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Original Article

Exploring the Potential Applications of Augmented Reality in Modern Dentistry

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ABSTRACT

This study aimed to test in practice the approach created for preparing and carrying out surgical procedures on the craniofacial region using the evaluated enhanced reality technology. Utilizing augmented reality glasses and the HoloDoctor program, a novel method of simulating implantological therapies in the maxillofacial region demonstrated a capacity to visualize the anatomical features of the implant placement area, allow the surgeon to thoroughly examine the intervention area before the procedure, and perform surgery under the conditions of the patient's actual anatomy. For example, the use of augmented reality directions allows us to practice operating on a virtual patient using phantom dummies (created using 3D printing) that are linked to holography in real time. It was done using computed jawbone tomography. After obtaining the lower jaw and antagonist impressions, plaster models were created using the impressions, which were then scanned. A 3D reconstruction of the jaw picture was done, a template was created, and implants were digitally placed with the aid of the planning application. 3D scanners are used for printing the template and the jaw model. The implants were placed into the plastic model following the template and the established procedure.

Keywords: 3D Scanner, Simulation system, Augmented reality glasses, Robotic-assisted surgery

Introduction

One pressing issue in contemporary dentistry is the restoration of maxillofacial deformities [1-4]. The clinical picture can be highly varied, ranging from a deficiency in a single tooth to major deficiencies encompassing many anatomical formations of the maxillofacial and surrounding areas due to the various factors that contribute to the decline of both soft and hard tissues in this region [5-8].

We can do away with the necessity for human work and computations and drawings thanks to 3D technology. We can view the model from every perspective on the screen thanks to modern software, and we can fix any issues that are found during the model's development and prototyping [9-15] rather than during the creation process like manual manufacturing [16, 17]. However, the potential for intrinsic faults in physical labor is almost eliminated. The devices are equipped with state-of-the-art software for processing images acquired during cone-beam CT and

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MRI procedures. There are situations when the capabilities of these systems are insufficient to carry out more intricate tasks using the data acquired, such as distinguishing between tumors in different illnesses [18-20].
Our earlier research [2, 21-32] demonstrated the primary drawbacks in this regard:

1. Insufficient knowledge of the integration of simulated and reconstructions on a patient in real-time using AR technology and augmented reality holographic glasses.
2. Absence of initiatives in dentistry for planning therapy and outcome monitoring according to objective metrics

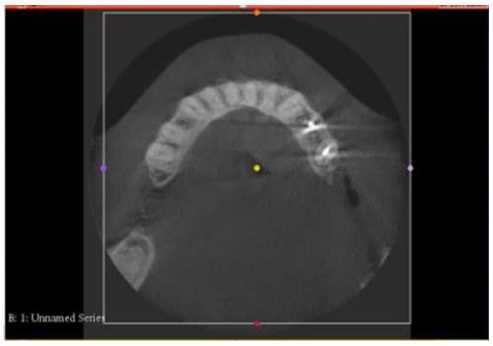
The development of a new type of surgical intervention planning and navigation simulation system is linked to the result. This effort aimed to test in practice the approach created for preparing and carrying out surgical procedures on the craniofacial region using the evaluated enhanced reality technology.

Materials and Methods

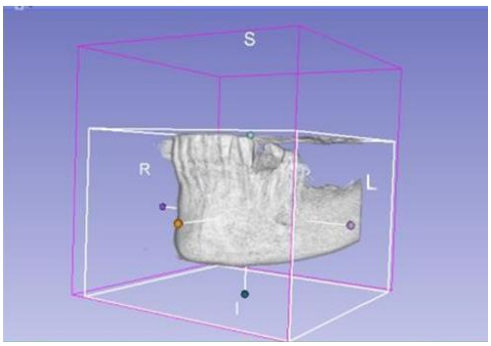
To achieve this purpose, we developed an additional functional module for dentistry using augmented reality glasses. The module can help with the practice of operations on a virtual patient using phantom dummies (made using 3D printing) that are linked to holography in real time. This technology in response to the actions of interns, not only shows the physiological parameters of the patient that are automatically changed, but also intraoperative, endosurgical, angiographic, and ultrasound images.
For this simulation technique, the PAX-i3D cone-beam computed tomography (CBCT) device with a FOV 10X8.5 (12X9) sensor and Ez3D-I software. The Avantis 3D implant treatment planning program, the 3Dison Multi 3D printer, and an out-of-mouth 3D scanner were used. For the diagnosis, specialized programs have been used that process the data of CBCT, allowing the diagnosis and subsequent planning of the operation. The planning system is based on computer data processing and the provision of information on the planning of the operation consists of the assessment of the state of the size and quality of bone tissue and the selection of a place for the installation of implants. This takes into account the location of the real teeth, the maxillary sinus, and the maxillary nerves.
The module for glasses developed by us is controlled by gestures, i.e. the medical specialist can point to the desired organ or instrument (tooth, surgical template), and remove it from the illustration. The software module interacts with the surgical dummy, using previously taken medical data from CT, and MRI.
The simulator module allows the surgeon to make notes in the virtual treatment plan before the operation begins. The resulting image is transmitted to the augmented reality glasses (HoloLens).
The developed method was tested based on the Dolgalev Dental Clinic (Stavropol, Russia).

