

# Dental implants in children: A multidisciplinary perspective for long-term success

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## ABSTRACT

Congenital hypodontia or trauma is a frequent cause of loss of teeth in children. The absence of teeth leads to loss of function and lack of normal alveolar growth, along with unpleasant esthetics that hamper the psychosocial development of the young child. Traditionally, the management of tooth loss in the young child is done by conservative means. None of those methods of treatment are completely satisfactory and have their own drawbacks. Dental implants in a young child would be an ideal mode of treatment for the absence of teeth. One of the main deterring factors for implant placement in children is the impending growth. Growth in the maxilla and mandible does not happen uniformly in one plane. It is multidirectional, occurring in sagittal, vertical, and transverse planes. It does not happen at a fixed pace, slow periods of growth are followed by phases of accelerated growth called the growth spurts. Successful implant treatment in children has been achieved by several clinicians when they incorporated a multidisciplinary approach in their treatment plan. The design and type of implant system used in pediatric patients is also responsible for successful treatment outcome. The purpose of this review is to understand the implications of growth and growth assessment and recommendations for the formulation of the treatment plan in pediatric dental implant patients.

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## INTRODUCTION

There are a large number of children suffering from absence or loss of teeth due to congenital hypodontia or trauma. Total anodontia is the congenital absence of all the teeth in the primary dentition and/or the permanent dentition and is a rare condition.<sup>[1]</sup> Hypodontia or oligodontia is the absence of one or a few teeth that may manifest in several genetic and syndromic conditions.<sup>[2]</sup> Congenitally missing teeth are commonly found in healthy individuals and may occur without the association of any developmental

disorders.<sup>[3-5]</sup> The most frequently missing teeth are the third molars; however, they do not require prosthetic replacement. Mandibular second premolars (2.8%), maxillary lateral incisors (1.6%), maxillary second premolars, and mandibular incisors (0.23%–0.08%) are the most frequently missing teeth that can be replaced through many treatment modalities.<sup>[6]</sup>

Trauma is a frequent cause of tooth loss in children. Maxillary proclination and incompetent lips are important predisposing factors for anterior tooth trauma,

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commonly resulting in avulsion of maxillary incisors. The prevalence of traumatic injuries in children has been reported by various authors. An Australian study by Stockwell reported the incidence of anterior tooth trauma in the permanent teeth in 6–12-year-old children to be 1.7 patients/100 children/year,<sup>[7]</sup> whereas an English study by Hamilton *et al.* stated it to be 34%.<sup>[8]</sup> Prevalence of trauma has been reported worldwide by several authors, ranging from 11% by Kaba and Maréchaux<sup>[9]</sup> in Switzerland to 30% by Bijella *et al.*<sup>[10]</sup> and Forsberg and Tedestam in Brazil and Sweden, respectively.<sup>[11]</sup>

Loss of teeth leads to loss of function and lack of normal alveolar growth, along with unpleasant esthetics that hamper the psychosocial development of the young child. Traditionally, the management of single tooth loss in the young child is done by conservative means. The presence of large pulp chambers in incompletely mineralized immature teeth of children predisposes the pulp to loss of vitality in cases of complete coverage restorations. Hence, the clinician resorts to partial coverage prosthesis such as Maryland Bridge, resin-bonded restorations or removable prosthesis in cases of multiple missing teeth.

None of these methods of treatment are completely satisfactory and have their own drawbacks. Partial dentures are dependent on the child's compliance. They increase the rate of decay and may cause gingival disease leading to bone resorption. Furthermore, there is the need to refabricate a new prosthesis from time to time to compensate for craniofacial growth.

Implant placement in a young child would be an ideal method of treatment for the absence of teeth. They restore the function, preserve the alveolar bone and give excellent esthetics, restoring the child's confidence and social acceptability. Parents are usually overzealous and keen to get this treatment done as soon as offered the suggestion. However, dental implant placement in children has special consideration, the impending growth, which needs to be understood before commencing on the treatment plan.

The purpose of this review is to understand the implications of growth and growth assessment and recommendations for the formulation of treatment plan in pediatric dental implant patients.

