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Restoration of Bone Tissue in the Area of a Radicular Cyst using a Developed Bio-Implant Based on Zirconium Dioxide (Clinical Case)

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Abstract

Subject: *The prospects for the introduction of all-ceramic implant in the clinical practice of orthopedic rehabilitation of patients with radicular cysts.*

Objective: *The to carry out a comparative analysis of changes in the state of bone tissue according to the data of targeted visiongraphic examination, CBCT examination and clinical observation after the installation of the developed zirconium dioxide bio-implant in the area of the radicular cyst.*

Methodology: *The paper presents 6-month clinical results of monitoring the state of bone tissue in the area of the radicular cyst after the use of the developed bio-implant and simultaneous temporary prosthetics of the patient.*

Results: *Despite the modern development of therapeutic dentistry, destructive bone tissue phenomena in the projection of previously treated tooth roots are still found in sufficient numbers in patients. Also, repeated endodontic treatment does not always promote bone regeneration. The development of new biocompatible materials and the improvement of technologies for obtaining surfaces with a given micro-roughness, new technologies for applying bio-coatings to the surface of a dental implant made of zirconium dioxide and the improvement of clinical protocols have made it possible to use such zirconium dioxide implants not only as a reliable fulcrum for orthopedic restorations, but also as a "therapeutic agent" for the regeneration of bone defects.*

The 6-month clinical results on the restoration of a bone defect using a developed all- ceramic bio-implant resulting from unsuccessful attempts of endodontic treatment and apical surgery in a patient with hepatitis C.

The possibility of using the developed implant will allow to meet the needs of patients in minimally invasive implantation procedure, ensuring its cost-effectiveness in relation to analog imported dental implant systems used in combination with bone substitutes. In addition, due to the specialized surface treatment, the developed implant does not require the use of bone-substituting drugs, and the presence of a bio-coating allows for expanded use in groups of patients with somatic pathologies.

Conclusions: *The presented case shows that the developed system of all-ceramic immediate implants is not only a reliable support for orthopedic restoration, but also restores bone tissue without the use of bone substitutes.*

Keywords: Ceramic Implants, Minimally Invasive Implantation, Implant Treatment, Bio- Implant, New Developments, Radicular Cyst

Introduction

Currently, the modern level of therapeutic dentistry helps to cope with most acute inflammatory diseases of the oral cavity. However, despite advances in endodontic, periodontal treatment and apical surgery, destruction of jaw bone tissue (radicular and periodontal cysts) is still found in the practice of a dental surgeon. And the more perseverance is manifested in an unsuccessful attempt to preserve the root of the tooth, the deeper trophic

disorders occur in the surrounding bone tissue with subsequent destruction. It is the long-term trophic changes in bone tissue and, as a result, the resulting bone defects that are the main problem for simultaneous implantation and require additional, complex, expensive and not always predictable reconstructive surgery. Timely removal of the tooth root and installation of a dental implant helps not only to prevent the further spread of the infectious process, but also to carry out early orthopedic rehabilitation of the patient.Due to this, dental implantation has become the main method of rehabilitation in orthopedic dentistry. Therefore, demands for dental implants are increasing every day from both patients and dentists. The existing complications arising from dental implantation require research and development in order to increase the effectiveness of orthopedic rehabilitation [1, 2].

Taking into account the disadvantages of titanium alloys and the growing needs of patients for safe and reliable dental implantation, metal-free solutions for orthopedic rehabilitation, the development of new biocompatible materials, new technologies for obtaining surfaces with a given micro-roughness, new technologies for applying bio-coatings to the surface of a dental implant made of zirconium dioxide and the improvement of clinical protocols have made it possible to use such zirconium dioxide implants as a reliable alternatives to their titanium analogues [3]. Numerous studies show that the clinical use of zirconium dioxide implants is practically not accompanied by manifestations of peri- implantitis, and the epithelial tissues of the gum are able to firmly and reliably attach to their surface. The integration of the ceramic implant into bone tissue and soft tissues has been verified and confirmed. Separately, it should be noted the rapid growth of soft gum tissues on the surface of a ceramic dental implant [4-7].

Taking into account all the advantages of using zirconium dioxide as a material for the manufacture of dental implants (including the experience of imported manufacturers), having studied the available modern technologies, A. A. Dovgerd, I developed and implemented a new endossal all-ceramic screw single-stage implant (RF Patent for Invention No. 2651052; Eurasian Patent No. 035482).

