

# Maxillary Partial Anodontia and Implant Dentistry

## Maxillary Anterior Partial Anodontia in 255 Adolescent Patients A 15-Year Retrospective Study of 276 Implant Site Replacements

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**M**axillary single tooth replacement is one of the most challenging restorations in dentistry. In an adolescent patient, the most common missing maxillary anterior tooth as a result of agenesis is the lateral incisor.<sup>1</sup> The absence of one or more teeth is known as anodontia, and may be complete (very rare) or partial (also called hypodontia).<sup>2</sup> It is many times more common than supernumerary teeth.<sup>3</sup> The primary etiology of partial anodontia is familial heredity, and reports range from 1.6% to as high as 9.6% (when excluding third molars) with an average incidence in the literature of 6%.<sup>4-14</sup>

There is a high correlation between primary tooth absence and a permanent missing tooth, but it is more frequent to occur only in the permanent dentition.<sup>15-18</sup> The incidence of anodontia occurs in a 3:2 ratio by sex; with the female population having the greater risk.<sup>15</sup> For maxillary anterior missing teeth, the

sex differences further increase with 41% of female anodontia patients vs. 15% of anodontia males missing lateral incisors.<sup>16</sup>

Caprioglio et al evaluated the records of almost 10,000 patients between the ages of 5 to 15 years.<sup>5,17</sup>

The absence of one or more teeth is known as anodontia, and may be complete (very rare) or partial (also called hypodontia).

Of all the missing single teeth, the mandibular second premolar was most often missing (38.6%), followed by the maxillary lateral incisor (29.3%), the maxillary second premolar (16.5%) and the mandibular central incisor (4.0%). The remaining teeth were absent only .5% to 1.8%, with the maxillary first molar being the one least affected. On the other hand, Brekhus et al evaluated

11,487 patients and found the maxillary lateral incisor was congenitally missing in 39.6% of anodontia patients and 20% of the patients had the mandibular second premolar missing, followed by 17.7% for the maxillary second premolar and seven percent of mandibular central incisors.<sup>3</sup> In both reports, a missing mandibular second premolar primarily occurred in males, while the maxillary lateral incisor primarily occurred in females.

The most common multiple teeth missing (other than third molars) were the maxillary lateral incisors, followed by the mandibular second premolars and maxillary second premolars. Fortunately, less than 1% of all children are missing more than two teeth and less than 0.5% are missing more than five teeth.<sup>17</sup> In addition to the congenital absence of teeth, the occurrence of trauma to the maxillary teeth in school children is common (20%), although the incidence of associated tooth loss is less than two per-



cent.<sup>19-22</sup> Nevertheless, as a consequence of heredity or trauma, dentists treat the missing maxillary anterior tooth condition with some frequency.

The purpose of this article is to retrospectively report on the implant treatment of adolescent patients missing one or two permanent maxillary anterior teeth from congenital causes in one orthodontic practice during a 13-year period and followed during a 15 year period. The shortest time period for implant function was two years and the longest period was 15 years. In addition, the age requirements related to implant treatment are presented. The advantages and disadvantages of treatment options selected to replace the missing permanent incisors are addressed.

## MATERIALS AND METHODS

### Patient Selection

In a single practitioner orthodontic practice, 328 consecutive adolescents (14 to 19 years old) with congenital anodontia of permanent maxillary anterior teeth were treated and evaluated yearly between 1990 and 2005. All of these patients had a full complement of primary teeth. The most common permanent tooth missing was the lateral incisor (94.2%, 309) followed by the canine (4.27%, 14) and the central incisor (1.53%, 5). There were 20 patients (6.1%) with bilateral missing lateral incisors and one patient with bilateral missing canines (Table 1).

All patients in this study were treated with fixed orthodontic appliances. The treatment options to replace the congenital missing anterior teeth consisted of either closing the missing tooth space with orthodontics, or replacing the missing dentition after orthodontic treatment with a prosthesis. Since the deciduous teeth are smaller than their per-

Table 1 Total patient distribution					
Total	Total Central	Lateral	Canine	Patients	Sites
Male	0.93% 3	10.05% 33 (4 with bilateral)	0	36	40
Female	0.6% 2	84.15% 276 (16 with bilateral)	4.27% 14 (1 bilateral)	292	309
Total	1.53% 5	94.2% 309	4.27% 14	328	349

Table 2					
Treatment	Tooth	Patient		Site	
Close		Male	Female	Total	
	Central	0	0	0	/
	Lateral	15	32	47	47
	Canine	0	4	4	4
	Total Close	15 <sup>a</sup> (4.6%) 15 <sup>b</sup>	36 <sup>a</sup> (11%) 36 <sup>b</sup>	51 (15.6%)	51
Open	Central	3	2	5	5
	Lateral	18 14+(4x2)=22 22 <sup>b</sup>	244 <sup>a</sup> 228+(16x2)= 260 <sup>b</sup>	262	282
	Canine	0	10 <sup>a</sup> 9+2=11 <sup>b</sup>	10	11
	Total Open	21 <sup>a</sup> (6.4%) 25 <sup>b</sup>	256 <sup>a</sup> (78%) 273 <sup>b</sup>	277 (84.4%)	298
	Total Patient	36 (11%)	292 (89%)	328 (100%)	349

<sup>a</sup> Patient; <sup>b</sup> Site

manent replacement, orthodontics was required to obtain a more ideal space prior to restoration. Prior to the restorative phase, either preparation of the abutment teeth or implant surgery was performed. A total of 51 patients (15.6%) consisting of 15 male patients (15 lateral incisors) and 36 female patients (32 lateral incisors and 4 cuspids) elected to have the edentulous spaced closed, primarily in the earlier years of this report (Table 2).

