

Trends in orthodontic management strategies for patients with congenitally missing lateral incisors and premolars

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ABSTRACT

Objectives: To identify changes in orthodontic management strategies in patients with hypodontia seen in 2000, 2010, and 2017/2018 (during a 1-year period).

Materials and Methods: An assessment of the panoramic radiographs of 3701 patients from a Western Australian private practice identified 276 individuals demonstrating hypodontia. The location of missing teeth, age, sex, type of malocclusion, and the management strategies (space closure or opening) for each patient were noted.

Results: Most hypodontia involved agenesis of three or fewer teeth (90%). Maxillary lateral incisors and mandibular second premolars were the most commonly missing teeth. Female preponderance was noted. When considering treatment, the odds ratio for orthodontic space opening and prosthetic replacement in 2000 was 3.266 (P value = $7e-04$; 95% confidence interval [CI], 1.464–4.633) compared with patients seen in 2010 and 1.632 (P value = $7e-04$; 95% CI, 0.811–2.434) compared with patients in 2017/2018. For patients demonstrating bilateral absence of maxillary lateral incisors, the odds ratio for orthodontic space opening was 3.185 (P value = 0.0215; 95% CI, 1.182–9.243) compared with counterparts with unilateral agenesis. None of the factors investigated were significantly associated with the types of treatment planned/provided for the patients with missing mandibular second premolars.

Conclusions: Maxillary lateral incisors and mandibular second premolars were the most commonly missing teeth. A trend away from space opening and prosthetic replacement toward orthodontic space closure was observed from 2000 to 2017/2018. This may reflect a change in attitude toward prosthetic replacement options and/or greater optimism with biomechanical strategies since the implementation of temporary anchorage devices to assist in space closure. (*Angle Orthod.* 2021;91:477–483.)

KEY WORDS: Hypodontia; Congenitally missing lateral incisors; Space closure

INTRODUCTION

Hypodontia is the absence of 5 or fewer teeth excluding the third molars and is likely to occur on the

most distal tooth of each tooth type.^{1,2} Retrospective radiographic studies have reported large differences in the prevalence of hypodontia ranging between 0.3–36.5% depending on geographic location, sample size,

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and age at diagnosis, with approximately 90% of hypodontia cases involving 3 or fewer missing teeth and exhibiting a greater prevalence in females.¹⁻⁵ Excluding third molars, the mandibular second premolars have been reported as the most commonly congenitally missing tooth in the permanent dentition, followed by the maxillary lateral incisors and the maxillary second premolars in Caucasians.¹⁻⁷

Genetic transmission of hypodontia has demonstrated variable penetrance, with reported polygenic, epigenetic, and environmental influences.^{4,8,9} Mutations in various genes causing disturbances in cellular proliferation and/or differentiation, heterozygous mutations in *AXIN2*, *PAX9*, and/or *MSX1* (mesenchymal transcription factors), have been linked to premolar and molar agenesis.^{7,10-12} Congenital tooth absence is often an isolated anomaly in an otherwise developmentally normal individual; however, hypodontia is reported in several well-documented syndromes and conditions such as ectodermal dysplasia and cleft lip and palate.^{4,7,11}

The decision to open or close spaces resulting from missing teeth remains controversial. Several treatment options have been suggested ranging from no treatment, orthodontic space closure,^{3,10,13-18} prosthetic replacement with a variety of prostheses,^{10,13,16,19} and replacement via autotransplantation.^{10,20} When considering prosthetic replacement, orthodontics is often required to idealize tooth positions in preparation for a prosthesis with case-specific considerations determined by the position and the type of tooth replacement.^{6,10,16,19} Prosthetic replacement may vary from a removable partial denture constructed in acrylic or cast alloy, bonded bridges, or full coverage crowns/bridges to implant-supported prostheses, all with their relative merits and strengths.

Space closure may offer the advantage of completing treatment during adolescence,^{10,14} leaving the growing child with some case-specific retention considerations, such as bonded upper retainers during growth to prevent spaces from reopening.¹⁴ The patient may then be left with a naturally embedded occlusion that grows and adapts to normal craniofacial maturational changes.^{10,14}

Historically, significant limitations have been imposed on clinicians when treating hypodontia patients because of the absence of potentially strategic anchor teeth to facilitate space closure. The advent of temporary anchorage devices (TADs) has expanded the range of tooth movements where space closure may be contemplated when previously unpredictable extended treatment times were considered to be difficult, problematic, or unrealistic.

