



PROSTHETIC REHABILITATION OF A RESORBED MAXILLA WITH AN INDIVIDUAL TITANIUM IMPLANT USING SELECTIVE LASER MELTING (SLM) TECHNOLOGIES. CASE REPORT

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Abstract

The purpose of presented case report was to show the outcome of prosthetic rehabilitation of a resorbed maxilla with an individual titanium maxillary implant using virtual 3D surgical planning and fabrication using Selective Laser Melting (SLM) technology. Oral rehabilitation in patients with severe atrophy using a custom titanium subperiosteal implant could be a solution with great potential to solve the well-known problems of traditional implantology.

It is also very important to have enough experience with implants in general to reach the skill level to perform custom subperiosteal titanium implants using SLM laser growth technology.

Keywords: atrophic maxilla three-dimensional (3D) models of, individual implant, Digital additive manufacturing technologies

Introduction

Rehabilitation of patients using dental implantats has shown long-term results with success rates up to 97%, in the presence of a sufficient amount of jaw bone. However, physiological atrophy of the jaws, post-extraction resorption, defect of the alveolar ridge different etiology, the installation of standard dental implants becomes more complicated.^{1,2}

For the implant rehabilitation of such patients, traditional augmentation procedures such as bone augmentation techniques, guided bone regeneration, maxillary sinus elevation techniques with or without transplantation provide effective long-term solutions in the treatment of atrophy.³⁻⁹

Various types of grafts have been available for alveolar ridge augmentation, Autografts (autogenous grafts), Allografts (allogenic, homologous,

homografts), Allografts (allogenic, homologous, homografts), Alloplasts (alloplastic grafts, synthetic grafts), Platelet-rich plasma (PRP), Platelet-derived growth factors (PDGF). Resorbed ridge reconstruction using Autografts is considered the gold standard in rehabilitation.^{10,11}

Effective implantation of bone grafts depends on the following factors: surgical asepsis, soft tissue coverage, secure fixation of the graft, presence of a bone blood vessel, and optimization of growth factors.¹² However, the obtained data suggest that the success of bone grafts also depends on the volume (size) of the restoration and the number of missing bones walls.¹³

Bone grafting may not always lead to a positive result, which dictates the search for alternative methods of implantation without bone grafting, which can reduce the risk of surgical complications and treatment time.¹⁴⁻¹⁶

Modern treatment options such as zygomatic implant, pterygoid implant, tilted implant, short implants, for posterior atrophic areas where aesthetics are not of paramount importance, may be the treatment of choice given that they may lead to an orthopedic and functional compromise.¹⁷⁻²⁰

The use of individual implants opens up new perspectives for the rehabilitation of patients with significant resorption of the jaw bones. Digital additive manufacturing technologies and methods have made it possible to create individual implants based on cone beam computed tomography (CBCT) data for each individual clinical case.²¹

In recent years, digital technologies, such as computer-aided design/computer-aided manufacture (CAD/CAM), digital intraoral scanners, and additive manufacturing (AM) technologies, have been successfully applied in implant dentistry.^{22,23}

Today, Selective Laser Melting (SLM) technology opens up promising possibilities for customized titanium dental and maxillofacial implants.

For the manufacture of individual implants, the obtained CT scans (DICOM files) are required; have a number of tools for virtual modeling of individual implants; convert virtual models of individual implants using Digital additive manufacturing technologies.²⁴

In this clinical case, the presented use of a 3D-modeled custom implant produced using Selective Laser Melting (SLM) technology for the rehabilitation of a patient with significant resorption in the edentulous upper jaw will be presented.

Case reporta

52 years female patient, presented to clinic with edentulous significant atrophic maxilla.

Objectively

Edentulous atrophic maxilla. After the clinical-radial examination, a treatment plan was defined that included: installation an individual implant implant. 3 months after implant placement non-removable metal-ceramic prosthetic restoration was fabricated and adjusted. The patient has been followed up for 1 years. So far, no further problem has occurred and the restoration has remained functional.

Preoperative Planning

Virtual surgery was planned using high-resolution computed tomography. The CBCT-derived DICOM files were imported into software to create three-dimensional (3D) models of the patient's bone anatomy. The next step was to design and determine the shape and extent of the subperiosteal structure, taking into account the position of the prosthetic abutments and the remaining bone, as well as its length in a particular position. Based on the CT images of the patient's bone anatomy, a CAD model an individual implant was digitally constructed figure 1-2.

