



Conventional vs. 3D-printed complete dentures in an irradiated edentulous patient: a case report with clinical comparison

Alessandra-Aniela Cerghedi¹, Manuela Chibelea², Mariana Pacurar², Melinda Szekely¹, Cristina-Stanca Molnar-Varlam¹

1) Department of Tooth Morphology and Dental Arches and Technology of Dental Prosthesis and Dental Materials, Faculty of Dental Medicine, George Emil Palade University of Medicine, Pharmacy, Science and Technology, Târgu Mureș, Romania

2) Orthodontic Department, Faculty of Dental Medicine, George Emil Palade University of Medicine, Pharmacy, Science and Technology of Târgu Mureș, Târgu Mureș, Romania

Abstract

Background and aims. In recent years, digital workflows for the fabrication of complete dentures have been developed, enabling patients to benefit from reduced chairside time, fewer clinical sessions, and improved comfort compared to conventional techniques. Additive manufacturing through 3D printing has emerged as a viable alternative to heat-cured acrylics, offering enhanced adaptation, esthetics, and clinical efficiency. The objective of this clinical case report is to compare two pairs of newly fabricated complete dentures: one produced through a conventional manufacturing process and the other through additive manufacturing (3D printing). The comparison focused on denture retention and peripheral seal, manufacturing time, and esthetic outcomes.

Case presentation. A fully edentulous male patient with a history of head and neck cancer presented for prosthetic rehabilitation. Clinical challenges included advanced mandibular ridge atrophy, post-radiotherapy hyposalivation, and recurrent prosthetic stomatitis. The existing prosthesis was repurposed as an individual tray, and functional impressions were recorded using a closed-mouth technique with addition-cured silicone material. Two sets of dentures were fabricated: a pair of conventional heat-cured acrylic dentures and a pair of digitally designed and 3D-printed dentures (maxillary and mandibular). A comparative evaluation was performed focusing on clinical adaptation, retention, esthetics, and fabrication efficiency.

The digitally produced complete dentures fabricated by 3D printing demonstrated comparable fit, retention, and suction to those achieved with conventional heat-cured acrylic dentures. Despite the patient's advanced mandibular ridge atrophy and hyposalivation, both sets of dentures provided functional adaptation and adequate stability. However, the additive manufacturing process offered less fabrication time and required fewer clinical visits. Esthetically, the printed dentures were rated as satisfactory by both the patient and the clinician, matching the outcome of the conventional pair.

Conclusions. These findings suggest that the digital workflow of complete dentures might be considered a promising alternative for prosthetic rehabilitation, particularly in medically complex geriatric patients. Further clinical studies are warranted to confirm long-term outcomes.

Keywords: complete dentures, 3D printing, prostheses, head and neck neoplasms

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Address for correspondence:
Cristina-Stanca Molnar-Varlam
cristina.stanca@gmail.com

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Introduction

Digitally fabricated complete dentures via 3D printing represent a modern approach in prosthodontics, combining advanced technologies to achieve high precision and individual customization. The workflow typically involves digital impression acquisition, virtual design, additive manufacturing, post-processing, and clinical adjustments. Key benefits include improved accuracy, reduced chairside time, and superior esthetics [1]. According to the Glossary of Prosthodontic Terms, complete dentures produced through digital workflows rely on CAD/CAM technologies, implemented either through subtractive milling or additive 3D printing. While milling is well established, it is associated with higher costs and considerable material waste, raising environmental concerns. By contrast, additive manufacturing offers reduced waste, lower production costs, and greater reproducibility, making 3D printing an increasingly attractive and sustainable alternative [2]. While advances in prosthodontics provide new opportunities, their clinical relevance is especially pronounced in populations affected by head and neck cancer (HNC). Globally, more than 800,000 new cases of HNC are diagnosed annually, resulting in approximately 400,000 deaths [3,4]. Incidence shows regional variation, with higher prevalence in low- and middle-income settings and projections indicate a steady increase in the coming decades [4,5].

Radiotherapy, a cornerstone in HNC treatment, is frequently associated with long-term oral complications. Among these, salivary gland hypofunction is one of the most debilitating, leading to xerostomia, altered pH, and increased susceptibility to caries and infections [6–8]. Simultaneously, irradiation induces progressive mandibular and maxillary atrophy through mechanisms of hypovascularity, hypoxia, and impaired remodeling [9]. These changes compromise denture retention and stability, while also heightening the risk of osteoradionecrosis [10]. As a result, prosthodontic rehabilitation of irradiated patients requires careful planning, preventive dental care, and the integration of digital workflows to improve adaptation in severely resorbed ridges [8,11].

