Case Report

Digital Workflow for the Rehabilitation of a Geriatric Patient with Microtia using Open-source Software

Flujo de trabajo digital para la rehabilitación de un paciente geriátrico con microtia mediante software de código abierto

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ABSTRACT

Introduction: microtia is defined as a congenital hypoplastic malformation of the auricle (external ear), with severity ranging from a slight reduction in auricular size to complete absence of the external ear. It is usually unilateral and may present noticeable asymmetry.

Objective: the present study was to fabricate an adhesive auricular prosthesis for diagnostic purposes using a fully digital workflow. The advantages of the digital methodology were evaluated in terms of diagnostic accuracy, patient comfort and treatment efficiency.

Case report: the patient was an 82-year-old male with no relevant systemic conditions. Extraoral examination revealed microtia of the right auricle, classified as Tanzer Type II and Hunter Grade III. A 3D facial scan was acquired using a structured light scanner. Once the 3D-printed prosthetic design was obtained, it was clinically evaluated to verify its adaptation, positioning, and morphology. Upon approval, medical-grade silicone was used to fabricate the definitive prosthesis.

Conclusions: this clinical case highlights the significant advantages of digital technology in the rehabilitation of geriatric patients with auricular defects. The integration of digital workflows with analog techniques provides an effective approach to enhance the precision, comfort, and aesthetic outcomes of prosthetic treatment.

Keywords: geriatrics; Rehabilitation; Digital Technology; Computer-Aided Design and Image Processing, Microtia; Maxillofacial Prosthesis; 3D Printing; Quality of Life.

RESUMEN

Introducción: la microtia se define como una malformación congénita hipoplásica de la oreja que varía en gravedad desde una leve disminución auricular hasta la ausencia total de la oreja externa. La microtia suele ser unilateral y puede presentarse con notorias asimetrías.

Objetivo: evaluar una prótesis auricular adhesiva con fines diagnósticos mediante un flujo digital completo. Se evaluó las ventajas de la metodología digital utilizada en términos de precisión diagnóstica, comodidad del paciente y eficiencia del tratamiento.

Presentación de caso: paciente masculino, 82 años, sin enfermedades sistémicas relevantes. El examen extraoral reveló una microtia en el pabellón auricular derecho Tipo II de Tanzer y grado III de Hunter. Se realizó un registro facial 3D mediante un escáner de luz estructurada. Una vez obtenido el diseño protésico 3D impreso fue evaluado clínicamente en el paciente para verificar su adaptación, posición y forma. Tras su aprobación, se procedió a la carga de silicona de grado médico para la confección de la prótesis definitiva.

Conclusiones: el caso clínico evidencia las ventajas significativas del uso de tecnología digital en la rehabilitación de pacientes geriátricos con pérdida auricular. La integración del flujo digital con técnicas análogas constituye una herramienta eficaz para mejorar la precisión, la comodidad y los resultados estéticos del tratamiento.

Palabras clave: geriatría; rehabilitación; tecnología digital; procesamiento de imágenes y diseño asistidos por computadora; microtia; prótesis maxilofacial; impresión 3D; Calidad de Vida.

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Introduction

Prosthetic rehabilitation in geriatric patients faces significant challenges because of the complexity of physiological aging, associated comorbidities, and functional limitations that often accompany this population. In specific cases of auricular loss, aesthetic and functional restoration is crucial for the patient's quality of life, affecting both self-esteem and social integration.

Congenital ear anomalies result from disruptions in the embryologic development of the fetal auricular cartilage between the fifth and ninth weeks of gestation, or from abnormal physical forces during later development that interfere with normal ear growth. The auricle derives from the first and second branchial arches, which also give rise to structures such as the middle and inner ear, facial nerve, mandible, maxilla, and hyoid bone. Congenital anomalies affecting the external ear are typically classified into two distinct categories: malformations, which occur early in development and include conditions such as microtia, anotia, and cryptotia; and deformations, which usually occur later in development and are associated with external physical forces, in cases such as lop ear, cup ear, and prominent auricles.[1,2]

Microtia is defined as a congenital hypoplastic malformation of the external ear, with severity ranging from a slight reduction in auricular projection to the complete absence of the pinna. It is usually unilateral and may present noticeable asymmetry.

