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Impact of Maxillary Incisor Retraction on the Nasolabial Angle: A Systematic Review.

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1. INTRODUCTION

Facial esthetics play a pivotal role in the perception of beauty, self-esteem and social interactions, making it an integral consideration in orthodontic diagnosis and treatment planning. Among the various facial features, the nasolabial angle formed by the intersection of the columella of the nose and the upper lip is a critical parameter in assessing facial harmony and profile balance. It serves as a vital soft tissue landmark that reflects the relationship between the maxilla, upper lip, and nasal base, thereby influencing the overall esthetic outcome following orthodontic intervention. In orthodontic practice, particularly in cases involving bimaxillary protrusion or dentoalveolar proclination, maxillary incisor retraction is a routinely performed procedure to achieve optimal occlusion and facial profile improvement. However, while skeletal and dental changes are objectively quantifiable, the associated soft tissue alterations, especially those affecting the nasolabial angle, remain complex and variable due to interindividual differences in tissue thickness, elasticity, and morphology.

Understanding the influence of maxillary incisor retraction on the nasolabial angle is essential because even minor soft tissue changes can profoundly affect facial esthetics and patient satisfaction. Several studies have investigated this relationship, yet the literature presents considerable heterogeneity in results. Some reports suggest that incisor retraction leads to a significant increase in the nasolabial angle due to posterior movement of the upper lip, while others document minimal or no change, attributing this variation to factors such as lip thickness, skeletal pattern, and anchorage mechanics employed during treatment. The variability in orthodontic techniques—including the use of extractions versus non-extraction protocols, the type of retraction mechanics, and the influence of anchorage control—further complicates the interpretation of soft tissue responses. Moreover, differences in cephalometric methodologies, population characteristics, and treatment durations add to the inconsistency across published findings.

In the current era of patient-centered orthodontics, where esthetic outcomes are often considered as important as functional correction, it becomes imperative to elucidate the true nature and magnitude of soft tissue changes accompanying orthodontic tooth movement. Despite the growing number of clinical studies and trials addressing this issue, there remains no consensus on the extent to which maxillary incisor retraction affects the nasolabial angle, nor on the predictive factors governing these variations. Most existing studies are limited by small sample sizes, lack of standardization in measurement techniques, and variations in demographic characteristics such as age, gender, and ethnicity all of which may influence soft tissue response. Consequently, a systematic evaluation of the available evidence is warranted to synthesize data from diverse clinical contexts and to establish a clearer understanding of this relationship.

This systematic review is therefore undertaken with the objective of critically analyzing and integrating existing scientific evidence on the impact of maxillary incisor retraction on the nasolabial angle.

2. METHODOLOGY

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The aim was to evaluate the impact of maxillary incisor retraction on changes in the nasolabial angle among orthodontic patients.

Search strategy:

In this review article, electronic search was carried out across multiple databases including PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar to identify relevant studies published from 2017 to 2025. Additional manual searches were performed through reference lists of selected articles and orthodontic journals to ensure comprehensive coverage.

The search strategy combined the following keywords and Boolean operators: *"maxillary incisor retraction"*, *"nasolabial angle"*, *"orthodontic treatment"*, *"extraction"*, and *"facial esthetics"*. The search was restricted to studies published in English involving human subjects.

All retrieved articles were screened independently by two reviewers. Initially, titles and abstracts were assessed for relevance, followed by full-text evaluation of potentially eligible studies. Discrepancies between reviewers were resolved by discussion and consensus, with arbitration from a third reviewer when necessary.

Selection criteria:

On the basis of following inclusion criteria included studies were screened:

Studies were included if they met the following criteria:

They were clinical trials or observational studies (prospective or retrospective) evaluating changes in nasolabial angle following maxillary incisor retraction.

They provided quantitative or measurable data on nasolabial angle changes using cephalometric analysis.

Participants were orthodontic patients who underwent treatment involving maxillary incisor retraction with or without premolar extraction.

The studies had pre-treatment and post-treatment cephalometric records for analysis.

Exclusion criteria:

Case reports.

Review articles.

Animal studies

Those studies which were lack of measurable cephalometric parameters related to the nasolabial angle.

