Treatment planning in the presence of congenitally absent second premolars: a review of the literature

Lori Lee Santos

One of the most common dental anomalies encountered by the pediatric dentist is the congenital absence of second premolars. Once diagnosed, the appropriate treatment necessitates the formulation of a comprehensive treatment plan, which is dependent upon a number of factors. Considerations include: the condition of the deciduous molar, dental and skeletal relationships, dental age of the patient, willingness of the patient to undergo extensive dental treatment and financial considerations. Approaches to the management of congenitally missing premolars have been described in the literature, including the more recently available option of dental implant placement. The objective of this paper is to present a review of the literature with emphasis on the considerations needed for appropriate treatment planning when the practitioner is confronted with this diagnostic challenge.

J Clin Pediatr Dent 27(1): 13-18, 2002

INTRODUCTION

Hypodontia is the most common developmental anomaly of the dentition and except for third molars, the most commonly missing teeth are the second premolars.[1-3] As such, it is imperative that the pediatric dentist, often the first clinician to establish the diagnosis, be aware of the etiology of the condition, the factors to consider when treatment planning and options available for treatment.

Clinically, teeth that are congenitally absent pose a challenge to the parents and the clinician, both of whom desire optimal treatment for the child. A positive outcome in the presence of this dental imbalance necessitates the formulation of a comprehensive treatment plan, which considers the possibility of restorative treatment, orthodontic treatment and possibly future prosthetic treatment. Additionally, addressing this condition during the early stages of the dentition maximizes the potential for a functional, esthetic and stable result.

* Lori Lee Santos, DMD, Resident, Department of Pediatric Dentistry, University of Texas Health Science Center at San Antonio.

Send all correspondence to Dr. Lori Lee Santos, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900.

Voice: 210-567-3529
Fax: 210-567-3526
E-mail: lorileesantos@hotmail.com

PREVALENCE

The frequency of congenitally absent premolars in the literature ranges from 2 to 5%,[1-5] with agenesis reported to be slightly more common in the mandible than the maxilla.[4,6] Thus far, there have been no reported differences between males and females with respect to the number of premolars absent, sites affected or symmetry of the agenesis.[2,4,6] Agenesis of a single lower premolar occurs with the highest frequency followed by the absence of both lower second premolars.[5-7]

ETIOLOGY

The congenital absence of second premolars represents a disturbance in the developmental biology of the tooth, presenting either as an isolated trait or in association with a more generalized disturbance. It has been related to several factors, including an evolutionary trend toward a smaller jaw size and fewer teeth,[6,8] failure of lingual or distal proliferation of tooth bud cells from the dental lamina[9] and chemotherapy and/or radiotherapy at a young age.[10] In addition, a study by Kjaer *et al*.[11] suggested that the pathogenesis of tooth agenesis was related to disturbances in tissues that interacted during odontogenesis (nerve tissue, oral mucosa and supporting tissue). More recently, research has shown that the absence of premolars is genetically determined, with mutations in various genes causing a disturbance in cellular proliferation and/or differentiation. Specifically, mutations in the genes *Pax9* and *Msx1*, both of which are mesenchymal transcription factors, have been linked to premolar agenesis.[12-14] Research continues to

Figure 1. Congenital absence of mandibular second premolar is diagnosed radiographically. Note mild root resorption that has occurred even in the absence of a succedaneous tooth.

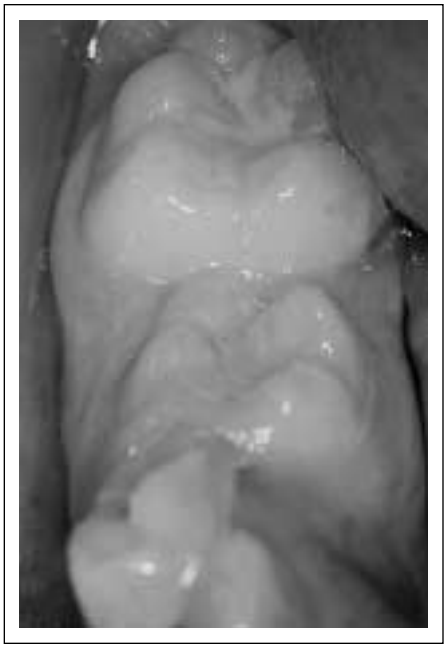

Figure 2. Severe infraocclusion of mandibular second primary molar lacking a permanent successor.

focus on furthering our understanding of the genetic and molecular basis of tooth formation.