Case presentation

Patient history

An 80-year-old male presented in August 2015 to the emergency department with acute dyspnea, dysphagia, and cervical pain. Clinical examination revealed nasopharyngeal mucosal thickening and lymph node enlargement, and histopathological analysis confirmed squamous cell carcinoma. The patient's medical history was notable for long-term tobacco and alcohol use, both recognized risk factors for orolaryngeal malignancies. Following tumor resection, he underwent tracheotomy and received the maximum prescribed dose of radiotherapy, which led to severe xerostomia secondary to radiation-

induced salivary gland atrophy. The patient had been a complete denture wearer for more than 20 years and had reported no difficulties with denture retention or suction before oncologic treatment, considering the prosthesis fully integrated into daily life. After radiotherapy, however, he developed progressive problems with denture adhesion and stability, mainly due to xerostomia and advanced alveolar ridge resorption, which severely compromised prosthetic fit and functional retention.

During follow-up, in 2025, the patient presented new symptoms, including persistent pain, dysphagia, and swelling of the posterior tongue. Examination revealed a large tumoral lesion on the right lateral border of the tongue, extending into the ipsilateral floor of the mouth and covered by whitish deposits consistent with secondary infection. The lesion was associated with severe radiating pain in the right hemicranium, causing significant functional impairment. Imaging and histopathological evaluation confirmed a recurrent squamous cell carcinoma of the tongue, representing a secondary malignant process in the setting of prior oropharyngeal cancer and longstanding exposure to risk factors (tobacco and alcohol use).

The study was conducted at the Faculty of Dental Medicine of the George Emil Palade University of Medicine, Pharmacy, Science and Technology, Târgu Mureș, Romania. It was approved by the Ethics Committee for Scientific Research of the university (Approval No. 3356/01.10.2024). Written informed consent was obtained from the patient before prosthetic rehabilitation.

Clinical intervention for conventional denture

The main challenge in this case was severe mandibular ridge atrophy, approaching a negative ridge morphology, compounded by xerostomia following oncologic treatment. The treatment plan was structured in two stages: first, fabrication of a conventional complete denture, followed by using this prosthesis as a reference for producing a digital denture.

The conventional denture, fabricated from heat-cured acrylic resin (Meliodent Heat Cure, Kulzer), was completed through a four-session clinical workflow. At the first clinical appointment, the patient's existing prosthesis, demonstrating optimal anatomical adaptation, was utilized as a custom impression tray. The purpose was to obtain a high-fidelity impression with maximal peripheral seal and suction, achieved using a polyvinyl siloxane impression system (Virtual, Ivoclar Vivadent) applied in a three-step protocol. In the first stage, a heavy-body silicone material was used to record vestibular depth and the functional dynamics of the peripheral soft tissues. In the second stage, a light-body silicone was applied to capture the overall morphology of the prosthetic field. Finally, an extra-light silicone wash was used to enhance surface detail reproduction and optimize adaptation of

the impression. Following the acquisition of the final functional impressions, intermaxillary relationships were initially recorded using wax occlusion rims, allowing re-establishment of the vertical dimension of occlusion (VDO), which had been diminished due to wear of the previous prosthesis. The intermaxillary relationship was further refined using a Centric Tray system to ensure accurate positioning of the mandible in centric relation. At the third clinical session, corresponding to the try-in stage, the wax try-in denture was evaluated, including verification of the vertical dimension of occlusion, occlusal relationships, and occlusal balance. Adjustments were performed as necessary to achieve optimal functional occlusion and patient comfort. (Figure 5)

The definitive prosthesis was delivered at the fourth session. After one week of use, the patient returned for minor adjustments due to overextension in the first quadrant. A localized traumatic mucosal lesion was identified, and the corresponding pressure area was marked using methylene blue. The affected region was selectively relieved to eliminate the source of irritation.

Additionally, a topical gel containing borax in glycerin, a local anesthetic, and a corticosteroid was prescribed, along with chlorhexidine mouth rinses, to promote mucosal healing and reduce inflammation.