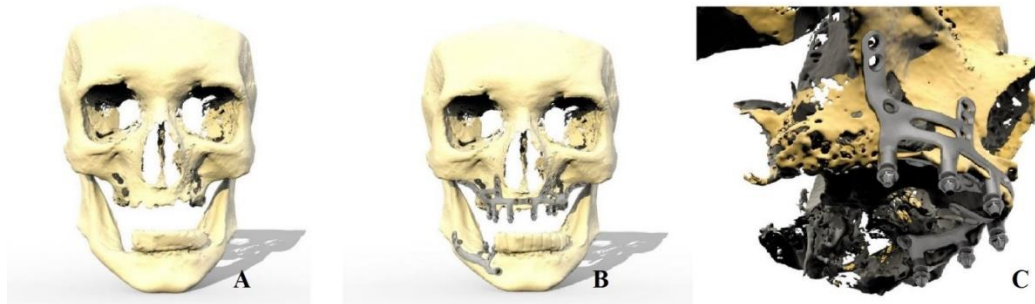


Figure 1. A, B, C. 3D CT images of the patient's bone anatomy, a CAD model an individual implant was digitally constructed

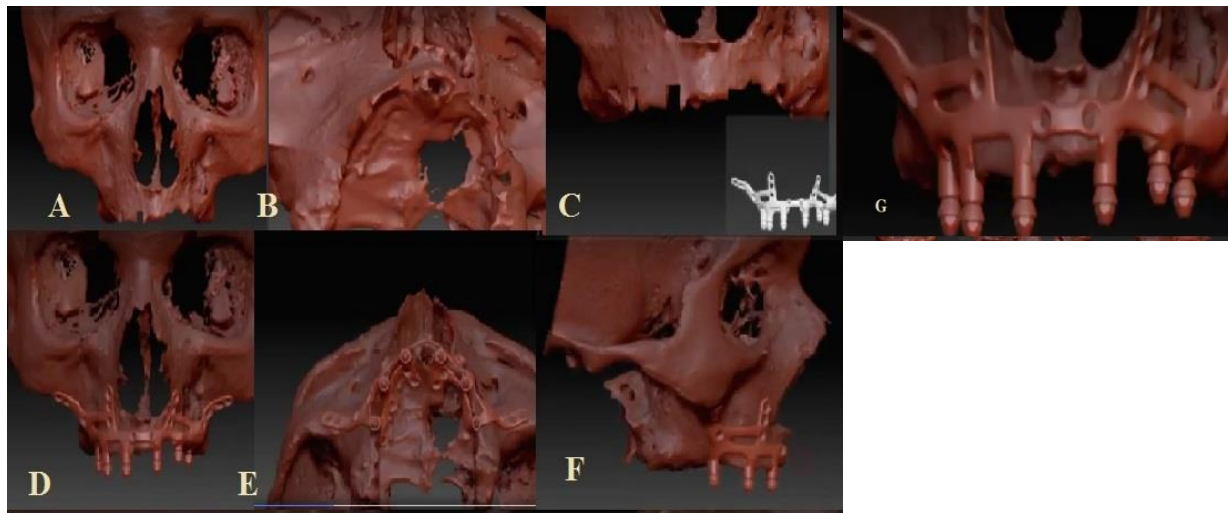


Figure 2 A, B, C, D, E, F, G. The planned position of the implant on the overview image in the frontal, axial and sagittal directions. The extreme planned position of the implant was located taking into account the position of the prosthetic abutments and the remaining bone

The biomodel was then physically built individual implant using Digital SLM manufacturing technologies.

Surgical Procedure

Crestal incisions were made to elevate the mucoperiosteal flap to ensure adequate soft tissue coverage of the titanium implant. After a thorough dissection with a periostotomy and complete exposure of the maxillary defect, a maxillary implant was placed, which provides a passive fit to the bone surface. Implant was fixed to the bone with screws 1.5 and 2 mm in diameter of different lengths according to a preliminary virtual plan. The ends of the prosthetic connections came out through small incisions in the flap. Finally, periosteal relaxation incisions were made in the periosteum to facilitate proper mobilization of the flap, and the wound was closed hermetically with absorbable sutures figure 3.