Importantly, acceptable occlusion can be achieved after space closure with results that are well accepted

by patients with improved periodontal health in comparison with prosthetic replacements.^{13,14} No relationship has been reported between the type of treatment and signs or symptoms of temporomandibular disorders.¹³

The aims of this study were, first, to retrospectively investigate the prevalence and distribution of hypodontia in a clinical population who presented for orthodontic treatment at a private orthodontic practice at the following three time periods: 2000, 2010, and 2017/2018 (during a 1-year period). Second, this research aimed to determine if there was a change in orthodontic management strategies (ie, space closure vs space opening) of missing lateral incisors and second premolars, which may reflect an increase in the use of TADs and/or change in philosophy with respect to prosthetic replacement.

MATERIALS AND METHODS

Approval to conduct this study was obtained from the Human Research Ethics Committee of The University of Western Australia (RA/4/1/4583).

Clinical records of 3701 patients treated with full-fixed orthodontic appliances in the years 2000, 2010, and 2017/2018 (July 2017 through June 2018) at a private orthodontic practice with six clinicians in Perth, Western Australia, were reviewed. Panoramic radiographs were initially reviewed to identify individuals affected by hypodontia (excluding third molars), confirmed with photographic, clinical diagnostic, and treatment planning information. Factors such as age, sex, angle classification, and strategy implemented for the space management (space opening/maintenance or space closure) were recorded.

Exclusion Criteria

The exclusion criteria were the following:

- Patients older than 10 years of age with no available panoramic radiographs.
- Any patient with a history of previous tooth extraction attributed to non-hypodontia-related reasons (ie, pulpal pathology, trauma, orthodontic extractions).
- Any adult patient without an interpretable panoramic radiograph taken in his or her first 2 decades.
- Any patient with 6 or more missing teeth.

Statistical Analysis

The results were analyzed using both univariate and multivariate regression. Logistic regression was used to determine which factors had an impact on the types of management strategies implemented. Adjusted odd

Table 1. Prevalence and Distribution of Patients With Hypodontia Seen in Years 2000, 2010, and 2017/2018

Year	Total	Hypodontia		
		Female	Male	Total
2000	1398	46	23	69
2010	925	56	35	91
2018	1380	64	34	98

ratios (ORs) and 95% confidence intervals (CIs) were calculated for this model.

RESULTS

Prevalence of Hypodontia

A total of 3701 orthodontic patients were screened, revealing a total of 276 patients with hypodontia (73 in 2000, 100/1398 in 2010, and 103/1380 in 2017/2018) identified (Table 1). The most commonly missing permanent teeth were mandibular second premolars followed by maxillary lateral incisors and maxillary second premolars. In total, these teeth represented more than three-quarters of the cases with congenitally missing teeth in all of the studied years (85% in 2000, 79% in 2010, and 87% in 2017/2018; Figure 1). The majority of cases involved the absence of 3 or fewer teeth (89%, 92%, and 91% of the patients seen in 2000, 2010, and 2017/2018, respectively), and females were affected more often than males (prevalence of hypodontia in females was 1.92 and 1.94 times higher than males in 2000 and 2017/2018, respectively); however, the prevalence was reduced to 1.56 times in 2010 (Figure 2). Unilateral agenesis of maxillary lateral incisors and mandibular second premolars was more prevalent than bilateral agenesis of the same tooth.

Treatment of Hypodontia

Regardless of the number and location of congenitally absent teeth, the OR of patients seen in 2000 to undergo orthodontic space opening and prosthetic

replacement was 3.266 (*P* value = 7e-04; 95% CI, 1.464–4.633) compared with their counterparts seen in 2010 and 2017/2018 (Table 2). The age, sex, and type of malocclusion did not have a significant influence on the type of treatment (orthodontic space closure vs orthodontic space opening/maintenance and prosthetic replacement). Compared with their counterparts with bilateral absence of maxillary lateral incisors, the OR to undergo orthodontic space opening was 3.185 (*P* value = 0.0215; 95% CI, 1.182–9.243; Table 3). For patients with missing second premolar(s) or specifically mandibular second premolar(s), none of the factors investigated were significantly associated with the types of treatment planned/provided for the patient (Table 4).

DISCUSSION

The literature presents contradicting opinions regarding the options for managing hypodontia.^{14,19} In cases involving missing lateral incisors, despite many reported morphological considerations that influence the decision to close or open spaces (such as occlusal relationship, arch length discrepancies, size, shape and color of the canine, lip line when animated, etc.), most patients do in fact require orthodontic tooth movement of some type to idealize the outcome of each option.

