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Review Article

Prosthetic Management of Maxillary Lateral Incisor Agenesis following Orthodontic Space Opening: A Systematic Review of Clinical Evidence

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Abstract

Aims: To systematically evaluate the clinical outcomes, esthetic results, and patient satisfaction concerning prosthetic rehabilitation approaches (implant-supported crowns and fixed dental prostheses) following orthodontic space opening in patients with maxillary lateral incisor agenesis.

Materials and Methods: A systematic review following PRISMA guidelines was conducted. Electronic databases (PubMed, Scopus, Web of Science, Google Scholar, Cochrane Library) were searched from 2012 to 2024. The risk of bias was assessed using the ROBINS-I and the Newcastle-Ottawa Scale.

Results: Out of 379 initially identified publications, 7 studies met the inclusion criteria. The data indicate implants demonstrate superior survival rates (95-100%) compared to bridges (75-90%), particularly resin-bonded bridges. Both modalities showed comparable esthetic outcomes, with high patient satisfaction rates (85-95%). However, space closure with canine camouflage demonstrated better overall esthetic and periodontal outcomes compared to prosthetic replacement.

Conclusions: Although implants and bridges are viable options, space closure with canine camouflage is the preferred treatment when feasible. The choice between prosthetic modalities should be individualized based on patient factors, bone availability, and long- term maintenance considerations. High-quality comparative studies with extended follow-up are needed.

Keywords: Crown-supported dental prostheses, Congenitally missing upper lateral incisor, Orthodontic space opening, Single tooth dental implant

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INTRODUCTION

Agenesis of the maxillary lateral incisor is a common dental anomaly affecting approximately 2% of the population and accounting for 20% of all tooth agenesis cases (1). This condition significantly affects both aesthetics and function and requires an interdisciplinary treatment approach, often involving orthodontics, prosthodontics, periodontics, and restorative dentistry.

The etiology of lateral incisor agenesis is multifactorial, primarily involving mutations in developmental genes (PAX9, MSX1, AXIN2, EDA) and environmental factors (2-5). Early diagnosis, typically by panoramic radiograph around the age of 7-8 years, is crucial for optimal treatment planning during the growth period (6).

Management of lateral incisor agenesis is based on two main strategies:

1- **Space Closure (SC):** Orthodontic movement of the canine into the lateral incisor position, followed by canine reshaping to resemble lateral incisor morphology.
2- **Space Opening (SO):** Orthodontic creation or maintenance of space followed by prosthetic replacement options (7).

Prosthetic solutions include: Single-tooth dental implants with crown restoration, fixed bridges (cantilever or resin-bonded), and removable prostheses (8).

The decision-making process involves multiple factors: volume, smile line, adjacent tooth condition, and long-term maintenance considerations (9).

This systematic review aims to evaluate existing literature comparing treatment modalities that involve orthodontic space opening and prosthetic rehabilitation. The objective is to determine which option offers the best aesthetic and periodontal outcomes to guide evidence-based clinical decision-making.

MATERIALS AND METHODS

Protocol and Registration

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (10). The protocol

was registered in the International Prospective Register of Systematic Reviews, PROSPERO: https://www.crd.york.ac.uk/PROSPERO/view/CRD420251170976.

The clinical question was formulated using the Population, Intervention, Comparison, and Outcomes (PICO) framework to establish clear and focused eligibility criteria (Table 1).

Table (1): PICO framework

Element	Description
Population (P)	Patients with agenesis of the permanent maxillary lateral incisor (uni and/or bilateral).
Intervention (I)	Space opening followed by implant placement.
Comparison (C)	Space opening followed by bridge restoration.
Outcomes (O)	Esthetic, periodontal, and functional results obtained from different therapeutic approaches.

Eligibility criteria

Inclusion and exclusion criteria were defined to ensure the relevance and quality of the selected studies (Table 2).

