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Pak J Med Res
Vol. 62, No. 2, 2023

Review Article

Tooth Agenesis in Human Population: Treatment Considerations in Subjects with Tooth Agenesis

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Abstract

Background: Tooth agenesis presents itself with one or more lost teeth and is one of the foremost common formative irregularities of the human dentition. Being polygenetic, it can occur entirely isolated or in conjunction with other syndromes.
Methodology: Research papers published in English from 1950-2020 were searched. Studies on non-human subjects & medically marginalized patients were excluded.
Results: Tooth agenesis is a commonly occurring congenital dental abnormality. This literature emphasizes on a multidisciplinary approach and a logically planned treatment with a precise well controlled follow up. When providing treatment for patients with tooth agenesis, several important considerations come into play. Thoroughly assessing the patient's oral health, collaborating with dental specialists to determine the best course of action, and developing individualized treatment plans are crucial steps to achieve optimal outcomes and ensure patient satisfaction. By addressing these factors, dental professionals can effectively navigate the unique challenges presented by tooth agenesis and provide comprehensive care for their patients.
Conclusion: Different treatment modalities and their resultant outcomes on the quality of life of hypodontia people have been discussed. A multi-disciplinary approach is vital to improve the oral health related quality of life for these patients.
Key words: Tooth agenesis, hypodontia, ectodermal dysplasia.

Introduction

Tooth agenesis, also called hypodontia, is a commonly occurring congenital dental abnormality.[1] The most frequent phenotype presents without any associated systemic condition as the lack of sometimes one and occasionally a few missing teeth. Familial predisposition is more prevalent as compared to the mass population.[2]

Occasionally environmental factors have an etiological part to play in the development of hypodontia. However, in most of the cases, the condition presents with a genetic basis. The occurrence of hypodontia may be an isolated finding, either sporadic or familial. Single dominant, recessive and X-linked genes have been confined in familial hypodontia, in spite of the fact that expressivity and dominance may moreover shift.[3] Kau et al reported that usually hypodontia is of genetic origin and the anomaly presents as a familial condition affecting two or three generations.[4] Patients should be informed about this familial nature of hypodontia and that the children of patients suffering from hypodontia are at an increased risk of tooth agenesis.

Hypodontia can now be considered more as a multifactorial condition. Recent molecular genetics show muscle specific home box genes (Msx1 and Msx2) to be mainly affected in this condition. In humans, a pronounced and selective effect on dentition is expected due to inactivation of MSX1 genes, but in case of hypodontia, other genes are also involved.[5] A variable manifestation of traits also shows a "polygenic mode of inheritance" with epistatic genes and interacting environmental factors.[6-10]

It has been found that MSX1, PAX9, and TGF-α usually result in isolated dental agenesis.[11-13] A good example of the complexity of the issue is the

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Received: 21 April 2021 **Accepted:** 29 November 2021,
Published: 24 July 2023

Authors Contribution

BA conceptualized the project and did the data collection. AS did the literature search and performed the statistical analysis along with drafting, revision & writing of manuscript.

recent discovery of a mutation in AXIN2, a wnt-signaling receptor, which causes teeth agenesis together with a predisposition for colorectal cancer.[14] Also Cleft lip/ palate, another common congenital anomaly, is associated with both hypodontia as well as the TGF-α gene.

Local factors have also been reported to induce agenesis of teeth. These include infections, mechanical trauma, accidental removal of tooth germs, effects of cytostatic radiation and harmonic or metabolic disturbances, acting prenatally probably via mutagenic activity.[15-17]

Brook reported an association between teeth number and size which linked microdontia and hypodontia in terms of cause.[18] Kjaer also connected tooth agenesis with nerve, mucosal and bone abnormalities.[19]

Methodology

Research papers published in English from 1950-2020 were searched. Data bases used were PubMed and Google Scholar. Studies on non-human subjects & medically marginalized patients were excluded.

This review focuses on treatment considerations in subjects with tooth agenesis. The review is presented as a critical appraisal of the research literature available online since 1950.