The prevalence of hypodontia in this study was consistent with the reported literature. The mandibular second premolars and maxillary lateral incisors were reported to be the most commonly absent teeth. Of the patients with hypodontia, 89%, 92%, and 91% seen in 2000, 2010, and 2017/2018, respectively, exhibited 3 or fewer missing teeth, consistent with a current meta-analysis (89.9%).² Similarly, a female preponderance in hypodontia was demonstrated, but this may reflect the greater proportion of females seeking orthodontic treatment.²¹

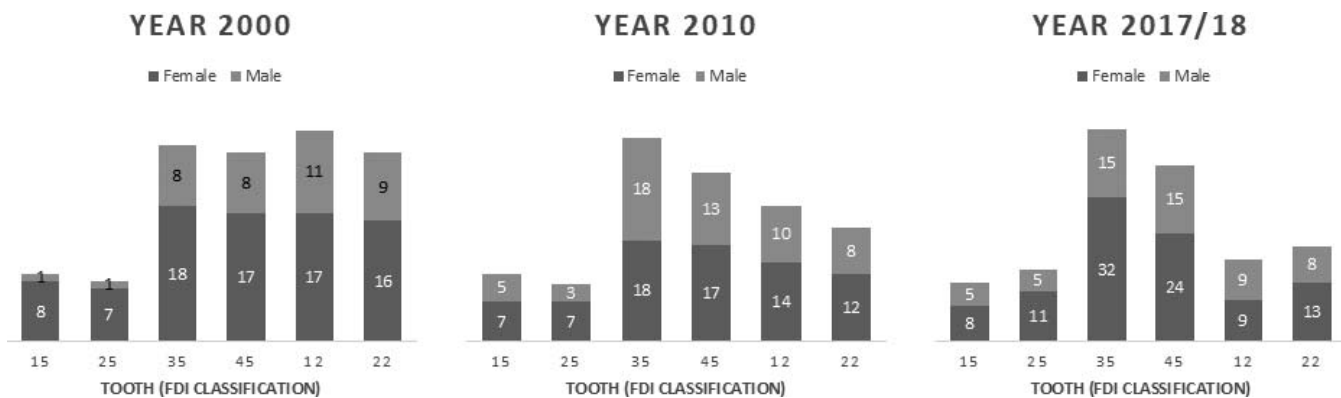


Figure 1. Frequency of the six most affected teeth among hypodontia patients seen in years 2000, 2010, and 2017/2018.

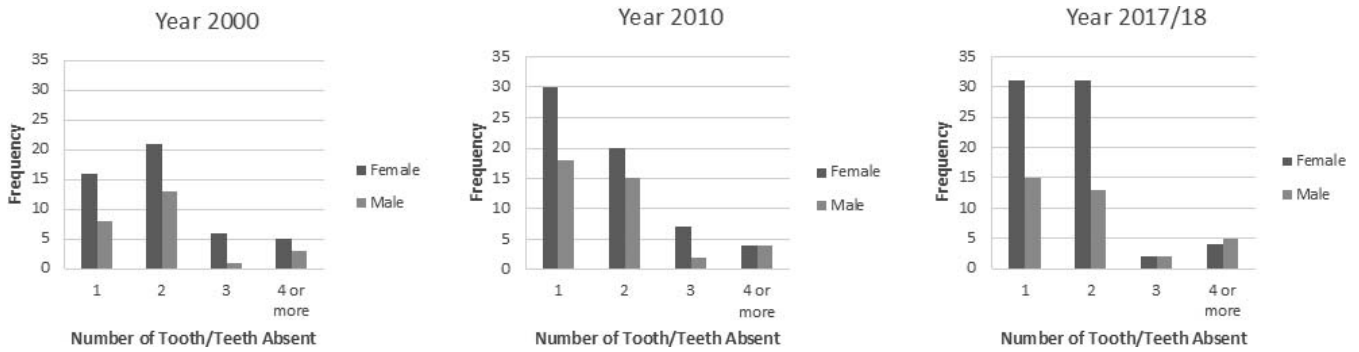


Figure 2. Prevalence and severity of hypodontia among patients seen in years 2000, 2010, and 2017/2018.

