.0%	-2.02 [-2.76, -1.28]
Oz et al., 2017	0.81	1.35	80	0.5	2.04	80	18.0%	0.31 [-0.23, 0.85]
Subtotal (95% CI)			**182**			**199**	**82.9%**	**-2.09 [-3.60, -0.57]**
Total (95% CI)			**207**			**224**	**100.0%**	**-1.94 [-3.16, -0.71]**

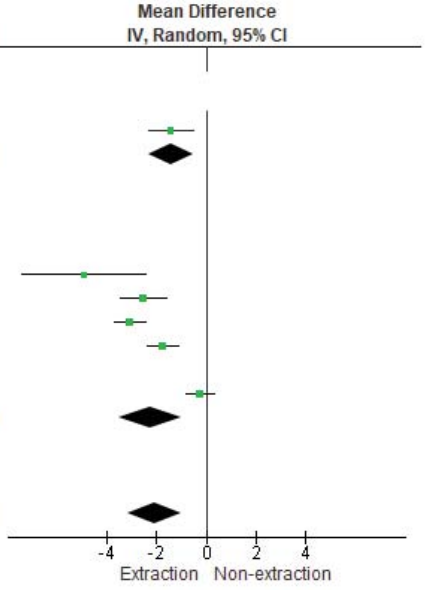
Heterogeneity: Tau² = 2.10; I² = 0%
Test for overall effect: Z = 3.10 (P = 0.002)



Sensitivity analysis (Mandibular intermolar width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.4.1 Class I dental/ Skeletal								
Aksu and Kocadereli, 2005	-0.93	1.29	30	0.59	1.8	3.		
De Almeida et al., 2011	-1.59	1.76	21	0.37	1.24	20	0.0%	-1.96 [-2.89, -1.03]
Sumit and Ashima, 2010	-1.33	1.87	25	0.1	1.34	25	17.4%	-1.43 [-2.33, -0.53]
Subtotal (95% CI)			**25**			**25**	**17.4%**	**-1.43 [-2.33, -0.53]**
1.4.2 Different malocclusion classes								
Choi et al., 2020	-5.13	4.31	15	-0.2	2.63	17	9.5%	-4.93 [-7.44, -2.42]
Işık et al., 2005	-1.42	2.08	27	1.12	1.68	42	17.2%	-2.54 [-3.47, -1.61]
Jeon et al., 2007 (Article in Korean)	-2.39	1.28	30	0.68	1.23	30	18.5%	-3.07 [-3.71, -2.43]
Kim and Gianelly, 2003	-0.94	1.38	30	0.81	1.02	30	18.6%	-1.75 [-2.36, -1.14]
MacKriel, 2008 (Thesis)	-2.15	1.06	26	0.19	1.21	26	0.0%	-2.34 [-2.96, -1.72]
Oz et al., 2017	0.9	1.61	80	1.14	1.92	80	18.8%	-0.24 [-0.79, 0.31]
Subtotal (95% CI)			**182**			**199**	**82.6%**	**-2.26 [-3.55, -0.97]**
Total (95% CI)			**207**			**224**	**100.0%**	**-2.09 [-3.17, -1.02]**

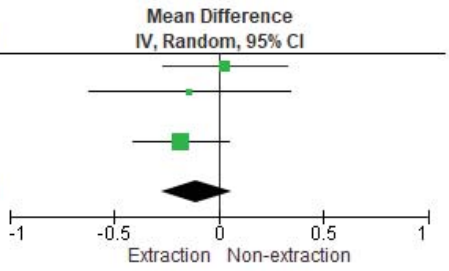
Heterogeneity: Tau² = 1.52; I² =13.68%
Test for overall effect: Z = 3.81 (P = 0.0001)



Sensitivity analysis (Aesthetic score)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Işiksal et al., 2006	3.15	0.46	25	3.12	0.6	25	32.9%	0.03 [-0.27, 0.33]
Johnson and Smith, 1995	2.93	1.03	30	3.07	0.86	30	12.5%	-0.14 [-0.62, 0.34]
Naik et al., 2014	3.01	0.4	15	3.07	0.42	15	0.0%	-0.06 [-0.35, 0.23]
Prasad et al., 2019	2.6	0.5188	40	2.78	0.5307	40	54.6%	-0.18 [-0.41, 0.05]
Total (95% CI)			95			95	100.0%	**-0.11 [-0.28, 0.06]**

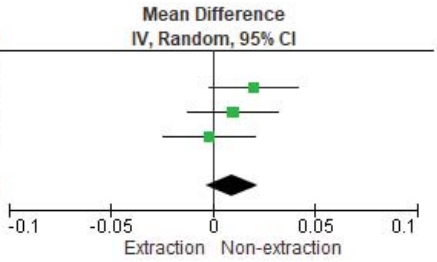
Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: (P = 0.22)



Sensitivity analysis (Maxillary intercanine width/smile width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.67	0.07	30	0.66	0.07	30	0.0%	0.01 [-0.03, 0.05]
Işiksal et al., 2006	0.72	0.03	25	0.7	0.047	25	34.3%	0.02 [-0.00, 0.04]
Johnson and Smith, 1995	0.72	0.044	30	0.71	0.044	30	33.1%	0.01 [-0.01, 0.03]
Prasad et al., 2019	0.6745	0.048	40	0.6762	0.0541	40	32.6%	-0.00 [-0.02, 0.02]
Total (95% CI)			95			95	100.0%	**0.01 [-0.00, 0.02]**

