European Journal of Prosthodontics and Restorative Dentistry (2019) **27**, 182-188

Dental Factors Influencing Treatment Choice For Maxillary Lateral Incisor Agenesis: A Retrospective Study

Keywords

Orthodontics
Hypodontia
Prosthodontics
Maxillary Lateral Incisor Agenesis
Absent Lateral Incisors

Authors

Aman Ulhaq*
(BDS MFDS MSc MOrth FDS(Orth))

Dr. Patrick Fee§
(BDS MFDS)

Dr. Marialena Cresta*
(BDS MFDS)

Stephen Turner*
(BSc MSc)

Dr. Arindam Dutta*
(BDS MDS MFDS MEndo FDS(Rest Dent))

Address for Correspondence

Aman Ulhaq

Email: aman.ulhaq@nhs.net

* *Edinburgh Dental Institute*

§ *Dundee Dental School*

Received: 06.03.2019
Accepted: 31.07.2019

doi: 10.1922/EJPRD_01792Ulhaq07

ABSTRACT

Objectives: Maxillary Lateral Incisor Agenesis (MLIA) pose significant orthodontic and restorative challenges. The aim of this study was to evaluate dental factors and their effect on decision making for MLIA. Methods: This is a retrospective study of patients who attended the Edinburgh Dental Institute between 2007 and 2016. Patients with unilateral or bilateral MLIA were included. Excusion criteria: inadequate pre-treatment records, hypodontia of additional teeth as well as MLIA, a craniofacial syndrome, previous orthodontic treatment. Archived records were used to record relevant dental features and treatment decisions. The independent variables were age, gender, overjet, molar relationship, space availability for lateral incisors, and canine aesthetics. The dependent variable was treatment outcome (orthodontic space opening or closing). Multiple regression models were used to identify predictors of treatment outcome. Results: 44 patients were included in the study (30 female and 14 male). Mean age was 13.7 (SD 2.3) years. Fifteen patients (34.1%) had space closure and 29 patients (65.9%) received space opening. Space availability was the only significant predictor of treatment outcome within the regression model ($p=0.02$). Conclusions: Presence of adequate space in the maxillary arch is associated with orthodontic space opening for MLIA.

INTRODUCTION

The prevalence of congenitally missing teeth has been reported to range from 2.6-11.3%[1,2] with a variable global distribution.[3] Maxillary lateral incisor agenesis (MLIA) is related to genetic factors[4] and its prevalence is between 1 and 2%.[5,6] It is estimated that 25% of all congenitally absent teeth are maxillary lateral incisors.[7] Different studies report this as being the most common,[8,9] second-,[10] or third-most common congenitally missing tooth.[5] Females are more commonly affected than males by approximately 1.4 times and the condition occurs more commonly bilaterally than unilaterally,[1,11,12] though reports are variable in this context.[13] Aesthetic problems associated with congenital absence of maxillary lateral incisors include unsightly spacing between the central incisor and canine, median diastema, and drifting and rotation of the central incisor and canine. The general mesio-distal width of teeth in patients with hypodontia can also be decreased.[14] The shape of the central incisor teeth is also affected, with reduced widths at the contact points, but not in the cervical thirds,

thus making the teeth more rectangular rather than the usual trapezoidal form.[15] In unilateral MLIA, these effects are asymmetric and may be associated with a centre-line shift to the affected side, while the contralateral tooth is frequently diminutive.[16] MLIA has also been associated with a Class II molar relationship, which is more frequent on the same side as the agenesis.[13]

In patients with MLIA, orthodontic treatment will usually be required either to close space with concomitant reshaping of the canine (canine substitution)[17] or redistribute space to allow for prosthodontic replacement;[18] usually resin retained bridges or implant-retained restorations. Whilst advantages of space closure reduce the need for tooth replacement, the aesthetic outcome may not be suitable for every patient. Conversely, the major drawback for space opening requires the placement of a prosthesis, which places the burden of maintenance, eventual failure, and further replacement, on the patient and the dental team. Therefore, the patient must be managed with an overall treatment plan which prioritises aesthetics and long-term dental health. Treatment planning can depend upon several factors such as the molar and incisal relationships, the patient's lip line and smile line, amount of space available, features of the canine tooth and its relationship with the central incisor, including gingival height. Studies have not established which factors are most significant when decisions are made with the patient. This study aimed to evaluate the effect of dental factors and their influence on decision-making for the hypodontia patient with unilateral or bilateral MLIA.