The vast majority (277) of patients in this report (84.4%) opted for a space opening and prosthesis. In the 277 patients who

selected this prosthetic option, there were 256 single edentulous sites and 21 bilateral incisor sites for a total of 298. A total of 256 female patients (78%) had space opening and a prosthesis for two central incisors, 260 lateral incisors (16 of which were bilateral and 11 cuspids [one bilateral for a total of 273 sites]). Out of the 21 male patients (6.4%), 22 missing lateral incisors (4 of which bilateral) and three missing central incisors were replaced (Table 3).

Following space opening orthodontics, 255 patients (92.0%) received one or two endosseous implant(s) to replace the missing



**Table 3**  
Treatment selection after space opening

Patient			Implant Number	Patient			FPD Number
Male	Central	1	1	Male	Central	2	
	Lateral	14	18 (4 bilateral)		Lateral	4	
	Canine	0	0		Cuspid	0	
Female	Central	2	2	Female	Central	0	
	Lateral	232	248 (16 bilateral)		Lateral	12	
	Canine	6	7 (1 bilateral)		Cuspid	4	
255			276	22			22 FPD
92%				8%			

**Table 4**

Site	Implant	Length	Total	Failed/ Replaced
	(mm) Diameter	(mm)	Number	
Central	3.5	12	1	—
	3.75	13	1	—
	4	12	1	—
Lateral	3.50	12	187	2
	3.75	13	25	2
	3.75	16	54	—
Canine	3.5	12	1	—
	3.75	13	2	—
	4	12	4	—

teeth, and 22 patients (8%) opted for a fixed partial denture (Table 3). A total of 276 implants were restored in 255 patients: three central incisors (one male, two female patients); 266 lateral incisors (14 male patients with four missing bilateral incisors and 232 female patients with 16 missing bilateral lateral incisors) and seven cuspids (six females with one bilateral treatment).

#### **Treatment time**

Prior to the restoration of the missing teeth, the dental and skeletal maturation were evaluated in function of the patient's age, hormonal changes (i.e. menstruation, facial hair and statural growth). In addition, the patients' orthodontic treatment was completed and stabilized before the implant or restorative phase of treatment was initiated.

The permanent teeth in the

premaxillary region had their final root position and angulation established along with stabilization of the occlusal relationship of the arches prior to implant placement. All implant patients remained in orthodontic retainers during the initial bone healing phase of the implant. During this period, the appliances also served as an esthetic tooth replacement using a bracket and denture tooth attached to the orthodontic appliance.

#### **Implant size and design**

Implant body diameter in these 255 patients varied from 3.5mm to 4.0mm based upon the mesiodistal dimensions of the missing tooth and the buccolingual dimensions of the bone (Table 4). Bone grafting to improve the implant site was performed as needed prior to implant placement to enhance hard tissue topography and ensure a harmonious crestal ridge

contour for a favorable esthetic outcome. All implants were inserted at least 1.5mm from the adjacent teeth. Implant length range was 12 to 16mm and was selected in function of the available bone height, which most often did not engage the opposing cortical plate.

All implant bodies were of a screw design with a resorbable blast media (RBM) or hydroxyapatite (HA) surface treatment. All implants had a two-piece design, with an abutment that was screw retained into the implant body after initial bone healing. All implants were left unloaded during the initial bone healing process.

#### **Orthodontic retention**

A six-month "stabilization" period was allowed between the debanding of the orthodontic appliance with the placement of an implant transitional crown and delivery of the final crown. A Hawley type orthodontic retainer was worn during this time frame. This period provided sufficient time for hard and soft tissue maturation around the implant and further occlusal stabilization of the natural teeth. In addition, it allowed most orthodontic relapse to occur prior to the final restoration, and occlusal adjustment of the prosthesis. The overall implant treatment time (from implant placement to final restoration delivery) lasted from 12 to 18 months.

#### **Implant restoration**

All implants were restored with porcelain fused to precious metal crowns cemented to the implant abutment. The occlusal concepts followed the implant protective occlusion philosophy.<sup>23</sup> For example, occlusal adjustment was performed with no contact on the implant crown during light occlusal force and some contact on the implant crown with a heavy bite force. Mandibular excursive contacts on the implant crowns were



**Table 5**  
**Summary - 15 year study**

Procedure	Patients	Sites	Survival at 15 years
Closure	51	51	100%
Opening	277	298	
FPD	22	22	77.3%
Implant	255	276	98.6%
Total	328	349	—

avoided when possible. All lateral incisors were restored with canine guidance in lateral excursions, while where canines were restored, a mutually protected occlusal scheme was implemented which included and the lateral incisors during excursive movements.

## RESULTS

In the 255 patients treated with an implant prosthesis, implants were inserted in 276 sites. Implant surgical failure occurred in four locations (1.4%). The four failed implant sites were retreated successfully with a new implant. All 276 successful implants were restored to an acceptable esthetic result according to the patient. According to the authors, there were two esthetic failures, due to a compromise in the soft tissue drape. These two cases required soft tissue management and the fabrication of a new restoration with the addition of pink porcelain.

The patients' follow-up was primarily performed in the same office as the orthodontics and restorative care and patients were scheduled for a yearly examination during the continued extent of this report. During this period, 29 patients moved and were contacted by telephone to obtain the information in this report. No teeth adjacent to the implant developed any decay during the length of this report. No adjacent teeth were lost.

In summary, 276 implant sites were restored in 255 patients. There were no implant failures during the 15 years of this report after the final prosthesis delivery.

Therefore, during this 15 year time frame, the implants had a survival rate of 98.6% and 100% of the surviving implants have maintained the same final restoration. All adjacent teeth were maintained, no tooth required endodontic therapy and no tooth required a restoration during the length of this report.

