

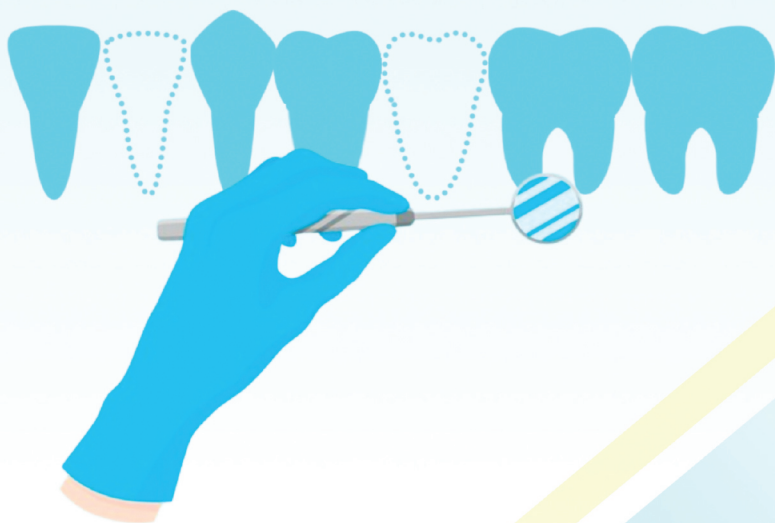


Ministry of Health Malaysia
Oral Health Programme

Clinical Practice Guidelines

MANAGEMENT OF HYPODONTIA

(SECOND EDITION)



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STATEMENT OF INTENT

These guidelines update and supplant the previous guidelines developed in 2012 and are based on the best available contemporary evidence. They are intended as a guide for the best clinical practice in the management of hypodontia presently. However, it must be noted that adherence to these guidelines do not necessarily lead to the best clinical outcome in individual patient care, as every health care provider is responsible for the management of his/her unique patient based on the clinical presentation and management options available locally.

REVIEW OF THE GUIDELINES

These guidelines were issued in November 2023 and will be reviewed in 2027 or earlier if important new evidence becomes available. When it is due for updating, the head of the related specialty will be informed about it. A multidisciplinary team will be formed and discussion will be done on the need for a revision including the scope of the revised clinical practice guidelines (CPG). The systematic review methodology used by the Malaysia Health Technology Assessment Section (MaHTAS) will be employed in reviewing the guidelines.

Every care is taken to ensure that this publication is correct in every detail at the time of publication. However, in the event of errors or omissions, corrections will be published in the web version of this document, which is the definitive version at all times.

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LEVELS OF EVIDENCE

Level	Study design
I	Evidence obtained from at least one properly designed randomised controlled trial.
II-1	Evidence obtained from well-designed controlled trials without randomisation.
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
II-3	Evidence obtained from multiple time series studies, with or without intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.
III	Opinions or respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

Source: Adapted from Harris RP, Helfand M, Woolf SH, Lohr KN, Mulrow CD, Teutsch SM, Atkins D. Current Methods of the U.S. Preventive Services Task Force: A Review of the Process. *Am J Prev Med.* 2001;20 (suppl 3):21-35.

FORMULATION OF RECOMMENDATION

In line with the current development in CPG methodology, the **Grading Recommendations, Assessment, Development and Evaluation (GRADE)** was adopted in the work process. The quality of each retrieved evidence and its effect size are carefully assessed and reviewed by the CPG Development Group. In formulating the recommendations, overall balances of the following aspects are considered in determining the strength of the recommendations:

- overall quality of evidence
- balance of benefits versus harms
- values and preferences
- resource implications
- equity, feasibility and acceptability

LIST OF KEY MESSAGES

Key Message 1

Hypodontia is suspected when there is:

- 1.5 years delayed eruption from its chronological eruption age
- 6 months delay after contralateral tooth erupted
- absence of bulge upon palpation of eruption site
- prolonged retained deciduous teeth
- a family history of hypodontia
- history of congenitally missing deciduous teeth
- anomalies associated with hypodontia seen (refer to **Table 4**)

Key Message 2

Hypodontia is categorised under Grade 5 and 4 in IOTN which indicates a high need for orthodontic treatment.

Key Message 3

Comprehensive treatment requiring space management of hypodontia patients should be managed by a multidisciplinary team.

Key Message 4

Factors to determine prognosis of retained deciduous teeth are:

- caries
- restoration
- root resorption
- bone resorption
- periapical or interradicular pathology
- ankylosis
- infraocclusion
- gingival recession

Key Message 5

Factors to be considered prior to implant placement in hypodontia patient:

- medical condition
- completion of growth
- oral hygiene
- thickness of ridge or bone volume at hypodontia site
- diameter of dental implant
- space availability
- root parallelism
- operator's skill
- cost

Key messages 6

Factors to be considered when prescribing types of retainers for hypodontia patients are:

- initial malocclusion
- treatment modality (open space or close space)
- tendency of relapse
- oral hygiene
- patients' compliance
- patients' preference
- operator's skill & laboratory support
- cost

Key message 7

Hypodontia has a negative impact on oral health-related quality of life (OHRQoL) however, it can be improved with appropriate management.

LIST OF KEY RECOMMENDATIONS

EXAMINATION AND DIAGNOSIS

- In hypodontia patients:
 - intraoral radiograph should be considered once a tooth is clinically missing
 - panoramic radiograph should be delayed until age of 9 to 10 years old
- Cone Beam Computed Tomography should be avoided as a diagnostic tool for hypodontia patients
- Early referral should be considered once hypodontia is diagnosed
- Essential pre-treatment records may include panoramic and lateral cephalometric radiographs, dental casts, intra- and extra-oral photographs

MANAGEMENT

- In hypodontia patients:
- preservation of deciduous teeth may be considered as an option
 - extraction of deciduous teeth with infraocclusion may be considered
 - orthodontic space closure should be considered if both orthodontic space closure and prosthetic replacement is a viable option
 - premolars with open apex may be considered for autotransplantation

POST-ORTHODONTIC TREATMENT RETENTION

Dual retention may be considered among hypodontia patients with high relapse tendency.

GUIDELINES DEVELOPMENT

These clinical practice guidelines (CPG) were developed by a multidisciplinary expert committee consisting of Orthodontic Specialists, a Paediatric Dental Specialist, a Restorative Dental Specialist, a Dental Public Health Specialist, Dental Officers and a Dental Therapist mainly from the Ministry of Health, Ministry of Higher Education and private sector.

The previous edition of the CPG on Orthodontic Management of Developmentally Missing Incisors (2012) was used as the basis for the development of these guidelines. The recommendations were formulated by taking into consideration the best available evidence and local practices. Several improvements have been introduced in this edition. The scope has been expanded to include new and updated information. In addition, clinical audit indicators have also been identified for the purpose of monitoring and evaluating outcomes.

Literature search was carried out using the following electronic databases: Medline, Pubmed, Cochrane Database of Systematic Reviews (CDSR) and Embase while full text journal articles were retrieved from these databases. The literature search was limited to human study, English language and published articles from 2012 to March 2023. In addition, the reference lists of all retrieved literature and guidelines were searched to further identify relevant studies. Future CPG updates will consider evidence published after this cut-off date. An example of the search strategy used can be found in **Appendix 1**. Details of the search strategy can be obtained upon request from the CPG Secretariat.

There were eleven (11) clinical questions which were assigned to members of the development group. The group members met a total of 12 times throughout the development of these guidelines. All retrieved articles were appraised using the Critical Appraisal Skill Programme (CASP) checklist by at least two members, presented in the form of evidence tables and discussed during group meetings. All statements and recommendations formulated were agreed upon by both the development group and reviewers. This CPG is based on the findings of systematic reviews, randomised controlled trials, and observational studies, with local practices taken into consideration. However, when there was lack of evidence, recommendations were based on consensus of group members. Although ideally patients' views and preferences need to be considered in the development of CPGs, in this instance, it was not feasible.

The literature used in these guidelines were graded using the US / Canadian Preventive Services Task Force Level of Evidence (2001),

while the formulation of recommendation was done using the principles of GRADE. The writing of the CPG strictly follows the requirements of Appraisal of Guidelines Research and Evaluation (AGREE II).

The draft was reviewed by a panel of internal and external reviewers. Recommendations were presented to the Technical Advisory Committee for CPGs, and finally to the HTA and CPG Council, Ministry of Health, Malaysia for approval.

GENERAL OBJECTIVES

To review and expand the scope of the existing guidelines and to provide evidence-based recommendations for the best management practices of hypodontia patients.

SPECIFIC OBJECTIVES

1. To disseminate and reinforce knowledge in the management of hypodontia among healthcare professionals and the public.
2. To determine factors that affect the outcome of treatment options for hypodontia patients.
3. To recommend current evidence-based management of hypodontia patients.

CLINICAL QUESTIONS

The clinical questions addressed by these guidelines can be found in **Appendix 2**.

TARGET POPULATION

These guidelines are to be applied to all patients presenting with congenitally missing teeth.

Inclusion criteria

Children and adults with congenitally missing permanent teeth.

Exclusion criteria

1. Cleft lip and palate or craniofacial syndromes.
2. Missing teeth due to caries or trauma.
3. Congenitally missing deciduous teeth.
4. Congenitally missing third molars.

