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# Treatment Approaches for Developmentally Absent Second Premolars

**Abstract:** This paper sets out to discuss the treatment options available for the management of patients with agenesis of second premolars. These include: retention of the deciduous molar, extraction followed by space closure, extraction and utilization of the space for the correction of malocclusion and extraction followed by restoration of the edentulous space.

**Clinical Relevance:** Congenital absence of second premolars is a common clinical problem faced by practitioners. Dentists should be aware of the treatment options when managing such cases.

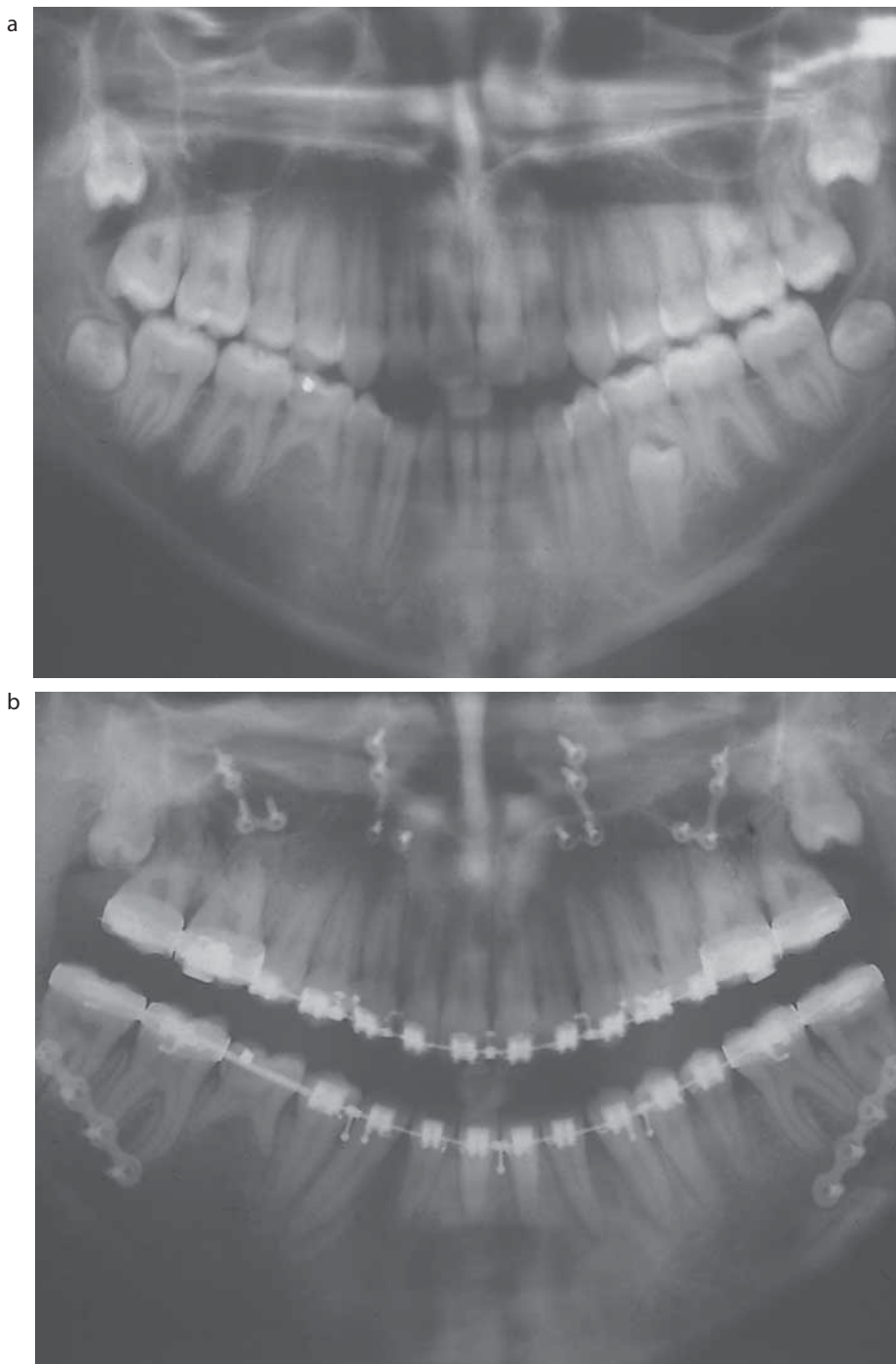
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Hypodontia is defined as the developmental absence of one or more teeth excluding the third molars. The prevalence of hypodontia in the permanent dentition is estimated to be between 3.5 and 6.5%.<sup>1</sup> Studies vary in their level of prevalence quoted as illustrated in Table 1,<sup>2,3,4,5</sup> with the main factor being differences in the population being investigated. Hypodontia is not only more prevalent amongst females, but also occurs with greater severity.<sup>6</sup> Several

