# Osseointegrated Dental Implants in Growing Children: A Literature Review

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Edentulism is usually associated with the aging patient. However, total or partial tooth loss also affects young individuals, mainly as a result of trauma, decay, anodontia, or congenital and acquired jaw defects involving the alveolar processes. For elderly patients, the use of oral implants has become an accepted treatment modality for edentulism, and most of today's knowledge regarding implants is based on such practice. There has been hesitation to perform implant therapy for growing children; hence, few children to date have been provided with implant-supported construction. Consequently, little is known about the outcome of the osseointegration procedure in young patients, and until now, only a limited number of case presentations have been reported. This article reviews the current literature to discuss the use of dental implants in growing patients and the influence of maxillary and mandibular skeletal and dental growth on the stability of those implants. The literature review was performed through Science Direct, Wileys Blackwell Synergy, PubMed, Google, Embase, Medknow publications, and Springer for references published from 1963 to 2011. It is recommended to wait for the completion of dental and skeletal growth, except for severe cases of ectodermal dysplasia.

***Key Words: dental implants, ectodermal dysplasia, alveolar bone growth, adolescents, hypodontia***



## INTRODUCTION

Growing patients often require prosthodontic rehabilitation for the restoration of edentulous areas. Traumatic tooth loss or congenital partial anodontia, mainly in patients with ectodermal dysplasia, are frequently encountered in children. In those cases, oral rehabilitation is required before skeletal and dental maturation, and removable prosthesis is often the only treatment of choice. However, it may lead to increased caries rates, increased residual alveolar resorption, and other periodontal complications.[1]

In the past few decades, with the increased predictability of root form dental implants, there has been heightened interest in the potential use of dental implants in the growing patient.[1,2] From a physiologic standpoint, the conservation of bone may be the most important reason for the use of dental implants in growing patients,[1,2] and it even may be beneficial in some cases to stimulate alveolar bone development.[3] Other factors that favor implant placement in children are their excellent local blood supply, positive immunobiologic resistance, and uncomplicated osseous healing.[4]

However, the use of implants in young patients creates special problems because their jaws are in a period of active, dynamic growth. Since data concerning the clinical use of implants are limited at the present time, a definite protocol for their use

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has not been developed, although opinions have been expressed.[5]

Clinicians should have an understanding of the potential risks involved in placing implants in jaws that are still growing and developing and consider the effect that implants have on craniofacial growth.[6]

## Review

According to OpHeji et al,[7] implants inserted into pediatric patients do not follow the regular growth process of the craniofacial skeleton and are known to behave similar to ankylosed teeth, resulting in both functional and esthetic disadvantages.

Rossi and Andreasen[8] found that they could interfere with the position and the eruption of adjacent tooth germs, thus resulting in potential severe trauma to the patient. These and many other adverse effects have resulted in a very restrictive indication for dental implants in those individuals who have not completed craniofacial growth.[7]

However, there are exceptions, for instance, children who suffer from extended hypodontia or even anodontia and congenital syndromes such as ectodermal dysplasia (characterized by an aplasia or dysplasia of tissues of ectodermal origin—hair, nails, skin, teeth).[9] In affected patients, the extensive lack of both deciduous and permanent teeth results in atrophy and a reduced growth rate of the affected alveolar processes. Recent reports suggest that these pediatric patients can benefit remarkably from an implant-supported oral rehabilitation.

Bjork[10,11] implanted pins in the jaws of children for longitudinal cephalometric studies and reported that those in the path of erupting teeth were displaced and those placed in resorptive areas were lost. Pins placed in areas of appositional bone growth became embedded.

Oesterle[12] compared dental implants to ankylosed primary and documented that ankylosis arrests both dental eruption and alveolar bone formation in the affected area. An osseointegrated implant would behave much like an ankylosed primary tooth, with the same lack of alveolar growth and dental eruption, and thus it would appear to submerge into the alveolus. The authors proposed that implants placed in the posterior maxilla in children might become buried to the point that the apical portion might become exposed as the nasal and antral floor remodel. They also warned of the possibility of loss of implants in the anterior maxilla because of resorption in the infradental fossa and nasal floor.