## GROWTH

Growth in the maxilla and mandible does not happen uniformly in one plane. It is multidirectional, occurring in sagittal, vertical, and transverse planes. It does not happen at a fixed pace, slow periods of growth are followed by phases of accelerated growth called the

growth spurts. The teeth maintain their position in the arches by following this pace of growth through remodeling and drifting within the alveolar bone. Functional forces are balanced by a stable interarch occlusal relationship, achieved gradually as transition from primary to permanent dentition occurs.

## MAXILLARY GROWTH

During early childhood, the transverse growth of the maxilla is influenced by the increasing width of the cranial base and growth at the median suture. This sutural growth accelerates at puberty and is the earliest of the three dimensions to be completed in adolescence.<sup>[12]</sup> Early placement of implant can give rise to a diastema with the adjacent teeth as transverse growth occurs, although transverse problems are not reported in implants placed in the anterior maxilla even as early as 9 years of age.<sup>[13,14]</sup> Moorrees *et al.* suggested that a decrease of incisor-canine circumference noted from 13 to 18 years of age was associated with a decrease in arch length.<sup>[15]</sup> In a long-term study carried out by Dager *et al.* it was observed that in a 30-year period from approximately 17–47 years of age, overall the changes lead to crowding in the dental arches.<sup>[16]</sup> Bishara *et al.* observed that tooth size-arch length discrepancy increases significantly from early adolescence to mid-adulthood in both maxillary and mandibular arches.<sup>[17]</sup> Hence, a reduction in arch length and increased crowding during the period of maximum growth can result in an implant crown that is out of alignment with adjacent natural teeth.<sup>[18]</sup>

For sagittal growth, resorption occurs at the anterior surface of maxilla that brings it downward and forward. Early placement of implant could result in a loss of labial cortical bone for the implant. Furthermore, there is a spontaneous mesial drift in the teeth in which the implants do not participate.<sup>[19]</sup> Hence, any implant placed in the lateral region can inhibit this drift laterally which may lead to an asymmetric arch while an implant placed in the anterior region may become more lingually positioned with time.<sup>[20]</sup>

Vertical growth of the maxilla occurs by sutural lowering.<sup>[21]</sup> There is growth in the orbits, increase in the size of the nasal cavity and maxillary sinuses by resorption on the nasal surface and deposition on the palatal and alveolar surface. The vertical growth of the face is the last to complete. Adult levels of vertical growth are near complete by 17–18 years in girls and even later in boys and are further influenced by the facial growth type (long face or short face). Hence, an early placement of an implant can lead to its presence in the nasal floor after puberty while the permanent teeth have moved down. Westwood reported the case of a boy

aged 15 years and 4 months in whom an implant was inserted to replace the congenitally missing maxillary left second premolar immediately after removal of the retained primary molar.<sup>[22]</sup> A radiograph taken 48 months following implant placement revealed bone resorption due to skeletal growth in the floor of the antrum that exposed the apical end of the implant in the sinus.

## MANDIBULAR GROWTH

The mandible being more closely associated with the cranial structures shows a differential growth as compared to the maxilla. This is more in the sagittal plane which is responsible for converting the more convex facial profile of the child to a straighter adult profile. The sagittal growth of the mandible is through endochondral growth in the condyle that extends the length but has no impact on the shape of the mandible as such.<sup>[23]</sup>

The transverse growth in the mandible completes very early because of the closure of the symphysis in the 1<sup>st</sup> year of life, and only limited changes occur afterward through remodeling. Posteriorly, there is resorption of the bone lingually and deposition buccally that leads to remodeling. This pattern of bone growth may bring about lingual positioning of the implant in case it is placed early.<sup>[23]</sup> Increase in the mandibular length is limited posterior to the primary second molars to accommodate the permanent molars.