TARGET GROUP / USER

This document is intended to guide those involved in the management of hypodontia at any healthcare level including:

- i. Dental specialists
- ii. Dental officers
- iii. General dental practitioners
- iv. Dental therapists
- v. Dental students
- vi. Patients and their advocates
- vii. Professional societies

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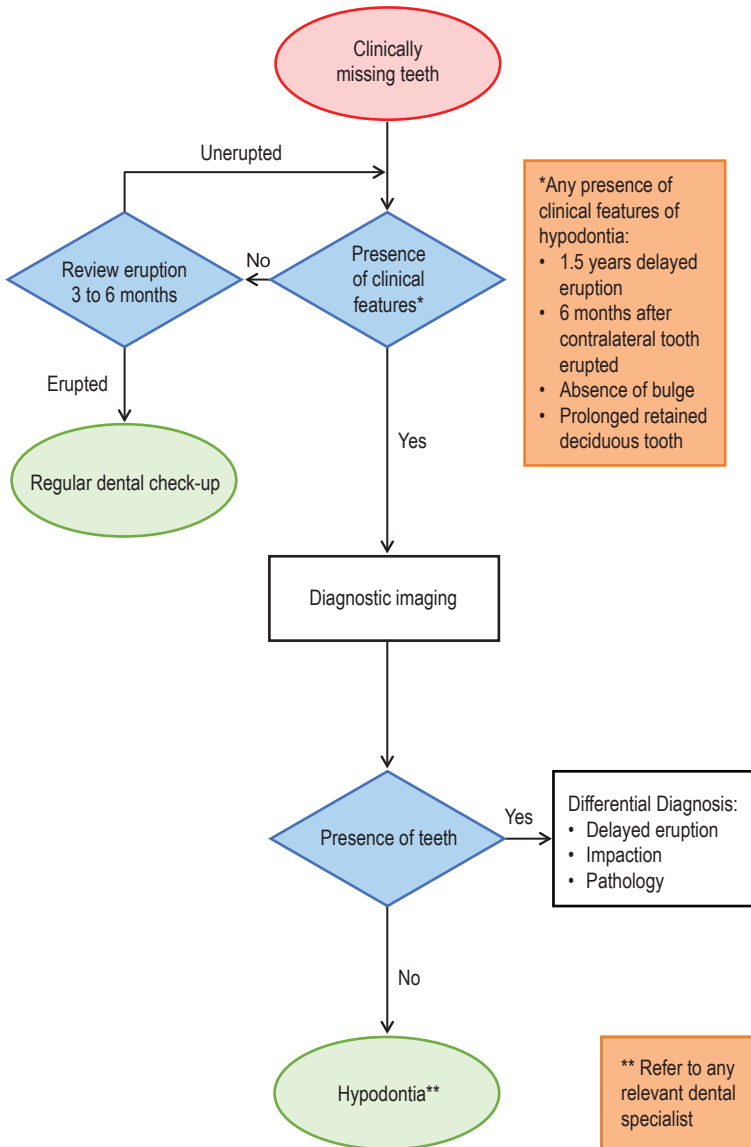
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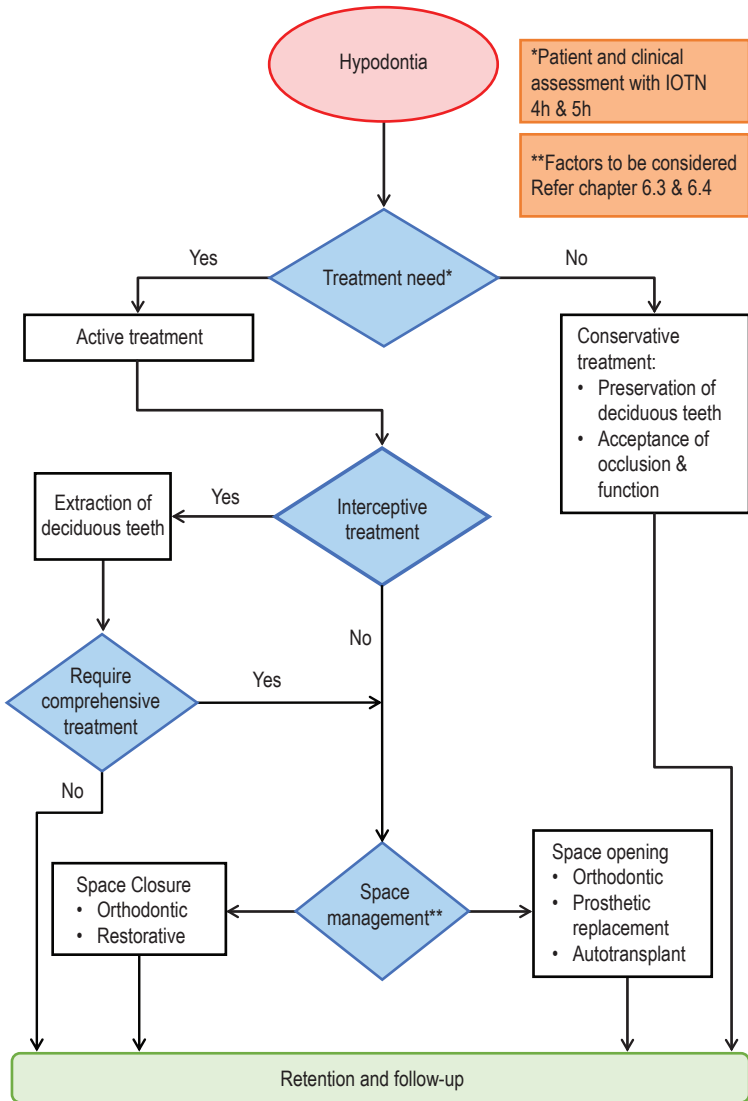
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ALGORITHM 1: DIAGNOSIS OF HYPODONTIA



ALGORITHM 2 : MANAGEMENT OF HYPODONTIA BY MULTIDISCIPLINARY TEAM



1. INTRODUCTION

Hypodontia is a condition characterised by the congenital absence of one or more teeth.⁽¹⁾ It is also known as “congenital tooth agenesis”, specifically defined by the terms hypodontia, oligodontia and anodontia. According to The International Classification of Diseases 11th Revision (ICD-11), hypodontia is defined as congenital agenesis of less than 6 teeth, oligodontia is when 6 or more teeth are missing and anodontia is when agenesis of all teeth, excluding third molars.⁽²⁾

It is a relatively common developmental anomaly that affects globally with prevalence of 6.4% (95% CI 5.7 to 7.2%) and 6.3% in Asia (95% CI 4.4 to 9.1%).^{(3) level II-2} However, prevalence among the Malaysian population was 1%.^{(4) level III} This condition can occur in both deciduous and permanent dentitions and the most commonly affected teeth are the permanent incisors and premolars. The aetiology of congenital tooth agenesis is multifactorial.

Hypodontia has unfavorable implications on dental and facial development particularly on functional and aesthetic outcomes. It can lead to problems with speech, mastication and self-esteem which may require complex and costly dental treatments. Patients may present with varying degrees of severity, prompting them to seek possible treatment. Hypodontia has been shown to have an impact on the oral health and well-being of individuals.

Early intervention and/or interceptive management can reduce the severity of malocclusion and preserve dental structures necessary for restorative/prosthesis procedures later.⁽⁵⁾ Treatment approach whether to open or close space for the replacement of the missing tooth depends on various parameters involving dento-skeletal profile, type of malocclusion, space availability, age and cooperation of the patient, periodontal health as well as financial issues.

Hypodontia patients may require a multidisciplinary treatment approach involving orthodontist, paediatric dental specialist, restorative dental specialist and other dental specialties. Thus, understanding the aetiology, diagnosis and management of hypodontia is crucial for dental professionals to facilitate appropriate care.

This updated review of the clinical practice guidelines (CPG) takes into account recent treatment modalities in the management of hypodontia patients, incorporating the aforementioned issues by embracing evidence-based decision making. It is anticipated that this new CPG will serve as a valuable resource for healthcare providers at all levels of care, enabling them to effectively manage patients with hypodontia.

This CPG is also essential to create awareness and knowledge among patients and guardians.

In this edition of CPG, more clinical questions were added to address the advances in the management of hypodontia, and its scope broadened, to include all permanent teeth rather than confining to missing incisors.

2. CLASSIFICATION

There are many ways to classify congenitally missing teeth. The International Classification of Diseases 11th Revision (ICD-11) released in 2022, described; Refer to **Appendix 3**. Classification of hypodontia based on ICD-11 is summarised in **Table 1**.⁽²⁾

Table 1: Classification of hypodontia⁽²⁾

ICD-11 (CODE)	Classification	Number of missing teeth
LA30.0	Anodontia	All deciduous and permanent teeth
LA30.1	Hypodontia	Less than 6 permanent teeth
LA30.2	Oligodontia	6 and more permanent teeth

Figure 1 illustrates a hypodontia patient with missing left maxillary lateral incisor (MxLI) and small right MxLI.⁽⁶⁾ **Figure 2** illustrates an oligodontia patient with multiple missing permanent teeth. **Figure 3** illustrates complete missing permanent teeth in an anodontia patient.



Figure 1: Hypodontia



Figure 2: Oligodontia



Figure 3: Anodontia

3. AETIOLOGY

Tooth agenesis is one of the most common dental anomalies which can occur in syndromic (e.g. ectodermal dysplasia, Down's syndrome and hemifacial microsomia) or non-syndromic conditions (e.g. cleft lip and palate). Multiple theories and evidences demonstrate that the development of tooth agenesis is linked to genetic and environmental factors.⁽⁶⁾

3.1 Genetic Factors

Tooth agenesis is closely related to cellular-level issues involving pathogenic variants of certain genes, which is the protein product in craniofacial and tooth development. To date, mutated genes have been identified related to tooth agenesis. These genes can be inherited through either paternal or maternal transmission in complete penetrance. Mutation of the genes is also noticed in persons with tooth agenesis even without familial history.^(7, 8)

In a recent systematic review, aimed to characterise and correlate oligodontia phenotypes with their causative genetic aetiologies, based upon analyses of available cases supplemented with a characterization of ten additional families with oligodontia showed:^{(9) level II-2}

- frequency of tooth absence at each tooth position was an effect of different causative genes
- PAX9 (24.7%), MSX1 (14.5%), WNT10A (26.0%), WNT10B (1.5%), AXIN2 (6.1%), EDA (5.9%), EDAR (4.0%), EDARADD (1.3%), LRP6 (4.1%), KREMEN1 (3.8%), PITX2 (2.8%), and SMOG2 (1.5%) mutation genes related to non-syndromic tooth agenesis
- WNT10A mutation caused 53.84% of syndromic oligodontia cases with a mean of 13.0 ± 6.2 teeth missing per case
- PAX9 mutation has a significantly higher percentage of missing teeth ($p < 0.05$) in maxillary second molar, maxillary first molar, mandibular first molar, and mandibular second molar positions
- EDA mutation has a significantly higher percentage of missing teeth ($p < 0.05$) in maxillary lateral incisor, mandibular lateral incisor, and mandibular central incisor positions

A retrospective cohort study reporting genetic mutation of PAX9 and phenotypic variation within the tooth agenesis spectrum revealed:^{(10) level II-2}

- missing lower second molar tooth was the most common pattern in patients with PAX9 mutations with a 100% affected rate
- the prevalence of missing teeth in patients with a PAX9 nonsense mutation (66.1%) was significantly higher ($p = 0.004$) than those

with a PAX9 frameshift mutation (49.6%) or a missense mutation (40.5%)

- the prevalence of microdontia in the missense mutation group (4.76%) was less than the frameshift mutation group (9.8%) and nonsense (9.8%) mutation group, and the difference was statistically significant ($p < 0.001$)

In a case-controlled study assessing the genetic background of non-syndromic hypodontia (NSH), a significant association was observed between the heterozygous and homozygous variant genotypes of MSX1, increasing the risk of hypodontia in the studied population when comparing the entire NSH group with controls ($p = 0.0008$).⁽¹¹⁾ level II-2

Summary of the affected genes based on the missing teeth in maxilla and mandible showed in **Table 2**.

