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Case Series

The Art of Maxillofacial Prosthesis in Pediatric Patients: A Case Series

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Abstract

Maxillofacial defects (extraoral or intraoral) are deformities associated with asymmetric regional body growth, unpleasing disfigurement, and a constant reminder of the traumatic experience to the individual, which mediates a more brutal impact on the tender minds of children. The primary goal in the prosthetic rehabilitation of physical defects in this case series was to maintain bodily symmetry, restore aesthetics, function to a limited extent, and psychologically uplift the patient. Reconstructive surgeries remain the mainstay of treatment modality due to better long-term results. However, some clinical scenarios make it not feasible to do so, demanding the need for prosthetic rehabilitation. To achieve the best results in growing children, complementary and cooperative work between prosthodontists and pedodontists is required. Quarterly review by the specialists ensures proper maintenance of the prosthesis and the periodic fabrication of a new prosthesis in harmony with the growing body. The following case series describes the maxillofacial rehabilitation in children with a right enucleated eye (right eye globe removed), amputated distal phalangeal part of the left index finger, and microtia right ear (malformed right external ear), highlighting the significance of minor modifications in workflow and boosting teamwork in effectively treating children.

Keywords: Auricular prosthesis, finger prosthesis, fused deposition modelling (FDM) technology, maxillofacial prosthesis, ocular prosthesis

Introduction

Physical defects in the form of maxillofacial deformities may be extraoral or intraoral. Common reasons for absent or deformed organs in children are genetic, trauma, or surgical resection post-treatment of pathologies. The loss of a body part has an immense impact on the symmetric body growth, cosmetic and psychological well-being of such young individuals.[1] Treatment modalities for such patients include reconstructive surgery and/or prosthetic management. Despite the evolution in the surgical field, reconstruction of these defects by surgical intervention may present its own limitations, such as cost, longer recovery time, and complications like infection, graft failure, and tissue necrosis.[2] Therefore, patient selection is an important criterion for the treatment modality preferred. Prosthetic management may serve as the solution for selected patients with the purpose of restoring form, limited function, and the achievement of normal appearance, thereby enhancing the overall quality of life. Rehabilitation of maxillofacial defects in growing children is often challenging, especially in younger or behaviorally challenged children.[3] The knowledge and

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skills of the specialist are critical to attain the cooperation of the child, the trust of the parents, and thus facilitate treatment in as efficient and comfortable a manner as possible for the patient while simultaneously inculcating a positive attitude in the child.

Collaborative practice between prosthodontists and pedodontists can serve as an aid in making the treatment process a smooth and efficient journey.[4] This includes shared decision-making, communication, and participation in the treatment progression. It allows a synergistic combination of two specialists for the betterment of the affected child. The essential components of a collaborative approach for the prosthetic management of pediatric patients are built on shared responsibility, coordination, communication, positive feedback, and mutual respect while adhering to the principles of patient care.[5]

The art and principle of maxillofacial prosthesis in pediatric patients are governed by multiple factors which are dependent on both the patient and practitioner. The complexities encountered during this can be eliminated more efficiently if an interdisciplinary approach is adopted, with the child as the epitome of treatment success. By recognizing and prioritizing the need for this approach, dental professionals can ensure successful treatment outcomes and create a positive experience for the child and their parents.

Prosthetic materials used in such cases may be divided into impression (elastic and non-elastic), modeling (modeling clay, plastolene, and waxes), and fabrication (acrylic resins, acrylic copolymers, polyvinyl chloride and copolymers, chlorinated polyethylene, and silicone elastomers) materials.[6] Acrylic resin and silicone material meet the majority of the criteria to be ideal prosthetic materials for ocular and other maxillofacial prostheses, respectively. Heat-temperature vulcanized (HTV) silicone elastomer offers the advantage of excellent mechanical, optical, and thermal stability with good tear strength over the room-temperature vulcanized (RTV) silicone elastomer.[7]

3D facial scanners are the new advent which record facial topography by recording landmarks on the face with acceptable accuracy.[8] The advantage of digital impression in the form of STL (Standard Tessellation Language) image over conventional is the ease, accuracy, ability to replicate the affected part, repeatability, data storage, and integration with other digital technologies. The main disadvantages are difficult availability and cost factor.[9]

