# Adverse Effects of Implants in Children and Adolescents: A Systematic Review

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***Objective**: To determine the evidence on the adverse effects of placing dental implants in healthy growing children. **Study design**: A systematic search was conducted in five electronic databases: PubMed, Ovid, Cochrane, EBSCO host, ProQuest. Studies on implants placed in children below the age of 19 years, with loss of tooth either due to trauma or caries were included, whereas, studies on mini implants and implants placed due to congenital absence of teeth were excluded. The articles that fulfilled the inclusion criteria were analyzed based on the predetermined criteria of success. **Results**: A total of 8 publications fulfilled the inclusion criteria. All the included articles were case reports/ series, involving a total of 16 implants (15 maxillary, one mandibular) in 11 adolescents (7 boys and 4 girls). The age of implant placement ranged between ten to 17 years with a mean age of 13.4 years and the follow up period, 4.5 months to 13 years. Pain, paresthesia, mobility or peri-implant radiolucency was not reported in any case report, indicating good integration. Radiographic crestal bone loss, probing depth and implant esthetics were not mentioned. The infraocclusion was not reported in 5 cases (age: 11-17 years, follow up: 4.5 months-two years), however, it was an adverse effect in 6 cases (age: ten-17 years, follow up: three-13 years). **Conclusion**: There is insufficient evidence to contradict the placement of dental implants in healthy growing children; the only reported adverse event is infraocclusion, the management of which too is discussed. However, as all the data is from case reports, the result should be interpreted with caution. Therefore, well-designed randomized controlled trials are needed to address this gap in the literature.*

**Keywords:** *Adolescents, Children, Dental, Implant*

## INTRODUCTION

Implant dentistry, in recent times, has tremendous popularity and attention for the prosthetic replacement of the lost teeth in adults.[1-3] The benefits and long term success of implants is the basis for its wide use.[2,4,5] However, this topic has gained certain controversies in children and adolescents; few advocate,[6-12] whereas, others contradict their usage.[13-19] Hence, in spite of the drawbacks with the use of removable prosthesis, such as retention problems, child's cooperation to wear the prosthesis, failure of alveolar ridge development, psychological and emotional disturbances in children due to missing teeth, it has been the choice of treatment for the interim rehabilitation in growing children with partial or complete edentulism.[20-22]

The use of implants in young patients differs significantly from adults in many aspects, among which special focus has been given in the existing literature to the growth of child that can lead to changes in the dentition and jaws, except for the area around the dental implant.[23,24] This is supposed to lead to infraocclusion of the implant-supported prosthesis compared with the rest of the dentition.[9,13-15,19,25] This aspect has been posed as a significant risk, due to which implant dentistry could not gain its place in Pediatric dentistry. Despite this, there are certain reports that presented the use of implants in the growing children and successful management of the infra occlusion.[9,13-15,25] Taking these aspects into consideration, as an in depth investigation of the existing literature is the

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need of the hour, the aim of the present scoping review is to provide a summary of the published evidence regarding the adverse events of implants placed in the anterior tooth region of healthy normal growing children and analyze the risk to benefit ratio for making the best clinical decision in such cases.

## MATERIALS AND METHOD

### Research question

Are there any adverse effects of placing implants in the anterior tooth region of healthy children?

Searches were performed in three major electronic databases, Medline/ PubMed (http://www.ncbi.nlm.nih.gov/pubmed), Ovid (http://ovidsp.ovid.com/) and Cochrane (http://www.cochranelibrary.com/) and two minor databases, Ebsco (https://search.ebscohost.com/) and ProQuest (http://search.proquest.com/). The following specific MeSH keywords were used: adolescent, child, dental implant, males, females, maxilla, mandible, dental arch, growth and development. [Table 1] The relevant MeSH terms as well as the entry terms were considered and combined to search for the studies. The search was supplemented by hand search of the reference list of articles obtained during the electronic search. Two reviewers (RK and PA) independently read the titles and abstracts of all the studies, based on the below mentioned selection/inclusion criteria. The procedure involved reading and excluding the irrelevant articles in the following phases: titles, abstracts and full articles.

#### *Eligibility criteria*

The selection involved articles that fulfilled the following criteria:

- Studies in which endosseous single implants were placed in normal growing children below the age of 19 years, either in maxilla/mandible or anterior/posterior region.
- Implants placed after traumatic loss of tooth or tooth extracted due to untreatable caries.
- All types of implants, irrespective of the abutment-connection, implant material and the loading protocol.
- Articles published in any language during the period, January 1990 to July 2017.