Prosthodontic considerations

A contemporary method to devise treatment options can be facilitated by categorizing cases into three groups according to their family history and patient desires. First group includes individuals with absence of teeth as the only atypical manifestation. The second group involves individuals where there is syndromic association with oligodontia with primary symptoms requiring treatment, all other manifestations being under control. The frequency of ectodermal dysplasia is the highest in this category since the common symptoms like hypohidrosis are efficiently countered by early childhood group. The most severe cases are categorized in the third group where oligodontia co-occurs with handicaps such as mental retardation or general growth failure. Therapy for the first and second groups mainly revolves around prosthetic rehabilitation, whereas for third group cases, the prosthodontic rehabilitation has to be deisgned as a multidisciplinary approach. Non- syndromic cleft cases with accompanied hypodontia are textbook examples in this aspect.[1,2]

A wide spectrum of management possibilities is available for the hypodontia patients. These usually depend on disease severity especially tooth size, morphology and amount of alveolar bone. Advancements in adhesive dentistry and the development of materials such as composite resins are the preferred materials for the dental restoration of patients affected by hypodontia. These options conserve remaining healthy tooth structures.[14]

Prosthodontic management of oligodontia patients is imperative to improve esthetics, function and the psychological health of the patients.[15] Instituting bilateral centric stops and a normal vertical dimension of occlusion as well as support for orofacial soft tissues is the primary focus.[16] A number of different treatment options are discussed.

In some cases with severe hypodontia, retained primary teeth were used as abutments for an overdenture prosthesis. Despite promoting dental implants as an exciting management option,[4,6] reports in the published literature have highlighted serious disadvantages and complications of implant placement in growing patients.[7,8]

Severe hypodontia cases tend to have a profound functional and psychosocial impact, thereby demanding a more complex management.[9] Different treatment options include cuspid lateralization, implant placement, conventional three-unit bridge, Maryland bridge and fiber reinforced composite (FRC) bridges, wether direct or indirect, offer a most conservative and minimally invasive treatment option, with possible replacement with implant supported prosthesis in future. Restoration longevity is affected by the appropriate selection of the type of fiber reinforcement and fiber placement. Retention is achieved via adhesive technique that requires strict moisture control protocols.[3]

In one study, under development of alveolar ridges in hypodontia patients was managed by placing tricalcium phosphate in sockets following extraction of deciduous incisor teeth.[10] This helped in preserving the width of alveolar bone.

The oral rehabilitation of hypodontia and anodontia patients has been facilitated greatly with the use of dental implants.[17] Insufficient bone presents as a hurdle, commonly in such patients due to local or general decrease of growth stimuli of the jaw bone. Bone augmentation procedures help in resolving this issue. The morbidity risk is however increased due to the additional invasive surgical interventions.[18]

Growing patients with congenitally absent teeth usually require restoration with dental implants even before the onset of puberty in order to restore

optimum functional and alleviate the psychosocial impact of the condition. Literature also suggests that dental implants could serve equally well in patients exhibiting partial and complete edentulism in relation to some congenital disorders.[20] However, as far as the normal human growth and development is concerned, dental implants cannot complement the physiologic remodelling of the alveolar processes. This may be attributed to the differences in "anchorage" between implants and a natural tooth, where the tooth is anchored to the bone via periodontal fibers while an implant is integrated directly to the bone. It has been advised to plan treatment before the age of 12 years and to follow the planned protocol diligently until the final treatment outcome.[21]

It was presumed that oligodontia patients could benefit considerably from implant prosthodontic rehabilitation given that satisfaction is generally reported for the technique with routine patients.[19] Finnema KJ and Raghoebar GM provided a strong support for dental implants in the dental therapy of patients with oligodontia. Subjects were contented, reporting a good overall treatment experience and substantial enhancement in oral function following treatment with dental implants. An implant survival rate of 86% and 96% for the maxilla and mandible respectively was reported.[22] These patients also showed poor development of the alveolar processes and spatial discrepancies in relation to the opposing arch, which emphasized the need for an additional treatment with orthodontics and oral surgery as well.[23]

Another study reported the suucessful placement, osseointegration and functional loading of four maxillary and four mandibular implants in an 8 year old subject. A 12 year post-treatment growth analysis revealed that the implants had followed maxillary and mandibular displacement. Maxillary implants showed minor impactions while mandibular growth rotation affected the mandibular implants. This led to changes in the inclination and alignment of implants.[5]