Clinical intervention for digital denture

Following the adaptation period, the second treatment stage was initiated for the fabrication of digital denture. The digitally manufactured denture required only three clinical sessions, thereby reducing patient discomfort and treatment time. At the first appointment, a closed-mouth impression technique was performed using a polyvinyl siloxane system (Virtual, Ivoclar Vivadent) of varying consistencies in a three-step protocol, replicating the conventional approach. Following functional impression of the maxillary and mandibular prosthetic fields, the impressions were stabilized on the supporting tissues using the inherent properties of the impression material. Due to the excellent suction and adaptation achieved, the impression material was partially displaced in several areas, allowing direct visualization of the underlying prosthesis. This finding indicated intimate contact between the denture base and the supporting tissues.

An interocclusal registration material (Virtual CADbite, Ivoclar Vivadent) was then applied, and the patient was instructed to close into the established occlusion and maintain this position until complete setting of the material. After polymerization, the entire assembly was removed as a single unit, preserving all relevant anatomical and functional details. This approach allowed simultaneous recording of the maxillary and mandibular functional impressions, the vertical dimension of occlusion, and the intermaxillary relationship, facilitated

by the use of the newly fabricated prosthesis, which had already restored the correct vertical dimension and to which the patient was functionally adapted.

Using the patient's well-adapted prostheses as reference, a complete digital scan of the complex was carried out, capturing the vertical dimension of occlusion, maxillary and mandibular prosthetic fields, the midline, canine line, occlusal plane, and all parameters required for computer-aided design (CAD).

Dental laboratory

The impressions and intermaxillary relationship records were subsequently digitized using a laboratory optical scanner, allowing accurate transfer of clinical data into the digital workflow. The prosthesis was digitized using a laboratory optical scanner (Medit T510, Medit Corp., South Korea), based on structured light technology, ensuring precise acquisition of the prosthetic geometry and facilitating accurate digital superimposition with the original CAD design. The STL files generated in Exocad DentalCAD were processed using v3.1-8349/64 software version, where printing parameters such as exposure time, layer thickness, and support structures were defined in accordance with the manufacturer's recommendations. All printing parameters were standardized to ensure reproducibility of the manufacturing process.

In Exocad, specific anatomical landmarks were identified and traced, including the terminal portion of the first palatal rugae (Figure 1), the incisive papilla, maxillary tuberosities, the crest midline (Figure 2), and the retromolar trigone. Based on these reference points, anatomic artificial teeth were selected, allowing inclusion of the second molar in the arch. Tooth arrangement was digitally aligned with the crest midline, guided by the established landmarks (Figure 3). In the final stage, the gingival morphology was virtually modeled, incorporating a stippling pattern to simulate the natural appearance of attached gingiva (Figure 4).

Try-in procedure

To verify the accuracy of the interocclusal relationship, a clinical try-in stage was performed using a prototype denture fabricated from transparent 3D-printed resin, with the artificial teeth printed separately and subsequently bonded to the base. This approach enabled precise clinical validation of occlusion, vertical dimension of occlusion, and esthetic parameters, thereby minimizing the risk of occlusal discrepancies in the final prosthesis. During the try-in stage, the vertical dimension of occlusion, tooth arrangement, and occlusal relationships were clinically verified and refined where necessary. Phonetic assessment was also performed to ensure proper pronunciation and functional integration of the prosthesis. Occlusal contacts were assessed using articulation papers of varying thicknesses (100 μ m, 40 μ m, and 8 μ m) to allow progressive occlusal adjustment and fine-tuning.