Growth in the vertical dimension occurs by the apposition at the dentoalveolar complex and rotation of the condyle that appears to displace the mandible downward and forward from the cranium. The vertical dimension is maintained through the dentoalveolar compensatory mechanism. This occurs when eruption proceeds normally, and there are no functional deviations.<sup>[24]</sup>

Endosseous implants (two in the maxilla and four in the mandible) were placed in a 3-year-old child with ectodermal dysplasia (ED). After a 5-year follow-up, implants placed in the anterior mandible moved with the mandible as growth occurred in the condyles and rami. The rotation of the mandible, which accompanies growth, did not cause a significant problem relative to the angulation of the implants and the prosthodontic occlusal plane. The maxillary implant however, was close to the nasal floor.<sup>[25]</sup>

Montanari *et al.* reported a case of a child affected with ED accompanied with anodontia. At 2 years of age, conventional upper and lower prosthesis were made to allow for mastication and normal physiological development. At 11 years and 11 months, fabrication of lower implant supported dentures, and an upper

conventional denture was indicated. Mandibular growth in sagittal and transverse direction showed no adverse effects on implant position. After a 3-year follow-up, the implant supported overdenture was well accepted by the patient.<sup>[26]</sup>

## GROWTH ASSESSMENT

Chronologic age is not a true indicator of growth cessation. There is a wide range of pubertal growth spurt in boys (11–17 years) and girls (9–15 years).<sup>[27]</sup> There is no accurate indicator as to when growth has ceased. A reliable assessment of growth is based on cephalometric radiographic examination. Serial cephalometric radiographs are taken 6 months apart, and their tracings are superimposed to ensure that no growth has taken place. Although it is the most reliable method, but it takes a lot of time and delays implant insertion.<sup>[21]</sup>

Another accurate way of determining skeletal age is to take a hand wrist radiograph and compare it to a standardized atlas.<sup>[28]</sup> Three quick indicators of growth completion are the appearance of adductor sesamoid of the thumb, capping of the epiphysis of the middle phalanx of the third finger and fusion of the epiphysis and diaphysis of the radius.<sup>[29,30]</sup> As the skeletal growth of the long bones is complete, facial growth too stops, or it is safe to assume that it is near completion and implants can be safely placed.<sup>[21]</sup>

## TREATMENT PLANNING-MULTIDISCIPLINARY APPROACH

Successful implant treatment in children has been achieved by several clinicians when they incorporated a multidisciplinary approach in their treatment plan. The child patient is seen by the pediatric dentist at a very small age and remains under his care for a long period giving sufficient time for appropriate treatment planning. Important factors to be considered when treating a child with missing tooth, apart from growth, are dentition present, residual space between the teeth present in the arch, amount of alveolar bone, and the timing of implant placement.<sup>[31]</sup> Preservation of primary teeth till their root resorption, prevention of caries or endodontic treatment to prevent any periapical pathology and subsequent bone loss is important for later implant placement. It prevents the loss of arch length and maintains the alveolar bone height. The pediatric dentist should be capable of managing the primary dentition to create a healthy oral cavity for future.

Valle *et al.* successfully treated a case of hypodontia in a child by a multidisciplinary treatment approach. The pediatric dentist maintained the primary second molars

till the child was 17-year-old and then combined with orthodontic treatment to allow for space sufficient for the placement of endosseous implants. Later when the primary teeth were extracted, external hex implants with a 4.1 mm rectangular platform were placed with immediate load.<sup>[31]</sup>

The orthodontist creates appropriate spaces for implant insertion and corrects the root angulations of the permanent teeth in the bone. Proper root alignment reduces the chances of angular defects that could lead to bone loss. Misch *et al.* performed a retrospective study on 328 adolescents with congenital anodontia of permanent maxillary anterior teeth between the years 1990 and 2005.<sup>[32]</sup> A total of 276 implant sites were restored in 255 patients. Orthodontic treatment was performed in all the cases. The final root position and angulation of the permanent teeth in the premaxillary region were established. Stabilization of the occlusal relationship between the arches was carried out before implant placement. Bone grafting was done wherever needed to improve the hard tissue topography and ensure a harmonious crestal ridge contour for a better esthetic outcome. Orthodontic retainers were given to all the patients during the initial bone healing phase of the implant. There were no implant failures during the 15 years of this report after the final prosthesis delivery.