Studies on mini-implants, implants placed in children with congenital absence of single tooth, partial anodontia, oligodontia, anodontia, multiple aplasia, ectodermal dysplasia or any other syndrome and all animal studies were excluded. All the review articles, letters, opinion articles, commentaries and gray literature were excluded.

In case of any disagreement between the reviewers, consensus was attempted through discussions; persistent disagreements were resolved by the intervention from the third reviewer.

## RESULTS

The systematic search strategy led to the retrieval of 1090 articles (with overlaps). Following the application of eligibility criteria, 21 papers qualified for final analysis and the complete texts were obtained of which eight fulfilled the inclusion criteria.[9-15,25] (Figure 1) The details of the included and excluded articles are represented in Tables 2a and 2b.

All these articles were case reports/series involving a total of 16 implants (15 in the maxillary anterior region and one in the mandibular anterior) in 11 adolescents (seven boys and four girls), the details of which are illustrated in tables 3a and 3b. The age of the implant placement ranged from 10 to 17 years with the mean age of 13.4 years. The time elapsed between avulsion due to trauma and implant placement was immediate to 2.5 years. The follow up period ranged from four -five months to 13 years [9-11,13-15,25] and for one patient follow up period was not mentioned.[12] The skeletal maturation was considered only in one report.[12] In all the articles, the authors considered self-defined criteria for evaluating the success of the implant.[9-15,25] As far as this review, for evaluating the adverse effects of implants in normal growing children, pain/paresthesia, mobility, peri implant radiolucency, radiographic crestal bone loss, probing depth, infraocclusion and implant esthetics were considered. [Tables 4a and 4b] Pain, paresthesia, mobility or peri implant radiolucencies were not reported in any of the case reports,[9-15,25] indicating a good osseointegration. Radiographic crestal bone loss was not regarded in 15 implants,[9-14,25] whereas, in one case report it was mentioned as 1.5 mm of adjacent tooth bone.[15] Probing depth and implant esthetics, as reported subjectively, was not mentioned in any of the case reports.[9-15,25] The infraocclusion was not reported in five cases (three articles), who's age ranged from 11 to 17 years (mean: 14.6 years).[10-12] The follow up period of these cases was in the range of 4.5 months to two years (0.9 years).[10-12] On the other hand, infraocclusion was reported in six cases (five articles), the age of whom ranged from 10 years to 17 years (mean: 12.3 years), with the follow up period in the range of three years to 13 years (mean: 8.1 years).[9,13-15,25] The amount of infraocclusion in mm was not mentioned in five cases,[9,14,15,25] whereas it was reported to be 9mm only in one case.[13] Infraocclusion was dealt by two authors using new prosthetic restoration[15] and orthodontic correction of adjacent and opposing teeth.[25]

**Table 1: MeSH terms considered for the review**

| PICO | Population | Intervention | Comparison | Outcome |
|---|---|---|---|---|
| Characteristics considered | Children/adolescents below the age of 19 years | Dental implant | Between boys and girls, Between maxilla and mandible, Between anterior and posterior region | Difference in vertical growth of adjacent teeth and alveolus |
| MeSH terms | Adolescent, Child | Dental implant | Males, Females, Maxilla, Mandible, Dental arch | Growth, Development |
| Alternative terms | Teenagers, Teens, Youth, Early adulthood, Puberty | Dental implantation, Artificial tooth, Implant support dental prosthesis | Upper arch, Lower arch, Anterior area, Posterior region | Infraocclusion, Occlusal relationship, Underocclusion, Maxillary growth, Mandibular growth |