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Author (year)	Study design	Sample size	Prevalence in males	Prevalence in females
Polder, Van't Hof, Van der Linden & Kuijpers-Jagtman <sup>2</sup> (2004)	Meta-analysis of 31 publications carried out in 2002.  Prevalence assessed by continent, race and gender. Statistical analysis determined by multiple regression analysis.		-Europe (white) 4.6% -N America (white) 3.2% -N America (African American) 3.2% -Chinese (Mongoloid) 6.1% -Australia (white) 5.5% -Saudi Arabia (white) 2.7%	-Europe (white) 6.3% -N America (white) 4.6% -N America (African American) 4.6% -Chinese (Mongoloid) 7.7% -Australia (white) 7.6% -Saudi Arabia (white) 2.2%
Silva Meza <sup>3</sup> (2003)	Retrospective study of orthodontic patients aged 9–20 yrs treated at Universidad Intercontinental, Mexico City between 1985-1999.	668 OPGs	78 subjects 11.7% (including third molars)	103 subjects 15.4% (including third molars)
Nordgarden, Jensen & Storhaug <sup>4</sup> (2002)	Prospective study of 18-yr-olds in Oslo & Akershus (Norway) during 1998-1999.	9,532	4.0%	5.1%
Backman & Wahlin <sup>5</sup> (2001)	Retrospective cross-sectional study of 7-yr-olds carried out in Umea (Sweden) during 1976.	739	6.5%	8.4%

**Table 1.** Recent studies of hypodontia prevalence (excluding third molars).



**Figure 1. (a)** OPG showing a lower right second deciduous molar in a patient of 12 years of age. **(b)** OPG shows the same patient at the age of 19 years when the majority of skeletal growth has occurred. Minimal root resorption of the retained deciduous molar occurred between the ages of 12 and 19 years. The retained deciduous molar was not included into the fixed appliance during orthodontic treatment as this can accelerate root resorption.

studies indicate that the mandibular second premolar is the most common missing tooth, followed by the maxillary

lateral incisor and second premolar.<sup>6,7,8</sup> Three percent of the population are estimated to have congenital absence

of second premolars and it occurs with bilateral symmetry in 60% of cases.<sup>6</sup>

## Diagnosis

Following a thorough history and dental examination, radiographic examination may be necessary to detect abnormalities of dental development.<sup>8</sup> Despite the fact that calcification of second premolars normally commences around 4 years of age, a large variation exists in the chronological development of second premolars. Congenital absence should only be diagnosed after the age of 9 years,<sup>9</sup> or in children with pronounced hypodontia after the age of 11 years in girls and 12 years in boys.<sup>7</sup>

## Treatment options

A number of treatment options can be considered in the management of developmentally absent second premolars and retained second deciduous molars. These include:

- Retention of the second deciduous molar(s);
- Extraction and spontaneous space closure;
- Extraction and orthodontic space closure;
- Extraction and utilization of the space for the treatment of malocclusion;
- Extraction and restoration of the space.

In determining the preferred treatment option, a number of factors must be considered. These are summarized in Table 2.

### Retention of the second deciduous molar

Little information exists within the literature relating to the long-term survival of retained deciduous molars. Sletten *et al.*<sup>10</sup> carried out a retrospective study in 2003, which reviewed 20 adult patients with radiographs spanning 5 years or more. Of the 28 retained deciduous molars, 24 were still in function. The remaining deciduous molars were lost owing to periodontal bone loss or caries, but none was lost to root resorption. Teeth which have a good root morphology and are minimally affected by caries may continue to function successfully for many years. None of the teeth within this study

had a reduced or slenderized mesio-distal width. Ostler and Kokich<sup>11</sup> have advocated the technique of reducing the width of a deciduous molar to a premolar pontic width to facilitate the placement of an appropriately sized pontic replacement when the deciduous molar is subsequently shed. Reducing the mesio-distal width may also provide space for the relief of crowding and help in the establishment of a Class I molar occlusion. Valencia, Saadia and Grinberg<sup>12</sup> have described controlled slicing of the deciduous molar to allow physiological mesial drift of the permanent molars. The amount of enamel reduction possible is limited by the thickness of approximal enamel and the mesio-distal divergence of the deciduous molar roots.

Factors that may jeopardize the long-term survival of these teeth include:

- Root resorption;
- Infra-occlusion;
- Caries or the presence of a large restoration.