The STL file is converted into the model by a 3D printing process using FDM technology. This is an additive manufacturing process comprising the extrusion of thermoplastic filament (in our case, PLA-polylactic acid) and its deposition in layers. It is simple and easy to use, ensuring comfort and reduced appointments for the patient. PLA is biocompatible, environmentally friendly, and stable with high mechanical strength.[10] Other materials such as acrylonitrile butadiene styrene, polycarbonate, and polyetherimide resin are also used. Although the application of this technology to create working models for wax pattern adaptation is an efficient method, limitations such as high cost, acquiring digital design files, and lack of well-trained operators are the drawbacks of this methodology.[11]

Various ways to enhance the retention of these prostheses include surgical, anatomical, and mechanical methods. Such aids are eyeglasses, utilizing undercuts present in tissues, medical-grade skin adhesives, magnets, and at times the merger of more than one.[6]

Although many technological advancements have been part of our dental practice, managing pediatric patients needs more of ‘pediatric patient engagement’.[12] Providing behavior management for children, especially the non-cooperative child, can be fairly challenging, even for the pediatric dentist. Moreover, in our cases, these patients were inflicted with either disease, trauma, or defect, making them more emotionally and psychologically vulnerable. The specialist team should incorporate communicative behavior and nonverbal communicative management (appropriate contact, gestures, gentle and soft handling), positive reinforcement, and voice control (repeated reassurance during the treatment procedure). By enabling constant and patient interaction with these children, it helps them to cope with the time-intensive and demanding procedure of prosthesis fabrication.

TLC (tender love and care) and technology go hand in hand to ensure that the prosthodontist and pedodontist duo work efficiently and meet the treatment objectives. This practice provides a much-needed union between prosthodontists and pediatric dentistry. From the first step of history taking to follow-up appointments, the trust of parents and children should remain intact. The following points should be addressed before, during, and after patient treatment: parental consent, child assent, behavior documentation, and follow-up appointments, considering all behavior guidance options under the keen observation of the pedodontist. For every step in

Figure 1. Ocular prosthesis (a, b), Wax try in (c), Iris centering with transparent graph grid retained using patient's spectacles (d)

the prosthetic management, a small modification by the prosthodontist can ensure the ease and comfort of the pediatric patient. Each option should be informed and assessed for achieving the objective it was intended for.

Knowledge of these modifications will aid the practitioner in providing optimum care and management for these patients, especially if they belong to the pre-cooperative age or have special needs. The authors believe there is a paucity of literature on the association and collaboration of prosthodontists and pedodontists in the handling of pediatric patients with maxillofacial prosthetic requirements. The following case series describes the expanding role of pedodontists in the prosthetic management of maxillofacial or other bodily defects in children, further underscoring the value of an interdisciplinary approach for the treatment of such patients. This article is an initiative to highlight how a small change brings about a big difference in our dental practice.

Case Series

Case 1: Ocular prosthesis

A six-year-old female patient reported to the Department of Prosthodontics with the chief complaint of missing right eye, which was enucleated following retinoblastoma two months back. Frankl behavior rating score of the patient was 2 for her age. The case was discussed with a pedodontist. On thorough history taking and clinical examination, the patient was planned for a custom-made ocular prosthesis. The treatment plan was explained to the parents. Assent from the child and informed consent from the parents were obtained. Tell-show-do was the behavior management technique utilized. The child, along with her parents, was demonstrated the entire procedure with the help of videos and photographs of other patients and, without deviating from what was shown in the videos, the procedure was started. Ocular impression was made with a two-step putty wash impression technique (Zhermack Elite HD+ light body, Zhermack SpA, Italy) (Fig. 1a, b). The patient was instructed to do the movements in superior, inferior, lateral, and circular motion of the socket as depicted in the video. The impression was poured in dental stone (Kalstone; Kalabhai Karson, India) in a two-pour technique, and the cast was retrieved. Wax (Pyrax carving wax; Pyrax, India) was poured into it, and the wax model was tried in the patient (Fig. 1c). Corneal button was trimmed from a stock eye (Monoplex System, American Optical Corp, Southbridge, USA) with a close resemblance to the patient's natural iris in both daylight and artificial light.

Centering of the iris was achieved using a transparent graph grid retained by the patient's spectacles and evaluated by asking the patient to look straight ahead to a distant object, keeping in mind the symmetry in terms of superoinferior, mediolateral, and anteroposterior position with the iris of the unaffected left eye of the patient (Fig. 1d).

