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Timing of Implant Placement in Growing Patients with Congenital Tooth Agenesis: A Systematic Review and Developmentally Guided Clinical Framework

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Abstract

Congenital tooth agenesis brings significant dental restorative and developmental challenges in children and adolescent patients. Dental implants show high survival rates and stability for extended periods in people who have reached adulthood, but unique biological problems are caused by implant placement during the period of growth and development, specifically adolescence. Natural teeth differ from dental implants because implants stay fixed in the bone and do not adapt to when the jaw grows. As a result, dental implants which are installed before one stop growing will eventually appear misaligned than the other teeth. The lack of development of the dental implant position along with the rest of the alveolar bone creates problems for the bone position, gingival shape and additional esthetic complications.

This systematic review looks at the gathered information from current research about the best time for implant placement in younger individuals who have hypodontia and oligodontia. Multiple research papers were analyzed including systematic reviews, retrospective cohort studies, narrative review and multidisciplinary case reports. It has been observed that dental implants which are placed prior to skeletal maturity have a high risk of being in the wrong position later in life, once development is complete. Even though dental implants attach to the bone well through osseointegration, the position of the implant itself becomes unstable over time. When implants are placed after the skeleton is finished developing, the survival rates stay high and the long-term esthetic stability.

Scientific writing also suggests that using temporary tools like interim rehabilitation strategies like mini-implants and transitional implants while the teenager is still growing. These temporary tools provide functional help and make the individuals receiving care gain esthetic benefits while the future available choices are preserved. Successful results depend on measuring bone growth correctly and working with a team of medical professionals. Parents and individuals receiving care must be given clear information about what to expect in the future through careful counseling. Standardized ways of checking developing growth must be conducted in future research papers because more gathered information is needed about congenital tooth agenesis populations. Long-term studies must be done to see how dental implants work for people in congenital agenesis populations.

Keywords

Congenital tooth agenesis; Hypodontia; Oligodontia; Adolescent implant therapy; Craniofacial growth; Infraocclusion; Orthodontic mini-implants; Transitional implants.

Introduction

The term congenital tooth agenesis refers to an absence or incomplete development of teeth that is present before birth: this is one of the most typically seen abnormalities of the adult dentition. Hypodontia for example characterizes people who are congenitally missing one to five permanent teeth, while oligodontia describes individuals who are congenitally missing sex or more teeth. There are many negative consequences associated with both hypodontia and oligodontia in terms of occlusal development, alveolar bone formation, facial esthetics and psychosocial consequences during childhood and adolescence [1,2].

Since the introduction of dental implants, dental implants have been established as a predictable method to replace missing teeth in adult patients. When compared to conventional fixed bridges or removable partial dentures, they provide improved stability, better aesthetics and higher levels of patient satisfaction. On the other hand, there are several unique biological characteristics of implant therapy in growing individuals that differ from treatment in skeletally mature individuals that distinguish it from an adult.

Implants do not have a periodontal ligament; therefore, they do not have the ability to erupt like a natural tooth and will not be able to adapt throughout normal dental and skeletal growth after osseointegration and will be fixed in a static position within the osseous or bony tissue surrounding the implant. During adolescence, the craniofacial skeleton is continually growing in a vertical and a sagittal direction. Natural teeth during this time will accommodate to this bone growth through eruption and alveolar remodeling's but implants will not be able to accommodate craniofacial growth which may result in relative infraocclusion and positional discrepancy when compared to adjacent natural teeth [3,4,5].

The differences noted in the front area of the upper jaw, known as the maxilla, can sometimes be very noticeable when comparing growth of the bone above the teeth (the gums) with the rest of the bony

facial structure because of different patterns of growth in these areas. When this happens, it can lead to gingival margin asymmetry, incisal edge discrepancy, and compromised smile esthetics [6].

These different patterns of growth have been the subject of much debate within the implantology literature, with some individuals saying that dental implants should not be placed until someone is fully grown.