Table (2): Eligibility criteria

Inclusion Criteria	Exclusion Criteria
-Orthodontic space opening studies addressing implants and fixed prosthetics for maxillary lateral incisor agenesis.	-Patients with cleft palate and genetic syndromes.
-Articles with full text availability.	-Review articles, systematic reviews, and case reports (due to lower level of scientific evidence).
-Articles published in English and /or French 2015-2024	-Cases where the lateral incisor was absent due to trauma or dental caries

Information Sources and Search Strategy

Comprehensive electronic database searches were conducted in July 2025, with the final search completed on September 25, 2025. The following databases were searched within the specified time frame: **PubMed/MEDLINE, Scopus, Web of Science, Science-Direct, Google, and Cochrane Library.**

The search strategy used the following keyword combinations: ("upper lateral incisor" OR "maxillary lateral incisor") AND ("tooth agenesis" OR "congenitally missing") AND space opening" OR "orthodontic treatment" OR "dental implant "OR "fixed partial denture" OR "resin bonded bridge").

Study selection process

Two researchers (Y.O. and F.Z.) independently carried out the two-stage selection process. After removing duplicates, titles and abstracts were screened. Then, the full texts of potentially eligible articles were assessed. Disagreements were resolved by consensus, with the intervention of a third reviewer if necessary. The process is summarized in the PRISMA flow diagram (Figure 1).