The modified wax pattern with the corneal button was flasked, dewaxed, packed with scleral polymer (Factor II, USA), and processed according to the manufacturers' instructions. The prosthesis was inspected for any imperfections (Fig. 2b). Finishing and polishing were carried out to achieve maximum adaptation and achieve overall hygiene of the prosthesis. The ocular prosthesis

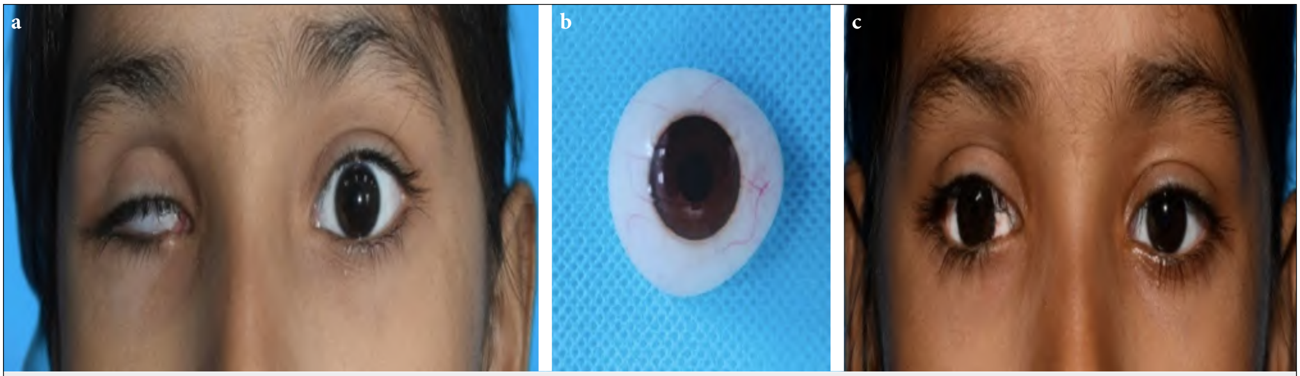

Figure 2. Pre-insertion photograph (a), Finished ocular prosthesis (b), Post-insertion photograph (c)

was washed with water and mild soap before inserting into the patient's anophthalmic socket and evaluated meticulously for lid drape, contour, and adaptation (Fig. 2a, c). The child and her parents seemed satisfactory on observing the outcome.

Case 2: Finger prosthesis

A ten-year-old male patient reported to the Department of Prosthodontics with the chief complaint of amputated fingertip of the left index finger due to accidental trauma at the age of eight. Frankl behavior rating score of the patient was 3 for his age. The case was discussed with a pedodontist. On thorough history taking and clinical examination, the patient was planned for a custom-made digit prosthesis. The treatment plan was explained to the parents. Assent from the child and informed consent from the parents were obtained. Tell-show-do was the behavior management technique utilized. The child, along with his parents, was demonstrated the entire procedure with the help of videos and photographs of other patients and, without deviating from what was shown in the videos, the procedure was started. Impression of both the affected and unaffected fingers was made using irreversible hydrocolloid impression material (Zhermack Hydrogum 5 Alginate, Zhermack SpA, Italy). The affected finger impression was poured in dental stone, and the unaffected finger impression was poured in modeling wax (Pyrax, India). The wax model was retrieved from the impression material and hollowed out. The fit was checked, and the outer surface was modified to achieve better esthetics followed by embedment of an acrylic nail into the wax try-in (Fig. 3a, b).

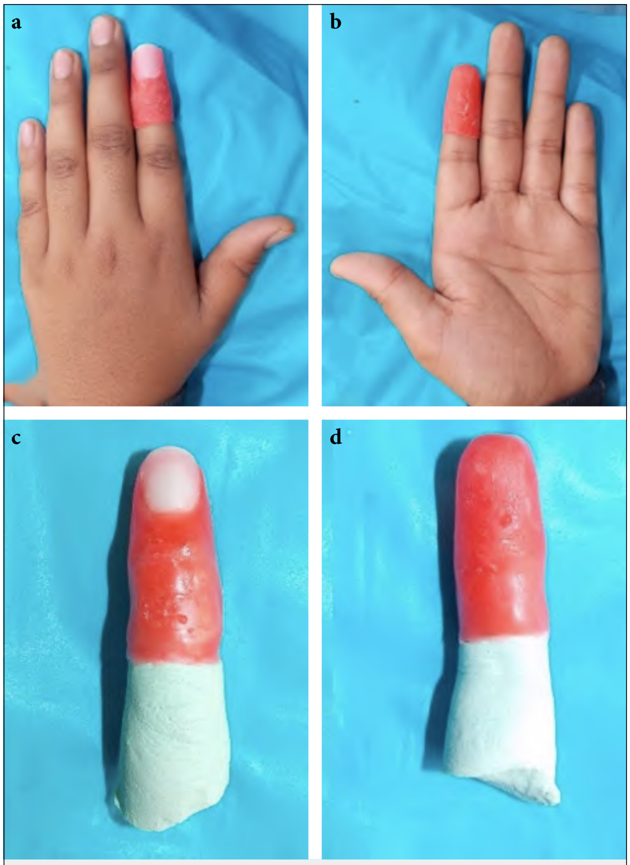

Figure 3. Wax pattern fabrication on the finger model (a, b), Wax pattern try in (c, d)