Table 2: Summary of affected genes

	Missing Tooth	Affected genes
Maxilla	Central Incisor	PITX2 ⁽⁹⁾ level II-2
	Lateral Incisor	EDA, LRP6 and KREMEN1 ⁽⁹⁾ level II-2
	Second Premolar	AXIN2, WNT10A and SMOC2 ⁽⁹⁾ level II-2
	Second Molar	PAX9 ⁽¹⁰⁾ level II-2, (9) level II-2
Mandible	Central Incisor	KREMEN1 ⁽⁹⁾ level II-2
	Lateral Incisor	EDA, WNT10B and KREMEN1 ⁽⁹⁾ level II-2
	Second Premolar	AXIN2 and MSX1 ⁽¹¹⁾ level II-2 EDARADD and SMOC2 ⁽⁹⁾ level II-2
	Second Molar	PAX9 ⁽¹⁰⁾ level II-2, (9) level II-2

3.2 Environmental Factors

Environmental variables may have stopped or disturbed the growth of teeth by preventing the dental lamina's tooth bud cells from proliferating which leads to failure of odontogenesis.

Tooth agenesis is occasionally caused by other environmental factors including:

- patient factor
 - infection e.g. osteomyelitis
 - trauma in the dental region
 - disturbances in jaw innervations
 - cancer treatment e.g. chemotherapy, radiotherapy and antineoplastic agents

- maternal factor
 - infection e.g. rubella
 - nutrition
 - substance abuse (smoking, alcohol and drug abuse)

In a recent meta-analysis of six case control studies investigating the association between dental agenesis and various types of cancer showed:⁽¹¹⁾ level II-2

- the odds of a patient with hypodontia having ovarian cancer is 6.43 times higher compared to patient without hypodontia (OR=6.43 95% CI 3.20 to 12.93)
- no significant difference in dental agenesis of patients with or without history of colorectal cancer.
- the odds of a patient with family history of cancer being diagnosed with tooth agenesis is 2.71 times higher compared to patient without family history of cancer (OR=2.71 95% CI 1.90 to 3.86)

However, the included studies were of very low certainty.

In a meta-analysis of 15 cohort studies assessing adverse effects of chemotherapy administered in children with mean age of 6.6 years demonstrated:⁽¹²⁾ level II-2

- a considerable increase in the risk of tooth agenesis compared to untreated patients (RR =2.47, 95% CI 1.30 to 4.71)
- every 7th child with cancer exposed to chemotherapy may develop tooth agenesis. (Number Needed to Treat, NNT=7)

However, the quality of the evidence was low due to bias.

4. PREVALENCE

A large meta-analysis aimed to determine the prevalence of hypodontia and associated factors in schoolchildren, dental patients and orthodontic patients showed:^{(3) level II-2}

- global prevalence is 6.4% (95% CI 5.7 to 7.2%) and by regions are listed below:

Region	Prevalence (%)	95% CI (%)
Africa	13.4	9.7 to 18.0
Europe	7.0	6.0 to 8.0
Asia	6.3	4.4 to 9.1
Australia	6.3	5.3 to 7.4
North America	5.0	4.1 to 5.9
Latin America and Caribbean	4.4	3.2 to 6.1

- females had a higher prevalence compared to males (OR=1.22, 95% CI 1.14 to 1.30)
- higher in Class III malocclusion compared to Class I and Class II (OR=2.15, 95% CI 0.78 to 5.89)
- higher percentage of missing teeth in maxilla 53.2% (95% CI 49.3 to 57%) compared with mandible 46.8% (95% CI 43 to 50.7%)
- most commonly missing teeth are listed below in descending order:

Types of teeth	Prevalence (%)
Mandibular second premolar	29.9
Maxillary lateral incisor	24.3
Maxillary second premolar	13.7
Mandibular central incisor	6.1
Mandibular lateral incisor	4.3
Maxillary first premolar	3.6
Mandibular first premolar	2.7
Maxillary canine	2.5
Other teeth	<2.0

- no statistically significant difference within Asian countries
- However, the included primary papers were moderate to good quality.

In a recent systematic review, the prevalence of hypodontia is reported to be $6.8 \pm 4.2\%$ ranging from $3.4 \pm 2.2\%$ in Africa to $8.1 \pm 6.3\%$ in Europe.^{(13) level III}

A cross-sectional study investigating the trend from the year of 2000 to 2018 of prevalence and distribution of hypodontia in an Australian population, who presented for orthodontic treatment, showed:^{(14) level III}

- most commonly missing permanent teeth in descending order:
 - mandibular second premolars
 - maxillary lateral incisors
 - maxillary second premolars
- occurrence of hypodontia in females was ranged 1.92 to 1.94 higher than males
- unilateral agenesis of maxillary lateral incisors and mandibular second premolars was more common than bilateral agenesis of the same tooth

A large cross-sectional study among Malaysian population assessing pattern and distribution of tooth agenesis showed:^{(4) level III}

- prevalence was 1.005%
- most frequently missing teeth were lateral incisors (28%) and second premolars (26.67%)
- maxilla (54.67%) and right side (54.67%) teeth were more frequently affected
- unilateral (71.42%) was more common compared to bilateral (28.57%)
- no significant difference between male and female

5. EXAMINATION AND DIAGNOSIS

5.1 General Assessment

5.1.1 Patient's complaint

Patients with hypodontia may experience various symptoms depending on the primary characteristics of the condition and also the opinions of the patients, their families and friends. Some of the most frequently reported symptoms include:⁽⁵⁾

- impaired aesthetics due to spacing which may be exacerbated by:
 - number of missing teeth
 - size and shape of remaining teeth
 - dimensions of the jaws
 - location of the spacing
- challenges with chewing particularly if multiple posterior teeth are missing
- difficulties with speech which are likely caused by the absence of anterior teeth

5.1.2 History

It is essential to obtain a comprehensive medical, dental and family history to confirm the developmental absence of permanent teeth and determine the potential aetiology. This is summarised in **Table 3**.⁽⁵⁾ However, aetiology is usually multifactorial and often influenced by a combination of gene function, environmental interaction and developmental timing.

Table 3: History associated with hypodontia⁽⁵⁾

History	Description
Medical	May be associated with medical conditions such as Ectodermal Dysplasia and Down Syndrome
Dental	To exclude clinically missing teeth due to either extraction or trauma
Family	Presence of hypodontia in other family members is an indication of a genetic basis

5.2 Clinical Assessment

5.2.1 Clinical examination

a. Extra-oral

There is an altered craniofacial morphology with tendency towards Class III malocclusion and reduced lower anterior facial height.⁽¹⁵⁾

In a hospital-based cohort study investigating the differences in the facial soft tissue morphology between mild and severe hypodontia using a three-dimensional (3D) optical surface scanner in growing patients found significant differences ($p < 0.05$) in reduction of:⁽¹⁶⁾ level II-2

- alar base
- lower face height
- nasolabial angle
- transgonial distance

Although the preceding evidence showed significant reduction in nasolabial angle, the CPG DG members opine that nasolabial angle is commonly found to be increased in the local population.

Figure 4 illustrates frontal and lateral three-dimensional surface scan views of one of the subjects with landmarks assessed in the study.⁽¹⁶⁾ level II-2

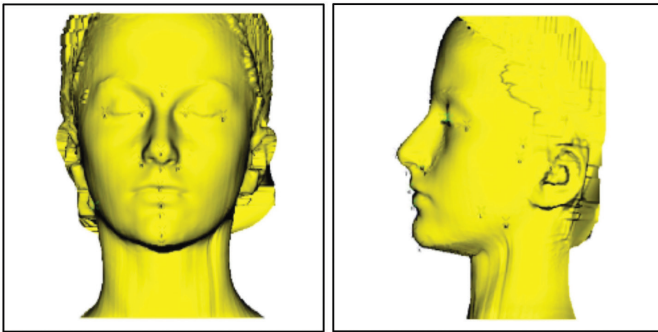


Figure 4: Frontal and lateral three-dimensional surface scan views

A meta-analysis with seven case-control studies, assessing dental agenesis with craniofacial morphological pattern showed statistically significant association between dental agenesis (mild, moderate and severe) and a retrognathic maxilla as indicated by a smaller sella-nasion angle (-1.74° , 95% CI -2.55 to -0.92). The included primary studies were of moderate to high quality.⁽¹⁷⁾ level II-2

Figure 5 illustrates severe hypodontia case with retrusive facial profile and reduced vertical proportions, resulting in increased overbite.⁽¹⁸⁾

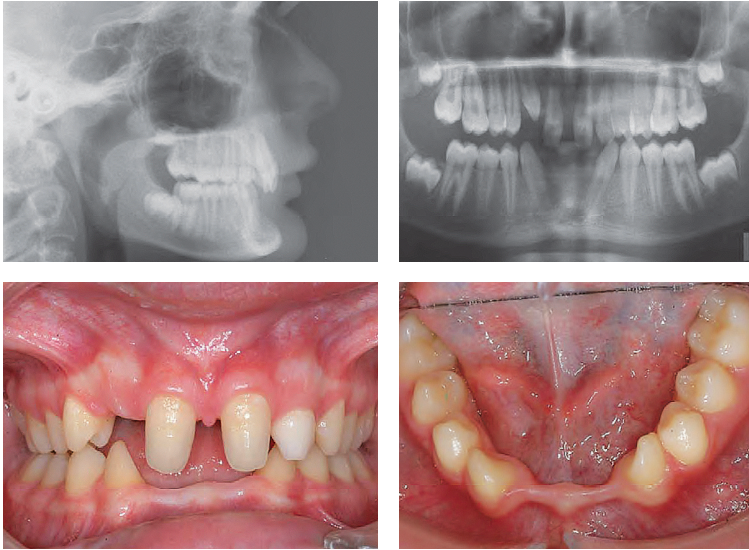


Figure 5: A case of severe hypodontia

a. Intra-oral:

A tooth is considered to be congenitally missing if it has not erupted in the oral cavity and is not visible on radiograph at an age when it should be detected. Permanent teeth can be clinically diagnosed between ages 12-14, but radiographic diagnosis can be done earlier, depending on age and stages of tooth development.⁽¹⁵⁾

In a recent cross-sectional study, comparing the difference between chronological age (CA) and dental age (DA) in permanent dentition among Spanish children with agenesis, showed significantly ($p < 0.01$) lower in agenesis group ($-0.16\text{yrs} \pm 1.12$) compared to a control group ($-0.58\text{yrs} \pm 0.90$), which suggests a delay in teeth development.⁽¹⁹⁾ level III

Two studies investigated the association between DA and CA in hypodontia patients.