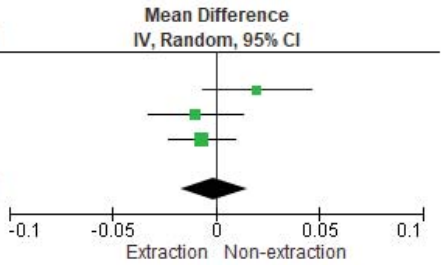
Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: (P = 0.14)



Sensitivity analysis (Visible dentition width/smile width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.84	0.12	30	0.84	0.06	30	0.0%	0.00 [-0.05, 0.05]
Işiksal et al., 2006	0.9	0.04	25	0.88	0.054	25	25.7%	0.02 [-0.01, 0.05]
Johnson and Smith, 1995	0.91	0.047	30	0.92	0.043	30	30.9%	-0.01 [-0.03, 0.01]
Prasad et al., 2019	0.8443	0.0382	40	0.8511	0.0367	40	43.5%	-0.01 [-0.02, 0.01]
Total (95% CI)			95			95	100.0%	**-0.00 [-0.02, 0.02]**

Heterogeneity: Tau² = 0.00; I² = 9.31%
Test for overall effect: (P = 0.91)



Sensitivity analysis (Maxillary intercanine width/visible dentition width)

Study or Subgroup	Extraction Mean	SD	Total	Non-extraction Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Ghaffar and Fida, 2011	0.77	0.1	30	0.79	0.07	30	0.0%	-0.02 [-0.06, 0.02]
Işiksal et al., 2006	0.78	0.043	25	0.79	0.045	25	32.5%	-0.01 [-0.03, 0.01]
Johnson and Smith, 1995	0.8	0.05	30	0.77	0.032	30	34.8%	0.03 [0.01, 0.05]
Prasad et al., 2019	0.7882	0.0514	40	0.7951	0.0585	40	32.7%	-0.01 [-0.03, 0.02]
Total (95% CI)			95			95	100.0%	**0.00 [-0.02, 0.03]**

Heterogeneity: Tau² = 0.00; I² = 0%
Test for overall effect: (P = 0.71)

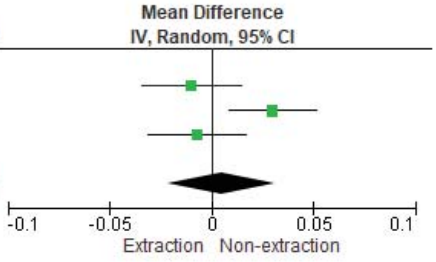


Table 1- Eligibility Criteria

	Arch width	Profile	Treatment duration	Occlusal outcomes	Smile aesthetics	Stability
Participants	Non-surgical patients with fixed orthodontic appliances with no adjunctive procedures reported such, as expansion appliances or interproximal reduction.	Non-surgical patients with fixed orthodontic appliances with no adjunctive procedures reported such, as expansion appliances or interproximal reduction and not reporting the use of extra oral or functional orthopaedic appliances.	Non-surgical patients with fixed orthodontic appliances with no adjunctive procedures reported such, as expansion appliances or interproximal reduction.			
Intervention	Four first premolar extraction treatment					
Comparison	Non-extraction treatment					
Outcome measures/ Pooled data	Maxillary and mandibular intercanine and inter-first molar width. Pooled data: mean treatment changes. (Pretreatment/end treatment).	Soft tissue cephalometric measurements: upper and lower lip prominence relative to E- plane Pooled data: mean treatment changes. (Pretreatment/end treatment)	Pooled data: treatment duration in years.	UK and US weighted (PAR) scores and American Board of Orthodontics Objective Grading System (ABO-OGS) Pooled data: end treatment for PAR scores and total score for ABO-OGS.	Aesthetic score (5 point scale), ratio of maxillary intercanine width/smile width, visible dentition width/smile width and maxillary intercanine width/visible dentition width Pooled data: post treatment measurements.	Maxillary and mandibular anterior alignment (Little's Irregularity Index from canine to canine). Post treatment measurements taken 3 years or more following treatment. Pooled data: mean post treatment changes. (End treatment/post treatment)
Study design	Prospective (randomized and non-randomized) and retrospective studies.					
Language	Language restrictions were not applied.					
Exclusion criteria	Studies with more than one error in sample size/treatment data (inconsistent data) in any part of the manuscript were considered of low internal consistency, and excluded.					