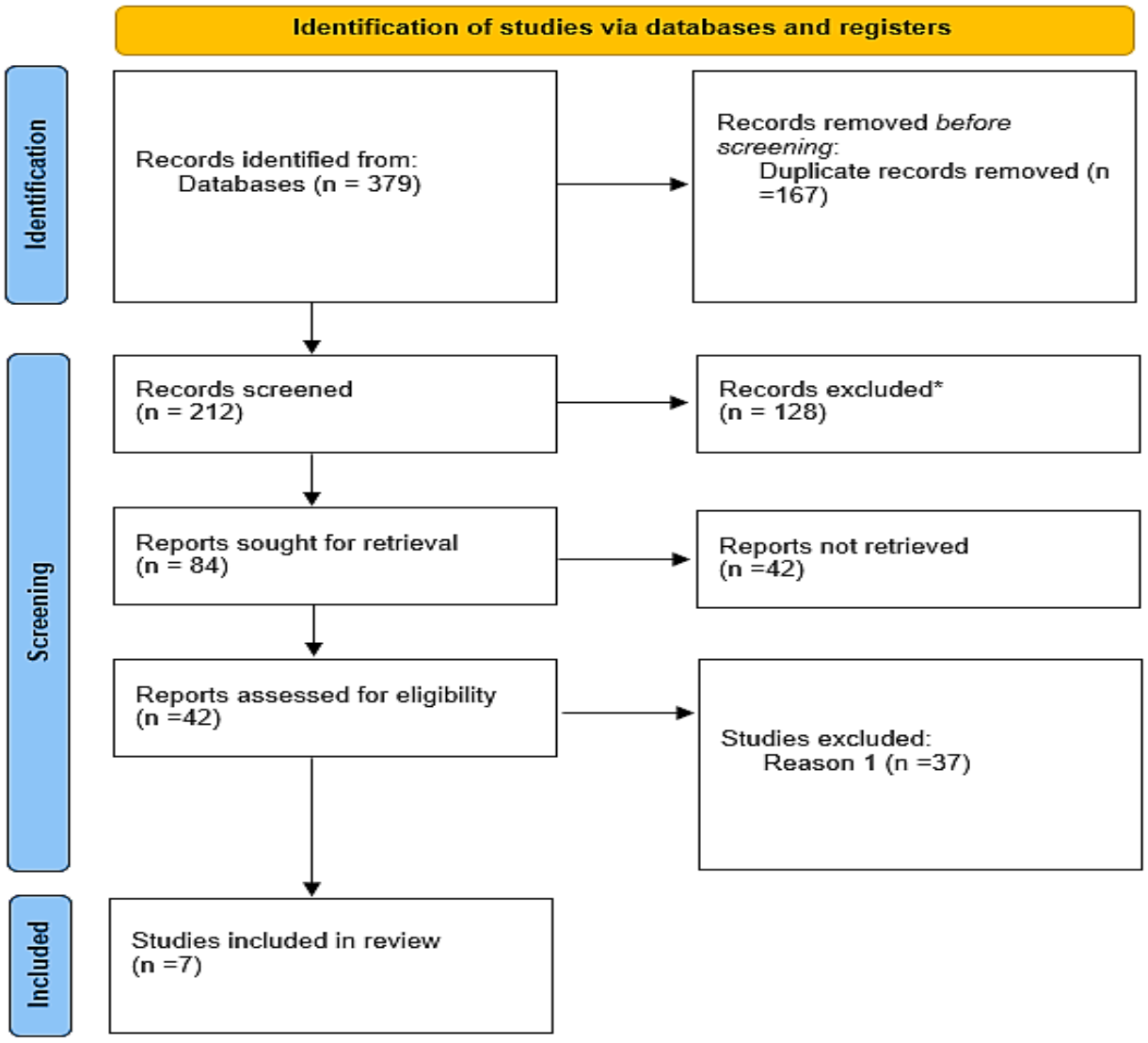


Figure (1): PRISMA Flowchart

Data Extraction

The data collection process was conducted by two independent reviewers (Y.O. and F.Z.). Titles and abstracts were initially evaluated based on relevance and predefined eligibility criteria. Duplicates were systematically identified and removed before proceeding to full-text screening. The following items were systematically extracted from each included study:

Author name and year of publication, study design type and methodology, prosthetic protocol, statistical analysis method, sample size and population characteristics, parameters evaluated, comparison or control group details, outcome measures assessed, main results and findings, follow-up duration. Disagreements were resolved by consensus.

Risk of Bias Assessment

Methodological quality was assessed by two reviewers. The Newcastle-Ottawa Scale (NOS) was used for six non-randomized observational studies. The ROBINS-I tool was used for one retrospective study.

RESULTS

Study Selection and Characteristics

The search identified 379 publications, and after a rigorous selection process, 7 studies were included. These studies varied in design, with sample sizes ranging from 20 to 100 patients and follow-up periods from 2 to 10 years. A total of 277 subjects were analyzed: 200 patients received implants, 45 received bridges, and 32 patients (control group) underwent space closure.

All of the studies compared and evaluated the outcomes of prosthetic rehabilitation for lateral incisor agenesis. All of the selected studies evaluated esthetics and patient satisfaction, periodontal health, and occlusal function; in addition, five of them assessed periodontal health. One study evaluated temporomandibular dysfunction (TMD). **(See Tables 3 and 4 for a detailed overview of the included studies and their methodological characteristics)**

Table (3): Overview of the studies included in this review

Authors AND year	**Study Design**	**Participants**	**Intervention**	**Measurement methods**	**Comparison**	**Outcome**
Jamilian et al. (2015)	Retrospective study	20 patients **IG group**: 10 patients (5 males, 5 females, mean age 20±1.4 years) **OSC group**: 10 patients (6 males, 4 females, mean age 19±2.1 years) (control group)	Space opening, Implant substitution (IG)	**Questionnaire** (VAS)/ **Clinical examination** (mobility, PD, infraocclusion, PI)/ Radiological exams	Orthodontic space closure (OSC)	Patient satisfaction Periodontal health Occlusion and function
Josefsson & Lindsten (2018)	Clinical evaluation study	**44 patients** - Implant group: 22 patients (8 males, 14 females) - Space closure group: 22 patients	Space opening Implant-supported crowns (Igroup)	**Clinical examination** (gingival color, crown color, crown length,visible screws, buccal recession, bleeding on probing, papilla formation – Jemt index, Angle classification, space condition, overjet, overbite, incisor inclination, midline, lip closure, smile appearance, dental harmony, mobility, PD, infraocclusion, PI)	Orthodontic space closure (SC group)	Esthetic and patient satisfaction Periodontal health Occlusion and function

				Questionnaire (VAS) **Radiological exams** (periapical radiographs, bone level assessment, infraocclusion measurement)		
Anweigi et al. (2019)	Clinical performance study	26 patients with a total of 51 RBBs. Resin-bonded bridges	Space opening + resin-bonded bridges	**Clinical examination** (survival assessment, marginal adaptation scoring, caries detection, occlusal contact documentation, pain/mobility/fracture evaluation) **Questionnaire** (VAS patient satisfaction, habit evaluation) **Tools** (periodontal probe, visual inspection, articulating paper assessment)	Single-arm cohort study	Resin-bonded bridges performance Longevity and survival