- A systematic review showed statistically significant:⁽²⁰⁾ level III
 - delay in DA compared with the control group ranging from 1.20 years to 1.64 years
 - delay in DA with increasing severity of dental agenesis ($p < 0.01$), with each additional missing permanent tooth resulting in a delay of 0.13 year in DA compared to CA

However, gender and ethnicity have no effect on DA delay.

- A cross-sectional study showed significant association with delayed development of permanent teeth (OR=8.931, 95% CI 3.89 to 20.52).
(21) level III

Multiple cross-sectional studies evaluating hypodontia with other dental anomalies showed:

- significant association with:
 - peg-shaped lateral incisor ($p=0.0445$) on the contralateral side⁽¹⁹⁾ level III
 - microdontia of maxillary incisors (OR=5.921, 95% CI 3.32 to 10.57)⁽²¹⁾ level III
 - distoangulation of the mandibular second premolar (OR=5.163, 95% CI 1.96 to 13.64)⁽²¹⁾ level III
 - infra-occlusion of primary molar (OR=2.933, 95% CI 1.35 to 6.36)
(21) level III
- 61.11% patients of those with agenesis have other associated dental anomalies (microdontia, hypomineralization and infra-occlusion)⁽²²⁾ level III

A local study among Malaysian population observing the pattern and distribution of tooth agenesis documented presence of 8.57% peg-shaped tooth and 5.71% microdontia.⁽⁴⁾ level III

Dental features that co-associated with hypodontia are summarised in **Table 4.**⁽⁵⁾

Table 4: Intra-oral features co-associated with hypodontia⁽⁵⁾

Feature	Descriptions
Microdontia	May be localised or generalised; may affect the crowns and roots of teeth; is a contributor to spacing
Conical teeth	May be localised (e.g. peg lateral incisor) or generalised
Ectopic eruption	Ectopic eruption into lateral incisor space; impaction and transposition may affect the maxillary canine
Retained deciduous teeth	Teeth may be infraoccluded or ankylosed
Reduced alveolar ridge development	May complicate prosthodontic management and orthodontic tooth movement
Delayed eruption of permanent teeth	An average delay in eruption is 1.5 years. May delay onset of orthodontic treatment
Enamel defects	Hypoplasia, hypocalcifications
Abnormal tooth position	Rotations (especially premolars)

According to American Academy of Paediatric Dentistry (AAPD), hypodontia should be anticipated in patients presenting with delayed or asymmetric eruption sequence, retained deciduous teeth, or ankylosis. They also recommended that palpation of unerupted teeth should be part of every dental examination during the early mixed dentition stage.⁽²³⁾

Figure 6 illustrates patient with missing right MxLI, and retained deciduous molars.⁽¹⁸⁾



Figure 6: Hypodontia case

5.2.2 Investigation

A definitive diagnosis usually can be established by carrying out a radiographic examination. A tooth is considered missing if there is no evidence of the tooth when observed either clinically or radiographically.

a. Radiographic Imaging

The standard radiographic techniques used for this purpose include periapical views, upper standard occlusal radiographs and dental panoramic radiographs. These imaging methods may be used if there are indications of underlying disease or developmental anomalies.⁽²⁴⁾ The use of panoramic radiography is recommended together with clinical examination in detecting or confirming a diagnosis of tooth agenesis.⁽²³⁾ When an unerupted tooth is not palpable, hypodontia should be suspected and diagnosis can be confirmed with dental radiographs. These radiographs are indicated to be taken at the time of early mixed dentition to provide diagnostic information concerning hypodontia.⁽²³⁾

Radiographic examination is often necessary to make a conclusive diagnosis of hypodontia, but caution must be taken to avoid taking radiographs too early. This is because the development of some permanent teeth such as the second premolars may not begin until a child is 9 to 10 years old. Therefore, waiting until a child is over 9 years of age before taking a dental panoramic radiograph for the diagnosis of hypodontia is essential.⁽⁵⁾

A recent systematic review of healthy children and adolescents revealed that out of 123 articles reporting various dental anomalies, 44 articles reported hypodontia. All of the 44 articles used radiographs as diagnostic tool to confirm hypodontia.^{(13) level III}

Recommendation 1

In diagnosing hypodontia:

- intraoral radiograph should be considered once a tooth is clinically missing.
- panoramic radiograph should be delayed until age of 9 to 10 years old.

b. Cone Beam Computed Tomography (CBCT)

Orthodontic patients are typically evaluated using low-dose radiographic imaging, which carries a small risk of cancer induction through stochastic effects. However, young orthodontic patients are at an increased risk, especially when undergoing high-dose CBCT imaging.⁽²⁴⁾

Based on Ministry of Health (MOH) Guideline, CBCT should not be routinely used for screening purposes, including for orthodontic diagnosis.⁽²⁵⁾

Recommendation 2

Cone Beam Computed Tomography should be avoided as a diagnostic tool for hypodontia patients.

5.3 Referral

Clinicians should be aware of family history of hypodontia or other abnormalities in affected parents or siblings, as delayed eruption is common among hypodontia patients. It is essential to determine the reasons for failure of tooth eruption, particularly if there is a disturbance of the sequence of tooth eruption.

Potential hypodontia patients presenting in the primary care setting should undergo the following:

- general and clinical assessment
- diagnostic imaging to confirm the hypodontia status

To ensure the optimal treatment outcome, it is crucial to refer the patient promptly after a diagnosis. The referral can be directed to any relevant dental specialist within the multidisciplinary team which may consist of orthodontist, paediatric dental specialist and restorative dental specialist.

Referrals should be made within 1.5 years from the hypodontia tooth's chronological eruption age. If it exceeds this range, it will be considered as late referrals. Thus, potentially increase treatment complexity and compromise the treatment outcome. Refer **Appendix 4** (Tooth Eruption Chart) which was adopted from the American Dental Association (ADA).⁽²⁶⁾

Key message 1

Hypodontia is suspected when there is:

- 1.5 years delayed eruption from its chronological eruption age
- 6 months delay after contralateral tooth has erupted
- absence of bulge upon palpation of eruption site
- prolonged retained deciduous teeth
- a family history of hypodontia
- history of congenitally missing deciduous teeth
- anomalies associated with hypodontia (refer to **Table 4**)

Recommendation 3

Early referral should be considered once hypodontia is diagnosed.

The Index of Orthodontic Treatment Need (IOTN) is used routinely in the orthodontic services within the MOH Malaysia to assess the need and eligibility for orthodontic treatment based on dental health component.⁽²⁷⁾ (Refer **Appendix 5**)

Key message 2

Hypodontia is categorised under Grade 5 and 4 in IOTN which indicates a high need for orthodontic treatment.

In cases where further comprehensive treatment is required, consultation with multidisciplinary team will help to develop an appropriate treatment plan.

Key message 3

Comprehensive treatment requiring space management of hypodontia patients should be managed by orthodontist or multidisciplinary team.

5.4 Pre-treatment Record

According to the AAPD:⁽²³⁾

- diagnostic dental casts can be obtained for patients with hypodontia to:
 - evaluate the occlusal relationship
 - determine the necessary arch length for inter- and intra-arch tooth size relationships
- intra-oral and extra-oral photographs to supplement clinical findings

In local setting, essential pre-treatment records required before treatment planning in hypodontia patients include panoramic and lateral cephalometric radiographs, dental casts, intra- and extra-oral photographs.

Recommendation 4

Essential pre-treatment records may include panoramic and lateral cephalometric radiographs, dental casts, intra- and extra-oral photographs in hypodontia patients.

6. MANAGEMENT

Management of hypodontia depends on various factors (i.e. size, shape and colour of the adjacent tooth, site of hypodontia, facial profile, smile line, arch length-tooth size discrepancy, ridge thickness, malocclusion, age, cooperation and aesthetic expectation of the patient) that should be taken into consideration during treatment planning for optimal aesthetic and functional outcomes.⁽²⁸⁾

Treatment planning

Diagnostic orthodontic wax-up of study models or Kesling set-up, serves as a valuable tool for patient communication. It enables the orthodontist to visually explain the treatment plan, demonstrate the potential outcome and discuss the available options with the patient. This helps in managing patient expectations, gaining informed consent and actively involving the patient in the decision-making process. With recent technological advancements, 3D scanners may be incorporated for digital treatment planning.

However, in growing hypodontia patients, the provision of comprehensive treatment related to prosthetic replacements (e.g. implant and bridges) may be delayed.

6.1 Conservative Treatment

Conservative treatment is an option in hypodontia if the occlusion is acceptable and the patient is satisfied with the dentition and not willing to commit to lengthy and costly treatment. This includes preservation of deciduous teeth with continuous monitoring. Preservation of deciduous teeth in hypodontia patients refers to the process of maintaining them in place and may involve various treatment options such as fillings, crowns and root canal therapy to ensure their longevity until exfoliated.

A recent systematic review comprising three observational studies assessing survival rate of deciduous molars with agenesis of premolars showed 82% to 89% of the retained molars were in good condition over a follow-up ranging from 5 to 13 years. However, all the three studies were of low certainty.⁽²⁹⁾ level II-2

In two retrospective studies analysing retained deciduous teeth with the same cohort of severe hypodontia patients showed, the tooth types with the highest tendency to remain in good condition were mandibular deciduous canine (64.3%) and second deciduous molar (35.7%) at 12 years follow up. Thus, preserving such teeth is often a worthy choice in growing patients.⁽³⁰⁾ level II-2; ⁽³¹⁾ level II-2

Another systematic review of moderate to good quality with seven observational studies assessing preservation of deciduous teeth in terms of:⁽³²⁾ level II-2

- survival rate
 - four studies reported deciduous tooth survival between 83% to 93% over follow-up of 5 to 15 years
- lifespan of deciduous tooth, only one study reported
 - mandibular deciduous canines had the most predictable prognosis followed by maxillary deciduous canines
 - deciduous molar teeth had the poorest and least predictable prognosis
- root resorption
 - reported in all studies, however its rate and pattern of progression varied among the studies
- infraocclusion
 - the incidence ranged from 25% to 43.6%
 - three studies reported the incidence and severity of infraocclusion increased over time, even into adulthood

However, most of the results above were not reported descriptively in terms of statistical analysis.