DIAGNOSIS

Early recognition of congenitally absent premolars is essential for providing the patient with the optimal treatment plan. Due to the clinical nature of this condition, it is diagnosed radiographically, often as an incidental finding (Figure 1). Although odontogenesis of the second premolar begins in the majority of cases at the age of 2 to 2.5 years,[15] the range can vary widely.[16] By age 8, the dental follicle and/or cusp tip of the premolar should be visible on routine bitewings, however, the clinician should take caution against radiographic diagnosis earlier than 7 years of age, as late development of the tooth germ can occur.[17] Wisth *et al.*,[18] concluded from his study that such development is more likely to occur in boys, where the frequency of hypodontia decreased by 0.5% between 7 and 9 years of age. Once diagnosed, the clinician can begin to formulate a long-term treatment plan.

TREATMENT

There are essentially two treatment options when faced with a congenitally absent second premolar: the clinician can opt to either close the space previously occupied by the second deciduous molar or can maintain this space. The treatment decided upon is based upon a number of factors including the condition of the deciduous molar, dental and skeletal relationships, dental age of the patient, willingness of the patient to undergo potentially extensive dental treatment and financial considerations.

If the decision is space closure, then planned extraction of the deciduous molar is followed by either spontaneous or orthodontic space closure. Candidates include those having an appreciable arch length deficiency, whereby the occlusion would remain acceptable by redistribution of the existing space. Obvious contraindications include a deep bite, the presence of excess spacing between teeth and those patients with Class I occlusion showing minimal to no crowding.[19-22] In addition, if treatment is done during the mixed dentition, the parents and patient should be aware that future orthodontic treatment may still be warranted.

To achieve spontaneous space closure, the primary molar should be extracted before the completion of root development of the adjacent teeth and prior to the eruption of the second molar.[17,23] In most cases, 8 to 9 years of age is ideal to facilitate bodily movement and minimize tipping.[17,19,23] Lindqvist,[17] in a study looking at spontaneous space closure 4 years following second primary molar extraction in children aged 5 to 12 years, reported residual spaces of 2mm in the mandible and less than 1mm in the maxilla irrespective of the age at the time of extractions. He reported, however, tipping of the teeth adjacent to the extraction space was more marked in cases where the extractions were done after root development of adjacent teeth was complete. A similar study by Mamopoulou *et al.*[23] found most of the extraction space closed during the first year and at the end of 4 years found a mean residual space of 0.9mm in the maxilla and 2mm in the mandible. An average angle of 12 degrees of tipping of adjacent teeth was found in both studies.

If the child has already reached the permanent dentition stage and it has been decided that the primary molar is to be extracted with no space maintenance, then orthodontic space closure is the treatment of choice to minimize tipping of the adjacent teeth and

achieve ideal root parallelism.[17,21] Treatment approaches include: traditional bands and brackets or the Lingual Functional Appliance. The latter option, described by Kocadereli,[20] uses the tongue to contact the acrylic portion of the appliance during function, applying a mesial force to the first permanent molar.

The option to maintain the space occupied by the second deciduous molar is indicated in those patients having no arch length deficiency, cases where space closure would be unfavorable such as the presence of a deep bite, spacing between teeth, low angle cases, or whereby the patient or parent opts to keep a restorable or sound primary molar. Several treatment options are available including maintenance of the primary molar, space maintenance (in the case of a non-restorable molar) with future restorative options such as conventional prosthodontics or implants, and autotransplantation.

When opting to leave the primary molar *in situ*, the main concern is predicting long-term survival of the primary molar when there is risk of infraocclusion or root resorption, both of which can lead to eventual loss of the tooth.

Infraocclusion was described by Kurol[24] as when the occlusal surface of the primary molar is more than 1mm below the occlusal plane of fully erupted teeth. Several studies have supported the finding that infraoccluded teeth can be considered ankylosed,[24-26] although the cause of the ankylosis is not fully understood. When a premolar is developmentally absent, infraocclusion of the associated deciduous molar progresses further than when a successor is present and exfoliation is severely delayed.[27] It can range from 1 to 7mm and occurs more frequently in the mandible than the maxilla[24] (Figure 2).