A Clinical Case

On 11/15/2022, a patient born in 1980 (with a history of hepatitis C) without smoking abuse applied to our clinic "Stoma" LLC (Kemerovo) in order to remove a 2.2 tooth, install an implant and temporary prosthetics. From the medical history: in 2011, primary endodontic treatment of tooth 2.2 was performed for acute pulpitis; in 2014, repeated endodontic treatment was performed for exacerbation of chronic granulating periodontitis; in 2017, tooth mobility 2.2 appeared, after a visiographic examination, a radicular cyst of the upper jaw from tooth 2.2 was revealed. For 8 months, therapy was carried out using various endo-drugs for the purpose of recovery, which eventually ended with root apical resection, cystectomy and obturation of the cavity with a bone substitute. On 11/10/2022, the patient repeatedly complained about the appearance of a fistula in the tooth area 2.2, its mobility and pain when biting. After examination by a dental surgeon and a visiographic examination, a radicular cyst was re-diagnosed and removal of the tooth root was proposed, followed by bone grafting and delayed implantation. An external examination of the oral cavity determines the darkening of the crown of the tooth 2.2, the fistula in the projection of a postoperative scar with a scanty purulent discharge; tooth mobility 2.2 was 2-3 degrees, percussion was painful. The soft tissues in the tooth area 2.2 are hyperemic, edematous. On a targeted R-gram of good quality of the upper jaw in the tooth area 2.2, in the projection of the resected apex, a focus of bone destruction with clear, even contours was determined (Fig.1).

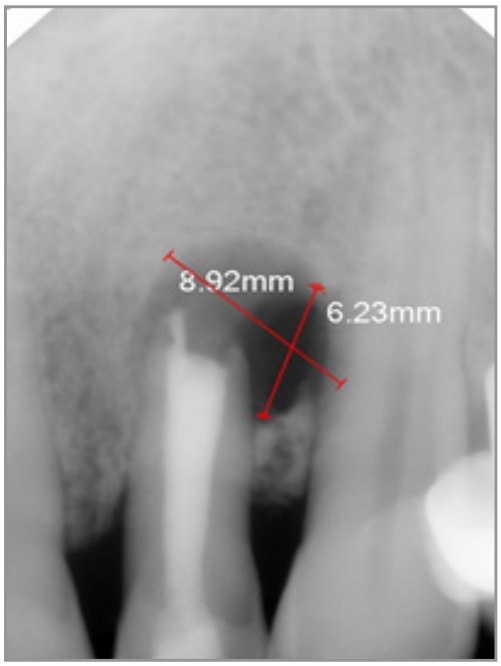

Figure 1: R-gram of the tooth area 2.2

On 11/18/2022, a tooth extraction operation was performed under local anesthesia 2.2, a cystectomy, and a developed all-ceramic implant made of nanostructured zirconium dioxide with a bio-coating was installed. (Fig. 2)

Figure 2: The appearance of the implant

At the request of the patient, immediately after the operation, a temporary composite crown was made and fixed on the implant with cement (Fig.3 et 3a). It should be noted that the entire procedure required one capsule with a volume of 1.7 ml. anesthetic drug. In total, 1 hour and 30 minutes were spent, at the stage of making a temporary crown, there was no bleeding anymore and the orthopedic dentist easily fixed the crown on cement.

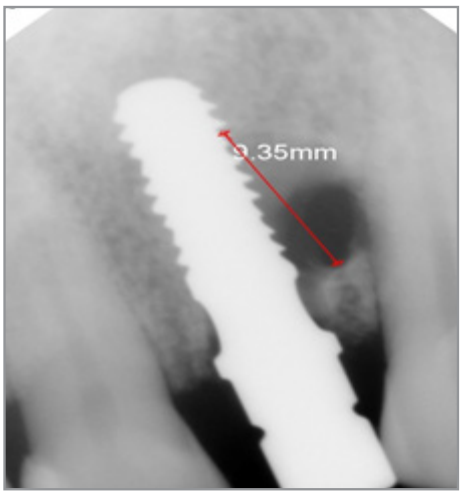

Figure 3: Control R-gram after surgery

Figure 3a: Temporary Crown

A course of antibacterial and anti-inflammatory therapy has been prescribed, and recommendations on hygiene and temperature regime have been given. The patient underwent a control CT scan. (Fig.4)

