



REVIEW ARTICLE

# Successful treatment modalities for missing lateral incisors– A systematic review

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Received 22 June 2021; revised 28 June 2021; accepted 4 July 2021  
 Available online 14 July 2021

**KEYWORDS**

Missing lateral incisor;  
 Orthodontic space closure;  
 Prosthesis

**Abstract Background:** Effective management of Missing lateral incisor has remained a challenge for the clinicians. A multi-disciplinary approach involving orthodontist, restorative dental specialist, pediatric dental specialist, periodontist, oral surgeon and general dentist has proved ideal. Our aim is to review the ultimate esthetic success, and long term survival results between the orthodontic and restorative management of missing lateral incisor.

**Materials and methods:** Following the PRISMA guidelines, a systematic review of the published articles pertaining to the topic of interest was done. Searches were carried out in four different databases since February 2021 to April 2021.

**Results:** A total of 580 references were found from searches conducted in PubMed, Scopus, Cochrane and Web of Science, and 19 articles were selected and analyzed fully, after screening the title and abstract, 6 articles were included for the study.

**Conclusion:** An essential orthodontic space closure in combination with modern aesthetic prosthetic tooth replacement techniques has been reported to achieve greater success.

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Peer review under responsibility of King Saud University.



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## 1. Introduction

Esthetic management of Missing lateral incisor has remained a great challenge for the clinicians from time immemorial. Hypodontia usually has a genetic basis and often a high proportion of affected individuals have a family history of hypodontia or associated dental Orthodontic anomalies (Al-Ani et al., 2017), Mutation in transcription factors (Javed, Ramalingam et al., 2014) MSX1, PAX9 and AXIN 2 have been identified in families with an autosomal dominant oligodontia (Tallon-Walton et al., 2014). Normally, teeth which are end of series are more commonly absent e.g. lateral incisors, second premolars and third molars (Lammi et al., 2004). Hypodontia is also often seen in patients presenting with syndromes such as ectodermal dysplasia, Down's syndrome and hemifacial microsomia and in non-syndromic conditions such as cleft lip and palate (Pagán-Collazo et al., 2014). However, familial hypodontia is complex and multifactorial; influenced by a combination of gene function, environmental interaction and developmental timing (Lammi et al., 2004). Woolf presented data on anomalies associated with agenesis of the maxillary lateral incisor, such as peg laterals (Zheng et al., 2021). Bailit stated that except for the maxillary lateral incisors, tooth sizes are fairly symmetrical bilaterally and when a maxillary lateral incisor is missing, it is most likely the left one (Zheng et al., 2021). Arte et al. also found strong genetic relationships between hypodontia and tooth anomalies such as ectopic maxillary canines (Al-Ani, Antoun et al., 2017).

Environmental factors which leads to arrested tooth development may include factors that cause failure of tooth bud cell proliferation from the dental lamina (Al-Ani et al., 2017). This may be due to infection (e.g. rubella, osteomyelitis), trauma in the dental region such as fractures, surgical procedures on the jaw and extraction of the preceding primary tooth, drugs (eg. thalidomide), chemotherapy or radiotherapy at a young age (Al-Ani et al., 2017). The prevalence of hypodontia in the primary dentition is about 0.5% and range from 3.5 to 6.5% in the permanent dentition in Caucasians, with females outnumbering males by a ratio of 3:2 (Pagán-Collazo et al., 2014). Moreover, it has been reported that bilateral agenesis of the maxillary lateral incisor is more frequent than the unilateral one (Richardson and Russell, 2001). Maxillary lateral incisors are more commonly missing than mandibular incisors in Caucasians (Rédua and Rédua, 2018). Al-Emran et al studied the prevalence of hypodontia and peg shaped maxillary lateral incisors in 500 male students within the age range 13 – 14 years in Saudi Arabia (al-Emran, 1990). The agenesis of maxillary lateral incisors was reported as 0.6% and peg-lateral incisor was observed in 4% of the sample (al-Emran, 1990). Salama and Abdul-Majeed also reported a similar prevalence of

hypodontia and peg shaped maxillary lateral incisors in 1300 Saudi Arabia male students within the age range of 5 – 10 years (Salama and Abdel-Megid, 1994).

