International Journal of Dental Research and Allied Sciences
2023, Volume 3, Issue 1, Page No: 119-136

Available online at: www.tsdp.net

ISSN: 3062-3502

Review Article

A Systematic Review and Meta-Analysis of Esthetic Perception in Various Clinical Scenarios of Maxillary Lateral Incisor Agenesis Among Individuals with and without Dental Backgrounds

Julia Lind[1*]

[1]Public Dental Care, Department of Orthodontics, The Institute for Postgraduate Dental Education, Box 1024, 551 11 Jönköping, Sweden.

***E-mail** ✉ j.lind.pro@yahoo.com

Received: 11 March 2023; **Revised:** 04 June 2023; **Accepted:** 06 June 2023

ABSTRACT

Managing unilateral or bilateral absence of the maxillary lateral incisor represents a complex and costly clinical challenge that demands meticulous planning to achieve predictable and esthetically pleasing results. This systematic review investigated how perceptions of esthetics differ among orthodontists, general dentists, other dental specialists, and non-dental individuals, as such variations may influence therapeutic choices. Electronic searches were conducted across multiple databases—EBSCO, PubMed, ScienceDirect, the Cochrane Library, and Google Scholar—using a Boolean-based keyword combination: "(congenitally missing OR agenesis OR hypodontia) AND (maxillary lateral incisors) AND (esthetic perception OR smile) AND (laypersons OR dental professional OR general dentist OR orthodontists)." Review papers and case reports were excluded. Thirteen studies were included for qualitative evaluation using a modified ROBINS-I tool, while eleven met the inclusion criteria for quantitative synthesis ($p < 0.05$), divided into "space opening versus space closure" and "no remodeling, dental remodeling, and combined dental–gingival remodeling" categories. The meta-analysis, based on mean differences and effect sizes ($\alpha = 0.05$; 95% CI; $Z = 1.96$), demonstrated that opinions regarding the most esthetic approach to managing lateral incisor agenesis remain inconsistent even within the dental community. Additionally, gingival contouring was generally considered less important than modifications of tooth morphology alone. Given the heterogeneity of the methodologies employed in the reviewed studies, no definitive consensus could be drawn. Therefore, individualized discussions with patients are strongly recommended in ambiguous cases to determine the most appropriate plan while avoiding unnecessary or excessive treatment.

Keywords: Orthodontist, Esthetic perception, Maxillary lateral incisor agenesis, Dental professional, Laypersons, General dentist

How to Cite This Article: Lind J. A Systematic Review and Meta-Analysis of Esthetic Perception in Various Clinical Scenarios of Maxillary Lateral Incisor Agenesis Among Individuals with and without Dental Backgrounds. Int J Dent Res Allied Sci. 2023;3(1):119-36. https://doi.org/10.51847/W6m9hSSkHg

Introduction

The perception of smile esthetics is a subjective process rooted in one's response to visual stimuli and the capacity to discern elements such as harmony, symmetry, proportion, and balance [1, 2]. It represents a multifaceted cognitive and emotional experience shaped by conscious and unconscious mechanisms, cultural background, personal experiences, and situational context, leading to wide variations in aesthetic preferences among individuals [3, 4]. A harmonious and proportionate smile is a central determinant of facial attractiveness, influencing expressions, overall appearance, emotional communication, personality perception, and psychological well-being [5]. The congenital absence of anterior teeth (agenesis) can have negative psychosocial consequences, including lowered self-esteem and impaired social interactions, often prompting patients to seek corrective treatment [6–9]. Consequently, patients' self-image and expectations, alongside the esthetic judgment of dental professionals,

are key factors influencing treatment decisions [10–13].

Maxillary lateral incisor agenesis (MLIA) represents the second most common type of non-syndromic congenital tooth absence, affecting approximately 1–2% of the Caucasian population. It occurs bilaterally in over half of the cases, while unilateral cases often feature a peg-shaped lateral incisor on the opposite side [6, 14–17]. Managing unilateral or bilateral MLIA is clinically demanding and involves two main therapeutic approaches: space opening (SOP), which requires prosthetic replacement of the missing lateral incisor, and space closure (SCR), which entails orthodontic mesial movement of the canine into the missing tooth space, followed by morphological remodeling using porcelain crowns or resin composite restorations to achieve esthetic symmetry with the contralateral incisor [6, 7, 9, 14, 16, 18, 19]. Both strategies are labor-intensive, costly, and technically intricate, with ongoing debate regarding their relative benefits [16, 20–23]. However, when extractions are excluded, treatment duration does not significantly differ between the two methods [24].

The SCR approach typically necessitates reshaping the canine to mimic a lateral incisor and adapting the first premolar to resemble a canine, ensuring anatomic, chromatic, and gingival consistency [6, 7, 16, 25]. Periodontal assessments conducted over 6 months to 7 years revealed no notable differences in plaque or bleeding indices between SOP and SCR patients [26], contradicting other findings that indicated superior periodontal health among SCR-treated patients after five years [22, 27]. SOP cases were generally associated with a thicker periodontal biotype, whereas SCR and control groups tended to exhibit a thinner one [26]. Furthermore, long-term follow-ups of patients treated with space closure involving first premolar intrusion and canine extrusion reported periodontal conditions comparable to those of individuals without agenesis who underwent similar orthodontic interventions [28].

Clinical concerns during treatment planning include potential root resorption related to orthodontic movement [11] and variations in gingival display during smiling, particularly when implant-supported crowns are used to replace lateral incisors [29]. Despite differences in absolute gingival zenith positioning, implant-based restorations can yield esthetic harmony comparable to natural tooth alignment [30, 31].

Investigating how both laypeople and dental professionals perceive esthetic outcomes is critical to understanding patient expectations and minimizing bias in professional judgment [7, 8, 22, 32]. Studies suggest that laypersons exhibit a broader tolerance for deviations in smile symmetry—such as midline shifts up to 2.2 mm, visible gingival margins, and variations in crown morphology—compared to dental professionals [8, 16, 33, 34], possibly due to differing visual focus, as laypersons tend to observe the eyes before the mouth [35].

Esthetics play a decisive role in MLIA treatment, often prioritized by dentists and orthodontists even over functional outcomes [16]. Nevertheless, opinions on the ideal therapeutic strategy—whether space closure or opening—remain inconsistent, and professional education appears to influence esthetic judgments [4, 36, 37]. As Senty observed in 1976 [38], the decision to close or open space is always "a compromise," one that must balance both functional and esthetic priorities for the patient.

Despite advancements in materials, techniques, and diagnostic precision, uncertainty persists regarding optimal management of MLIA—particularly in younger patients and unilateral cases. Long-term issues such as infraocclusion in implant-supported crowns [27] and the need for periodic maintenance of restorative solutions [20, 27, 39–41] complicate treatment planning.

Thus, a systematic review aimed to synthesize current evidence on how laypersons, general dentists, and orthodontists perceive esthetic outcomes in MLIA cases may support evidence-based clinical decision-making, especially when multiple valid treatment paths exist. The primary goal of this review was to compare esthetic perception between individuals with and without dental training and to assess differences between cases treated with space closure versus space opening. Within space-closure cases, the study also examined the impact of dental and gingival remodeling of the mesialized canine, whether symmetric or not. The authors hypothesized that esthetic perception across all observer groups would not differ significantly when evaluating treated MLIA cases.

Materials and Methods

General aspects

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines [42]. The research question was structured using the Population, Intervention, Comparison, and Outcome (PICO) framework as follows: "Between the treatment options of space closure and space opening for unilateral or bilateral MLIA, which is perceived as more esthetic by different observer groups?" The population comprised clinical cases of treated MLIA. The intervention consisted of the treatment modality—either space

opening or space closure—while the comparison included unilateral versus bilateral agenesis and various canine management approaches. The primary outcome measured was the esthetic evaluation scores provided by different observer groups, including laypersons, patients, general dentists, orthodontists, and other dental professionals.

Search strategy and criteria

A comprehensive electronic search was conducted across EBSCO, PubMed/MEDLINE, ScienceDirect, and the Cochrane Library databases, supplemented by Google Scholar, covering the period from 1 January 2000 to 31 July 2022. The search employed keyword combinations and Boolean logic: "(congenitally missing OR agenesis OR hypodontia) AND (maxillary lateral incisors) AND (esthetic perception OR smile) AND (laypersons OR dental professional OR general dentist OR orthodontists)." Additional search terms included congenitally missing, maxillary lateral incisors, anterior tooth agenesis, esthetic, aesthetic, perception, smile, and orthodontists. Articles written in languages other than English or Portuguese, as well as reviews and case reports, were excluded.