Microtia shows a known male predilection, with a male-to-female ratio of approximately 2,5:1. Among affected individuals, 77 % to 93 % present unilateral involvement, and approximately 60 % of cases involve the right ear.[1,3]

Surgical reconstruction of the auricle is complex, and outcomes are often unsatisfactory. Therefore, prosthetic rehabilitation represents a viable therapeutic alternative.[4]

Many patients adapt to living with an imperceptible or tolerable difference, integrating microtia into their self-concept and reporting no lasting negative impact on their quality of life. However, several psychosocial challenges have been documented, including anxiety about exposing their ears (even after reconstruction), disclosing their diagnosis to romantic partners, making decisions regarding surgery, and perceiving a lack of support in the workplace.[5]

Rehabilitation of geriatric patients with microtia may become necessary due to changes in their lives, such as assuming a more active role in family or social settings, which can increase their desire to enhance appearance and self-esteem. Auricular prostheses can help restore confidence and social integration, improve quality of life, and support participation in everyday activities. Although bone-anchored implants are considered advantageous for retaining an auricular prosthesis,[6,7,8] they require the irreversible removal of the entire auricular remnant. Alternatively, an initial diagnostic prosthesis with adhesive retention can be fabricated using a fully digital workflow, allowing the patient to evaluate the prosthetic experience. Traditionally, the fabrication of auricular prostheses has relied on analog techniques, which require extensive facial impressions. This process can be uncomfortable for patients and prone to inaccuracies due to tissue compression.

Advances in digital technology have eliminated the need for analog impressions of oral and maxillofacial rehabilitation. New devices capable of recording and obtaining three-dimensional data of the patient's facial structure have emerged. This approach not only enhances precision and patient comfort but also optimizes the time and resources required for prosthesis fabrication.

This study is aimed to report the case of an 82-year-old patient treated with an adhesive ear prosthesis for diagnostic purposes using a fully digital workflow, without analog impressions or plaster flasks. The advantages of this methodology were evaluated in terms of diagnostic accuracy, patient comfort, and treatment efficiency, providing a foundation for broader implementation of such technologies in clinical practice.

Case report

The treatment of an elderly patient with microtia using a partially adhesive auricular prosthesis with digital flow is described below.

The patient was an 82-year-old male, without any systemic disease, who was attended at the Maxillofacial Prosthetics Clinic at the School of Dentistry, University of Chile.

During the extraoral examination, microtia of the right auricle was observed, with a slight anterior remnant in the area (Tanzer Type II; Hunter Grade III)[(9)] (fig. 1A).

The patient was informed of the available treatment options, including surgical alternatives such as auricular reconstruction,[(4,9,10)] implant-retained prosthetic solutions,[(6,7,8,11)] and adhesive prostheses. Ultimately, it was decided to fabricate a partial external tissue prosthesis of the right auricle using an adhesive retention system for diagnostic purposes.

The patient signed a written informed consent for the publication of all relevant clinical information and images included in this case report.

Following the initial diagnostic procedure and patient approval of the treatment plan, a 3D facial scanning was performed using a structured light scanner[(12,13)] (CR-Scan Lizard 3D Scanner, Shenzhen Creality 3D Technology Co., Ltd), without the use of analog facial impressions.[(12,14,15,16)]

The scan data obtained (fig. 1B) were processed within the CR-Studio software environment (Creality 3D Technology Co., Ltd). (fig. 1 C).

Once the 3D record of the patient was obtained, the analysis and design were conducted using Blender software,[(17)] which allowed simultaneous visualization from multiple perspectives.[(12,15)] (fig. 1 D-F).

In this manner, a mirror image of the contralateral auricle was created, and the digital wax-up was adapted to the remaining right ear. (fig. 1 G).

