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Review

Advanced restorative management of focal microdontia: A brief review and case report

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Abstract

Focal microdontia is a dental anomaly characterized by the presence of a single abnormally small anterior or posterior tooth. The objective of this article is to provide an updated review of the literature on the advanced restorative management of focal microdontia, and to document a clinical case where the reviewed advanced restorative approaches were applied to treat a young adult presenting with a non-syndromic asymmetrical focal microdontia.We conducted a preliminary examination of the existing literature on the advanced restorative management of focal microdontia. Additionally, we presented a minimally invasive approach to the treatment of an 18-year-old female patient with non-syndromic asymmetrical focal microdontia. The primary advantage of adhesive dentistry is that it can better preserve the structure of smaller teeth. A review of literature reveals a paucity of reports on localized microdontia in the maxillary anterior region of the mouth. However, novel minimally invasive restorative procedures satisfy patients' aesthetic and functional preferences. Well-executed additive diagnostic wax-ups and intraoral mock-ups can serve as a permanent restoration blueprint, providing predictable results for focal dental anomalies in the aesthetic zone. In conclusion, the use of minimally invasive dental approaches in young patients with focal microdontia can result in long-term satisfactory aesthetic outcomes.

Keywords: minimally invasive, microdontia, adhesive dentistry, aesthetic dentistry, dental anomaly

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Introduction

Microdontia is a dental anomaly characterized by the presence of teeth smaller in size. It can cause malocclusion, aesthetic concerns and food trapping. Microdontia has been associated with genetic and environmental factors; however, its etiology remains unclear.[1] Genetic factors are involved in the complex etiology of microdontia and play a key role in its formation. Ectodermal, mesodermal and neural crest cells contribute to the development of the teeth, and the enamel organ determines the tooth size variation at the bell stage.[2] The crown formation is thought to be related to the oral epithelium, which is responsible for the initial shape of the crown.[3] Microdontia is the second most common dental abnormality after hypodontia. The condition occurs more frequently in females than males,[4,5] with a reported prevalence of 1.5–2% in the general population. Microdontia can be classified into 3 types: localized true or focal microdontia for a single tooth; relative generalized microdontia, in which teeth are of regular size but jaws are larger than normal; and true generalized microdontia, in which all teeth are smaller than normal but maxilla and mandible are of regular size (Table 1).[6] The etiology of microdontia is poorly understood. However, external factors such as radiotherapy, chemotherapy or pollutants are known to cause developmental dental problems.[7,8]

Material and methods

A straightforward MEDLINE (PubMed) search was conducted in December 2022 to identify relevant articles published between January 1970 and December 2022. The search terms used were "microdontia" AND ("diagnostics" OR "management" OR "treatment" OR "therapy") AND ("dental" OR "dentistry" OR "stomatology"). We considered reviews, systematic reviews, guidelines, statements, observational studies, clinical case reports, and case series. The articles included in this review were limited to those written in the English language. Letters, book chapters, case reports, and studies for which the full text was not available were excluded. Only publications addressing the protocol for diagnosing microdontia patients and potential or successful treatments were analyzed. Articles pertaining to extensive or invasive treatments in microdontia patients were excluded.

The study selection was conducted independently by 2 reviewers (CAJ and JVT), with any disagreements resolved by the third reviewer (KIA). No quantitative analysis (e.g., meta-analysis) was performed.

Diagnostics

The treatment management of true microdontia is dependent upon the number and location of teeth and the patient's aesthetic demands. There is a paucity of literature on localized microdontia in the maxillary anterior region of the mouth. This is heavily associated with patients' aesthetic concerns.[9] Effective communication between the patient, clinician and dental technician is vital to ascertain the patient's preferences and to inform them about the limitations of the proposed treatment.[10] If the treatment does not meet the patient's expectations, further options must be discussed to address as many aspects as possible.