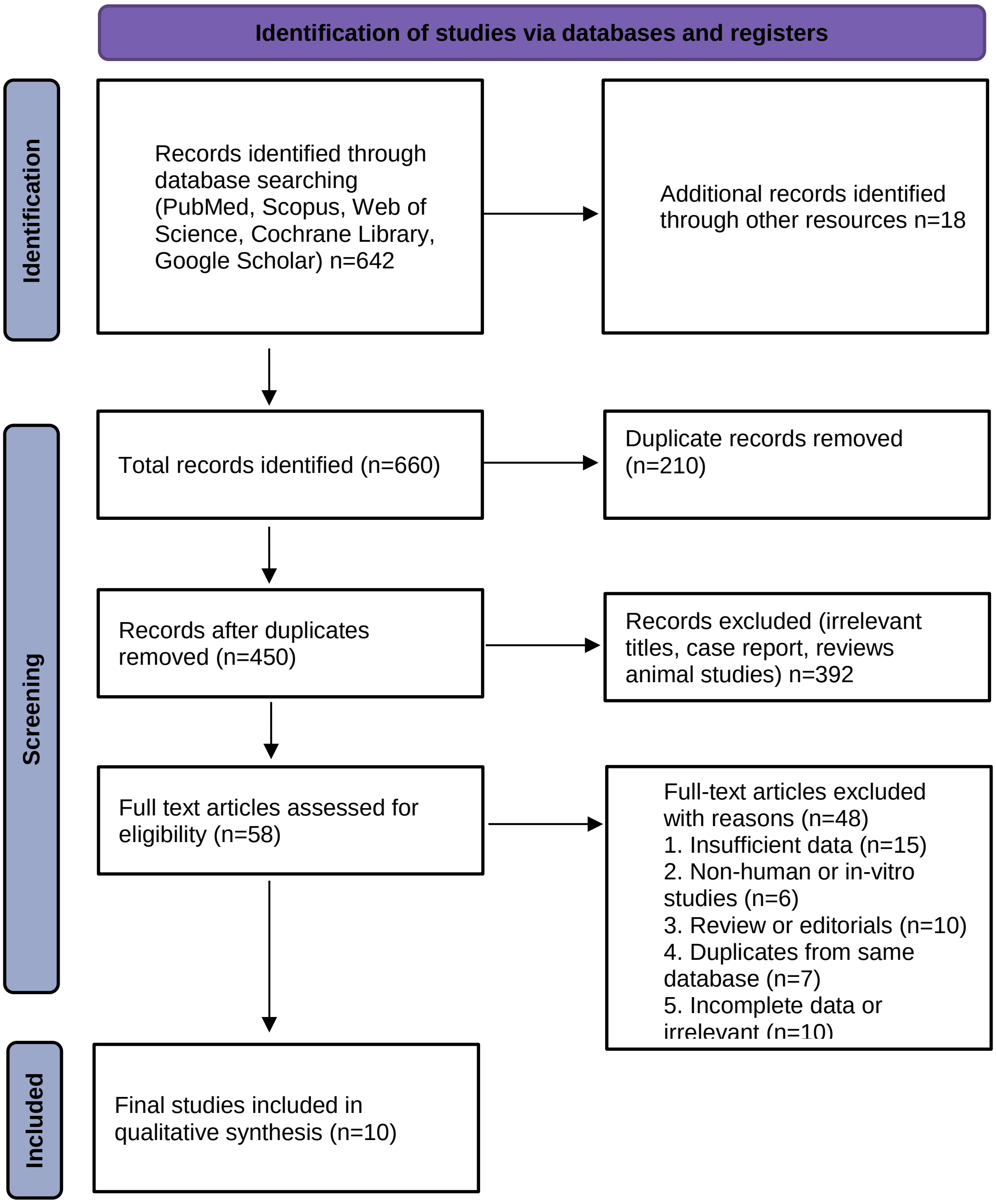
Data extraction:

Data extraction was performed independently by two reviewers using a standardized data extraction form. Extracted information included study design, sample size, age and gender of participants, treatment modality, method of incisor retraction, cephalometric parameters used, pre- and post-treatment nasolabial angle measurements, and key findings. Any disagreements were resolved by discussion. On the basis of selection criteria, a total of 10 studies were included in the final qualitative synthesis (Figure 1/Table 1). The extracted data were analyzed descriptively, and the results were tabulated to compare changes in the nasolabial angle relative to the amount of maxillary incisor retraction. Due to heterogeneity in study design, measurement techniques, and population characteristics, meta-analysis was not performed.