The tried-in wax pattern was placed into the slightly scraped affected finger model to achieve intimate contact with the tissues (Fig. 3c, d). It was flasked, dewaxed, and packed with heat-temperature vulcanizing (HTV) silicone M 511 (Technovent, Bridgend, UK). Processing was performed according to the manufacturer's instructions, followed by the insertion of the finished and polished prosthesis (Fig. 4a-c).

Case 3: Auricular prosthesis

A fifteen-year-old female patient, who was diagnosed with hemifacial microsomia at birth, reported to the Department of Prosthodontics with the chief complaint of a congenitally deformed right ear. The patient had a history of failed auricular reconstruction surgery at the age of seven due to graft loss.

Figure 4. Pre-insertion photograph (a), Post insertion photograph (b, c)

Figure 5. Standard Tessellation Language design file (a), Fused Deposition Model (b), Wax pattern try in (c)

NCCT: Non-contrast computerised tomography

Digital design file in the form of a Standard Tessellation Language (STL) image was formed using the patient's recent review NCCT scan (Fig. 5a). The left ear was mirrored to the affected side, overlying skin created using the software (Materialise Mimics software), and a 3D printed model was fabricated using a Fused Deposition Modeling machine (Flashforge 2S FDM 3D printer, Zhejiang Flashforge 3D Technology Co., LTD, China) (Fig 5b). The model was duplicated into a wax pattern, followed by verification on the patient (Fig 5c, d).

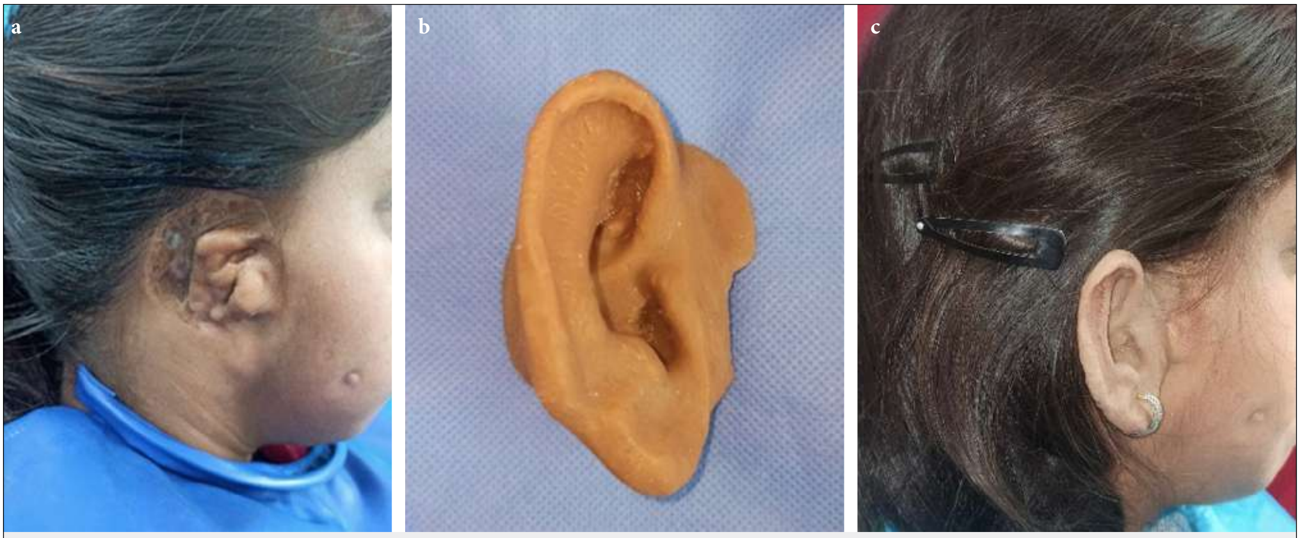

Figure 6. Pre-insertion photograph photograph (a), Auricular prosthesis (b), Post-insertion photograph (c)

Shade matching was achieved using the trial-and-error visual method. The wax model was flasked, dewaxed, and packed with heat-temperature vulcanizing (HTV) silicone M 511 (Technovent, Bridgend, UK). The processed silicone prosthesis was further characterized using extrinsic staining (Technovent, Bridgend, UK) and piercing a hole in the ear lobule for an earring (Fig. 6a-c). The prosthesis showed adequate retention using anatomical undercut and silicone adhesive (Daro adhesive hydrobond).