Table 2- Search strategy

Database	Search strategy/ Keywords
Cochrane Library (September 1993- June 2nd, 2023)	((orthodonti* OR "orthodontic treatment") AND (extract*) AND (nonextract* OR non-extract* OR "non extract*") AND ("arch width" OR width OR intraarch OR intra-arch OR intercanine OR inter-canine OR intermolar OR inter-molar OR "occlusal outcome*" OR abo OR "objective grading system" OR "par index" OR "par score" OR "treatment duration" OR "treatment time" OR stability OR relapse OR "little's irregularity index" OR esthetic* OR aesthetic* OR smil* OR "hard tissue*" OR "soft tissue*" OR lip OR profile OR "facial profile"))
DOSS (EBSCO) (April 1982- June 2nd, 2023)	
Medline Ultimate (EBSCO) (August 1975- June 2nd, 2023)	
PubMed (August 1975- June 2nd, 2023)	
Scopus (May 1949- June 2nd, 2023)	TITLE-ABS-KEY (((orthodonti* OR "orthodontic treatment") AND (extract*) AND (nonextract* OR non-extract* OR "non extract*") AND ("arch width" OR width OR intraarch OR intra-arch OR intercanine OR inter-canine OR intermolar OR inter-molar OR "occlusal outcome*" OR abo OR "objective grading system" OR "par index" OR "par score" OR "treatment duration" OR "treatment time" OR stability OR relapse OR "little's irregularity index" OR esthetic* OR aesthetic* OR smil* OR "hard tissue*" OR "soft tissue*" OR lip OR profile OR "facial profile"))) AND (LIMIT-TO (SUBJAREA , "DENT"))
VHL Regional Portal (December 1974- June 2nd, 2023)	((orthodonti* OR "orthodontic treatment") AND (extract*) AND (nonextract* OR non-extract* OR "non extract*") AND ("arch width" OR width OR intraarch OR intra-arch OR intercanine OR inter-canine OR intermolar OR inter-molar OR "occlusal outcome*" OR abo OR "objective grading system" OR "par index" OR "par score" OR "treatment duration" OR "treatment time" OR stability OR relapse OR "little's irregularity index" OR esthetic* OR aesthetic* OR smil* OR "hard tissue*" OR "soft tissue*" OR lip OR profile OR "facial profile"))
Web of Science (January 1964- June 2nd, 2023)	
ClinicalTrials.gov (Until June 2nd, 2023)	Condition or disease: extraction in orthodontics Other terms: non extraction treatment
Google Scholar (Until June 2nd, 2023)	((orthodonti* OR "orthodontic treatment") AND (extract*) AND (nonextract* OR non-extract* OR "non extract*") AND ("arch width" OR width OR intraarch OR intra-arch OR intercanine OR inter-canine OR intermolar OR inter-molar OR "occlusal outcome*" OR abo OR "objective grading system" OR "par index" OR "par score" OR "treatment duration" OR "treatment time" OR stability OR relapse OR "little's irregularity index" OR esthetic* OR aesthetic* OR smil* OR "hard tissue*" OR "soft tissue*" OR lip OR profile OR "facial profile"))
OpenGrey (DANS EASY) (Until June 2nd, 2023)	

Note:

For Cochrane Library, (title, abstract, keyword) selected in advanced search. No search limits were applied.

For Medline/ DOSS, no limiters/ expanders were applied in advanced search, with no field selected. Boolean/ Phrase selected in search mode.

For PubMed, no filters were applied in basic search.

For Scopus, Field codes (TITLE-ABS-KEY) and (LIMIT-TO (SUBJAREA, "DENT") used in advanced search.

For VHL Regional Portal, (title, abstract, subject) selected in advanced search. No filters were applied.

For Web of Science, search documents within all fields. No filters were applied.

For ClinicalTrials.gov, Status (all studies) selected within basic search, (country) field left blank.

For Google scholar, (include citations) and (include patents) selected. No filters were applied. Search resulted in 4440 hits. 990 hits were reviewed in 99 pages.

For OpenGrey, basic search applied within DANS EASY Archive.

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Table 3- Outcomes included in quantitative synthesis

(Meta-analysis)

Arch width

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Aksu and Kocadereli, 2005[27]	RS	University clinic	F 1st PE: 19 F, 11 M NE: 18 F, 12 M	F 1st PE: 14.3± 2.02 NE: 14.1± 2.9	Skeletal class I and Angle class I.	F 1st PE: 30 NE: 30	Max. & Mand. ICW, IMW
Choi et al., 2020[31]	RS	Seoul National University Bundang Hospital, Seongnam, Korea	All female	F 1st PE: 24.6±5.8 NE: 28.6±8.4	F 1st PE: 11 Class I, 4 Class II molar NE: 13 Class I, 4 Class II molar	F 1st PE: 15 NE: 17	Max. & Mand. ICW, IMW.
De Almeida et al, 2011[56]	RCT	University of Lins, Dental School, SP, Brazil	F 1st PE: 9 M, 12 F NE: 10 M, 10 F	F 1st PE: 13.4± 1.0 NE: 13.1 ± 1.7	Angle Class I	F 1st PE: 21 NE: 20	Max. & Mand. ICW, IMW.
Dong et al., 2007[54] (Article in Chinese)	RS	Shandong University, China	Not mentioned	13-15 yrs.	F 1st PE: 11 Class I, 10 Class II, 4 Class III NE: 15 Class I, 6 Class II, 4 Class III	F 1st PE: 25 NE: 25	Max. & Mand. ICW.
Işık et al., 2005[39]	RS	University Clinic	F 1st PE: 7 M, 20 F NE: 13 M, 29 F	F 1st PE: 13.57± 2.58 NE: 14.21± 2.79	Not mentioned	F 1st PE: 27 NE: 42	Max. & Mand. ICW, IMW.
Jeon et al., 2007[42] (Article in Korean)	RS	Kyung Hee University, South Korea	Not mentioned	F 1st PE: 14.3 NE: 14.1	F 1st PE: 20 Class I, 10 Class II NE: 20 Class I, 10 Class II	F 1st PE: 30 NE: 30	Max. & Mand. ICW, IMW.
Kim and Gianelly, 2003[44]	RS	University clinic	F 1st PE: 17 M, 13 F NE: 12 M, 18 F	F 1st PE: 14.1 NE: 14.2	F 1st PE: 18 Class I, 12 Class II division 1 NE: 18 Class I, 12 Class II division 1	F 1st PE: 30 NE: 30	Max. & Mand. ICW, IMW.
MacKriel, 2008[47] (Thesis)	RS	Not mentioned	F 1st PE: 13 M, 13 F NE: 13 M, 13 F	F 1st PE: 13.93±1.72 NE: 13.73±3.66	F 1st PE: 20 Class I, 3 Class II division 1, 3 Class II division 2 NE: 16 Class I, 5 Class II division 1, 5 Class II division 2	F 1st PE: 26 NE: 26	Max. & mand. ICW, IMW.
Oz et al., 2017[49]	RS	Ondokuz Mayıs University, Turkey	F 1st PE: 35 M, 45 F NE: 32 M, 48 F	F 1st PE: 14.3 ± 3.4 NE: 13.8 ± 2.1	Not mentioned	F 1st PE: 80 NE: 80	Max. & Mand. ICW, IMW.
Sumit and Ashima, 2010[51]	RS	Manipal College of Dental Sciences, India	F 1st PE: 9 M, 16 F NE: 11 M, 14 F	F 1st PE: 18.2± 3.5 NE: 18.3± 3.8	Class I dental and skeletal.	F 1st PE: 25 NE: 25	Max. & Mand. ICW, IMW.