To verify the comprehensiveness of the Boolean strategy and identify relevant literature, independent open searches using various keyword combinations were also performed across the same databases and Google Scholar [43], followed by methodological filtering. The search process was collaboratively designed by three investigators (M.J.C.L., M.C.L., and T.P.). After duplicate removal, two reviewers (M.J.C.L. and M.C.L.) independently screened the titles, abstracts, and full texts according to pre-defined inclusion criteria, and discrepancies were resolved by consensus. Reference lists of included studies were manually reviewed to identify additional eligible papers.

Data extraction and collection

Information extracted from the included studies encompassed observer groups (professionals vs. laypersons), treatment modalities, and the degree of tooth symmetry or remodeling involved. The collected data were systematically tabulated. Any disagreements between reviewers during data extraction or synthesis were resolved in consultation with a third author (T.P.). For analytical purposes, studies were grouped into two primary categories: "Space Opening vs. Space Closure" and, within the closure subgroup, "Canine without remodeling," "Canine with dental remodeling," and "Canine with both dental and gingival remodeling." To harmonize differing measurement formats, esthetic scores originally reported on a 0–100 mm scale were standardized to a 0–10 scale. Mean conversions were calculated with a 95% confidence interval ($p < 0.05$) using previously validated procedures [44, 45]. Each study's sample size and key parameters were summarized in concise tables.

Methodological quality

The risk of bias and methodological soundness of the selected studies were evaluated using a modified version of the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) tool [46], following adaptations from previous dental research [47]. The assessment considered several domains: adequacy of sample size calculation, clarity of sample description, occurrence of dropouts, validity of methods, control of confounding factors, implementation of blinded evaluations, appropriateness of statistical analyses, and an overall quality rating. Studies were classified as High (scores 5–7), Moderate (scores 3–4), or Low (scores 0–2) quality.

Sample size evaluation determined whether sufficient participants were included to support reliable conclusions. The accuracy of sample description depended on whether the sample's source, main characteristics, and professional expertise were clearly stated. Dropouts were not considered applicable since participants voluntarily rated clinical images rather than undergoing treatment. The validity of methodological approaches was reviewed based on established evaluative criteria. Confounding variables were examined in terms of study design elements that could mislead or distract participants from the intended assessment focus.

Blinding was assessed by determining whether evaluators were unaware of the treatment identity of the cases under review, thereby preventing biased opinions. Finally, statistical validity was judged on the adequacy of both descriptive and inferential analyses applied to the data.

Meta-analysis

A quantitative synthesis was performed to evaluate the esthetic assessments of various treatment modalities as perceived by different observer groups, using Stata software version 17.0 (StataCorp, Lakeway, TX, USA). Subgroup analyses were organized based on the study author, treatment approach, type of MLIA (unilateral or bilateral), and the kind of recontouring intervention (canine and/or gingival modification).

Statistical heterogeneity among the studies was assessed using the I^2 statistic ($\alpha = 0.05$). To account for variability between studies, a random-effects model with restricted maximum likelihood estimation was applied for comparing mean differences ($p < 0.05$).

Subgroups containing control images were further analyzed to determine both intra- and inter-study heterogeneity through mean difference and effect size calculations ($\alpha = 0.05$; 95% CI; $Z = 1.96$). The Hedge's g measure was used as it provides a more accurate estimate for studies with small or unequal sample sizes. To detect potential publication bias and evaluate heterogeneity, Funnel and Galbraith plots were generated under the random-effects model ($\alpha = 0.05$; 95% CI; $Z = 1.96$). Additionally, paired t-tests ($p < 0.05$; 95% CI) were applied within subgroups to determine whether there were significant mean differences between original and remodeled images, following normality testing using the Shapiro–Wilk test ($p < 0.05$; 95% CI) and outlier identification through boxplot analysis ($p < 0.05$; 95% CI). All variables were considered continuous and derived from related samples. When control images were unavailable, results from the "No Remodeling" group served as a reference for comparison with the "Dental Remodeling" and "Dental plus Gingival Remodeling" groups.

Two studies were excluded from the quantitative synthesis: one [6] reported only qualitative ratings, and another [19] provided a collective global evaluation rather than independent image scoring, without distinguishing between unilateral and bilateral cases, and used a scale that could not be converted for numerical comparison.

Results and Discussion

Study selection

Database searches using the specified Boolean expression initially identified 36 articles. After removing duplicates, 6 studies were excluded based on title screening, 10 after abstract review, and 7 following full-text evaluation for failing to meet the inclusion criteria or for irrelevance to MLIA. An additional study [48] was identified through manual reference checking, resulting in a total of 13 studies [6, 7, 9, 14, 16, 18, 19, 25, 48–52] included in the qualitative assessment.

A broader keyword-based search yielded 2787 initial titles, which, after duplicate removal and filtering for language, publication type, study purpose, and MLIA relevance, resulted in the same final set of studies as identified through the Boolean search—plus the one added manually. The complete selection process is depicted in **Figure 1**.

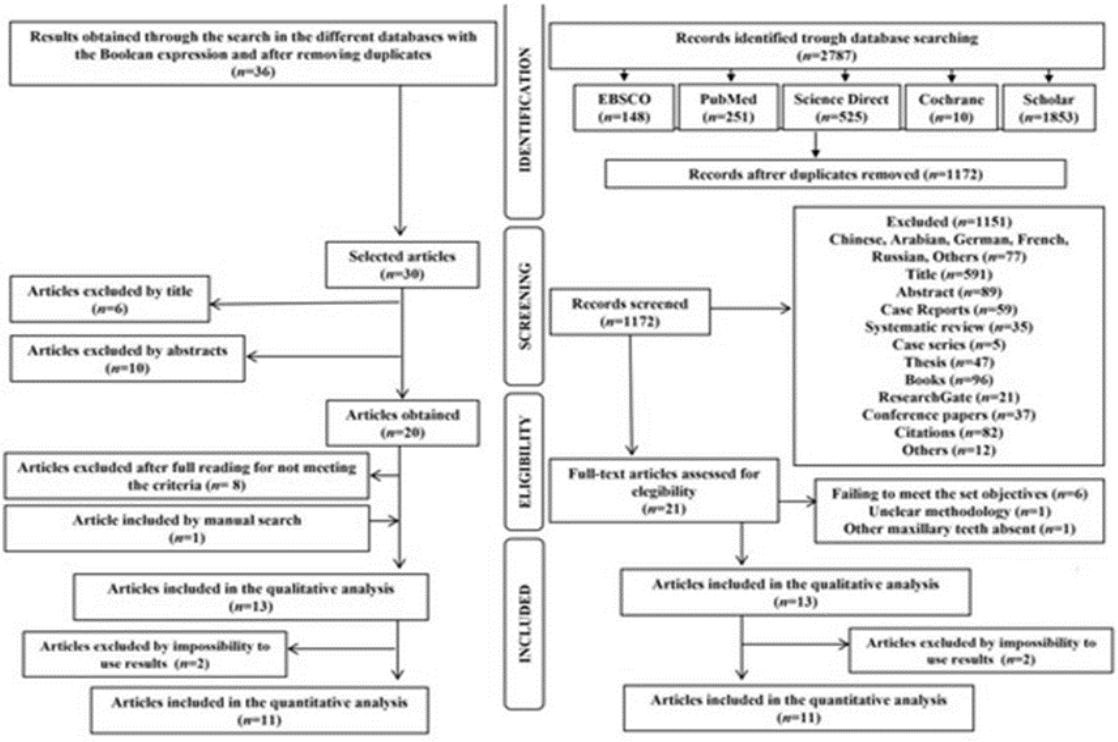


Figure 1. Overview of the PRISMA-based process used for both targeted and extensive article selection. (EBSCO: information services platform providing access to electronic databases, e-books, and other academic resources; PUBMED: free online search engine primarily indexing the MEDLINE database for biomedical and life science literature; Google Scholar: open-access academic search engine indexing full texts and metadata from diverse scholarly sources and publication formats).

Study characteristics and descriptive data analysis

The methodological quality analysis is summarized in **Table 1**.

Table 1. Synthesis of qualitative analysis for risk-of-bias assessment.