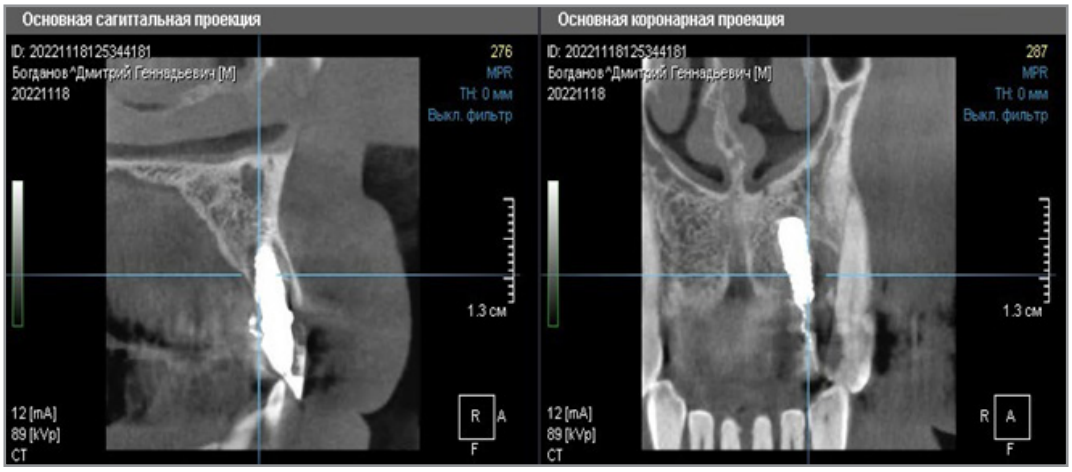

Figure 4: Ct monitoring on the day of surgery

The postoperative period proceeded without the formation of external edema, the patient did not take painkillers. After 14 days, an external examination, assessment of the condition and R-control were carried out. (Figures 5a and 5b)

