



Canine Substitution Versus Implant for Treating Congenitally Missing Lateral Incisors: A Systematic Review

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Received: 2021 December 23; Revised: 2021 December 26; Accepted: 2021 December 28

Abstract

Background: Addressing the challenges posed by the Congenitally Missing Maxillary Lateral Incisors (CMMLI) is not limited to single treatment modality.

Objective: This systematic review is intended to evaluate the evidence for the best treatment option available for the CMMLI.

Methods: Electronic data base search was done across PubMed, Google scholar, Embase, Publons, Web of Sciences, etc. Selection of articles was limited to English language publications pertaining to CMMLI treatment modalities either by closing the space orthodontically and substituting canine or by prosthetic replacement. Two authors reviewed the articles for the eligibility criteria to overcome the selection bias. The risk for assessment of bias across and within the studies was done through Cochrane ROBINS-I assessment tool.

Results: Out of 130 studies which were searched for review questions, only 3 studies met the selection criteria. There was no difference in the periodontal status evaluation or in the patient's perception of aesthetics between the two treatment modalities. Neither of the two treatment modalities cause any TMJ abnormalities.

Conclusion: Both closing the space orthodontically by substituting canine and prosthetic replacement by the use of implant for the missing maxillary lateral incisor seem to be viable treatment plans.

Keywords: Canine Substitution, Congenitally Missing Teeth, Missing Lateral Incisors, Prosthetic Replacement, Prosthetic Implants

1. Introduction

It is not uncommon to have patients with a congenitally missing tooth, two teeth or more; the prevalence could reach up to 5% (1). It has been recognized that there are genetic elements and environmental components that can play a part in the occurrence of hypodontia, although genetics seem to have a greater part in the matter (2). The most commonly missing teeth are lower premolars, which include 2.6% of the cases and are predominantly bilateral, other commonly absent teeth would be the upper lateral incisors that include 2% of the cases and are often symmetrical (3,4). Because of the relatively high occurrence of absence, and its location being in an aesthetically significant area, the upper lateral incisor is

considered the most often restored, or substituted missing tooth (5).

Although an array of treatment alternatives are available to address this issue, the most common one remains prosthetic replacement with an implant. Contrary to implant, where the space needs to be maintained for a long period, the canine substitution renders a good alternative with an advantage of early space closure finished immediately after orthodontics, where there is no need to wait until the "end of growth" to substitute the absent tooth. Although canine replacement is the alternative treatment plan for absent lateral incisors, canine recontouring to the shape of lateral incisor, a favorable color to match the maxillary central incisors, properly positioning

the gingival margin and midline control are major challenges (6).

Previous studies have mentioned various potential indications as well as shortcomings of both treatment modalities (7-10). In both treatment modalities, the resulting occlusion should be planned so that the lateral excursions would be in an anterior group function (11). So far, there are no evidence to suggest the best method suited for the CMMLI in the form of systemic reviews.

2. Objectives

This systematic review was undertaken with the aim to verify the most popular method of treatment for maxillary missing lateral incisors, either canine replacement in place of the missing lateral or the implant substitution of the missing lateral and also to rationally compare the published outcomes.

3. Methods

Protocol & title registration

The review protocol was registered in the National Institute of Health Research database (<https://www.crd.york.ac.uk/prospero/>; protocol no: CRD42020212763; registration Date: November 14, 2020).

Eligibility criteria

The inclusion criteria for the studies undertaken were:

- Studies comparing canine substitution v/s prosthetic replacement of congenitally missing laterals
- Randomized controlled trials, prospective and retrospective case series who had reported treatment of unilateral or bilateral missing lateral incisors
- Studies with adequate description of treatment modality used
- Studies with thorough clinical evaluation of the treatment modality
- Full text articles
- Adequate statistical analysis
- If possible, with a follow-up record

The exclusion criteria for the studies were:

- Animal studies and reviews
- Studies reporting treatment for tooth agenesis other than lateral incisors.

Information sources, search strategy & study selection

The focused PICO (population, intervention, comparison and outcome) question of the

current systematic review was whether canine substitution was similar or better than implant prosthesis for treating congenitally missing lateral incisors in terms of functional, periodontal and esthetical concerns, and to determine whether the available scientific data concludes well enough for accepting one treatment modality over the other. Ethical approval was not required since we gathered the data from researches that had formerly been published and informed consent had already been collected by the previous researchers.