Digital smile design

Diagnostic wax-up and digital smile design are essential diagnostic tools for providing tentative treatment in the aesthetic zone prior to any irreversible dental procedures.[11,12] A diagnostic wax-up allows for modifying the dimension of the teeth in the cast. Subsequently, a putty index can be fabricated to create an intraoral diagnostic mock-up.[13] Diagnostic mock-ups allow the patient to

Table 1. Summary of microdontia types, associated conditions and treatment options[4–9]

Type	Description	Associated conditions	Treatment
Focal microdontia	A single tooth is smaller than average. The maxilla and the mandible are of regular size. This condition typically affects maxillary teeth, with the lateral incisor being the tooth most likely to be affected.	• chemotherapy or radiation • cleft lip and cleft palate • pituitary dwarfism • Down syndrome • ectodermal dysplasia • Turner syndrome • Williams syndrome • oro-facial-digital syndrome • hypodontia • Hallermann–Streiff syndrome • Routhmund–Thomson syndrome	• ceramic veneers pros: conservative preparation; high aesthetic results; long-lasting restoration cons: high cost; many appointments needed; sensitivity to bonding procedures
Relative generalized microdontia	This condition affects all the dentition. The teeth are of regular size but the maxilla and the mandible are larger in size, which results in the teeth appearing smaller.		• direct composites pros: conservative preparation; cost-effective; fewer appointments needed; satisfactory outcomes cons: low fracture resistance; susceptibility to staining
True generalized microdontia	This condition affects all the dentition. The teeth are smaller than the average size. The maxilla and the mandible are of regular size.		• crowns pros: high fracture resistance; high aesthetic results; long-lasting restoration cons: high cost; many appointments needed; aggressive tooth preparation

have an intraoral prototype of the proposed restorations. The patient and clinician can modify the blueprint until the patient is satisfied, and keep a record of the changes so that the dental technician can replicate this information in the final prosthesis.[14,15]

If a patient presents with a smaller tooth within the arch, an additive wax-up can be employed to increase the length and width of the tooth without modifying its structure. This shape can then be impressed with a putty index guide for a conventional diagnostic mock-up.

Minimally invasive approach

A recent consensus statement has recommended the use of minimally invasive procedures for the treatment of patients with tooth malformations such as microdontia.[16] The objective of minimally invasive preparations is the preservation of most tooth and periodontal tissues. This concept has been promoted with ceramic veneers since the early 1980s.[17,18] The development of bonding procedures provides predictable long-term success. However, it is required to remove minimal tooth structure.[19] Maintaining the entire tooth preparation in enamel is vital for the long-term success of the procedure. A 12-year retrospective study concluded with a 99% survival rate for ceramic veneer preparations confined in enamel and 94% survival rate for veneers confined in enamel only at the margins.[20] These findings underscore the importance of maintaining minimally invasive tooth preparation in the enamel structure.

The amount of tooth structure removed during preparation is contingent upon the tooth's position within the arch. If a smaller tooth is rotated or protruded, a more aggressive tooth preparation is necessary to correct it in the final prosthesis. Thus, having an affected tooth in an optimal position eliminates the necessity of employing an aggressive preparation technique. After the initial evaluation, an additive wax-up and diagnostic mock-up are performed.

Management of intrinsic and extrinsic tooth discoloration

Teeth whitening has become a popular conservative measure for the management of tooth discoloration. A precise diagnosis of the etiology of tooth discoloration is essential for the appropriate management of patients who require whitening procedures.[21–23] Intrinsic or extrinsic factors can cause tooth discoloration. Intrinsic discoloration affects the interior layer of the teeth with deep stains or tooth defects caused by a variety of factors, including medication, systemic conditions and metabolic diseases. The treatment of intrinsic stains usually involves restorative procedures, such as veneers and crowns.

Extrinsic stains can be caused by wine, tobacco, products rich in polyphenols, inadequate oral hygiene, and surface changes or defects. Treatment for extrinsic stains may involve teeth whitening procedures.[24–26] These procedures have shown to be very successful, with patients reporting satisfaction with color changes after 2 weeks of bleaching gel application. The color demonstrated stability for up to 12 months.[27] Patients with microdontia in the visible smile area may have critical aesthetic concerns due to the discrepancy in size and space between teeth.