**Figure 1: Flow diagram**

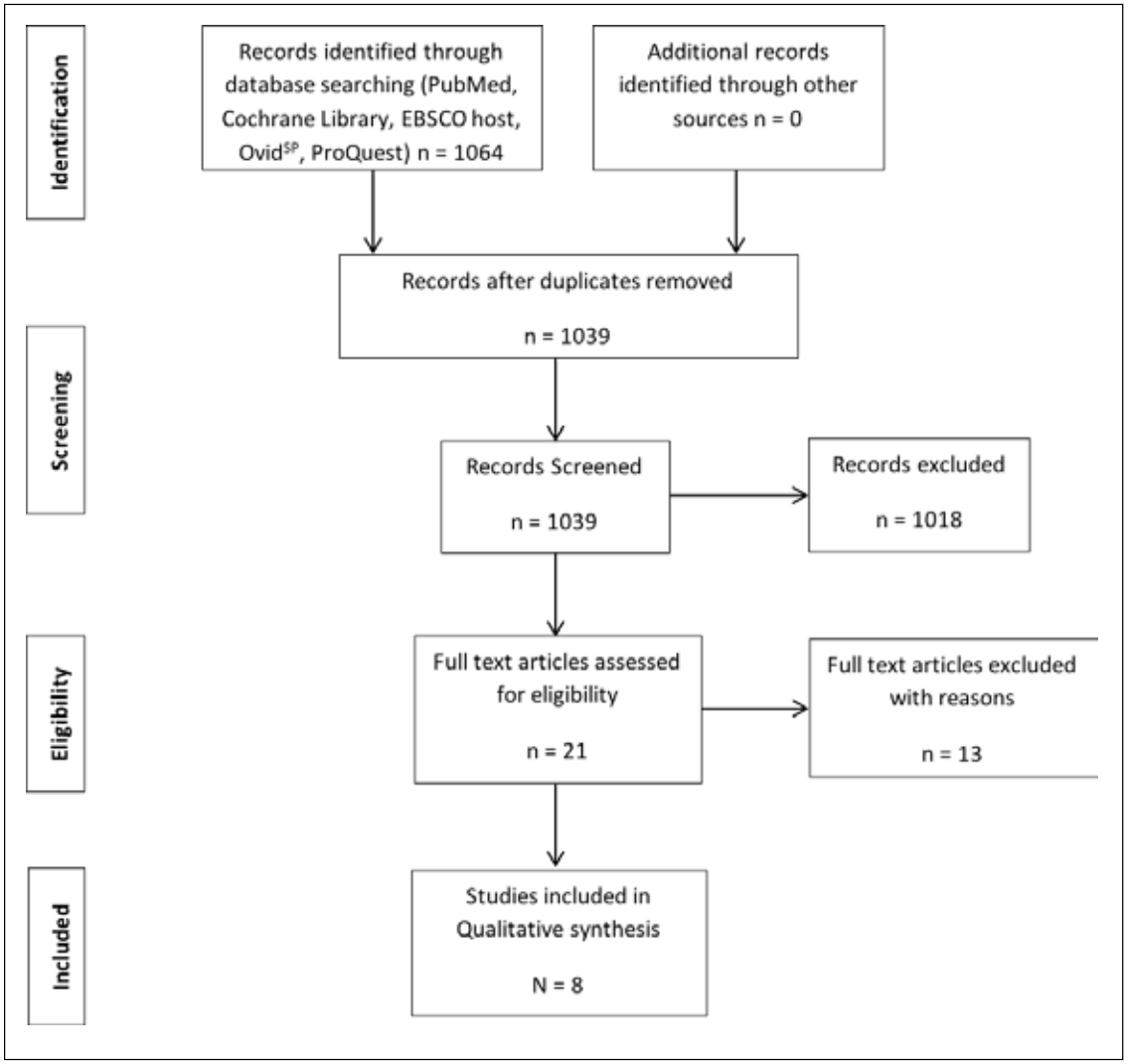


**Table 2a : Articles included in the review**

| S.No. | Details of included articles | Source |
|---|---|---|
| 1 | Hulsmann M, Engelke W. Delayed endodontic and prosthetic treatment of two traumatized incisors. Endod Dent Traumatol. 1991 Apr;7(2):90-5. | PubMed |
| 2 | Johansson G, Palmqvist S, Svenson B. Effects of early placement of a single tooth implant. A case report. 28. Clin Oral Implants Res. 1994 Mar;5(1):48-51. | PubMed |
| 3 | Brugnolo E, Mazzocco C, Cordioll G, Majzoub Z. Clinical and radiographic findings following placement of single-tooth implants in young patients: Case reports. Int J Periodontics Restorative Dent. 1996 Oct;16(5):421-33. | PubMed |
| 4 | Mehrali, Mark C; Baraoidan, Mylene; Cranin, A Norman. Use of endosseous implants in treatment of adolescent trauma patients: Three case studies. Oral Health. 1996 Oct;10(86):49-56 | Proquest |
| 5 | Rossi E, Andreasen JO. Maxillary bone growth and implant positioning in a young patient: a case report. Int J Periodontics Restorative Dent. 2003 Apr;23(2):113-9. | PubMed |
| 6 | Chen Y. Correction of early implanted upper anterior teeth by distraction osteogenesis and orthodontic treatment: 285 Posters–Implant Therapy Outcomes, Surgical Aspects. Clinical Oral Implants Research. 23 Supplement 7:129-130, October 2012. | Proquest |
| 7 | Krieger E, Wegener J, Wagner W, Hornikel S, Wehrbein H. A combined prosthodontic and orthodontic treatment approach in a case of growth inhibition induced by dental implants: A case report. Quintessence Int. 2012 Jan;43(1):9-14. | Ebsco |
| 8 | Scheuber S, Bosshardt D, Bragger U, von Arx T. Implant therapy following trauma of the anterior teeth – A new method for alveolar ridge preservation after post-traumatic ankylosis and external root resorption. SchweizMonatsschrZahnmed. 2013;123(5):417-39. | PubMed |

**Table 2b: Articles excluded from the review**

| S.No | Details of excluded article | Source |
|---|---|---|
| 1 | Cronin RJ, Oesterle LJ, Ranly DM. Mandibular implants and the growing patient. Int J Oral Maxillofac Implants 1994;9:55-60. | PubMed, Ebscohost |
