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Implants in Young Patients: At Cross Roads

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ABSTRACT

Background: Children and adolescents often require prosthodontic rehabilitation for the restoration of edentulous areas which could be due to congenitally missing teeth and teeth lost due to trauma. These children are usually treated with removable prosthesis considering the fact that skeletal and dental growth and development is incomplete and this treatment modality can lead to residual alveolar resorption, periodontal problems and increased risk of dental caries. The concern of placing implants in growing children is jaw growth. An osseointegrated implant behaves like ankylosed teeth and fails to move with surrounding structure leading to infraocclusion. When a choice is made to place the implant in growing children it should be closely monitored and implant prosthesis should be designed to accommodate the growth and development. This article gives a brief review on implants in growing children and effect of growth and development on implants.

Keywords: Implants in children, ectodermal dysplasia, growth and development.

INTRODUCTION

Today, dental treatment is highly predictable and renders itself as a valid option for completely or partial edentulous patients[1]. Traumatic injuries and disease conditions such as ectodermal dysplasias, congenital absence of teeth, or oligodontia can lead to edentulous conditions in children. This can be a source of immense psychological trauma to the child as well as affect the orofacial development.

Generally, the only form of rehabilitation of these teeth is by removable prosthesis as growth restricts the use of any fixed appliances. Considering from a child's perspective a removable prosthesis is not a very desirable option as it is dependent on the patient's compliance. Also, it is difficult to maintain, leads to increased rate of decay, gingival diseases and bone resorption associated with the prosthesis. Along with this there is the need to re-fabricate a new prosthesis from time to time to compensate for craniofacial growth. To overcome these drawbacks it would be desirable to restore the dentition of these children by means of implants rather than removable prosthesis[2].

Recent advances in implant materials, implant designs and improvised surgical protocol have played a significant role in making implant as predictable treatment option[1]. Implants can be a good alternative because it can prevent residual alveolar resorption. Other factors that favours early placement of implants in children would include excellent local blood supply, positive immunological resistance, uncomplicated osseous healing[3].

When restoring the edentulous space in young children and adolescents using implants, the basic knowledge of growth and development is essential to assess the implants' response to craniofacial growth. Implants behave like ankylotic teeth and fail to move together with the surrounding structures leading to infraocclusion of implants and difficulties with prosthesis[4]. This article will discuss current status of using implants in growing children and its effect on growth and development.

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GROWTH AND DEVELOPMENT

A basic knowledge of facial growth is critical in assessing how an implant may respond in the adolescent. An osseointegrated implant behaves like an ankylosed primary tooth because both lack a periodontal ligament. The periodontal ligament has an important function in allowing teeth to erupt and adapting for dentoalveolar and facial growth, not only vertically but also in anteroposterior and transverse dimensions[5]. Early animal studies have shown that osseointegrated implants remain fixed in their initial position and cannot adapt for growth changes[6,7].

GROWTH OF THE JAWBONES

Growth is first completed in the transverse plane then in sagittal plane and finally in vertical plane. The growth of mandible is closely associated with general body growth, whereas growth of the maxilla is more associated with the growth of the cranial structures. As a rule of thumb, which applies to both the maxilla and mandible, transverse growth is first completed before the pubertal growth spurt and is followed by growth in length and finally growth in height, which is completed last[8].

MAXILLARY GROWTH AND IMPLANTS

Transverse growth

During early childhood, the transverse growth of maxilla is influenced by the increasing width of the cranial base. Transverse growth is the earliest of the three-dimensional growth completed in adolescence. The width of the anterior portion of the arch is completed prior to the adolescent growth spurt, but for the posterior portion , the width increase is closely tied to the increasing jaw length. The width in the anterior portion increases mainly by growth at the midpalatal suture (sutura palatine mediana), a growth that is 3 times larger in the first molar area than in the front. The inter-canine distance will change only little after the age of 10 (0.9mm). Thus if a central incisor was replaced with an implant shortly after eruption, a diastema could develop between the implant and the adjacent natural central incisor, resulting in a subsequent shifting of the midline to the implant side. Replacement of both central incisors prior to the end of transverse anterior growth could result in a diastema between them. The enlargement between the molars appears smaller than the sutural widening in this area, suggesting an adaptation of the dental arch. In the more posterior area, changes can occur until complete tooth eruption. In case reports9,10 of implants placed in the anterior maxilla as early as 9 years of age, no transverse problems have been reported; however, significant problems in the vertical dimension will overwhelm any transverse problem. The midpalatal suture usually closes after puberty around the age of 15 (from 15 to 27years). The latter should be kept in mind when planning the placement of a midpalatal implant as anchorage for orthodontic appliances.