MATERIALS AND METHODS

A retrospective study was carried out to identify hypodontia patients attending the Edinburgh Dental Institute between January 2007 and June 2016 using the hospital patient archive system, Software of Excellence Health (Henry Schein, Melville, NY, USA). Patients were included if they had one or both maxillary lateral incisors missing, and had been treatment planned by the hypodontia multi-disciplinary team. Patients were excluded on the following basis:

1. Inadequate pre-treatment records
2. Hypodontia affecting additional teeth other than the maxillary lateral incisors
3. Craniofacial syndromes
4. Patients who had received a previous course of orthodontic treatment

Baseline data was collected using the electronic patient records and the following information was recorded by two assessors [AU and AD] for each patient using the pre-treatment orthodontic study casts and clinical photographs:

1. Overjet (mm)
2. Molar relationship (Angle's classification)[19]
3. Space availability for the missing lateral incisor(s) was determined by measuring the arch perimeter as described by Adkins *et al.*[20] *(Figure 1)*. The individual tooth widths were subtracted from the arch perimeter including the missing lateral incisor(s) which were estimated to be of 6.5 mm in width. If there was less than 4.5 mm of space within the arch perimeter for each missing lateral incisor, then the space available was seen to be inadequate.
4. Canine aesthetics
   a. Prominence of labial ridge
   b. Definition of cusp tip

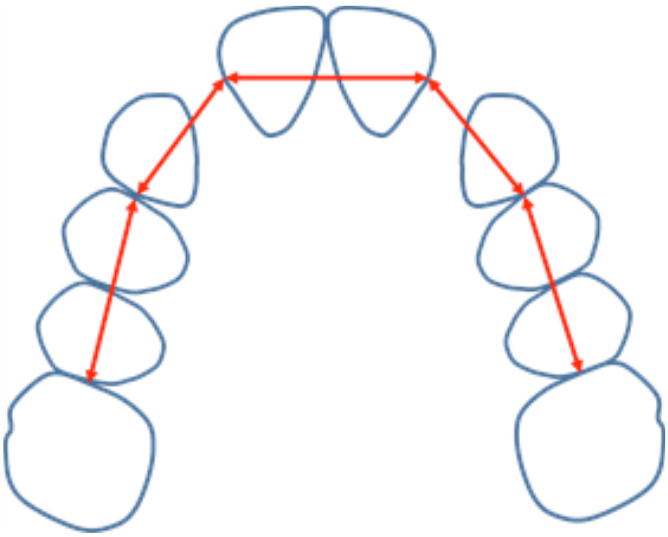

Figure 1: Arch perimeter measurement for space analysis

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM SPSS Statistics version 22 (IBM Corporation, Armonk, North Castle, NY, USA). Descriptive statistics were used for baseline data. The independent variables were age, gender, overjet, molar relationship, space availability for lateral incisors, canine ridge prominence, and definition of canine cusp tip. The dependent variable was treatment outcome.

Tests of proportions of dichotomous predictor variables between the two outcome groups were conducted using Fisher's exact or Chi-square tests. An unpaired t-test was used for age *(Table 1)* when normality of data had been confirmed with Levene's test. Multivariate analysis (logistic regression) was used to control for patient age and gender as potentially confounding factors and to identify any statistically significant predictors among the orthodontic variables. The variable entry criterion used in model building was the size of the Wald statistic. Statistical significance was set at the α=0.05 level.

ejprd.org - Published by Dennis Barber Journals.