Overeruption of the opposing dentition can occur, however normal vertical relationships occur as the permanent dentition settles.[28] Studies have found tipping of adjacent teeth is not a common problem, occurring only in cases of severe (4- to 7mm) infraocclusion.[17,19]

Bjerklin and Bennet[19] found second primary molars with no successors showed no typical pattern for the development of infraocclusion. They reported 6 to 14% of 6 to 11 year olds and 20% of 11 to 12 year olds showed greater than 1mm of submergence. Fifty-five percent of 19 to 20 year olds had 0.5 to 4.5mm of submergence of the mandibular second primary molars. They concluded infraocclusion is unpredictable and is generally not a problem for the survival of the primary molar.

The progress of root resorption of the primary molar is not fully understood and occurs regardless of the absence of the secondary tooth germ[19,29] (Figure 1). It is a very slow process and the rate of resorption varies between individuals, antimeres and roots of the same tooth. Bjerklin and Bennet[19] found that by age 11, 80% of primary molars with no successors had mild root resorption; by age 19 to 20, all roots had some degree of root resorption. They concluded it is not possible to predict the probability of survival of the primary molars at a very early age, but that the prognosis for the molars after 20 years of age is good.

If the primary molar is to be restored, conventional materials such as amalgam, resin composite and stainless steel crowns can be used. In cases of infraocclusion, the clinician can opt to restore the tooth with an occlusal resin composite "onlay" or appropriately positioned stainless steel crown to reestablish the occlusal plane and prevent the introduction of interfering contacts.[30] The patient and parent must be aware that in most cases, the primary molar is considered a long term temporary that will eventually need to be replaced by more definitive treatment.

If the primary molar is non-restorable, space maintenance is warranted and the patient is too young for conventional prosthodontics or implants, then a space maintainer can be placed. Such examples include a band and loop, band and bar[31] and "occlusal pad" appliance.[31] The patient should be recalled appropriately to monitor the condition of the banded teeth. Once growth is complete, the appliance is removed and the space restored.

With increased popularity and success of dental implants, many dentists and patients are opting to maintain space for future implant placement when mandibular second premolars are absent.[32,33] As such, the timing of second primary molar extraction has become a new concern. Ostler and Kokich[34] investigated the alveolar ridge changes following mandibular second primary molar extraction with no successor and found the alveolar ridge width decreased approximately 25% over a three year period (from 11.5mm to 8.5mm) and slowed over the next 4 years for an additional 4% loss of ridge width. The results suggest that the ridge resorbs to the dimension of the first premolar and maintains that dimension. The authors concluded that findings permit the extraction of the primary molar with little concern for the age of the patient. Because implants are usually postponed until the patient completes facial growth, delaying implant placement should not be detrimental, as ridge width stabilizes after initial narrowing.

Unfortunately, dental and skeletal growth is the major confounding variable when implants are used in children.[35] The major complication is failure of the dental implants to respond to vertical growth of adjacent teeth and alveolus due to ankylosis.[35-37] Therefore, it is still recommended to wait for the completion of dental and skeletal growth, except possibly in cases of severe ectodermal dysplasia.[37-39]

A final option available to the clinician for maintaining the space previously occupied by a non-restorable primary molar is autotransplantation, the surgical movement of a tooth from one location in the mouth to another in the same individual. Although not a common practice in North America, select cases could ben-

efit from this procedure. For younger patients, the transplant can replace the missing tooth, to ensure preservation of bone until growth has ceased and then, if needed, the patient can become a candidate for implants.[40] Recent studies demonstrate that autotransplantation of teeth can be as successful as dental implant placement when the appropriate protocol is followed.[41-43] Success is dependent on a number of factors.[44,45] The recipient site should have adequate bone support, keratinized gingiva and be free from infection and inflammation. Extraction of the donor tooth (often another premolar or third molar) must be as atraumatic as possible, so as to preserve the periodontal ligament. For the most predictable results, donor teeth should have approximately three-quarters of completed root development.[42,43,46,47] Several reports in the literature review the appropriate surgical protocol.[43-45,47] Although practitioners are reluctant to perform a technique with no distinct "standard of care", with appropriate case selection, autotransplantation should be considered a viable option for the treatment of an edentulous space in the growing patient.