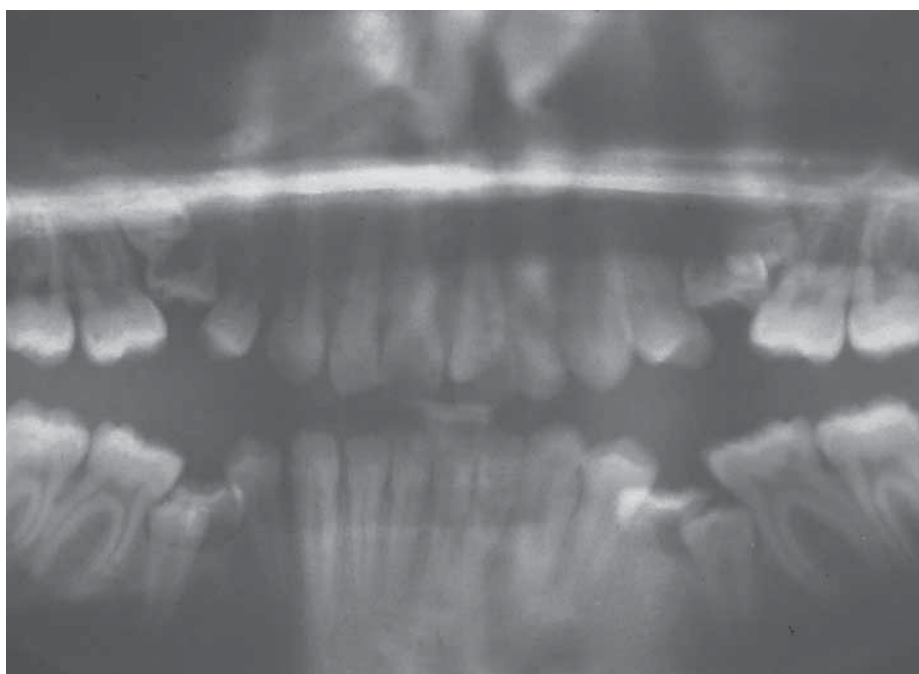
### Root resorption

From the results of studies (see Table 3)<sup>13,14,15</sup> it may be concluded that:

- The majority of roots will undergo progressive root resorption;

CRITERIA	FACTORS
1. Patient	<ul style="list-style-type: none"> <li>● Oral hygiene, compliance, motivation</li> </ul>
2. Long term prognosis of retained deciduous molar	<ul style="list-style-type: none"> <li>● Level of caries, root resorption, infra-occlusion, alveolar bone loss, toothwear</li> </ul>
3. Condition of the rest of the dentition	<ul style="list-style-type: none"> <li>● Caries, periodontal state, restorative state, toothwear</li> </ul>
4. Age of the patient	<ul style="list-style-type: none"> <li>● Younger patients: spontaneous space closure may be a valid option</li> <li>● Older patients: spontaneous space closure may be prolonged with risk of alveolar atrophy</li> </ul>
5. Malocclusion	<ul style="list-style-type: none"> <li>● Class I: consider maintaining the retained deciduous molars or extraction of 4 units in crowded cases</li> <li>● Class II: upper deciduous molar extraction space may be used for overjet reduction. Lower deciduous molar extraction space may provide valuable intermaxillary anchorage and permit molar correction. In a well aligned lower arch it may be preferable to retain the deciduous molar in order to maintain the position of the lower labial segment</li> <li>● Class III: lower extraction space can be used to retract the lower incisors</li> <li>● Low angle: space closure may be more difficult</li> </ul>
6. Degree of crowding	<ul style="list-style-type: none"> <li>● Extraction considered in moderate-severely crowded arches</li> <li>● Avoid extractions in spaced arches</li> </ul>

**Table 2.** Factors to consider when treatment planning cases with missing second premolars.



**Figure 2.** Ankylosis of the second deciduous molars has resulted in their submergence and exaggerated tipping of the adjacent teeth.



**Figure 3.** Tension arises in the transeptal fibres as the infra-occluded molar progressively moves below the level of the occlusal plane. The direction of this force results in occlusal features such as exaggerated tipping, reduced vertical development and centreline shifts of adjacent teeth.

- The rate of root resorption shows individual variation but progression is generally slow;
- Roots exhibiting small amounts of resorption at the age of 11–12 years are likely to be maintained to an age where the majority of skeletal growth

Author (year)	No. of subjects & age (at start)	No. of retained second deciduous molars	Observation period (yrs)	Level/rate of root resorption
Rune & Sarnas <sup>13</sup> (1984)	77 Males: 7.8–15 yrs  Females: 5.8–16.7 yrs	123	5	<ul style="list-style-type: none"> <li>50% maintained same level of resorption</li> <li>With resorption: took 4yrs to resorb by 25%</li> <li>Great individual variation</li> </ul>
Bjerklin & Bennett <sup>14</sup> (2000)	41  11–20 yrs	59	9	<ul style="list-style-type: none"> <li>70% underwent slow progressive resorption between 11–20 yrs</li> <li>At 11–12 yrs majority exhibited 25–50% resorption</li> <li>At 20yrs majority exhibited 50–75% resorption</li> <li>Progression was very slow although considerable individual variation</li> </ul>
Ith-Hansen & Kjaer <sup>15</sup> (2000)	18 subjects (25 at start with 6 drop-outs) No age stated, patients were in their late twenties at end of study	26	15	<ul style="list-style-type: none"> <li>26 retained molars remained <i>in situ</i></li> <li>20/26 showed no change in the degree of root resorption</li> </ul>

