



Dental implants in growing patients: A quality assessment of systematic reviews

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ABSTRACT

Background: Dental implants in the recent past have become indispensable in restoring loss of space and support as well as aiding the aesthetics. Although in practice for a few years there is no consensus on the protocols for placement and usage of dental implants in growing jaws.

Objective: The present study aims to evaluate evidence-based literature on single or multiple dental implant placements in children (up to 17 years) and to identify areas lacking and gaps in knowledge. The quality assessment tool, namely AMSTAR-2, will also aim to evaluate the quality of said research around paediatric dental implants.

Design: The study was prospectively registered on the Open Science Framework https://osf.io/e59bt/?view_only=ec8fb69455c240ecbfc7379734784bf7.

For source selection, electronic searches were performed on MEDLINE, EMBASE, Scopus databases as well as Google Scholar for all English language systematic reviews and meta analysis on dental implants placed on children up to 17 yrs of age by 2 reviewers, wherein the publications until December 2020 were included. A final dataset of 4 systematic reviews were incorporated and analysed using the AMSTAR-2 grading tool.

Results: It was seen that only one study showed moderate overall confidence while one low overall confidence as per the AMSTAR-2. The other 2 systematic reviews were of critically low confidence levels. Hence, the existing systematic reviews on the subject are not of high quality. Most of the reviews have no consensus regarding use and placement of implants in growing patients.

Conclusion: More research and stricter adherence to the quality assessment guidelines is recommended for all future systematic reviews regarding dental implant in children.

1. Background

The loss or absence of teeth especially in the anterior region in children and adolescents is one of the most challenging areas of a paediatric dentist's practice. Predicaments like complete or partial anodontia, oligodontia and hypodontia all can present as functional, psychological and speech impediments.

Avulsion presents as one of the most common sequelae post injury or trauma. Most of these result in missing or lost teeth. Edentulism may plague a child due to a variety of reasons like congenital or acquired jaw defects. One the most prevalent of which is ectodermal dysplasia,

thought to occur in approximately 1 of 1,00,000 live births with a mortality rate of 28% in males up to 3 years of age.⁸ It is characterized by the classical triad of hypodontia, hypohidrosis and hypotrichosis with characteristic dysmorphic facial features.⁹

Osseointegrated implants have been unceasingly used in dentistry as early as 1969 by Branemark with apparent success.¹¹ Although its other terms like "osseotolerance", "bone bonding" and "bone ankylosis" that better define the interactions of bony-titanium interface.¹²

The authors in the included articles argue that traditional prosthetic treatments in certain conditions like PLS causes aesthetic and operational problem with decreased stability and retention. In these patients,

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especially children, implant-based prosthesis usually preceded by pre-surgical augmentation was evaluated and examined.¹³

The continuous growth and development of bony framework in a child's cranium and maxilla-mandibular complex poses a unique challenge for implant placements. The site of placement, depth and timing all are questionable as per research so far and no consensus can be reached as to which protocol will lead to maximum stability and least variability when the child continues to grow. Also, the osseointegration and follow up after loading of the implants are highly variable due to the uneven growth spurts and trends among children.

1.1. Objective

Implants in paediatric population remain a widely debated topic with no proper agreement as to the effectiveness and success of it. The wide variety of type, position, timing and technique while placing implants in children leads to confusion and disparities in knowledge amongst paediatric dental practitioners while treatment planning.

Hence the present study was undertaken with the aim of assessing the quality of systematic reviews already published on the subject and identifying the gaps in understanding of the above.

1.2. Research question

The evaluation of evidence-based literature on dental implant placements in children and adolescents upto the age of 17 years and its quality assessment to identify the areas lacking and gaps in knowledge.

2. Methodology

2.1. Inclusion criteria

- We included systematic reviews and meta-analysis which assessed the effects and follow up of dental implants in children upto 17 years of age
- The included systematic reviews consisted of implants being indicated for a specific medical/dental condition or in healthy children.
- Only English language reviews were included.