Oral hygiene is also a challenge for patients, as smaller teeth are often unable to make contact with the adjacent teeth, which can result in the accumulation of food debris on the interproximal surfaces.[28,29]

Laminate veneers

Dental laminate veneers can be fabricated from feldspathic porcelain for patients with high aesthetic demands who are seeking long-term success. Highly aesthetic results are required when treating 1 or 2 single teeth in the aesthetic zone. Many reports have demonstrated the efficacy of feldspathic porcelain in fulfilling aesthetic demands in anterior teeth.[30–34] A systematic review and meta-analysis evaluating porcelain veneers for anterior teeth concluded that the central incisor teeth had a success rate of 95% after 9 years of service.[35]

Clinical case

The objective of this case report is to illustrate the steps involved in the diagnostic wax-up, intraoral mock-up, minimally invasive tooth preparation, shade selection, and fabrication of a single hand-crafted ceramic veneer to successfully address the aesthetic concerns, oral hygiene difficulties and occlusal function in a young adult patient presenting with an individual tooth with microdontia in the aesthetic zone.

An 18-year-old Hispanic female presented to the clinic with the chief complaint of having a small tooth in the front and disliking the color of her teeth (Fig. 1). After clinical, photographic and radiographic evaluation, the patient was diagnosed with localized microdontia affecting the maxillary left central incisor, the space between central incisors, the left central incisor, and the left lateral incisor. The patient understood her clinical condition and claimed that no family member had a similar condition.

The patient acknowledged that a minimally invasive approach could be provided, involving teeth whitening for the anterior tooth and a single facial veneer restoration for the maxillary left central incisor. An in-office vital teeth whitening procedure was performed using 35% hydrogen peroxide (Philips Zoom WhiteSpeed; Philips, Amsterdam, the Netherlands) for 30 min, with a second

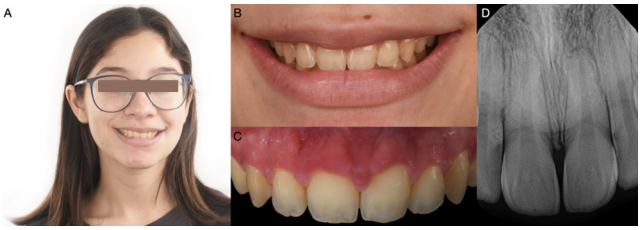

Fig. 1. Initial clinical situation

A. Extraoral frontal view; B. Extraoral close-up; C. Intraoral view; D. Radiographic image.

session repeated 1 week later. An at-home bleaching product, containing 9% hydrogen peroxide, was recommended to the patient (Philips Sonicare Teeth Whitening Kit; Philips). The patient was instructed to apply the product daily for 2 weeks. After the in-office and at-home whitening treatments, the patient expressed satisfaction with the result (Fig. 2).

During the implementation of a minimally invasive approach, an additive diagnostic wax-up (GEO Classic; Renfert GmbH, Hilzingen, Germany) for the maxillary left central incisor was performed, matching the adjacent central incisor and closing the spaces (Fig. 3). A putty guide with light body impression material (elite P&P; Zhermack, Badia Polesine, Italy) and tooth reduction guides were made based on the diagnostic wax-up, and an intraoral mock-up was provided (Fig. 4). The diagnostic mock-up was placed in the patient's mouth, and the patient expressed satisfaction with the contours of the proposed restoration. Consequently, she requested to proceed with the restorative procedure (Fig. 5). Once the aesthetic approval and informed consent had been obtained, the tooth reduction was carried out based on the diagnostic mock-up. In order to maintain the conservative approach, the preparation was performed with the aid of reduction guides, and the final preparation was polished and smoothed with polishing discs (Sof-Lex™ discs; 3M, St. Paul, USA) (Fig. 6).

After evaluating the final preparation, the double cord impression technique was employed, with the first packing being 00 and the second packing being 0 (Ultrapak cord; Ultradent Products, Inc., South Jordan, USA), impregnated with a hemostatic agent without epinephrine