At the same time, however, some people believe that waiting until a patient has reached adulthood to place dental implants can create a situation in which that patient will not have any solid, functional restoration while going through this very critical time of social and developmental stages. Due to this ongoing issue, search for and implement new treatments that allow for effective treatment of growing patients with missing teeth has been greatly increased. Among the various strategies that have been looked into including orthodontic space management, placing resin-bonded prosthetics, orthodontic mini-implants and transitional implants [7,8,9].

This systematic review is intended to evaluate all of the studies published in a peer-reviewed journal on the placement of dental implants in growing children with congenital tooth agenesis and to provide clinicians a structured framework to see how to plan for placing the implants. These authors made the decision to conduct a systematic review of only full-text peer- reviewed journal articles for assessing the methodology, population, timing relative to growth, reported complications and ultimately determining if the results of the studies apply to the use of dental implants in patients with congenital tooth agenesis.

The research problem/question guiding this systematic review is as follows:

What effect does the timing of dental implant insertion relative to skeletal maturity have on future outcomes in patients due to congenital tooth agenesis?

Materials and Methods

Research design

The current research was performed as a systematic, narrative review with the objective of synthesizing clinical evidence related to timing of therapeutic implant insertion in younger patients with congenital tooth agenesis. The review methodology was structured to provide transparency, reproducibility and a direct evaluation of each piece of evidence included. Due to the stated objective of the reviews, only peer-reviewed articles published in full, from sources available to the authors, were included.

Research strategies employed in literature searches

The electronic databases searched included:

- The PubMed
- Scopus
- Google Scholar

The literature searches for articles published in 2008 through 2025.

The following were combinations of the type of terms of the keyword(s) used to search the database(s):

- Congenital tooth agenesis
- Hypodontia
- Oligodontia
- Dental implants
- Adolescent dental implants
- Growing patients
- Implant placement timing
- Infra-occlusion

Each of the aforementioned keywords was searched using various combinations with Boolean operators to yield clinically appropriate published literature. In addition to the database search of literature, through manual examination of the reference list of each relevant article identified, additional full-text studies meeting the criteria for inclusion were identified.

Inclusion criteria

All studies must have met the following criteria:

- Published in English
- available in full text
- Included patients with congenital tooth agenesis, including hypodontia or oligodontia
- Studied implant placement in growing patients, or examined/considered implant placement timing with reference to skeletal maturity
- Considered clinical outcomes such as difficulty, complications, multidisciplinary treatment considerations, or benefits of utilizing implants

Eligible study designs included:

- Systematic reviews
- Retrospective cohort studies
- Narrative clinical reviews
- Multidisciplinary case reports or case series with clinical relevance to timing decisions

Exclusion criteria

Studies were excluded if they:

- Disagreed with the growth/skeletal maturity aspects of all studies involving adults with implants
- Supported implants but have no patient outcome data from studies involving use of implant materials, instruments used for surgical implantation etc
- Did not include any patients who had a congenital or developmental absence of tooth developing in the mouth

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- Did not provide clinical evidence to support the findings of any articles and included only editorials, expert opinion and/or commentaries as supporting evidence
- Did not have complete article available through any means

Study selection

Research studies initially identified based on keywords and an extensive literature search. The titles and abstracts were studied for appropriate criteria relating to congenital tooth agenesis and implant placement in patients with developing dentition, while the full-text versions of any articles that were still deemed to be potentially eligible to meet the research questions were also accessed. Ultimately, after the application of the inclusion and exclusion criteria, there were 20 articles included in the final qualitative synthesis. The articles that resulted in the study included systematic/synthesizing reviews, retrospective cohort studies, narrative reviews, and interdisciplinary case reports.

Data extraction

Data extraction was performed according to a standardized extraction framework that included:

- Study design
- Patient demographic information
- age range of enrollees
- type and degree of tooth agenesis
- timing of implant surgery relative to skeletal maturity
- Type and failure of implant survival and complication outcomes
- interdisciplinary treatment planning considerations
- interim or transitional restorative strategies

Synthesis of evidence

A qualitative synthesis was performed on the differences in time points for placement of implants since the range of studies were very different with types of design, patient population, and the outcome measures. The findings were grouped into major categories such as biological risk associated with early implant placement, outcomes following skeletal maturity, interdisciplinary planning for treatment, and interim rehabilitation strategies.