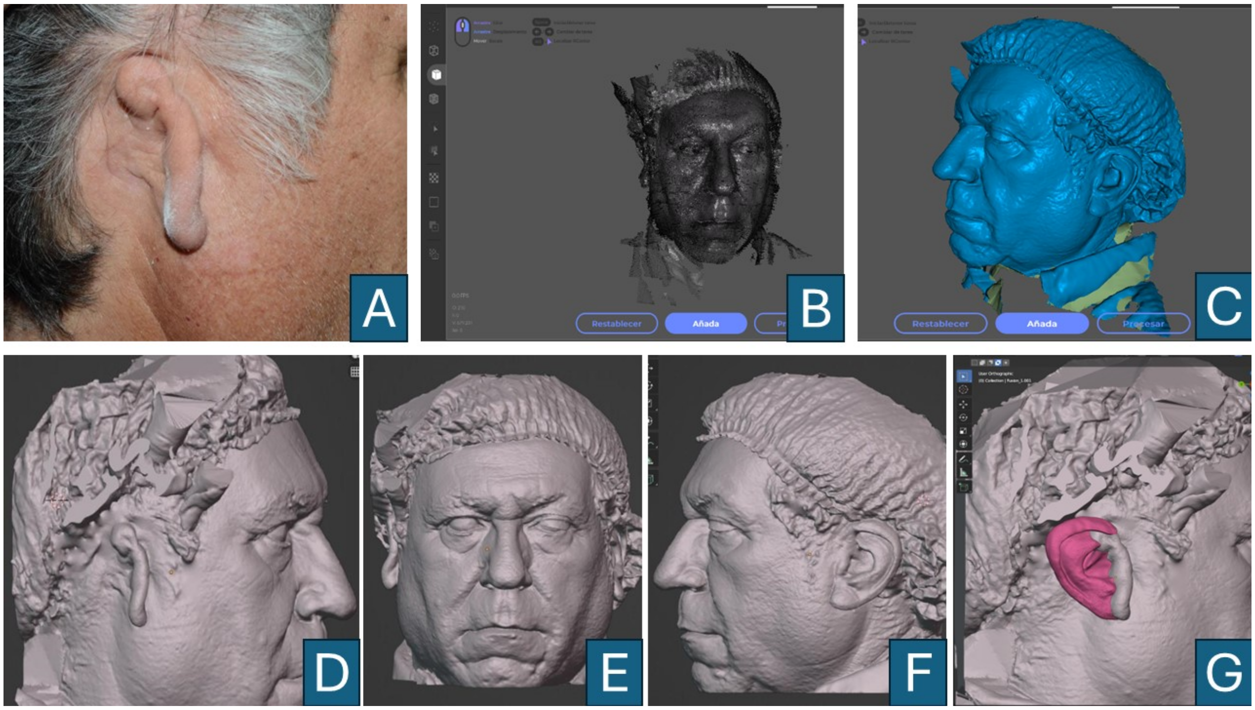

Fig. 1- A) Right lateral photograph showing the degree of microtia; B) Data acquisition by the scanner; C) Data processing of 3D model; D), E), F) Side and front views of the resulting 3D model. Blender environment; G) Simultaneous lateral view using a mirror image of the left auricle (pink) on the right remnant.

Once the digital wax-up of the right auricle was completed, the master model was digitally offset, and the undercut areas were blocked out to prevent issues related to the path of insertion (fig. 2 A). A Boolean modifier was then applied to section the auricular sculpture according to the modified master model (fig. 2 B-C).