Sagittal growth

The maxilla increases in length due to both sutural growth and bone apposition at the maxillary tuberosity. The anterior part of the maxilla is rather stable. However, when the maxilla is displaced downward and forward during growth, up to 25% of the displacement is lost via resorption at the anterior site. The latter could result in an implant gradually losing labial bone. A case report of implants replacing a lateral incisor of a 13year old boy and an 11.5year old girl noted problems with labial fenestrations as early as 11months after placement in the girl and 19months in the boy, increasing in severity with growth[11]. The sagittal growth of the maxilla is closely associated with the growth in skeletal body height, but stops earlier. The eruption of the third molars can be responsible for some changes afterwards, through a process of bone apposition.

Teeth have a spontaneous mesial drift. The lateral segment (canine to first molar) moves on average 5mm mesially (between 10 and 21years of age) but the maxillary incisors move only 2.5mm bucally, causing a net loss in space, which lead to crowding. An implant does not take part in this “spontaneous tooth migration”. Thus an implant in the lateral region could stop the mesial drift resulting in an asymmetric arch, while an implant in the frontal region cannot follow the teeth and will become relatively more palatal with time.

Vertical growth

The vertical growth in the maxilla occurs via both displacement (sutural growth) and drift. The maxilla is displaced downwards, away from the cranium, by growth in the orbits (eyes increase in size) and by increase in size of the nasal cavity and maxillary sinuses (by resorption on their nasal surface and by deposition of bone on their palatal and alveolar surface). This vertical growth continues beyond the age at which transverse and sagittal growth cease. Usually, adults levels of vertical growth are reached at 17 or 18 years for girls and somewhat later for boys.

Afterwards, depending on the facial growth type and due to the continued eruption of the teeth, changes still might occur, though much slower than during the active growth phase. However, over decades it can still contribute to significant changes and as such it has an impact on the use of osseointegrated implants. Between 9 and 25years of age, the maxillary incisors will move about 6mm downwards and circa 2.5mm bucally. The average eruption velocities reaches 1.2 to 1.5mm/year during the active growth phase, and 0.1 to 0.2 mm/year afterwards, even after the age of 18years. Ranly 1988[12], calculated that an implant inserted in the anterior part of the maxilla at the age of 7, will 9 years later be located 10mm more apically than the neighbouring teeth. This assumption was confirmed by clinical observations[9,12,4] after placement of solitary implants at the average age of 12, showing a "relative" infraocclusion of 5 to 7mm 4 years later, sometimes combined with a labial fenestration. In the molar similar changes were measured.

GROWTH OF THE MANDIBLE AND IMPLANTS

The timing of the mandibular growth is similar but not identical to that of the maxilla. Where the former is more closely associated with the growth in stature, the latter is more associated with growth of the cranial structures. This accounts for the greater amount of sagittal growth of the mandible than of the maxilla during adolescence[10]. This "differential jaw growth" converts the more convex child profile to the straighter adult profile. In girls, mandibular growth is nearly completed 2 to 3 years after menarche, (usually at age 14 or 15) while for boys, growth can continue into the early 20s, but usually reaches adult levels by age 18.

Transverse Growth

Changes in the width of the mandible are much less than in the maxilla. The increase in the width of the mandible occurs primarily in the posterior region of the mandible. As the mandible increases in length, it also increases in posterior width because of its V-shape. The width in the anterior mandible ceases due to early closure of mandibular symphysis (around 1-year). Thus, mandibular anterior width stabilizes relatively early and increases only slightly by appositional growth, whereas mandibular posterior width increases with the increasing length of the mandibular body[13]. Implants can be placed in anterior mandibular region at an early age. But implants in mandibular posterior region of growing children will result in lingual position due to bone remodeling in premolar molar region.