Our search for the selection of studies was according to the method described by the guidelines of the PRISMA (Preferred Reporting Items for Systematic reviews and Meta Analyses) (12). Literature was reviewed from January 1985 to September 2019. The search protocol consisted of published researches internationally, review articles, published bibliographies, case reports, and relevant citations in articles, in English language only.

Early electronic literature searches were performed in PubMed, Google scholar, Embase, Publons web of sciences and many relevant journals were also hand searched including the American Journal of Orthodontics and Dentofacial Orthopedics, the Journal of Orthodontics (formerly, British Journal of Orthodontics), the Angle Orthodontist, the European Journal of Orthodontics, and the Journal of Clinical Orthodontics.

MeSH Terms

Medical Subject Headings (MeSH) terms “maxillary lateral incisor, agenesis of lateral incisors, congenitally missing laterals, congenitally missing maxillary lateral incisors, missing upper laterals” and “orthodontic approach, orthodontic treatment, orthodontic space closure, canine substitution” were crossed with combinations of the MeSH terms “implant supported restoration, lateral incisor implant, prosthodontic intervention”.

The key words used to identify the corresponding studies in the other databases were: “missing lateral”, “canine substitution” and “implant replacement”. Search was performed using the following Boolean operators:

Population - (Maxillary lateral incisor) AND (Agenesis) OR (Congenitally missing lateral incisor) OR (Missing lateral incisors) OR (Unilateral lateral agenesis).

Intervention - (Orthodontic approach) OR (Orthodontic treatment) OR (Orthodontic space closure) AND (Canine substitution)

Control - (Implant supported restoration) OR (Prosthetic intervention) OR (Lateral incisor implant)

Outcome - (Esthetic judgment) OR (Overall success) OR (Long term survival) AND (Periodontal assessment).

Data items and collections

Initially, electronic search and hand search were performed by two reviewers (TRS & SK) to eliminate the chance of selection bias. By applying the inclusion and exclusion criteria,

the overlapping articles, animal trials and those that lacked adequate intervention details were eliminated. In total, three studies were screened through the eligibility criteria (Figure 1).

Assessment of risk bias

As this was an interventional review, the assessment for risk of bias across and within the researches was done through Cochrane ROBINS-I assessment tool (13) (Figure 2).

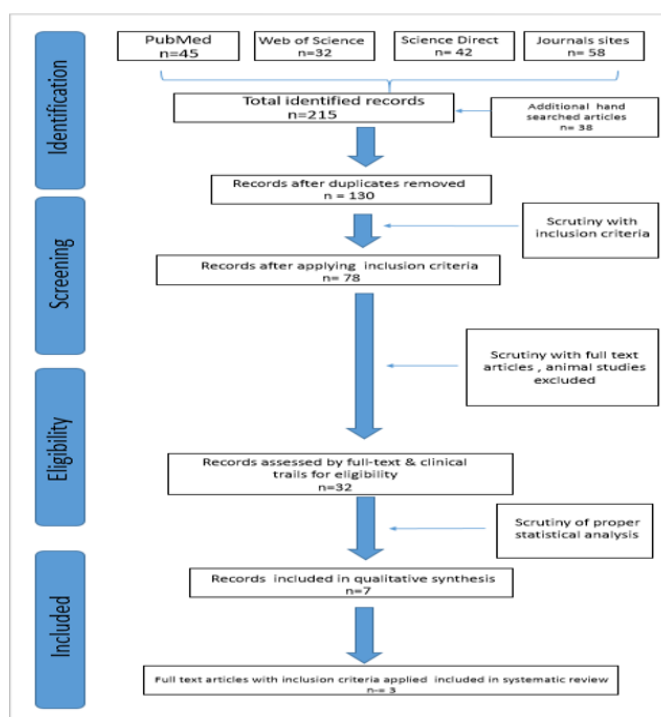


Figure 1. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flowchart of study selected

Study	Risk of bias domains							Overall
	D1	D2	D3	D4	D5	D6	D7	
Schneider et al 2018	+	-	+	+	-	-	+	-
Jamilian et al 2015	+	+	+	+	+	-	+	+
Demarchi et al 2012	-	+	+	+	+	-	+	-

Domains:
 D1: Bias due to confounding.
 D2: Bias due to selection of participants.
 D3: Bias in classification of interventions.
 D4: Bias due to deviations from intended interventions.
 D5: Bias due to missing data.
 D6: Bias in measurement of outcomes.
 D7: Bias in selection of the reported result.