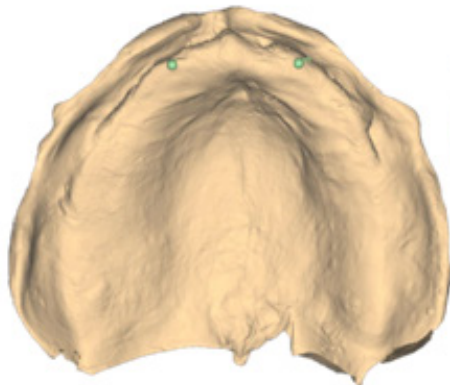


Figure 1- Maxillary model analysis

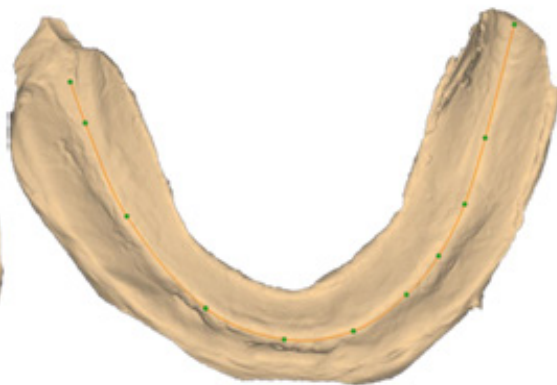


Figure 2- Marking the mandibular alveolar ridge

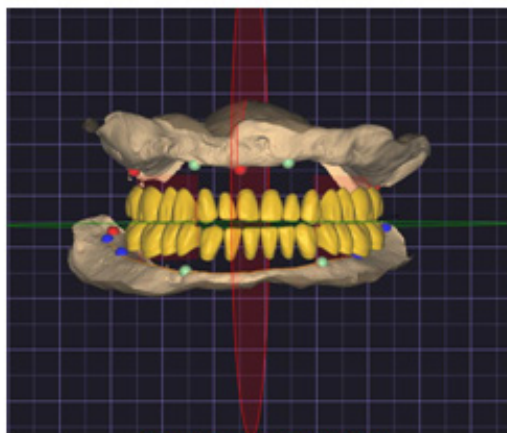


Figure 3 - Teeth design



Figure 4- Final design for maxillary complete denture



Figure 5- The conventional wax try-in served as a clinical reference for validating occlusion and esthetic parameters

The digital try-in denture was fabricated using a transparent photopolymer resin, specifically designed for additive manufacturing using DLP/LCD technologies. The material exhibits high optical transparency, allowing visualization of tissue adaptation and identification of pressure areas during clinical evaluation. The printing process was performed with a layer thickness of approximately 50 μm , ensuring adequate surface resolution and dimensional accuracy. Following fabrication, the prosthesis underwent a standardized post-processing protocol, including cleaning in isopropyl alcohol to remove residual uncured resin, followed by post-polymerization in a UV curing unit according to the manufacturer's recommendations.

The material is classified as a Class I biocompatible medical device and complies with the requirements of ISO 20795-1, ensuring its suitability for intraoral use in temporary applications. Reported mechanical properties include a flexural strength in the range of approximately 50–65 MPa and a modulus of elasticity between 1500–2000 MPa, which are sufficient for short-term clinical evaluation while allowing easy adjustment and modification during the try-in stage.

Following the try-in stage, minor occlusal adjustments were required in the right posterior region, consisting of selective grinding to achieve optimal contact distribution. The prosthesis was subsequently returned to the laboratory, where it was scanned and digitally superimposed onto the original design, allowing precise incorporation of the required corrections into the final prosthesis.

Additive manufacturing (3D printing)

The digital complete denture was fabricated using a desktop 3D printer (Elegoo Mars 4 Max, Elegoo, China) with a photopolymer resin specifically designed for denture bases (NextDent Denture 3D+, Vertex-Dental, the Netherlands). The material is classified as a Class II biocompatible medical device according to ISO 20795-1 standards, with properties suitable for long-term intraoral use. Manufacturer specifications report a flexural strength of approximately 65–75 MPa and a modulus of elasticity of 2000–2500 MPa, ensuring adequate mechanical performance for clinical application. After printing, the denture bases were subjected to a standardized post-processing protocol. Excess, non-polymerized resin was removed using a dedicated cleaning station with isopropyl alcohol rinsing, followed by secondary polymerization in a UV curing unit (Anycubic Wash & Cure, Anycubic, China) according to the manufacturer's instructions. This dual process ensured complete polymerization of the resin, reduction of residual monomers, and optimal mechanical and biocompatibility properties of the 3D-printed prosthesis.

The denture bases were fabricated using additive manufacturing, while the artificial teeth were 3D printed

separately and subsequently bonded to the printed base, rather than produced as a monolithic structure. The bonding procedure was performed using the same photopolymer resin system to ensure optimal chemical compatibility and adhesion between components. The printing process was carried out using a layer thickness of 50 μm , ensuring an optimal balance between surface resolution and mechanical properties.