Sagittal Growth

Changes in arch length in the mandible differ from those in the maxilla. As the permanent incisors erupt, there is generally little or no change in mandibular arch length. Sagittal growth of mandible is due to both endochondral growth and remodeling of bone. The growth of the condyle results in increase in the length of mandible. To accommodate posterior teeth, the body of the mandible increases in length by resorption on anterior aspect of ramus and deposition on the posterior aspect. An implant placed in early age will result in exposure of an implant due to pattern of resorption[13].

Vertical Growth

Mandibular growth increases by condylar growth and by bone apposition at dentoalveolar complex. When serial lateral cephalograms are superimposed on the cranial base, the mandible appears to grow downward and forward. Bjork however, using metallic implants as stable landmarks for serial cephalometric superimposition, found that during puberty the mandible does not necessarily grow downward and forward in a linear manner. Instead, the mandible rolls forward, with apposition below the symphysis and resorption below the gonial angle[13]. Thus, during growth, the face and the mandible tend to rotate, with the center of rotation influenced by the direction of condylar growth.

IMPLANTS IN PATIENTS WITH ECTODERMAL DYSPLASIA

Ectodermal dysplasia is an inherited disorder in which at least two structures derived from the ectoderm are abnormal. Kearns et al 1999 did not find evidence of restriction to transverse and sagittal growth due to implant use in children with ectodermal dysplasia. Endosseous implants can be successfully placed and can provide support for prosthetic restoration in patients with hereditary ectodermal dysplasia. However, vertical dentoalveolar growth results in submergence of the implant relative to the adjacent natural dentition when implants are placed adjacent to erupting permanent teeth. Prosthesis remodelling was necessary is some patient secondary to implant submergence. Another study by Bergendal et al 1996 concluded that implants must be placed when growth is almost completed, except for rare cases of total aplasia, as ectodermal dysplasia. Elsewhere, it has been recommended that treatment with implant must be delayed until the age of 1, since an implant placed at age 7 or 8 may not be in a favorable position at age 16. Johnson et al 2002 in his analysis of craniofacial development in children with hypohidrotic ectodermal dysplasia with and without endosseous implants concluded that craniofacial morphology did not differ significantly between implant-treated and nontreated ectodermal dysplasia children[13]. This suggested that treatment with intraosseous dental implants, as applied in this population, did not reduce normal craniofacial growth and development.

Birgitta et al[14] found that in patients with ectodermal dysplasia, the dimensions of mandible available for implant placement are very small and hence lead to formation of fistula after primary healing and will be subsequently lost within 6 weeks, or there might be fractures of the buccal bone during implant placement, or implant may be lost before abutment placement since the available bone will usually be of poor quality. Also, the treatment options were limited to use of small diameter implants or treatment had to be postponed until adequate jaw size was obtained. Yap and klineberg[15] found that implants placed in adolescent patients with ectodermal dysplasia did not show any significant effect on craniofacial growth, while implants placed in ectodermal dysplasia patients below the age of 18 years had a higher failure risk.

Conversely, Mark Pigno et al[16] found that immediate implant placement was beneficial to preserve alveolar bone and those implants which were placed at an age of 15years in girls and 18years in boys showed a good prognosis. Nurhan et al[17] found that mini implant placement in adolescent patients did not require osseointegration for immediate loading and showed long-term potential stability when integrated under functional biting forces.

SUGGESTIONS FOR IMPLANT PLACEMENT IN UNAFFECTED PATIENTS

Extreme caution must be used in placing implants in children because of growth changes in jaw and the dentition.

1. Whenever possible, implant placement must be delayed until the age of 15years for girls and 18 years for boys.
2. Growing patient treated with dental implant should have adequate follow – up.
3. Further research is needed in the areas of implants in growing children.
4. 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 implant.
5. It is still recommended to wait for the completion of dental and skeletal growth, except for severe cases of ectodermal dysplasia.

RECOMMENDATIONS FOR IMPLANT PLACEMENT

Specific recommendations can be made for the placement of dental implants in the growing patient.