Quality of evidence

There is a predominance of retrospective studies in this literature. This makes it difficult to trust results due to the variability in study design and design type, as well as the presence of so few high quality, prospective data. Systematic reviews within the included literature also report variability in methodological quality amongst the pediatric implant studies. In conclusion: due to the variables above, there is a need to interpret findings with caution; paying particular attention to study comparative evidence rather than relying on any single design.

Results

Study characteristics

A final review consisted of a total of 20 studies which were all published in full text and met all the selection criteria. These studies presented evidence through different types of publication including systematic review, retrospective cohort study, narrative review and case reports. Collectively, they have been grouped into the four following categories:

1. The biological risks that are associated with implant placement during active growth
2. The survivability and stability of an implant after the jaw have reached full skeletal maturity
3. The proper sequence of various types of implants in order to rehabilitate a patient with complex agenesis
4. Interim solutions (e.g., mini-implants) that may be used while a permanent implant will ultimately be placed, have been delayed.

This distribution reflects current levels of published information about pediatric implants. Generally speaking, there is limited availability of high-quality evidence to support use in treating pediatric patients and the majority of the general recommendations are based on either retrospective cohort studies or informed by the clinical experiences of various authors through their respective cases.

Study	Year	Study Type	Primary Focus	Relevance to timing
Cherian et al.	2023	Assessment of systematic review quality	Quality Systematic Review of Children and Pediatric Implant Systematic Reviews	Cautious Interpretation of the timing evidence
Casaña-Ruiz et al.	2023	Systematic Review and Meta Analysis	Children with Multiple Agenesis have Implants	Supportive Use of Strict Selection Criteria for Use of Implants
Shah et al.	2013	Narrative Clinical Writing	Implants for Adolescents	Outlines the risks associated with growth due to the placement of implants
Mishra et al.	2013	Narrative Clinical Review	Dental Implants for growing children	Concerns relating to Infraocculsion and Discrepancy with Growth
Agarwal et al.	2016	Narrative Clinical Review	Multidisciplinary Approach to Implant Therapy for Children	Supports deferring definitive implant placement
Attia et al.	2019	Retrospective clinical study	To assess Dental Implant success in Dental Aplasia	The findings indicate successful outcomes after implant placement at the age of maturity
Al Najam et al.	2021	Retrospective data report	Type of missing teeth (congenital vs non-congenital)	Demonstrates a better prognosis overall for young individuals with agenesis
Mikkola et al.	2025	Retrospective Cohort Study	Oral rehabilitation for individuals with tooth agenesis	Shows interdisciplinary plan before implant placement

Table 1: Characteristics of the full-text studies included in the review.

Biological Risks of Implant Placement During a Time of Growth

Numerous studies show that when a craniofacial growth is taking place, the implant that has been placed will eventually be relatively inferior to its adjacent natural teeth due to the increase in vertical skeletal height [3,4,5]. This situation is referred to as infraocclusion.

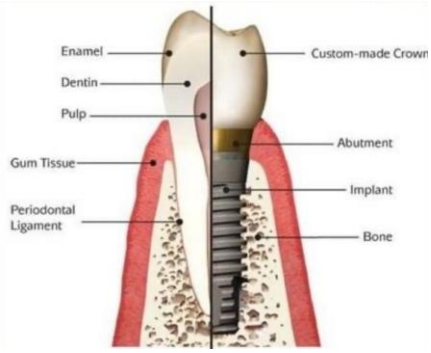

Figure 1: Natural teeth grow through eruption and undergo alveolar bone remodeling as they do so. On the other hand, dental implants do not move as the bone around them continues to grow; therefore, overtime, they will become increasingly infraoccluded in relation to the natural teeth growing adjacent to them.

This occurs when a natural tooth rises, but the implant stays in the same location within the maxilla. An infraoccluding implant can create asymmetry in the gingival margins (gum line), occlusal discrepancies, could affect the esthetics of the general anterior region of the maxilla [6].