| 2 | Iseri H, Solow B. Continued eruption of maxillary incisors and first molars in girls from 9 to 25 years studied by the implant method. Eur J Orthod 1996;18:245-56 | PubMed, Ebscohost |
| 3 | Thilander B, Odman J, Jemt T. Single implants in the upper incisor region and their relationship to the adjacent teeth. An 8-year follow-up study. Clin Oral Implants Res 1999;10:346-55. | PubMed, Ebscohost, Ovid |
| 4 | Henry PJ. Tooth loss and implant repalcement. Aus Dent J 2000;45:150-172. | Proquest |
| 5 | Poggio C, Salvato A. Implant repositioning for esthetic reasons: A clinical report. J Prosthet Dent 2001;86:126-9 | PubMed, Ebscohost |
| 6 | Thilander B, Odman J, Lekholm U. Orthodontic aspects of the use of oral implants in adolescents: A 10-year follow up study. Eur J Orthod 2001;23:715-731. | Ovid, Proquest |
| 7 | Andersson L, Emami-kristiansen Z, Hogstrom J. Single tooth implant treatment in the anterior region of the maxilla for treatment of tooth loss after trauma: A retrospective clinical and interview study. Dent Traumatol 2003;19:126-31 | PubMed, Ebscohost |
| 8 | Bernard JP, Schatz JP, Christou P, Belser U, Kiliaridis S. Long term vertical changes of the anterior maxillary teeth adjacent to single implants in young and mature adults. A retrospective studt. J ClinPeriodontol 2004;31:1024-8 | PubMed, Ebscohost, Ovid, Proquest |
| 9 | Sharma AB, Vargervik K.Using implants for the growing child. J Calif Dent Assoc 2006;34:719-24. | Ebscohost |
| 10 | Carmichael, Robert P, Sandor, George KB. Dental implants, growth of the jaws, and the determination of skeletal maturity. Atlas Oral Maxillofac Surg Clin North Am 2008;16 | Ebscohost |
| 11 | Degidi M, Lezzi G, Perrotti V, Piatelli A. Comparative analysis of immediate functional loading and immediate nonfunctional loading to traditional healing periods: A 5–year follow-up of 550 dental implants. Clin Implant Dent Relat Res 2009 | PubMed |
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| 13 | Kokich VG. Maxillary lateral incisor implants: Planning with the aid of orthodontics. J Oral MaxillofacSurg 2014;62:48-56 | Ebscohost |