Figure 5a: Appearance, condition after 14 days

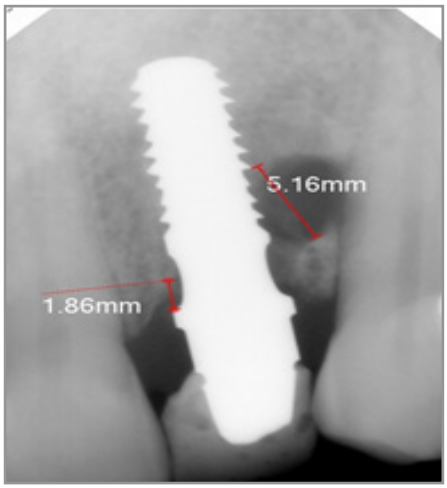

Figure 5b: X-ray control in 14 days

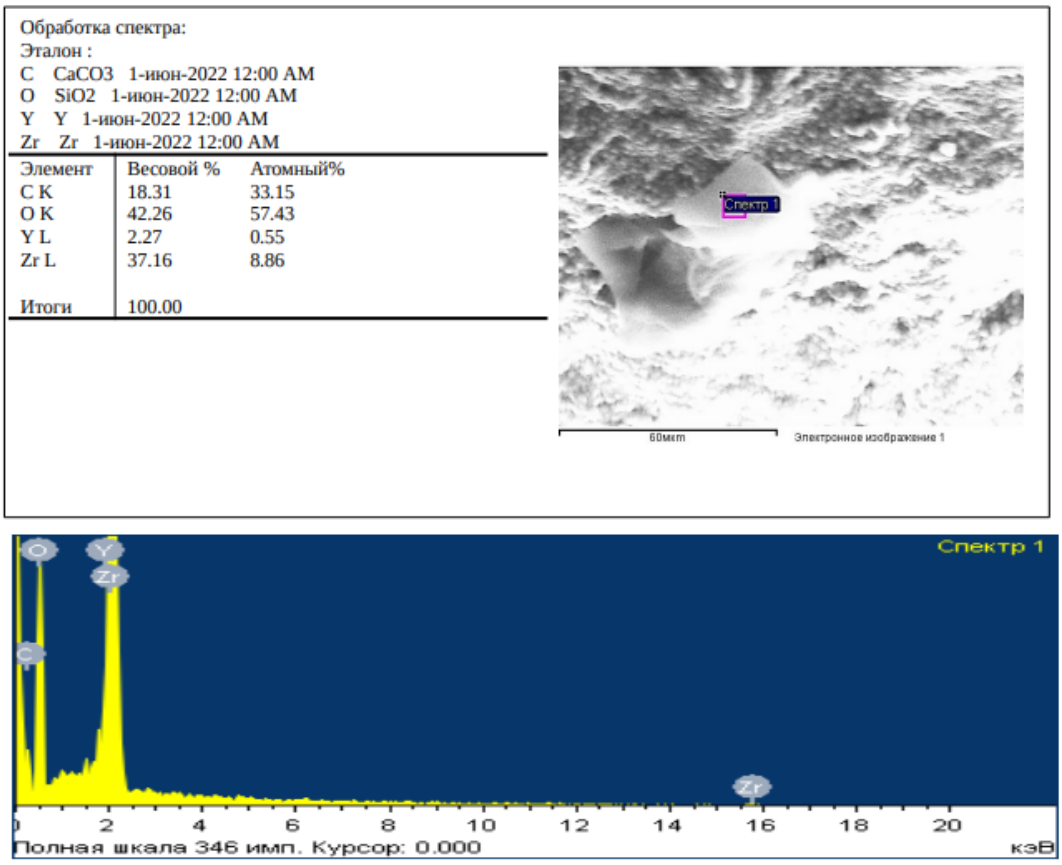

Figure 6: Atomic and spectral analysis of the surface of the threaded part of the developed bio-coated implant

Results

Since the day of the operation, the patient has not experienced pain or any discomfort, the temporary crown did not cause any anxiety. According to the stages of treatment, the patient underwent control CbCt studies after 3 months (February 2023 in dynamics) and 6 months (May 2023 dynamic comparison). (Fig. 7-9)