The 22 patients who opted for a fixed partial denture were also followed during a similar time frame. Three abutment teeth needed endodontic therapy prior to the completion of the fixed prosthesis. Twelve patients received a fixed traditional fixed-partial denture while 10 opted for a resin bonded restoration. During the first seven years, all fixed prostheses were in function. During the second phase of the study, five of these devices failed due to caries of an abutment or uncemented restoration. Two abutment teeth required endodontic treatment and no teeth were lost. Of these patients, four opted for single tooth implants, rather than refabricating the prosthesis (not included in this report) (Table 5).

## DISCUSSION

When a permanent maxillary anterior tooth is congenitally missing in an adolescent with a

full compliment of primary teeth, the decision must be made to either: (1) orthodontically close the missing tooth site, or (2) to maintain the space and prosthetically restore the missing tooth.<sup>24</sup> In this report, 51 patients elected to have one missing lateral or canine incisor space closed with orthodontic treatment.

There are two main advantages to orthodontic space closure to treat the missing anterior tooth situation:<sup>25,26</sup> (1) minimal additional procedures (recontouring the natural tooth) were required after orthodontics, (2) the overall treatment fee was less. The disadvantages of the lateral or canine space closed with orthodontics include: (1) loss of the canine tooth in the canine position resulting in mandibular excursions guided on the first maxillary premolar; (2) the canine eminence was not formed, causing a depressed labial lip position lateral to the nose; (3) It was difficult to the contour cuspid facio-palatally and mesiodistally to appear as a lateral incisor;<sup>27</sup> (4) the free gingival margin of the canine was higher than the contralateral lateral incisor; (5) patient compliance was necessary during orthodontic procedures, (6) the midline was usually shifted to the missing tooth side. Anchorage to advance the canine and all posterior teeth forward was often insufficient.

The advantages of obtaining intra-tooth spaces and replacing the tooth with an implant prosthetic device include: (1) the remaining natural teeth were in a more ideal esthetic position; (2) the canines may be properly positioned for incisal guidance and ideal occlusion; (3) the canine eminence forms over the root and supports the maxillary labial lip position lateral to the nose; (4) the proper midline between the central incisors is more ideal (5) the missing tooth



can be restored similar to the contralateral tooth size and position; (6) the adjacent teeth did not require restoration during the length of the report and (7) no adjacent tooth required endodontic therapy.

The disadvantages related to space opening and prosthetic restoration of the space included: (1) compliance of the patient (use of elastics), etc. for orthodontic movement; (2) obtaining sufficient space between the teeth when posterior mesial collapse of the dentition existed; (3) the intra-tooth space needed a prosthetic restoration with a fixed partial denture or implant; (4) overall cost increased; (5) adjacent teeth to the space must be prepared or surgery for a bone graft and/or an implant was required; (6) the final tooth restoration may result in an esthetic compromise relative to the interdental papilla soft tissue drape or contour of the restoration; (7) a three-unit fixed restoration may result in less hygienic conditions and result in future decay or endodontic therapy of the abutment teeth and (8) more overall time to treat the patient was required for implant restorations.

The fixed treatment options of space maintenance and prosthetic restoration for a missing permanent maxillary anterior incisor include: (1) a resin bonded restoration, (2) a traditional fixed partial denture, (3) a cantilevered FPD or (4) an implant and single tooth crown.

The reported failure rate for resin bonded restorations may reach 30% by two to five years.<sup>28</sup> No patients in this report used a resin bonded prosthesis to replace the missing teeth.

A fixed partial denture may have a 98% survival at five

years,<sup>29-33</sup> however, at 10 to 15 years the rate may be reduced to 50 to 70%.<sup>33</sup> Since the primary cause of failure is decay at the interproximal margin of the pontic, a fixed prosthesis failure is often related to the loss of an abutment tooth. In this report, 22 patients received a fixed partial denture. The primary indication was a lateral incisor mesial-distal space inferior to 6.0mm or unfavorable adjacent root angulation. The minimum implant available in the early part of this study had a crest module of 3.5mm. The ideal implant position is 1.5mm from an adjacent tooth, hence a 6.5mm space was required.

**In this clinical report, it has been observed that when conditions are favourable an anterior single tooth implant is the treatment of choice for a congenitally missing anterior tooth.**

Therefore, when sufficient space was not available, a fixed partial denture was a treatment option employed. Fabricating a central incisor crown adjacent to an unrestored tooth is one of the more difficult esthetic restoration in dentistry. As a consequence, there were three esthetic failures of the fixed prosthesis. At the prosthetic delivery appointment in these patients the esthetic failure required additional laboratory and operative procedures in those patients. In addition, five of these devices failed between seven to 15 years as a result of caries and/or an uncemented restoration.

Before 1990, there were few long-term studies of single tooth implant replacement with osseointegrated implants.<sup>34</sup> Since then,

there have been more clinical studies for single tooth replacement with an implant than any other treatment option. Not only are retrospective reports available as with other modalities, but even more important, there are many prospective clinical studies to confirm the data of previous reports.<sup>35-42</sup> The maxillary anterior single tooth implant has yielded the highest prosthetic survival rate compared to any other treatment option. For example, in a systematic review of single tooth implant restorations, Creugers et al, reported a cumulative survival rate of 97% success at four years<sup>41</sup> and a 10 year survival of 97% has also been widely observed.<sup>41</sup> In this report the implant survival was 98.6% during a 15 year evaluation time.