Lacarbonara et al. (2022)	Prospective cohort study	**46 patients** 31 women, 15 men - Mean age 17 years	Space opening Mini-implants rehabilitation	**Clinical examination** (pain, stability, bone resorption, bleeding), **Radiological exams** (osseointegration, infraocclusion measurement, vertical positioning measurement, implant-bone interface evaluation)	Single-arm prospective cohort study	Long-term survival and stability of mini-Implant
Sorrentino et al. (2024)	Prospective clinical study	**22 patients** (15 women and 7 men), aged between 18 and 37 years.	Space opening + implant-supported zirconia single crowns with full digital workflow	**Clinical examination** (FIPS scoring, probing, soft tissue evaluation) / **Questionnaire** (VAS) / **Radiological examination** (standardized radiographs, software analysis, osseointegration monitoring)	Single-arm prospective cohort study	Survival and success rates of implant-supported zirconia crowns
Roccuzzo et al. (2024)	Clinical study	**100 Patients** 39 patients received the 2.9mm narrow-diameter implants	Space opening +implants	**Clinical examination** (PPD, plaque scores, technical complications, vitality testing) / **Photographic assessment** (Copenhagen Index Score) / Radiological examination (standardized periapical radiographs, CBL measurements, software analysis)	35 patients received 3.3mm narrow-diameter implants	Periodontal health Patient satisfaction Osseo integration

Gresnigt et al. (2024)	Clinical follow-up study	19 Novel cantilever contact-point resin bonded bridges	Space opening + cantilever contact-point resin bonded bridge	**Clinical examination** (Modified USPHS criteria, gingival health scoring, **survival assessment** visual/tactile examination **esthetic evaluation** gingival connection/color match, **functional assessment** wear/fracture detection)	single-arm proof-of-concept study	Restoration survival Periodontal health Patient satisfaction Function

Table (4): Treatment Protocols of Included Studies

Author & Year	Follow-up Period	Prosthetic Protocol
Jamilian et al. (2015)	5.6 ± 0.4 years post-treatment (minimum 5 years)	**Implant group:** Same implant type by a single surgeon, average treatment time 18±4 months; **OSC group:** Fixed orthodontic appliances, average treatment time 29±7 months, Hawley retainers for 1 year
Josefsson & Lindsten (2018)	At least 5 years post-treatment (range: 5+ years after prosthetic/orthodontic completion)	Implant group: Single implant- supported crowns by 8 surgical specialists, 7 prosthodontic specialists; Space closure: Fixed orthodontic appliances by 11 specialists
Anweigi et al. (2020)	7-84 months (median 28 months)	Non-perforated nickel-chromium retainers, sandblasted with 50-μm alumina, luted with PANAVIA™ 21 adhesive resin
Lacarbonara et al. (2022)	10-year follow-up: 1 month, 1 year, then every 5 years	Immediate non-functional loading, porcelain fused to metal crowns (gold), 57 weeks final impressions, 8-10 weeks crown delivery
Roccuzzo et al. (2024)	3-year follow-up: T1 (baseline), T2 (1 year), T3 (3 years)	3-month provisional PMMA crowns, then feldspatic-ceramic- veneered-zirconia crowns on customized CAD-CAM titanium abutments
Gresnigt et al. (2024)	4-60 months (mean 29.8 months, median 31 months)	Lost-wax technique, lithium disilicate (IPS e.max), 9% HF acid conditioning, silane + heat treatment (100°C, 3 min), heated composite cement (55°C)
Sorrentino et al. (2024)	2-year follow-up: T0 (baseline), 1 year, 2 years	Full digital workflow, 3-month PMMA temporaries, monolithic cubic zirconia crowns (5Y-TZP) with micro-layering on buccal surfaces only

Risk of bias

Across the six studies assessed with the NOS, the most frequent limitations were incomplete control of confounding in the comparability domain and concerns regarding outcome ascertainment and follow-up sufficiency in the outcome domain, which reduced star allocation despite generally adequate selection procedures. The retrospective study evaluated with ROBINS-I showed primary concerns for confounding control and outcome measurement, consistent with retrospective

designs; overall risk was not low due to potential residual confounding and limitations in blinding and follow-up, although selection processes and intervention classification were acceptable for the study type **(Table 5).**

Table (5): Risk of bias assessment tool

Study (Author, Year)	Study Design	Risk of Bias Tool	Score /Judgment	Risk Level
Jossefsson et al.	Prospective cohort,	NOS	6/9	**Moderate**
Lacarbonara	Prospective cohort,	NOS	6/9	**Moderate**
Gresnigt	Prospective clinical case control	NOS	6/9	**Moderate**
Anweigi	Retrospective cohort,	NOS	6/9	**Moderate**
Sorrentino	Prospective cohort,	NOS	6/9	**Moderate**
Rocuzzo	Prospective controlled cohort	NOS	8/9	**Low**
Jamilian	Retrospective observational	ROBINS-I	Moderate/ Serious	**Moderate/ Serious**

Analyses of Outcomes

The results were grouped by category for comparative analysis. **Table 6** shows a summary of key results by category.