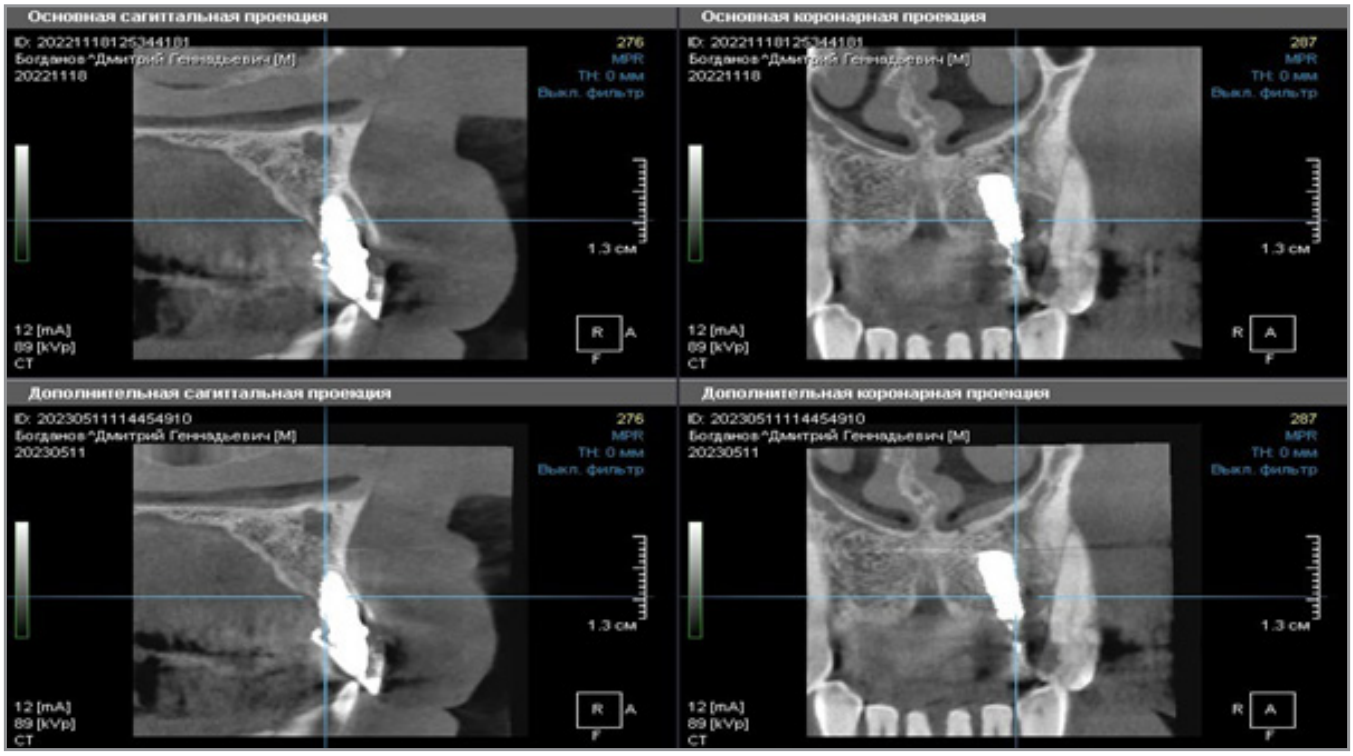

Figure 7: Ct- control November 2022 — February 2023 in dynamics

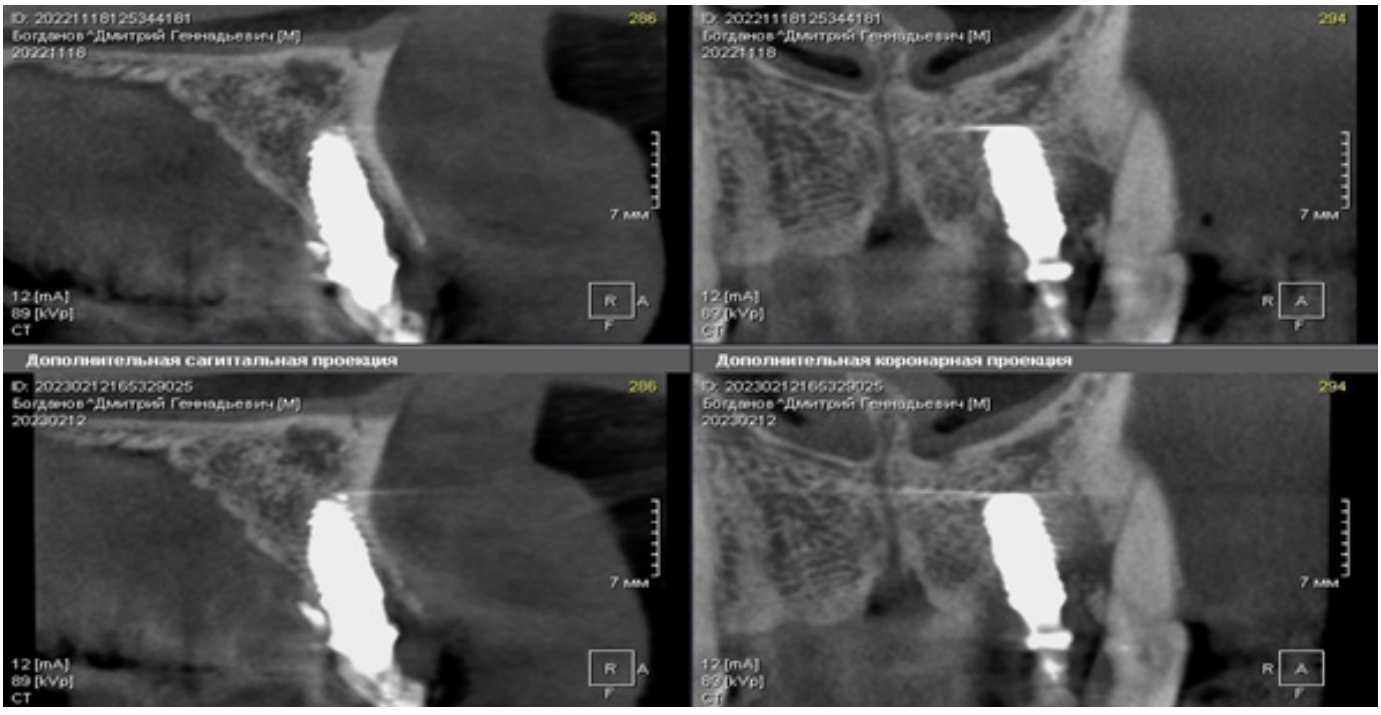

Figure 8: Ct- control November 2022 – May 2023 in dynamics

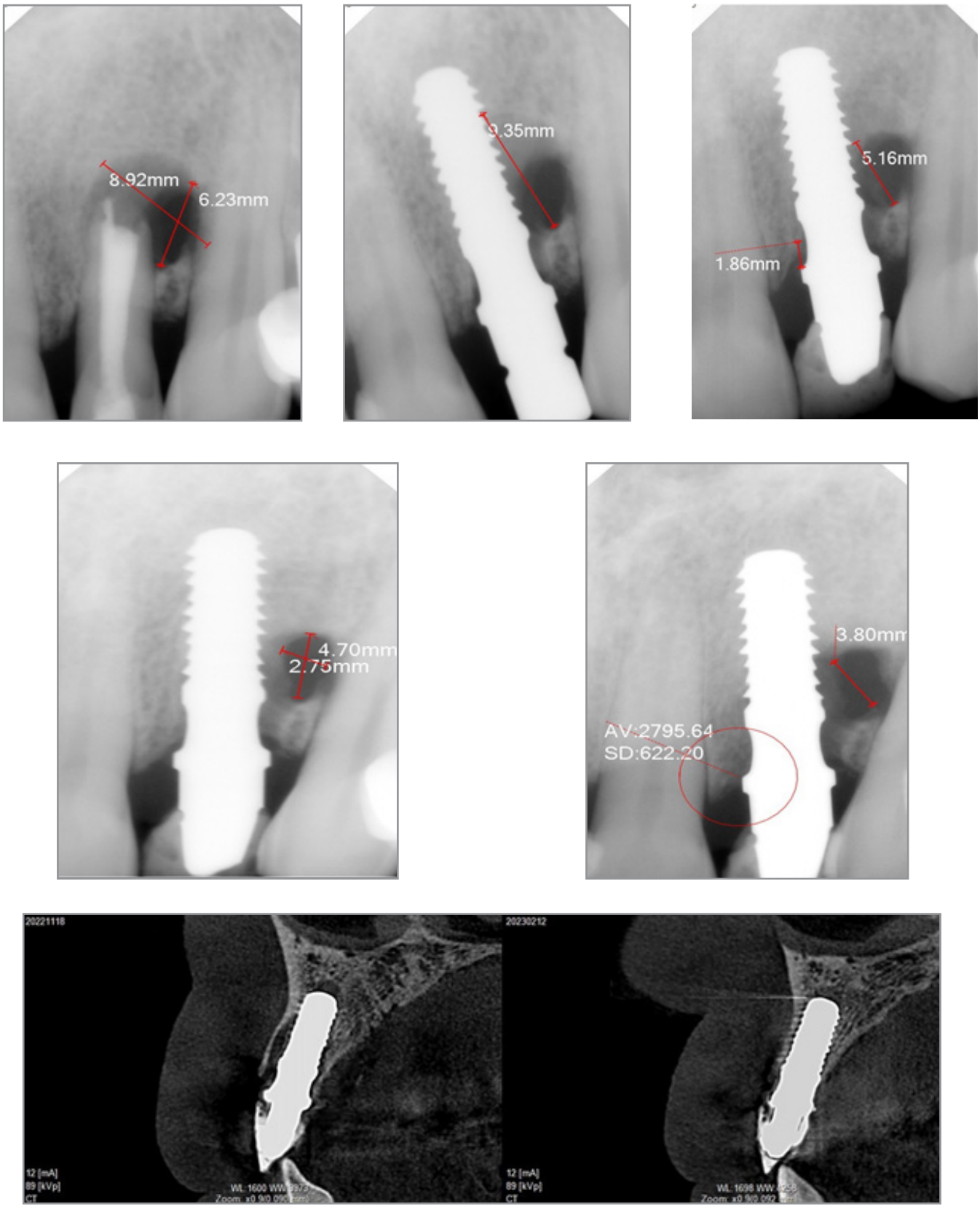

Figure 9: Dynamics of bone tissue restoration in the implant area 2022-2023

As the bone tissue was restored, soft tissues were restored without the use of autoplastic techniques (Fig.10)

Figure 10: Dynamics of soft tissue repair.

Conclusions

The clinical case given here took place 9 months ago. According to the results of the observation of the performed restoration, to date, no signs of peri-implantitis have been detected in the area of the developed zirconium implants with bio-coating. This case shows that the developed system of all-ceramic immediate implants with bio-coating is not only a reliable fulcrum for orthopedic restoration, but also independently contributes to the restoration of bone tissue, despite the long-term violation of tissue trophic caused by chronic inflammation. This system allows the patient to immediately undergo temporary prosthetics, which has a positive effect on the psycho-emotional status of the patient. In the described clinical case, the result fully justified our expectations — even though implantation was performed in the alveolus of the infected tooth simultaneously with its removal. This is important for the successful implementation of this system in the daily practice of implantological treatment, especially for patients with a thin gum phenotype and poor bone density. The presented system of all-ceramic immediate implants with bio-coating provides flexibility of application for various rehabilitation tasks. The developed thread and coating allows for better primary stability and transmission of axial loads, and also allows you to be confident in maintaining the volume and density of bone tissue in the implantation area in the long term [8-10].

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