**Table 3.** Review of literature on root resorption of the deciduous molars with agenesis of the permanent successor.



**Figure 4.** Spontaneous space closure following enforced loss of the maxillary second deciduous molars. The first permanent molars have rotated mesio-palatally with migration.

mechanism that maintains the level of the occlusal plane during continued vertical skeletal development. Without compensatory eruption, an ankylosed tooth progressively becomes infra-occluded (Figure 2). Evidence suggests a genetic role in the aetiology of infra-occlusion because a high proportion of siblings of affected children are also affected by this condition.<sup>16</sup> The prevalence has been reported between 1.3% and 8.9%, with the mandibular first or second deciduous molars often cited as the most commonly affected teeth.<sup>17</sup> The large variation in reported prevalence may be related to age differences between the children investigated, differing definitions of infra-occlusion between studies, and the study of different racial groups. The prevalence of infra-occlusion appears to be higher in children affected by hypodontia, possibly reflecting a common aetiological mechanism.<sup>18</sup>

Table 4 summarizes the reported complications associated with infra-occlusion of deciduous molars.<sup>19</sup> Occlusal disturbances, such as tipping, inhibition of the vertical development of adjacent teeth and deviation of the dental centre-line to the affected side, have been proposed to result from the pull of transeptal periodontal fibres interlinking adjacent teeth (Figure 3).<sup>20</sup>

Table 5<sup>14,21</sup> provides a review of the studies investigating infra-occlusion of deciduous molars with agenesis of the permanent successor. It can be concluded that, when infra-occlusion affects a deciduous molar with no permanent

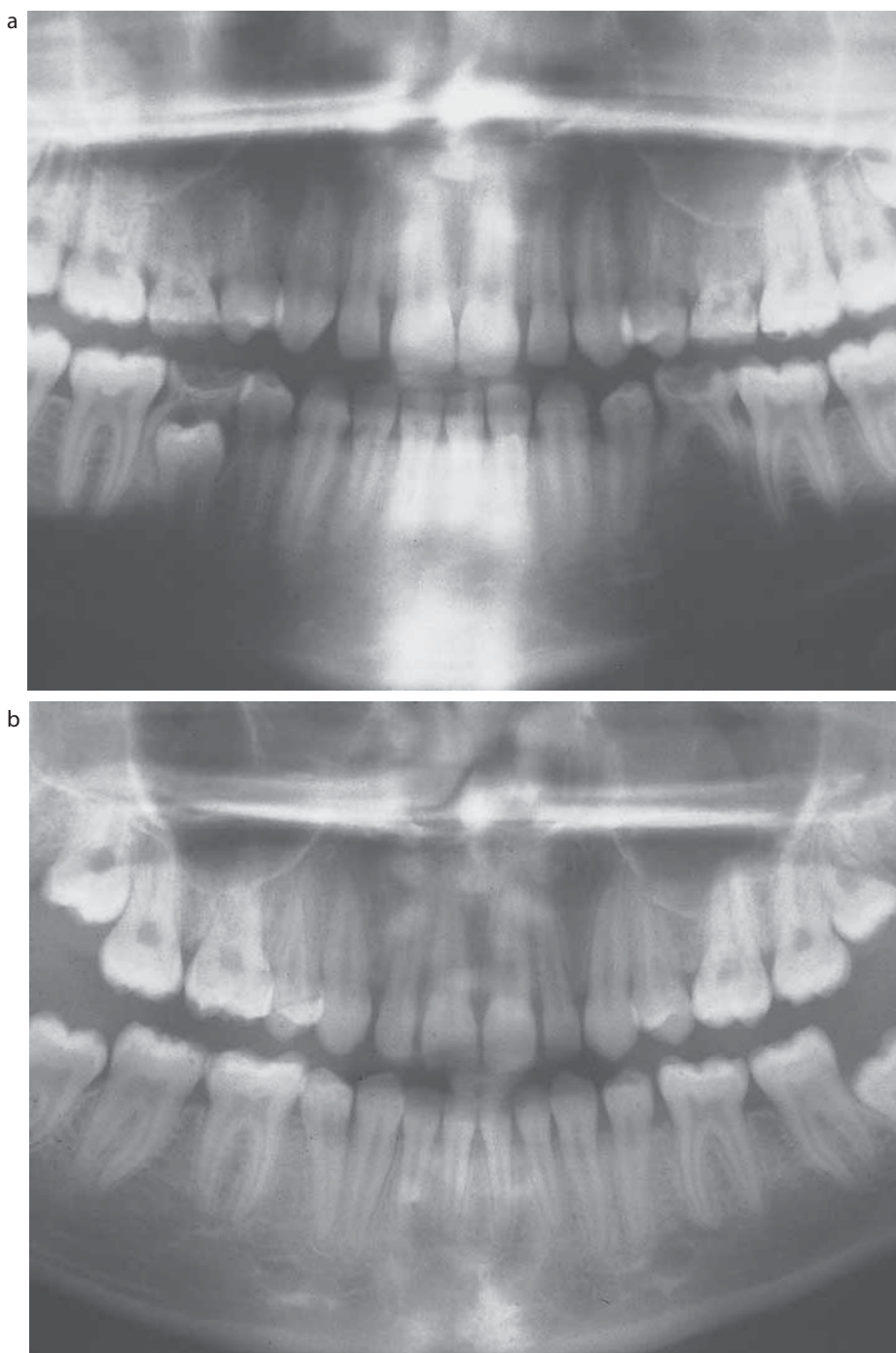
Feature	Consequences
Infra-occluded deciduous molar	<ol style="list-style-type: none"> <li>Delayed exfoliation</li> <li>Increased difficulty in extraction often requiring surgery</li> <li>Progressive development of infra-occlusion</li> </ol>
Permanent successor	<ol style="list-style-type: none"> <li>Delayed eruption or impaction</li> <li>Abnormal eruption pattern</li> <li>Disturbed root development</li> <li>Rotation of successor</li> <li>Cystic formation</li> </ol>
Developing occlusion	<ol style="list-style-type: none"> <li>Potential site for developing malocclusion</li> <li>Centre-line shift</li> <li>Overeruption of opposing teeth</li> <li>Tipping of adjacent teeth</li> <li>Localized open bite</li> <li>Inhibited vertical bone growth of the alveolar process</li> <li>Impaired masticatory function</li> <li>A higher frequency of impacted maxillary canines, ectopic first permanent molars, hypodontia and taurodontism possibly due to a common developmental mechanism</li> </ol>