Figure 3 A, B, C, D. A patient with a total maxillary edentation treated with a subperiosteal implant (implant aspect and surgical stage)

In the postoperative period, oral antibiotic therapy (amoxicillin/clavulanic acid 1 g/8 h) was prescribed

for the first 7 days, analgesics, anti-inflammatory drugs, and 0.12% chlorhexidine solution for mouthwash 2–3 times a day, during the first week. Two weeks after the intervention, removes the sutures and installs a temporary prosthesis, turning the edges to avoid friction and trauma to the mucous membrane. 3 months after the operation, after the gums have completely healed, impressions are taken and a fixed prosthesis is made from metal-ceramic according to the CAD/CAM project fig.4,5. Prostheses were made in the clinic according to the generally accepted protocol. The patients were rehabilitated with a fixed prosthesis on subperiosteal implants with good aesthetic and functional results figure 6, 7.



Figure 4. The position of the abutments in the working laboratory plaster model

Figure 5. Finished metal-ceramic prosthesis according to the CAD/CAM project on a working lab plaster



Figure 6. The position of the abutments in the cavity makes the final fixation of the prosthesis

Figure 7. Finished metal-ceramic prosthesis fixed in the oral cavity

A follow-up CT scan was performed to assess the accuracy and placement of the implant.

Discussion

Treatment of severely atrophied posterior jaws with standard length root implants is a challenge. Bone reconstructive surgery is the treatment of choice; however, some patients may not take it for economic reasons or due to higher morbidity. For severe bone

resorption in the jaw where the patient does not want to undergo bone regeneration, modern digital technologies may represent a viable solution with the possibility of fabricating customized implants ideally adapted to their local morphology and anatomy.²⁵ Computer-aided design / computer-aided manufacturing (CAD/CAM) technologies have recently opened up new frontiers in biomedical applications. Selective laser melting (SLM), is a CAD/CAM technique that allows the creation of complex three-dimensional (3D) structures created using image-based computer-aided design techniques. With Selective laser melting (SLM) technology, individual implants can be made for individual patients. SLM technology allows the creation of porous implant structures, which help provide attachment points to the bone tissue and promote accelerated osseointegration.²⁶ Therefore, implants made using SLM technology can adequately transfer loads between the implant and the bone, thereby increasing the life of the implant and the implant-supported restoration. In terms of materials, titanium is a widely used material in implants and other biomedical applications due to its high strength-to-weight ratio, corrosion resistance, low density, and non-magnetic properties.²⁷⁻²⁹ Due to its high biocompatibility, Ti-6Al-4V is considered one of the most suitable biomaterials for dental and maxillofacial implants, manufactured using selective laser melting (SLM) technology. The highly porous surface of laser-sintered titanium implants clearly demonstrated a high level of bone contact and osseointegration with bone inclusion in the pores in the posterior maxilla 2 months after placement.³⁰⁻³³

Purpose

The purpose of this case report is to present a protocol for the fabrication and clinical use of custom-made SLM implants with a titanium subperiosteal implant as an alternative prosthetic treatment for orthopedic rehabilitation of severely atrophied posterior jaws. The patient's CT scan datasets were transferred to dedicated reconstruction software where a 3D projection of the atrophied jaw was obtained and a customized implant was designed. A customized implant was fabricated using the SLS technique, placed in a severely atrophied posterior maxilla and restored with fixed restorations 3 months later,

demonstrating good aesthetic integration. The implants can be made on an individual basis as a custom designed device. This non-traditional approach may represent an option for reconstructing an atrophied posterior jaw in patients who do not wish to accept traditional bone graft protocols.

Dental rehabilitation in edentulous patients with severe maxillary resorption has traditionally been treated with bone grafting to restore the alveolar ridge. This complex technique has a number of problems, including unpredictable medium to long term success rates, associated morbidity, duration of treatment (due to waiting times for graft consolidation and implant osseointegration, among other reasons), and overall cost. Thanks to modern new technologies for designing and manufacturing individual implants in patients with severe jaw resorption, new opportunities for orthopedic rehabilitation open up. This method is simpler and faster as it does not require the use of grafts and thus significantly reduces the treatment time.