Post-insertion, all the patients were comfortable and pleased with the esthetic outcome. Maintenance instructions were explained to them to ensure cleanliness of the prostheses. The patients were recalled quarterly for review, and the condition of the prostheses was satisfactory. Follow-up appointments also showed the children's positive psychology devoid of any social stigma.

Discussion

Reconstructive surgeries with free flap techniques are still the gold standard in maxillofacial defect rehabilitation, making prosthetic management the next best option. However, the selection of treatment modality and mode of retention is governed by other factors like size, location, and depth of defect, anatomic limitations, surgical complications, economical constraints, and patients' preference.[13] Orbital implants are routinely placed in children at the time of surgery. However, implants in other body parts have special consideration of impending growth; therefore, they should be placed post-cessation of growth.[14] Enucleated sockets have shown a high risk of craniofacial disfigurement and growth retardation, resulting in facial asymmetry.[15] This physiological response can be better explained with Moss' functional matrix hypothesis,[16] which states that a functional relationship exists between soft tissue and osseous growth. The objective in treatment for pediatric patients is early replacement of conformer with ocular prosthesis to stimulate tissue growth, achieve adequate palpebral and conjunctival tissue for supporting the ocular prosthesis, which restores orbital volume and promotes socket and facial development.[17] The visual deformity and social stigma associated with defects like anophthalmic socket, microtia, and amputated fingers can be rehabilitated with a maxillofacial prosthesis. Difficulties that are encountered with pediatric patients may range from behavioral disorders, patient communication, and parental expectation. Prosthetic rehabilitation of defects in them requires the clinician to be knowledgeable about growth and development, behavioral management, prolonged patient appointments, and long-term follow-up. Frankl behavior rating scale was recorded for the patients, which serves as a behavior guidance tool for planning subsequent visits that require the active participation of a pedodontist.

Impression making can be done conventionally or digitally. Conventional impression making may be a challenge in young children due to the time consumed and discomfort to the patient. It was ensured to perform impression making for our patients using fast-setting impression materials (Zhermack Elite HD+ light body and Zhermack Hydrogum 5 Alginate) in a single turn and finish as soon as possible while engaging them in conversations. Advantages offered by digital impression making using the patient's recent review NCCT ensured ease, comfort, biocompatibility, no need for a donor, data storage, and integration with other digital technologies. These changes bring a positive impact on the appointments with the children. However, its use has limitations like availability, cost, and skill of the practitioner.[10] The digital scan files are then imported, segmented, and designed before 3D printing the prosthesis (direct method) or printing the mold (indirect method).

Of all the materials used for fabricating maxillofacial prostheses, silicone is the most commonly used material due to ease of availability and low cost.[18] Heat-temperature vulcanizing silicone elastomer ensures better mechanical property and color stability. Its limitations are compromised edge strength and cost. Means of retention of these prostheses are aids like anatomical (tissue undercuts), mechanical (implants, eyeglasses, magnet), chemical (tissue adhesives), and combinations of the above are used.[19] The present cases acquired retention by anatomical for ocular and finger prosthesis and combination with chemical (Daro adhesive hydrobond, Factor II, Arizona) for auricular prosthesis. Chemical retention ensures better merging of the edges, imparting better aesthetics.

Limitations of silicone prostheses include delamination, degradation of the silicone, and poor edge strength.[18] These shortcomings were eliminated with meticulous fabrication procedure and patient education. Patients, in the presence of their parents/guardians, were instructed to take out the prosthesis, clean it daily for the health of the skin and hygiene of the prosthesis.[19] For ocular prosthesis, once a month is sufficient.[19] The cleaning is carried out using a soft-bristled brush with mild soap; quarterly review may require removal of adhesive remnants with adhesive remover (Detachol, Ferndale Laboratories, USA), highlighting extrinsic staining, and polishing of the prosthesis. Post-insertion instructions provided to the patient were helpful in achieving a favorable outcome that was evident at follow-up visits.