A systematic review of six observational studies among congenitally missing premolars with a mean follow-up of 12.5 years in preservation of deciduous molar showed:⁽³³⁾ level I

- survival rate of 89.7%
- success rate of 51.7% when there is no associated root resorption, ankylosis or infraocclusion

Careful monitoring of retained deciduous teeth is crucial in hypodontia patients to identify potential complications like ankylosis, root resorption, or infraocclusion. This monitoring plays an important role in preserving the alveolar bone and the remaining teeth, as to ensure optimal prognosis of retained deciduous teeth.

Figure 7 illustrates retained upper left deciduous canine as seen in left buccal view photograph and panoramic radiograph.

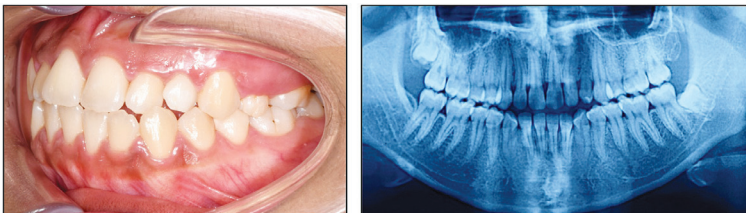


Figure 7: A case of retained deciduous tooth

Recommendation 5

Preservation of deciduous teeth may be considered as an option in individuals with hypodontia.

6.2 Interceptive Treatment

Interceptive treatment of hypodontia in early mixed dentition prevents the development of malocclusion and complications in the permanent dentition, eventually reducing or eliminating the need for complex treatment. In cases of missing maxillary permanent lateral incisor, early extraction of deciduous incisor or canine may prevent impaction and allow eruption of permanent canine into the lateral incisor position.⁽³⁴⁾ Extraction of deciduous teeth when permanent successors are missing, constitutes an active treatment modality.

A recent Cochrane Review assessed the effectiveness of extraction of the primary teeth to promote the eruption of palatally displaced canine (PDC) among 9 to 14 years old patients.⁽³⁵⁾ level I

- An RCT found extracting the primary canine may increase the proportion of PDCs that successfully erupt into the mouth at 12 months compared with no extraction (RR=2.87, 95% CI 0.90 to 9.23). However, statistically there was no significant difference between the groups.
- Three RCTs comparing single versus double primary teeth extraction found no significant difference between the two groups in terms of eruption of PDC at 18 months. However, at 48 months, 2 out of 3 RCTs showed significantly higher eruption of the PDC when double, compared to a single primary tooth, was extracted (RR=1.28, 95% CI 1.06 to 1.54).

Despite the low risk of bias of the included RCTs, the certainty of the evidence was very low.

A retrospective study evaluating the prognosis of retained deciduous mandibular molars without successors showed significant correlation between root resorption and infraocclusion (mesial root $r=0.37$; $p=0.001$; distal root $r=0.29$; $p=0.006$).⁽³⁰⁾ level II-2 As the severity of root resorption increases, the likelihood of infraocclusion also tends to increase. Thus, in the presence of infraocclusion, extraction of the deciduous teeth is advisable.

Interceptive treatment is an integral part of the overall management of hypodontia as it is sufficient to obtain a partial result, while establishing the pre-requirements for normal growth. The prognosis of retained deciduous teeth is determined based on clinical and radiographic examination of the alveolar, crown and root.⁽³⁶⁾

A multidisciplinary team approach is needed when deciding on extracting retained deciduous teeth in congenitally missing permanent dentition. Long-term prognosis of the deciduous teeth, future space requirements and patient preferences are some of the aspects which should be considered in managing hypodontia patients.^{(23); (37); (38)}

Key message 4

Factors to determine prognosis of retained deciduous are:⁽³⁶⁾

- caries
- restoration
- root resorption
- bone resorption
- periapical or interradicular pathology
- ankylosis
- infraocclusion
- gingival recession

Recommendation 6

Extraction of deciduous teeth with infraocclusion may be considered in hypodontia patients.

6.3 Management by Space Closure

Space closure approach is a treatment option for ensuring overall dental health in the long-term which can be achieved either via orthodontically closing the space or by modification of the tooth for aesthetic reasons.

Factors to be considered for space closure are:

- facial profile
 - a straight or slight convex profile.⁽³⁸⁾ level II-3; (39) level II-2
 - bimaxillary dentoalveolar protrusion.⁽³⁴⁾
 - Class II division 1 incisor relationship
- canine angulation
 - mesial tilting of the canine crown as to imitate the tilting of the lateral incisor
- shade of canine
 - canines have darker shade than incisors and the colour difference between canines and incisors is to be considered
- gingival height
 - if the canine is replacing the lateral incisor, then extrusion of the canine and intrusion of the first premolar will result in better marginal gingival height

6.3.1 Orthodontic Space Closure

a. Missing Maxillary Lateral Incisors (MxLI)

Two systematic reviews comprising 10 observational studies comparing the outcome of two treatment alternatives between orthodontic space closure (SC) and implant-supported prosthetic replacement (PR) for patients with MxLI agenesis showed in terms of:

- aesthetics:
 - both treatments were equally satisfying but SC was more acceptable than PR aesthetically, however, there was no statistically significant difference between the groups⁽⁴⁰⁾ level II-2
 - only one cross-sectional study using 5-point Likert scale by dentists and laypersons found aesthetics after SC to be statistically more pleasant ($p<0.05$)⁽⁴⁰⁾ level II-2
 - one study had assessed and revealed good acceptability in the implant group. However, there was no statistically significant difference between the 2 groups⁽⁴¹⁾ level II-2
 - overall, patients were almost equally satisfied with both approaches⁽⁴¹⁾ level II-2
 - periodontal status:
 - no significant difference in tooth mobility⁽⁴⁰⁾ level II-2; ⁽⁴¹⁾ level II-2
 - no significant differences were found in plaque index and bleeding when probing⁽⁴⁰⁾ level II-2
 - in both systematic reviews, gingival recession was found significantly more common in the SC group ($p<0.001$)⁽⁴⁰⁾ level II-2 although no recession was greater than 2 mm ($p<0.05$)⁽⁴¹⁾ level II-2
 - another cross-sectional study showed gingival recession and papillary defect to be more common in the PR group, however there was no significant difference between the two groups⁽⁴⁰⁾ level II-2
 - significant elevation in probing depth of more than 3 mm occurred in 12 out of 14 replaced teeth in implant group ($p<0.001$)⁽⁴⁰⁾ level II-2; ⁽⁴¹⁾ level II-2
 - one study reported significant infra-occlusion in the implant group⁽⁴¹⁾ level II-2
 - temporomandibular joint and occlusion morphology disorder, there was no significant difference between the two groups⁽⁴⁰⁾ level II-2; ⁽⁴¹⁾ level II-2
- Nevertheless, primary papers included in these observational studies were of low to moderate risk of bias, thus clinical trials are needed to support the evidence.

Another systematic review comparing effectiveness between orthodontic space closure versus implant-supported and tooth-supported dental prostheses for MxLI agenesis showed in terms of:⁽⁴²⁾ level II-2

- aesthetics
 - no significant differences in terms of patient's opinion on shape, symmetry and distribution of spaces in upper anterior teeth except for colour of teeth where more patients in the PR (80%) were satisfied than in the SC (45%) ($p < 0.01$)
 - no significant differences of the width-to-height ratio of the 6 anterior teeth and the gingival zenith of the tooth or the dental prosthesis located in the position of the lateral incisor between the two groups
 - increased interdental space in the implant group ($p < 0.05$)
 - periodontal status
 - three observational studies found no significant difference in gingival recession of upper premolars between SC and PR
 - occlusal function
 - prevalence of group function in SC (96-100%) was more than PR (67-89%)
 - no statistically significant difference in the temporomandibular disorder (TMD) index (modified Helkimo) between the two groups
- However, the included primary papers are of moderate quality.

In a retrospective cohort study to evaluate periodontal health status between agenesis of MxLI with orthodontic space closure (AG) and control group (CG) over a 10-year period showed in terms of $f^{(43)}$ level II-2

- probing depth:
 - in AG, only 0.5% had a pocket depth > 4 mm, and 2.4% sites were 4 mm
 - no significant differences between the two groups.
 - 97.1% of probing pocket depths were within normal limits (4mm) in both groups
- bleeding on probing:
 - was observed in 8.6% of the 3942 examined sites in AG whilst 17.6% of the 1536 examined sites in CG
 - significantly higher in the interproximal sites in CG compared to AG ($p < 0.05$) however, no significant differences on the labial and lingual sites in both groups
- gingival recession and tooth mobility:
 - no significant differences between the two groups

This study also reviewed occlusal function and TMD. The study found most patients had group function occlusion in lateral excursions both in AG (92.3%) and CG (68%) with a small percentage having a canine-raised occlusion. The quality of the study is moderate, due to the small sample size, and because the control group only included non-extraction orthodontic patients.

Figure 8 illustrates a case where spaces had been closed orthodontically and the canines resembled missing MxLI.⁽⁵⁾



Figure 8: Orthodontic space closure

Recommendation 7

If both orthodontic space closure and prosthetic replacement is a viable option in hypodontia cases, orthodontic space closure should be considered.

b. Missing Mandibular Second Premolars

Congenitally missing mandibular second premolars have less aesthetic impact compared to missing MxLI, but careful management is still required.⁽⁴⁴⁾

- In a crowded arch, retained second deciduous molars should be removed and the space closed.
- In a well aligned or spaced arch, closing the space may cause excessive retraction of the anterior teeth. However, second deciduous molar:
 - can be kept if the long-term prognosis is good
 - should be extracted if the prognosis is poor and the space should be restored
 - extraction may result in a decrease in alveolar width, which can pose challenges for implant placement

6.3.2 Modification of Tooth Size and Shape

Orthodontic space closure with canine substitution or existing residual space without malalignment where no orthodontic intervention needed often requires modification of tooth size and shape by reshaping with composite restoration build up or porcelain laminate veneers.