Individual subperiosteal titanium maxillary implants may be a safe alternative for maxillary defect reconstruction, our experience shows promising results in terms of functional and aesthetic restoration. Using the latest SLM laser growth technology, individual implants are made for orthopedic rehabilitation of patients with significant atrophy of the jaw bones. This is of particular interest to patients who are unwilling or unable to undergo complex

regenerative surgery but require fixed prosthetics. However, prospective and randomized trials with long-term follow-up are needed to evaluate its long-term efficacy and safety.

Conclusions

Oral rehabilitation in patients with severe atrophy using an individual titanium subperiosteal implant could be a solution with great potential to solve the well-known problems of traditional implantology. It is also very important to have enough experience with implants in general to reach the skill level to perform individual subperiosteal titanium implants using SLM laser growth technology.

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Institutional Review Board Statement

The study was conducted by the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee).

Informed Consent Statement

Informed consent was obtained from patient involved in the study.

Data Availability Statement

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

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ԱՐՏԱՀԱՅՏՎԱԾ ԱՏՐՈՖԻԱՅՈՎ ՎԵՐԻՆ ԾՆՈՏԻ ՊՐՈԹԵԶԱՅԻՆ ՎԵՐԱԿԱՆԳՆՈՒՄ ԱՆՀԱՏԱԿԱՆ ՏԻՏԱՆԻ ԻՄՊԼԱՆՏՈՎ՝ ՍԵԼԵԿՏԻՎ ԼԱԶԵՐԱՅԻՆ ՀԱԼՄԱՆ (SLM) ՏԵԽՆՈԼՈԳԻԱՆԵՐԻ ԿԻՐԱՌՄԱՍԲ. ԿԼԻՆԻԿԱԿԱՆ ԴԵՊԶԻ ՀԱՇՎԵՏՎՈՒԹՅՈՒՆ

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Ամփոփում

Ներկայացված կլինիկական դեպքի հաշվետվության նպատակն էր ցույց տալ արտահայտված աստրոֆիայով վերին ծնոտի պրոթեզային վերականգնման արդյունքը անհատական տիտանի իմպլանտով՝ սելեկտիվ լազերային հալման (SLM) տեխնոլոգիաների կիրառմամբ: Բերանի խոռոչի վերականգնումը ծանր աստրոֆիայով հիվանդների մոտ՝ օգտագործելով տիտանային ենթավերն ոսկրային իմպլանտը, կարող է մեծ ներուժ ունեցող լուծում լինել ավանդական իմպլանտոլոգիայի հայտնի խնդիրները լուծելու համար: Նաև շատ կարևոր է ավանդական իմպլանտների հետ կապված բավականաչափ փորձ ունենալ՝ հասնելու հմտությունների մակարդակի՝ սելեկտիվ լազերային հալման (SLM) տեխնոլոգիաների կիրառմամբ անհատական ենթավերն ոսկրային և տիտանի իմպլանտներ օգտագործելու համար:

ПРОТЕЗИРОВАНИЕ РЕЗОРБИРОВАННОЙ ВЕРХНЕЙ ЧЕЛЮСТИ ИНДИВИДУАЛЬНЫМ ТИТАНОВЫМ ИМПЛАНТАТОМ С ИСПОЛЬЗОВАНИЕМ ТЕХНОЛОГИЙ СЕЛЕКТИВНОГО ЛАЗЕРНОГО ПЛАВЛЕНИЯ (SLM): КЛИНИЧЕСКОЕ СЛУЧАЯ

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Резюме

Целью представленного клинического случая было показать результат ортопедической реабилитации резорбированной верхней челюсти с применением индивидуального титанового поднадкостничного имплантата с использованием виртуального 3D-хирургического планирования и изготовления с использованием технологии селективного лазерного плавления (SLM). Оральная реабилитация у пациентов с тяжелой атрофией с применением индивидуального титанового поднадкостничного имплантата может стать решением с большим потенциалом известных проблем традиционной имплантологии. Также очень важно иметь достаточный опыт работы с имплантатами в целом, чтобы достичь уровня навыков для применения индивидуальных поднадкостничных титановых имплантатов с использованием технологии лазерного выращивания SLM.