Treatment duration

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Beit et al., 2017[29]	RS	Private orthodontic offices and school of Dentistry of the National and Kapodistrian University of Athens, Greece	F 1st PE: 23 F, 18 M NE: 24 F, 18 M	F 1st PE: 13.71±3.28 NE: 14.62±3.84	Class I dental and skeletal	F 1st PE: 41 NE: 42	Treatment duration in years

Bishara et al., 1995[30]	RS	University of Iowa, USA	F 1st PE: 21 M, 23 F NE: 20 M , 27 F	F 1st PE: M: 11.5±1.6 yrs., F: 11.6±1.6 NE: M: 12.1±1.5, F: 10.9±1.5	Class II division 1	F 1st PE: 44 NE: 47	Treatment duration in years
De Almeida et al, 2011[56]	RCT	University of Lins, Dental School, SP, Brazil	F 1st PE: 9 M, 12 F NE: 10 M, 10 F	F 1st PE: 13.4± 1.0 NE: 13.1 ± 1.7	Angle Class I	F 1st PE: 21 NE: 20	Treatment duration in years
Francisconi et al., 2014[32]	RS	Bauru Dental School, University of Sao Paulo, Brazil	F 1st PE: 15 M, 25 F NE: 17 M, 27 F	F 1st PE: 13.01± 0.99 NE: 12.96± 1.10	F 1st PE: 25 Class I, 15 Class II (6 ½, 1 ¾ & 8 full unit). NE: 21 Class I, 23 Class II (4 ½, 6 ¾ & 13 full unit).	F 1st PE: 40 NE: 44	Treatment duration in years
Freitas et al., 2013[33]	RS	Bauru Dental School, University of Sao Paulo, Bauru, Brazil	F 1st PE: 44 M, 53 F NE: 24 M, 34 F	F 1st PE: 13.03±1.09 NE: 12.83±1.11	F 1st PE: 60 Class I, 37 Class II (7 ¼, 9 ½, 5 ¾ & 16 full unit). NE: 29 Class I, 29 Class II (5 ¼, 7 ½, 4 ¾ & 13 full unit).	F 1st PE: 97 NE: 58	Treatment duration in years
Gorucu-Coskuner et al., 2017[36]	RS	Hacettepe University, Turkey	F 1st PE: 9 F, 6 M NE: 13 F, 3 M	F 1st PE: 13.89±5.69 NE: 13.34±1.82	Skeletal Class I	F 1st PE: 15 NE: 16	Treatment duration in years
Kouli et al., 2019[46]	RS	Orthodontic offices and Department of Orthodontics National and Kapodistrian University of Athens, Greece	F 1st PE: 15 M, 19 F NE: 15 M, 19 F	F 1st PE: 13.94±3.23 NE: 13.98±3.37	Class I dental	F 1st PE: 34 NE: 34	Treatment duration in years
MacKriel, 2008[47] (Thesis)	RS	Not mentioned	F 1st PE: 13 M, 13 F NE: 13 M, 13 F	F 1st PE: 13.93±1.72 NE: 13.73±3.66	F 1st PE: 20 Class I, 3 Class II division 1, 3 Class II division 2 NE: 16 Class I, 5 Class II division 1, 5 Class II division 2	F 1st PE: 26 NE: 26	Treatment duration in years
Mahmood, 2009[55]	RS	College of dentistry, Mosul, University, Iraq	F 1st PE: 13 F, 7 M NE: 11 F, 9 M	F 1st PE: 13.18±1.63 NE: 12.97±1.76	Class I dental and skeletal	F 1st PE: 20 NE: 20	Treatment duration in years

Occlusal outcomes (US weighted PAR score)

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Freitas et al., 2013[33]	RS	Bauru Dental School, University of Sao Paulo, Bauru, Brazil	F 1st PE: 44 M, 53 F NE: 24 M, 34 F	F 1st PE: 13.03±1.09 NE: 12.83±1.11	F 1st PE: 60 Class I, 37 Class II (7 ¼, 9 ½, 5 ¾ & 16 full unit). NE: 29 Class I, 29 Class II (5 ¼, 7 ½, 4 ¾ & 13 full unit).	F 1st PE: 97 NE: 58	PAR score US weight
Holman et al., 1998[38]	RS	Clinic of the co-author (MGH).	F 1st PE: 39 M, 61 F NE: 50 F, 50 M	F 1st PE: 13.5±1.4 NE: 13.5±1.2	F1st PE: 40 Class I, 35 Class II division 1, 4 Class II division 2, 14 Class II subdivision, 7 Class III NE: 54 Class I, 29 Class II division 1, 3 Class II division 2, 11 Class II subdivision, 3 Class III	F 1st PE: 100 NE: 100	PAR score US weight.
Janson et al., 2015[41]	RS	Bauru Dental School, University of Sao Paulo, Brazil	F 1st PE: 15 F, 15 M NE: 19 F, 11 M	F 1st PE: 13.10±1.56 NE: 12.38±1.22	Class II division 1.	F 1st PE: 30 NE: 30	PAR score US weight