A few studies have reported the use of zygomatic implants in patients exhibiting severe maxillary resorption, instead of using a bone graft material. The treatment was not only successful, but results were achieved in a shorter duration of time.[11] Successful rehabilitation of these hypodontia patients with the use of osseointegrated implants in the anterior strongly endorses them as a sound treatment option for restoring mandibular dentition.[12,13]

According to Kotsiomiti E et al., a removable partial or complete denture was often recommended in childhood as these could easily be modified to compensate growth.[24,25] Osseointegrated implants are increasingly becoming the front line treatment of choice, after growth cessation in adults. These implants could be used to provide retention, stability and support to the prosthesis.[26]

These different treatment options are available to hypodontia patients depending on the age, severity of condition, status of existing structures, psychosocial and financial status of the patients and facilities available.[27]

Morgan & Howe also stated that hypodontia patients are an extremely diverse and complex group. Osseointegrated implants were widely used and were particularly useful in hypodontia patients in whom good esthetic results could be achieved. Implants were, therefore, biologically conservative and suited to the unrestored dentition of today.[28]

It is recommended that the occlusion in the dentures of hypodontia patients be customized and artificial teeth be selected according to the patient's age if substantial improvements in phonetics, mastication and/or esthetics are required. The treatment restored the normal dietary habits of the affected children as well as an enhanced and rapid social integration and acceptance.[29]

In a study, a rotational path of insertion was established for a partial removable dental prosthesis by selective contouring of the metal-ceramic crowns placed on the central incisors. Esthetics and stability were enhanced by the incorporation of "rigid metal retention", in place of clasps, on the distal surface of the central incisors.[30]

Complex prosthodontic rehabilitation of growing subjects should ideally be executed in conjunction with a multidisciplinary team. Reports suggest that such an approach yields successful results, with the added benefit of "shared responsibility" for therapeutic decisions. Such a multidisciplinary approach also has a positive impact on the quality of life of the affected subjects.[31]

Jepson et al. in his study supported resin-bonded and implant-supported fixed prostheses as the preferred definitive treatment modality for most of the patients suffering from hypodontia. Removable partial dentures serve better as an "interim prosthesis" in the restoration of esthetics and function.[32]

Bergendal et al & other authors explained how maxillofacial relationships and restoration of functional efficiency prosthodontically could offer the lower facial height patients the chance to grow normally.[33,34] Cephalometric values were immediately corrected by the placement of a prosthodontic device.[35] Bergendal et al. also stated

that the prosthodontic responsibility lies in that every treatment measure should be applied cautiously utilizing a multidisciplinary approach and having a precise follow up so that the success of the final, post-growth result is not jeopardized.[36,37]

Orthodontic considerations

Orthodontic management of these hypodontia patients always poses a major challenge to the clinician. Literature suggests that these hypodontia cases were frequently accompanied by a retrognathic underdeveloped maxilla, a reduced vertical jaw relationship and a forward rotation of the mandible. This may involve an abnormal growth pattern, which means that the genetic factors that induce tooth agenesis may also affect the growth process of the lower face. However, the absence of teeth could block or deviate the growth pattern; or even it can be estimated that the lack of dental growth may result in impaired craniofacial development.[38]

Orthodontics can be utilized to alter the pattern of orofacial development as well as tooth alignment prior to prosthodontic rehabilitation of growing subjects suffering from hypodontia. Growth modification can be achieved with functional appliances provided at the same time as the eruption of maxillary and mandibular molars. Alternatively, expansion of the dental arch, alignment of teeth, and space management can be accomplished using fixed orthodontic appliances. A second orthodontic treatment phase may be carried out closer to the maturation age of the patient with the intention of achieving optimal tooth alignment prior to definitive treatment with dental implants.