Figure 2: Flow of complications tied to the implant placement because of skeletal maturity, including gingival asymmetry occlusal discrepancies and infraocclusion.

The biological reasons why this happens are consistently described throughout the literature listed in the compatibility database and are still the best scientific reason against placing an implant before full skeletal maturity.

Implant outcomes after skeletal maturity

After the skeletal maturation of the jawbone, studies have consistently shown that dental implants placed at the time have a high survival rate and predictable, successful long-term outcomes.

Attia et al [10], documented favorable success rates for implants placed in patients with dental aplasia, while Al Najam Y [11], reported similar survival rates for congenital and non-congenital dental implants. In further parallel retrospective evaluations of patients with agenesis and who had planned for

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interdisciplinary rehabilitation, each of the studies performed by Mikkola et al. [1], and Hassan et al [2]. documented good long-term results after dental implant therapy. These studies confirm that implant therapy is successful in providing a suitable solution for patients diagnosed with congenital agenesis when performed after growth has stopped.

Immediate versus delayed placement

In the study conducted by Alexandre [13], direct data were provided regarding the timing of treatment by comparing whether to plan an implant now or wait in cases where there were no teeth present and the use of temporary and permanent replacement of the missing teeth. Their results support the general conclusion that the timing of replacement affects long-term stability after treatment has been completed, as how osseointegration affects the outcome. The entire body of literature regarding dental implants in children and adolescents suggest that most growing children should be placed with a permanent replacement after they grow into adulthood.

Interdisciplinary treatment planning

To effectively treat congenital tooth agenesis, coordination among multiple dental specialties is often required. Orthodontic treatment is commonly needed to help ensure that proper space and alignment are established before placing any implants.

In more severe cases of oligodontia, orthognathic surgery may need to be done to restore skeletal relations prior to definitive implant rehabilitation [14].

Other example-based studies have emphasized the need for interdisciplinary/cooperative treatment planning when managing severe cases of agenesis [15,16,17,18]. As these studies illustrate, timing of implant surgery should not be considered separately but must be included as part of a complex continuum of developmental/restorative sequences.

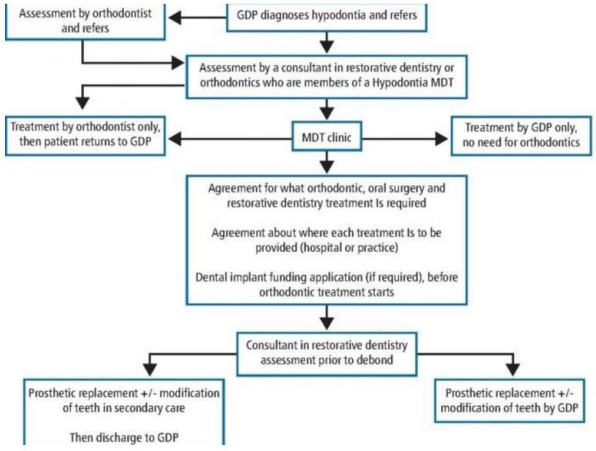

Figure 3: This coordinated approach highlights the importance of sequencing care across different specialties, such as orthodontics, surgery and prosthodontics.

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Transitional and interim treatment options

If definitive implant placement cannot occur until skeletal maturation occurs, transitional/temporary restorative options to maintain aesthetics and function can be utilized.

Orthodontic mini-implants are another option for use as temporary tooth replacements in young patients [7]. Transitional implants may also help the patient with functional needs during their adolescent years while maintaining future restorative potential [8,9].

Clinicians must counsel the patient and their families on the temporary nature of these services and that future revision/alternative procedures may be necessary [19].