Risk of bias assessment:

RevMan software version 5.4 was used to examine the risk of bias. Attrition bias (incomplete data), reporting bias (selective reporting), performance bias (blinding participants and staff), selection bias (random sequence creation), and other biases were among the primary domains assessed. According to these criteria, each study was categorized as low (+), unclear (?), or high risk (-), as shown in Figure 2. All 10 studies had methodological flaws, with randomization presenting serious issues. The following Figure 3 shows that, 6.67% (4/60) of trials had high risk, 58.33% (35/60) had low risk, and 35% (21/60) had uncertain risk.

Figure 1: Showing the PRISMA flow diagram of included studies.



Results:

A total of 10 studies were included in this systematic review after a comprehensive search and screening of electronic databases. These studies collectively evaluated the impact of maxillary incisor retraction on changes in the nasolabial angle (NLA) among orthodontic patients. Of the ten studies, five were prospective observational studies, three were retrospective observational studies, one was a comparative observational study, and one was a predictive modeling study utilizing an artificial neural network approach. Together, these studies represented a combined sample of 826 participants, comprising approximately 122 men (14.8%) and 704 women (85.2%), with participants aged between 13 and 35 years. The predominance of female participants reflected the higher esthetic treatment demand among women seeking orthodontic correction.

The included studies were conducted across eight countries China, Korea, Turkey, Poland, Vietnam, Indonesia, Saudi Arabia, and India providing wide geographical and ethnic representation. The largest datasets originated from China and India, reflecting the increasing contribution of Asian populations to orthodontic soft tissue research. The majority of the included participants were adolescent and adult orthodontic patients presenting with Class I bimaxillary protrusion or Class II Division 1 malocclusion, conditions that frequently required premolar extraction and incisor retraction to achieve improved facial balance.

The primary focus of all studies was the evaluation of changes in the nasolabial angle following orthodontic incisor retraction. The first premolar extraction protocol followed by anterior retraction was the most commonly employed treatment approach, particularly in studies from India, Saudi Arabia, Turkey, and Indonesia, where this method was more prevalent among female patients. Non-extraction and moderate anchorage treatment protocols were less frequently applied and were primarily assessed in studies from Korea and China for comparative analysis. Most of the included studies relied on two-dimensional lateral cephalometric radiography for measuring soft tissue angular changes, whereas more recent investigations adopted three-dimensional facial scanning systems (3dMD) and predictive artificial intelligence models, reflecting the technological evolution of research methodologies.

Over time, a clear temporal trend was observed in diagnostic and analytical approaches. Earlier studies conducted between 2017 and 2019 primarily used traditional cephalometric analysis to measure pre- and post-treatment angular variations of the nasolabial region. However, between 2022 and 2025, newer studies transitioned toward 3D imaging and data-driven computational modeling, enabling more detailed assessment of volumetric soft tissue changes and predictive outcome estimation. This shift indicated a gradual movement from conventional radiographic evaluations toward precision-based digital orthodontics.

When the overall outcomes were synthesized, eight of the ten studies (80%) reported a statistically significant increase in the nasolabial angle following maxillary incisor retraction. The mean angular change ranged approximately between 2° and 15°, depending on the treatment protocol, population characteristics, and cephalometric reference planes. These studies demonstrated that posterior movement of the maxillary incisors caused upper lip retraction and reduction in facial convexity, resulting in an esthetically favorable widening of the nasolabial angle. The most pronounced improvements were consistently observed in extraction-based treatment groups, where the degree of anterior tooth retraction was greater.

Conversely, two studies (20%) reported minimal or non-significant changes in nasolabial angle post-retraction. These differences were attributed to individual variations in lip morphology, anchorage mechanics, and soft tissue resilience, which influenced the degree of response to underlying dental movements. The results from Korea and Poland emphasized that upper lip thickness and incisor inclination significantly affected nasolabial angle behavior, with thicker lips showing less change despite similar dental retraction magnitudes.