2.2. Exclusion criteria

- Double publication of same sample
- Studies on cleft lip and palate patients
- Systematic reviews on mini-implants.
- Overviews of systematic reviews.
- Original research or case reports/series

2.3. Source of information

- For the purpose of the current study the electronic search was performed on MEDLINE, EMBASE and Scopus databases via institution login.
- Where studies were reported in abstract form, full length articles were sourced.
- The search was made in January 2021 and all publications until December 2020 were included.
- The search strategy was individualized for every database ([supplemental data](#)).
- Additionally, we manually searched Google Scholar for any relevant literature.

2.4. Selection of studies

The study was prospectively registered on the Open Science Framework https://osf.io/e59bt/?view_only=ec8fb69455c240ecbfc7379734784bf7 dated 2021-03-11. The preliminary search of the included

databases was performed by 2 individual researchers. Following the search, at least 2 reviewers independently examined the titles and abstracts of identified studies: any report found irrelevant or repetitive was excluded. Full text documents were retrieved of potentially relevant studies and assessed for eligibility according to the inclusion criteria pre-decided for this study. We resolved disagreements on study selection and data extraction by consensus and discussion with the third author and attempted to contact the authors for clarifications if required.

The search terms used in the study selection were "Dental implants in adolescents" and "Dental implants in growing patients". The search terms were used to manually search each database and then results were screened for relevancy as per pre decided inclusion criteria. The search strategy for Embase database included as a supplemental file (supplemental file no. 1-3) The selection process of the reviews is detailed in [Fig. 1](#). In the end, 4 systematic reviews were included in the final dataset.

2.5. Data charting

The following data were extracted from the included reviews:

1. Bibliometric data
2. Characteristics of the review
3. Characteristics of the participants included.
4. Description of the interventions.
5. Recommendations or follow-up of the surgical interventions

The systematic reviews included in the present study were analysed using the AMSTAR-2 grading tool.¹⁶ This data extraction was done independently and in duplicate by 2 reviewers and then graded. Any disagreements were resolved via discussion and arbitration by the third author. The percentage of systematic reviews achieving each item from the AMSTAR 2 and the overall confidence in the results were tabulated.

PICO details of included studies are tabulated in [Tables 1 and 2](#).

3. Results

3.1. Selection of a source of evidence

The data search was done over the course of months independently by 2 reviewers on MEDLINE, EMBASE and Scopus databases. Initially a total of 10,251 articles were searched out of which 45 were accepted satisfying our inclusion criteria. On independent manual screening 36 were removed for duplicates and 5 were discarded for other reasons. Finally, a total of 4 systematic reviews were included in the present study. ([Fig. 1](#))

3.2. Characteristics of sources of Evidence

Within the systematic reviews, the number of studies evaluated ranged from 8 to 42 studies, the majority of which were case series or reports. The ages of the included patients ranged from 4.5 months to 17 years. Overall, the number of implants placed ranged from 16 to 493 in both anterior and posterior region of both maxilla and mandible. The type of implant varied greatly Bonelit, ITI, 3i implant, Nobel Biocare, Straumann AG, Denstply Frialit, Branemark System, IMZ Pressfit, Interpore, MTI transitional implant etc. The prosthesis was loaded on the implant within the span of 3–10 months and ranged from single crowns to bilateral fixed prosthesis or complete implant supported dentures.

Out of the 4 included systematic reviews one consisted only of case series and reports, and one excluded all review articles and grey literature. All studies searched multiple databases. All the systematic reviews included PICO components in their research question and inclusion criteria and use a comprehensive literature search strategy. Only one of the included SR included a meta-analysis.