Cephalometric studies examining craniofacial morphology in cases of teeth agenesis, but not considering the number of missing teeth, reported reduced maxillary prognathism.[36] Dermaut et al [39] and Yukcel [40] however, reported normal cephalometric values concluding that agenesis of teeth had little effect on orofacial structures. The issue became clearer when focusing on severe hypodontia cases. Sarnas & Rune examined patients with 1-21 missing teeth and found normal mean values for the whole sample, but tendencies towards skeletal class III spatial relationship and decreased values for maxillary-mandibular planes angle only when severe hypodontia patients were considered. This result confirmed their early work where they found a retrognathic maxilla and upright incisors in children with 4 or more missing teeth.[41] Nodal et al.[33] also found a substantial association between the number of missing teeth and cephalometric variables. They found that an increased number of missing teeth corresponded to decreased vertical jaw relation and a prognathic mandible. A threshold of about 12 missing teeth was identified, beyond which the cephalometric values were considerably affected. Using a similar design for children with three or more missing teeth, Ben-bassat and Brin[42] observed a characteristic skeletal pattern, which was more evident in cases with more than 10 missing teeth.

Yamashita et al[43] cephalometrically examined an 8-year old girl with permanent teeth anodontia and reported that the role of dental growth was significant in the development of maxillary alveolar bone, but not in the development of mandible.

Roald et al[44] reexamined the sample of Wisth et al[45] seven years after the first measurements and reported that the characteristic craniofacial morphology was not accompanied with abnormal growth pattern.

Ogaard and Krogstad[46] examined a sample of young subjects with mild, moderate and severe hypodontia and compared them to a control group. Bondarets and McDonald[47] concluded that “the typical dentofacial structure in persons with advanced hypodontia may be due to dental and functional compensation rather than due to a different growth pattern” and hence, these cases are “dependent on the teeth for vertical growth”.

The most significant findings reported that the affected individuals have universal tendency to undergo sagittal jaw discrepancies, markedly worsening to class III pattern over time. Studies have also reported a noteworthy variance in the anterior and posterior facial heights, suggesting that the affected patients present with a propensity towards anterior growth rotation. An analysis of serial cephalometric findings depicted reduced growth of maxilla without any obvious effect on the mandible. Hypodontia has been found associatd with a markedly deficient antero-posterior development of the maxillary complex, irrespective of the presence or absence of primary molars.[48]

Ith- Hansen documented a marked tendency of the patients to become more class III owing to a reduction in antero-posterior relationship of the jaws. A marked difference was observed between the vertical posterior and anterior facial growths, suggesting a marked tendency towards an anterior growth rotation.[49]

Other studies also suggested that the more severe the hypodontia, the greater was the tendency towards a skeletal class III relationship and a reduced maxillary-mandibular plane angle.[50,51]

The management was aimed at providing

the patient with well aligned arches and coincident midlines. The overall result should not only be esthetically acceptable but also stable occlusally and periodontally.[52]

Three main choices were available namely to reopen the space for prosthesis, to close space with natural dental units, or to redistribute space in crowded arches.[53] It is always a good practice to use kesling wax setup to see the results of potential treatment plan without compromising the retention or long term stability in those cases.

The goal of adjunctive orthodontics is to facilitate restorative treatment by repositioning teeth, allowing ideal and conservative techniques to be applied; improving general health of dental and soft tissues by eliminating plaque harboring areas; and by instituting favorable crown-root ratio and inter-arch relationship so that the occlusal forces are parallel to the long axis of the teeth. It is also imperative to understand that the treatment aims should be realistic without overly lumbering the patient with overly lengthened treatment time troubled with iatrogenic complications.[53]

The multidisciplinary approach for treating subjects with tooth agenesis has yielded promising results as supported by previous studies. By involving various dental specialists such as orthodontists, prosthodontists, and oral surgeons, comprehensive treatment plans can be formulated to address the functional and aesthetic concerns associated with tooth agenesis.

Orthodontic interventions play a crucial role in managing tooth agenesis, as they help create adequate space for prosthetic replacements or orthodontic alignment of existing teeth. Through orthodontic treatment, malocclusions can be corrected, and the remaining dentition can be properly aligned, enhancing both function and aesthetics.

Prosthodontic solutions, including removable or fixed partial dentures, dental implants, and adhesive bridges, have shown favorable outcomes in restoring missing teeth. The selection of the appropriate prosthesis depends on factors such as the number and location of missing teeth, patient preferences, and the overall oral health condition.