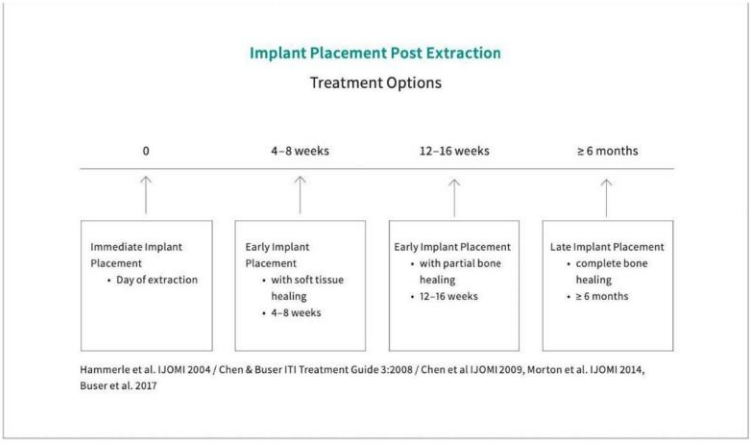

Figure 4: Typical staged treatment for patients with congenital tooth agenesis. Interim solutions are used while the patient grows, and then, once skeletal maturity is reached, definitive placement of the implants will be provided.

Discussion

The complex relationship between implant therapy and skeletal growth is evidenced by research conducted regarding patients with congenital tooth loss. While dental implants have high rates of success in adult patients, as well as populations of mature individuals with agenesis, any implant placed in a growing patient should be planned to minimize concerns regarding positioning and complications in the long-term.

The literature supports the finding that implants placed prior to the completion of growth craniofacial growth have a higher tendency to infraoccluded or to create an esthetic concern. As a result, most authors suggest waiting until all growth has occurred prior to placing a definitive dental implant whenever possible. The recommendation to postpone placement of the implant is supported not only through narrative reviews, but also through retrospective cohort studies, and systematic level reviews of pediatric dental implant literature.

These findings are particularly strong since all of the references used in this review were available in form of full-text articles for evaluation. Hence, the authors were able to evaluate methodology, patient

population, treatment sequence, and the way that outcomes were reported directly rather than relying on a title or abstract-level evaluation.

Nevertheless, early treatment may be warranted for patients with severe oligodontia if there are significant functional or psychosocial issues related to their loss. In these cases, transitional or staged rehabilitation procedures may provide temporary solutions until definitive treatment can be provided.

Overall, the treatment of the patient will depend upon the accuracy of the growth assessment, interdisciplinary collaboration, and comprehensive evaluation of the patients regarding risks and limitations of implant therapy during adolescence.

Impact of craniofacial growth and implant outcomes

Tooth agenesis does not just involve the teeth but also has an impact on the development of the alveolar bone and thus can affect facial appearance. A missing tooth can decrease the volume of the bone in the religion of the missing tooth, and this can pose a challenge for implant placement in the future.

Additionally, placing an implant early may disrupt the natural growth of the jaw. As the implant does not erupt or grow, it could become submerged in comparison to the surrounding structures as the jaw continues to develop. The result is a change in facial symmetry, which can lead to longer term esthetic issues.

Psychosocial and functional considerations

Patients with congenital tooth agenesis are impacted negatively by this condition psychologically, especially adolescents, where self-image and social interpretation of the way someone looks tend to play a large role in how an individual feels about themselves and the world around them. A missing tooth can cause an adolescent to have low self-esteem and be anxious about their ability to socialize, smile, or speak publicly. Research supports that treatment planning should consider not just the biological outcomes of your treatment but also what effect your treatment will have on their emotional well-being and social health.

During adolescence, adolescents should be given access to temporary restorative options available until they reach adulthood to allow them to feel better about themselves and improve their quality of life overall. At the same time, making sure to communicate the temporary nature of these solutions.

Effects of temporary appliances

Patients undergo changes during their development; therefore, they require interim solutions such as removable prosthesis, bonded resin bridges and traditional implants. Not only do these interim solutions work well for short-term aesthetics and functional purpose, they also create a multitude of limitations to a patient and can produce the following:

- Discomfort/Irritation
- Less stability compared to Natural Teeth
- Difficulty with Maintenance

Some of these limitations create necessity for utilizing temporary appliances to retain space, support soft tissues contours and maintain patients' confidence until a definitive treatment can occur.

Esthetics (color matching & smile)

Natural esthetics in implant therapy does not just involve replacing a lost tooth. Esthetic success requires matching the color correctly, aligning the contour of the gingival tissues and creating symmetry with neighboring teeth.