On analysing the systematic reviews included in the present study,

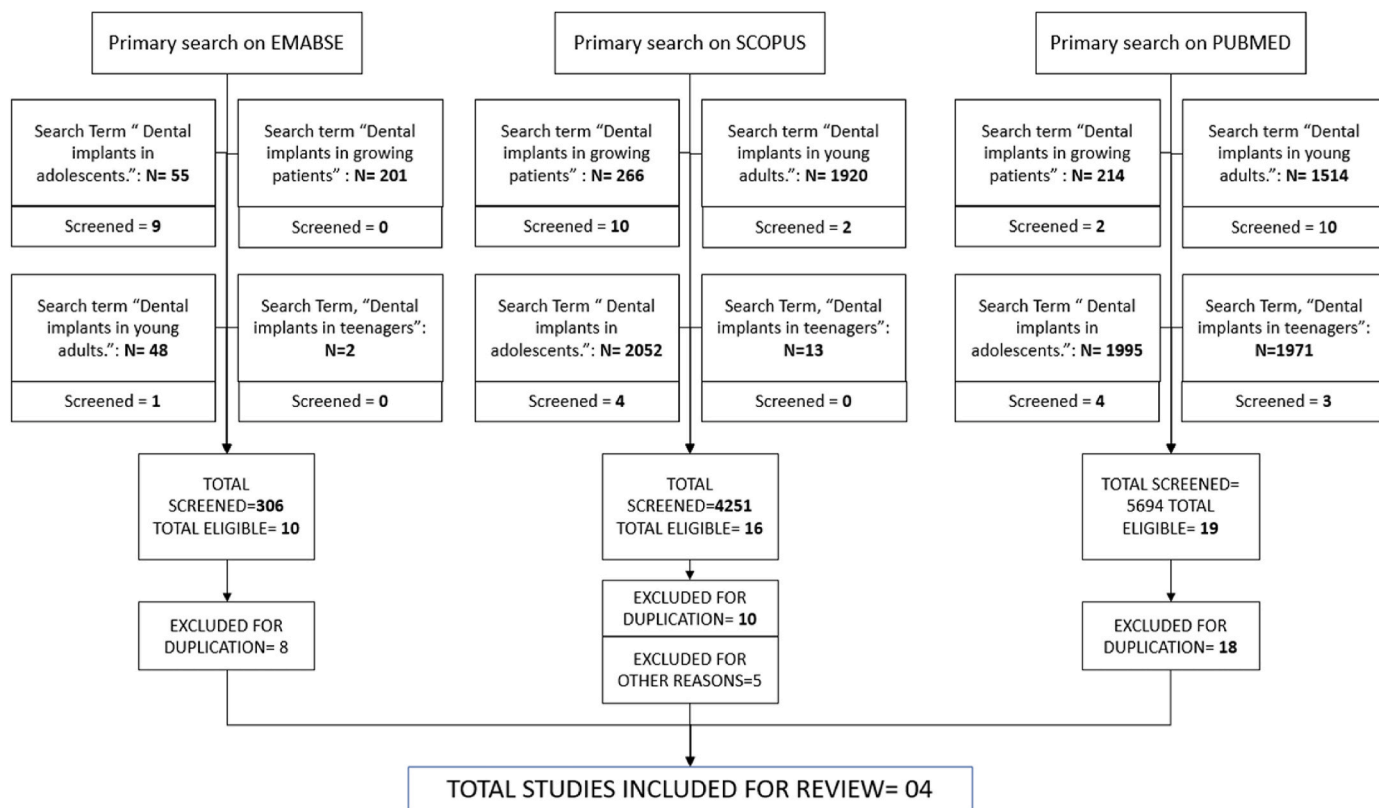


Fig. 1. Flow-Chart showing the search terms and screening of systematic reviews in various databases. The total number of systematic reviews screened and excluded are also shown above leading to a total of 4 systematic reviews in the final dataset.

Table 1
Table depicting the PICO information of included studies.

Population	Intervention	Comparison	Outcome
Children under the age of 17years	Single tooth or multiple dental implants	Conventional prosthetics, natural teeth, orthodontic treatments, position of implants	Primary: Success, survival or failure of dental implant Secondary: Difference in the vertical growth of teeth and alveolus.

using the AMSTAR-2 checklist it was seen that all the studies qualified for the critical appraisal tool. Wherever there was no meta-analysis done the relevant questions in the checklist were disregarded. The complete assessment chart of the questionnaire of all included studies is tabulated in Table 3.