Discussion

This case illustrates the complex interplay between oncologic history, prosthetic rehabilitation, and long-term oral health outcomes in an elderly patient. Radiotherapy for head and neck cancer is well documented to induce xerostomia, salivary gland atrophy, mucosal changes, and compromised vascularity, all of which predispose patients to oral dysfunction, mucosal irritation, and difficulties with prosthesis retention and comfort [6,10,12]. In this patient, the absence of prosthetic problems before radiotherapy underscores the critical role of salivary flow and ridge anatomy in denture stability. Following irradiation, severe xerostomia and alveolar ridge resorption resulted in loss of suction and adhesion, making conventional prostheses unstable and uncomfortable.

Ten years post-treatment, the recurrence of a large tumoral lesion of the tongue, accompanied by secondary infection, reflects the persistent oncologic risk associated with tobacco and alcohol use, as well as the long-term sequelae of radiotherapy. Clinically, this progression highlights the importance of continuous monitoring of cancer survivors, particularly those with risk factors and extensive oral rehabilitation needs. From a prosthodontic perspective, such patients represent a high-risk group in whom digital denture fabrication techniques (CAD/CAM milling and 3D printing) may provide advantages, including improved fit, reduced chairside adjustments, and shorter treatment times [11,13,14]. However, the recurrence of malignant disease and the associated functional impairments must be considered as limiting factors for prosthetic success and patient quality of life. Recent reports have highlighted the feasibility of digital workflows in the rehabilitation of elderly edentulous patients [15]. Gomes et al. (2024) described the successful use of 3D-printed CAD/CAM complete dentures in a 90-year-old patient, emphasizing advantages such as faster production, fewer clinical sessions, reduced material waste, and lower costs [15,16]. While subtractive milling offers superior mechanical strength and color stability, additive 3D printing provides comparable clinical outcomes with the added benefits of efficiency and affordability [16,17]. Nevertheless, potential drawbacks of printing, including deformation during removal from the platform, monochromatic esthetic limitations, and the need for thorough cleaning of unpolymerized resin layers, were also noted [15,17]. These findings align with the present case,

where a digitally fabricated prosthesis offered satisfactory retention and comfort, reinforcing the clinical potential of 3D-printed dentures as an alternative to conventional approaches in medically complex geriatric patients [16].

From a technical perspective, additive manufacturing presents certain drawbacks compared to subtractive CAD/CAM milling. The layer-by-layer fabrication process may result in anisotropic mechanical properties and lower material homogeneity, potentially affecting long-term durability. Furthermore, aesthetic limitations and the need for post-processing procedures remain important considerations. In contrast, milled dentures generally demonstrate superior mechanical strength, accuracy, and color stability, although at the expense of higher cost and material waste [17,18].

Current literature supports the clinical feasibility of digital dentures; however, evidence remains limited and heterogeneous. While some studies report satisfactory retention and reduced clinical time, systematic reviews emphasize the lack of long-term data and standardized evaluation protocols [16,19,20]. Moreover, many reported workflows rely on hybrid approaches that incorporate conventional clinical steps, particularly for impression accuracy and intermaxillary relationship recording [21].

This case underscores not only the therapeutic potential of digital dentures in medically complex geriatric patients, but it also highlights the critical importance of an interdisciplinary approach involving prosthodontists, oncologists, and maxillofacial surgeons. Such collaboration is essential to ensure comprehensive care, addressing both functional and esthetic rehabilitation needs, as well as the oncologic safety and long-term oral health of the patient.

Clinical implications

This case suggests that digitally fabricated complete dentures may be used as an adjunct to conventional techniques in irradiated edentulous patients presenting with severe ridge atrophy and xerostomia. In this patient, the digital workflow was associated with reduced clinical visits and improved treatment efficiency. However, these observations are limited to a single clinical case and should be interpreted with caution. Careful case selection, atraumatic prosthetic design, and close follow-up remain essential due to the increased risk of mucosal trauma and osteoradionecrosis in this patient population.

The patient was followed for a period of 12 months after insertion of the final prosthesis. During the first week, minor adjustments were required to relieve pressure areas, resulting in the resolution of localized mucosal ulcerations. At the one-month follow-up, the patient demonstrated complete functional adaptation to the prosthesis, with no mucosal lesions or functional complaints reported. Follow-up evaluations at 3, 6, and 12 months showed stable clinical outcomes, with no need for further adjustments or signs of complications.