Across all included studies, several commonalities and differences were evident. Most studies agreed that maxillary incisor retraction resulted in improved facial esthetics through an increase in the nasolabial angle and a reduction in facial convexity. However, the magnitude of improvement varied by gender and ethnicity, with women demonstrating greater soft tissue adaptability. Extraction-based techniques were consistently associated with more pronounced soft tissue remodeling, while non-extraction approaches produced subtler changes. Additionally, differences in imaging modality contributed to variability in measurements—3D imaging and AI-based systems provided more precise and dynamic analyses compared to conventional 2D cephalometry.

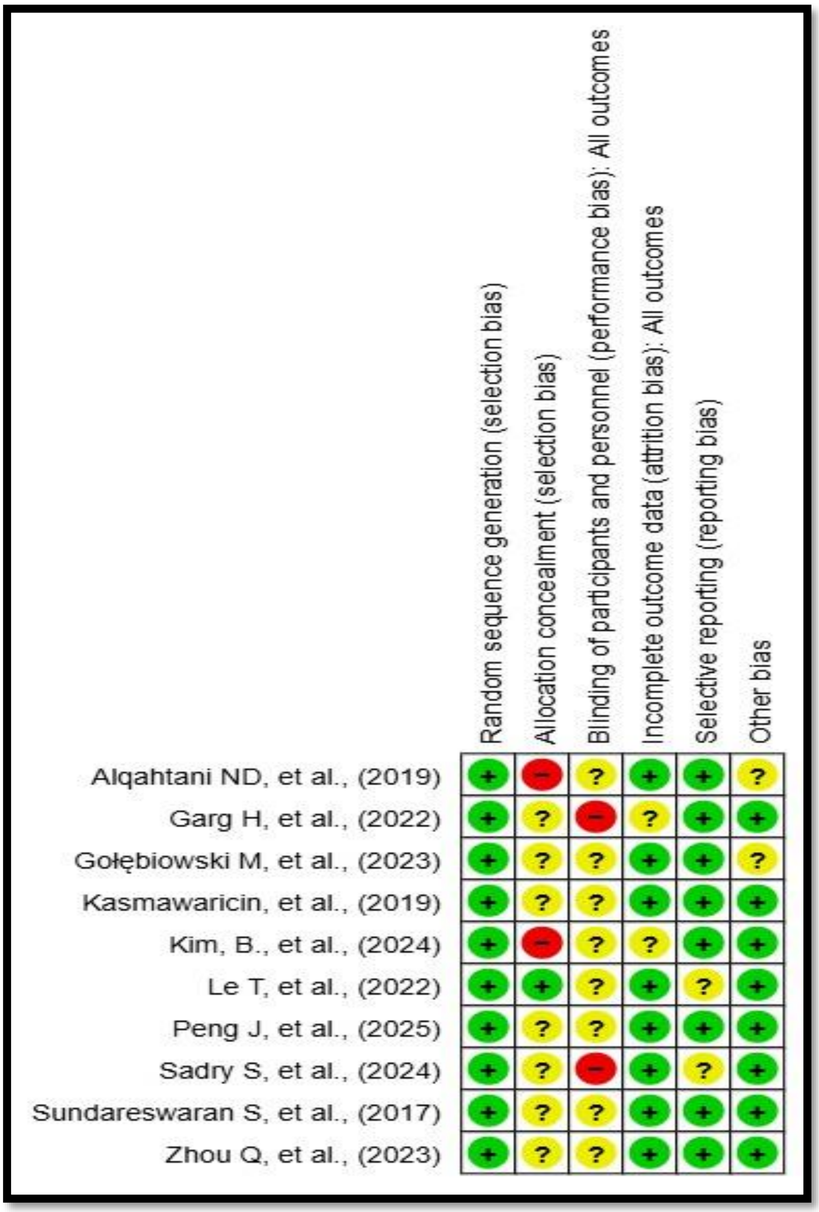


Figure 2: Showing the risk of bias assessment.