A systematic review of 30 cohort studies evaluating effectiveness of porcelain laminate veneers (PLVs) showed survival rate at long-term (>10 years) ranged from 73% to 100%, at medium-term (6-10

years) ranged from 47% to 100% and at short term (<5 years) was more than 90%.⁽⁴⁵⁾ level II-2 Included primary studies in this review were of moderate to good quality. However, the studies included patients who received PLVs irrespective of their hypodontia status, but the presence or absence of hypodontia did not have an impact on the survival rate of the PLVs.

Figure 9 illustrates a combination of missing right MxLI and peg-shaped left MxLI. Treatment involved orthodontic space closure with composite build-up of left MxLI and right maxillary canine.⁽⁴⁶⁾

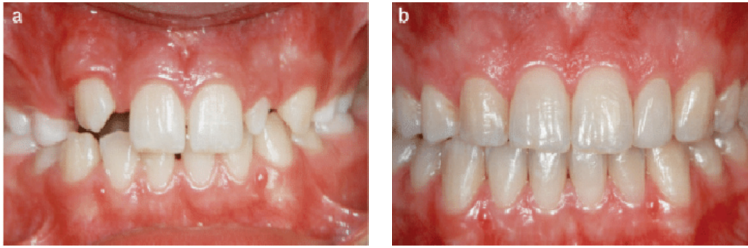


Figure 9: Orthodontic space closure with composite build-up

6.4 Management by Space Opening

Space opening approach in hypodontia patients can vary depending on the individual's needs and the available treatment options. This will require multidisciplinary management from various dental specialties such as orthodontist, paediatric dental specialist, periodontist, restorative specialist, and oral maxillofacial surgeon.

Factors to be considered for space opening:

- facial profile
 - Class I malocclusion with normal intercuspation of posterior teeth
 - Class II malocclusion with well aligned or spaced mandibular dentition
 - Class III malocclusion with a concave facial profile or spaced maxillary dentition
- multiple missing teeth
- cost
 - depends on type of definitive prosthesis

6.4.1 Orthodontic Space Opening

Space opening involves orthodontic space redistribution to create enough space for future dental replacements such as an implant, bridge, removable denture or autotransplantation. However, the specific treatment plan should be determined by experienced and trained clinicians.

6.4.2 Rehabilitation with Prosthetic Replacement

There are various types of prosthetic replacements available for the treatment of hypodontia. These prosthetic replacements aim to improve the patient's appearance and function of the dentition, as well as to prevent further complications such as bone loss and malalignment of the remaining teeth. Prosthetic replacements for hypodontia patients include dental implants, resin-bonded bridge (RBB), fixed partial dentures (conventional bridgework) and removable dentures. The choice of prosthetic replacement will depend on various factors such as growth, extent of the missing teeth, status of remaining dentition, financial status and patient's preferences.

The survival rate is defined as the likelihood that the prosthetic replacement will remain securely in place and functioning for the intended duration.

a. Implant

Two systematic reviews of 20 observational studies of dental implants in hypodontia patients showed survival rate:

- 86% to 100% with follow-up ranging from 0.1 to 18 years.⁽³²⁾ level II-2
- 35.7% to 98.7% (mean 93.7%). Most implants were lost during the first year after placement. No long-term results (>10 years) are available.⁽⁴⁷⁾ level II-2

Key Message 5

Factors to be considered prior to implant placement in hypodontia patient:

- Medical condition
- Completion of growth
- Oral hygiene
- Thickness of ridge or bone volume at hypodontia site
- Diameter of dental implant
- Space availability
- Root parallelism
- Operator skill
- Cost

Figure 10 illustrates a patient with missing right MxLI where space had been opened orthodontically before dental implant placement five years later.⁽⁴⁸⁾

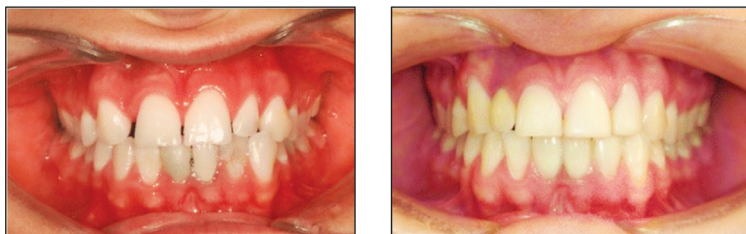


Figure 10: Pre- and post-implant treatment of missing right MxLI

b. Bridge

i. Resin-Bonded Bridge

Two systematic reviews of 21 moderate quality studies were conducted on the survival rate of RBB showed:

- in 24 months was 96.9% and 100 months was 59%⁽³²⁾ level II-2
- in 5 years was 83.6% (CI: 0.77 to 0.886) and 10 years was 64.9% (CI: 0.478 to 0.789)⁽⁴⁹⁾ level II-2

A systematic review of five studies comparing effectiveness between single-retainer versus two-retainer RBB among patients with missing anterior teeth.⁽⁵⁰⁾ level I

- A prospective cohort study showed significantly lower failure rates in single-retainer cantilever RBB (OR=0.08, 95% CI 0.01 to 0.75) compared to two-retainer RBB
- No significant difference in terms of debonding between the two groups in all the studies

Another good quality systematic review of one RCT and seven observational studies with moderate risk of bias at estimated 5-years follow-up among patients who require all-ceramic RBB in the replacement of missing teeth showed:⁽⁵¹⁾ level I

- cantilevered design (single-retainer) of all-ceramic RBB had a significantly higher survival rate (RBB remaining in situ for the follow-up time without multiple debonding) compared with the two-retainer design (98.1% vs. 92.0%, $p < 0.01$)
- two-retainer design of all-ceramic RBB had a significantly higher debonding rate compared to cantilevered design (7.2% vs. 6.1%, $p < 0.05$)
- two-retainer design of all-ceramic RBB had a significantly higher fracture rate compared to cantilevered design (10.7% vs. 1.4%, $p < 0.01$)

Figure 11 illustrates orthodontic space opening followed by composite build-up of right MxLI and prosthetic replacement for left MxLI with RBB.⁽⁵⁾

- Right MxLI is a microdont and left MxLI is missing (**Figure 11a**)
- Space was opened orthodontically for the missing left MxLI (**Figure 11b**)
- Right MxLI was built-up with composite and an RBB replaced the left MxLI (**Figure 11c**)



Figure 11a: Pre-orthodontic treatment



Figure 11b: Post-orthodontic treatment



Figure 11c: Post-restorative treatment

Figure 12 illustrates prosthetic replacement with single retainer RBB to replace missing right mandibular second premolar



Figure 12: Pre- and post-prosthetic replacement

Figure 13 illustrates fabrication of two-retainer RBB to replace missing mandibular central incisors.

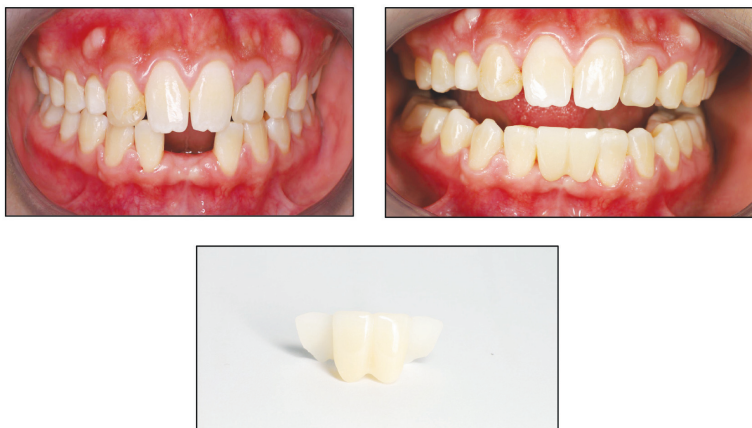


Figure 13: Missing mandibular central incisors replaced with two-retainer RBB

ii. Conventional Bridge

There is a scarcity of literature reporting on the use and outcomes of conventional bridgework (fixed partial dentures), specifically in hypodontia patients. This is likely because most hypodontia patients receive treatment at a younger age where abutment teeth have large pulp chambers. Thus, bridgework preparation of the abutment teeth would be destructive to the healthy tooth structure.⁽³²⁾ level II-2

c. Partial Denture

Removable partial dentures can be an interim phase as space maintainer and for stability before implant therapy or prior to definitive treatment, in severe hypodontia patients.⁽³⁴⁾ However, it may need to be replaced within 3.5 to 4 years on average due to its deteriorated appearance, fracture, wear or oral changes.⁽⁴⁷⁾ level II-2 It also can be the definitive treatment for patients who cannot afford or refuse any fixed prosthesis replacement.

6.4.3 Autotransplantation

Autotransplantation can be an alternative for missing tooth replacement. It is a technique that involves surgical transplantation of a donor tooth to a receptor site in the same individual. It can be performed at an early age in a growing patient.⁽⁵²⁾ In current practice, ideal timing for the tooth

to be transplanted is when root development is between one half to two thirds completed.

The survival rate of an autotransplanted tooth is commonly assessed by the percentage of transplanted teeth present at the time of examination over the total number of transplanted teeth. The success rate is usually based on the presence of the tooth in the mouth without ankylosis or inflammatory root resorption, and/or continuation of root development.

A meta-analysis of 17 observational studies assessing open apex autotransplanted teeth with or without socket preparation for a minimum 12 months follow-up showed:⁽⁵³⁾ level II-2

- success rate
 - was higher in premolars compare to molars (OR=0.46, 95% CI 0.25 to 0.84)
 - no significant difference in terms of development stage of the root and receptor site (maxilla and mandible)
- survival rate was 98.21% (95% CI 96.99 to 99.44)

However, the quality of included primary papers were of high risk of bias.

Another meta-analysis of six observational studies with at least 6 years of follow-up assessing the prognosis of autotransplanted teeth in replacing missing teeth found:⁽⁵⁴⁾ level II-2

- prevalence of survival rate was 81% (95% CI 0.738 to 0.866)
- rate of ankylosis was 4.8% (95% CI 0.023 to 0.098)
- rate of root resorption was 4%, (95% CI 0.018 to 0.085)

However, the included primary papers were of moderate risk of bias.