SUMMARY

A review of the literature leads to the following conclusions:

1. Addressing this clinical condition during the early mixed dentition stage allows the clinician and parent to consider all available treatment options.
2. There are essentially two treatment options when faced with a congenitally absent mandibular second premolar: closing or maintaining the space. The former is accomplished by spontaneous or orthodontic space closure. The latter is accomplished by maintaining the primary molar, space maintenance and eventual conventional prosthodontics, implant placement, or autotransplantation.
3. Appropriate treatment is dependent upon a number of factors including the condition of the deciduous molar, dental and skeletal relationships, dental age of the patient, willingness to undergo potentially extensive dental treatment and financial considerations.

ACKNOWLEDGEMENT

The author wishes to express thanks to Dr. Kevin J. Donly for his valuable comments and review during the preparation of this article.

REFERENCES

1. Thilander B, Myrberg N. The prevalence of malocclusion in Swedish school children. Scand J Dent Res 81: 12-20, 1973.
2. Bergstrom K. An orthopantomographic study of hypodontia, supernumeraries and other anomalies in school children between the ages of eight to nine years. Swed Dent J 1: 145-157, 1977.
3. Locht S. Panoramic radiographic examination of 704 Danish children aged 9-10 years. Comm Dent Oral Epid 8: 375-378, 1980.
4. Grahen H. Hypodontia in the permanent dentition. A clinical and genetic investigation. Odontologisk Revy 7: Supp 3, 1-100, 1956.
5. Rolling S. Hypodontia of permanent teeth in Danish school-children. Scand J Dent Res 88: 365-369, 1980.
6. Stritzel F, Symons AL, Gage JP. Agenesis of the second premolar in males and females: distribution, number and sites affected. J Clin Ped Dent 15: 39-41, 1990.
7. Hunstadbraten K. Hypodontia in the permanent dentition. J Dent Child 40: 31-33, 1973.
8. Suarez BK, Spence MA. The genetics of hypodontia. J Dent Res 53: 781-785, 1974.
9. Ten Cate AR. Development of the tooth and its supporting structures. In Oral histology: Development, structure, and function, 5th Ed. St. Louis, Mosby, pp 78-103, 1998.
10. da Fonseca MA. Pediatric bone marrow transplantation: oral complications and recommendations for care. Pediatr Dent 20: 386-393, 1998.
11. Kjaer I, Kocsis G, Nodal M, Christensen LR. Aetiological aspects of mandibular tooth agenesis—focusing on the role of nerve, oral mucosa, and supporting tissues. Eur J Orthod 16: 371-375, 1994.
12. Chen Y, Bei M, Woo I, Satokata I, Maas R. Msx1 controls inductive signaling in mammalian tooth morphogenesis. Development 122: 3035-3044, 1996.
13. Peters H, Balling R. Teeth. Where and how to make them. Trends in Genetics 15: 59-65, 1999.
14. Stockton DW, Das P, Goldenberg M, D'Souza RN, Patel PI. Mutation of Pax9 is associated with oligodontia. Nat Gen 24: 18-29, 2000.
15. Haavikko K. The formation and the alveolar and clinical eruption of permanent teeth. An orthopantomographic study. Suomen Hammaslaakariseuran Toimituskia 66: 103-170, 1970.
16. Garn SM, Lewis AB, Polachek DL. Variability of tooth formation. J Dent Res 38: 135-148, 1959.
17. Lindqvist B. Extraction of the deciduous second molar in hypodontia. Eur J Orthod 2:173-181, 1980.
18. Wisth PJ, Thunhold K, Boe OE. The craniofacial morphology of individuals with hypodontia. Acta Odonto Scand 32: 293-302, 1974.
19. Bjerklin K, Bennet J. The long-term survival of lower second primary molars in subjects with agenesis of the premolars. Eur J Orthod 22: 245-255, 2000.
20. Kocadereli I, Ciger S. Congenitally missing teeth: an alternative approach for space closure. Clin Pediatr Dent 17: 213-216, 1993.
21. Joondeph DR, McNeill RW. Congenitally absent second premolars: an interceptive approach. Am J Orthod 59: 50-66, 1971.
22. Dewel BF. Second premolar extraction in orthodontics: principles, procedures and case analysis. Am J Orthod 41: 107-120, 1955.
23. Mamopoulou AM, Hagg U, Schroder U, Hansen K. Agenesis of mandibular second premolars. Spontaneous closure after extraction therapy: a four year follow up. Eur J Orthod 18: 589-600, 1996.
24. Kurol J. Infraocclusion of primary molars: and epidemiologic and familial study. Comm Dent Oral Epidem 9: 94-102, 1981.
25. Darling AI, Levers GH. Submerged human deciduous molars and ankylosis. Arch Oral Biol 18: 1021-1040, 1973.
26. Thornton M, Zimmerman ER. Ankylosis of primary teeth. J Dent Child 31: 120-126, 1964.
27. Kurol J, Thilander B. Infraocclusion of primary molars with aplasia of the permanent successor. Angle Orthod 54: 283-294, 1984.
28. Kurol J, Thilander B. Infraocclusion of primary molars and the effect on occlusal development—a longitudinal study. Eur J Orthod 6: 277-293, 1984.
29. Rune B, Sarnas KV. Root resorption and submergence in retained deciduous second molars. Eur J Orthod 6: 123-131, 1984.
30. Evans RD, Briggs PFA. Restoration of an infraoccluded primary molar with an indirect composite onlay: a case report and literature review. Dent Update 23: 52-54, 1996.