Table 1. Demographic characteristics of study participants by treatment group

		Space Opening (n=29)	Space Closure (n=15)	Total (n=44)	P-value
Gender	Male	9 (31.0%)	5 (33.3%)	14 (31.8%)	P=1.00
	Female	20 (69.0%)	10 (66.7%)	30 (68.2%)	
Age in years (SD)		13.4 (2.6)	14.3 (1.4)	13.7 (2.3)	P=0.26
Age in years (SD)/Gender	Male	N=9 12.7 (2.1)	N=5 15.2 (0.7)	N=14 13.6 (2.2)	P=0.03
	Female	N=20 13.8 (2.8)	N=10 13.8 (1.3)	N=30 13.8 (2.4)	P=1.00

RESULTS

Eighty-eight patients were initially identified as having congenitally absent maxillary lateral incisors. Forty-four patients were excluded based on the study criteria, leaving 44 patients included with at least one unilateral congenitally missing lateral incisor (*Figure 2*). Thirty were female and 14 were male, with a mean age of 13.7 years (SD 2.3 years) (*Table 1*). Twenty-one patients (47.3%) had bilateral missing lateral incisors and 23 (52.3%) had a unilateral missing lateral incisor. Of the 23 patients with unilateral missing lateral incisors, 20 patients (87.0%) had a diminutive lateral incisor on the contralateral side. Fifteen patients (34.1%) had space closure and 29 patients (65.9%) received space opening. There was a significant interaction effect between gender and age and the treatment outcome: boys in the space closure group were on average two and one-half years older than boys in the space opening group (p=0.03), while no such difference was found for girls.