In another similar study by Cronin et al,[13] the authors discussed rotational growth of the mandible as related to implants in children with a strong rotational growth pattern. Posterior teeth continue to erupt along with continued alveolar growth to maintain the occlusal plane, possibly causing implants to become deeply buried within the mandibular alveolar process. Children without this rotational growth would not be expected to exhibit this same submergence of implants.

Ledermann et al,[4] in their 7-year follow-up with a mean length of 35.5 months, reported a 90% success rate on 42 endosseous dental implants placed in 34 patients aged 9 to 18 years. There was a positive soft and osseous tissue reaction to the implants, and most of the failures occurred because of subsequent traumatic injuries sustained during the healing phase after implant placement. The major complication reported was the failure of dental implants to respond to the vertical growth of adjacent teeth and alveolus due to ankylosis.

Brugnolo et al [14] noted the infraocclussion of implants placed in patients aged 13 to 14.5 years, secondary to vertical growth, and prosthesis was redesigned. Anteroposterior and transverse growth seemed not to influence the implants' position negatively.

According to Smith and Vargervik,[15] implant use in children with ectodermal dysplasia is a treatment of choice, since its placement in the mandibular anterior region of a 5-year-old patient did not affect adjacent tooth buds. Prosthesis remodeling was performed due to implant submergence.

Guckes et al[16] described a case of 3-year-old patient with ectodermal dysplasia in which dental implants located in the mandible and maxilla have not moved despite growth. During the 5-year follow-up, the prosthesis was remodeled to accommodate eruption of the maxillary teeth and facial growth.

Kearns et al[17] did not find evidence of restriction to transverse and sagittal growth due to implant use in children with ectodermal dysplasia. Prosthesis remodeling was necessary in some patients secondary to implant submergence.

### *Animal studies*

Thilander et al[18] concluded that osseointegrated implants in pigs remained stable in place and either became buried in alveolar bone, creating a deviation of the erupting adjacent teeth, or were lost because of bone resorption. This study recommended that implants not be placed posterior to the canines during active growth. In addition, adjacent tooth germs exhibited morphologic changes and disorders of eruption.

In another similar study done by Sennerby et al,[19] it was shown that endosseous implants placed in young pigs have limited the effects of ankylosed teeth. Placed in alignment with adjacent teeth, the implants did not participate in growth processes, resulting in an infraocclusion and multidimensional dislocation when compared with the developing teeth.

## Discussion

The benefits of implant use in growing patients are as important as the concerns for their premature use. It is a controversial matter, and not many reports have been published; therefore, an individual and careful diagnosis and treatment plan are required. As dental implants in children are a new treatment modality, the impact that a bone-supported prosthesis might have on facial growth or, conversely, how growth might influence the longevity and esthetics of the implant prosthesis is not very clearly known.

There are 2 primary concerns. First, if implants are present during several years of facial growth, do they face a danger of becoming embedded, relocated, or displaced as the jaws grow? Any of these outcomes are possible because implants, in contrast to teeth, are not capable of compensatory eruption or other physiologic movements. The second concern is the effect of prosthesis on growth. Can a rigid prosthesis attached to implants bridging a growth area inhibit growth? As a corollary, are there design changes that must be incorporated into such a prosthesis to compensate for growth changes?

Several aspects of craniofacial skeletal growth seem relevant for implant insertion in growing children with hypodontia.

Both the maxilla and the mandible are dynamically changing during childhood. Behaving similar to ankylosed teeth, implants cannot participate in the maxillary growth processes of drift and displacement,[20] resulting in unpredictable implant dislocations during growth, or, if implants are fixed together, there are maxillary growth disturbances.