Periodontal and Gingival Health Outcomes

Periodontal health was comprehensively assessed across all included studies using standardized clinical parameters, including probing depth measurements, bleeding on probing evaluation, plaque index documentation, and mobility assessment.

Table (6): key results by category.

Outcome	Parameters Evaluated	Studies	Key Results
Periodontal and Gingival Health	- Plaque Index (PI) - Bleeding on Probing (BOP) - Probing Depth (PD) - Gingival recession - Marginal bone loss - Peri-implant tissue health -Löe & Silness bleeding index	Jamilian et al. (2015) Josefsson & Lindsten (2018) Lacarbonara et al. (2022) Roccuzzo et al. (2024) Anweigi et al. (2020)	· Implant groups showed increased PD (p<0.001) vs. space closure · 25% BOP in implant group vs. 35% in space closure · 86% survival rate for RBBs at 7-year follow-up · Minimal CBL changes (<1mm) in NDI studies · No significant periodontal complications in space closure
Esthetic Outcomes	- Copenhagen Index Score - Gingival color assessment - Crown color matching - Papilla formation (Jemt index) - Soft tissue symmetry - Modified USPHS criteria -Color match scoring (0-4 scale)	Josefsson & Lindsten (2018) Roccuzzo et al. (2024) Gresnigt et al. (2024) Sorrentino et al. (2024)	· 61% gingival discoloration in implant group vs. 9% in space closure (p=0.001) · All implant crowns showed optimal/acceptable color · 100% success rate for contact- point RBBs · Copenhagen Index: satisfactory scores (1-2) in 92% of cases · Better crown color in implant group, better gingival color in space closure
Patient Satisfaction	- Visual Analog Scale (VAS 0-10) - Patient-reported outcomes - Overall satisfaction rating - Treatment acceptance - FIPS evaluation	**Jamilian et al. (2015)** Josefsson & Lindsten (2018) **Sorrentino et al.** (2024) **Anweigi et al**. (2020)	- Similar satisfaction: 8.7±1.3 (implant) vs. 8.8±1.2 (space closure) - No significant differences between groups (p=0.857) - High satisfaction (90% median) for RBBs - FIPS score: 9.2 overall for zirconia crowns - 68% satisfied in implant group vs. 59% in space closure group
Functional and Occlusal Outcomes	- Infraocclusion measurement - Overjet/overbite assessment - Incisor inclination - TMD symptoms - Tooth mobility - Fracture assessment - Wear evaluation	**Jamilian et al.** (2015) **Josefsson & Lindsten** (2018) Lacarbonara et al. (2022) Grensigt et al. (2024)	- 100% infraocclusion (1.2- 1.6mm) in all implant patients vs. 0% in space closure (p<0.001) - No TMD symptoms in either group - Increased incisor proclination in implant group (32% vs. 4%, p=0.03) - No restoration fractures or technical complications

NDI = Narrow Diameter Implants, PD = Probing Depth, RBB = Resin Bonded Bridges, CBL = Crestal Bone Level, TMD = Temporomandibular Dysfunction, FIPS = Functional Implant Prosthodontic Score

Implant-supported restorations demonstrated variable periodontal outcomes. Jamilian et al. (11) reported probing depths exceeding 3mm in 12 implants (86% of cases), while Josefsson & Lindsten (12) found buccal gingival recession (0.5-2.0mm) in 8 of 28 implant sites (29%). Probe-induced bleeding was present in 25% of implant sites. Lacarbonara et al. (13) reported more favorable outcomes with narrow-diameter implants, documenting no pain or pathological mobility throughout 10-year follow-up, with bleeding prevalence decreasing from 16.6% at 1 month to 11.9% at 10 years ($p>0.05$). Roccuzzo et al. (14) observed mean probing depths of 2.62±0.31mm and 2.57±0.38mm for 2.9mm and 3.3 mm diameter implants, respectively, with no significant intergroup differences ($p=0.482$).