**Table 4.** Complications associated with infra-occlusion of deciduous molars.

has occurred (Figure 1). Retention of such teeth helps to maintain alveolar bone, which can facilitate future restorative treatment.

#### **Infra-occlusion**

Ankylosis, an anatomical fusion between cementum and alveolar bone, prevents the compensatory eruptive



**Figure 5.** (a) Pretreatment OPG showing congenital absence of the maxillary second premolars and mandibular left second premolar. (b) Following loss of the retained deciduous molars and the mandibular right second premolar, the patient underwent comprehensive fixed appliance treatment. The post-treatment OPG demonstrated that the spaces were closed with minimal tipping using fixed appliances.

successor, the rate of progression is slow and therefore should not be an indication for immediate extraction.

Treatment options for infra-occluded teeth include:<sup>19,22</sup>

- Restoration of the occlusal surface to

help prevent tipping of adjacent teeth and overeruption of antagonist teeth. Restorative options include building up the occlusal surface with composite to occlude with the opposing arch or stainless steel crowns for carious teeth.

- Extraction if the adjacent teeth are severely tipped. Surgical removal, which carries the risk of mental nerve damage in the lower arch, may be necessary because the roots of ankylosed teeth have a tendency to fracture.

#### Extraction and spontaneous space closure

Correctly timed interceptive extraction of second deciduous molars may offer the following potential advantages:

- Spontaneous space closure with avoidance of restorative treatment, which may compromise the periodontal health of adjacent teeth and require long-term maintenance (Figure 4).
- Relief of crowding and increased likelihood of third molar eruption.<sup>23</sup>

Few studies have investigated the quantitative and qualitative aspects of spontaneous space closure following planned extraction of second deciduous molars. Lindqvist<sup>24</sup> followed up 101 children, aged between 5–12 years, over four years following the loss of second deciduous molars. The rate of space closure was not affected by the age of extraction, and approximately 2 mm of space remained in the lower arch and less than 1 mm in the upper arch at the end of the study period. When extractions were undertaken nearer the time of root completion of the adjacent teeth, greater tipping contributed to space closure.

Mamopoulou and co-workers<sup>25</sup> followed up 11 cases in which mandibular second deciduous molars were extracted, at a mean age of 11 years, in patients with well-aligned arches and fully erupted first premolars. The opposing maxillary second premolars were also extracted to aid mesial movement of the mandibular first molars. The majority of space closure occurred by mesial movement of the first molars, with distal movement of the first premolars averaging 1.5–2 mm during the first year. After one year, 55% (4.6 mm) and 46% (4.3 mm) of the space had closed in the maxilla and mandible, respectively.