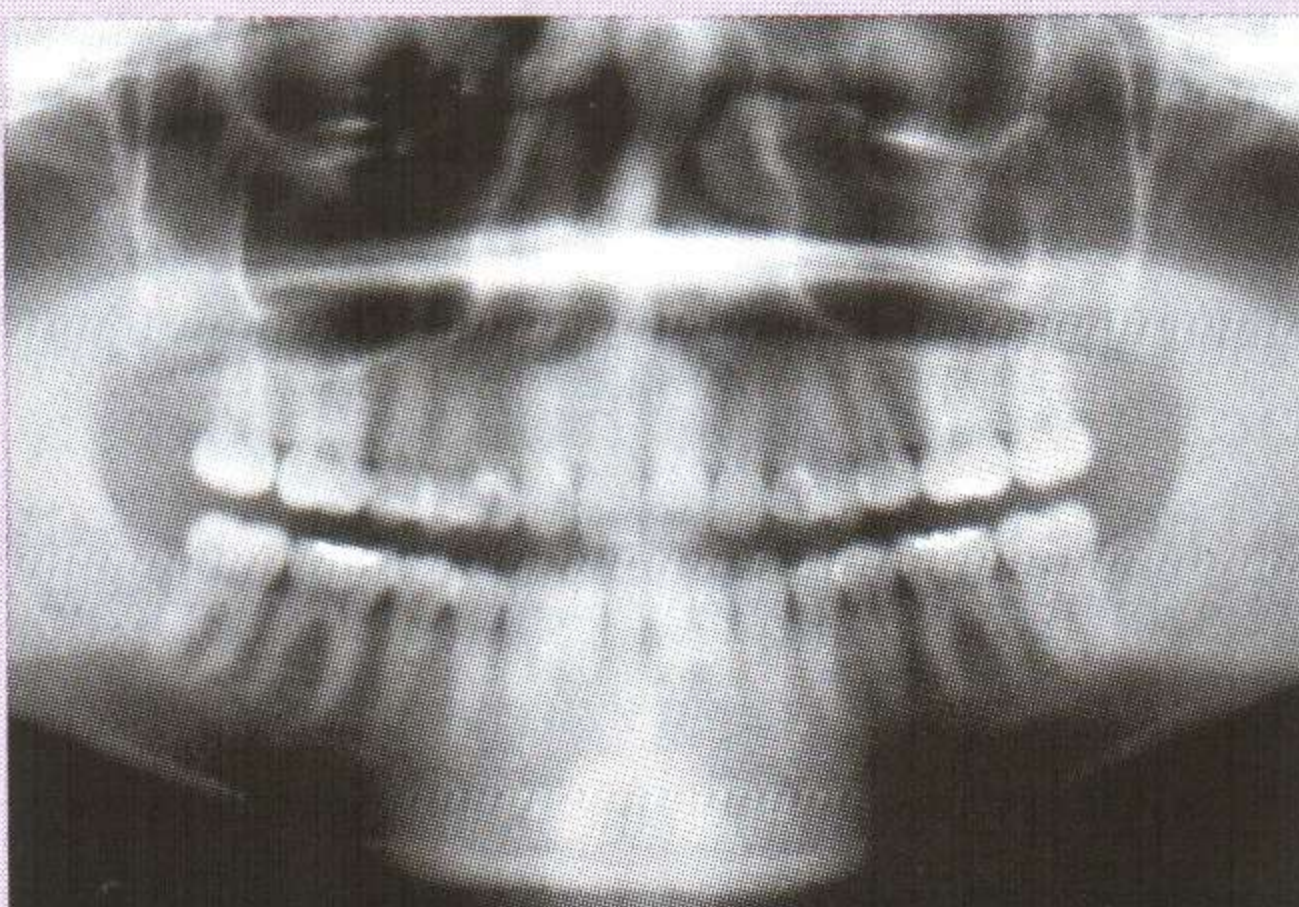
The loss of an abutment tooth for a fixed prosthesis is reported in the range of 8 to 30% within 10 to 15 years. As important as implant survival rates, the adjacent teeth prognosis generally improved with single tooth implants compared to a fixed prosthesis. In a 10 year report, Priest indicated adjacent teeth next to implants have less decay, endodontic risk, less sensitivity, less plaque retention and/or evidence of adjacent tooth loss over 10 years compared to a fixed partial denture.<sup>42</sup> In comparison to a fixed partial denture, the adjacent tooth loss of implant restorations is less than 1%. In this 15-year retrospective report, no tooth adjacent to an implant required endodontic therapy or a restoration. As such, the maxillary anterior single tooth implant has often become the treatment of choice when bone and space parameters are sufficient or may be created.

The authors have also observed the importance of the emotional aspect of the re-



placement of a congenitally missing tooth. Since the cause is most often genetic, the parent often feels a psychological healing when the implant returns their son or daughter to "normal". A single tooth implant appears less traumatic, since the adjacent healthy teeth do not require preparation. This often makes the parent eager for an implant, regardless of the time or cost of the procedure. However, if the bone graft and/or implant should cause damage to an adjacent tooth emotional consequences may result. If the young patient loses an adjacent tooth, or suffers severe bone loss because of improper implant insertion or as a consequence of complications of a bone graft or distraction osteogenesis, the patient-doctor relationship is stretched to the limit. As such, it is suggested highly predictable augmentation procedures be used when necessary, along with adequate space and bone present prior to implant placement. In addition, implant surgery is not a procedure an adolescent patient desires. Sedation is usually advantageous and was used as a regular protocol for all implant surgeries in this report.

In this clinical report, it has been observed that when conditions are favorable, an anterior single tooth implant is the treatment of choice for a congenitally missing anterior tooth. (Figs. 1-10) However, the roots of the adjacent natural teeth often converge toward the edentulous site, or the mesio-distal length is insufficient at the intra-tooth crest or apical region. A deciduous anterior tooth is smaller mesiodistally than the permanent tooth. As such, when a permanent tooth is missing, the space to replace the tooth is often deficient and requires orthodontic therapy to correct the condition.