Results and Discussion

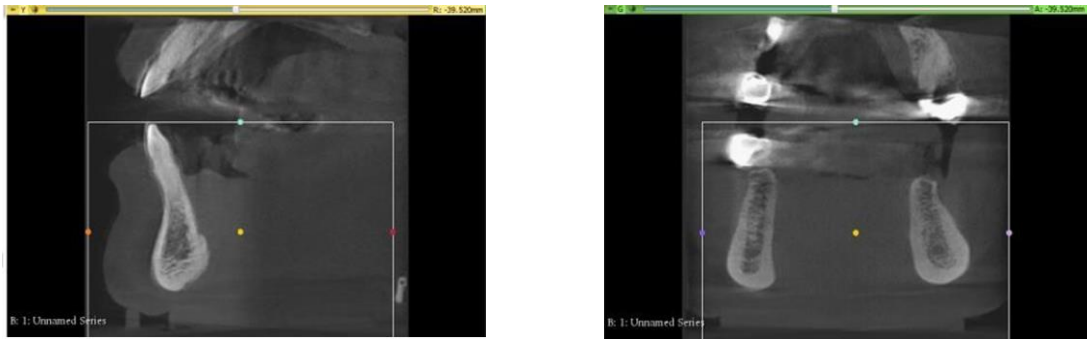
We utilized the data of a 48-year-old patient who visited a Dolgalev Dental Clinic complaining of trouble chewing food because of a lack of chewing teeth in the left lateral region of the lower jaw to evaluate the procedure. The diagnosis is a terminal abnormality of the left lower jaw and partial tooth loss. Implant placement in the tooth region is the treatment strategy.
With the aid of the program, the patient's jawbone anatomy was fully replicated in three-dimensional pictures and plastic stereolithographic models **(Figures 1 and 2)**.



a)



b)



c) d)

Figure 1. Cone-beam computed tomography data of the patient.

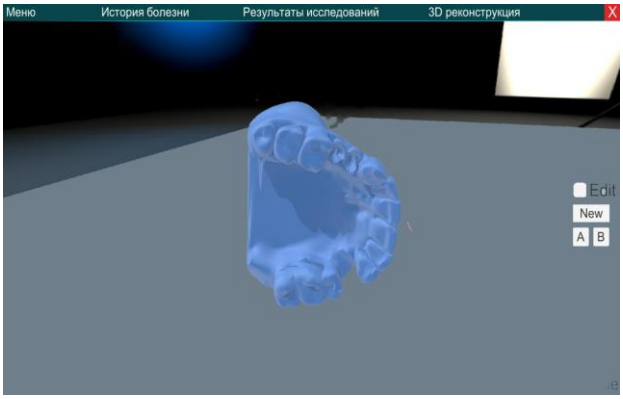


Figure 2. 3D model of the upper jaw processed for a surgical intervention simulator.

With the help of the acquired drawings and models, we were able to fully understand the extent of bone tissue atrophy in the alveolar procedure, which greatly improves the precision of the implantation procedure and the forecast of the outcome of surgical intervention.

Using DICOM information acquired using CBCT, stereolytic plastic models of the jaws were created to replicate the implant insertion procedure. A 3D template modeling application was used to create the template after the molded plaster models of the dentition were scanned with an extraoral scanner. You may use this tool to overlay a 3D reconstruction of the dentition that was produced via CBCT with a scanned model of the dentition in the form of STL files. To model the template, a 3D scene is made. A 3D printer receives the computer project and uses it to generate a template that precisely depicts the anatomy of the jaw region where the implants will be placed. The anatomically confirmed template already indicates the proper implant orientation.