Montanari *et al.* advocated a dental multidisciplinary team that includes a pediatric dentist, an orthodontist, a prosthodontist and an oral and maxillofacial surgeon for a successful outcome in implant placement in children.<sup>[26]</sup> They carried out the oral rehabilitation in a child with hypohidrotic ED with an implant supported overdenture. Conventional dentures were made for the child at the age of 2 years. At the age of 11 years and 11 months, an upper conventional denture and a lower implant supported overdenture was made. Two tapered screw endosseous implants were placed in the anterior aspect of the mandibular jaw. After a healing period of 2 months, the implants were exposed, and two ball-attachments were connected to the implants to avoid a rigid connection. This was done to allow normal mandibular growth and to reduce interference with the patient's growth. The prosthesis was connected with implants using the two ball-attachments. After 3 years of follow-up, the mandibular implant-supported overdenture was well accepted from the patient who reported excellent masticatory and esthetic improvements.

There can be loss of alveolar bone in many conditions such as trauma, congenitally missing teeth or severely malposed teeth which require bone augmentation procedures. The alveolar bone assessment should be carried out through computed tomography (CT) or cone beam CT. Kohawwi discussed the sequence and

timing of bone augmentation and implant insertion for the adolescent patient in a case report of three patients. The patients had avulsed teeth that had been replanted but became mobile after some time. Confirmation of adequate bone was done by a CT. In one patient, it was obvious that the buccal plate was missing for which an expanding polytetrafluoroethylene membrane (Gore-Tex) and demineralized, freeze-dried bone were used to augment the bone. Implants were not placed immediately, rather after 10 months, when gap was completely filled, a screw-type implant was inserted. A follow-up radiograph taken 2 years and 10 months after implant placement showed that the integration was maintained without any changes in the relation between the implant and adjacent teeth.<sup>[33]</sup>

The design and type of implant system used in pediatric patients are also responsible for successful treatment outcome. Misch *et al.* placed the implants at a distance of least 1.5 mm from the adjacent teeth. Implant length range was 12–16 mm and the body diameter varied from 3.5 mm to 4.0 mm. This was based on the mesiodistal dimensions of the missing tooth and the buccolingual dimensions of the bone. All implant bodies were of a two-piece screw design in which surface treatment was done with a resorbable blast media or hydroxyapatite (Ha). All implants were left unloaded during the initial bone healing process.<sup>[32]</sup>

Ledermann *et al.* used the Ha-titanium (Ti) implant system in their patients. The Ha-Ti implant features a highly polished neck with the dimension of a natural tooth, and a step-screw implant shape analogous to a natural tooth root. Ha-Ti implants were placed in 34 patients, aged 9–18 years through a 7-year period. Their follow-up has been associated with a success rate of 90%. Guided tissue regeneration procedures using Gortex or Vicryl® membrane were used in two patients showing bony dehiscence after the implant was completely inserted. They stated that when a root-form implant is placed into an alveolus immediately after tooth loss, the degree of resorption can be minimized even when narrow bone dimension results in a dehiscence after implantation.<sup>[14]</sup>

The advantage of the Ha-Ti system was that the crown is never cemented onto the implant base or onto any type of coping, rather, it is fixed with a Ti transverse screw. Hence, the crowns can be removed easily at any time by simply taking out the transverse screw. If the adjacent permanent teeth continue to erupt and the crown starts appearing short, additional porcelain can be added to the incisal edge. Their results showed successful use of implants as an alternative to fixed prostheses or orthodontics in young children, especially those who are nearing or have already reached complete alveolar

bone growth. They also reported that the failures were not related to implant failure or the fact that the patients were children.<sup>[14]</sup>

## CONCLUSION

Dental implant insertion is a possible mode of rehabilitation in children and adolescents. Systematic planning of treatment can lead to desired esthetic and functional results. Growth assessment accompanied with alveolar bone evaluation should be done at the initiation of treatment planning. The orthodontic treatment and surgical treatment can be initiated about a year before the planned implant placement. This would utilize the period and create a greater chance for success after the implant insertion. The greater the physiologic harmony that can be created within the teeth, alveolar bone and growth, greater are the chances of successful implant placement in children.

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