Fig. 2. Before (A) and after (B) teeth whitening procedure

Fig. 3. Additive diagnostic wax-up

A. Frontal view; B. Left view; C. Right view.

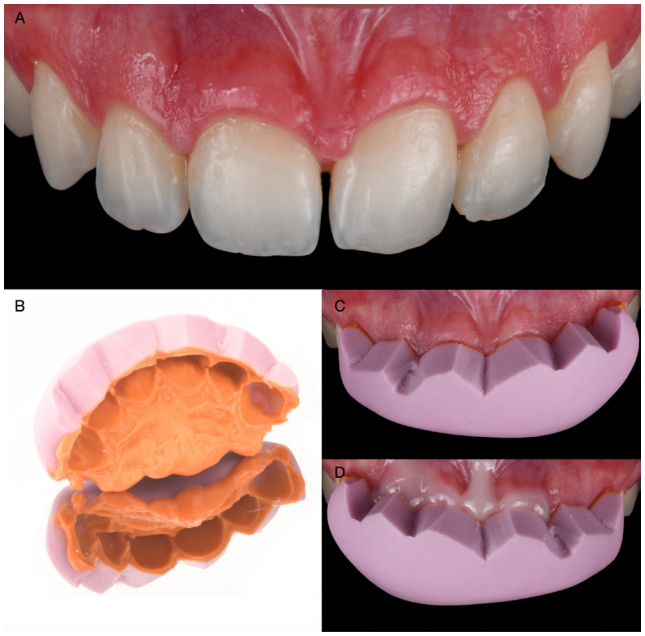

Fig. 4. Wax-up-based putty matrix for intraoral mock-up fabrication

A. Lubrication of the enamel surface; B. Putty index washed with light body material; C. Intraoral try-in of the putty guide; D. Guide insertion containing bis-acryl material for mock-up fabrication.

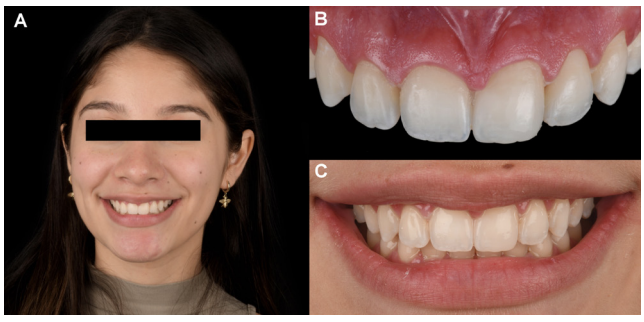

Fig. 5. Assessment of the diagnostic mock-up

A. Extraoral frontal view of the dentofacial restorative proposal; B. Intraoral frontal view of the dentogingival aesthetic proposal; C. Maximum intercuspation.

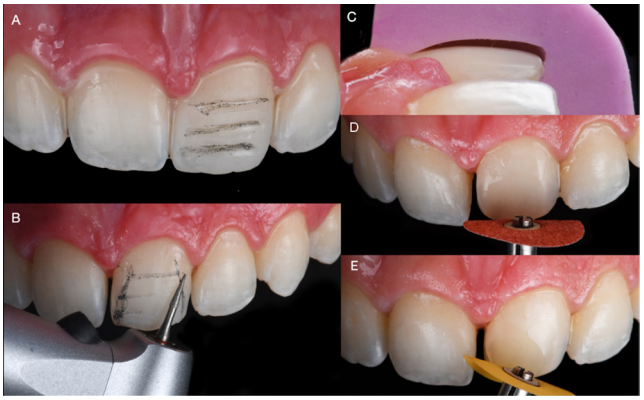

Fig. 6. Conservative tooth preparation

A. Horizontal reduction grooves; B. Line angles for tooth preparation; C. Evaluation with the use of reduction guides; D. Polishing with a coarse disc; E. Polishing with a fine disc.

(Hemodent®; Premier Dental, Plymouth Meeting, USA). The final impression was prepared using light and heavy body viscosity polyvinyl siloxane (Virtual® 380; Ivoclar Vivadent Inc., Amherst, USA) (Fig. 7).

Intraoral photographs (EOS 1300D Canon, Canon EF 100 mm f/2.8L Macro IS; Canon Inc., Tokyo, Japan) were captured with a cross-polarization filter (polar_eyes; PhotoMed International, Van Nuys, USA) to evaluate the shade and substrate present. A light source was positioned on the palatal side to take another photograph that would appear orange in color. This photograph was used to evaluate the translucency of the enamel, with the goal of obtaining a value measurement (Fig. 8). Subsequently, all photographs and the final impression were sent to the dental technician. The final impression was poured out in type IV stone (GC FUJIROCK® EP; GC America, Alsip, USA). Feldspathic porcelain (Noritake Super Porcelain EX-3™; Kuraray, Yokyo, Japan) veneer was handcrafted based on the photographic information, and the photos of the patient's mouth and restoration were superimposed to evaluate the final shade (Fig. 9).