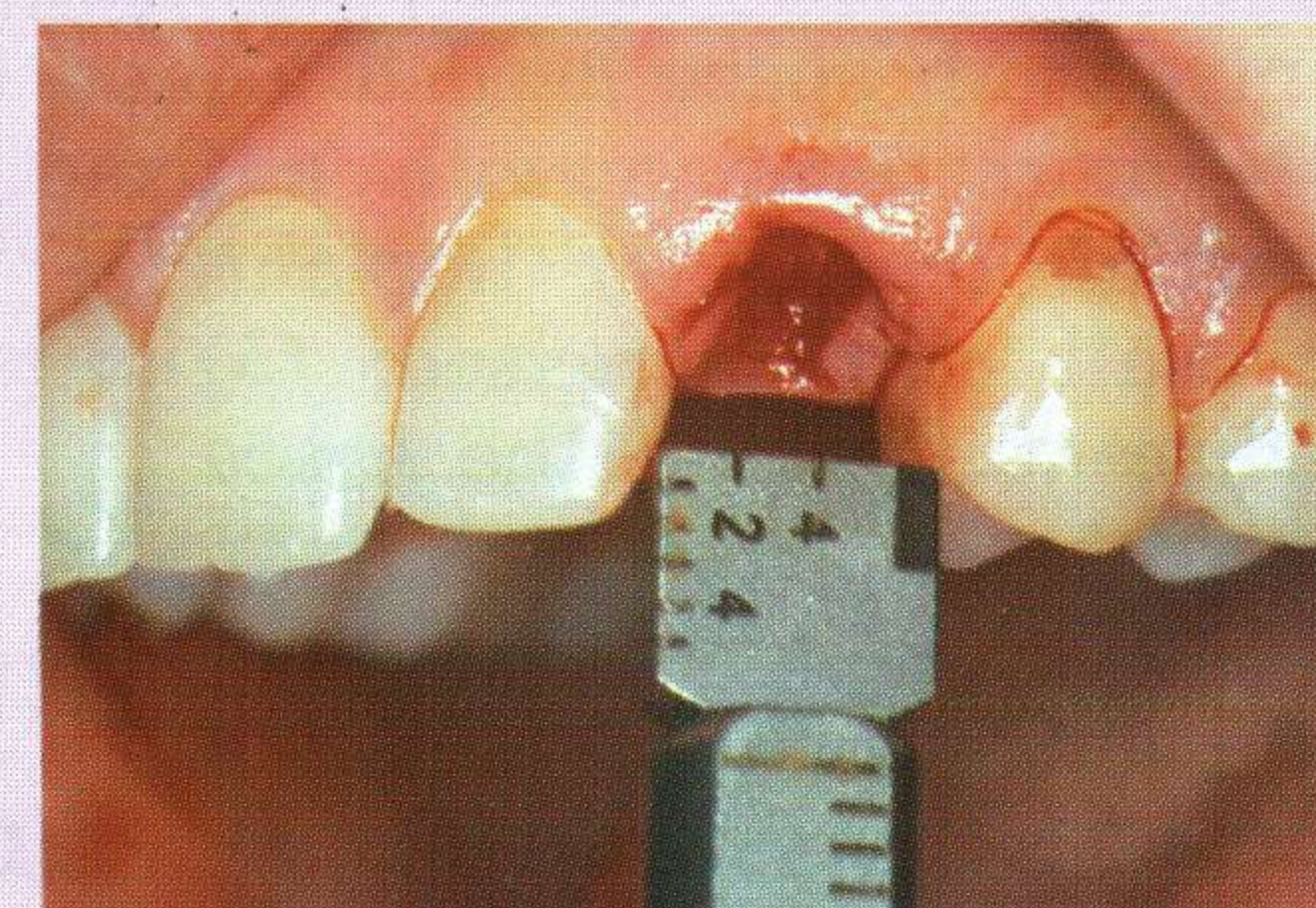
**FIGURE 1**—A panoramic radiograph of bilateral congenitally missing canines in a female, 17-years-old. She had no structural growth the last six months, is taller than her mother and is able to menstruate.



**FIGURE 2**—An intraoral picture of a female with bilateral deciduous canines and the absence of permanent canines. The roots are resorbed and the teeth are mobile.