Esthetic outcomes in growing patients will be more difficult to control because:

- The gingival margins keep changing
- The adjacent teeth continue to erupt and shift
- The proportions of the face continue to change

Therefore, an early implant placement often creates a visible discrepancy over time.

Chewing, digestion, and speech

Missing teeth can alter how your mouth works when you eat and talk.

- **Chewing:** When dental units may have fewer teeth to touch and will have an effect on mealtime and digestion's ability to break down food.
- **Speech:** No anterior teeth, individuals have difficulty pronouncing (e.g., "s," "f," "th").
- **Function:** Replacement of missing teeth perform these oral functions, as the permanent replacements are late to be implemented.

Temporary teeth are an important reason for changing to temporary dental products to improve function. They're necessary and continuing use, even when being late with placing permanent dental units.

Summary of Findings

The studies that are included in this review show a distinct trend among the relationship between craniofacial growth and the stability of an implant. While it is still possible for an implant to be Osseo integrated in a younger patient, and there have been cases of osseointegration with implants placed prior to skeletal maturity do not maintain the appropriate position over time. The most likely reason this occurs is the implants are essentially a fixed structure within the bone and as the facial skeleton continues to grow and remodel, the bone that the implant is in will grow and remodel also. This leads to complications such as infraocclusion in which the implant is placed too low, gingival margins being uneven, aesthetic discrepancies, and so on.

In contrast, when an implant is placed following the completion of growth, the long-term outcomes appear to be more predictable, yielding better positional stability, better alignment with adjacent teeth, and improved aesthetic integration. Because of the predictable nature of these outcomes, the majority of literature supports the need to delay definitive implant placement until such time as the patient is completely finished growing.

In the same light, delaying treatment creates a void in care during the adolescent years as many patients have difficulty with function, difficulty with speech, and are self-conscious due to the absence of teeth. To fill this void, there are several studies that report the use of interim solutions such as orthodontic space maintainers, resin-bonded prosthetics, and traditional implants. These interim solutions provide patients with functionality and appearance while allowing for the continuation of future treatment options.

Overall, appropriate management requires a balancing of both biological constraints and psychosocial necessities for an optimal outcome through well-timed definitive treatment based on individual skeletal maturity.

Clinical implications

From the findings of this review, the following clinical recommendations are given:

- When placement of definitive implants is being considered, an attempt should be made to determine whether skeletal growth has stopped
- Implants should not place in the anterior maxilla while an active growth spurt in occurring
- Transitional or orthodontic mini-implants may be used when an interim restoration is to take place
- Orthodontic, surgical and prosthodontic treatment planning should be integrated
- Complete informed consent should be obtained by having a discussion regarding possible long-term effects

The clinical implications of this paper will be useful for late adolescents or young adults that have requested an early fixed treatment option prior to completion of normal skeletal development.

Future research recommendations

Future research should focus on:

- Develop ways to determine skeletal growth before implant placement
- Long-term prospective cohort studies evaluating the stabilization of implants in individuals with agenesis
- Investigating the efficacy of transitional and orthodontic mini-implants would additionally warrant further study
- The effect of digital planning technologies on the outcome of patients undergoing treatment would be worth investigating

Uniformity is the outcome reporting will also allow for meaningful comparison across future studies.

Conclusion

Regarding patients with tooth agenesis; dental implants may provide a sound long-term option. However, a careful consideration of craniofacial development must be taken into account when planning treatment for adolescents. The data is clear that delaying definitive implant placement until skeletal maturation will help mitigate the risk of infraocclusion and esthetic complications. In some cases, if early intervention is

warranted, transitional restorative modalities that can provide both functional and psychosocial benefits while also conserving future treatment options are available.

Ultimately, a successful outcome is based upon case selection, interdisciplinary cooperation, and the adaption of implant therapy to the ongoing physiological process associated with craniofacial growth. Although this review is limited to full-text studies, the results are based on clinical studies that have been fully; however, the current literature is heterogeneous and requires standardization through prospective investigation.

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