Tooth isolation was achieved with a rubber dam, which was secured from the maxillary left second premolar to the maxillary right second premolar with holding clamps (Rubber Dam #2; Hu-Friedy Manufacturing, Chicago, USA). An additional clamp (Hygenic Brinker Clamp B4; Coltène/Whaledent Inc., Cuyahoga Falls, USA) was placed on the tooth to ensure the optimal conditions for the bonding procedure. The adjacent teeth were isolated with polytetrafluoroethylene (PTFE) film (Masters® Orange T-Tape; GF Thompson Co., Ltd., Newmarket, Canada), and the maxillary left central incisor was initially treated with 32% phosphoric acid gel (Uni-Etch® w/BAC; BISCO Dental, Schaumburg, USA) for 30 s on the enamel surface, rinsed and gently dried. Then, the primer and adhesive were applied (OptiBond™ FL; Kerr Dental, Orange, USA) following the manufacturer's instructions, and subjected to light curing (VALO X LED curing light; Ultradent Products, Inc.).

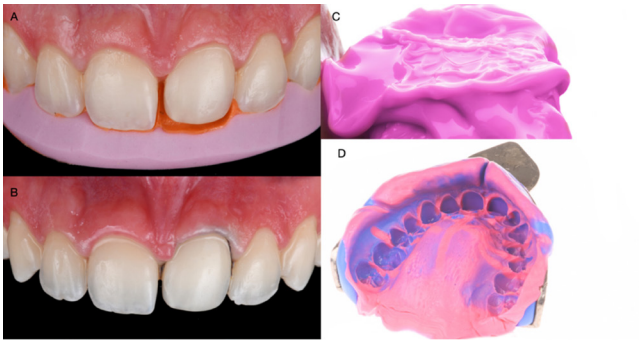

Fig. 7. Preparation of the final impression

A. Evaluation of the final preparation; B. Cord packing; C. Light and heavy body application; D. Final impression.

Fig. 8. Intraoral photographs used for shade matching

A. Photograph taken with a cross-polarization filter and enamel tabs; B. Photograph taken with a cross-polarization filter and dentin tabs; C. Photograph taken with a light source positioned on the palatal side.

Fig. 9. Restoration and shade matching

A. Feldspathic veneer with shade tabs; B. Tooth restoration; C. Intraoral view for the evaluation of the incisal shade; D. Intraoral view for the evaluation of the interproximal shade.

The restoration was treated with hydrofluoric acid (IPS Ceramic Etching Gel; Ivoclar Vivadent, Schaan, Liechtenstein) for 60 s, followed by rinsing and drying. Then, the restoration was cleaned in an ultrasonic bath (5300 Sweep Ultrasonic Cleaner; Quala Dental Products, Nashville, USA) for 5 min. Silane (Monobond-S; Ivoclar Vivadent) was applied for 60 s, after which the restoration was allowed to air dry. A light-colored resin cement (Variolink Esthetic LC; Ivoclar Vivadent) was applied to the veneer restoration, and the excess was removed with a microbrush and floss (Fig. 10). Light curing was performed for 20 s on the facial, mesial, distal, and incisal surfaces. Subsequently, glycerine gel was applied to prevent the formation of an oxygen inhibition layer, and the surface was light-cured for 20 s. The rubber dam was then removed, and any excess cement at the cervical margin was removed with a surgical scalpel blade (#12 Sterile; Salvin® Dental Specialties, Charlotte, USA).

Fig. 10. Bonding of the final restoration

A. Teflon tape packing; B. Application of the rubber dam; C. Application of the abutment clamp; D. Tooth etching; E. Dental bonding application; F. Veneer placement; G. Cemented restoration.

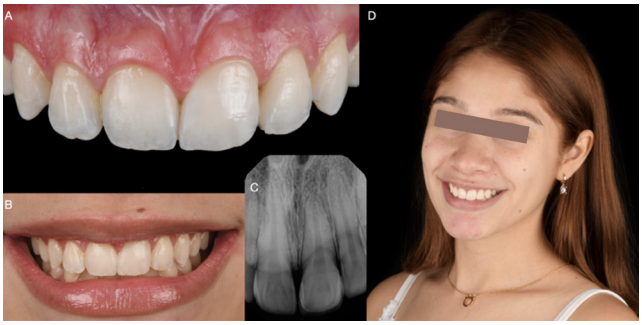

Fig. 11. Final restoration

A. Frontal intraoral view; B. Extraoral close-up; C. Radiographic image; D. Extraoral frontal view.

Static and dynamic occlusion (e.g., incisal guidance and lateral movements) were evaluated. An occlusal night guard was provided to prevent the teeth from wearing down and to protect the new restoration. The patient was satisfied with the results (Fig. 11). At the five-year follow-up, the patient reported continued satisfaction with the clinical outcome (Fig. 12).