	Sample Size Calculation	Selection Description	Dropout	Valid methodology	Confounding Variables	Blind Measurements	Adequate Statistics Analysis	Qualitative Scoring
Armbruster *et al*. 2005 [19]	-	?	+	+	-	+	+	Moderate
Brough *et al*. 2010 [6]	-	+	+	+	+	+	+	High
De-Marchi *et al*. 2014 [7]	-	?	+	+	-	+	+	Moderate
Gomes & Pinho 2019 [25]	-	+	+	+	+	+	+	High
Li *et al*. 2019 [48]	-	?	+	+	+	+	+	High
Mota & Pinho 2016 [14]	+	+	+	+	+	+	+	High
Pinho *et al*. 2015 [18]	-	?	+	+	+	-	+	Moderate
Qadri *et al*. 2016 [49]	+	+	+	+	+	-	+	High
Rayner *et al*. 2015 [9]	+	+	+	+	+	+	+	High
Rosa *et al*. 2013 [16]	+	?	+	+	+	+	+	High
Schneider *et al*. 2016 [50]	-	?	+	+	-	+	+	Moderate
Souza *et al*. 2018 [51]	+	+	+	+	+	+	+	High
Thierens *et al*. 2017 [52]	-	+	+	+	+	+	+	High

(+)—Item with quality; (?)—Item with dubious quality; (-)—Item without quality; Scored by number of (+) as High (5–7), Moderate (3–4), or Low (0–2) quality.

Only three investigations [9, 14, 16] performed sample size estimations to ensure that the included participants adequately represented the target population. Regarding participant characterization, most studies failed to clearly differentiate between general dentists and specialists such as orthodontists, with several not specifying the level of professional qualification or whether participants were formally recognized as specialists [16, 18, 19, 48, 52]. Both digital [14, 16, 48] and physical models [6, 7, 9, 18, 19, 25, 49-52] were deemed suitable for fulfilling the objectives outlined by the respective authors. Blind assessment procedures were reported in just one study [19]. The variable "opening vs. closure" was analyzed in three investigations [18, 49, 50], which compared bilateral opening with bilateral closure, and in one study [7], which compared unilateral opening with bilateral closure involving dental remodeling. Within the space-closure category, data differentiating unilateral and bilateral cases were gathered from nine studies [7, 9, 14, 16, 18, 25, 48, 51, 52], alongside comparisons among canines without remodeling, with only dental remodeling, or with combined dental and gingival remodeling. The findings across studies were compiled and interpreted according to various rating systems. Participants generally provided both quantitative and qualitative feedback. Numerical scoring scales ranged from 0 to 10 ((1) representing least attractive and (10) most attractive) and from 0 to 100 mm on a visual analog scale ((0–50.99 mm) denoting unpleasant and (>51 mm) pleasant). Studies applying the 0–100 mm scale demonstrated greater variability in results compared to those using the 0–10 whole-number scale. **Table 2** summarizes the sample sizes of the reviewed studies, highlighting considerable heterogeneity among observer types and numbers.

Table 2. Sample sizes according to author and observer.

Author, Year	Type of Observer	Sample
Armbruster *et al*. (2005) [19]	General dentist	140
+	Layperson	60
+	Orthodontist	40
+	Dental specialists	29
Brough *et al*. (2010) [6]	General dentist	40

-	Layperson	40
-	Orthodontist	40
De-Marchi *et al*. (2014) [7]	Orthodontist	20
+	Periodontists	20
Gomes and Pinho (2016) [25]	General dentist	141
+	Layperson	142
+	Orthodontist	100
	Periodontists	51
Li *et al*. (2019) [48]	Layperson	60
	Orthodontist	41
Mota and Pinho (2016) [14]	General dentist	215
	Layperson	303
	Orthodontist	81
	Prosthodontist	55
Pinho *et al*. (2015) [18]	General dentist	181
	Layperson	120
	Orthodontist	80
Qadri *et al*. (2016) [49]	Layperson	959
Rayner *et al*. (2015) [9]	General dentist	30
	Layperson	30
	Orthodontist	30
Rosa *et al*. (2013) [16]	General dentist	40
	Layperson	40
	Orthodontist	40
	Patient	40
Schneider *et al*. (2016) [50]	General dentist	100
	Orthodontist	87
Souza *et al*. (2018) [51]	Dental student	50
	Dental surgeon	50
	Layperson	50
Thierens *et al*. (2017) [52]	General dentist	77
	Layperson	46
	Orthodontist	37
	Periodontists	14

Table 3 summarizes the information extracted from the included studies. All 13 studies assessed for methodological quality were non-randomized, and five of them [6, 16, 18, 48, 49] lacked control images.

Table 3. Data Extracted and Compiled for Qualitative Analysis from Studies in the Systematic Review

Study	Population	Interventions	Objectives	Parameters	Outcome	Validity of Methods	Confounding Variables	Study Design
Armbruster *et al*. (2005) [19]	40 laypeople (L), 140 general dentists (GDPs), 43 orthodontists (O), 29 specialists (SP: 9 prosthodontists, 11 endodontists, 3 surgeons, 4 oral diagnosticians, 2 periodontists)	Blinded direct visual assessment of treatment options	Evaluate esthetic appeal of different treatments for maxillary lateral incisor agenesis (MLIA)	MLIA treated with Maryland bridges (MB), dental implants (IP), canine repositioning (CR), or no-MLIA (control, NT). Rated 1 (most attractive) to 5 (least attractive).	Orthodontists: NT > CR > MB > IP; General dentists: NT = CR > MB = IP; Specialists: NT = CR > MB = IP; Laypeople: CR > NT > MB > IP ($p < 0.001$).	Valid (real model used)	Present (multiple variables)	Non-randomized controlled trial (N-RCT), control image (CI)
Brough *et al*. (2010) [6]	40 laypeople, 40 general dentists, 40 orthodontists	Blinded, randomized direct visual ranking of digitally altered images	Assess smile attractiveness in MLIA cases compared to	Incremental changes in canine width, crown length, morphology, and gingival margin	All groups found dark, large canines with gingival margin >0.5 mm above central incisor unattractive. Narrow canines ranked	Valid (digital model)	Absent (same teeth, same gums)	N-RCT, no control image (NCI)

			natural dentition	height (no quantitative measures)	better. General dentists preferred natural tones, orthodontists slightly brighter, laypeople brightest. Orthodontists preferred cusps <1.0 mm, laypeople 1.0–1.5 mm.			
De-Marchi *et al*. (2014) [7]	20 laypeople (10 male, 10 female), 20 general dentists with >4 years' experience (10 male, 10 female)	Direct visual review of 68 photos: 26 (space closure + restoration, SC+R), 20 (space opening + implant, SO+IP), 22 (no-MLIA)	Compare smile attractiveness in MLIA versus natural dentition	Standardized photo protocol. Smiles rated unpleasant (0–50.99 mm) or pleasant (51–100 mm)	Male general dentists most critical. Control group (volunteers) highly satisfied. SC+R more satisfying than SO+IP and control group ($p < 0.002$).	Valid (real model)	Present (varied lips, teeth)	N-RCT, CI
Gomes & Pinho (2019) [25]	142 laypeople, 141 general dentists, 100 orthodontists, 51 prosthodontists	Anonymous quiz with numerical ranking of digitally manipulated images	Investigate esthetic perceptions of asymmetric MLIA treated with space closure and canine mesialization	Space closure for MLIA with asymmetric canines, 2 symmetric simulations (smile 1: smaller canines; smile 2: larger canines). Visual analog scale (VAS, 0–10).	Pretreatment least esthetic. Orthodontic treatment improved esthetics. Symmetric and larger canines most esthetic. Laypeople more impressed than professionals; specialists more critical ($p < 0.05$).	Valid (real model)	Absent (same parameters, model)	N-RCT, no control (NC)
Li *et al*. (2019) [48]	60 laypeople, 41 orthodontists	Direct visual ranking of 140 digitally manipulated photos	Examine impact of canine edge width and height on esthetics in canine mesialization	127 space closure treatments, top 5 cases digitally altered. Canine edge widths (0–75% of central incisor width) and heights (−0.5 to 1.0 mm relative to central incisor).	Most esthetic: canine edge 62.5% of central incisor width, −0.5 mm gingival to central incisor ($p < 0.005$). Width ($p = 0.003$) and height ($p < 0.001$) influenced esthetics.	Valid (digital model)	Absent (same gingiva, teeth)	N-RCT, NCI
Mota & Pinho (2016) [14]	303 laypeople, 215 general	Online survey with digitally	Assess perception of smile	9 digital photos of MLIA space	Laypeople scored all cases higher. All groups preferred	Valid (digital model)	Absent	N-RCT, CI