Smile aesthetics

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Mean age (years)	Pre-treatment malocclusion		
Ghaffar and Fida, 20113[35]	RS	Aga Khan University, Karachi, Pakistan.	F 1st PE: 10 M, 20 F NE: 11 M, 19 F	15- 30 yrs.	Not mentioned	F 1st PE: 30 NE: 30	Ratio: ICW/ SW, VDW/ SW, ICW/VDW
Işiksal et al., 2006[40]	RS	Ege University, Izmir, Turkey	F 1st PE: 13 F, 12 M NE: 13 F, 12 M	F 1st PE: 19.08±2.40 NE: 19.04±1.97	Angle Class I	F 1st PE: 25 NE: 25	Aesthetic score Ratio: ICW/ SW, VDW/ SW, ICW/ VDW
Johnson and Smith, 1995[43]	RS	Three Private orthodontic practices	F 1st PE: 15 M, 15 F NE: 15 M, 15 F	F 1st PE: 16.4±2.93 NE: 15.6±1.45	Not mentioned	F 1st PE: 30 NE: 30	Aesthetic score Ratio: ICW/ SW, VDW/ SW, ICW/ VDW
Naik et al., 2014[48]	RS	College of Dental Sciences, Davangere, India	All female	F 1st PE: 21.07±2.84 NE: 21.87±1.68	Not mentioned	F 1st PE: 15 NE: 15	Aesthetic score
Prasad et al., 2018[50]	RS	King George's University of Dental Sciences, Lucknow, India	F 1st PE: 20 M, 20 F NE: 20 M, 20 F	20.16 yrs.	Not mentioned	F 1st PE: 40 NE: 40	Aesthetic score Ratio: ICW/ SW, VDW/ SW, ICW/ VDW

RS: Retrospective study, RCT: Randomized Controlled Trial, F 1st PE: Four first premolar extraction, NE: Non-extraction, mos.: months, yrs.: years, ICW: Intercanine width, IMW: Intermolar width, Max.: maxillary, Mand: mandibular, UL: upper lip, LL: lower lip, SW: Smile width, VDW: Visible dentition width, LII: Little's Irregularity Index

Table 4- Outcomes included in qualitative synthesis

(Narrative synthesis)

Profile

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Choi et al., 2020[31]	RS	Seoul National University Bundang Hospital, Seongnam, Korea	All female	F 1st PE: 24.6±5.8 NE: 28.6±8.4	F 1st PE: 11 Class I, 4 Class II molar NE: 13 Class I, 4 Class II molar	F 1st PE: 15 NE: 17	UL- E plane, LL- E plane
Freitas et al., 2019[34]	RS	Centro de Educação Continuada do Maranhão, São Luís/MA	F 1st PE: 6 F, 4 M NE: 5 F, 5 M	12.3 yrs.	Angle Class I	F 1st PE: 10 NE: 10	LL- E plane
Hassan et al., 2019[37]	RS	University Hospital in Karachi, Pakistan	All female patients	F 1st PE: 23.43 NE: 24.49	F 1st PE: 12 Class I, 18 Class II NE: 20 Class I, 10 Class II	F 1st PE: 30 NE: 30	LL- E plane
Konstantonis, 2012[45]	RS	Saint Louis University Graduate Orthodontic Clinic, USA	Not mentioned	Not mentioned	Class I dental and skeletal	F 1st PE: 30 NE: 32	UL- E plane, LL- E plane
Xu et al., 2006[53]	RS	Orthodontic Department, Peking University School of Stomatology, China	F 1st PE: 4 M, 9 F NE: 6 M, 6 F	F 1st PE: 12.46±1.71 NE: 12.08±1.08	F 1st PE: 4 Class I, 8 Class II, 1 Class III NE: 7 Class I, 5 Class II	F 1st PE: 13 NE: 12	UL- E plane, LL- E plane

Occlusal outcomes (ABO- OGS)

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Anthopoulou et al., 2014[28]	RS	University of Athens graduate clinic and private orthodontic practices, Greece	F 1st PE: 16 F, 9 M NE: 20 F, 10 M	F 1st PE: 16.3±7.84 NE: 13.79±3.99	Class I dental and skeletal	F 1st PE: 25 NE: 30	ABO- OGS
Vaidya et al., 2018[52]	RS	JSS dental college and hospital, JSS University, Mysore, India	F 1st PE: 11 F, 9 M NE: 12 F, 8 M	F 1st PE: 15.2±4.2 NE: 14.6±2.7	Class I dental and skeletal	F 1st PE: 20 NE: 20	ABO- OGS

Stability

Author/ year	Study design	Participants				Intervention	Outcome
		Place/ Country	Sex	Pre-treatment mean age (years)	Pre-treatment malocclusion		
Francisconi et al., 2014[32]	RS	Bauru Dental School, University of Sao Paulo, Brazil	F 1st PE: 15 M, 25 F NE: 17 M, 27 F	F 1st PE: 13.01± 0.99 NE: 12.96± 1.10	F 1st PE: 25 Class I, 15 Class II (6 ½, 1 ¾ & 8 full unit). NE: 21 Class I, 23 Class II (4 ½, 6 ¾ & 13 full unit).	F 1st PE: 40 NE: 44	Max. & Mand. LII.