Orthodontic space opening was three times as likely to be performed in patients with hypodontia of lateral incisors and/or premolars in 2000 compared with 2010 and 2017/2018 (OR, 3.266) in a large, multiclinician practice of six orthodontists trained in accredited specialist training institutions both in the United States and Australia. This was not influenced by age, sex, or type of malocclusion. It was interesting to note that for patients with missing lateral incisors, patients with one missing incisor were significantly more likely to have space opening than when bilateral agenesis was present (OR, 3.185). These findings were not significant for the lower premolars; therefore, the change in trend to close space was mainly related to maxillary lateral incisors, so some significant factors have influenced the clinician’s decision to reduce the likelihood of a single prosthetic lateral incisor.

Although space closure for patients with missing teeth was more prevalent in 2010 and 2017/2018 compared with 2000, patients were more likely to undergo space opening when unilateral missing

maxillary lateral incisors were observed (after adjusted for age, sex, type of malocclusion, and treatment year). This may have been related to the difficulty in matching the canine with the contralateral maxillary lateral incisor. However, occasionally there is concurrent microdontia of the contralateral maxillary lateral incisor, and orthodontic space opening or redistribution prior to prosthetic replacement allows for the restoration of the microdont tooth.

It was interesting to note that when the esthetic outcome of space closure or space opening strategies was compared in a group of patients, lay people, dentists, and orthodontists rated the esthetic outcome of canine substitution above all prosthetic outcomes (ie, bridges or implants). However, the dentists suggested that they anticipated a better esthetic outcome following implant replacement.^{13,22–24}

In cases with missing second premolars, two major approaches used are orthodontic space closure and allowing the mesial drift of the permanent first molar(s) or space maintenance by retaining the deciduous molar or a lower lingual arch and subsequent

Table 2. Univariate and Multivariate Analyses of the Overall Sample: Age, Sex, Malocclusion, and Year Seen (2000, 2010, and 2017/2018)

Variable	Category	Management Strategy		Univariate OR (95% CI)	Multivariate OR (95%CI)
		Opening	%		
Age (years)	Overall <i>P</i> value			0.1396	0.0306*
	≤12	26	20.80	59	30.41
	(>12, <20)	85	68.00	119	61.34
	≥20	14	11.20	16	8.25
Sex	Overall <i>P</i> value			0.2393	NS ^a
	Female	75	60.00	129	66.49
	Male	50	40.00	65	33.51
Malocclusion	Overall <i>P</i> value			0.4659	NS
	Class I	45	36.00	65	33.51
	Class II	73	58.40	111	57.22
	Class III	7	5.60	18	9.28
Treatment year	Overall <i>P</i> value			0.0042**	7e-04***
	2000	47	37.60	42	21.65
	2010	43	34.40	71	36.60
	2018	35	28.00	81	41.75

^a NS indicates not significant.

* *P* = 0.01–0.05; ** *P* = 0.001–0.01; *** *P* < 0.001

Table 3. Univariate and Multivariate Analyses of Patients With Missing Maxillary Lateral Incisors: Age, Sex, Malocclusion, Unilateral/Bilateral Absence and Treatment Year (2000, 2010, and 2017/2018)

Variable	Category	Management Strategy				Univariate OR (95% CI)	Multivariate OR (95% CI)
		Opening	%	Closure	%		
Age (years)	Overall <i>P</i> value					0.3667	NS ^a
	≤12	11	27.50	12	25.00	1	
	(>12, <20)	22	55.00	32	66.67	0.75 (0.279–2.018)	
	≥20	7	17.50	4	8.33	1.909 (0.447–9.034)	
Sex	Overall <i>P</i> value					0.497	NS
	Female	23	57.50	31	64.58	1	
	Male	17	42.50	17	35.42	1.348 (0.569–3.213)	
Malocclusion	Overall <i>P</i> value					0.4122	NS
	Class I	16	40.00	13	27.08	1	
	Class II	19	47.50	29	60.42	0.532 (0.206–1.346)	
	Class III	5	12.50	6	12.50	0.677 (0.161–2.743)	
Treatment year	Overall <i>P</i> value					9e-04***	0.0027**
	2000	20	50.00	12	25.00	8.75 (2.61–35.815)	9.225 (2.488–41.77)
	2010	16	40.00	15	31.25	5.6 (1.671–22.707)	4.742 (1.233–21.495)
	2018	4	10.00	21	43.75	1	1
Unilateral/bilateral	Overall <i>P</i> value					0.065	0.0215*
	Unilateral	22	55.00	17	35.42	2.229 (0.952–5.341)	3.185 (1.182–9.243)
	Bilateral	18	45.00	31	64.58	1	1

^a NS indicates not significant.