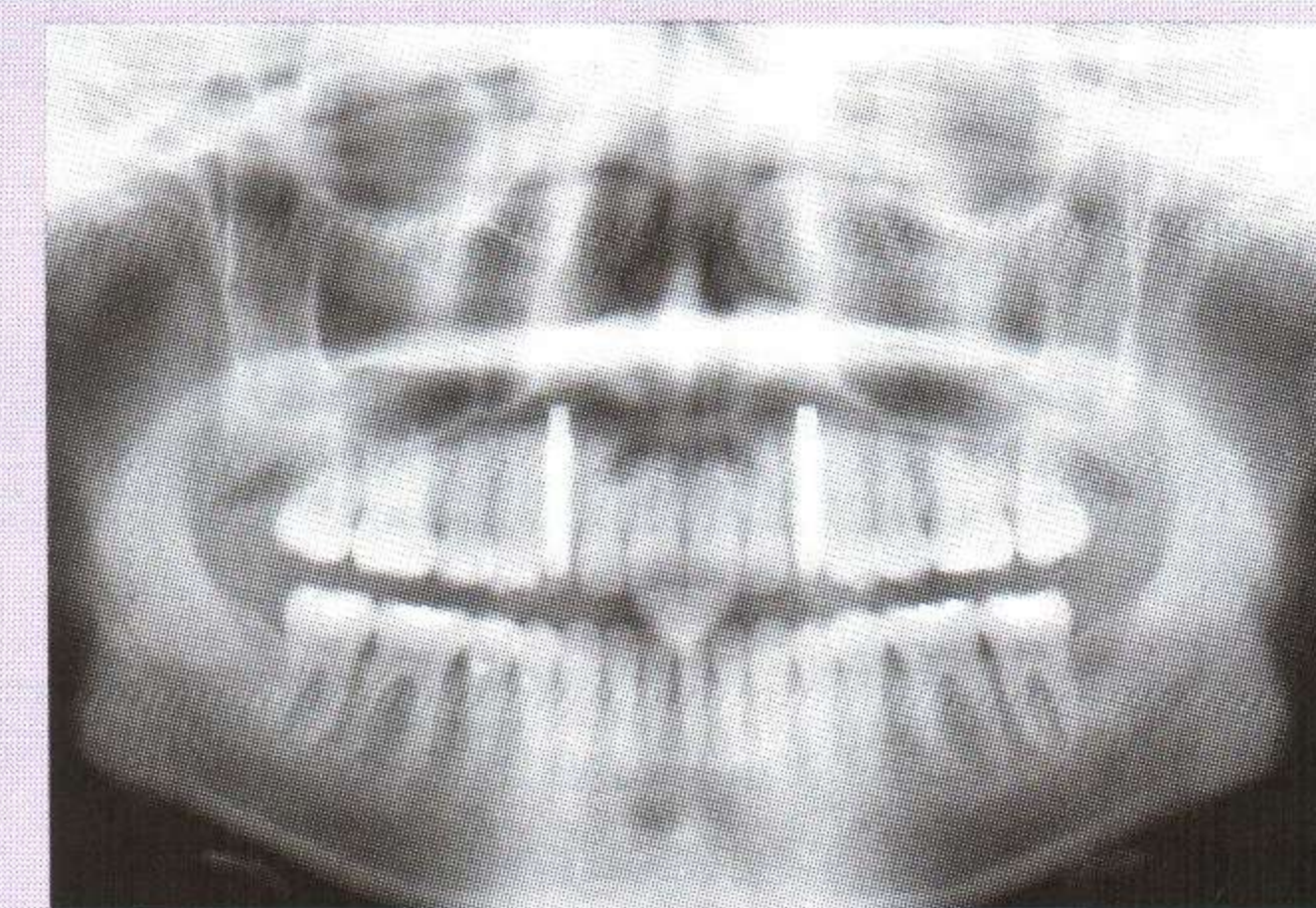
**FIGURE 3**—The maxillary right deciduous canine was extracted, and an implant inserted (Biohorizons®, Birmingham, AL).



**FIGURE 4**—The left canine was extracted and the mesio-distal space helps select an implant 1.5mm or more from the adjacent teeth.



**FIGURE 5**—An implant is inserted into the left canine (Biohorizons®, Birmingham, AL)



**FIGURE 6**—A panoramic radiograph of the two canine implants after integration and transitional prosthesis are inserted.

As a consequence, orthodontic therapy prior to implant placement most always should be considered. In addition, malocclusion, arch space deficiency and/or skeletal deformation in congenital anodontia were often observed and corrected with orthodontic therapy. An additional advantage of orthodontics prior to or in conjunction with implant treatment for the congenitally missing tooth

was the missing incisor may be restored provisionally by a denture tooth attached to the orthodontic wire, without trauma to the augmented ridge or implant during healing.

#### AGE GUIDELINES

The minimum age of the patient is more often a concern for maxillary anterior tooth replacement. Fixed partial dentures to replace



congenitally missing teeth in children increase the risk of pulp necrosis of the abutment teeth, because of the size of the pulp horns. Resin bonded prostheses often become unrestrained in the younger patient, since diet and/or habit guidelines (i.e. hard food, gum chewing) are often neglected. If bone is available, the dentist wishes to place the implant prior to future bone loss in the site. However, once the implant is surgically inserted, growth and development in the intratooth region may be modified, and with the implant acting similar to an ankylosed tooth. It has been documented that implants do not erupt along with adjacent teeth, nor do they become secondarily displaced in space compared to deciduous teeth during growth of the jaws.<sup>43-45</sup> They may also alter the



**FIGURE 7**—An intraoral picture of the restored bilateral implants in the canine positions.

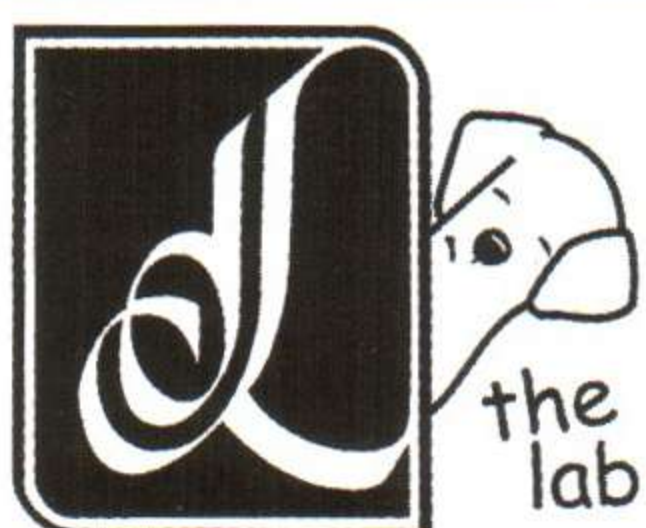


**FIGURE 8**—A periapical radiograph of the right maxillary canine after one year in function.

growth pattern of the jaws and the eruption path of tooth germs adjacent to the implants.<sup>46</sup> A new crown may correct the esthetic problem, but the bone position creates a greater soft tissue pocket around the implant, which may lead to shrinkage and/or periimplant conditions.<sup>47</sup>