The use of these prostheses demands periodic changes in the form of relining (ocular prosthesis), extrinsic staining or characterization, or fabrication of new ones with continued growth of hard and soft tissues in the region and deterioration of silicone material as time progresses. Pedodontist and prosthodontist should expand their roles and exhibit teamwork to treat such pediatric patients and establish their successive appointments. Pedodontist can play a crucial role in reinforcing the maxillofacial prosthesis maintenance and guiding the patients for review for fabrication of new prosthesis when need be. Comprehensive research to further improve facial scanners and direct silicone 3D printing will provide a much-needed leap in the era of maxillofacial prosthetics.

Conclusion

The modified treatment steps and behavior modification techniques employed for rehabilitation of missing or deformed body parts in children make the procedure more children-friendly and centered. With the advent of dental materials, boost in digital technology, and emphasis on a multidisciplinary approach, such defects can be rehabilitated in an effective and efficient method.

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References

1. Iyer J, Hariharan A, Cao UMN, Tran SD. Acquired facial, maxillofacial, and oral asymmetries- a review highlighting diagnosis and management. Symmetry 2021;13(9):1661–80.
2. Hery D, Schwarte B, Patel K, Elliott JO, Vasko S. Plastic surgery tourism: Complications, costs, and unnecessary spending? Aesthet Surg J Open Forum 2023;6(1):1–7.
3. Shand J. Paediatric oral and maxillofacial surgery. Aust Dent J 2018;63(1):69–78.
4. Hawari WE, Rokhssi H, Zaroual A, Bentahar O. Collaboration between the maxillofacial prosthodontists and the maxillofacial surgeons: Overview. Int J Surg Open 2023;51(1):1–5.
5. Bridges D, Davidson RA, Soule Odegard P, Maki IV, Tomkowiak J. Interprofessional collaboration: Three best practice models of interprofessional education. Med Educ Online2011;16(1):6035–45.
6. T. D. Taylor. Clinical maxillofacial prosthetics. Quintessence Publishing.
7. Mitra A, Choudhary S, Garg H, HG J. Maxillofacial prosthetic materials - an inclination towards silicones. J Clin Diagn Res 2014;8(12):8–13.
8. Amornvit P, Sanohkan S. the accuracy of digital face scans obtained from 3D scanners: An *in vitro* study. Int J Environ Res Public Health 2019;16(24):5061.
9. Cristache CM, Tudor I, Moraru L, Cristache G, Lanza A, Burlibasa M. Digital workflow in maxillofacial prosthodontics – an update on defect data acquisition, editing and design using open-source and commercial available software. Appl Sci 2021;11(3):1–20.
10. Barazanchi A, Li KC, Al-Amleh B, Lyons K, Waddell JN. Additive technology: Update on current materials and applications in dentistry. J Prosthodont 2017;26(2):156–63.
11. Tian Y, Chen C, Xu X, Wang J, Hou X, Li K, et al. A review of 3D printing in dentistry: Technologies, affecting factors, and applications. Scanning 2021;2021:1–19.
12. Teela L, Verhagen LE, van Oers HA, Kramer EEW, Daams JG, Gruppen MP, et al. Pediatric patient engagement in clinical care, research and intervention development: A scoping review. J Patient Rep Outcomes 2023;7(1):32–43.
13. Vosselman N, Alberga J, Witjes MHJ, Raghoebar GM, Reintsema H, Vissink A, et al. Prosthodontic rehabilitation of head and neck cancer patients - challenges and new developments. Oral Dis 2021; 27:64–72.

14. Kraut RA. Implants for children. Dental implants. Elsevier.

15. Ji Y, Ye F, Zhou H, Xie Q, Ge S, Fan X. Bony orbital development after enucleation. J Anat 2015;227(5):647–53.

16. Do NTK, Buchman SR. Combating constraints of the functional matrix: the importance of overcorrection in pediatric craniofacial surgery. Plast Reconstr Surg Glob Open 2021;9(6):3604–9.

17. Goiato MC, Caxias FPD, Santos DMD. Quality of life living with ocular prosthesis. Expert Rev Ophthalmol 2018;13(4):187–9.

18. Caxias FPD, Santos DMD, Bannwart LC, Neto CLDMM, Goiato MC. Classification, history, and future prospects of maxillofacial prosthesis. Int J Dent 2019;2019:1–7.

19. Beumer J, Curtis TA, Marunick MT. Maxillofacial rehabilitation prosthodontic and surgical considerations. Ishiyaku Euro America.