Fig. 12. Five-year follow-up

A. Lateral intraoral view; B. Lateral close-up; C. Lateral extraoral view; D. Frontal intraoral view.

Discussion

The patient described in the case report was diagnosed with localized true microdontia, as evidenced by the maxillary left lateral incisor being the only tooth smaller in the arch. Additionally, the radiographs demonstrated smaller roots than those of the adjacent central and lateral incisors, and the patient's facial profile exhibited regular jaw sizes. None of the patient's relatives had any of the most common genetic disorders associated with microdontia. Thus, it can be implied that the development of the dental anomaly may be related to the exposure to environmental factors during the growth and development of the teeth. As previously stated, the etiology of microdontia remains unclear.

The patient described in our report expressed satisfaction with the shade improvements observed after the third whitening appointment and requested to proceed with the restorative stage. The patient evaluated the diagnostic mock-up and approved the proposed restoration of the morphology. The tooth preparation was conducted on the diagnostic mock-up in order to preserve the enamel structure. Following the preparation stage, the remaining mock-up material was removed, and the preparation was polished. Tooth reduction guides were also fabricated on the diagnostic wax-up so that the prosthetic space for the proposed ceramic veneer could be evaluated intraorally. Clinical studies have shown that veneers bonded to enamel have higher long-term success than veneers bonded to dentin.[36,37] The tooth preparation for our patient was completed using an enamel structure.

The selection of tooth shade for the fabrication of a single ceramic restoration in the aesthetic zone is considered one of the most challenging procedures in dentistry. Clinicians can use visual methods and digital devices to record the desired shade.[38] Visual assessment is a traditional and popular technique in which the clinician places shade tabs next to the teeth, with the intention of color matching. The use of shade tabs is a cost-effective and convenient method that depends on human eye observation. However, the disadvantages of shade matching with shade selection include a lack of shade standardization during the manufacturing process of the tabs,[39] light conditions,[40] tooth background,[41] and the clinician's experience.[42,43]

Digital devices used for shade taking include digital cameras, spectrophotometers and spectroradiometers. Digital photography offers a feasible method for shade matching and comparing results before and after treatment under controlled conditions.[44] Spectrophotometers can estimate the shade of a tooth or ceramic object by emitting a light source that, upon reaching the object, is reflected and measured. This process allows for a rapid, accurate and straightforward shade matching.[45] A recent study compared shade matching by visual assessment, cross-polarized photos and spectrophotometry.[46] Similar results were achieved for the cross-polarized photos and spectrophotometry, but there were large differences with the traditional visual assessment.[46] This clinical report used a digital camera to take photos of the prepared tooth with a dark background and a polarizing filter to avoid undesirable surface reflection. Additionally, images of dentin and enamel shade tabs were taken, and photographs with a light background were taken to evaluate fine details, such as craze or microcrack lines. A single feldspathic porcelain veneer with a thickness of 0.6 mm was found to be an appropriate solution for the described patient.

Limitations

The limitations of this brief narrative review include the use of a single database to apply a concise search strategy, which is contrary to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Conclusions

Dental care for patients with focal microdontia may involve the use of adhesive and minimally invasive dentistry techniques since the affected teeth are smaller than usual, and bonding restorations to the enamel structure provide a successful protocol. A single hand-crafted feldspathic porcelain veneer can effectively mimic adjacent teeth, satisfying patients' aesthetic expectations. The additive diagnostic wax-up and intraoral mock-up enable visualization and testing of the aesthetic and functional outcomes of the proposed restoration. Minimally invasive dentistry is an effective treatment option for non-syndromic focal microdontia in young patients, with the potential for long-term high aesthetic results.

Ethics approval and consent to participate

Not applicable.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

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