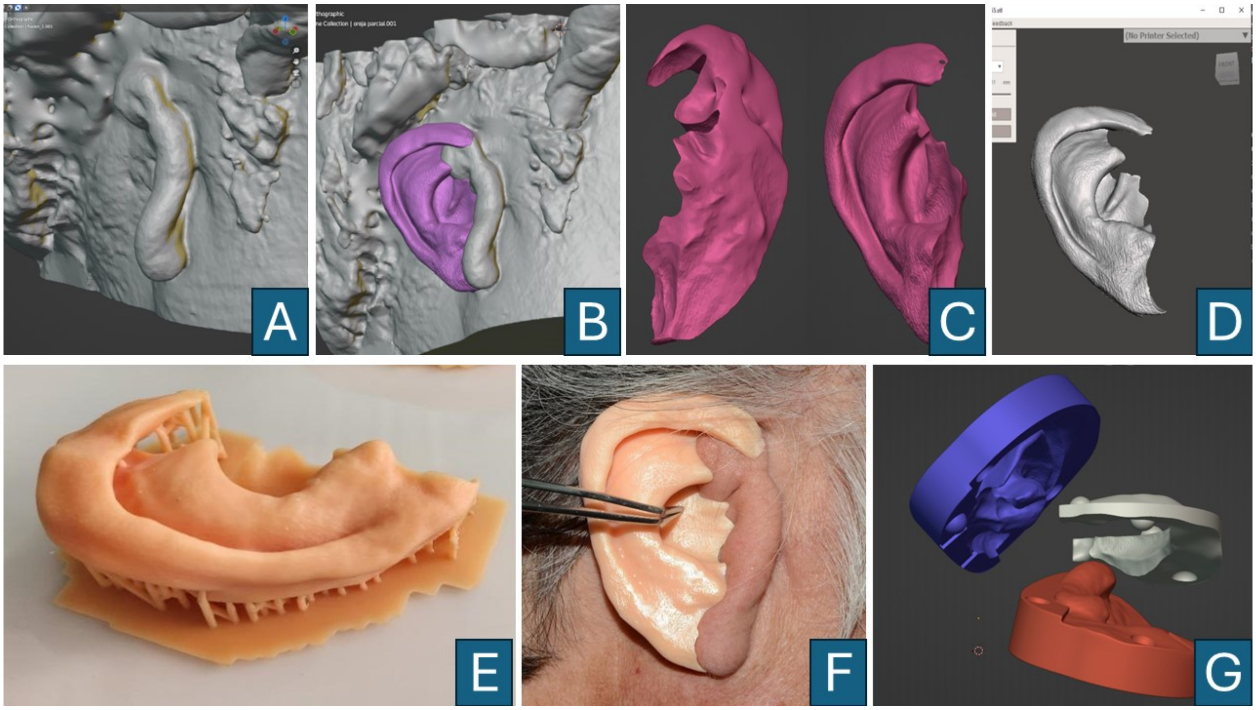

Fig. 2 - A) Offset model showing yellow retentive areas in relation to insertion/removal axis; B) Adaptation of the sculpture (purple) in the conditioned model; C) Two perspectives of the cut sculpture according to the model; D) Error inspection. Meshmixer environment; E) Resin-printed model before removing the supports; F) Preoperative lateral image and lateral image during the auricular sculpture test; G) The sectional design of a flask is composed of three parts (opened muffle).

The resulting auricular sculpture was prepared for 3D printing by performing an error inspection using Meshmixer software (Autodesk) (fig. 2 D). The model was then sliced using Anycubic Photon Workshop (Anycubic) to generate a file compatible with the 3D printer (Anycubic Photon Mono 4K, Anycubic), enabling additive manufacturing of the design (fig. 2 E).

The printed diagnostic prosthesis was cleaned ultrasonically with isopropyl alcohol and post-cured using UV light at 405 nm. After removing the supports, the auricular sculpture was fitted on the patient to verify adaptation, position, and morphology (fig. 2 F).

After evaluation of the printed model and patient approval, a digitally sectioned flask was designed according to the auricular form (fig. 2 G and fig. 3 A) and printed (fig 3 B-C) for the fabrication of the final prosthesis using medical-grade silicone (A-588-1, Factor II, Lakeside, CA, USA).

Once the medical-grade silicone was loaded into the flask, it was tested on the patient, and extrinsic characterizations were applied to enhance the anatomical realism of the final result (fig. 3 D).

The residual shine from the extrinsic characterization was removed, and the final fitting was performed (fig. 3 E-F). Once the test was completed and accepted, instructions and recommendations were provided to the patient.