3.3. Critical appraisal within sources of evidence

The critical domains and scoring using the criteria were used as per the AMSTAR 2 information sheet provided online. AMSTAR 2 provides a broad assessment of quality, including flaws that may have arisen through poor conduct of the review (with uncertain impact on findings).¹⁶

According to the same 7 critical items have been marked which need to be assessed to mark the strength of a review. Reporting of the results was done according to the details specified by the developer 2017 modifications.¹⁶

Table 2
Table depicting the PICO information as provided by the included systematic reviews (n = 4).

Publication	Population	Intervention	Comparison	Outcome
Bohner et al. (2019)	(young) OR (adolescents) OR (children) OR (oligodontia) OR (hypodontia) OR (anodontia)	(dental implant) OR (single-tooth implant) OR (dental implants [MeSh terms])		(success) OR (survival) OR (failure) OR (outcome) OR (follow up)
Terhyden and Wusthoff (2015)	Patients with congenitally missing teeth	Rehabilitation, dental implants, bone augmentation	Tooth auto-transplants, preservation of deciduous teeth, conventional prosthodontic or orthodontic treatments	Implant/ tooth success/ survival Prosthesis survival/ success
Sijanivandis (2020)	PLS patients	Oral rehabilitation using dental implants		Success of dental implant
Kamatham R et al. (2019)	Children and adolescents <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

Table 3
The table showing the final assessment and scoring as per AMSTAR-2 questionnaire for all included systematic reviews (n = 4).

Question	Bohner et al. (2019)	Terhyden and wusthoff (2015)	Sijanivandi s (2020)	Kamatham r et al. (2019)
Include components of PICO	Yes	Yes	Yes	Yes
Contain a statement that review methods pre-established	Yes	Yes	Yes	No
Explain their selection of study	Yes	Yes	No	Yes
Use comprehensive search strategy	Partial yes	Partial yes	Partial yes	Partial yes
Perform study selection in duplicate	No	Yes	Yes	Yes
Perform data extraction in duplicate	No	Yes	Yes	Not clear
Provide a list of excluded articles	Yes	No	No	Partial yes
Describe included articles in details	Yes	Yes	No	Yes
Satisfactory technique to assess risk of bias	Partial yes	Yes	No	No
Report sources of funding of included studies	No	Yes	No	No
Appropriate methods for statistical combination	No meta analysis	No meta analysis	Yes	No meta analysis
Assess potential impact of risk of bias in individual studies	No meta analysis	No meta analysis	No	No meta analysis
Account for individual risk of bias in results	Yes	Yes	Yes	No
Discuss the heterogeneity in result	No	Yes	Yes	No
Adequate assessment of production bias	No meta analysis	No meta analysis	No	No meta analysis
Report COI including funding	Yes	Yes	Yes	No

3.4. Results of individual sources of evidence

- By assessing our dataset, it was deciphered that one systematic review by Bohner L et al. ranked **moderate overall confidence** as per AMSTAR-2 guidelines.¹⁷ The study had no critical weaknesses. The study had some minor flaws as the authors did not perform the study selection or data extraction in duplicate. The authors also failed to report the source of funding from the individual studies in the dataset and did not provide a satisfactory explanation for heterogeneity observed in their results. There was no meta-analysis done.
- In the systematic review done by Terheyden and Wusthoff there was one critical weakness found wherein the authors did not provide a list of excluded studies or justify their exclusions. This ranked the systematic review as **low overall confidence**. The study reported no other weaknesses, and no meta-analysis was done.
- Sijanivandi S. et al published a systematic review which on assessment had more than one critical weakness. The authors did not provide a list of excluded studies and failed to give a justification for the same. Since this study included a meta-analysis, the authors should have carried out an investigation of publication bias and

discussed it's impact on the results; this was not done. Due to these the review was graded as **critically low overall confidence** by AMSTAR-2. Apart from this the authors did not explain the selection of the study design for inclusion of the review and failed to describe all the included studies in detail. No information was provided by the authors on the individual funding of the included studies in the review.