Conclusion

Tomography of the jawbones was done. Plaster models were created from the opponents' and the lower jaw's imprints, which were subsequently scanned. With the aid of the planning tool, the implantations were virtually placed, a 3D reconstruction of the jaw picture was carried out, and a template was created. 3D scanners are used to produce the template and the jaw model. The implants were placed into the plastic model following the template and the established procedure.

When doing surgery or patient consultations, the extra reality complex can be used as a means of telemedicine.

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Ethics Statement: None

References

1. Galabueva AI, Biragova AK, Kotsoyeva GA, Borukayeva ZK, Yesiev RK, Dzgoeva ZG et al. Optimization of modern methods of treating chronic generalized periodontitis of mild severity. Pharmacophore. 2020;11(1):47-51.
2. Nagdalian AA, Rzhepakovsky IV, Siddiqui SA, Piskov SI, Oboturova NP, Timchenko LD, et al. Analysis of the content of mechanically separated poultry meat in sausage using computing microtomography. J Food Compost Anal. 2021;100:103918.
3. Salins SS, Siddiqui SA, Reddy SVK, Kumar S. Experimental investigation on the performance parameters of a helical coil dehumidifier test rig. Energy Sources, A: Recover, Util, Environ Eff. 2021;43(1):35-53.
4. Salins SS, Siddiqui SA, Reddy SVK, Kumar S. Parametric analysis for varying packing materials and water temperatures in a humidifier. Proceedings of the 7th International Conference on Fluid Flow, Heat and Mass Transfer (FFHMT'20), 2020. [online] Available from: https://avestia.com/FFHMT2020_Proceedings/files/paper/FFHMT_196.pdf.
5. Nuzhnaya KV, Mishvelov AE, Osadchiy SS, Tsoma MV, Slanova RH, Kurbanova AM, et al. Computer simulation and navigation in surgical operations. Pharmacophore. 2019;10(4):46-52.
6. Orsaeva AT, Tamrieva LA, Mischvelov AE, Osadchiy SS, Osipchuk GV, Povetkin SN, et al. Digital clinic "smart ward". Pharmacophore. 2020;11(1):142-6.
7. Asgari I, Soltani S, Sadeghi SM. Effects of iron products on decay, tooth microhardness, and dental discoloration: a systematic review. Arch Pharm. Pract. 2020;11(1):60-82.
8. Hamed MT, Mously HA. Investigating economic and clinical implications of tooth implant supported prosthesis among patients and practitioners. Int J Pharm Res Allied Sci. 2019;8(4):116-21.
9. Baklanov I, Rodionova V, Ivashova V, Shvachkina L, Medvedeva V. Social trends for increasing satisfaction with the educational services of a modern university. Calitatea. 2020;21(179):88-90.
10. Baklanov IS, Baklanova OA, Erokhin AM, Ponarina NN, Akopyan GA. Myth as a means of ordering and organizing social reality. J Hist Cult Art Res. 2018;7(2):41-7.
11. Baklanov IS, Baklanova OA, Shmatko AA, Gubanova MA, Pokhilko AD. The historical past as a factor of sociocultural transformations of postmodernity. J Hist Cult Art Res. 2018;7(1):373-8.
12. Barabanov PV, Gerasimov AV, Blinov AV, Kravtsov AA, Kravtsov VA. Influence of nanosilver on the efficiency of Pisum sativum crops germination. Ecotoxicol Environ Saf. 2018;147:715-9.
13. Blinov AV, Yasnaya MA, Blinova AA, Shevchenko IM, Momot EV, Gvozdenko AA, et al. Computer quantum-chemical simulation of polymeric stabilization of silver nanoparticles. Physical and chemical aspects of the study of clusters nanostructures and nanomaterials. 2019;11:414-21.
14. Zimmerman T, Siddiqui SA, Bischoff W, Ibrahim SA. Tackling airborne virus threats in the food industry: a proactive approach. Int J Environ Res Public Health. 2021;18(8):4335. doi:10.3390/ijerph18084335
15. Cheboi PK, Siddiqui SA, Onyando J, Kiptum CK, Heinz V. Effect of ploughing techniques on water use and yield of rice in maugo small-holder irrigation scheme, Kenya. Agri Engineering. 2021;3(1):110-7. doi:10.3390/agriengineering3010007
16. Siddiqui SA, Ahmad A. Implementation of Newton's algorithm using fortran. SN Comput Sci. 2020;1(6):1-8. Available from: https://link.springer.com/article/10.1007/s42979-020-00360-3 [Accessed 18 Feb. 2021].
17. Siddiqui SA, Ahmad A. Implementation of thin-walled approximation to evaluate properties of complex steel sections using C++. SN Comput Sci. 2020;1(6):1-11. Available from: https://link.springer.com/article/10.1007/s42979-020-00354-1 [Accessed 18 Feb. 2021].
18. Bledzhyants GA, Mishvelov AE, Nuzhnaya KV, Anfinogenova OI, Isakova JA, Melkonyan RS. The effectiveness of the medical decision-making support system "electronic clinical pharmacologist" in the management of Patients therapeutic profile. Pharmacophore. 2019;10(2):76-81.
19. Blinova A, Blinov A, Baklanova O, Yasnaya M, Baklanov I, Siddiqui A, et al. Study of wound-healing ointment composition based on highly dispersed zinc oxide modified with nanoscale silver. Int J Pharm Phytopharmacol Res. 2020;10(6):237-45. doi:10.51847/Cu6KX0JDE322
20. Demchenkov EL, Nagdalian AA, Budkevich RO, Oboturova NP, Okolelova AI. Usage of atomic force microscopy for detection of the damaging effect of CdCl2 on red blood cell membrane. Ecotoxicol Environ Saf. 2021;208:111683.