* $P = 0.01-0.05$; ** $P = 0.001-0.01$; *** $P < 0.001$

prosthetic replacement.²⁵ In this study, the change in strategy from space maintenance to space closure was not seen statistically, suggesting that esthetic considerations may not be so influential in a posterior tooth prosthesis, and therefore the clinician was more likely to accept a posterior prosthesis or be optimistic about the deciduous molar(s) prognosis. Despite the absence of its successor, physiological resorption and/or infraclusion of clinically healthy deciduous molars may still occur, but approximately 50% of deciduous molars

were reported to remain healthy and functional after 2–3 decades.^{25,26}

The decision to open or close anterior spaces has changed in this clinical environment. Although the reasons for change have not been assessed, it is proposed that this trend to avoid anterior prosthetic replacement was related to a number of factors. The long-term esthetic impact of prostheses has been demonstrated to be less favorable to both patients and clinicians.^{22–24} In addition, the financial cost and

Table 4. Univariate and Multivariate Analyses of Patients With Missing Second Premolars: Age, Sex, Malocclusion, Unilateral/Bilateral Absence and Treatment Year (2000, 2010, and 2017/2018)

Variable	Category	Management Strategy				Univariate OR (95% CI)	Multivariate OR (95% CI)
		Opening	%	Closure	%		
Age (years)	Overall <i>P</i> value					0.0652	NS ^a
	≤12	11	16.92	39	32.50	1	
	(>12, <20)	48	73.85	72	60.00	2.364 (1.132–5.26)	
	≥20	6	9.23	9	7.50	2.364 (0.669–8.117)	
Sex	Overall <i>P</i> value					0.4174	NS
	Female	40	61.54	81	67.50	1	
	Male	25	38.46	39	32.50	1.298 (0.689–2.432)	
Malocclusion	Overall <i>P</i> value					0.1688	NS
	Class I	21	32.31	44	36.67	1	
	Class II	42	64.62	65	54.17	1.354 (0.712–2.618)	
	Class III	2	3.08	11	9.17	0.381 (0.056–1.586)	
Treatment year	Overall <i>P</i> value					0.3938	NS
	2000	17	26.15	26	21.67	1.06 (0.488–2.276)	
	2010	19	29.23	47	39.17	0.655 (0.32–1.32)	
	2018	29	44.62	47	39.17	1	
Unilateral/bilateral	Overall <i>P</i> value					0.1577	NS
	Unilateral	39	60.00	59	49.17	1.551 (0.844–2.88)	
	Bilateral	26	40.00	61	50.83	1	

^a NS indicates not significant.

potential biological impact of the prosthesis and potential for failure may have influenced the clinician's decision to close spaces.^{3,14,19,27–36} In addition, up to 11% of patients may require orthodontic retreatment to realign the roots of adjacent teeth as a result of significant relapse during the retention phase.³⁷

Patients with complex restorative dentistry requirements are referred to orthodontists by a wide range of clinicians with various levels of experience and expertise. At times, the prosthetic outcomes are less than ideal and outside the control of the orthodontist. Although it would be ideal for all patients to seek the services of a prosthodontist for comprehensive or complex prosthetic treatments, the reality of daily practice is that this objective is not always realized.

An additional factor that should never be overlooked is the time involved in achieving a satisfactory treatment outcome. Orthodontic space closure can lead to an extended period in fixed appliances. However, the implementation of TADs has reduced treatment times. It is recognized that some patient-specific factors, such as patient motivation and oral hygiene, may contraindicate a protracted course of therapy.

The impact of TADs to facilitate predictable space closure in circumstances when it would otherwise be biomechanically challenging or impossible cannot be underestimated.⁸ Although this was not the purpose of the study, the combination of issues previously discussed related to prosthetic replacement and the implementation of TADs into contemporary orthodontics may partially explain the trend toward choosing to close spaces in cases with missing lateral incisors.

CONCLUSIONS

- In the present study, hypodontia reflects previously reported historical findings; maxillary lateral incisors and mandibular second premolars were the most commonly missing teeth.
- Regarding the treatment of hypodontia, since 2000 a trend away from space opening and prosthetic replacement and a trend toward orthodontic space closure was observed. This trend may reflect a change in attitude toward prosthetic replacement and/or greater optimism with biomechanical strategies since the implementation of TADs to assist in space closure.

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