- We found that in the systematic review done by Kamatham R et al. there were critical weaknesses wherein no explicit statement was made about the review methods prior to the conduct of the review nor any deviations from these methods reported. Also, the authors did not take in to account the individual risk of bias in all the included studies while discussing their results. The article does not clarify whether the authors performed the data extraction in duplicate. This rated as **critically low overall confidence** as per AMSTAR-2 scoring. Beyond these, authors gave no information on individual funding regarding the included studies. Review authors also provide no satisfactory explanation or any discussion on the heterogeneity observed in their results, nor did they report any potential conflict of interest or source of funding while conducting their review. There was no meta-analysis done.

3.5. Synthesis of results

As per our results it was seen that only one study showed a moderate overall confidence which translated the accurate summary of the results of the available studies that were included in the review. This is important as any flaws or weaknesses in a systematic review can impact the overall result and compromise on the quality of information it carries. This result is in accordance with a study by Souto-Maior JR et al. on diabetes and dental implants where no systematic review was found to be of high overall confidence by AMSTAR assessment.¹⁹

One of the systematic reviews included in the present study was found to be low overall confidence and the other 2 SRs were assessed to be of critically low confidence as per AMSTAR 2. This finding seems to echo the one previously done on treatments for peri-implantitis where majority of the included SRs were of critically low confidence.²⁰

The systematic reviews seemed to be vague on the topic of technique used to assess risk of bias in the individual studies included in their dataset.

This is indicative of the major disparity between knowledge and practical application in the field of dental implants used in children. The limited quantity and quality of literature should be a source of concern for all paediatric practitioners. The range of research questions and the concluded inferences of each enlisted SR is enlisted in the Table 4.

4. Discussion

4.1. Description of the condition

In children variety of conditions can lead to missing or absence of teeth. The physiology associated with ongoing development and growth of the oro-facial structures complicates the management even more. Classically described as lack of one or more teeth, either in the deciduous or permanent dentition or in both commonly known as *partial anodontia* differs from *total anodontia* which means complete absence of the deciduous and the permanent dentitions or of either of them.¹ *Oligodontia* is the congenital missing of six or more teeth, excluding the third molars.² *Hypodontia or Congenitally missing teeth*, is the developmental absence of one or more primary or secondary teeth, excluding the third molars.³ In children, missing teeth can be a corollary even in the absence of genetic abnormalities or syndrome and are more common than syndromic associative type.^{4,5} *Avulsion* in young children consequential to trauma constitutes a sequelae post injury. The prevalence of avulsion out of all types of traumatic injuries to primary teeth ranges between 5.8%⁶ and 19.4%.⁷ Another syndrome frequently involving primary and

Table 4

Table including the research question posed by each systematic review, the conclusions derived after research and the recommendations posted in each included systematic review (n = 4).

Articles	Research question	Conclusion	• Recommendations
Bohner L et al.	What complications are related to the placements of dental implants in growing jaws? Is there a specific protocol that provides a favourable outcome of treatment?	Complications included • infraocclusion because of vertical growth. • Changes in positioning due to rotational mandibular growth. Placement of implant more coronally to avoid infraocclusion.	• Patients with missing teeth for maxillary implants a minimum age of 10 years to avoid structural growth related complications. • Risk of passive eruption lower in children >15years.
Terheyden and Wusthoff	In patients with congenitally missing teeth does an early occlusal rehabilitation with dental implants in comparison to tooth auto transplants, conventional prosthetics on teeth or preservation of deciduous teeth have better general outcomes in terms of survival, success and better patient centred outcomes in terms of quality of life, self-esteem, satisfaction and chewing function?	• Dental implants in patients with congenitally missing teeth have prognosis with survival rates of 95.3% after mean follow up of 4.6 years. • Low prognosis of dental implants in children (72.4%) as compared to adolescents (93%) and adults (97.4%). • Annual failure rates of implants in children (50.2%). • Complications included a majority of healing fractures and no long term problems. • Autotransplants and deciduous teeth are better options. • Conventional prosthetics lower success rates that other options.	• Decision making of implant placement not only dependent on survival data but also on secondary infraocclusion of restorations on implants which can account in maxillary anterior region to be upto 2.2 mm. • Less infraocclusion for teeth in lower jaw and upper canines. • Implants have better results in children >13years.
Sijanivandi S et al.	Assess the clinical outcome and survival rates of dental implants used for oral rehabilitation of PLS patients.	• Dental implant complications (ankylosed teeth) in growing PLS patient less important than bone preservation. • Optimum age unclear. • If implant placement done early, immunological assay is necessary. • Causes of failure mostly cited were poor oral hygiene,	• Areas lacking soft and hard tissue distraction osteogenesis is suggested.