Maxillary Anterior Region

The maxillary anterior region is an important area for consideration because frequent congenital tooth absence and traumatic tooth loss are often encountered in this area. The vertical and anteroposterior growth changes in this area are substantial, and for esthetic and functional reasons implant placement should be delayed until growth is completed in this region.

The vertical growth of the maxilla exceeds all other dimensions of growth in this region; therefore, premature implant placement can result in the

repetitive need to lengthen the transmucosal implant connection resulting in poor implant-to-prosthesis ratio and the potential for load magnification. Premature placement of an implant near the midline can create a mesiodistal spatial disharmony secondary-to-median sutural growth, which accelerates at puberty. The placement of implants in the anterior maxillary region before age 15 in female patients and age 17 in male patients should be attempted only to achieve unique treatment planning goals and with particular emphasis on the determination of skeletal age, informed consent and the possibility of future implant replacement[18].

Maxillary Posterior Region

The extreme variation in vertical and anteroposterior growth is also seen in the posterior maxilla. An important additional growth factor is transverse maxillary growth at the midpalatal suture and in the alveolus. The increase in width at the posterior aspect of the midpalatal suture is approximately three times that seen at the anterior aspect of the midpalatal suture. This variation not only produces heightened transverse growth, but also a rotational growth. All of these variables serve as a cautionary note and reinforce the fact that the more predictable treatment occurs closer to the end of maturation. The severe variability of vertical growth seen in this region has the potential to cause a serious biomechanical load magnification problem because of the increased masticatory force placed on posterior occlusal surfaces. Placement of osseointegrated dental implants in the maxillary posterior quadrant is best delayed until age 15 in females and age 17 in males. Particular care must be exercised when placing implants before skeletal maturity because of the appositional and resorptive pattern of the posterior maxilla[18].

Mandibular Anterior Region

From a standpoint of growth and development, the anterior mandibular region presents the best site for the placement of an osseointegrated implant before skeletal maturation. Although, the mandible presents fewer confounding variables, the closure of the mandibular symphysis suture occurs during the first two years of life. Recommendations have been made to begin treatment in children with ectodermal dysplasia as early as three years of age, creating improvement in facial appearance leading to demonstrable emotional, psychological, phonetic and functional benefits.

Mandibular Posterior Region

A large variation in the growth occurs in the posterior mandibular region leading to progressive infraocclusion of the implant, and harms the adjacent teeth. So implant in this region should not be placed until skeletal growth is completed.

CONCLUSION

While placing implant for single missing tooth adjacent to permanent teeth, dentoalveolar development occurs around the edentulous space. If an implant is placed before dentoalveolar growth is complete, the implant will become submerged relative to the adjacent teeth because implant behaves like an ankylosed tooth, resulting in poor esthetics and poor implant to crown ratio. To avoid such complication in the growing child, it is recommended not to place implants until two annual cephalograms shows no change in the position of the adjacent teeth.19 Missing single or multiple teeth with adjacent permanent teeth form the most complex group of patients to be treated using Implants[18].

In terms of overall diagnosis, they may have some form of non-syndromic partial anodontia or ectodermal dysplasia. In planning implant placement, future dentoalveolar development and the psychological development of the patient needs to be considered. In cases of completely edentulous arch, because teeth are not present, one need not to be concerned about dentoalveolar growth. The only concern is the downward and forward growth of the entire mandible. This can result in a jaw size discrepancy due to mandibular rotation, but the implant position will not be adversely affected. Careful consideration must be given to the physical and psychological development of the patient when an implant placement is planned. Patients must understand the oral hygiene requirements and perform them adequately. Oral hygiene is rarely satisfactory in patients younger than seven years old. For these reasons, the placement of implants in patients younger than the age of 7 is not indicated. On the basis of the studies of jaw growth, it is better to avoid placement of implants posterior to the

mandibular canines. In patients with ectodermal dysplasia, implants have been successfully placed in the maxillary arch and in the mandible anterior to the mental foramen. Extreme caution must be used in placing implants in children because of growth changes of the jaws and the dentition. Whenever possible, implant placement should be delayed until age 15 for girls and 18 for boys. Growing patients treated with dental implants should have adequate follow-up. Further research is needed regarding placing implants in growing children.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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