	dentists, 81 orthodontists, 55 prosthodontists	manipulated images	attractiveness in MLIA cases treated with canine mesialization	closure (unilateral and bilateral). Numeric scale (1–10, least to most attractive; >5 attractive, <5 unattractive).	smiles with lateral incisors. Canine and gingival remodeling deemed more attractive by general dentists, orthodontists, and prosthodontists.			
Pinho *et al*. (2015) [18]	120 laypeople, 181 general dentists, 80 orthodontists	Online survey evaluating pre- and post-treatment esthetic preferences	Evaluate smile esthetics in MLIA with focus on gingival exposure	4 clinical cases, 24 smile photos. Numeric scale (0–10).	Orthodontists scored lowest, followed by general dentists, then laypeople. Males gave higher scores. Symmetric cases and medium smiles scored higher. Gingival exposure significantly affected post-treatment esthetics ($p < 0.001$).	Valid (real model)	Present (same lips, different teeth)	N-RCT, NCI
Qadri *et al*. (2016) [49]	959 dental students and university staff (76% female, 24% male), 5 orthodontists, 5 restorative dentists	Online survey with 9590 judgments on 4 photo pairs (bilateral MLIA only)	Assess esthetic perceptions of bilateral MLIA treatment outcomes (space closure, space opening, or implants)	21 patients (11 space closure, 10 prosthetic replacement). Photos ranked from most (1) to least (22) attractive by specialists	Space closure more attractive than prosthetic replacement ($p < 0.001$). Females and staff gave higher ratings. Space closure preferred 3:1 over prosthetic replacement ($p < 0.001$).	Valid (real, morphed model, standardized photo size)	Present (multiple variables)	N-RCT, NCI, cross-sectional
Rayner *et al*. (2015) [9]	30 laypeople, 30 general dentists, 30 orthodontists	Direct visual observation of digitally manipulated images (average female face from 4 volunteers)	Evaluate effect of canine characteristics and symmetry on smile attractiveness in MLIA treated with canine mesialization	1 ideal image, 6 morphed images (canine replacing lateral incisor, unilateral/bilateral). Variations in canine shape, length, color.	Orthodontists and general dentists found space closure with canines less attractive than ideal smile unless ideal canines used ($p < 0.001$). Laypeople noted differences but not clinically significant. Unilateral replacement not significantly less attractive than bilateral.	Valid (real model)	Absent (same face, teeth, smile)	N-RCT, CI
Rosa *et al*. (2013) [16]	40 laypeople, 40 oral pathologists, 40 general dentists, 40 orthodontists	Quiz with numerical valuation and ranking of digital ideal smile model	Assess esthetic perception of altered smiles in MLIA cases with or without treatment	12 simulations, VAS (0–100).	Significant differences between professionals and laypeople ($p < 0.005$). Orthodontic treatment, no diastema, and symmetry highly valued by all.	Valid (digital model)	Absent (same parameters, model)	N-RCT, NCI

Schneider *et al*. (2016) [50]	100 laypeople, 100 general dentists, 87 orthodontists (blinded)	Direct visual observation of 9 frontal photos: 3 space closure + restoration, 3 space opening + implant, 3 no-MLIA	Compare esthetics of implants versus canine substitution in MLIA	7 bipolar adjective pairs, smiles rated 1–5 (less to more attractive).	Orthodontists/general dentists: no-MLIA > SC+R > SO+IP (non-significant). Laypeople: SC+R > no-MLIA > SO+IP. Laypeople/general dentists gave higher scores for SC+R, all groups lowest for SO+IP (non-significant).	Valid (real model, best photos preselected)	Present (multiple variables, mixed cases)	N-RCT, CI
Souza *et al*. (2018) [51]	150 laypeople, general dentists, dental students (aged 22–40, similar socioeconomic status)	Direct visual observation of digitally manipulated extraoral photos (unilateral/bilateral space closure)	Evaluate attractiveness of MLIA treated with canine mesialization	Photos of a 20-year-old woman with normal occlusion, digitally altered to simulate canine repositioning. VAS (0–10, less to more esthetic).	Original image most accepted. Left-side alterations least accepted. Bilateral reshaping + gingival recontouring scored highest by laypeople. Reshaping + bleaching lowest for general dentists. Dental students found bilateral alterations least attractive. Laypeople gave lowest scores, often missing interventions.	Valid (real, digitally manipulated model)	Absent (same teeth, gums, mandibular teeth)	N-RCT, CI
Thierens *et al*. (2017) [52]	46 laypeople, 77 general dentists, 37 orthodontists, 14 periodontists (1.5:1 female:male ratio, similar age/experience except orthodontists vs. laypeople)	Direct visual observation and ranking of digitally manipulated unilateral images	Assess influence of substitute canine size, morphology, and color on dento-gingival esthetics	Standard image, 5 series (width, color, gingival margin height, canine crown tip, premolar gingival margin). Most deviated image per parameter combined into final series.	Dark canines and pronounced tips least attractive to all. Premolar gingival height least impactful.	Valid (real, digitally manipulated model)	Absent (same teeth, gums, mandibular teeth)	N-RCT, CI

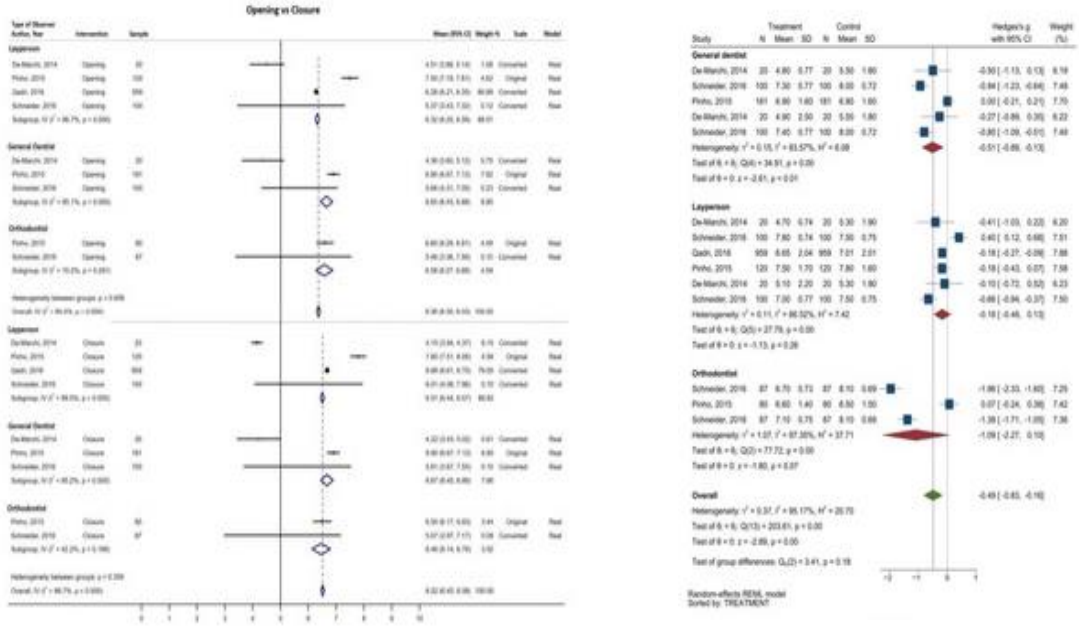
All = all observer groups; B = bleaching; CI = control image; MLIA = maxillary lateral incisor agenesis; F = female; L = laypeople; G = gingival recontouring; GDPs = general dental professionals; M = male; NCI = no control image; N-RCT = non-randomized controlled trial; O = orthodontists; PT = prosthodontists; R = canine crown reshaping; SC+R = space closure and composite restorations; SO+IP = space opening + implant-supported crown.

Two studies not represented in the plots are summarized here due to their relevance to the overall discussion. The first study [6] investigated how smiles were perceived in individuals with MLIA compared to those with full natural dentition. Across orthodontists, dentists, and laypeople, the shape of maxillary canines influenced attractiveness ratings: wider canines were generally deemed unattractive, narrower canines were preferred, and sharply pointed canines were rated negatively by all groups. The second study [19] examined the esthetic perception of adhesive Maryland bridges, implant-supported crowns, canine

mesialization, and natural dentition without MLIA through clinical dental photographs. There was no consensus among dental professionals or between professionals and laypersons regarding the most appealing method for closing spaces via canine mesialization, while implant-supported crowns after space opening received the lowest attractiveness ratings (higher scores indicated less favorable outcomes, with 7 as the best and 35 as the worst). Because evaluations pooled symmetrical and asymmetrical cases, the effect of symmetry on smile perception could not be isolated.