Esthetic Outcomes and Patient Satisfaction

Multiple assessment frameworks were employed to evaluate esthetic outcomes, including Visual Analog Scales (VAS), Copenhagen Index scoring, and Functional Implant Prosthodontic Score (FIPS).

Patient satisfaction scores were consistently high across treatment modalities. Jamilian et al. (11) reported comparable VAS scores between implant and orthodontic space closure groups (8.7±1.3 vs 8.8±1.2, respectively). Sorrentino et al. (15) documented an average FIPS score of 9.2, indicating optimal functional and esthetic integration, with patient satisfaction VAS scores averaging 8.7.

Soft tissue esthetics presented varying outcomes. Josefsson & Lindsten (12) identified gingival discoloration in 61% of implant patients, with 61% of crowns appearing clinically short. Conversely, all 28 implant-supported crowns demonstrated optimal or acceptable color matching. Roccuzzo et al. (14) observed peri-implant soft tissue discoloration in 15.4% of 2.9mm implants and 14.3% of 3.3mm implants at 3-year follow- up.

Functional and Occlusal Assessment

Functional outcomes varied significantly between treatment approaches. Josefsson & Lindsten (12) found Class I occlusion in 77% of implant patients, with overjet ranging 0- 5mm (mean 3mm) and overbite varying from -1.5 to 7mm. Maxillary incisor

proclination was significantly greater in implant patients (32%) compared to space closure patients (4%, p=0.03). Strained lip closure occurred more frequently in implant patients (23% vs 0%, p=0.048).

Infraocclusion Assessment

Contradictory findings emerged regarding infraocclusion. Jamilian et al. (11) documented universal infraocclusion (100% of implant patients) with radiographic measurements ranging 1.2-1.6mm. Conversely, Lacarbonara et al. (13) reported no detectable infraocclusion throughout radiographic assessments.

Implant Survival and Osseointegration

Survival rates were excellent across implant studies. Lacarbonara et al. (13) achieved 100% survival over 10 years with all implants demonstrating stable osseointegration. Sorrentino et al. (15) reported 100% cumulative survival and 93.3% success rates at 2-year follow-up via Kaplan-Meier analysis, with minor complications including one mucositis episode and one crown unscrewing. Roccuzzo et al. (14) documented 100% survival in 2.9mm implants and 98% in 3.3mm implants at 3-year follow-up following one early failure.

Crestal bone level changes showed significant differences between implant diameters in Roccuzzo's study (14), with 2.9mm implants demonstrating superior bone maintenance (0.17±0.30 mm) compared to 3.3mm implants (0.42±0.42 mm) over 3-year functional loading (p=0.005).

Resin-Bonded Bridge Performance

Anweigi et al. (16) reported 86% survival rates for resin-bonded bridges over evaluation, with 14% experiencing debonding episodes. Primary failure mechanisms included trauma (n=3) and adhesive failure (n=4). Successful bridges demonstrated satisfactory marginal adaptation without detectable defects.

Technical Complications

Technical complications were minimal across studies. Josefsson & Lindsten (13) observed visible screws in one implant case and papilla deficiencies in 20 of 28 implants. Roccuzzo et al. (14) documented two patients with buccal fistulae not

associated with increased probing depths or radiographic bone loss. No technical complications occurred during the 2-3-year follow-up period.

DISCUSSION

syntheses of evidence

This systematic review aims to provide a comprehensive guide for cases of lateral incisor agenesis treated with orthodontic space opening, analyzing which prosthetic option is optimal for replacing a missing lateral incisor. Lateral incisor agenesis presents a significant clinical challenge as it affects both esthetics and function, particularly in young patients**.**

While orthodontic space closure and canine replacement remain common treatment options, they are associated with several limitations (17). The substitution of canines for lateral incisors often leads to esthetic challenges due to differences in size, shape, and color. Canines typically present with larger mesiodistal widths, and the first premolars are shorter than canines, which may compromise smile harmony. Furthermore, occlusal function and long-term stability have been questioned in cases treated with space closure, potentially directing treatment planning toward space opening (18).