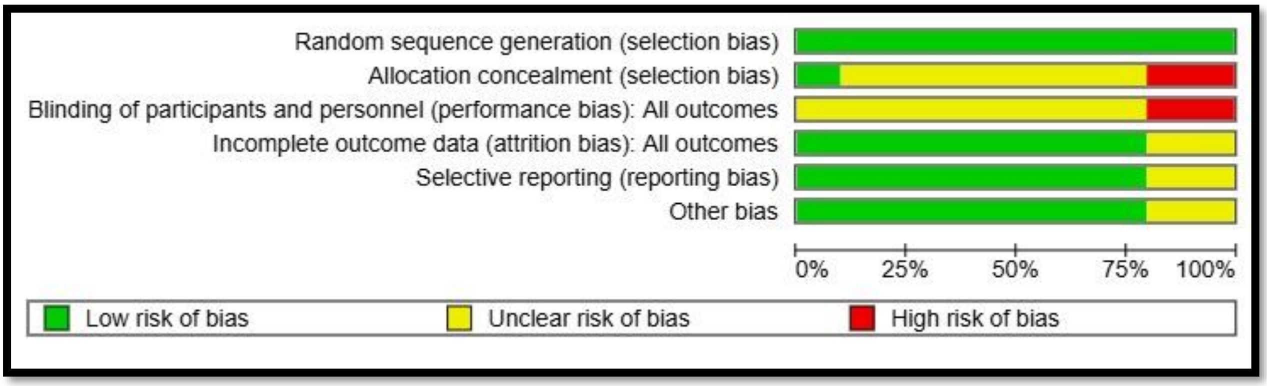


Figure 3: Risk of bias assessment.

Table 1: Showing the study characteristics.

Author, Year	Country / Setting	Study Design	Sample Size	Gender M/F	Population / Age (Years)	Intervention / Exposure	Comparison	Outcome Measures	Conclusion
Peng J, et al., (2025)	China	Predictive modeling study using Artificial Neural Network (BP-ANN)	346 patients	48 M/ 298 F	Orthodontic patients; 23. 5 years	Orthodontic treatment data with 28 predictors (model measurements, cephalometric analysis, extraction pattern, etc.)	Predicted vs. actual incisor and profile changes (U1-SN, L1-MP, Z angle, facial convex angle)	MSE, MAE, R^2 for U1-SN, L1-MP, Z angle, facial convex angle	BP-ANN accurately predicts incisor and facial profile changes in orthodontic patients, with key predictors identified. This approach supports objective decision-making and personalized aesthetic treatment planning.
Kim, B., et al., (2024)	Korea	Comparative observational study	62	8M/54 F	Patients with skeletal Class I malocclusion; (25.54 years)	Orthodontic treatment with tooth extraction	Orthodontic treatment without tooth extraction	Soft tissue measurements: SAL (A'–Sn–Ls) depth/angle, PBL (B'–Li–Pg) depth/angle; regression analysis	No significant difference in lip flattening between extraction and non-extraction groups; upper lip flattening not pronounced with moderate anchorage; retraction of upper

									incisors does not always cause obtuse lip profiles
Sadry S, et al., (2024)	**Turkey**	Retrospective study	81	NA	Class II, Division 1 malocclusion patients	Fixed orthodontic treatment with/without premolar extraction (non-extraction, upper first premolar extraction, or four first premolar extractions)	Pre- and post-treatment cephalometric measurements across different extraction groups	Changes in soft tissue and nasal profile: nasolabial angle, nasomental angle, columella convexity, lip-to-E-plane distances, nasal depth, nasal tip angle, nasal height, and facial convexity	Tooth extraction in orthodontic treatment significantly alters the nasolabial angle, nasal depth, and columella convexity, underscoring the need to consider nasal esthetics in Class II, Division 1 treatment planning.
Gołębiowski M, et al., (2023)	Poland	Retrospective observational study	142 female adolescents	142 F	Female adolescents aged 13–18 years	Cephalometric analysis of nasolabial angle (NLA), upper incisor inclination, upper lip thickness	Assessment of NLA and its components (labial L/FH, nasal N/FH)	Correlation between NLA, its components, upper incisor inclination (1+:SN, U1FA), and upper lip thickness (ULT)	The nasolabial angle in adolescent females is influenced by upper incisor position and upper lip thickness via its labial component, while the nasal

									component remains unaffected.
Zhou Q, et al., (2023)	China	Prospective observational study	52 adult female patients	52 F	Female adults undergoing orthodontic treatment; 18 to 35 years	Orthodontic treatment: 24 extraction cases, 28 non-extraction cases	Comparison between extraction vs non-extraction orthodontic treatment	3D soft tissue changes in nasolabial folds (NLFs), lips, and cheeks measured using 3dMD Face system	Orthodontic treatment affects soft tissues around the nasolabial folds, with tooth extraction causing more pronounced negative changes in NLFs and lips in female adults.
Garg H, et al., (2022)	India	Observational cross-sectional study	120 patients	60 M/ 60 F	Pretreatment orthodontic patients; 12 to 20 years	Measurement of nasolabial angle (NLA), upper incisor proclination (U1-NA), and upper lip thickness (ULT) from lateral cephalometric radiographs	Correlation of NLA with U1-NA and ULT	Pearson correlation coefficient (r) between NLA and U1-NA, and between NLA and ULT	There is a statistically significant relationship between NLA and U1-NA.