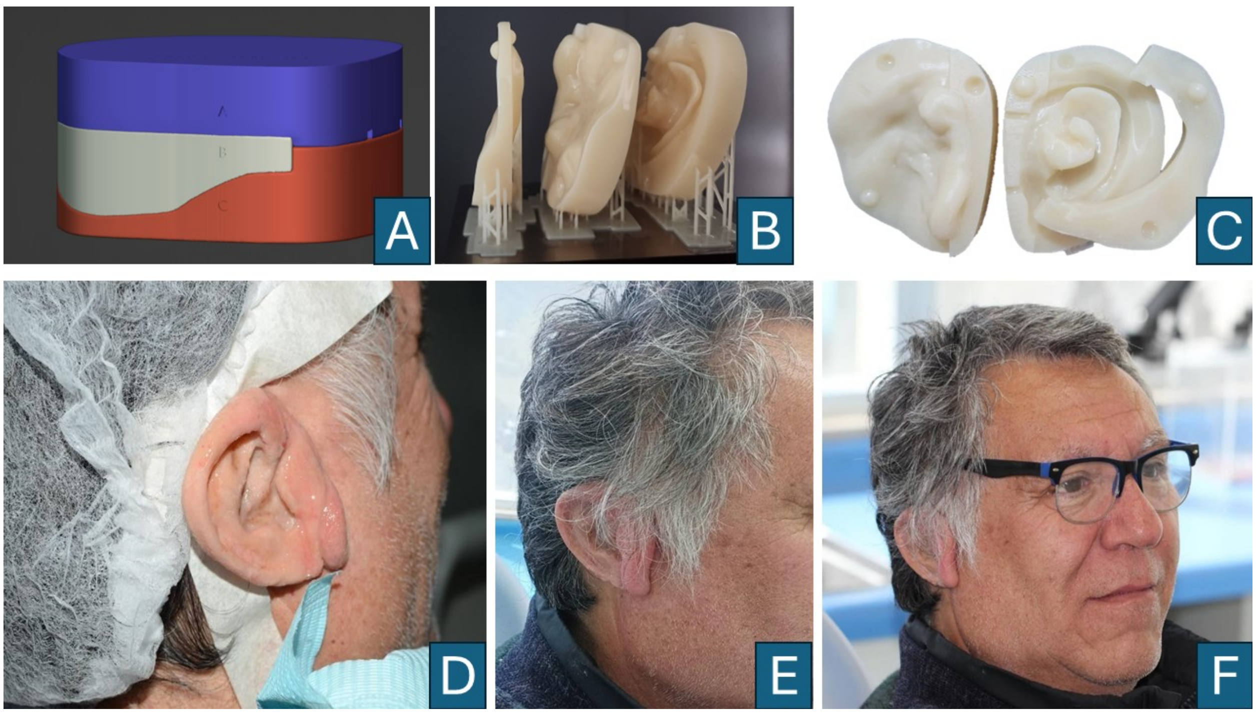

Fig. 3 - A) The sectional design of a flask is composed of three parts (closed muffle); B) Sectioned resin flask impressions prior to support removal and C) Post-processed flask; D) Extrinsic characterization of auricular prosthesis; E) and F) Completion Test of the Patient.

To enhance clarity in the clinical sequence, a timeline was constructed to summarize the key steps in the diagnostic and rehabilitative process. This overview facilitates the understanding of the digital workflow and patient management. The chronological details are presented in table 1.

Table 1 - Timeline of Clinical Events

Clinical Event	**Description**	**Approximate Timing**
Initial consultation	Patient evaluated at the Maxillofacial Prosthesis Clinic	Day 0
Extraoral examination and diagnosis	Microtia Type II, Hunter Grade III identified	Day 0
Patient consent and planning	Treatment options discussed and diagnostic prosthesis planned	Day 2
3D facial scanning	Digital capture of facial morphology	Week 1
Digital modeling and prosthesis design	CAD software used for modeling and adaptation	Week 2
3D printing and trial	Diagnostic prosthesis printed and tested on the patient	Week 3
Definitive prosthesis fabrication	Medical-grade silicone loaded into flask and finalized	Week 4
Final delivery and instructions	Prosthesis delivered and patient educated on care	Week 4

Ethical Considerations

The treatment described in this case was conducted in accordance with institutional clinical protocols and the ethical principles outlined in the Declaration of Helsinki.(18) No experimental interventions were performed, and all procedures adhered to professional and ethical standards for maxillofacial rehabilitation.