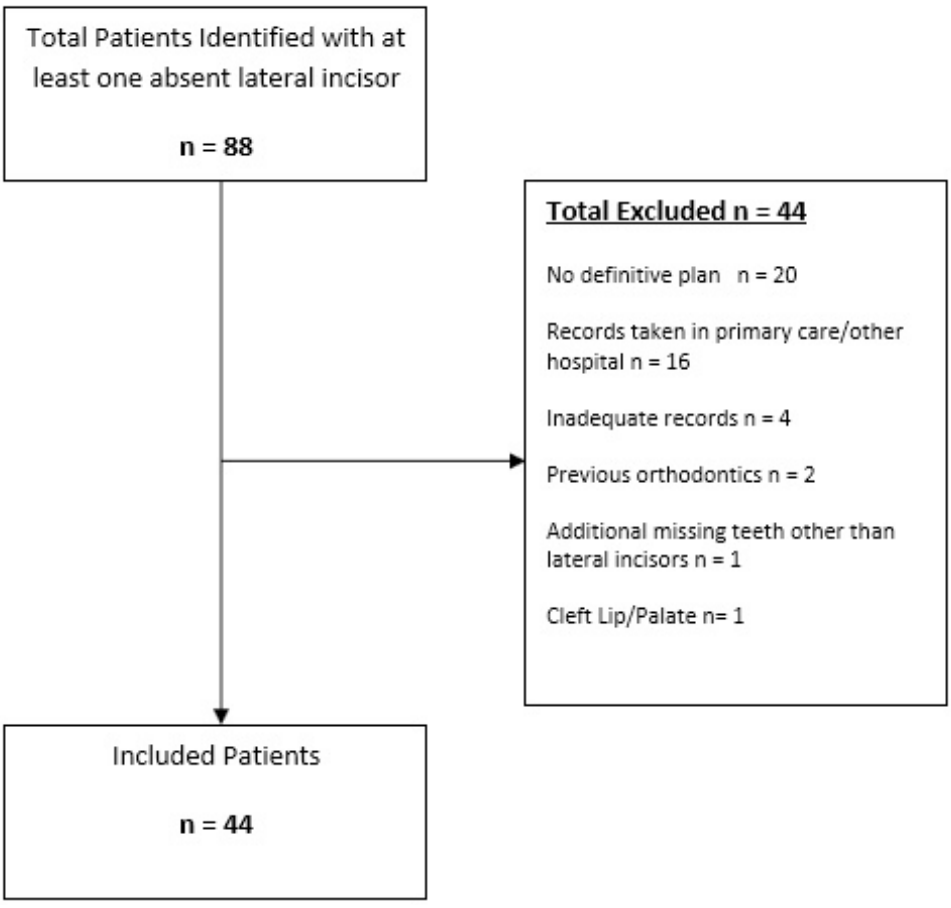

Figure 2: Study Flow Diagram

The distribution of the patients in relation to the orthodontic variables is shown in table 2. Univariate analyses were carried out using Chi-square and Fisher's Exact tests to assess statistical significance. The relationship of the following independent variables with the outcome was not statistically significant: overjet (p=0.65), molar relationship (p=0.14), canine ridge (p=1.00), and canine cusp tip (p=0.65). For the space availability variable, there was a statistically significant difference between the space closure and space opening groups (p=0.01)

As two variables (canine cusp and canine ridge) had missing data for two cases and had no significant relationship with the outcome measure, the logistic regression analysis was run without these variables in order to increase the number of cases analysed from 42 to 44.

The results of the logistic regression showed that the only orthodontic variable that appears to have an impact on the treatment outcome for this group of patients is the space availability dichotomy (p=0.02, R2=0.23) *(Table 3)*. The other variables in the model were not significant, but contributed to the accurate prediction of treatment option. The model predicted 32 of the 44 cases correctly for the treatment option selected in these cases (72.7%). The level of prediction was similar for both the space opening (72.4%) and space closure (73.3%) cases *(Table 4)*. Figure 3 shows the receiver operating characteristic (ROC) curve: the cut-off value is 0.40 and the area under the curve of the ROC graph is 0.79 (p=0.002, 95% CI:0.63–0.93). This shows that the model has 'fair' predictive ability for outcomes.

When the 2 cases that were initially removed in the analysis were included the model correctly predicted 29 of 44 cases (65.9%, R2=0.20).

DISCUSSION

The management of patients with MLIA has involved either space closure and canine substitution or space opening and prosthodontic replacement with a suitable prosthesis, though neither approach has been found better.[21] One potential reason for this lack of clarity is the absence of high quality evidence in the literature,

Table 2. Clinical characteristics of study participants by treatment group

		Space Opening 29		Space Closure 15		Total	
		Unilateral 16	Bilateral 13	Unilateral 7	Bilateral 8	Unilateral 23	Bilateral 21
Incisor Classification	I	5	9	4	1	9	10
	II Div 1	5	1	1	1	6	2
	II Div 2	2	0	1	4	3	4
	III	4	3	1	2	5	5
Overjet	≥ 2mm	13	10	6	5	19	15
	< 2mm	3	3	1	3	4	6
Molar Classification	Class I	10	8	3	3	13	11
	Class II	5	4	4	5	9	9
	Class III	1	1	0	0	1	1
Space available for lateral (s)	Adequate	9	7	1	1	10	8
	Inadequate	7	6	6	7	13	13
Canine Ridge*	Prominent	12	10	4	7	16	17
	Flat	3	3	2	1	5	4
Canine Cusp*	Defined	13	11	6	7	19	18
	Undefined	2	2	0	1	2	3

*missing data for 2 subjects

Table 3. Logistic Regression Model

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Age	.272	.170	2.566	1	.109	1.313
Gender	-.880	.876	1.009	1	.315	.415
Space Availability	2.530	1.093	5.352	1	.021	12.548
Molar Relationship	-.377	.809	.218	1	.641	.686
Overjet	-.321	.866	.138	1	.711	.725
Constant	-5.305	2.860	3.441	1	.064	.005