Al-Hummayani carried out a study to determine the prevalence of congenital absence and malformation of maxillary lateral incisors in 1500 Saudi Arabian female students with an age range of 11 – 19 years (Yemitan et al., 2017). The findings indicated that, agenesis of maxillary lateral incisors were present in 0.7% and peg shaped lateral incisors were observed in 2% of the sample (Yemitan et al., 2017). Surveys have shown that a very high proportion of children with severe hypodontia have reported functional and psychosocial impacts as a result of developmentally missing teeth (Robertsson and Mohlin, 2000). Excessive spacing and compromised aesthetics becomes a focus for bullying in school and may lead to psychosocial implications in children, such as depression, loneliness, anxiety, low self-esteem and underachievement (Salama and Abdel-Megid, 1994). Effective counseling will help the victims and the family overcome this and prepare themselves for the complex management of this condition (Scher, 1990).

Early detection of developmentally missing incisors associated with dental anomalies and developing malocclusion is important for interceptive and comprehensive treatment with the respective specialists (Tanimoto et al., 2010). Effective counseling can help the family accept multi-disciplinary treatment and improve patient satisfaction (Xu and Tan, 2015). Continuance for follow up visits is important for long-term success and patient satisfaction (Xu and Tan, 2015).

A multi-disciplinary approach involving orthodontist, restorative dental specialist, pediatric dental specialist, periodontist, oral surgeon and general dentist is ideal in these patients (Kuroda et al., 2014). In the previous studies, judging of smile aesthetics in space-closed and space-opened cases vary between and within groups of dentists, orthodontists, dental specialists and layman (Kiliaridis et al., 2016). The decision to open or close space should be made early and restorative procedures for space opening explained in advance to the patient (Park et al., 2010). Spaces may be restored by auto-transplantation of premolars, removable dentures or interim bridge until growth completion of the patient when final restorations are done (Pisek et al., 2013). Space closure may or may not involve fixed appliance treatment. If implants are planned as the final restoration, the timing for implantation should be close to the end of orthodontic treatment (Scher, 1990; Aljhani and Zawawi, 2010). In the meantime the alveolar bone may be preserved by retaining the primary tooth (Sheerah et al., 2019). Conventional porcelain fused to metal bridge is usually not recommended in young patients because of the large amount of tooth reduction required in teeth with young pulps (Jahanbin et al., 2010). Our aim is to review the ultimate success, esthetic and long-term survival results

between the orthodontic and restorative management of missing lateral incisor.

## 2. Materials and methods

This systematic review followed the criteria established by PRISMA (Moher et al., 2009), and the search criteria and organizations have been depicted as a PRISMA CHART (Fig. 1).

### 2.1. Inclusion criteria

Design of studies reported as randomized clinical trials (RCT) that followed the Consort recommendations.

### 2.2. Exclusion criteria

Studies on treatment methods for management of missing lateral incisor other than orthodontic space closure and prosthetic replacements, studies without follow-up of patients and studies with conflict of interest were excluded.

### 2.3. Search strategies

Searches were carried out in four different databases since February 2021 to April 2021, with no publication date restrictions of the articles: The electronic Medline/Pubmed, CENTRAL (Cochrane Central Register of Controlled Trials), Web of Science and LILACS (Latin American and Caribbean