Judgement
 - Moderate
 + Low

Figure 2. Assessing the risk of bias with Cochrane ROBINS-I tool

3. Results

Assessment of bias risk in each study

When compared individually, one study was considered to have moderate risk in selection of participants, one with bias due to missing

data and all three had moderate risk of bias in result measurements. After evaluation, two of the selected studies were evaluated to have moderate risk of bias, while one of them was found to have low risk. Overall, the systematic review has low to moderate risk of bias in the included studies.

Assessment of bias risk across the studies

The seven domains considered were bias due to confounding (D1), bias due to selection of participants (D2), bias in the classification of interventions (D3), bias regarding differences with the planned interventions (D4), bias related to missing data (D5), bias in result measurements (D6) and bias in the selection of the reported results (D7).

Out of a total of 130 studies that were searched for our review question, 3 studies were shortlisted by our two reviewers after the application of the inclusion and exclusion criteria. (Table 1). However, no randomized clinical trial was found pertaining to our review question. Due to our study being an

interventional review, non-randomized studies were taken into consideration. Amongst the studies included, two were retrospective observational studies, while one of them was a cross-sectional study. The average age of participants in the studies ranged from 15.24 to 24.95 years, with one study in which age was not specified. Sample for each intervention was half the total sample in two studies; it differed only in one study. In all three studies, periodontal status in terms of plaque index, tooth mobility, papilla index, bleeding on probing and pocket depth was assessed. In addition, two studies had also assessed patient's self-perceived dental esthetic appearance on the VAS scale; and one of them mentioned assessing TMJ symptoms (through Modified Helkimo questionnaire and the Research Diagnostic Criteria for Temporomandibular Disorders) after the intervention. The outcomes of these studies are discussed under following headings (Table 2).

Table 1. Studies satisfying eligibility criteria

Study By	Study Type	No. Of Patient	Intervention		Avg. Age	Results
			*Osc	*Imp		
De Marchi et al (2012)	Cross sectional Study	46	26	20	24.95 year	No Statistical difference between the 2 groups
Jamilian et al (2015)	Retrospective Study	20	10	10	19 + 2.1 year (m) 20 + 1.4year(f)	Significant infra-occlusion and increased probing depth was noted in the implant substitution group (p <0.001)
Schneider et al (2018)	Retrospective Study	32	16	16	Not specified	Gingival recession was greater in orthodontic space closure than the implant substitution (p<0.001)

*OSC- Orthodontic space closure; IMP- Implant treated

Table 2. Summary of the included studies

S. No	Study	Results
1.	De Marchi et al., (2012)	Both treatment alternatives for patients with congenitally missing maxillary lateral incisors were satisfactory and achieved functional and periodontal results similar to those of the control group.
2.	Jamilian et al., (2015)	Orthodontic space closure and implanting the missing maxillary incisors produced similar, well-accepted esthetic results. None of the treatments impaired temporomandibular joint function.
3.	Schneider et al., (2018)	Similar esthetic and periodontally stable outcomes can be achieved and maintained with either approach over more than five years, as long as correct 3D implant positioning is used and the patient has at least a 2mm vestibular bony wall and a thick gingival biotype.

Periodontal assessment

Assessment of periodontal status in terms of tooth mobility showed no statistically notable variation between the two treatment methods. Probing depth was studied by De Marchi et al. and Jamilian et al.; however, only the reports of

Jamilian et al. indicated a statistically significant elevation in probing depth in the implant group, with 12 replaced teeth showing increased probing depth of more than 3mm. The above-mentioned authors also evaluated the TMJ symptoms and no statistical difference was

found amongst the implant and orthodontic space closure groups.

Interestingly, one of the studies reported significant infra-occlusion in the implant group and recession in the orthodontic space closure group.

Esthetic evaluation

On evaluation of patient's perception through VAS scale, no statistically significant difference was discovered between the studies. One study had assessed modified Pink Esthetic Score (PES) and White Esthetic Score (WES) that revealed good acceptability in the implant group. Overall, patients were almost equally satisfied with both implant and substituted canine treatments.

Temporomandibular joint assessment (TMJ)

Of the three selected studies for this review, two had assessed the TMJ on the basis on headache symptoms, tenderness while chewing and joint noises. Neither of the studies showed any statistically meaningful difference between the canine substitution and the implant group, concluding that neither treatment modalities had caused any TMJ abnormalities.