Le T, et al., (2022)	Vietnam	Prospective observational study	32 adults	NA	Vietnamese adults with convex facial profile; 22.0 ± 3.6 years	Fixed orthodontic treatment with anterior incisor retraction	Analysis of dentoskeletal and soft tissue changes pre- and post-treatment	Lip changes at cervical point and incisal edge, measured using Arnett's analysis and superimposition; multiple logistic regression for correlation	Lip change was associated with incisor retraction at the cervical and incisal edge, but it did not correlate with the rotation axis of the upper incisors.
Kasmawaricin, et al., (2019)	Indonesia	Prospective observational study	25	8 M/17 F	Class I bimaxillary protrusion patients; 18 to 35 years	Extraction of four first premolars and incisor retraction using standard Edgewise fixed appliance	Pre- and post-treatment cephalometric measurements	Changes in lower facial height, upper and lower lip retraction, lip thickness, upper lip angle, nasolabial angle; correlations between incisor retraction and soft tissue changes	Extraction of four first premolars with incisor retraction leads to significant changes in upper and lower lip retraction, upper lip angle, and nasolabial angle, but does not affect lower facial height or lip thickness.
Alqahtani ND, et al., (2019)	Saudi Arabia	Retrospective observational study	46	16 M / 30 F	Adults with bimaxillary protrusion, 18–30 years	Extraction of four first premolars and anterior teeth retraction	Pre- and post-treatment cephalometric analysis	Upper and lower incisor inclination and retraction, maxillary incisor exposure, nasolabial angle,	Extraction and retraction of anterior teeth led to significant retroclination of

								upper lip length, facial convexity angle, mentolabial sulcus depth	incisors, increased nasolabial angle, upper lip length, reduced maxillary incisor exposure, facial convexity, and mentolabial sulcus depth. Upper and lower lip retraction correlated with incisor retraction.
Sundareswaran S, et al., (2017)	India	Prospective observational study	31	6M/25 F	Adult Class I bimaxillary protrusion patients, 18–30 years	Orthodontic treatment using MBT mechanics with extraction of four first premolars	Pre- and post-treatment cephalometric measurements	Soft and hard tissue changes: nasolabial angle, lip position, circumoral convexity, interlabial gap, lip thickness; correlations between incisor retraction and soft tissue response	MBT mechanics with premolar extractions produced favorable hard and soft tissue changes. Upper and lower lip retraction correlated with incisor retraction; nasolabial angle increased. These correlations are useful for treatment planning.

3. DISCUSSION:

The findings of this systematic review revealed that maxillary incisor retraction exerted a generally favorable and clinically significant influence on the nasolabial angle (NLA), thereby enhancing the overall facial harmony and soft tissue balance in orthodontic patients. Among the ten included studies, the majority (80%) demonstrated a statistically significant increase in the nasolabial angle following orthodontic space closure, particularly in cases managed with premolar extractions. The variability in reported outcomes could be attributed to differences in patient demographics, craniofacial morphology, anchorage strategies, and methodological approaches utilized for soft tissue assessment.

A consistent pattern of nasolabial angle augmentation observed in the studies by Sundareswaran et al. (2017), Kasmawaricin et al. (2019), Alqahtani et al. (2019), and Sadry et al. (2024) reaffirmed the established orthodontic concept that posterior displacement of the maxillary incisors results in concomitant posterior repositioning of the upper lip, subsequently leading to widening of the nasolabial angle and reduction in facial convexity. These studies, predominantly performed in adult cohorts presenting with Class I bimaxillary protrusion and treated with first premolar extraction and maximum anterior retraction, demonstrated that soft tissue adaptation is more pronounced when larger retraction movements are executed under controlled anchorage conditions. Moreover, Sadry et al. (2024) observed concurrent modifications in nasal depth, columella convexity, and nasomental angle, underscoring the influence of anterior dental movements on the perinasal region and nasal morphology, particularly in patients with Class II Division 1 malocclusion.