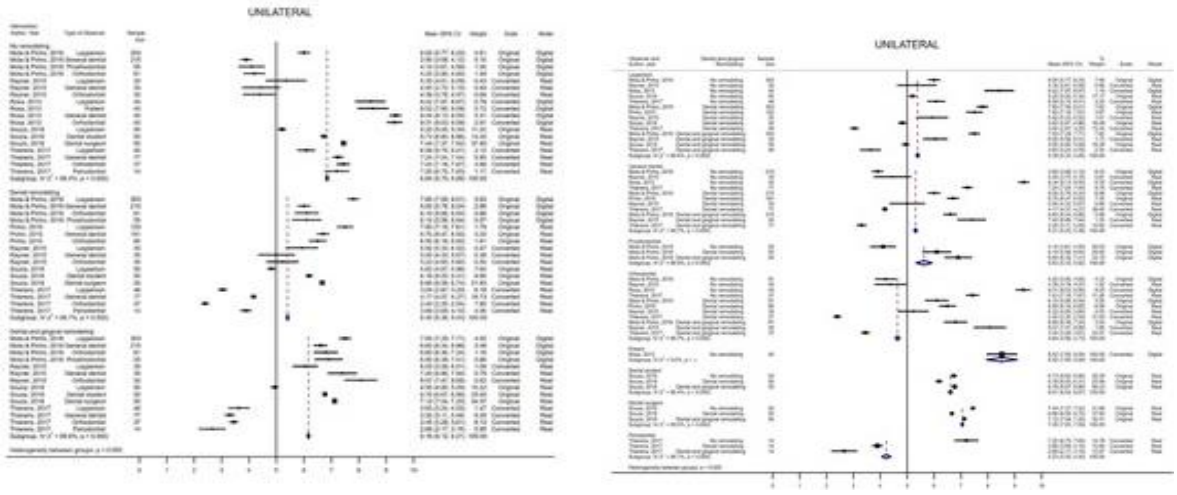
Meta-analysis

A summary of the 11 studies included in the quantitative synthesis is presented in **Figures 2–4**.



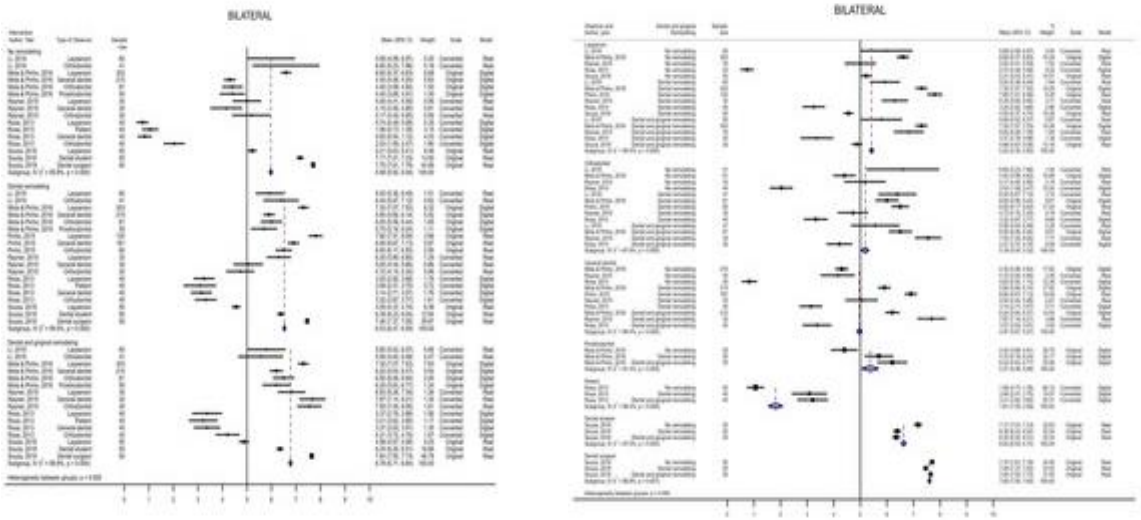
a) b)

Figure 2. Forest plots illustrating the outcomes for the "Opening versus Closure" category. (a) Results are broken down by individual authors and the type of observers assessing the cases. (b) Calculated mean differences along with Hedges's g effect sizes compare control and intervention groups, based on data extracted from studies [7, 18, 49, 50].



a) b)

Figure 3. Forest plot depicting the unilateral comparisons among three groups: no remodeling, dental-only remodeling, and combined dental and gingival remodeling. (a) Differences are illustrated according to the type of remodeling within each study. (b) The plot also breaks down results by observer category alongside remodeling type, based on data from studies [9, 14, 16, 18, 51].



a) b)

Figure 4. Forest plot illustrating outcomes for bilateral cases comparing "Canine without remodeling, Canine with dental remodeling, and Canine with dental and gingival remodeling." (a) Comparisons are presented by remodeling type within each study. (b) Results are shown according to both observer category and remodeling type, based on data from the included studies [9, 14, 16, 18, 48, 51].

For the "Opening versus Closure" group **(Figure 2a)**, analysis of four studies [7, 18, 49, 50] revealed no statistically significant differences between treatment approaches ($p < 0.05$). The forest plots indicate lower ratings for both treatments in De-Marchi *et al*. [7], wide variability in Schneider *et al*. [50], and generally higher scores from laypersons compared with dental professionals in Pinho *et al*. [18]. In Qadri *et al*. [49], which included the largest sample, no differences were found between space opening and closure for the same observer type. Examining mean differences and Hedges's g effect sizes ($\alpha = 0.05$; 95% CI; $Z = 1.96$) in **Figure 2b**, the overall effect was moderate ($g = 0.5$; $p < 0.05$), with the greatest variability observed in Schneider *et al*. [50] among orthodontist ratings.

In unilateral MLIA cases **(Figures 3a and 3b)**, scores slightly decreased when comparing no remodeling to combined dental and gingival remodeling. Within-study comparisons showed that Rayner *et al*. [9] reported higher ratings with increased canine reshaping across all participant groups, with laypersons generally providing higher scores except in the combined remodeling category, where professionals rated the procedure as more esthetic. Mota and Pinho [14] found the greatest score increase between canines without remodeling and those with dental remodeling alone, with the smallest increase observed for combined remodeling ($p < 0.05$); laypersons consistently gave higher ratings than professionals, though the difference was less pronounced for complete remodeling. Souza *et al*. [51] reported lower scores for dental-only remodeling across all observer groups, with laypersons showing the lowest evaluations.

Studies focusing on a single procedure revealed similar trends. Rosa *et al*. [16] reported lower esthetic scores for canines without remodeling across all observers, whereas Pinho *et al*. [18] (dental remodeling only) found comparable results to other studies using the same approach. Thierens *et al*. [52] observed lower ratings for both dental-only and combined remodeling compared to no remodeling, with considerable heterogeneity among observer groups.

For bilateral MLIA cases **(Figure 4a and 4b)**, symmetry did not result in significant differences in esthetic evaluations ($p < 0.05$), although procedures involving both dental and gingival remodeling were generally rated more favorably. An exception was Rosa *et al*. [16], which showed consistently negative ratings for all remodeling types. In study-specific comparisons, Rayner *et al*. [9] noted that laypersons rated gingival remodeling lowest, consistent with Rosa *et al*. [16]. Pinho *et al*. [18] displayed patterns similar to Mota and Pinho [14], with laypersons generally providing higher scores, though differences were smaller when combined dental and gingival remodeling was involved due to more favorable ratings from professionals.

Regarding sample sizes across the 11 studies included in the meta-analysis **(Table 2)**, variation among studies may have contributed to an overestimation of the intervention effect, as suggested by asymmetries in **Figures 5a–5f**, indicating a potential risk of bias. In

particular, two studies [16, 52] showed evidence of higher publication bias relative to the others.