31. Veis RW, Christian JC, Salzer A: Space maintenance. In Manual of appliance therapy for adults and children. Chatsworth: Space Maintainers Laboratory, 1998, pp2.1-2.2, 1998.
32. Jemt T, Laney WR, Harris D et al. Osseointegrated implants for single tooth replacement: a one year report from a multicenter prospective study. Int J Oral Maxillofac Implants 2: 29-36, 1991.
33. Lederman PD, Hassel TM, Hefti AF. Oseointegrated dental implants as alternative therapy to bridge construction or orthodontics in young patients: seven years of clinical experience. Pediatr Dent 15: 327-332, 1993.
34. Ostler MS, KokichVG. Alveolar ridge changes in patients congenitally missing mandibular second premolars. J Prosth Dent 71: 144-149, 1994.
35. Cronin RJ, Oesterle LJ. Implant use in growing patients—treatment planning concerns. Dent Clin North Am 42: 1-35, 1998.
36. Brugnolo E, Mazzocco C, Cordioli G, Majzoub Z. Clinical and radiographic findings following placement of single-tooth implants in young patients—case reports. Int J Periodon Rest Dent 16: 421-433, 1996.
37. Kearns G, Sharma A, Perrott D, Schmidt B, Kaban L, Vargervik K. Placement of endosseous implants in children and adolescents with ectodermal dysplasia. Oral Surg Oral Med Oral Pathol 88: 5-10, 1999.
38. Mehrali MC, Baraoidan M, Cranin AN. Use of endosseous implants in treatment of adolescent trauma patients. N Y State Dent J 60: 25-29, 1994.
39. Escobar V, Epker BN. Alveolar bone growth in response to endosteal implants in two patients with ectodermal dyplasia. Int J Oral Maxillofac Surg 27: 445-447, 1998.
40. Thomas S, Turner SR, Sandy R. Autotransplantation of teeth: is there a role? Br J Orthod 25: 275-282, 1998.
41. Andreasen JO, Paulsen HU, Yu Z, Bayer T, Schwartz O. A long-term study of 370 autotransplanted premolars. Part II. Tooth survival and pulp healing subsequent to transplantation. Eur J Orthod 12: 14-24, 1990.
42. Lundberg T, Isaksson S. A clinical follow-up study of 278 autotransplanted teeth. Br J Oral Maxillofac Surg 43: 181-185, 1996.
43. Josefsson E, Brattstrom V, Tegsjo U, Valerius-Olsson H. Treatment of lower second premolar agenesis by autotransplantation: four-year evaluation of eighty patients. Acta Odontol Scand 57: 111-115, 1999.
44. Clokie CML, Yau DM, Chano L. Autogenous tooth transplantation: an alternative to dental implant placement? J Can Dent Assoc 67: 92-95, 2001.
45. Schuman NJ, Owens BM, Mincer HH. Dental transplants: discussion and case report. J Clin Pediatr Dent 21: 281-285, 1997.
46. Northway WM, Konisberg S. Autogenic tooth transplantation: the "state of the art". Am J Orthod 77: 146-162, 1980.
47. Cohen AS, Shen TC, Pogrel MA. Transplanting teeth successfully: autografts and allografts that work. J Am Dent Assoc 126: 481-485, 1995.