Table 4 (continued)

Articles	Research question	Conclusion	• Recommendations
Kamatham R et al.	Are there any adverse effect of placing implants in anterior tooth region of healthy children?	poor compliance and lack of osseointegration. • Should not contraindicate the use of implants in young individuals just to avoid infraocclusion as significant changes happen during adulthood too. • Best timing – 13–17years • Maxillary incisor region (LI) most prone for adverse effects of continuous eruption of adjacent teeth and craniofacial changes post adolescence. • Complication of infraocclusion persists.	• Guidelines associated with natural teeth should not be applied to potential implant site or existing implant restorations. • The shorter the distance between implant and adjacent teeth larger the bone loss around implant. • Mini implants

secondary dentition is the Papillon-Lefevre Syndrome with a prevalence of 1–4 cases per million.¹⁰ The problem becomes even more important when seen with respect to the young individuals and adolescents. The timely correction of the space created also contributes towards normal jaw growth and development. The psychological benefits far outweigh the concerns in most of the aforementioned conditions.

4.2. Description of the intervention

Implants present a reasonable alternative to other treatment options as they prevent alveolar ridge resorption. In the present study the implants were placed in children up to 17 years across both genders placed in both maxilla and mandibular in anterior as well as posterior regions. The studies included implants of various manufacturers and type, with variable diameters and heights. Most of the implants were loaded within 3–10 months. There were a few comparative studies also including the comparison of implants with auto-transplants and calvarium bone grafts.

4.3. How the intervention might work

It has been observed by the collected dataset here that, as younger teeth with their large pulp chambers pose problems while being prepared as abutments and the inability to splint dentures in growing and immature dentitions, the use of dental implants is an attractive alternative in children. Also, in countries that cover dental costs up to 18 years this is a lucrative option for parents with restricted monetary access.¹⁴ The established hypothesis that enhanced blood supply and uncomplicated healing in younger ages contribute to the success of implants was also quoted by researchers.¹⁵

4.4. Critical appraisal Tool

Clinical practice guidelines often base their recommendations on findings from systematic reviews.¹⁸ Therefore in the present study we

aimed to assess the quality and reliability of data and information on the topic of dental implants in children and their follow up as evidenced in the available systematic reviews available to clinicians.

AMSTAR-2 was used to analyse the included reviews. As far as the AMSTAR 2 checklist is concerned, we found the 16 questions self-explanatory. The item 15 on the checklist where investigation regarding the publication bias and its impact on results is mentioned, seemed to be difficult to assess.

5. Limitation

The current scoping review had constraints regarding being able to include only single language papers for evaluation. Also, authors limited the evaluation of full-length systematic reviews leading to exclusion of a lot of published information otherwise available regarding the topic.

6. Conclusion

As per the current assessment, it was found that there is insufficient research and evidence-based literature regarding the use, prognosis and result of dental implants in children. The existing systematic reviews on the subject are not of high quality and do not satisfy all the requirement of a sound study. Most of the reviews have subpar reporting and do not follow the criteria specified. More research and stricter adherence to the quality assessment guidelines is recommended for all future authors while compiling systematic reviews..

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Availability of data and material

Not applicable.

Ethical approval and patient consent

Since this study did not involve any human intervention, no ethical clearance or consent was required.

Declaration of competing interest

The authors declare no potential conflict of interest and no competing financial interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jobcr.2023.07.004>.

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