**Table 3a: Details of included articles**

| Authors (Year) | Study design/ Level of evidence | No. of subject/s | Gender | Age at the time of implant placement | No. of implant/s placed | Implant details | Reason for implant placement/ History |
|---|---|---|---|---|---|---|---|
| **Hulsmann et al., (1991)** | Case report/ Level IV | 1 | Girl | 16 years | 1 | After extraction, the bony defect is filled with macroporous hydroxyapatite and missing tooth temporarily replaced by a removable prosthesis. Eight months later ITI titanium screw implant (*Bonefit, ITI*) is incorporated. | Complaint of draining sinus tract and discoloration with a history of traumatic injury at the age of 8 years. Authors tried endodontic therapy for maxillary right and left central incisor. Treatment failed for left central hence they extracted and placed an implant. |
| **Johansson et al., (1994)** | Case report/ Level IV | 1 | Boy | 12 years 3 months | 1 | 15-mm self-tapping fixture *ad modumBrane-mark* is inserted in the 21 region. After 6 months, a healing abutment is connected to the osseointegrated fixture with a gold-resin crown retained to the fixture by means of a titanium abutment screw. | Avulsion due to trauma at the age of 9.5 years. After 2.5 years implant was placed. |
| **Brugnolo et al., (1996)** | Case series/ Level IV | 3* | Boy | 12 years | 1 | 15-mm self-tapping fixture (3i, Implant innovations). A screw-retained porcelain-fused-to-metal crown constructed on a nonrotating single tooth abutment (3i) is connected to the implant. | Loss of maxillary left central incisor due to trauma at the age of 10 years. Two years later implant is placed. |
| | | | Girl | 11 years | 1 | 15-mm standard screw type fixture (3i) screw-retained porcelain-fused-to-metal crown is provided. | Trauma at the age of 9 years. Subsequently implant was placed. |
| **Mehrali et al., (1996)** | Case report/ Level IV | 3 | Boy | 11 years | 1 | Calcitek registered Omnilock 3.25 × 15mm. | Trauma at the age of 11 years. After 8-9 months implat was placed. |
| | | | Boy | 12 years | 2 | Sustain registered 4.0 × 13mm | Trauma at the age of 12 years. After 6 weeks implant was placed. |
| | | | Boy | 17years | 1 | Calcitek registered 3.25 ×13mm | Trauma at the age of 17 years. 1 week later implant was placed. |

**Table 3b: Details of included articles**

| Authors (Year) | Study design/Level of evidence | No. of subject/s | Gender | Age at the time of implant placement | No. of implant/s placed | Implant details | Reason for implant placement/History |
|---|---|---|---|---|---|---|---|
| **Rossi, Andreasen (2003)** | Case report/ Level IV | 1 | Boy | 10 years | 1 | Frialit Tubingen 4.0mm diameter cylindrical root-form implant | Trauma |
| **Chen (2012)** | Case report/ Level IV | 1 | Girl | 12 years | 3 | Not mentioned | Trauma |
| **Krieger et al., (2012)** | Case report/ Level IV | 1 | Boy | 17 years | 2 | Self tapping (regular platform, Mk III, Branemark System, Nobel Biocare; diameter: 3.75mm mm, length: 13 mm) | Avulsion of both maxillary central incisors and a concurrent fracture of the alveolar bone ridge due to an accident. |
| **Scheuberet al., (2013)** | Case report/ Level IV | 1 | Girl | 17 years | 2 | An SLActive Bone LEVEL IMPLANT BL4.1/12mm RC (Straumann AG, Basel, Switzerland) was in region 11 and SLActive Bone-Level Implant BL 3.3/10mm NC in region 12 | Trauma at the age of 10 years due to accident while climbing |

**Table 4a: Criteria of success considered for evaluating the included articles**

| Considered Criteria | Authors | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hulsmann et al., (1991) | Johansson et al., (1994) | Brugnolo et al al., (1996) | | Mehrali et al., (1996) | | |
| | | | Case 1 | Case 2 | Case 1 | Case 2 | Case 3 |
| **Area of implant placement** | Maxillary anterior | Maxillary anterior | Maxillary anterior | Maxillary anterior | Maxillary anterior | Maxillary anterior | Mandibular anterior |
| **Skeletal maturation** | Not considered | Not considered | Not considered | Not considered | Not considered | Not considered | Not considered |
| **Follow up period** | 10 months | 4.5 years | 6 years | 3 years | 2 years | 4-5 months | 6 months |
| **Criteria considered for implant success** | Self defined | Self defined | Self defined | Self defined | Self defined | Self defined | Self defined |
| **Pain/ Paresthesia** | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported |
| **Mobility** | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported |
| **Peri implant radiolucency** | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported | Not reported |
| **Radiographic crestal bone loss** | Not mentioned | 1.5mm of mesial bone of 22 | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned |
| **Probing depth** | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned |
| **Infraocclusion** | Not reported | Observed in 18 months follow up* | Observed in 2 years follow up* | Observed in 1 year follow up* | Not reported | Not reported | Not reported |
| **Implant esthetics subjective** | Not considered | Not considered | Not considered | Not considered | Not considered | Not considered | Not considered |