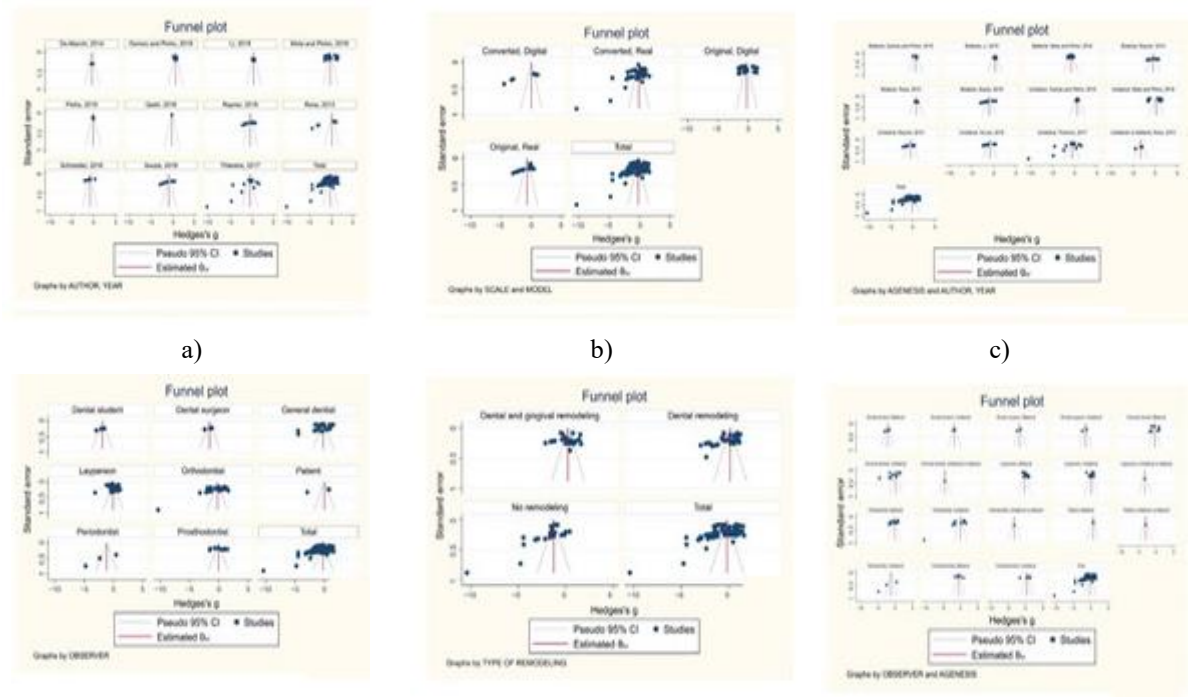


Figure 5. Funnel plots assessing potential publication bias, displayed according to (a) study author, (b) scale and model, (c) combination of agenesis type and author, (d) observer, (e) remodeling type, and (f) observer combined with agenesis type [7, 9, 14, 16, 18, 25, 48, 50-52].

Figure 6 indicates heterogeneity in study effect sizes, as several points fall outside the 95% confidence interval. Some studies on the far right of the x-axis demonstrate high precision. All studies are positioned on or above the green reference line, and the slightly upward-sloping red line suggests that the intervention tends to yield a modestly better outcome compared with the control group.

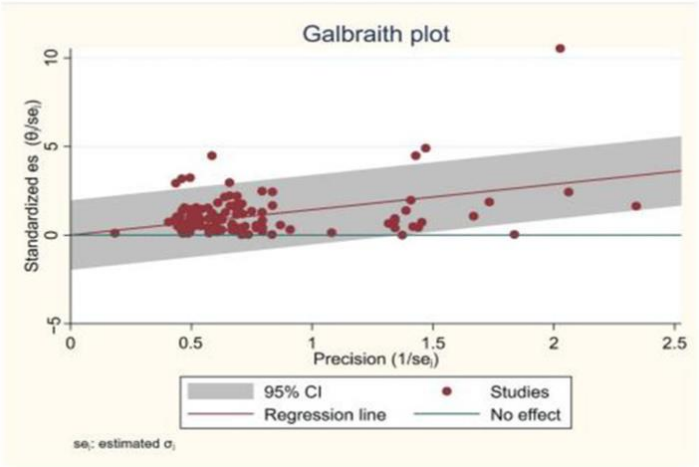


Figure 6. Heterogeneity assessment of effect sizes.

A paired t-test conducted on the treatment-type subgroup (space opening versus space closure) revealed that the ideal control image (6.93 ± 1.11) received higher ratings than the intervention image (6.46 ± 1.09), with a significant mean decrease of 0.47 (95% CI, 0.7246 to 0.2126), $t(13) = -3.99541$, $p < 0.002$. This result indicated no clear preference for either treatment approach in this comparison.

Shapiro–Wilk tests for normality ($\alpha = 0.05$; 95% CI) and boxplot analyses to identify significant outliers (p

< 0.05; 95% CI) confirmed that the paired t-test assumptions were satisfied.

This review examined differences in esthetic perception between laypersons and dental professionals. Based on the results ($p < 0.05$), the null hypothesis asserting no differences in esthetic evaluations among observers across MLIA treatment scenarios was rejected.

The authors employed a two-pronged search strategy to maximize study inclusion. A Boolean-based search initially narrowed the results, while a broader search verified that no relevant studies were overlooked. Google Scholar, despite being relatively recent, has proven effective in identifying relevant literature [43], comparable to established databases such as Web of Science and Scopus. However, its limited filtering options generate a large volume of extraneous data, which can introduce noise.

Across the identified studies, esthetic evaluations were not standardized. Some studies [14, 49, 51] considered both sample size and characteristics, while others [9, 16] accounted only for sample size. This distinction was reflected in the methodological ratings **(Table 1)**, with the first group providing more comprehensive analyses. Only five studies [9, 14, 16, 49, 51] conducted formal sample size calculations. One study [19] acknowledged the lack of such calculations as a limitation, which may have led to a biased representation of the population. Two studies [11, 53] were excluded for reasons including unclear agenesis location, evaluation by a single observer, or non-maxillary agenesis.

Differentiation among professional groups

Most studies did not clearly distinguish professional categories, particularly orthodontists, whose official recognition varies internationally. Some individuals practicing orthodontics may have extensive clinical experience without formal certification, making it difficult to separate them from general dentists and potentially introducing bias. Three studies [7, 49, 51] did not include orthodontists, while several others [16, 18, 19, 25, 48, 50, 52] included them without specifying their training. In a few cases, the designation encompassed senior specialty students or hospital consultants [6], and only one study [14] explicitly defined orthodontists as professionals with at least two years of full-time orthodontic training and more than 50% of clinical practice in this field.

Given that orthodontists typically plan MLIA treatment and decide between space opening or closure, and that orthodontic procedures often precede gingival remodeling, future studies should better differentiate professional roles. As MLIA treatment is inherently multidisciplinary, some authors [14, 49, 52] included restorative dentists, periodontists, or prosthodontists in assessments without specifying their level of expertise.

Age and gender of participants

Only two studies categorized participants by age (25–60 years [16] and mean age 25 years [49]), which is relevant because older laypeople generally tolerate greater deviations in smile esthetics than younger individuals, except when gingival exposure exceeds 6 mm, which is perceived as unattractive across all ages [54]. In contrast, gender appears to have little impact on esthetic perception according to the literature [30, 48, 49, 54, 55]. Most studies either briefly mentioned participants' gender or omitted it entirely. From available results, there is a tendency for women to prefer narrower teeth and a larger vertical step between the remodeled canine and the adjacent central incisor [48], and to assign higher esthetic ratings [49], though these differences may vary depending on cultural context [4].

Digital vs. real models

Digital and real models each present specific advantages and limitations. Digital models reduce confounding factors by using computer-generated images or virtual reconstructions from clinical photographs, maintaining consistent teeth, lips, and smile features, with only minor variations. However, such models may not fully replicate actual clinical conditions, making it harder to evaluate esthetics realistically [16]. The studies reviewed suggest that digital models often receive higher ratings because the images appear more flawless, introducing an inherent bias.

Real models better reflect true clinical scenarios without adhering to standardized references. Nevertheless, individual variations in teeth, lips, and smile characteristics are unavoidable, potentially distracting observers and highlighting anatomical imperfections, which may explain lower scores. To mitigate these issues, some studies focused on the lower face while superimposing the same lips across different agenesis phenotypes [6, 16, 18], whereas others digitally modified a female model to reflect the most common features for that gender [9, 14]. Studies using unaltered real models [7, 19, 49, 50] could not control for these confounding variables, leading to evaluation bias. Digital manipulation of real photographs to standardize teeth, lips, and facial features has been proposed [9] to approximate realistic perception while reducing distractions. Similar minor digital adjustments have been applied in other studies

to generate a series of simulations from a single image [25, 48, 51, 52].

A common limitation across studies is the brief observation period (only a few seconds), which captures only the initial impression and may bias scores that could differ with longer viewing times.

Rating scales

A key limitation in this review arose from the use of heterogeneous rating scales, which required adapting results to a common scale for comparison. The Visual Analogue Scale (VAS) allows for fine-grained ratings, including fractional values, unlike the 0–10 scale restricted to whole numbers. This lack of direct comparability posed a challenge, as no published references supported the conversions used. Two studies [49, 50] employed a 0–5 scale, which reinforced the need for careful adaptation. Additional conversions involved transforming mean ± standard deviation [7, 14, 16] or median values [9] to mean values with 95% confidence intervals, as provided in one study [18]. These conversions are methodologically supported [44, 45], enabling values to be compared on the same metric. For future research, adopting a standardized numeric rating scale (NRS) could facilitate consistent assessment of subjective smile esthetics, as VAS and NRS show strong agreement, are simple to use, and unaffected by evaluator differences, though NRS is easier to handle [56].