Because of the resorptive aspects of maxillary growth at the nasal floor and the anterior surface of the maxilla, unpredictable implant dislocations in the vertical and anteroposterior direction can occur, and even implant losses have to be expected. Transversal growth of the maxilla occurs mostly at the midpalatal suture. Consequently, fixed implant constructions crossing the midpalatal suture will result in a transversal growth restriction of the maxilla.

All in all, the insertion of implants in the growing maxilla should be avoided until early adulthood.[1]

In the mandible, however, the transversal skeletal or alveolodental changes are less dramatic than in the maxilla. In the posterior mandible, growth changes occur predominantly in late childhood with large amounts of anteroposterior, transverse, and vertical growth.[20] In addition, the mandible undergoes rotational growth, resulting particularly in vertical alterations.[20,21] When several teeth are present, vertical growth is a major aspect of dental height increase and results in anteroposterior compensatory changes in the dentition. Consequently, implants would remain in an infraocclusal position and would probably be displaced in the anteroposterior direction.[22] In the anterior mandible, however, alveolar growth seems relatively small when teeth are missing.[22] Most of the transversal growth of the mandible occurs quite early in childhood, and the anteroposterior growth occurs mainly at the posterior mandible.[21] However, in children with severe hypodontia, the anterior mandible might represent probably the most suitable site of implant placement.[22] In the past few years, several case reports of implant insertions in the anterior mandible of children have been published.

In a monocentric prospective study, the survival rate of implants placed in the anterior mandible of pediatric patients with ectodermal dysplasia was reported to be 91%.[23]

Interestingly, some reports have demonstrated that craniofacial morphology did not differ significantly between implant-treated and nontreated children with ectodermal dysplasia, suggesting that treatment with intraosseous dental implants did not necessarily interrupt normal craniofacial growth, as assumed before.[24] But, in the long run, implants located at the anterior mandible probably seem affected by the mandibular growth rotation, which can result in a change in implant angulation.[25]

### *Implant timing*

Finding the ideal time of implant treatment in children seems quite difficult because many different aspects have to be considered while finding the best individual treatment strategy. Nevertheless, reports in the literature describe placement of implants as early as 3 years[16] or 5 years of age.[15] But the safest time to place implants seems to be during the lower portion of the declining adolescent growth curve at or near adulthood that can be determined by cephalographic radiographs, serial measure of stature, or handwrist radiographs.[22] Other relevant aspects to consider include the individual status of the existing dentition, the functional status of mastication and phonetics, esthetic aspects, and emotional and psychological well-being.[26] Finally, both the parents and the child have to be compliant to implant treatment and implant hygiene.[17] According to the 1988 National Institutes of health Consensus Development Conference on Dental Implants in Bethesda, Maryland, child patients with ectodermal dysplasia could benefit from the use of dental implants. Published reports of implant use in young patients are as yet very limited, and long-term clinical studies are necessary for sound conclusions.

In the past few years, several case reports of implant insertions in the anterior mandible of children have been published; most of the authors agree that the mandibular anterior area seems to hold the greatest potential for early use of an implant-supported prosthesis. The survival rate of implants placed in the anterior mandible of pediatric patients with ectodermal dysplasia was reported to be 88% in preadolescents and 91% in adolescents. Survival rates were consistently higher for implants placed in the mandible (91% to 92%) than for those placed in the maxilla (71% to 86%). Considering the evidence presented, osseointegrated implants in the maxilla of growing patients must be undertaken with a great deal of caution, since anterior maxillary implants were 2.8 times more likely to fail than those placed in the anterior mandible.

If the goals of treatment planning favor implant use before skeletal maturation, parents must be informed about benefits and possible complications, and careful attention must be given to prosthesis design.

## Conclusion

1. Implant location, the sex of the patient, and the skeletal maturation level are the most important factors in the final decision of when to place implants.
2. It is still recommended to wait for the completion of dental and skeletal growth except for severe cases of ectodermal dysplasia.

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