In a systematic review of 11 studies assessing on autotransplantation regardless mature or immature teeth with a minimum follow-up of 12 months showed success rate ranged 44% to 96% and survival rate ranged 87% to 100%.⁽³³⁾ level I

Autotransplantation of premolar to missing incisor site is recommended if:⁽³⁴⁾

- donor premolar roots are less than ¾ formed
- multiple incisors are missing
- the procedure is handled by skilled surgeons

Subsequently, the autotransplanted teeth may require root canal treatment depending on the root maturity followed by permanent restoration.

Autotransplantation is a valuable technique for treating hypodontia patients. However, it is important to note that the success of the procedure is highly technique-sensitive by the dental professional. The benefits can only be achieved if the procedure is performed with precision and expertise.

Recommendations 8

Autotransplantation may be considered using premolars with open apex in hypodontia patients.

Management of hypodontia is summarised in **Appendix 6**.

7. POST-ORTHODONTIC TREATMENT RETENTION

Retention is the final phase of orthodontic treatment with the aim to maintain the teeth in their corrected positions after completion of orthodontic treatment. Teeth tend to move back to its original position which is known as relapse. Orthodontic retainers are needed to prevent relapse.

Orthodontic retainers can be categorised into removable and fixed retainers. Removable retainers can be removed by the patient for cleaning and eating and are worn as prescribed by the clinician. Fixed retainers (bonded retainers) are typically bonded to the lingual or palatal surface of the teeth and cannot be removed by the patient.

Both types of retainers have their advantages and disadvantages, and the choice between them often depends on the patient's individual needs and preferences.

7.1 Removable Retainer

Removable retainers which are most commonly used are Hawley and vacuum-formed retainers. Vacuum-formed retainers are also known as thermoplastic or Essix retainers.

A systematic review investigating the performance of the Hawley-type retainers compared with other types of retainers.⁽⁵⁵⁾ level I

- Two RCTs showed no significant difference between the two types of retainers in terms of survival, lost retainer, assessment of occlusion, discomfort, self-reported compliance at 3 months, speech, overjet (OJ), overbite (OB), intercanine width (ICW), intermolar width (IMW), and arch length.
- An RCT showed significantly greater dental arch measurements changes by using Little's Irregularity Index in Hawley retainer at six months follow-up ($p < 0.05$).
- Another RCT showed relapse during retention in terms of teeth rotation was significantly higher in Hawley retainers compared to thermoplastic ($p < 0.04$) in nine months follow-up.

However, possible adverse effects related to the retainers were not investigated in this study.

A Cochrane systematic review of 13 RCTs, of low to moderate quality was assessed for effectiveness and safety comparing Hawley retainer vs thermoplastic retainer showed significant difference in terms of.⁽⁵⁶⁾ level I

- stability (Little's Irregularity Index)
 - in upper arch, more relapse was found in Hawley retainer (MD= 0.25 mm, 95% CI 0.08 to 0.42)

- in lower arch, thermoplastic retainers were better compared to Hawley (MD=0.42, CI 95% 0.23 to 0.61), and Begg retainers (MD=0.25, 95% CI 0.19 to 0.31)

However, there is no significant difference between part-time wear compared full-time wear in both groups.

- failure
 - Hawley retainers were more likely to break (RR=2.96, 95% CI 1.58 to 5.55)
- patient satisfaction
 - ability to wear retainer as instructed was higher in thermoplastic retainers (RR=0.89, 95% CI 0.83 to 0.96)
 - feeling embarrassed by the retainers was less with thermoplastic retainers (RR=2.42, 95% CI 1.30 to 4.49)
 - Hawley retainers were more difficult to wear (RR=9.37, 95% CI 3.80 to 23.10)

An RCT in a systematic review comparing the efficacy of vacuum-formed and Hawley retainers in retaining corrected tooth rotations showed derotated teeth are better retained with thermoplastic retainers (9 months part time) than with Hawley retainers (3 months full time, 6 months part time)⁽⁵⁷⁾ level I

Figure 14 and **Figure 15** illustrate the use of a Hawley retainer to replace the missing left maxillary central incisor and Essix retainers with pontic of maxillary left central incisor respectively.⁽⁵⁸⁾



Figure 14: Hawley retainer with pontic



Figure 15: Essix retainer with pontic

Key messages 6

Factors to be considered when prescribing types of retainers for hypodontia patients are:

- initial malocclusion
- treatment modality (open space or close space)
- tendency of relapse
- oral hygiene
- patients' compliance
- patients' preference
- operator's skill & laboratory support
- cost

7.2 Fixed Retainer

A meta-analysis comprising eight RCTs evaluating the amount of relapse of anterior crowding and effectiveness of retention appliances after fixed orthodontic treatment between 6 and 24 months follow-up using Little's Irregularity Index showed:⁽⁵⁹⁾ level I

- significant relapse for:
 - mandibular removable retainers (MD=0.72mm, 95% CI 0.47 to 0.98)
 - maxillary removable retainers (MD=0.48mm, 95% CI 0.27 to 0.68)
- no significant changes were found for mandibular fixed retainers.

Even though removable retainers had small statistical differences in the alignment of both arches, it is not clinically significant.

Dual retention, which is a fixed retainer combined with removable retainer worn at night, is usually indicated for high relapse tendency among hypodontia patients.

Due to a lack of sufficient evidence-based studies on orthodontic retention, expert opinions and clinical evidence are often relied upon to determine the best long-term maintenance for treatment results. Therefore, it is important for clinicians to assess each individual patient with hypodontia to determine types of retention.

Figure 16 illustrates fixed retainer in a patient with missing single mandibular incisor.



Figure 16: Mandibular fixed retainer

Recommendation 9

Dual retention may be considered among hypodontia patients with high relapse tendency.

8. IMPACT ON ORAL HEALTH-RELATED QUALITY OF LIFE

Oral health-related quality of life (OHRQoL) is the extent to which oral disorders could affect function and psychosocial wellbeing. Many instruments had been developed to assess OHRQoL such as the Oral Health Impact Profile (OHIP), Child Perceptions Questionnaire (CPQ) and condition-specific-quality-of-life-in-children-with-developmentally-absent-teeth (ChildQoLDAT).

The OHIP is a validated questionnaire with seven domains namely functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. The CPQ is another validated questionnaire assessing impact in oral symptoms, functional limitation, emotional and social wellbeing of children. Meanwhile, ChildQoLDAT is a condition-specific questionnaire for assessing OHRQoL in patients with hypodontia.

In a prospective (pre-post) study assessing the impact of implant retained crowns on OHRQoL using OHIP-20 among hypodontia in the anterior maxilla found that significant improvement in OHRQoL following treatment ($p=0.026$) with the effect size of 1.17, indicating a large clinically meaningful change at 24 months post-treatment.⁽⁶⁰⁾ level II-3 However, the study had a small sample size.

A cross-sectional study comparing agenesis and non-agenesis using OHIP-14 among participants aged 14 to 55 years old revealed that the agenesis group has significantly higher overall mean score ($p=0.01$), indicating poorer OHRQoL, and in the specific domain:

- psychological discomfort ($p=0.04$)
- psychological disability ($p=0.01$)
- social disability ($p=0.04$).

However, other four domains i.e. functional limitation, physical pain, physical disability and handicap were not significant between the two groups.⁽⁶¹⁾ level III Unfortunately, the severity of hypodontia was not taken into consideration in this study.

A small cross-sectional study in children aged 11 to 14 years old showed overall scores of CPQ were significantly higher with tooth agenesis ($p=0.001$) compared to non-agenesis in all the domains (oral symptoms, functional limitations, social well-being and emotional well-being), indicating poorer OHRQoL. No significant correlation was detected between the number of missing teeth and the quality of life score.⁽⁶²⁾ level III

Another cross sectional study using ChildQoLDAT questionnaire among oligodontia children revealed that younger children (11–12 years old)

were less negatively affected ($p=0.048$) by their condition than the older ones (13–17 years).⁽⁴⁷⁾ level III

Despite limited available evidence and heterogeneity of tools used to measure OHRQoL, hypodontia does have a negative impact on OHRQoL and can vary among individuals.

Key message 7

Hypodontia has a negative impact on oral health-related quality of life (OHRQoL) however, it can be improved with appropriate management.

9. IMPLEMENTING THE GUIDELINES

The implementation of this CPG is the responsibility of the healthcare providers. The management of hypodontia should be guided by an evidence-based approach in order to provide safe and optimum care for the patients. Clinicians are required to keep abreast with knowledge through continuing professional education as well as understanding of patients' expectations.

Therefore, it is important for these guidelines to be disseminated to all healthcare professionals in primary and secondary healthcare facilities. This can be facilitated through the development of appropriate training modules and quick references. Several factors may affect the implementation of the recommendations of the CPG.

9.1 Facilitating and Limiting Factors

Existing facilitators for application of the recommendations in the CPG include:

- a) wide dissemination of the CPG to healthcare professionals and teaching institutions via printed and electronic copies
- b) continuing professional education on the management of hypodontia for healthcare professionals
- c) adequate facilities at primary and secondary care level for diagnosing and managing hypodontia patients

Existing barriers for application of the recommendations of the CPG include:

- a) lack of understanding or limited knowledge on the management of hypodontia patients
- b) variation in skills and treatment practices
- c) constraints in equipment and facilities

9.2 Potential Resource Implications

To implement the CPG, there must be strong commitment to:

- a) ensure widespread distribution of the CPG in hard and soft copy to healthcare professionals in primary and secondary healthcare facilities
- b) strengthen training of healthcare professionals to ensure knowledge and information is up to date

9.3 Proposed Clinical Audit Indicators

To assist in the implementation of the CPG, the following are proposed as clinical audit indicators for quality management of hypodontia:

Percentage of late referral* of hypodontia patients to orthodontic clinic	=	$\frac{\text{Number of late referral of hypodontia patients to orthodontic clinic in a period of time}}{\text{Total number of referral of hypodontia patients to orthodontic clinic in the same period of time}} \times 100\%$	
Target percentage : <30% of late referral of hypodontia patients to orthodontic clinic			

*Late referral is considered when referrals are made exceed 1.5 years from the hypodontia tooth's chronological eruption age. (Refer **Appendix 4**)

Appendix 1

Search Strategy

Literature search was carried out using the following electronic databases: Medline, Pubmed, Cochrane Database of Systematic Reviews (CDSR) and Embase while full text journal articles were retrieved from these databases. The following Medical Subject Heading terms of free text terms were used either singly or in combination. The literature search was limited to human study, English language and published articles from 2012 to 2023.