Smile evaluation

No significant differences ($p < 0.05$) were observed between space opening and closure treatments in the "Opening vs. Closure" group **(Figures 2a and 2b)**. Within individual studies, this likely reflects laypersons' limited ability to detect subtle differences, rating both treatments highly [7, 18]. Across studies, discrepancies in absolute values can be attributed to the different scales and conversions applied. Overall, both approaches produced comparable esthetic outcomes ($p < 0.05$) [7, 18].

In unilateral cases comparing "No remodeling vs. Dental remodeling vs. Dental and gingival remodeling" **(Figures 3a and 3b)**, the main esthetic differences were linked to symmetry, particularly for lay observers who prioritized matching canine morphology to the contralateral incisor when space closure was performed. Additionally, laypersons valued the similarity between lateral incisors and canines more than dental professionals ($p < 0.05$). The impact of gingival remodeling alone was comparable to that of dental remodeling ($p < 0.05$). Interestingly, for both bilateral [9, 16] and unilateral [9] treatments, laypersons sometimes rated images with no remodeling or only dental remodeling higher than professionals did, a pattern also observed in more recent studies [51], whereas images with combined dental and gingival remodeling did not show this trend.

This reversal may be explained by professionals' heightened ability to detect details due to training, or by laypersons' limited perception of gingival margin changes. Gingival remodeling often requires additional orthodontic procedures—such as canine extrusion, premolar intrusion, gingival zenith adjustment, extensive crown reshaping, or even mucogingival surgery [14]—which laypersons may undervalue. Observational thresholds also differ: laypersons tolerate up to 2 mm of central incisor gingival asymmetry, while professionals detect deviations exceeding 0.5 mm [9]. Minor asymmetries between lateral incisors and canines are generally acceptable, given their proximity to the midline [8].

To bridge perception differences, some studies [9, 14] included laypersons with advanced academic backgrounds to approximate professional assessment. Despite this, training remained a major factor influencing smile evaluation. Regardless of treatment type, bilateral agenesis cases that achieve symmetrical outcomes are generally perceived as esthetically satisfactory, with higher overall ratings consistent with prior reports [8, 18, 34]. Symmetry relative to the midline is critical, as orthodontists typically detect deviations over 2 mm, whereas laypersons generally notice differences only beyond 3 mm [16, 34].

Canine morphology

Although some limitations exist—such as evaluating canine esthetic variables separately rather than holistically and using qualitative ratings—one study [6] provided insights into how features like crown width, height, morphology, color, and gingival margin position can individually influence esthetic perception. Findings indicated that laypersons generally prefer narrower canines and brighter shades compared with dental professionals. A darker canine color is associated with less attractive smiles, a correlation supported by recent studies [51, 52], highlighting that even small changes in canine hue can enhance overall smile esthetics. Similar results were observed in studies examining perceptions of dental discoloration among patients and dentists, though not in the context of agenesis [57].

However, no consensus exists regarding ideal canine width for substitution. Gomes and Pinho [25] reported that, in a digitally manipulated scenario involving asymmetric mesialized canines with varying shape,

color, and gingival contour, all observer groups preferred broader canines, partially contradicting other studies [6, 52]. Notably, the measurement method in [25] was imprecise, limiting comparisons across studies. Another study [52] used the original canine as a reference, raising concerns about how representative these dimensions are for the general population. To address this, future research should measure canine width relative to the central incisor in the frontal view, as previously recommended [30, 58].

The observed discrepancies may also stem from temporal shifts in esthetic preferences, cultural differences among participants [59], or variations in substitute canine dimensions, such as edge width or height [48], which can impact treatment esthetics. Moreover, the inherent subjectivity of esthetic perception, influenced by shared community standards, must be acknowledged.

Li *et al*. [48] found that a canine with an edge width equal to 62.5% of the central incisor and positioned 0.5 mm gingival to the central incisor edge was considered most esthetic. Orthodontists tend to dislike pronounced cusp slopes exceeding 1.0 mm [48], whereas laypersons preferred cusps between 1.0 and 1.5 mm, consistent with prior reports [13] noting that slight wear on canine cusps does not significantly affect esthetics, potentially favoring a minor step between the substitute canine and central incisor edge [48, 60]. Additionally, when the lateral incisor serves as the reference, laypersons preferred wider teeth, often exceeding the 62.5% golden width/height ratio favored by orthodontists [55].

Overall, this review emphasizes the need for standardized, randomized clinical trials to evaluate symmetrical MLIA space opening versus closure, as well as asymmetrical cases, using consistent rating scales. Given the current evidence, dental professionals should be cautious about projecting personal preferences when recommending MLIA treatment, since the most esthetically favored outcome may differ from the treatment they would personally recommend.

Management options for MLIA

Based on the collected evidence, the management of maxillary lateral incisor agenesis in children and adolescents can include: (1) observation, as treatment may not be necessary if the missing tooth does not compromise dental health, function, or esthetics, allowing natural mesial drift of the canine; (2) space maintenance, using a fixed tooth-shaped appliance to preserve the space until a permanent replacement can be placed; and (3) orthodontic intervention, depending on misalignment severity, whether space closure or opening is planned, and other orthodontic considerations. In young adults and adults, additional options include: (4) placement of a single-tooth implant, ideally delayed to minimize infraocclusion risk, or (5) a tooth-supported bridge, using one or two abutments.

Conclusion

Esthetic perceptions of MLIA treatment remain variable, even among dental professionals. Laypersons generally focus on symmetry and do not differentiate between space opening and space closure, while orthodontists tend to have the strictest esthetic standards due to their specialized expertise. Gingival remodeling did not receive significantly higher esthetic ratings ($p < 0.05$) compared with dental-only remodeling. In cases of uncertainty, consultation with a less demanding patient can guide decision-making, helping to avoid overtreatment. There remains a need for randomized clinical trials comparing symmetrical MLIA space opening versus closure and assessing asymmetrical cases. Future studies should employ standardized methodologies, including uniform observer groups and consistent rating scales, to allow more reliable comparisons.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

References

1. Rodrigues CDDT, Magnani R, Machado MS, Oliveira OB. The perception of smile attractiveness. Angle Orthod. 2009;79(3):634–9.
2. Oliveira PLE, Motta A, Pithon M, Mucha J. Details of pleasing smiles. Int J Esthet Dent. 2018;13(4):494–514.
3. Shamban A. The signature feature™: A new concept in beauty. J Cosmet Dermatol. 2019;18(3):692–9.
4. Romsics L, Segatto A, Boa K, Becsei R, Rózsa N, Szántó I, et al. Dentofacial mini- and microesthetics as perceived by dental students: A cross-sectional multi-site study. PLoS One. 2020;15(3):e0230182.
5. Lukez A, Pavlic A, Trinajstic Zrinski M, Spalj S. The unique contribution of elements of smile