**Table 4b: Criteria of success considered for evaluating the included articles**

| Considered Criteria | Authors | | | |
|---|---|---|---|---|
| | Rossi and Andreasen (2003) | Chen (2012) | Krieger et al., (2012) | Scheuber et al., (2013) |
| **Area of implant placement** | Maxillary anterior | Maxillary anterior | Maxillary anterior | Maxillary anterior |
| **Skeletal maturation** | Not considered | Not considered | Not considered | Hand Wrist Radiograph |
| **Follow up period** | 13 years | 10 years 5 months | 10 years | Not mentioned |
| **Criteria considered for implant success** | Self defined | Self defined | Self defined | Self defined |
| **Pain/Paraesthesia** | Not reported | Not reported | Not reported | Not reported |
| **Mobility** | Not reported | Not reported | Not reported | Not reported |
| **Peri implant radiolucency** | Not reported | Not reported | Not reported | Not reported |
| **Radiographic crestal bone loss** | Not mentioned | Not mentioned | Not mentioned | Not mentioned |
| **Probing depth** | Not mentioned | Not mentioned | Not mentioned | Not mentioned |
| **Infraocclusion** | 9mm | Observed in 8 years follow up* | Observed in 7 years follow up* | Not reported |
| **Implant esthetics subjective** | Not considered | Not considered | Poor | Not considered |

## DISCUSSION

The scoping review is a type of research synthesis to map the literature on the selected topic or research area and provide an opportunity to identify key concepts, gaps in the research and types and sources of evidence to inform practice, policymaking and research. The major limitation of this review is the lack of critical appraisal of included studies. However, the present study has enabled us to categorize the existing literature in terms of its nature, features and volume.

Only eight publications fulfilled the pre-specified inclusion criteria[9-15,25] and all the studies were case reports and series. In the present research question selected, there were no clinical trials conducted to compare the difference in the success of implants in growing children and adults; which can be ascribed to the difficulty in balancing the confounding factors, paucity in cases and lack of control. Therefore, all the available data in the form of case reports was brought together to provide an evidence-based approach of placing an implant in a healthy growing child in this scoping review. There was also a need to frame self-defined criteria for measuring the success of the implants in growing children and adolescents. For adults, there are certain criteria for measuring the success as proposed by Albrektsson and Buser, but most of the researches in this field self-defined the criteria.[4,26,27] Hence, based on the existing literature, pain/paresthesia, mobility, periimplant radiolucency, radiographic crestal bone loss, probing depth, infra occlusion and subjective perceptive of implant esthetics have been considered for the present review.

Caries, trauma, congenital absence or syndromes are the etiological factors for the partial or complete edentulism in children and adolescents.[6-15,17,20,21,25] Of these, congenital absence or syndromes can have genetic basis, which impacts the success of an implant.[7,8,28,29] However, much of the published data is on the implants placed in ectodermal dysplasia and those with congenital absence of teeth.[29] In order to exclude the impact of these conditions on the success, in the present review, the implants placed in patients with acquired loss of tooth were considered.

The failure of implants in the form of pain/paresthesia, mobility or peri-implant radiolucency has not been reported in any of the cases included in the review, [9-15,25] which indicates the best possible osseointegration in growing children. The only drawback reported in six of the 11 was infraocclusion,[9,11,13-15,25] with the follow up period ranging between one to 13 years. The amount of infraocclusion in millimeters (mm) has been mentioned in one of the 11, as nine mm with a follow up time of 13 years[13] and the exact amount has not been specified in the other reports.[9,14,15,25] This drawback has been projected as the reason for not considering implants in growing children. However, the problem of infraocclusion is not a concern only in the growing children, but has also been reported in the adults.[30] The physiological bone changes are observed not only from adolescence into young adulthood, but also from young adulthood to old age, as the occlusion is a developmental process which is dynamic rather than static, interrelationship between facial structures.[31] Studies have demonstrated significant changes in craniofacial dimensions during adulthood, including eruptive movement of teeth and dento-alveolar changes.[32] Due to endogenous individual variations in dental age and skeletal maturity, no fixed chronological age that guides the implant placement can be suggested. Many authors have recommended full eruption of permanent teeth and completion of craniofacial growth before placement of implant to avoid an infraoccluded position.[3-19,33] However, the important factor that need to be considered during implant placement in children and adolescents, is the skeletal maturation to minimize infraocclusion; which is assessed with the help of hand wrist radiographs or cephalometric analysis. However, of all the included articles, only one author has mentioned the details about skeletal maturation.