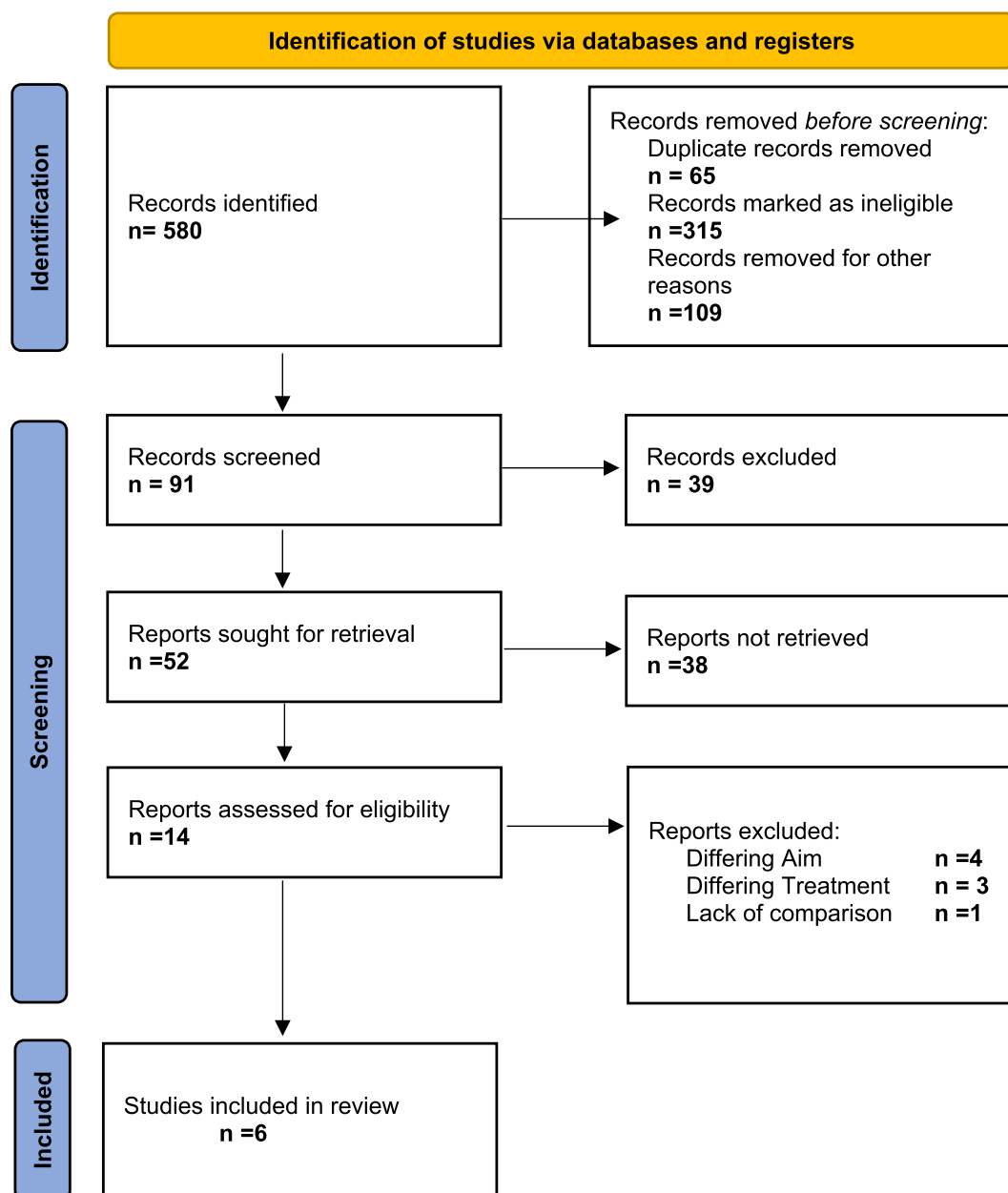


Fig. 1 PRISMA CHART.

Health Sciences Literature/Virtual Healthy Library). The supplementary hand-search was performed by checking the list of references of studies included in the review or in previous reviews. The search was also carried out in international databases for theses and dissertations: *ProQuest Dissertations & Theses Database*. The search strategy has been properly adapted for each database and assessed to identify the eligible studies.

2.4. Selection of studies

The articles were screened according to the inclusion and exclusion criteria (Fig. 1). Titles and abstracts were initially evaluated and the studies appearing to meet the inclusion criteria, the full reports were obtained and independently assessed. The initial search terms included “congenitally missing lateral incisors”, “Missing lateral incisors”, “Mini implants”, “Treatment protocols”.

3. Results

A total of 580 references were found from searches conducted in PubMed, Scopus, Cochrane and Web of Science, and 19 articles were selected and analyzed fully, after screening the title and abstract. Six references were excluded due to the lack of comparison between the treatment options. Three other articles were excluded because: it was case reports, and did not compare the orthodontic treatment with cosmetic replacements. The search strategy is detailed in the flow diagram (Fig. 1).

The inter-examiner test (kappa) presented a total score of 0.82 for PubMed/MEDLINE; 0.90 for Scopus and 0.93 for The Cochrane Library. Data were extracted from each study: authors and year of publication, treatment of choice, details of the interventions (Table 1). Based on the design of the selected studies, their quality was assessed following the recommendation by *Cochrane Reviewers Handbook 5.1.0*.