Conversely, Kim et al. (2024) and Zhou et al. (2023) reported negligible differences in nasolabial angle changes between extraction and non-extraction groups, indicating that anchorage mechanics, lip morphology, and perioral soft tissue thickness play critical modulatory roles in the extent of soft tissue response. Zhou et al. employed three-dimensional stereophotogrammetry (3dMD system) to quantify volumetric facial soft tissue changes and demonstrated that excessive anterior retraction might induce undesirable flattening of the upper lip and accentuation of nasolabial folds, particularly in individuals with inherently flat midfacial contours. These findings echoed earlier evidence by Kocadereli (2002) and Looi and Mills (1986), which established that the linear relationship between incisor retraction and lip movement is neither absolute nor uniform, being significantly influenced by lip thickness, muscular tonicity, and skeletal pattern.

The investigations by Gołębiowski et al. (2023) and Garg et al. (2022) further elucidated the predictive role of upper incisor inclination and upper lip thickness in determining nasolabial changes. Their results demonstrated that individuals with thicker lips exhibited smaller angular variations despite comparable degrees of dental retraction, emphasizing that soft tissue resilience and elasticity critically determine esthetic outcomes. These observations aligned with classical analyses by Holdaway (1983) and Burstone (1967), which underscored the significance of perioral musculature and subcutaneous tissue architecture in governing post-orthodontic soft tissue adaptation. Collectively, these findings reinforced the principle that while dentoalveolar retraction initiates structural modification, the soft tissue envelope ultimately dictates the visible esthetic transformation.

A novel dimension to this body of evidence was introduced by Peng et al. (2025) through the application of an artificial neural network (ANN)-based predictive model. This approach demonstrated high predictive accuracy for parameters such as U1–SN inclination and Z-angle, allowing clinicians to anticipate the magnitude and direction of soft tissue changes prior to treatment initiation. Such integration of machine learning and cephalometric datasets represents a transformative step toward personalized orthodontic planning, wherein treatment simulations can be tailored to patient-specific esthetic objectives and anatomical characteristics.

From a clinical perspective, these synthesized findings highlight the critical importance of achieving a biomechanical and esthetic equilibrium during orthodontic space closure. Excessive incisor retraction, especially in patients with thin upper lips, acute nasolabial angles, or retrusive nasal profiles, may result in an over-obtuse nasolabial angle and a flattened midfacial contour, thereby compromising esthetic harmony. Conversely, insufficient retraction may fail to correct lip prominence or facial convexity, leading to suboptimal profile refinement. Therefore, pre-treatment evaluation of nasolabial morphology, lip thickness, nasal projection, and facial convexity is indispensable for formulating individualized extraction and anchorage protocols.

When compared with previous meta-analyses such as Anand et al. (2018) and Liu et al. (2019), the present review corroborated the overarching consensus that maxillary incisor retraction induces a measurable increase in the nasolabial angle, although the magnitude of change remains patient-specific. However, methodological heterogeneity—stemming from variations in cephalometric reference points, demographic composition, and imaging modalities—limited precise quantification. It was evident that earlier studies (2017–2019) relied primarily on two-dimensional cephalometric analysis, which, despite its diagnostic utility, failed to capture the complex three-dimensional dynamics of soft tissue displacement. More recent investigations (2022–2025) adopting 3D imaging and computational modeling provided a more comprehensive and anatomically faithful depiction of soft tissue response, signifying a progressive transition toward digitally driven orthodontic diagnostics.

4. CONCLUSION

The present review concluded that, **maxillary incisor retraction generally led to a measurable and favorable increase in the nasolabial angle**, enhancing facial harmony and esthetic outcomes. Nevertheless, the extent of this effect remained **heterogeneous**, being influenced by demographic factors, lip morphology, treatment design, and analytical methodology. The **temporal evolution from cephalometric tracing to 3D imaging and predictive computational modeling** underscored the orthodontic community's shift toward **personalized, technology-driven treatment planning,** aimed at achieving optimal facial esthetics alongside functional correction.

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