Table 4. Predicted and observed cases

		Predicted		
		Space Opening	Space Closure	Percentage Correct
Observed	Space Opening	21	8	72.4
	Space Closure	4	11	73.3

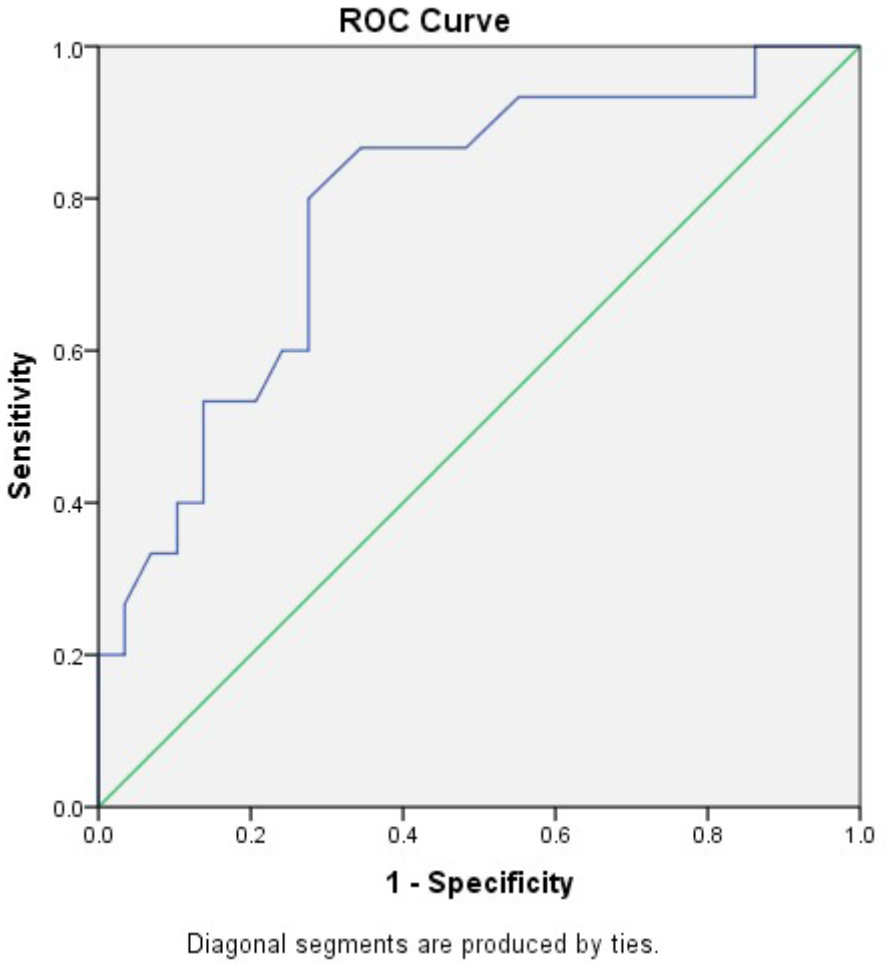

Figure 3: Receiver operating characteristic (ROC) curve derived from the regression model