Freitas et al., 2013[33]	RS	Bauru Dental School, University of Sao Paulo, Bauru, Brazil	F 1st PE: 44 M, 53 F NE: 24 M, 34 F	F 1st PE: 13.03±1.09 NE: 12.83±1.11	F 1st PE: 60 Class I, 37 Class II (7 ¼, 9 ½, 5 ¾ & 16 full unit). NE: 29 Class I, 29 Class II (5 ¼, 7 ½, 4 ¾ & 13 full unit).	F 1st PE: 97 NE: 58	Max. & Mand. LII.

RS: Retrospective study, F 1st PE: Four first premolars extraction, NE: Non-extraction, mos.: Months, yrs.: Years, Max.: maxillary, Mand.: mandibular

Table 5- ROBINS-I tool

Study	Assessment by outcome	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall bias
Aksu and Kocadereli, 2005[27]	Max ICW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand ICW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Max IMW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand IMW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
Anthopoulou et al., 2014[28]	ABO- OGS	Low	Serious	Low	Low	Low	Moderate	Low	Serious
Beit et al., 2017[29]	Tx duration	NI	Serious	Low	Low	Low	Moderate	Serious	Serious
Bishara et al., 1995[30]	Tx duration	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Choi et al., 2020[31]	Max ICW	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	Mand ICW	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	Max IMW	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	Mand IMW	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	UL- E plane	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	LL- E plane	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
Dong et al., 2007[54] (Article in Chinese)	Max ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
Francisconi et al., 2014[32]	Max. LII	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand. LII	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Tx duration	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Freitas et al., 2013[33]	Max. LII	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand. LII	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	US weighted PAR score	Moderate	Serious	Low	Low	Low	Moderate	Serious	Serious
	Tx duration	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Freitas et al., 2019[34]	LL- E plane	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
Ghaffar and Fida, 20113[35]	ICW/ SW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	VDW/ SW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	ICW/VDW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious

Gorucu-Coskuner et al., 2017[36]	Tx duration	NI	Serious	Low	Low	Low	Moderate	Serious	Serious
Hassan et al., 2019[37]	LL- E plane	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Holman et al., 1998[38]	US weighted PAR score	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
Işık et al., 2005[39]	Max ICW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand ICW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	Max IMW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand IMW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Işiksal et al., 2006[40]	Aesthetic score	Low	Low	Low	Low	Low	Serious	Low	Serious
	ICW/ SW	Moderate	Low	Low	Low	Low	Moderate	Serious	Serious
	VDW/ SW	Moderate	Low	Low	Low	Low	Moderate	Serious	Serious
	ICW/VDW	Moderate	Low	Low	Low	Low	Moderate	Serious	Serious
Janson et al., 2015[41]	US weighted PAR score	Moderate	Low	Low	Low	Low	Moderate	Serious	Serious
Jeon et al., 2007[42] (Article in Korean)	Max ICW	NI	Moderate	Low	Low	Low	Moderate	Low	Moderate
	Mand ICW	NI	Moderate	Low	Low	Low	Moderate	Low	Moderate
	Max IMW	NI	Moderate	Low	Low	Low	Moderate	Low	Moderate
	Mand IMW	NI	Moderate	Low	Low	Low	Moderate	Low	Moderate
Johnson and Smith, 1995[43]	Aesthetic score	Low	Serious	Low	Low	Low	Serious	Serious	Serious
	ICW/ SW	NI	Serious	Low	Low	Low	Moderate	Serious	Serious
	VDW/ SW	NI	Serious	Low	Low	Low	Moderate	Serious	Serious
	ICW/VDW	NI	Serious	Low	Low	Low	Moderate	Serious	Serious
Kim and Gianelly, 2003[44]	Max ICW	NI	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand ICW	NI	Low	Low	Low	Low	Moderate	Low	Moderate
	Max IMW	NI	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand IMW	NI	Low	Low	Low	Low	Moderate	Low	Moderate
Konstantonis, 2012[45]	UL- E plane	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	LL- E plane	NI	Serious	Low	Low	Low	Moderate	Low	Serious

Kouli et al., 2019[46]	Tx duration	NI	Low	Low		Low	Moderate	Serious	Serious
MacKriel, 2008[47] (Thesis)	Max ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Max IMW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand IMW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Tx duration	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Mahmood, 2009[55]	Tx duration	NI	Low	Low	Low	Low	Moderate	Serious	Serious
Naik et al., 2014[48]	Aesthetic score	Low	Serious	Low	Low	Low	Serious	Low	Serious
Oz et al., 2017[49]	Max ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand ICW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Max IMW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
	Mand IMW	Moderate	Serious	Low	Low	Low	Moderate	Low	Serious
Prasad et al., 2018[50]	Aesthetic score	Low	Serious	Low	Low	Low	Serious	Low	Serious
	ICW/ SW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	VDW/ SW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
	ICW/VDW	NI	Serious	Low	Low	Low	Moderate	Low	Serious
Sumit and Ashima, 2010[51]	Max ICW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand ICW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Max IMW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
	Mand IMW	Moderate	Low	Low	Low	Low	Moderate	Low	Moderate
Vaidya et al., 2018[52]	ABO- OGS	NI	Low	Low	Low	Low	Moderate	Low	Moderate
Xu et al., 2006[53]	UL- E plane	Low	Serious	Low	Low	Low	Moderate	Low	Serious
	LL- E plane	Low	Serious	Low	Low	Low	Moderate	Low	Serious