Most often, age guidelines for

implant insertion are related to the patient's biologic age more than chronologic age.<sup>48-51</sup> In an eight-year study of single maxillary incisor implants in adolescents (younger than 19-years-old at the time of implant insertion), Thilander et al concluded that a fixed chronological age is not a sufficient guideline because of a slight continuous eruption of the



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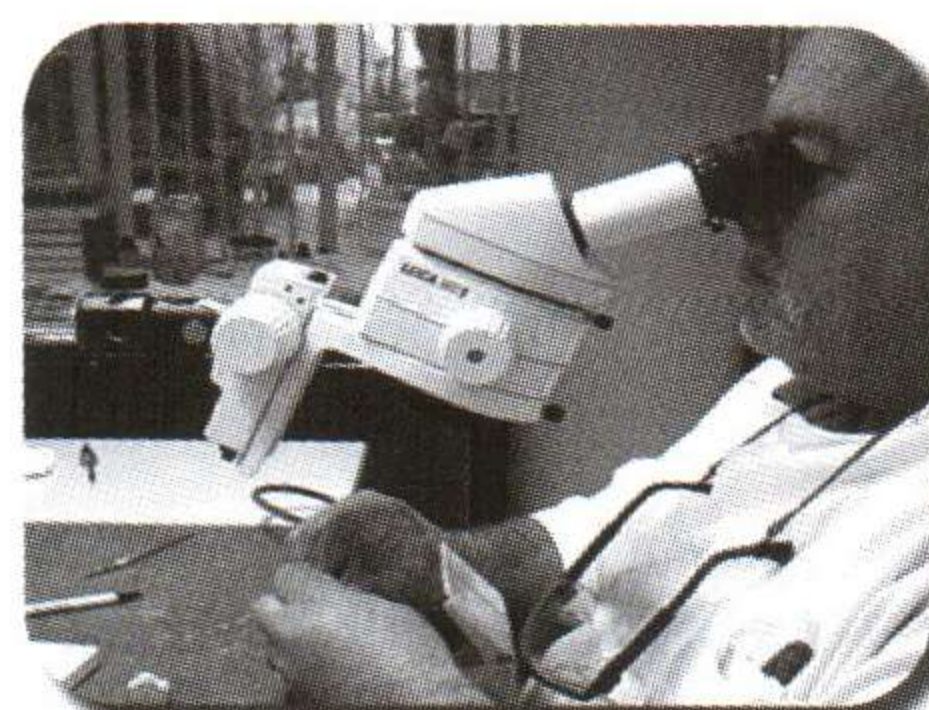
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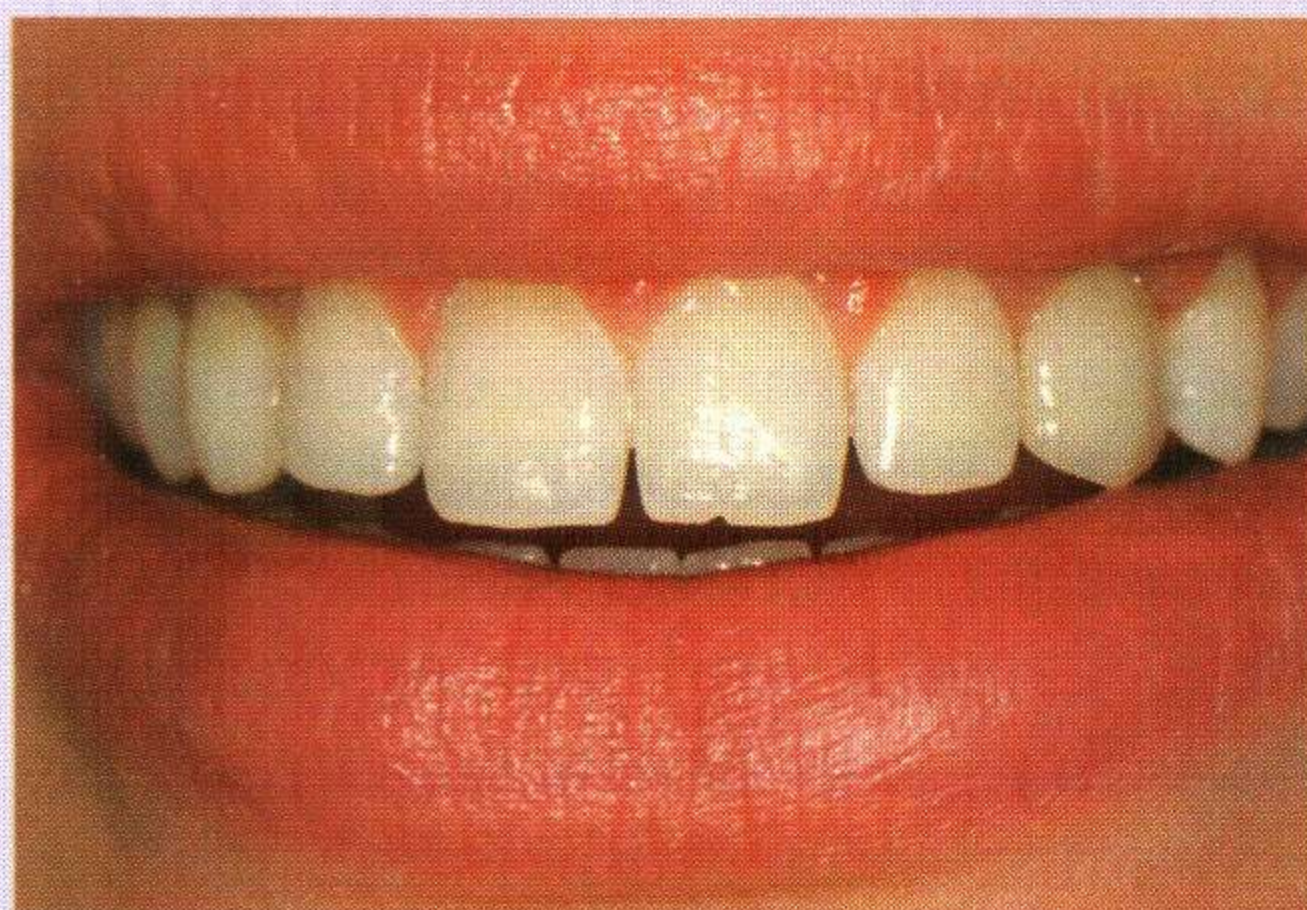
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**FIGURE 9**—A periapical radiograph of the left maxillary canine after one year in function.