with consensus statements therefore recommending a joint orthodontic-restorative approach through multidisciplinary treatment planning clinics;[22] which is the standard protocol within the United Kingdom. The influence the clinic setting has indeed determined the type of treatment choices that are made for the patient,[23] with an increased tendency for space closure with an orthodontic-only input and space opening at the MLIA sites, when a restorative input was available to the orthodontist. This has been borne out in the results of our study wherein the only significant factor that influenced decision making for the patient was the amount of space available in the dentition. Space opening itself comes with several challenges that influence the future direction of treatment: most importantly, the amount of bone that is available at the lateral incisor site. In the MLIA patient, this has been found deficient following space opening with a 17-25% deficit (2-10mm) along the height of the ridge and a significant labial concavity in the bone, both of which necessitate additional surgery in term of bone grafting to augment the sites[24] and using small diameter implants to support the restorations, the latter demonstrating marginal bone stability and soft tissue outcomes.[25] The best alternative in terms of MLIA tooth replacement regarding cost effectiveness has been found to be autotransplantation,[26] though this is not a common choice in the UK. Resin bonded bridges (RBB) are reasonably successful in the hypodontia patient with a mean survival of approximately 5 years[27] but are slightly less cost effective than cantilever fixed partial dentures.[26] However, the biological cost of a RBB is much less as compared with conventional bridgework, and is increasingly being chosen as a readily available & easily provided modality of treatment within the National Health Service. The failure of RBBs is usually associated with debonding, which does not affect teeth on either side of the missing gap. Other more invasive options can be chosen if the RBB tends to fail repeatedly.

Surveys have shown that patient who have space closure and canine recontouring are perceived as having the best aesthetic results.[28–32] Furthermore, MLIA treated with canine intrusion and substitution as a lateral incisor, as well as first premolar extrusion and substitution into the canine position has shown to have no detrimental effect on the periodontium or temporomandibular joint.[33] Although space closure does appear to have many benefits, space opening with prosthetic replacement may also be a suitable alternative.[18] It has also been shown that the aesthetic result produced when space opening with tooth replacement in MILA cases is preferred over the space closure option, however the authors did note that the methodology used in this study may not be reliable.[34] Implant based-prosthodontic treatment requires life-long maintenance and issues such as thin gingival biotype, grey show-through of the implants, development of peri-implantitis, and mechanical issues with implant prosthetics will require further treatment following the provision of restorations. Our study has shown that the influence of canine morphology did not play a significant role in decision-making, though space was more frequently opened in patients who had a prominent canine cusp tip. Space was more commonly opened than closed for our patient cohort, and unilateral/bilateral MLIA did not influence this choice. The occlusal patterns themselves did not influence the direction of treatment either, even though traditional approaches have resulted in space opening in patients with a class III incisors and space closure in class II incisor relationships. However, dentofacial orthopaedics (protraction facemask therapy) can be used for class III relationships, and functional appliances can be used for the correction of class II sagittal relationships, thus reducing the influence of this factor on younger patients with growth potential. Temporary anchorage can be used to distalise upper molars or maintain upper incisor position, when deciding to open or close space.

This study focused on dental factors and we were unable to assess the influence of patient related factors on the treatment of choice. Maintenance for prosthetic restorations of any kind is life-long. Those who feel that the financial burden of future maintenance is too great may opt for the space closure option. Our study suggests that male patients who had space closure were over two years older than those who had space opening; this may reflect that older adolescents may have a greater awareness of the potential financial implications of having prosthetic restorations. 'Gatekeeping' factors such as cost and dental anxiety have been noted as barriers to patients' uptake of dental implant treatment.[35] Studies have also shown that patients may have misconceptions regarding dental implants; in particular they overestimate their lifespan and underestimate the clinical skill level required to place and restore them.[36] Patients and their parents may see implants as the ideal solution for their problem and this may be a driving factor towards the space opening approach. Understanding patient expectations is important in helping them engage with the treatment process and delivering high quality clinical care. The development of appropriate assessment tools may aid in this process.[37,38] In addition, the opinion from dentists can be seen as the most important influence on the patient's decision,[35] and certain clinical teams may prefer a particular clinical approach in the absence of robust evidence in the favour of alternatives.

A further limitation of our study may be that we used an estimated value of 6.5mm for the lateral incisors, however the size of the central incisors and canines would influence the amount of space required for the absent lateral incisor. Future research should incorporate clinical and patient related measures in assessing decision making for the management of MLIA. Decision making should be scrutinised with long-term follow-up studies looking at patient related outcome measures and success rates of restorations where applicable. Prospective studies with larger sample sizes will be able to add valuable evidence in this field.