After four years, 89% of the space in the maxilla (residual space 0.9 mm) and 80% in the mandible (residual space 2 mm) had closed. Regarding the quality of space closure, the first molars and premolars rotated and tipped into the extraction space. The mandibular centre-line shifted

by 0.8 mm to the extraction side, whilst there was no accompanying shift of the centre-line in the maxilla. The overbite and overjet remained stable for the duration of the study.

It can be concluded that extraction of second deciduous molars

may be considered in well-aligned arches after the age of 9 years (when a diagnosis of hypodontia can be made) and before root formation of the first premolar is complete. Consideration should be given to compensating the extraction of mandibular second deciduous molars, with the loss of the opposing maxillary second deciduous molar, to aid mesial migration of the mandibular first permanent molar. Fixed appliance treatment may be required in some cases to complete space closure and upright tipped teeth. A specialist orthodontic opinion should be obtained before making this treatment decision.

**Extraction and orthodontic space closure**

Fixed appliances may be used to achieve space closure more predictably than relying on spontaneous tooth movement, or as an adjunct to spontaneous tooth movement, where extraction spaces have not fully closed (Figure 5). Potential problems whilst using fixed appliances for such purposes include:

- A lengthy treatment period as a result of the difficulty in closing large spaces in the mandibular arch;
- The risk of retracting the lower incisors and deepening the overbite and increasing the overjet secondary to poor anchorage control;
- Causing displacement of the dental centre-line in cases of unilateral loss;
- Spaces reopening if the treated occlusion is not adequately retained.

The majority of these complications can be avoided by the careful use of fixed appliances. Complete space closure may not be the preferred treatment option, but controlled space closure to one premolar unit space to allow a premolar span pontic replacement can be considered.

**Extraction and space utilization for the correction of a malocclusion**

When fixed appliance treatment is planned, the space created by the loss of second deciduous molars may be used for the relief of dental crowding and/or incisor retraction.

**Class II malocclusions**

The loss of upper second

Author (year)	No. of subjects mean age	No. of infra-occluded deciduous molars	Observation period (yrs)	Level of infra-occlusion
Kuroi & Thilander <sup>21</sup> (1984)	12 10.9 yrs (mean age)	20	2.7	<ul style="list-style-type: none"> <li>● Start: 2.7 mm</li> <li>● Mean annual increase: 0.5±0.26mm</li> <li>● Progression slower in the older children</li> </ul>
Bjerklin & Bennett <sup>14</sup> (2000)	41 11–20 yrs of age	12/59 deciduous molars with aplasia of successional premolars	9	<ul style="list-style-type: none"> <li>● 11–12 yrs of age: 0.47 mm (SD = 1.13 mm)</li> <li>● 11–20 yrs of age: mean increase of 0.99 mm</li> <li>● No severe infra-occlusion found</li> <li>● 45% showed none</li> </ul>

**Table 5.** Review of literature regarding infra-occlusion of deciduous molars with agenesis of the permanent successor.

Complications of Transplantation	Prevention
<p><b>Loss of Vitality</b></p> <p><b>Root Resorption</b> Inflammatory (may be evident after 4 wks)</p> <p>Replacement (may be evident after 1 year)</p> <p><b>Incomplete Root Development</b></p> <p><b>Damage to the Inferior Dental Nerve</b></p>	<ul style="list-style-type: none"> <li>● Use of transplants with half to three-quarter root development has the best prognosis. The likelihood of vascularization reduces with apical maturity.</li> <li>● Minimal damage to periodontal ligament cells during removal.</li> <li>● Transplants with half to three-quarter root development ideal. Teeth with mature apices should be root treated within 4 wks of transplantation.</li> <li>● Non-rigid fixation for 7–10 days.</li> <li>● Minimal damage to Hertwig's root sheath during removal.</li> <li>● Teeth should be replanted in the alveolus at the same occlusal level as that of the donor site. Teeth placed at a more occlusal level develop a shorter root.</li> <li>● Careful preparation of the recipient socket. Teeth should not be placed too far below the occlusal plane if the mandibular canal is high.</li> </ul>

**Table 6.** Complications of transplantation and methods of prevention.



**Figure 6.** Resin-retained bridges have been used to replace the missing premolars. The retainers are extended maximally on the abutment teeth to maximize the bonding area and reduce the risk of bond failure.



**Figure 7.** (a) Implant replacing the missing lower left second premolar. Note the >1 mm of thickness of alveolar bone in between the implant and the adjacent tooth. (b) A clinical view of second premolar implant demonstrating the aesthetics that can be achieved.