4. Discussion

According to a recent meta-analysis by Mattheeuws et al., the tendency for the prevalence of hypodontia has increased in the twentieth century and congenitally missing lateral, being a common and esthetically important issue, needs to be addressed (15). The prosthodontic choices presently at hand for the substitution of absent teeth include traditional fixed partial dentures, resin bonded fixed partial dentures, removable partial dentures and Osseo-integrated implants (16-18). Although there are many options for treating congenitally missing lateral incisors, canine replacement and implant substitution are the most common ones. The best possible treatment should be the most conservative option that gives the optimum esthetic results as well as assuring functional requirements.

To start with a case of congenitally missing lateral incisor, the orthodontist usually has the most important role in the diagnosis and treatment of these cases. Patient's age and expectation of treatment results are of utmost importance as canine substitution by closing the space via orthodontic forces is achieved earlier than waiting for the patient to reach adolescence for the placement of implants. Otherwise unavoidable consequences, including infra-occlusion, were evident in many of the earlier studies (8,9), despite the fact that

significant improvements have been achieved in implantology, mucogingival surgery, abutment design and prosthodontic materials (19). Whereas in treatment with canine substitution, the amount of space required for substituting the absent lateral incisors is decided by two elements. Firstly, the esthetics of the mesiodistal width of teeth in the anterior region should be considered, the relationship between the width of the lateral and central incisors must be according to the golden proportions (20). Occlusion is the second element that has an effect on the amount of space required. Achieving adequate intercuspation as well as aligned midlines and normal overbite and overjet relationships should give us the optimum space for a prosthetic lateral incisor with satisfactory esthetics (21). Moreover, an additional restorative procedure is usually required to recreate favorable lateral incisor esthetics. According to literature (22), the main benefit of orthodontic approach is the stability of the final outcome.

In contrast, in cases where implants are considered for the treatment plan, the size of the implant indicates how much space is required to be created. The standard Brånemark implant that has been created for supporting dentures and bridges and not designed for replacing one tooth, has a diameter of 3.75 mm (23). The least amount of space necessary for the placement of a 3.7 mm implant with good periodontal support would be around 6mm. Should the present space be less, the implant placement would be hazardous and obtaining a healthy periodontal support is sometimes impossible (24).

Our systematic review revealed that both treatment modalities of implant substitution and OSC had comparable results, indicating that no notable variation was found between the included studies regarding periodontal considerations, esthetic evaluation and TMJ abnormalities.

Although newer progresses in the field of restorative dentistry would require the reassessment of our management techniques regarding these cases (19), canine replacement by means of orthodontic space closure can be considered as an acceptable treatment option for congenitally cases of absent maxillary lateral incisors (CMMLI). In this case, patient selection should depend on the malocclusion type, profile, canine shape and color and smiling lip level. Evaluation of these factors before the treatment is required in order to achieve the best results as well as favorable esthetics (8).

When implant replacement is considered, the treatment choice varies based on occlusion,

anterior relationships, space requirements, and the condition of neighboring teeth (25-27).

The recent review article on the treatment of congenitally absent lateral incisors by Datta R states that the assessment of the extent of space required for the absent lateral incisor is a crucial factor among all treatment choices (28). Furthermore, it is also advised that in patients with the absence of maxillary lateral incisor on one side, removal of a the other small or peg-shaped lateral and then closing the space on both sides would be considered as an alternative (29). Nevertheless, the recent contemporary review by Gupta S and Rauniyar S (2021) reports that space closure with canine mesialization seems to be a more conservative option, which can be accomplished sooner with stable results (30).

Limitations

This study included literature published in English language only; perhaps including research articles in other languages would have provided additional evidence to the current systematic review. Nevertheless, the issue needs to be further investigated using controlled clinical studies in order to clarify the best approach that satisfies our patients' needs in the future, substituting canines in the place of lateral incisors in the esthetic zone or the use of implants. The choice should be clarified to the patients and meet their expectations. Meta-analysis could not be performed since the available studies allowed us to make only qualitative assessments and no direct quantitative comparison could be made amongst the selected studies.

Conclusion

The missing of upper lateral incisor develops an aesthetic issue that can be treated in different ways. The conclusions that can be derived from the present systematic review:

- There was no gross difference between closing the space orthodontically and prosthetic replacement with implant for the management of absent upper lateral incisors.
- Both treatment modalities are equally competent in achieving an adequate esthetic harmony in the patients.
- No signs and symptoms of TMJ ill health were noticed in either of the groups.
- There are possibilities of infra-occlusion in case of prosthetic replacement of congenitally missing lateral incisors by using implants in children and gingival recession in case of

orthodontic canine substitution in place of the missing lateral incisor.

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