**Table 1** Enumeration of the salient features of the reviewed studies.

Author	Year	Title	Aim of research	Research results
Kiliaridis, S., et al.	2016	Treatment options for congenitally missing lateral incisors	To examine maxillary lateral incisor agenesis treatment, by either orthodontic space closure by canine mesial repositioning and reshaping, or by a prosthodontic intervention, in order to compare the biological, functional and aesthetic outcomes of these two approaches	Both therapeutic options are effective. However, it seems that the orthodontic space closure, whenever this is possible, is advantageous over the prosthodontic rehabilitation.
Mangano, C., et al.	2014	Esthetic evaluation of implants placed after orthodontic treatment in patients with congenitally missing lateral incisors.	To evaluate the esthetic outcome of single tooth Morse taper connection implants used to replace congenitally missing lateral incisors after orthodontic treatment by means of the pink esthetic score (PES) and white esthetic score (WES) index	The placement of single-tooth Morse taper connection implants for rehabilitation of congenitally missing lateral incisors after orthodontic treatment represents a successful procedure
Park, J. H., et al.	2010	Orthodontic treatment of a congenitally missing maxillary lateral incisor	How orthodontics is combined with other specialties in treating a congenitally missing lateral incisor.	Patients with missing teeth, crowding, midline deviation, unesthetic gingival contours, or other restorative needs may require the interaction between various specialists. For the successful treatment of orthodontic-restorative patients, an interdisciplinary team effort is vital.
Richardson, G. and K. A. Russell	2001	Congenitally missing maxillary lateral incisors and orthodontic treatment considerations for the single-tooth implant	The central incisor and canine often erupt in less than optimal positions adjacent to the edentulous lateral incisor space, and therefore preprosthetic orthodontic treatment is frequently required.	Derotation of the central incisor and canine, space closure and correction of root proximities may be required to create appropriate space in which to place the implant and achieve an esthetic restoration
Robertsson, S. and B. Mohlin).	2000	The congenitally missing upper lateral incisor. A retrospective study of orthodontic space closure versus restorative treatment	To examine treated patients who had congenitally missing lateral incisors and to compare their opinion of the aesthetic result with the dentists' opinions of occlusal function and periodontal health	Orthodontic space closure produces results that are well accepted by patients, does not impair temporomandibular joint (TMJ) function, and encourages periodontal health in comparison with prosthetic replacements
Thunold, K.	1991	Loss of permanent upper incisors– orthodontic treatment	After loss of permanent central incisors the treatment of choice could be either orthodontic closure or maintenance of the gap for a replacement-prosthetic, autotransplantation or implant.	When one or two central incisors are missing, there will be no treatment alternative giving a 100% satisfactory result. Orthodontic closure, however, proves to be a favourable solution, concerning both long-term prognosis, esthetics and function.

The articles which were finally selected were compared and analyzed, the results of interest were tabulated (Table 1). In a study by Kiliaridis S. et al both orthodontic space closure and prosthodontic intervention were found to be effective. However, orthodontic space closure was reported to be more advantageous in terms of biological functions and aesthetics. In another included study, Mangano C. et al. reiterated the successful esthetic outcome of post orthodontic treatment of single tooth implants for congenitally missing lateral incisor. Further, Park J.H. and Richardson G. enumerate the importance of a multidisciplinary management of missing lateral incisors. In comparison Robertson S. and Thunold K. have greatly advocated orthodontic space closure as a more favorable solution in comparison to prosthetic replacements.

#### 4. Discussion

Anterior hypodontia has a significant effect on the Anterior-Posterior (more retrusive) and vertical skeletal (reduced) relationships as well as the interincisal angle (increased) with increasing severity of the hypodontia (Bukhary, Bukhary et al., 2021). Therefore, a careful examination of the clinical features must be performed to obtain all information necessary for proper treatment planning (Nguyen, 2010). Extra-oral examination includes a Facial Analysis to identify adverse skeletal patterns in sagittal, transverse and vertical dimensions (Messina et al., 1999). A convex soft tissue profile is usually an indication for space closure; whereas space opening in the maxillary arch is favored in patients with a concave profile (Park et al., 2010). Other parameters include, a high smile line, color matching, size and possible reshaping of the canine replacing the missing incisor as well as labial gingival contours and canine root prominence become more important (Felicita, 2017).

Aesthetic values may not be the same between different clinicians and patients. Orthodontist plays a key role in determining and establishing space requirement for patient with missing maxillary lateral incisor (al-Emran, 1990). After a careful aesthetic assessment of the incisors in terms of incisor display, gingival levels and the dental midline as well as contour and shade of the anterior teeth has to be given due consideration prior to planning for orthodontic-restorative treatment (Kiliaridis et al., 2016). The panoramic radiograph (OPG) is essential for diagnosis of missing permanent teeth in patients who are 6 years or older (Glaros et al., 2007). Lateral cephalogram radiographs are taken for analysis of skeletal, dental and soft tissue facial components (Glaros et al., 2007). A suitable long-term treatment plan requires knowledge of the presenting and developing skeletal pattern and this can be obtained through cephalometric analysis (Mangano et al., 2014)

Photographs and study casts are usually needed for proper patient assessment and for documentation purposes (Onyeaso, 2004). Diagnostic orthodontic wax-ups of study models are very useful to evaluate different treatment options and aid treatment planning (Onyeaso, 2004). Earlier researches advised no treatment is necessary if there is absence of malocclusion associated with a missing incisor and the patient is happy with his/her esthetics (Habib et al., 2014). Treatment is also not recommended if the patient is unwilling to commit to lengthy and expensive treatment (Park et al., 2010).