aesthetics to psychosocial well-being. J Oral Rehabil. 2015;42(4):275–81.
6. Brough E, Donaldson AN, Naini FB. Canine substitution for missing maxillary lateral incisors: The influence of canine morphology, size, and shade on perceptions of smile attractiveness. Am J Orthod Dentofacial Orthop. 2010;138(6):705.e1–9.
7. De-Marchi LM, Pini NI, Ramos AL, Pascotto RC. Smile attractiveness of patients treated for congenitally missing maxillary lateral incisors as rated by dentists, laypersons, and the patients themselves. J Prosthet Dent. 2014;112(3):540–6.
8. Kokich VO, Kokich VG, Kiyak HA. Perceptions of dental professionals and laypersons to altered dental esthetics: Asymmetric and symmetric situations. Am J Orthod Dentofacial Orthop. 2006;130(2):141–51.
9. Rayner WJ, Barber SK, Spencer RJ. The effect of canine characteristics and symmetry on perceived smile attractiveness when canine teeth are substituted for lateral incisors. J Orthod. 2015;42(1):22–32.
10. Almuzian M, McIntyre G. Great expectations of patients with missing lateral incisors: When are space opening and space closure appropriate? Eur J Clin Orthod. 2015;3(2):68–74.
11. Dueled E, Gotfredsen K, Trab Damsgaard M, Hede B. Professional and patient-based evaluation of oral rehabilitation in patients with tooth agenesis. Clin Oral Implants Res. 2009;20(7):729–36.
12. Kokich VO Jr, Kiyak HA, Shapiro PA. Comparing the perception of dentists and lay people to altered dental esthetics. J Esthet Dent. 1999;11(6):311–24.
13. Pinho S, Ciriaco C, Faber J, Lenza MA. Impact of dental asymmetries on the perception of smile esthetics. Am J Orthod Dentofacial Orthop. 2007;132(6):748–53.
14. Mota A, Pinho T. Esthetic perception of maxillary lateral incisor agenesis treatment by canine mesialization. Int Orthod. 2016;14(1):95–107.
15. Polder BJ, Van't Hof MA, Van der Linden FP, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. Community Dent Oral Epidemiol. 2004;32(3):217–26.
16. Rosa M, Olimpo A, Fastuca R, Caprioglio A. Perceptions of dental professionals and laypeople to altered dental esthetics in cases with congenitally missing maxillary lateral incisors. Prog Orthod. 2013;14(1):34.
17. Lupinetti GM, Li P, Feagin K, MacDougall M, Lamani E. Non-syndromic hypodontia of maxillary lateral incisors and its association with other dental anomalies. Prog Orthod. 2022;23(1):53.
18. Pinho T, Bellot-Arcis C, Montiel-Company JM, Neves M. Esthetic assessment of the effect of gingival exposure in the smile of patients with unilateral and bilateral maxillary incisor agenesis. J Prosthodont. 2015;24(5):366–72.
19. Armbruster PC, Gardiner DM, Whitley JB Jr, Flerra J. The congenitally missing maxillary lateral incisor. Part 1: Esthetic judgment of treatment options. World J Orthod. 2005;6(4):369–75.
20. Abdulrahman NAM, Khalifa N, Alhajj MN. Dentists' preferences in the treatment of congenitally missing maxillary lateral incisors. Braz Dent Sci. 2019;22(3):243–51.
21. Carlson H. Suggested treatment for missing lateral incisor cases. Angle Orthod. 1952;22(4):205–16.
22. Silveira GS, de Almeida NV, Pereira DM, Mattos CT, Mucha JN. Prosthetic replacement vs space closure for maxillary lateral incisor agenesis: A systematic review. Am J Orthod Dentofacial Orthop. 2016;150(2):228–37.
23. Westgate E, Waring D, Malik O, Darcey J. Management of missing maxillary lateral incisors in general practice: Space opening versus space closure. Br Dent J. 2019;226(5):400–6.
24. 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. 2019;42(5):460–5.
25. Gomes AF, Pinho T. Esthetic perception of asymmetric canines treated with space closure in maxillary lateral incisor agenesis. Int J Esthet Dent. 2019;14(1):30–8.
26. De-Marchi LM, Pini NI, Hayacibara RM, Silva RS, Pascotto RC. Congenitally missing maxillary lateral incisors: Functional and periodontal aspects in patients treated with implants or space closure and tooth re-contouring. Open Dent J. 2012;6:248–54.
27. Jamilian A, Perillo L, Rosa M. Missing upper incisors: A retrospective study of orthodontic space closure versus implant. Prog Orthod. 2015;16(1):2.
28. 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. Am J Orthod Dentofacial Orthop. 2016;149(3):339–48.
29. Schroeder DK, Schroeder MA, Vasconcelos V. Agenesis of maxillary lateral incisors: Diagnosis and treatment options. Dent Press J Orthod. 2022;27(Spec No 1):e22spe21.
30. Tan D, Playle R, Harris A, Tredwin C, Addy L. Does the gender of the subject affect perceived smile aesthetics when varying the dimensions of maxillary lateral incisors? Br Dent J. 2018;225(3):235–40.
31. Pini NI, De-Marchi LM, Gribel B, Ramos AL, Furquim L, Pascotto RC. Analysis of width/height ratio and gingival zenith in patients with bilateral agenesis of maxillary lateral incisor. Dent Press J Orthod. 2012;17(5):87–93.
32. Patusco V, Carvalho CK, Lenza MA, Faber J. Smile prevails over other facial components of male facial esthetics. J Am Dent Assoc. 2018;149(9):680–7.
33. Fernandes L, Pinho T. Esthetic evaluation of dental and gingival asymmetries. Int Orthod. 2015;13(2):221–31.
34. 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):153–61.
35. Miyoshi CS, Rached RN, Meira TM, Allahham A, Saga AY, Tanaka OM. The eye-tracking study of the impact of the gingival margin height of maxillary lateral incisors. Int J Periodontics Restor Dent. 2020;40(2):261–70.
36. Armbruster PC, Gardiner DM, Whitley JB Jr, Flerra J. The congenital missing maxillary lateral incisor. Part 2: assessing dentists' preferences for treatment. World J Orthod. 2005;6(4):376–81.
37. Althagafi N. Esthetic smile perception among dental students at different educational levels. Clin Cosmet Investig Dent. 2021;13(1):163–72.
38. Senty EL. The maxillary cuspid and missing lateral incisors: esthetics and occlusion. Angle Orthod. 1976;46(4):365–71.
39. Kafantaris SN, Tortopidis D, Pissiotis AL, Kafantaris NM. Factors affecting decision-making for congenitally missing permanent maxillary lateral incisors: a retrospective study. Eur J Prosthodont Restor Dent. 2020;28(2):43–52.
40. Cocconi R, Rapa S. Unilateral agenesis of the maxillary lateral incisor: space closure versus space preservation in growing patients. Semin Orthod. 2020;26(1):24–32.
41. Josefsson E, Lindsten R. Treatment of missing maxillary lateral incisors: a clinical and aesthetic evaluation. Eur J Orthod. 2019;41(3):273–8.
42. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372(71):n71.
43. Harzing AW, Alakangas S. Google Scholar, Scopus and the Web of Science: a longitudinal and cross-disciplinary comparison. Scientometrics. 2016;106(2):787–804.
44. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol. 2014;14(1):135.
45. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. BMC Med Res Methodol. 2005;5(1):13.
46. Sterne JA, Hernan MA, Reeves BC, Savovic J, Berkman ND, Viswanathan M, et al. ROBINS-I: A tool for assessing risk of bias in non-randomised studies of interventions. BMJ. 2016;355(1):i4919.
47. Andrade DC, Loureiro CA, Araujo VE, Riera R, Atallah AN. Treatment for agenesis of maxillary lateral incisors: a systematic review. Orthod Craniofac Res. 2013;16(3):129–36.
48. Li R, Mei L, Wang P, He J, Meng Q, Zhong L, et al. Canine edge width and height affect dental esthetics in maxillary canine substitution treatment. Prog Orthod. 2019;20(1):16.
49. Qadri S, Parkin NA, Benson PE. Space closing versus space opening for bilateral missing upper laterals – aesthetic judgments of laypeople: a web-based survey. J Orthod. 2016;43(2):137–46.
50. Schneider U, Moser L, Fornasetti M, Piattella M, Siciliani G. Esthetic evaluation of implants vs canine substitution in patients with congenitally missing maxillary lateral incisors: Are there any new insights? Am J Orthod Dentofacial Orthop. 2016;150(3):416–24.
51. Souza RA, Alves GN, Mattos JM, Coqueiro RDS, Pithon MM, Paiva JB. Perception of attractiveness of missing maxillary lateral incisors replaced by canines. Dent Press J Orthod. 2018;23(6):65–74.
52. Thierens LAM, Verhoeven B, Temmerman L, De Pauw GAM. An esthetic evaluation of unilateral canine substitution for a missing maxillary lateral incisor. J Esthet Restor Dent. 2017;29(6):442–9.
53. De-Marchi LM, Pini NI, Pascotto RC. The relationship between smile attractiveness and esthetic parameters of patients with lateral agenesis treated with tooth recontouring or

implants. Clin Cosmet Investig Dent. 2012;4(1):43–9.
54. Sriphadungporn C, Chamnannidiadha N. Perception of smile esthetics by laypeople of different ages. Prog Orthod. 2017;18(1):8.
55. Martinez Florez D, Rinchuse D, Zullo T. Influence of maxillary lateral incisor width ratio on perception of smile esthetics among orthodontists and laypersons. J Esthet Restor Dent. 2021;33(4):510–5.
56. Rosas S, Paço M, Lemos C, Pinho T. Comparison between the visual analog scale and the numerical rating scale in the perception of esthetics and pain. Int Orthod. 2017;15(4):543–60.
57. Greta DC, Colosi HA, Gasparik C, Dudea D. Perceptions of dental dyschromia by patients and dentists. Int J Prosthodont. 2021;34(2):154–62.
58. Bukhary SM, Gill DS, Tredwin CJ, Moles DR. The influence of varying maxillary lateral incisor dimensions on perceived smile aesthetics. Br Dent J. 2007;203(11):687–93.
59. Saffarpour A, Ghavam M, Saffarpour A, Dayani R, Fard MJ. Perception of laypeople and dental professionals of smile esthetics. J Dent (Tehran). 2016;13(2):85–91.
60. Chandra Pani S, Fernandez RA, Ihsan Kudsi R, Elkhawly FF, AlBatran AN, Nasser MA. The impact of lateral incisor dimensions on smile perception: a study of patients' tolerance for deviation from the ideal. Periodontics Prosthodont. 2016;2(5):5.