In complex cases involving skeletal discrepancies or severe tooth agenesis, orthognathic surgery in combination with orthodontic treatment may be required to achieve optimal results. This interdisciplinary approach ensures proper jaw alignment and functional occlusion, enhancing the overall treatment outcome.

Hypodontia doesn't pose a threat to the life on individuals but the physical, intellectual and psychological health of the patient is seriously affected. The whole family rather than the patient alone is affected. To prevent these patients from being crippled, they must be provided proper counselling and appropriate treatment. Reassurance and empathy can help these patients to cope with their atypical functions and appearance as well as encourage them to comply with their normal social requirements.

A good communication both between professionals including pediatric dentists, orthodontists and prosthodontists in an interdisciplinary team, and also with patient/ parents/carers is absolutely vital.

Lin et al examined a patient who had 11 congenitally missing teeth causing an obvious esthetic and functional compromise. A combined orthodontic, periodontic and finally prosthodontic intervention was required for the patient, who by the end of treatment had a good occlusion with enhanced function and esthetics.[54]

The severity of a genetic disorder and social resources available to a person to cope with that abnormality are the primary factors determining type of treatment. It has been reported that individuals with congenital craniofacial anomalies are more dissatisfied with their facial appearance as well as a lower self-esteem and quality of life. Therefore, the goals of the treatment modalities include enhancement of aesthetics, phonetics, function and mastication, thereby improving the tone of facial and masticatory muscles to compensate for the reduced vertical dimensions with a resultant positive impact on the psychological wellbeing. Joint orthodontic /restorative diagnostic clinics provide the ideal basis of successful treatment for providing patients with top quality care.[55]

The areas of primary concern in the management of hypodontia are timely deliberation of the likely final restoration and the maintenance of the esthetics and function. Necessary restorative treatment will reflect the decision to accept, close or redistribute spacing resulting from the absence of the teeth.[56] A collective dental therapeutic approach has been advocated including endodontic therapy with post-and-core build ups, mandibular removable prosthesis and a maxillary fixed prosthesis. Canine protected occlusion and equal distribution of protrusive guidance between upper and lower incisors was implemented [57]. Adjunctive orthodontic treatments are best employed when a multidisciplinary approach is implemented.[58]

Early referrals are key for optimal management of hypodontia.[59] Specialist pediatric dental care is indispensable to ensure retention of the reduced number of teeth.[60] Orthodontic space

distribution, composite restorations, resin retained bridges, veneers, onlays and tooth transplants contribute to an improvement in aesthetics and function.[61] Because early intervention and sustained treatment are required, the finances incurred by these families resulted in a considerable financial burden and play a vital role in planning the treatment design.[62]

Literature review has revealed that oligodontia is referred to both as a symptom and as an individual trait. Bibliographic evidences propose that the solitary congenital absence of more than six permanent teeth is a rare finding; however, its weak prevalence percentage is incremented in syndrome cases.

As previously mentioned, these dental genetic disorders do not result in significant mortality; however, significant morbidity has been reported. However, the effect on individuals and their families must not be underestimated as data concerning treatment experience, patient satisfaction and functional improvement has been scarcely reported.[63] Whenever encountered, hypodontia presents a challenge to the prosthodontist, as it requires an early scheduled, yet long term oriented treatment plan.[64]

The management of tooth agenesis necessitates a multidisciplinary treatment approach, involving collaboration between orthodontists, prosthodontists, and oral surgeons. By addressing functional and aesthetic concerns through orthodontic interventions, prosthetic solutions, and, when necessary, orthognathic surgery, comprehensive treatment plans can be developed to meet the specific needs of each patient.

The successful management of tooth agenesis not only improves oral function but also enhances the patient's self-esteem and quality of life. It is crucial for dental professionals to remain up-to-date with the latest advancements in multidisciplinary treatment modalities to provide optimal care for subjects with tooth agenesis. Further research and long-term follow-up studies are warranted to evaluate the longevity and effectiveness of different treatment approaches and to refine existing protocols. Ultimately, the integration of multidisciplinary expertise is vital in ensuring favorable outcomes and patient satisfaction in the management of tooth agenesis.

Conflict of interest: None declared.

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