CONCLUSIONS

Space opening was the preferred treatment of choice within this study sample. The space availability within the dental arch was a significant dental factor in predicting the treatment of choice for the management of MLIA. Adequate space availability within the dental arch was predictive of the space opening approach. Overjet, molar relationship, and canine aesthetics were not predictive of the treatment decision.

REFERENCES

1. Polder BJ, Van't Hof MA, Van der Linden FPGM, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. *Community Dent Oral Epidemiol* 2004;**32**:217–226.
2. Larmour CJ, Mossey PA, Thind BS, Forgie AH, Stirrups DR. Hypodontia--a retrospective review of prevalence and etiology. Part I. *Quintessence Int* 2005;**36**:263–270.
3. Khalaf K, Miskelly J, Voge E, Macfarlane T V. Prevalence of hypodontia and associated factors: a systematic review and meta-analysis. *J Orthod* 2014; **41**:299–316.
4. Alves-Ferreira M, Pinho T, Sousa A, Sequeiros J, Lemos C, Alonso I. Identification of genetic risk factors for maxillary lateral incisor agenesis. *J Dent Res* 2014;**93**:452–458.
5. Robertsson S, Mohlin B. The congenitally missing upper lateral incisor. A retrospective study of orthodontic space closure versus restorative treatment. *Eur J Orthod* 2000; **22**:697–710.
6. Zilberman Y, Cohen B, Becker A. Familial trends in palatal canines, anomalous lateral incisors, and related phenomena. *Eur J Orthod* 1990;**12**:135–139.
7. Fekonja A. Hypodontia in orthodontically treated children. *Eur J Orthod* 2005;**27**:457–460.
8. Nik-Hussein NN. Hypodontia in the permanent dentition: a study of its prevalence in Malaysian children. *Aust Orthod J* 1989;**11**:93–95.
9. Lynham A. Panoramic radiographic survey of hypodontia in Australian Defence Force recruits. *Aust Dent J* 1990;**35**:19–22.
10. Rakhshan V. Meta-Analysis of Observational Studies on the Most Commonly Missing Permanent Dentition (Excluding the Third Molars) in Non-Syndromic Dental Patients or Randomly-Selected Subjects, and the Factors Affecting the Observed Rates. *J Clin Pediatr Dent* 2015;**39**:199–207.
11. Stamatiou J, Symons AL. Agenesis of the permanent lateral incisor: distribution, number and sites. *J Clin Pediatr Dent* 1991;**15**:244–246.
12. Aasheim B, Ogaard B. Hypodontia in 9-year-old Norwegians related to need of orthodontic treatment. *Scand J Dent Res* 1993;**101**: 257–260.
13. Pinho T, Lemos C. Dental repercussions of maxillary lateral incisor agenesis. *Eur J Orthod* 2012;**34**:698–703.
14. Fekonja A. Comparison of mesiodistal crown dimension and arch width in subjects with and without hypodontia. *J Esthet Restor Dent* 2013;**25**:203–210.
15. Olivadoti A, Doldo T, Treccani M. Morpho-dimensional analysis of the maxillary central incisor clinical crown in cases of congenitally missing upper lateral incisors. *Prog Orthod* 2009;**10**:12–19.
16. Lai PY, Seow WK. A controlled study of the association of various dental anomalies with hypodontia of permanent teeth. *Pediatr Dent* 1989;**11**:291–296.
17. Zachrisson BU, Rosa M, Toreskog S. Congenitally missing maxillary lateral incisors: Canine substitution. *Am J Orthod Dentofac Orthop* 2017;**139**: 436.
18. Kokich Jr. VO, Kinzer GA, Janakievski J. Congenitally missing maxillary lateral incisors: Restorative replacement. *Am J Orthod Dentofac Orthop* 2017;**139**:437.
19. Angle EH. Classification of malocclusion. *Dent Cosm* 1899;**41**:248–264.