Table 6- Synthesis of results

Time points of assessment	Outcome	Total 95% CI	Total 95% PI	Subgroup analysis (Class I subjects)	Sensitivity analysis
Treatment changes (Pre/end tx)	Max. ICW	(MD 0.02 mm; total 95% CI [-0.38, 0.43]; I^2 = 0%; P= 0.91)	(MD 0.02 mm; total 95% PI [-1.00, 1.04])	(MD 0.26 mm; subtotal 95% CI [-0.46, 0.98]; I^2 = 8.65%; P= 0.47)	(MD -0.06 mm; total 95% CI [-0.53, 0.41]; I^2 = 0%; P= 0.80)
	Mand. ICW	(MD 0.68 mm; total 95% CI [0.36, 0.99]; I^2 = 0%; P<0.0001)	(MD 0.68 mm; total 95% PI [-0.14, 1.50])	(MD 0.77 mm; subtotal 95% CI [0.31, 1.24]; I^2 = 0%; P= 0.001)	(MD 0.61 mm; total 95% CI [0.17, 1.04]; I^2 = 0%; P= 0.006)
	Max IMW	(MD -2.03 mm; total 95% CI [-2.97, -1.09]; I^2 = 0%; P< 0.0001)	(MD -2.03 mm; total 95% PI [-5.26, 1.20])	(MD -1.60 mm; subtotal 95%CI [-2.40, -0.80]; I^2 = 0.32%; P< 0.0001)	(MD -1.94 mm; total 95% CI [-3.16, -0.71]; I^2 = 0%; P= 0.002)
	Mand IMW	(MD -2.00 mm; total 95% CI [-2.71, -1.30]; I^2 = 5.32%; P< 0.00001)	(MD -2.00 mm; total 95% PI [-4.44, 0.44])	(MD -1.62 mm; subtotal 95% CI [-2.12, -1.12]; I^2 = 0%; P< 0.00001)	(MD -2.09 mm; total 95% CI [-3.17, -1.02]; I^2 = 13.68%; P= 0.0001)
	UL- E plane	Narrative synthesis included three retrospective studies, with vote counting indicating retraction of upper lip with four first premolar extraction.			
	LL- E plane	Narrative synthesis included five retrospective studies, with vote counting indicating retraction of lower lip with four first premolar extraction.			
Treatment duration (years)	Treatment duration	(MD 0.36 years; total 95% CI [0.10, 0.62]; I^2 = 3.18%; P= 0.007)	(MD 0.36 years; total 95% PI [-0.52, 1.24])	(MD 0.57 years; subtotal 95% CI [0.22, 0.91]; I^2 = 7.79%; P= 0.001	(MD 0.38 years; total 95% CI [0.06, 0.69]; I^2 = 0%; P= 0.02)
End treatment	UK weighted PAR score	No eligible studies were found.			
	US weighted PAR score	(MD 0.33; total 95% CI [-0.21, 0.87]; I^2 = 0%; P= 0.23)	(MD 0.33; total 95% PI [-3.17, 3.83])	N/A	N/A
	ABO-OGS	Narrative synthesis included two retrospective studies with inconclusive evidence.			
Post treatment	Aesthetic score	(MD -0.09; total 95% CI [-0.24, 0.05]; I^2 = 0%; P=0.21)	(MD -0.09; total 95% PI [-0.40, 0.22])	N/A	(MD -0.11; total 95% CI [-0.28, 0.06]; I^2 = 0%; P= 0.22)
	Max. ICW/SW	(MD 0.01; total 95% CI [-0.00, 0.02]; I^2 = 0%; P=0.12)	(MD 0.01; total 95% PI [-0.01, 0.03])	N/A	(MD 0.01; total 95% [-0.00, 0.02]; I^2 = 0%; P= 0.14)
	VDW/SW	(MD -0.00; total 95% CI [-0.01, 0.01]; I^2 = 0%; P=0.81)	(MD -0.00; total 95% PI [-0.02, 0.02])	N/A	(MD -0.00; total 95% CI [-0.02, 0.02]; I^2 = 9.31%; P= 0.91)
	Max. ICW/VDW	(MD 0.00; total 95% CI [-0.02, 0.02]; I^2 = 0%; P=0.94)	(MD 0.00; total 95% PI [-0.04, 0.04])	N/A	(MD 0.00; total 95% CI [-0.02, 0.03]; I^2 = 0%; P= 0.71)
Post treatment changes (End/post tx)	Max. LII	Narrative synthesis included two retrospective studies with inconclusive evidence.			
	Mand. LII				

ICW: Intercanine width, IMW: Intermolar width, Max.: maxillary, Mand: mandibular, UL: upper lip, LL: lower lip, SW: Smile width, VDW: Visible dentition width, LII: Little's Irregularity Index