Methods for the management of infraoccluded implants have been mentioned in the literature;[9-15,25,34,35] which include new implant borne prosthetic restoration, orthodontic pretreatment with intrusion of adjacent teeth and extrusion of opposing teeth and distraction osteogenesis.

New implant borne prosthetic restoration has been successfully considered in the management of infraocclusion.[15] The factor that might influence the prognosis of the new implant borne prosthetic restoration is the crown-root ratio. In a study, with retrospective cohort design, crown-root ratios of single tooth implant restorations were determined, and compared with the guidelines on crown-root ratios established for the ratios of natural teeth. The results suggested that the guidelines associated with natural teeth should not be applied for the potential implant site or existing implant restoration, as the crown-root ratios of implants in function were similar to those that failed.[36] This factor has been substantiated in studies conducted on the same topic, which proved that, this factor was not as important to the success of implants as previously thought, [37] though the ideal ratio for the replacement has not yet been determined.

Another procedure that allows a better predictable management of osseous and gingival tissues is distraction osteogenesis.[35] The successful use of this technique in the management of infraoccluded implant has been reported.[36] This procedure elongates bones by creating gaps and filling them with newly formed bone without the need for soft or hard tissue grafting.[36] The positive outcome of this procedure has made this treatment a reliable option, as it saves time and improves esthetics by changing the implant-crown ratio.[37] However, there are certain limitations with this technique, such as infection, premature consolidation and incomplete osteotomy, delayed consolidation leading to nonunion, undesirable shape, undesirable inclination of transported bony segment, either lingually or palatally relative to the basal bone.[38] Thus, further clinical investigation is required to determine the predictability of this treatment.

Dentists should not contraindicate the usage of dental implants in young individuals, just to avoid infraocclusion, as the studies of craniofacial dimensions have demonstrated significant changes during adulthood too.[39] Thus, the advantage of implants should always be weighed against the complications. Reduced bone loss, improved esthetics, function and dental hygiene are the major advantages in addition to the psychological comfort of the child.[34] Rehabilitation with implant improves the self-esteem of children or adolescents,[38] which is an important factor to suggest the usage of implants.

In a ten year follow up study conducted, that was excluded from the review as the reason for implant placement not specified, 47 implants were placed in children between the ages 13 to 17 years which showed implants as a good treatment option for replacing missing teeth.[8] The authors mentioned few important points;

maxillary incisor region, especially lateral incisors are more prone for the adverse effects due to the continuous eruption of adjacent teeth and craniofacial changes post adolescence. Hence, it is called as the critical area for implant placement.[40] Another factor, the distance between implant and adjacent teeth has also been mentioned to have an influence. The shorter the distance between the implant and adjacent teeth, the larger will be the bone loss around the implants. Thus, gaining sufficient space for the implant before placement is an essential factor that influences the success.[36,37] Hence, before placement of the implant, sufficient space must be gained in the implant site by uprighting and paralleling the adjacent teeth using non-intrusive movements.

If the child is in an active growth phase, mini implants are another treatment protocol that gives esthetic and functional success.[41] If infraoccluded, they can be easily unscrewed, enabling a conservation approach and are effective in growth phase.[41,42]

## CONCLUSION

There is no sufficient evidence to either indicate or contradict usage of implants in growing children, as suggested by the present scoping review, which included only case reports and series. The infra occlusion, which is the only reported problem in the included articles has been managed by using treatment modalities such as, new prosthetic restoration, orthodontic treatment or distraction osteogenesis. This seems to encourage the usage of implants in children due to the high success rate. Therefore, to reassess the present research question, well-designed randomized controlled trials are needed to address this gap in the literature. The future emendation might increase the scope of pediatric dentists to prefer this treatment modality, and enhance the self-esteem of children and adolescents.

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