Research implications

Given the limitations inherent to a single-case report, further well-designed randomized controlled trials with larger sample sizes are necessary to evaluate the long-term performance, durability, and biological safety of 3D-printed complete dentures, particularly in medically compromised patients. Future research should incorporate standardized and objective outcome measures, including quantitative assessment of retention, stability, masticatory efficiency, and mucosal response, alongside patient-reported outcomes and extended follow-up periods. Such studies are required to clarify the clinical reliability of digital denture workflows and their role in complex patient populations.

Limitations

Despite the advantages of digital workflows, several limitations must be considered, particularly in irradiated patients. Radiation-induced mucosal fragility and reduced salivary lubrication increase the susceptibility to mucosal injury and prosthesis intolerance. In such cases, even minor inaccuracies in denture base adaptation or pressure distribution may lead to ulceration and discomfort. Furthermore, the risk of osteoradionecrosis (ORN) remains a significant concern in patients with a history of radiotherapy. Mechanical trauma from ill-fitting dentures or excessive localized pressure may act as a triggering factor. Therefore, careful occlusal adjustment, regular follow-up, and atraumatic prosthetic design are essential in this patient population.

From a technical perspective, additive manufacturing presents certain drawbacks compared to subtractive CAD/CAM milling. These include lower material homogeneity, potential anisotropy due to layer-by-layer fabrication, and limitations in esthetic characterization, particularly in monolithic printed prostheses [18]. However, a systematic review by Alotaibi HN concluded that current evidence comparing 3D-printed and conventional dentures remains inconclusive, particularly regarding patient satisfaction and long-term outcomes. In contrast, milled dentures generally exhibit superior mechanical strength and color stability, although at a higher cost and material waste [20].

Recent literature supports the growing use of digital workflows in complete denture fabrication, although evidence remains limited. Gomes et al. reported favorable clinical adaptation and patient acceptance using a hybrid digital-conventional approach [15,21,22]. Similarly, Garcia demonstrated that digital techniques allow objective evaluation of denture retention, offering a potential advantage in cases with compromised anatomy [23]. These findings suggest that while digital dentures represent a promising alternative, their success remains dependent on clinical factors, especially in complex cases such as irradiated patients with xerostomia and severe ridge resorption [24].

This report has a few important drawbacks. First,

because it focuses on a single patient and does not include a comparison group or random assignment, the findings cannot be generalized to a larger group of edentulous patients. Second, both the digital and traditional methods were done by the same dentist and dental laboratory, and their experience might have affected the results, likely benefiting the method they know best. Also, the digital method described uses certain tools and materials, meaning the results cannot just be assumed to work the same way with different systems. The comfort and satisfaction of the patient were mostly measured by personal opinions, and since the follow-up period was relatively short, we cannot really tell how long the dentures will last. These points show that we need more controlled studies, including a larger number of patients and longer monitoring, to truly understand the pros and cons of dentures made digitally compared to those made the traditional way.

Originality of the case

The originality of this case lies in the application of a hybrid digital–conventional workflow for complete denture fabrication in a medically complex patient with a history of head and neck radiotherapy, severe ridge atrophy, and xerostomia. While digital dentures have been increasingly reported in the literature, their use in irradiated patients remains limited and insufficiently documented. In this case, the integration of a clinically validated conventional prosthesis as a reference for digital design, combined with a transparent 3D-printed try-in stage and subsequent digital correction, represents a pragmatic and reproducible approach. This workflow allowed precise control of occlusion and tissue adaptation in a high-risk patient, highlighting a clinically applicable strategy in situations where fully digital protocols may be insufficient.

Conclusions

Within the limitations of this single clinical case, digitally fabricated complete dentures using additive manufacturing demonstrated satisfactory clinical performance in terms of retention, stability, and patient comfort. However, these findings are based on short-term clinical observation and should not be generalized. The successful outcome was strongly dependent on the conventional workflow, particularly for impression accuracy and intermaxillary relationship recording.

Digital dentures may represent a useful adjunct in the rehabilitation of medically complex and geriatric patients by reducing clinical time and improving workflow efficiency. Nevertheless, further controlled clinical studies with long-term follow-up are required to validate their functional durability and biological compatibility, especially in irradiated patients.

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