**FIGURE 10**—A smile of the female after one year of function with the canine implants.

adjacent teeth post adolescence.<sup>49</sup> Instead, it was recommended that to avoid relapse, a proper orthodontic treatment be performed to achieve proper space, avoiding tooth intrusion movement, establishing good incisor stability and ensure proper stabilization with a retainer to avoid relapse.

The following guidelines were used in this report for the youngest age of the patient in conjunction with implant placement. The first requirement was the chronologic age of the patient. Skeletal and dental growth are not completed for females until at least 13-years-of-age and males at 17 years old.

However, other factors indicative of completed growth were also assessed.

The young female patient should also be able to menstruate and the males demonstrate changes from testosterone (eg. shaving, pubic hair, change in voice). In addition, the size of the child was also monitored. They should have greater height than their parent of similar sex. In addition, if the adolescent patient has statural growth in the last 6 months, implant placement can be performed.<sup>50</sup> All four of these factors must have been fulfilled prior to implant placement. When all these skeletal and dental stability criteria were fulfilled, the dental occlusal stability and the implant had no observable risk or compromise during the course of this report.

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## CONCLUSION

Partial anodontia of permanent maxillary anterior teeth is a relatively common occurrence. During a 15-year period in one practice, 328 consecutive adolescents with congenital anodontia of maxillary anterior teeth were treated and yearly evaluated. Three patients out of four opted for an implant-supported crown to replace the missing tooth. The parent of the adolescent treated often desired the implant therapy more than the patient. A total of 280 implants were placed in 255 patients and an implant surgical success of 98.6% was achieved. Once the implant was successfully restored, 100% of the implants and restorations remained in place during the duration of this report. In addition the adjacent teeth to the implant had no history of decay or endodontic therapy.

As a consequence, implant single tooth replacement should be considered the treatment of choice when maxillary anterior teeth are congenitally missing in adolescence.

Orthodontic therapy prior to implant surgery may be per-

formed during growth and development of the jaws. Its advantages include the correction of asymmetric mesio-distal spaces in the edentulous site, improper occlusion, midline discrepancy and other abnormal skeletal relationships. Implant insertion after final growth and proper occlusal stability are achieved was also advantageous. Additional studies of long-term result is mandated to validate the implant restoration as the treatment of choice in case of partial anodontia. **OH**

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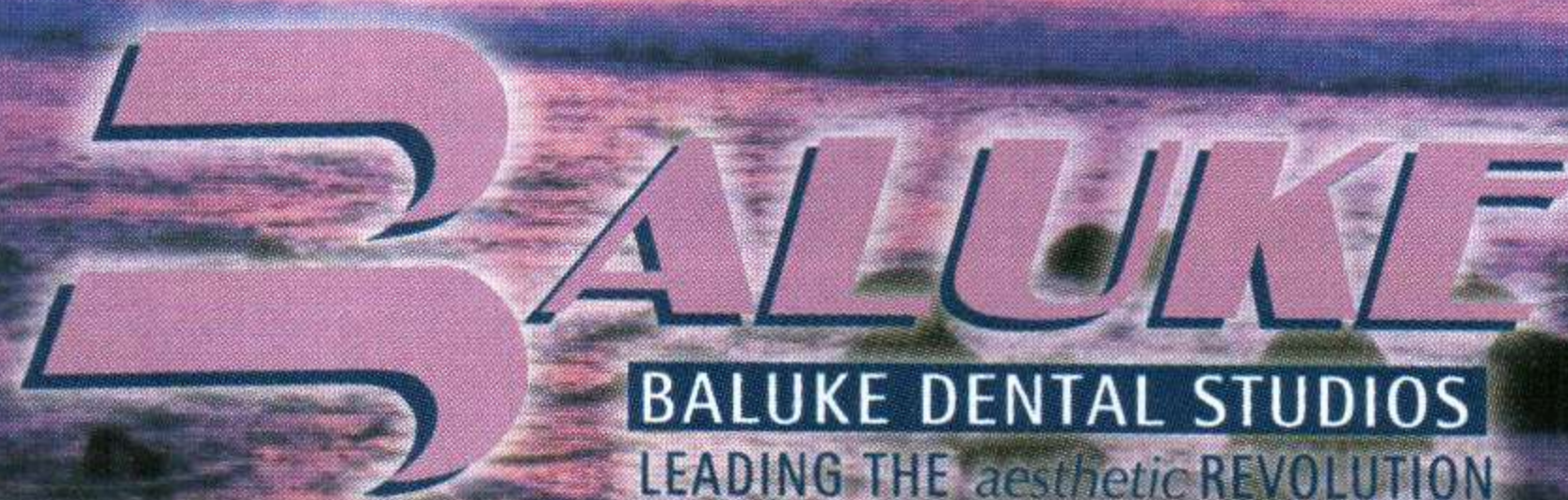
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