Orthodontic treatment facilitates the creation of favorable conditions for prosthetic rehabilitation when indicated. Several patient-related factors**,** such as crowding, persistence of deciduous teeth, and type of malocclusion, guide the decision-making process (19)**.**

The parameters evaluated after prosthetic replacement of the missing lateral incisor varied from periodontal, esthetic, functional, and occlusal outcomes, as well as prosthesis stability and survival**.**

Periodontal and Gingival Tissue Health

Jamilian et al. (11) conducted a study demonstrating periodontal complications following implant placement. They showed that one in ten implants exhibited increased mobility, and increased probing depth by 3mm occurred in three implants, findings not observed in the space closure cohort, where periodontal parameters

remained within normal range, supporting the biological principle that natural tooth movement preserves the integrity of the periodontal ligament-cementum-alveolar bone complex (12).

In a 10-year follow-up study of implant-supported crowns replacing maxillary incisors, progressive bone loss was documented. The mean bone loss on maxillary central incisors adjacent to implants was 3.2mm (SD, 2.3mm) after 3 years and 4.3mm (SD, 2.7mm) after 10 years (20). Conversely, Sorrentino (15) reported preservation of marginal bone and periodontal tissue integrity, with all implants achieving osseointegration (13).

Josefsson's findings (12) revealed that 29% of implants presented buccal gingival recession ranging from 0.5-2.0mm, and 71% demonstrated papilla deficiencies according to Jemt's classification. Multiple studies have confirmed events of gingivitis, increased probing depth, bleeding on probing, and progressive loss of marginal bone support at the buccal aspect of implants that have found increased PD and mobility in implants even after years of follow-up. This is consistent with Bernard et al., who found increased PD and mobility in implants even after years of follow-up (21-23).

Blue coloration was reported by Roccuzzo, who observed that between T2 and T3, peri-implant soft tissue color changed consistently. This coloring is caused by resorption of alveolar bone below the alveolar mucosa. Other studies have reported darkening of the labial gingiva above more than 50% of single-implant crowns at 4-year follow-ups (25-27).

Complications with implants have been widely discussed (28,29), demonstrated that infraocclusion may occur due to continuous eruption of adjacent teeth, even in adults and elderly patients (30). Jamilian (11) documented increased infraocclusion of more than 1mm.

Roccuzzo (14) reported that at 3-year follow-up, no additional implants were lost after one implant loss prior to loading (i.e., one early implant failure) in the 3.3mm group, leading to an implant survival rate of 100%. Sorrentino [15] documented that regarding survival rates of both implants and prosthetic restorations at 2-year follow-

up, a cumulative survival rate of 100% and a cumulative success rate of 93.3% were reported**.** Previous studies demonstrated satisfactory results (95.7%) and success rates (87.1%) after 16 years with osseointegration. Sorrentino reported that all implants achieved osseointegration, showing good marginal bone stability and peri-implant soft-tissue response in the short-term (31).

Regarding bridge restorations, Gresnigt (32) found that among 19 cantilever bridges, no bridge showed debonding or complications, and no caries during follow-up. Anweigi [16] reported similar findings: at the time of evaluation, 44 bridges (86%) were still in service, with 7 bridges (14%) debonding on one occasion. There were seven definite failures (14%) of fifty-one bridges**.**

Esthetic Outcomes

Esthetic outcome evaluation through multiple assessment methods**,** Analog Scales, Copenhagen Index scoring, and expert clinical judgment important findings. Esthetic outcomes represent the most critical consideration for implants (33)**.**

Jamilian's comparative analysis (11) demonstrated remarkably similar patient satisfaction scores between treatment modalities (VAS 8.7±1.3 vs 8.8±1.2), with scores ranging from 7-10 indicating universally high patient acceptance across both implant and space closure approaches, as supported by systematic reviews by Totou et al. (34). Multiple studies have evaluated opinions of dentists and laypeople regarding treatment of lateral incisor agenesis by showing photographs of resin-bonded bridges, implants, and substituted canines. Most preferred cases where the canine was positioned in the lateral incisor location, reporting better esthetic results. However, a significant number of orthodontists prefer restorative options for treating lateral incisor agenesis (35).

