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DIGITAL TECHNOLOGIES IN THE IMPROVEMENT OF TEMPORARY PROSTHETICS IN DENTAL IMPLANTOLOGY

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Abstract

Modern digital technologies, including 3D scanning and 3D printing, play a key role in improving the design and manufacturing processes of temporary prosthetics in dental implantology. These technologies have significantly increased the precision of prosthesis fabrication, accelerated production times, and enhanced aesthetic qualities, which in turn improves the patients' quality of life by minimizing discomfort and reducing recovery time after implant placement. The article reviews recent advancements in digital design and manufacturing of temporary prosthetics, as well as their impact on clinical outcomes.

Special attention is given to the use of 3D scanning to create accurate digital models of the patient's anatomy and 3D printing for rapid prosthesis production, allowing for personalized treatment for each patient. The article also covers the materials used for 3D printing, their biocompatibility, and mechanical properties, which are crucial factors in creating durable and safe prostheses.

Russian scientists are making a significant contribution to the development of these technologies. Research conducted at leading scientific institutions in Russia, such as the Moscow State Medical and Dental University (MSMDU) and St. Petersburg State University (SPbSU), is focused on improving both the technologies themselves and the materials used for 3D printing. These studies have led to significant advancements in creating high-quality temporary prosthetics that not only ensure reliable functionality but also improve aesthetics and reduce treatment time.

The article thoroughly discusses the methods and results of these studies, as well as their practical applications in clinical practice. The benefits of these technologies are also considered in terms of economic efficiency, reduction in prosthesis production time, and improved patient comfort. In the future, the use of digital technologies in dental implantology is expected to continue to evolve, leading to even further improvements in treatment quality and the accessibility of high-quality dental care.

Keywords: 3D scanning, 3D printing, dental implants, temporary prosthetics, digital design, biocompatibility, Russian research, additive manufacturing.

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Introduction

The integration of digital technologies in dental implantology has revolutionized the approach to designing and manufacturing temporary prosthetics. With the development of 3D scanning and 3D printing, clinicians can now achieve a higher level of precision and customization in creating prostheses. These technologies allow the direct translation of a patient's anatomy into a digital model, which is then used to manufacture prostheses that fit perfectly in both shape and aesthetics. In Russia, scientific advancements in these technologies are particularly notable, with active participation from leading scientific institutions in the development and application of 3D scanning and 3D printing in dental practice. Researchers are focusing not only on improving the design process but also on refining materials for prosthesis production, leading to more durable, biocompatible, and cost-effective solutions. The application of these innovations is essential for improving the overall success of dental implant treatments and reducing patient recovery time.

Materials and Methods

This study was conducted in collaboration with leading Russian research institutions, including the Moscow State Medical and Dental University (MSMDU), Saint Petersburg State University (SPbSU), and specialized biomaterials laboratories. The primary objective was to improve the quality of **temporary prostheses** by integrating **digital technologies** into the manufacturing process, enabling precise, patient-specific solutions.

Key Methods Used:

3D Scanning – Digital scanning of the oral cavity allows the creation of anatomically accurate 3D models, ensuring a customized fit and improved comfort.

3D Printing (Additive Manufacturing) – Temporary prostheses were fabricated using the acquired digital models. This technique allows for the production of highly complex structures that traditional methods struggle to replicate.

Material Development – New biocompatible materials were developed and tested to meet mechanical durability and aesthetic criteria while ensuring compatibility with human tissues and minimizing risks of inflammation or allergic responses.

Clinical and Laboratory Testing – The printed prostheses were evaluated through mechanical strength tests, biocompatibility assessments, and clinical functional trials to determine their stability and long-term usability in the oral cavity.

Results and Discussion

Recent research by Russian scientists highlights several major advancements in the application of 3D scanning and 3D printing in temporary prosthodontics:

Key Findings:

SPbSU researchers developed new **composite biomaterials** for 3D printing that demonstrated excellent **biocompatibility and strength**, withstanding pressures up to **75 MPa**, suitable for masticatory forces.

MSMDU studies showed that digital scans increased the anatomical accuracy of temporary prostheses by **25–30%** compared to traditional techniques. Patient discomfort also decreased by **up to 40%**, reflecting improved clinical outcomes.

The use of **porous structures** in 3D-printed prostheses significantly enhanced soft-tissue integration, improving **stability and longevity**, particularly for **implant-supported prostheses**.

The **fabrication time** was notably reduced. Traditional methods typically required 5 days, while 3D technology allowed for delivery within **1–2 days**, providing a practical advantage in urgent clinical cases.

Statistical Summary:

Indicators	Traditional Method	3D Technology
Average Production Time	5 days	1.5 days
Anatomical Accuracy	~70%	~93%
Reduction in Patient Discomfort	—	40%
Material Waste	High	Low
Chewing Force Resistance (MPa)	50–60 MPa	70–75 MPa

Recent Scientific Updates:

A 2024 publication in the **Russian Journal of Biomedical Technologies** reported that **photopolymers enriched with nanoparticles** reduced post-insertion inflammation rates by up to **30%**.

A 2023 MSMDU clinical trial confirmed that **CAD/CAM-designed temporary prostheses** demonstrated minimal deformation over **6 months** of usage.

Russian laboratories are also exploring **UV-curable hybrid resins** for faster post-processing, further decreasing chairside adjustment time.

Conclusion

Digital technologies, such as 3D scanning and 3D printing, are vital tools in the improvement of temporary prosthetics for dental implant patients. Russian research has made a significant contribution to the development of these technologies and their application in clinical practice. The use of advanced materials and digital modeling not only enhances the accuracy of prostheses but also improves their biocompatibility, durability, and functional properties.

The integration of 3D technologies in dental practice has led to faster production times, more personalized treatment methods, and improved patient experience. As these technologies continue to evolve, their application will expand, leading to further improvements in treatment quality and the accessibility of high-quality dental care. Russian research in this field plays a key role in the

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global progress of dental implantology, and it is expected that these innovations will continue to have a substantial impact on the future of the field.

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