**Figure 8.** Necking of the alveolar ridge following loss of the second deciduous molar can result in a lack of bone volume for implant placement.

deciduous molars does not produce an ideal anchorage balance for maximum retraction of the maxillary incisors. The use of intermaxillary Class II elastic traction can be significantly facilitated by the loss of mandibular second deciduous molars. The latter not only provides valuable intermaxillary anchorage, but also facilitates space closure, thus minimizing retraction of the lower labial segment. Further anchorage reinforcement may need to be considered in the maxillary arch, depending on the space requirements.

**Class III malocclusions**

In cases where maximum retraction of the lower incisors is desirable, the space obtained from the loss of second deciduous molars can be useful.

**Extraction and restoration of the space**

Extraction followed by restoration of the residual space may be considered in cases where:

- The retained deciduous molar has a poor long-term prognosis;
- Space is not required for the correction of a malocclusion;
- Orthodontic space closure is considered inappropriate.

Orthodontic treatment may still be required to allow space closure in order to reduce the pontic span or for tooth uprighting. Treatment options following the enforced loss of a retained deciduous molar include:

- Non-replacement of the missing molar;
- Tooth replacement with resin-bonded bridges, implant-retained prosthesis, removable prosthesis or autotransplantation.

**Non-replacement of the missing molar**

Non-replacement may be considered in poorly motivated patients who exhibit poor oral hygiene and caries control. This treatment option may also be considered for patients who do not show non-aesthetic dark spaces on smiling, where there is good interdigitation with minimal risk of tipping, rotation or overeruption taking place.

**Options for tooth replacement**

**Resin-retained bridges (Figure 6)**

The advantages of resin-

retained bridges include minimal tooth preparation, which is particularly important in younger patients who have large pulp chambers and they permit physiological tooth movement to occur. Disadvantages include difficulty in maintenance of oral hygiene, the risk of dental caries associated with undetected debond, the need for life-long maintenance and cost incurred to the patient. The failure rate of resin-retained bridges is highly variable and has been reported to range from 10% over 11 years to 54% over 11 months.<sup>26</sup> Adherence to particular design principles can help to improve the success of these restorations.