Discussion

Prosthetic rehabilitation in geriatric patients presents a significant challenge due to the need to balance functionality, aesthetics, and comfort.

The implementation of an adhesive auricular prosthesis enables patients to evaluate the functionality and aesthetics of the device prior to considering more invasive options, such as osseo integrated implants.

Traditionally, auricular prostheses have been manufactured using facial impression techniques and sculpted with thermoplastic materials on the resulting models-processes that are often lengthy and uncomfortable for patients. However, the introduction of digital technologies such as 3D scanners and computer-aided design (CAD) has revolutionized the field, offering a more precise and patient-friendly alternative to conventional manufacturing methods.

This case illustrates how a digital workflow built on traditional foundations can eliminate the need for conventional facial impressions, thereby reducing both clinical and laboratory time. Moreover, the use of a 3D scanner combined with modeling software such as Blender and Meshmixer enables the creation of a dermostatic model of the auricular region, offering greater consistency and precision in the final outcome.

The laboratory process can be further streamlined through digital design by directly 3D printing the flasking system used to fabricate the prosthesis. This typically involves casting wax-printed sculptures within sectioned plaster flasks using the lost-wax technique.

Additionally, the use of biocompatible materials and the ability to customize texture and color through analog finishing techniques ensure satisfactory prosthetic rehabilitation.

However, despite its many benefits, the digital workflow presents challenges such as a steep learning curve and the need for specialized equipment, which may limit its adoption among some clinicians. The dental and maxillofacial community must continue to explore and adopt these technologies to improve rehabilitation outcomes. Furthermore, the development of standardized clinical protocols can help optimize the integration of digital tools. Ultimately, both digital and analog workflows should be viewed as complementary.

The goal of the clinician is to combine the strengths of both approaches to achieve optimal and patient-centered results.

Conclusions

The presented case demonstrates the significant advantages of digital technology in the rehabilitation of geriatric patients with total or partial external auricular loss, showing that both digital and analog workflows are valuable tools to improve the accuracy, comfort, and aesthetics of clinical treatments.

The application of an adhesive retention system for diagnostic purposes allows for the assessment of patient acceptance prior to opting for more invasive solutions. Therefore, this digital workflow approach not only optimizes the clinical experience of geriatric patients but also offers an effective treatment model that could be established as a standard in routine practice.

This report highlights the feasibility and benefits of using an entirely digital workflow for auricular prosthetic rehabilitation in elderly patients. It demonstrates that digital tools can provide accurate, efficient, and patient-friendly alternatives to traditional techniques. Clinicians are encouraged to adopt similar approaches to enhance treatment outcomes and patient experience, particularly in cases involving complex anatomical challenges.

References

1. Liaw J, Patel V, Carr M. Congenital Anomalies of the External Ear. Oper Tech Otolaryngol-Head Neck Surg. 2017;28(2):72-6. DOI: https://doi.org/10.1016/j.otot.2017.03.012

2. Kelley P, Scholes M. Microtia and Congenital Aural Atresia. Otolaryngol Clin North Am. 2007;40(1):61-80. DOI: https://doi.org/ 10.1016/j.otc.2006.10.003

3. Tan T, Constantinides H, Mitchell T. The Preauricular Sinus: A Review of its Aetiology, Clinical Presentation and Management. Int J Pediatr Otorhinolaryngol. 2005;69(11):1469-74. DOI: https://doi:org/10.1016/j.ijporl.2005.07.008

4. Malick R, Sham M, Reddy T, Jacob P. Reconstruction of the External Ear Using Implant-Supported Alloplasts-Our Experience. Natl J Maxillofac Surg. 2023;14(3):499. DOI: https://doi.org/10.4103/njms.njms_160_22

5. Hamlet C, Harcourt D. Exploring the Experiences of Adults with Microtia: A Qualitative Study. Cleft Palate Craniofac J. 2020;57(10):1230. DOI: https://doi.org/10.1177/1055665620931611