20. Adkins MD, Nanda RS, Currier GF. Arch perimeter changes on rapid palatal expansion. *Am J Orthod Dentofac Orthop* 1990;**97**:194–199.
21. Andrade DCM, Loureiro CA, Araujo VE, Riera R, Atallah AN. Treatment for agenesis of maxillary lateral incisors: a systematic review. *Orthod Craniofac Res* 2013;**16**:129–136.
22. Johal A, Katsaros C, Kuijpers-Jagtman AM. State of the science on controversial topics: missing maxillary lateral incisors--a report of the Angle Society of Europe 2012 meeting. *Prog Orthod* 2013;**14**:20.
23. Louw JD, Smith BJ, McDonald F, Palmer RM. The management of developmentally absent maxillary lateral incisors--a survey of orthodontists in the UK. *Br Dent J* 2007;**203**:E25; discussion 654-5.
24. Uribe F, Padala S, Allareddy V, Nanda R. Cone-beam computed tomography evaluation of alveolar ridge width and height changes after orthodontic space opening in patients with congenitally missing maxillary lateral incisors. *Am J Orthod Dentofacial Orthop* 2013;**144**: 848–859.
25. King P, Maiorana C, Luthardt RG *et al.* Clinical and Radiographic Evaluation of a Small-Diameter Dental Implant Used for the Restoration of Patients with Permanent Tooth Agenesis (Hypodontia) in the Maxillary Lateral Incisor and Mandibular Incisor Regions: A 36-Month Follow-Up. *Int J Prosthodont* 2016; **29**:147–153.
26. Antonarakis GS, Prevezanos P, Gavric J, Christou P. Agenesis of maxillary lateral incisor and tooth replacement: cost-effectiveness of different treatment alternatives. *Int J Prosthodont* 2014;**27**:257–263.
27. Garnett MJ, Wassell RW, Jepson NJ, Nohl FS. Survival of resin-bonded bridgework provided for post-orthodontic hypodontia patients with missing maxillary lateral incisors. *Br Dent J* 2006;**201**:527–34; discussion 525.
28. Hvaring CL, Ogaard B, Birkeland K. Tooth replacements in young adults with severe hypodontia: Orthodontic space closure, dental implants, and tooth-supported fixed dental prostheses. A follow-up study. *Am J Orthod Dentofacial Orthop* 2016;**150**:620–626.
29. 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**:416–424.
30. Silveira GS, de Almeida NV, Pereira DMT, Mattos CT, Mucha JN. Prosthetic replacement vs space closure for maxillary lateral incisor agenesis: A systematic review. *Am J Orthod Dentofacial Orthop* 2016;**150**:228–237.
31. 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**:137–146.
32. De-Marchi LM, Pini NIP, 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**:540–546.
33. 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**:339–348.
34. Barber SK, Houghton N, Spencer RJ. Limitations of a method used for adolescent assessment of smile aesthetics. *Eur J Orthod* 2015;**37**:135–141.
35. Narby B, Hallberg U, Bagewitz IC, Soderfeldt B. Grounded theory on factors involved in the decision-making processes of patients treated with implant therapy. *Int J Prosthodont* 2012;**25**:270–278.
36. Wang G, Gao X, Lo ECM. Public perceptions of dental implants: a qualitative study. *J Dent* 2015;**43**:798–805.
37. Gassem A Ben, Foxton R, Bister D, Newton T. Development of a measure of hypodontia patients' expectations of the process and outcome of combined orthodontic and restorative treatment. *J Dent* 2016;**55**:114–120.
38. Akram AJ, Jerreat AS, Woodford J, Sandy JR, Ireland AJ. Development of a condition-specific measure to assess quality of life in patients with hypodontia. *Orthod Craniofac Res* 2011;**14**:160–167.

ejprd.org - Published by Dennis Barber Journals.