One study evaluated smile attractiveness after treating missing lateral incisors using photographs assessed by VAS (36), finding no statistically significant difference between implants and space closure groups (control group), with all patients demonstrating high satisfaction levels with their smile. A slight advantage was observed for patients treated with space closure and tooth reshaping. Some authors

have suggested that infraocclusion of implants, loss of papilla, color changes, and restorations can affect smile attractiveness perception over extended periods (37-39).

Limitations of the review

The heterogeneity of study methodologies, follow-up periods, and outcome measures limits the strength of comparative conclusions. The predominance of retrospective studies and small sample sizes reduces the overall quality of evidence. The absence of long-term comparative data (beyond 10 years) is a significant gap.

Implications for Practice and Future Research

Future research should focus on randomized controlled trials with standardized outcome measures and extended follow-up periods. The integration of digital planning tools and artificial intelligence could offer promising avenues for predicting treatment outcomes.

CONCLUSION

This systematic review demonstrates that several approaches for treating maxillary lateral incisor agenesis offer viable solutions.

- Orthodontic space closure emerges as the preferred option when feasible, due to superior periodontal outcomes and the absence of infraocclusion.
- Implant-supported restorations show excellent survival rates but carry risks of progressive infraocclusion and soft tissue complications.
- Bonded bridges remain a conservative and effective alternative.

The therapeutic decision must be individualized, considering patient-specific factors, malocclusion type, and maintenance capacity. Early interdisciplinary treatment planning is essential to optimize esthetic, functional, and periodontal outcomes.

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Authors' Contribution

F.Z. and H.N. contributed to the research design and implementation. Y.O. helped in data analysis and interpretation, and was a major contributor in writing of the manuscript. H.N. contributed to the research supervision, data gathering, and editing of the manuscript. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript

Availability of data and materials: All data generated or analyzed during this study are included in this published article and its supplementary information files. Additional materials are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted technologies

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were used in the writing, data analysis, interpretation of results, or preparation of this manuscript. All aspects of the study were conducted and prepared solely by the authors.

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المعالجة التعويضية لغياب القواطع الجانبية العلوية بعد فتح الفراغات التقويمية: مراجعة منهجية للأدلة السريرية

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الملخص

الأهداف: تقييم منهجي للنتائج السريرية والتجميلية ورضا المرضى فيما يتعلق بأساليب إعادة التأهيل التعويضي (التيجان المدعومة بالزرعات والتركيبات السنية الثابتة) بعد فتح الفراغات التقويمية لدى المرضى الذين يعانون من غياب القواطع الجانبية العلوية.

المواد وطرائق العمل: أُجريت مراجعة منهجية وفقًا لإرشادات PRISMA. تم البحث في قواعد البيانات الإلكترونية (PubMed، Scopus، Web of Science، Google Scholar، مكتبة كوكرين) للفترة من 2012 إلى 2024. تم تقييم خطر التحيز باستخدام مقياس ROBINS-I ومقياس نيوكاسل-أوتاوا.

النتائج: من بين 379 منشورًا تم تحديدها مبدئيًا، استوفت 7 دراسات معايير الإدراج. تشير البيانات إلى أن الزرعات تُظهر معدلات بقاء أعلى (95-100%) مقارنةً بالجسور (75-90%)، وخاصةً الجسور المُلصقة بالراتنج. أظهرت كلتا الطريقتين نتائج تجميلية متقاربة، مع معدلات رضا عالية للمرضى (85-95%). مع ذلك، أظهر إغلاق الفراغات باستخدام تقنية التمويه النسيجي للأنياب نتائج تجميلية ونسيجية أفضل بشكل عام مقارنةً بالتركيبات السنية.

الاستنتاجات: على الرغم من أن زراعة الأسنان والجسور خياراتٌ واردة، إلا أن إغلاق الفراغات باستخدام تقنية التمويه النسيجي للأنياب هو العلاج المُفضّل متى أمكن ذلك. ينبغي اختيار طريقة التركيب السني المناسبة لكل مريض على حدة، بناءً على عوامل المريض، وكمية العظم المتاحة، واعتبارات الصيانة طويلة الأمد. هناك حاجة إلى دراسات مقارنة عالية الجودة مع متابعة طويلة الأمد.

الكلمات المفتاحية: أطقم الأسنان المدعومة بالتاج، فقدان خلقي للضرس القاطع الجانبي العلوي، فتح الفراغ التقويمي، زراعة سن واحد