6. Cobein M, Coto N, Crivello O, Lemos J, Vieira L, Pimentel M, *et al*. Retention Systems for Extraoral Maxillofacial Prosthetic Implants: A Critical Review. Br J Oral Maxillofac Surg. 2017;55(8):763-9. DOI: https://doi.org/10.1016/j.bjoms.2017.04.012

7. Diken A, Saglam S, Bulut A. Retention Systems Used in Maxillofacial Prostheses: A Review. Niger J Clin Pract. 2019;22(12):1629. DOI: https://doi.org/10.4103/njcp.njcp_92_19

8. Khan U, Dhawan P, Jain N. The Survival Rate of the Retention System for Extraoral Maxillofacial Prosthetic Implant: A Systematic Review. Cureus. 2024;16(10):e70705. DOI: https://doi.org/10.7759/cureus.70705

9. Zhang T, Bulstrode N, Chang K, Cho Y, Frenzel H, Jiang D, *et al*. International Consensus Recommendations on Microtia, Aural Atresia and Functional Ear Reconstruction. J Int Adv Otol. 2019;15(2):204-8. DOI: https://doi.org/ 10.5152/iao.2019.7383

10. Lewin S, Bishop R, Woerner J, Yates D. Three Techniques for Reconstruction of Congenital Microtia: Porous Implant Ear Reconstruction, Auricular Reconstruction Using Autologous Rib, and Osseo integrated Craniofacial Implants with Auricular Prosthesis. Atlas Oral Maxillofac Surg Clin. 2022;30(1):113-28. DOI: https://doi.org/10.1016/j.cxom.2021.11.009

11. Heydenrych A, van der Walt J, van den Heever H. Auricular Prosthesis Positioning Using Virtual Planning in Combination with Additive Manufacturing. J Stomatol Oral Maxillofac Surg. 2023;124(1):101258. DOI: https://doi.org/ 10.1016/j.jormas.2022.08.001

12. Suresh N, Janakiram C, Nayar S, Krishnapriya V, Mathew A. Effectiveness of Digital Data Acquisition Technologies in The Fabrication of Maxillofacial Prostheses-A Systematic Review. J Oral Biol Craniofacial Res. 2021;12(1):208. DOI: https://doi.org/10.1016/j.jobcr.2021.12.004

13. Unkovskiy A, Spintzyk S, Brom J, Huettig F, Keutel C. Direct 3D Printing of Silicone Facial Prostheses: a Preliminary Experience in Digital Workflow. J Prosthet Dent. 2018;120(2):303-8. DOI: https://doi.org/10.1016/j.prosdent.2017.11.007

14. Salazar-Gamarra R, Cárdenas-Bocanegra A, Masch U, Moraes C, Seelaus R, Silva J, *et al.* Color Translation from Monoscopic Photogrammetry +ID Methodology into a Polyjet Final 3D Printed Facial Prosthesis. F1000Research. 2022;11:582. DOI: https://doi.org/10.12688/f1000research.111196.1

15. Salazar-Gamarra R, Binasco S, Seelaus R, Dib L. Present and Future of Extraoral Maxillofacial Prosthodontics: Cancer Rehabilitation. Front Oral Health. 2022;3:1003430. DOI: https://doi.org/10.3389/froh.2022.1003430

16. Cardoso R, Montgomery P, Kiat-Amnuay S. Extraoral Maxillofacial Prosthetic Materials: Results of the 2020 International Survey. Int J Prosthodont. 2023;36(5):570-80. DOI: https://doi.org/10.11607/ijp.7970

17. Bruns N. Blender. Universelle 3D-Bearbeitungs- und Animationssoftware. Die Unfallchirurgie. 2020;123(9):747-50. DOI: https://doi.org/10.1007/s00113-020-00836-0

18. Asociación Médica Mundial. Declaración de Helsinki de la AMM; 2000 [acceso 20/12/2024]. Disponible en: https://www.wma.net/es/policies-post/declaracion-de-helsinki-de-la-amm-principios-eticos-para-las-investigaciones-medicas-en-seres-humanos/

Conflict of interests

Authors declared no conflict of interests.

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