Table 7- GRADE

Certainty assessment							№ of patients		Effect		Certainty
Outcome of interest	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Extraction	non-extraction	Relative (95% CI)	Absolute (95% CI)	
Maxillary intercanine width	9 observational studies+ 1RCT	serious[a]	not serious[b]	serious[c]	serious[d]	none[e]	309	325	-	MD **0.02 higher** (0.38 lower to 0.43 higher)	⨁◯◯◯ Very low
Mandibular intercanine width	9 observational studies+ 1RCT	serious[a]	not serious[b]	serious[c]	not serious[f]	none[e]	309	325	-	MD **0.68 higher** (0.36 higher to 0.99 higher)	⨁⨁◯◯ Low
Maxillary intermolar width	8 observational studies+ 1RCT	serious[g]	serious[h]	serious[c]	not serious[i]	none[e]	284	300	-	MD **2.03 lower** (2.97 lower to 1.09 lower)	⨁◯◯◯ Very low
Mandibular intermolar width	8 observational studies+ 1RCT	serious[g]	not serious[b]	serious[c]	not serious[i]	none[e]	284	300	-	MD **2 lower** (2.71 lower to 1.3 lower)	⨁⨁◯◯ Low
UL- E plane	3 observational studies	serious[k]	not serious[l]	serious[c]	very serious[m]	none[e]					⨁◯◯◯ Very low
LL- E plane	5 observational studies	serious[n]	not serious[l]	serious[c]	very serious[m]	none[e]					⨁◯◯◯ Very low
Treatment duration	8 observational studies+ 1RCT	serious[o]	not serious[b]	serious[c]	not serious[p]	none[e]	338	307	-	MD **0.36 higher** (0.1 higher to 0.62 higher)	⨁⨁◯◯ Low
UK weighted PAR score	0 studies										
US weighted PAR score	3 observational studies	serious[q]	not serious[b]	serious[c]	serious[r]	none[e]	227	188	-	MD **0.33 higher** (0.21 lower to 0.87 higher)	⨁◯◯◯ Very low
ABO-OGS	2 observational studies	serious[s]	serious[t]	serious[c]	very serious[m]	none[e]					⨁◯◯◯ Very low
Aesthetic score	4 observational studies	serious[u]	not serious[b]	serious[c]	very serious[v]	none[e]	110	110	-	MD **0.09 lower** (0.24 lower to 0.05 higher)	⨁◯◯◯ Very low
Maxillary intercanine width/smile width	4 observational studies	serious[w]	not serious[b]	serious[c]	very serious[v]	none[e]	125	125	-	MD **0.01 higher** (0 to 0.02 higher)	⨁◯◯◯ Very low
Visible dentition width/smile width	4 observational studies	serious[w]	not serious[b]	serious[c]	very serious[v]	none[e]	125	125	-	MD **0** (0.01 lower to 0.01 higher)	⨁◯◯◯ Very low
Maxillary intercanine width/ visible dentition	4 observational studies	serious[w]	not serious[b]	serious[c]	very serious[v]	none[e]	125	125	-	MD **0** (0.02 lower to 0.02 higher)	⨁◯◯◯ Very low
Maxillary anterior alignment (Little's Irregularity Index)	2 observational studies	serious[x]	serious[t]	serious[c]	very serious[m]	none[e]					⨁◯◯◯ Very low

Mandibular anterior alignment (Little's Irregularity Index)	2 observational studies	serious[x]	serious[t]	serious[c]	very serious[m]	none[e]		⨁◯◯◯ Very low

Explanations

a. Data extracted from five studies with serious concerns regarding selection of participants, four studies with moderate concerns regarding measurement of outcomes and one RCT of high risk of bias with concerns regarding allocation concealment and no information regarding blinding.

b. A random effects model was used; I-sq was low according to the rule of thumb. Confidence intervals overlap.

c. Different age pooled on the same estimate without a subgroup analysis for adolescents or adults.

d. Total number of patients is equal to 634 patients. Imprecise results due to wide confidence interval.

e. No risk of publication bias as different sources were searched including key databases and grey literature.

f. Confidence interval does not cross the null effect line, indicating significant increase in mandibular intercanine width with non-extraction group. 634 participants included.

g. Data extracted from four studies with serious concerns regarding selection of participants, four studies with moderate concerns regarding measurement of outcomes and one RCT of high risk of bias with concerns regarding allocation concealment and no information regarding blinding.

h. A random effects model was used; I-sq was low according to the rule of thumb. Oz et al., 2017 not overlapping on confidence intervals.

i. Confidence interval does not cross the null effect line, indicating significant decrease in maxillary intermolar width with four first premolar extraction group. 584 participants included.

j. Confidence interval does not cross the null effect line, indicating significant decrease in maxillary intermolar width with four first premolar extraction group. 584 participants included.

k. Data extracted from three studies with serious concerns regarding selection of participants.

l. Results seem quite consistent.

m. Narrative synthesis was conducted; estimates are not precise and small sample size.

n. Data extracted from four studies with serious concerns regarding selection of participants and one study with moderate concerns regarding measurement of outcomes.

o. Data extracted from six studies with serious concerns regarding selection of participants, two studies with serious concerns regarding selection of the reported results and one RCT of high risk of bias with concerns regarding allocation concealment and no information regarding blinding.

p. Confidence interval does not cross the null effect line, indicating significant shorter treatment duration in non-extraction group. 645 participants included.

q. Data extracted from three studies of serious risk of bias. Serious concerns regarding selection of participants in two studies and selection of reported results in one study.

r. Total number of patients is equal to 415 patients which is considered to be acceptable according to the rule of thumb. However, confidence interval is wide.

s. Data extracted from one study with serious concerns regarding selection of participants and one study of moderate concerns regarding measurement of outcomes.

t. Inconsistent results. Two studies included with conflicting evidence.

u. Data extracted from four studies of serious risk of bias. Serious concerns regarding outcome measurement, being a subjective parameter.

v. Small sample size.

w. Data extracted from four studies of serious risk of bias.

x. Data extracted from two studies of serious risk of bias with serious concerns regarding selection of participants.