21. Hight GY, Mishvelov AE, Melchenko EA, Nuzhnaya CV, Epanov VA, Dolgalev AA, et al. New image modeling features for planning surgical interventions. Res J Pharm, Biol Chem Sci. 2019;10(1):140-3.
22. Hite GJ, Mishvelov AE, Melchenko EA, Vlasov AA, Anfinogenova OI, Nuzhnaya CV, et al. Holodoctor planning software real-time surgical intervention. Pharmacophore. 2019;10(3):57-60.
23. Kenijz NV, Koshchaev AG, Nesterenko AA, Omarov RS, Shlykov SN. Study the effect of cryoprotectants on the activity of yeast cells and the moisture state in dough. Res J Pharm Biol Chem Sci. 2018;9(6):1789-96.
24. Kubanov SI, Savina SV, Nuzhnaya CV, Mishvelov AE, Tsoroeva MB, Litvinov MS, et al. Development of 3d bioprinting technology using modified natural and synthetic hydrogels for engineering construction of organs. Int J Pharm Phytopharmacol Res. 2019;9(5):37-42.
25. Lopteva MS, Povetkin SN, Pushkin SV, Nagdalian AA. 5% Suspension of Albendazole Echinacea magenta (Echinacea Purpurea) toxicometric evaluation. Entomol Appl Sci Lett. 2018;5(4):30-4.
26. Luneva A, Koshchayev A, Nesterenko A, Volobueva E, Boyko A. Probiotic potential of microorganisms obtained from the intestines of wild birds. Int Trans J Eng Manag Appl Sci Technol. 2020;11(12):11A12E.
27. Lunin LS, Lunina ML, Kravtsov AA, Blinov AV. Effect of the Ag nanoparticle concentration in TiO2–Ag Functional Coatings on the Characteristics of GaInP/GaAs/Ge Photoconverters. Semiconductors. 2018;52(8):993-6.
28. Mezhidov BS, Belyaeva AA, Bimarzaev KSM, Bektashev AS, Shekhshebekova AM, Dzgoeva MG, et al. Prospects for creating 3d models of internal organs based on computer and magnetic resonance imaging images in emergency surgery and resuscitation. Pharmacophore. 2021;12(1):8-14.
29. Nagdalian AA, Oboturova NP, Povetkin SN, Ziruk IV, Egunova A, Simonov AN, et al. Adaptogens instead restricted drugs research for an alternative items to doping in sport. Res J Pharm Biol Chem Sci. 2018;9(2):1111-6.
30. Shevchenko YS, Plohova DP, Bulakhova IN, Mishvelov AE, Kubalova ME, Badriev GB, et al. Experience of carrying out magnetic resonance imaging with the use of specialized protocols and programs computer post-processing. Pharmacophore. 2020;11(2):77-81.
31. Suleymanov TA, Kosinkova AM, Mishvelov AE, Povetkin SN, Simonov AN, Ziruk IV. Overview of the Holodoctor Software Package. Pharmacophore. 2020;11(2):65-72.
32. Siddiqui SA, Ahmad A. Dynamic analysis of an observation tower subjected to wind loads using ANSYS. In2021 2nd International Conference on Computation, Automation and Knowledge Management (ICCAKM) 2021 Jan 19 (pp. 6-11). IEEE.