Studies have shown strong association of hypodontia with maxillary canine impaction (Kuroda et al., 2014). Although there is inadequate evidence to support routine extraction of primary maxillary canines to facilitate eruption of impacted permanent canines in children, early extraction of the deciduous canine has been advocated in many studies (Alfaleh and Al Thobiani, 2020). To maintain the alveolar bone for future implant placement (Ramalingam et al., 2020) the canine maintains the width and depth of the alveolar bone for insertion of future dental implants (Ramalingam et al., 2015). When the canine is then orthodontically moved distally to create space for the implants, the width and depth of the alveolar bone in the lateral incisor region is maintained (Scher, 1990).

Literature reveals that for natural space closure, allowing the canine to erupt and drift into the lateral incisor position will help to reduce the amount of space to be closed orthodontically in the future (Kiliaridis et al., 2016). This can be recommended if the criteria allows for donor premolars to be donated to the receiver site especially in cases with multiple missing maxillary incisors (Xu and Tan, 2015). In growing children, the transplanted tooth will not only maintain growth and development of the alveolar ridge, but also provide a permanent solution to agenesis of teeth (Tai et al., 2012).

Successfully transplanted premolars appear to continue erupting and aesthetics is good when restored with porcelain veneer crowns or full porcelain crowns (Fig. 2) (Thunold, 1991). Auto-transplanted premolars may act as tooth support for bridges in large-span spaces (Thunold, 1991). Space opening is usually not recommended before the age of 13 years so as to prevent relapse and progression of alveolar bone atrophy. In young patients, anterior spaces due to missing incisors may be closed and redistributed to the posterior regions for implant placement later (Fig. 3). The posterior space may then be restored with interim bridges or bonded retainers while waiting for osseointegrated implants (Mangano et al., 2014). Most evident advantage is the permanence and biological compatibility of the finished dentition when the patient has his/ her own natural dentition with no need for prosthetic replacement (Yemitan et al., 2017).

According to Stefan Robertson, both the treatment groups have a measured normal mandibular movement range, while 18% of his study subjects experienced pain provoked by free mandibular movements, around 38% of them reported deviation of the mandible during opening and closing of the mandible (Robertsson and Mohlin, 2000). However, majority (74%) showed muscle tenderness on palpation with common referred point to lateral pterygoid and insertion of the temporalis (Glaros et al., 2007). Nevertheless, insignificant difference was observed in the clinical signs of TMD between the orthodontic space closure and the prosthetic replacement groups. The periodontal assessment in the same study group showed statistically significant difference in plaque and bleeding points between the central incisors and canines. Further, buccal gingival retraction was observed to have a significant difference between the two groups with enhanced plaque retention in the prosthetic replacement study group.

Richardson et al. states that dental implants are a treatment of choice for most patients with congenitally missing laterals. An implant will preserve tooth structure and alveolar bone and provide esthetics and function (Richardson and Russell, 2001). However, successful restorative treatment involving implants depends on interdisciplinary treatment





**Fig. 2** Pre and post treatment Images of Missing lateral Incisor management with Prosthetic replacement.



**Fig. 3** Pre and post treatment Images of Missing lateral Incisor management with Orthodontic space closure.

planning, especially if pre-prosthetic orthodontic tooth alignment is required (Richardson and Russell,2001). The roots of the teeth adjacent to the edentulous implant region must be parallel or slightly divergent to create sufficient bone (Albeshri et al., 2018) for implant placement, and there must be sufficient space between the crowns to place and restore the implant(Rédua and Rédua,2018).

Interestingly, Park et al. stated that treating congenitally missing lateral incisors, the two major alternatives, orthodontic space closure or space opening for prosthodontic replacements, can both compromise esthetics, periodontal health, and function (Park et al., 2010). If orthodontists and restorative dentists communicate the sequence of treatment, interact during treatment, evaluate dental and gingival esthetics, and

position teeth to facilitate proper restorative treatment, the esthetics and long-term dental health of the patient after all treatment will be greatly enhanced (Park et al., 2010).

## 5. Conclusion

Clinical management of missing lateral incisors, has been successfully performed with either orthodontic space closure or space opening followed by prosthetic replacements. The realistic objectives communicated to the patient with interactions encouraging patient commitment and continuous meticulous follow up are essential for long term success. In addition, Interdisciplinary treatment planning with orthodontic tooth alignment has often proved promising when the adjacent teeth root should be parallel and slightly divergent to create sufficient space for Implant placement. Hence, in combination with the available modern aesthetic dental materials and tooth restorations techniques, orthodontic space closure is an attractive option.

## CRedit authorship contribution statement

**Nasser D. Alqahtani:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Writing - original draft, Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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