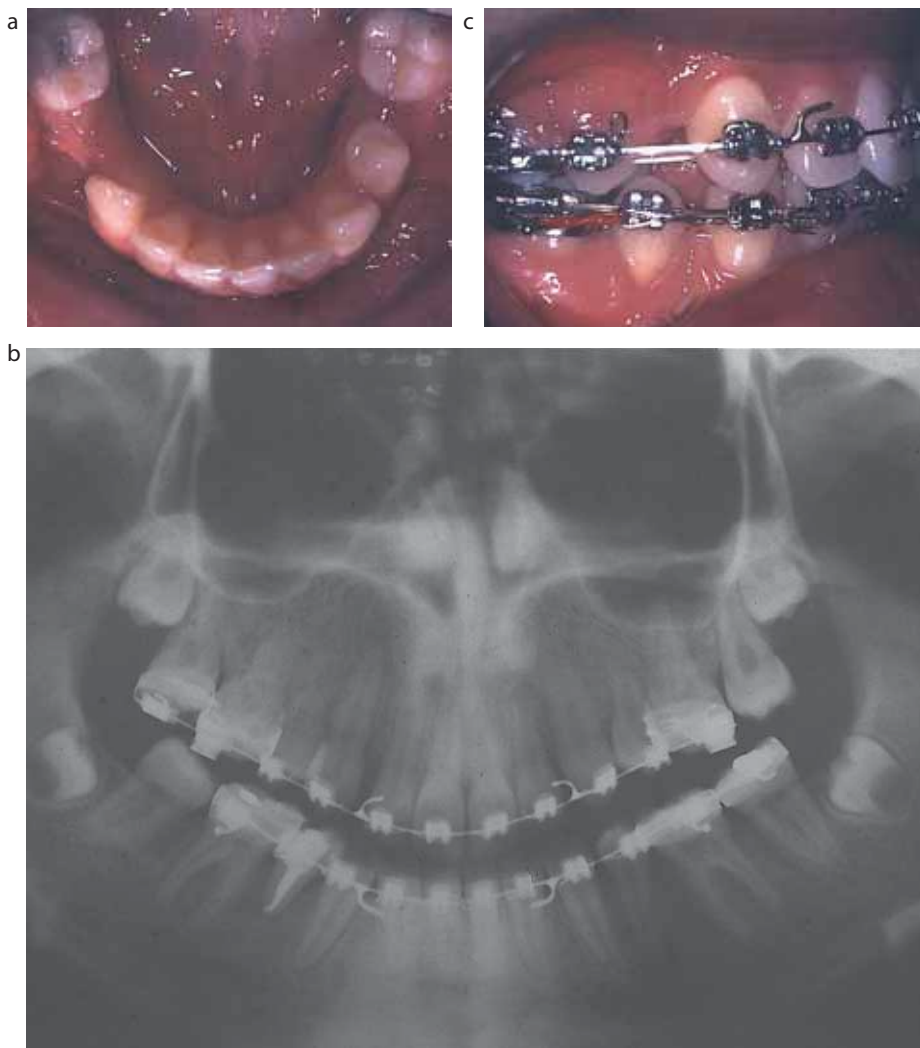
**Implants (Figure 7)**

Implant-retained prostheses offer a significant long-term solution. It is important that they are not placed in growing children because the implant is likely to submerge as it does not possess an eruptive mechanism to compensate for continued vertical skeletal growth.<sup>27</sup> As a result of the variability in skeletal growth that can be seen in some patients, it has been recommended that standing height measurements be taken in order to detect the end of statural growth.<sup>28</sup> After growth in height has reached a plateau, two lateral cephalographs should be taken 6–12 months apart and superimposed on the cranial base to confirm that minimal vertical skeletal growth is occurring.

The advantages of this form of restoration include:

- Minimal tooth preparation of abutment teeth is required; and
- Predictable results with significantly enhanced aesthetics can be achieved. However, the disadvantages include:
  - Dependence on adequate alveolar bone volume for implant placement (Figure 8);
  - The involvement of a surgical procedure which carries the risk of damaging the mental nerve if implants are considered in the lower premolar region;
  - The considerable expense involved; and
  - The need for long-term maintenance.

In cases where an ankylosed second deciduous molar is extracted late, the residual alveolar bone discrepancy may prevent placement of an implant. An alternative to alveolar bone grafting has been suggested recently for eliminating



**Figure 9.** (a) Pretreatment photograph of an edentulous site in the lower right second premolar region. (b) Post autotransplantation OPG showing the donated premolar *in situ* following root canal therapy. (c) Intra-oral view of transplanted tooth undergoing orthodontic treatment.

the requirement for this surgical procedure.<sup>28</sup> This involves using fixed appliances to move the first premolar distally into the second premolar space, which acts as a stimulus for bone formation at the defective site. The ridge that was previously occupied by the first premolar is often adequate in such cases to provide a suitable site for implant placement without the need for bone grafting. To ensure proper healing and development of the gingival papilla, it is essential that adequate space is created to accommodate the implant with at least 1 mm of surrounding alveolar bone.

#### Removable prostheses

A removable denture or a retainer can be used as a valuable space maintainer in patients who are judged too young to undergo replacement with a fixed prosthesis. The advantages of this form of restoration include:

- Facilitation of oral hygiene as the appliance is removable;
- Ease of adjustment in a developing dentition;
- No preparation of abutment teeth is necessary;
- The restoration is less expensive than other restorative options.

However, the main disadvantages are that wear is dependent on patient compliance and that this form of restoration does not maintain the alveolar bone height.

#### Autotransplantation

Autotransplantation may be defined as the transplantation of embedded, impacted or erupted teeth from one site to another in the same individual (Figure 9).<sup>29</sup> An important advantage of this procedure is that it helps to maintain or restore alveolar bone<sup>30</sup> and can be used in a growing patient, as the transplanted tooth erupts to compensate for skeletal growth. Maxillary third molars have suitable root morphology to be transplanted to the mandibular premolar region. The success rate of transplanted molars to premolar sites over six years has been reported to be 97% for teeth with open apices.<sup>31</sup> Patient factors that contraindicate transplantation include poor oral hygiene and a medical history that predisposes to infective endocarditis. Table 6 summarizes the complications that may arise following transplantation and the methods by which these may be reduced.

At least 3 months should elapse before applying active orthodontic forces, following transplantation, assuming normal healing.<sup>32</sup> In the long-term, a transplanted tooth usually achieves less than half the expected post-transplant root growth and pulpal obliteration is common.<sup>32</sup>

## Conclusions

All practitioners are likely to encounter patients with agenesis of second premolars. Patients may need to be referred to an orthodontist to arrange a multidisciplinary consultation with restorative and surgical colleagues for a comprehensive treatment plan. Owing to the variability in dental development, a firm diagnosis of hypodontia should not be made until the patient is at least nine years of age. A number of treatment options are available for the management of these patients dependent on the age of the patient, the long-term prognosis of the retained deciduous molar and the presenting malocclusion. Space closure



may be preferable because it avoids the need for long-term restoration and may provide adequate space for the eruption of crowded third molars. On the other hand, if space closure is thought to be inappropriate, then the options include, retention of the retained deciduous molar or restoration of the edentulous space using a variety of techniques.

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