Clinical Question: What are the safe and effective early/interceptive treatments for hypodontia patients?

1. Anodontia/ **3923**
2. (ageneses, familial tooth or agenesis, familial tooth or anodontia or familial tooth agenesis or familial tooth agenesis or hypodontia or hypodontia oligodontia 1 or hypodontia oligodontia 1s or oligodontia 1, hypodontia or oligodontia 1s, hypodontia or tooth agenesis, familial or tooth agenesis, familial or tooth agenesis, selective, 1).mp **4797**
3. (hypodontia adj1 patient*).tw. **62**
4. 1 or 2 or 3 **4797**
5. Orthodontics, Interceptive/ or Orthodontics, Preventive/ **1704**
6. orthodontics, interceptive.mp. **1039**
7. orthodontics, preventive.mp. **761**
8. 5 or 6 or 7 **1708**
9. 4 and 8 **31**
10. limit 9 to (english language and humans and yr="2012 -Current") **6**

Appendix 2

Clinical Questions

1. What is the aetiology of hypodontia in permanent dentition?
2. What is the prevalence of hypodontia in permanent dentition?
3. What are the accurate types of investigations in diagnosing hypodontia patients?
4. What are the safe and effective early/interceptive treatments for hypodontia patients?
5. What are the safe and effective approaches in orthodontic space management for hypodontia patients?
6. What are the safe and effective tooth modifications or replacement options for hypodontia patients?
7. What are the indications of close space management for hypodontia patients?
8. What are the indications of open space management for hypodontia patients?
9. What are the implications of space management for hypodontia patients?
10. What are the safe and effective types of retention for orthodontically treated hypodontia patients?
11. What is the impact of hypodontia on oral health-related quality of life?

Appendix 3

International Classification of Diseases 11th Revision (ICD-11)²

Missing teeth is coded under LA30.

1. LA30.0 Anodontia

Description:

Anodontia is a genetic disorder commonly defined as the absence of all teeth, affecting both temporary and permanent dentitions, and is extremely rarely encountered in pure form without any associated abnormalities. Rare but more common than complete anodontia are hypodontia.

2. LA30.1 Hypodontia

Description :

Hypodontia presents as lack of one or a few (less than 6) permanent teeth, without any systemic disorders.

Inclusions :

Congenital absence of one tooth

3. LA30.2 Oligodontia

Description :

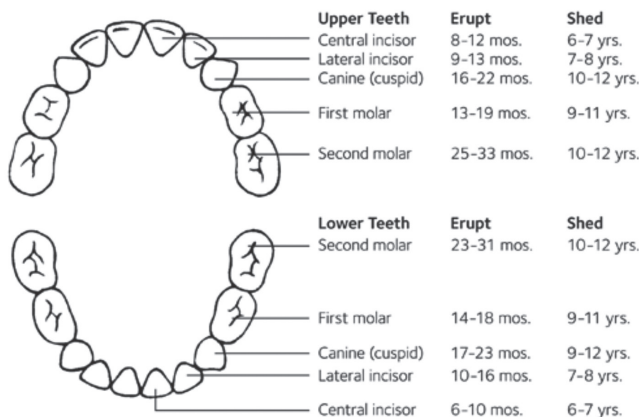
A genetic condition characterised by the development of fewer than the normal number of teeth. The diagnosis of Oligodontia is usually made in cases in which more than six teeth are missing.

Source: https://icd.who.int/devct11/icd11_mms/en/beta

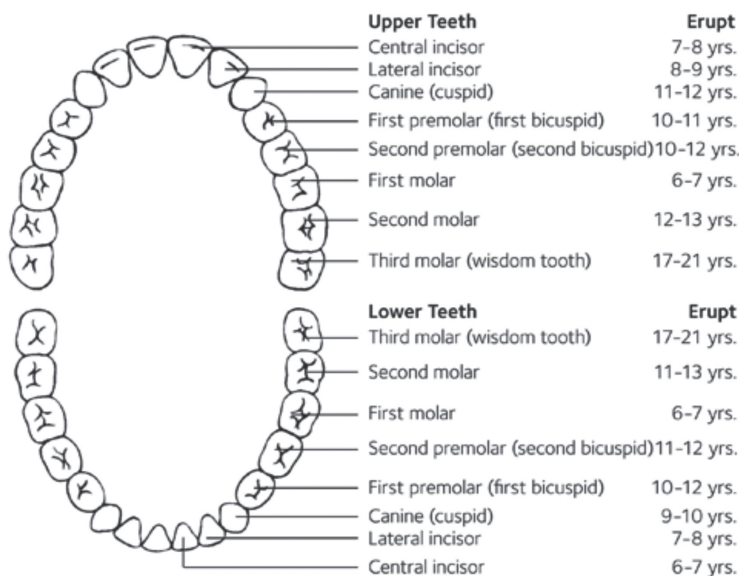
Appendix 4

Tooth Eruption Charts

Tooth Eruption Charts for the deciduous dentition



Tooth Eruption Charts for the permanent dentition



Appendix 5

The Dental Health Component of Index of Orthodontic Treatment Need (IOTN)

Dental Health Component of IOTN (Treatment from a dental health perspective)	
Grade 5 (very great)	<ul style="list-style-type: none"> a Increased overjet > 9 mm h Extensive hypodontia with restorative implications (more than one tooth missing in any quadrant) requiring pre-restorative orthodontics l Impeded eruption of teeth (with the exception of third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause m Reverse overjet greater than 3.5 mm with reported masticatory and speech difficulties p Defects of cleft lip and palate s Submerged deciduous teeth
Grade 4 (great)	<ul style="list-style-type: none"> a Increased overjet > 6 mm but ≤ 9 mm b Reverse overjet > 3.5 mm with no masticatory or speech difficulties c Anterior or posterior crossbites with > 2 mm discrepancy between retruded contact position and intercuspal position d Severe displacements of teeth > 4 mm e Extreme lateral or anterior open bites > 4 mm f Increased and complete overbite with gingival or palatal trauma h Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis l Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments m Reverse overjet greater than 1 mm but ≤ 3.5 mm with recorded masticatory and speech difficulties t Partially erupted teeth, tipped and impacted against adjacent teeth. x Supplemental teeth.
Grade 3 (Borderline)	<ul style="list-style-type: none"> a Increased overjet > 3.5 mm but ≤ 6 mm with incompetent lips. b Reverse overjet greater than 1 mm but ≤ 3.5 mm c Anterior or posterior crossbites with > 1 mm but ≤ 2 mm discrepancy between retruded contact position and intercuspal position d Displacements of teeth > 2 mm but to ≤ 4 mm e Lateral or anterior open bites greater than 2 mm but ≤ 4 mm f Increased and complete overbite without gingival or palatal trauma
Grade 2 (little)	<ul style="list-style-type: none"> a Increased overjet > 3.5 mm but ≤ 6 mm with competent lips. b Reverse overjet > 0 mm but ≤ 1 mm c Anterior or posterior crossbites with ≤ 1 mm discrepancy between retruded contact position and intercuspal position d Displacements of teeth > 1 mm ≤ 2 mm e Anterior or posterior open bite > 1 mm but ≤ 2 mm f Increased overbite ≥ 3.5 without gingival contact g Prenormal or postnormal occlusions with no other anomalies. Includes up to half a unit discrepancy
Grade 1 (none)	Extremely minor malocclusions including displacements < 1 mm

Appendix 6

Summary Management of Hypodontia

Conservative Treatment			Preservation of deciduous teeth with acceptable occlusion. Patient satisfied with the dentition and not willing to commit lengthy and costly treatment.		
Interceptive Treatment			Reducing or eliminating the need for complex treatment by extraction of deciduous teeth with infraocclusion		
Management by Space Closure	Orthodontic space closure	Missing maxillary lateral incisors		Achieved either via orthodontically closing the space or modification of the tooth for aesthetic reasons. Factors to be considered for space closure: <ul style="list-style-type: none">• facial profile• canine angulation• shade of canine• gingival height	
		Missing mandibular second premolars			
	Modification of tooth size and shape				
Management by Space opening	Orthodontic space opening		Space opening involves orthodontic space redistribution to create enough space for future prosthetic replacements. Factors to be considered for space opening: <ul style="list-style-type: none">• facial profile• multiple missing teeth• cost		
	Rehabilitation with prosthetic replacement	Implant			
		Bridge			Resin Bonded Bridge
					Conventional bridge
	Partial Denture				
Autotransplantation					
Post-Orthodontic Treatment Retention	Removable retainer		Final phase to maintain the teeth in their corrected positions after completion of orthodontic treatment. The choice between the retainers depends on the patient's individual needs and preferences.		
	Fixed retainer				

LIST OF ABBREVIATIONS

AAPD	American Academy Of Paediatric Dentistry
AGREE	Appraisal Of Guidelines Research and Evaluation
CA	Chronological Age
CASP	Critical Appraisal Skill Programme
CBCT	Cone-Beam Computed Tomography
CDSR	Cochrane Database of Systematic Reviews
ChildQoLDAT	Condition-Specific-Quality-Of-Life-In-Children-With-Developmentally-Absent-Teeth
CI	Confidence Intervals
CPG	Clinical Practice Guidelines
CPQ	Child Perceptions Questionnaire
DA	Dental Age
GRADE	Grading of Recommendations, Assessment, Development and Evaluation
HTA	Health Technology Assessment
ICD-11	International Classification of Diseases 11th
ICW	Inter canine Width
IMW	Intermolar Width
IOTN	Index of Orthodontic Treatment Need
MaHTAS	Malaysia Health Technology Assessment Section
MD	Mean Difference
MOH	Ministry Of Health
MxLI	Maxillary Lateral Incisor
NNT	Number Needed to Treat
OB	Overbite
OHIP	Oral Health Impact Profile
OHP	Oral Health Programme
OHRQoL	Oral Health Related Quality of Life
OJ	Overjet
OR	Odd Ratio
PDC	Palatally Displaced Canine
PLVs	Porcelain Laminate Veneers
PR	Prosthetic Replacement
RBB	Resin-Bonded Bridge
RCT	Randomised Control Trials
RR	Relative Risk
SC	Space Closure
SD	Standard Deviation
TMD	Temporomandibular Disorders

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