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Pulsed short waves in the remineralization of alveolar bone structures of the jaw in patients with diabetes mellitus – a series of cases

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Abstract

This clinical study included three patients aged between 50 and 78 years who had chronic marginal periodontitis and type 2 diabetes mellitus, diseases that are frequently associated due to changes occurring in polymorphonuclear cells, as well as to alterations of microcirculation. No bone augmentation therapies were performed. Bone regeneration was strictly influenced by conventional periodontal therapy, supplemented with ten pulsed short wave sessions applied to the lower face shortly after closed periodontal curettage. The allocated time was ten minutes for the first two sessions, and 15 minutes for the following 8 sessions. Clinical and radiological evaluations were performed at the time of presentation, as well as after initiation of pulsed short wave therapy: in the first case, three weeks after initiation of therapy and three years after the end of complex oral rehabilitation; in the second case, eight weeks after the onset of pulsed short wave therapy and in the third case, five weeks after the onset of pulsed short wave therapy. The results were significant in all three cases, demonstrated radiologically by the same type of radiological examination at identical scales. Bone remineralization was obvious in the alveolar processes of the jaw. Although further studies in this direction are necessary, the results are both clinically and radiologically significant.

Key words: *pulsed short waves, alveolar bone resorption, periodontal disease, diabetes,*

Introduction

Resorption and demineralization of the alveolar bone structures of the jaw in the presence of teeth are frequently found in outpatient dental services and are associated with periodontal diseases, which may occur in aggressive, chronic, necrotic and periodontal abscess forms (1).
The following factors are involved in the etiology of periodontal diseases:
Intrinsic factors
Systemic diseases are frequently involved: diabetes, osteoporosis, autoimmune diseases, cardiovascular diseases, endocrine diseases, renal diseases, dermatological diseases, digestive diseases, blood diseases and immune deficiencies, psychosomatic dysfunctions, vitamin deficiencies, the hereditary factor (1,2), etc.
Extrinsic factors
The local predisposing factors of alveolar bone destruction are represented by:
Irritating mechanical factors, lifestyle (deficient oral hygiene, smoking, trauma, stress), functional factors (1,2,3).
The determining factor of periodontal disease is bacterial plaque, which forms under poor oral hygiene conditions (1,2,3).
As regards the treatment of periodontal diseases, this includes extremely complex individualized stages and the therapeutic approach varies depending on the degree of tooth mobility, the response to local therapy, the number and position of residual teeth, the general health status, systemic therapy, patient compliance with treatment **(1).**
For good bone remineralization results, the following are required: educating and motivating the patient to achieve individualized oral hygiene, as well as eliminating bad habits (e.g. smoking, interposing objects between the dental arches), removing local irritating factors (supra- and subgingival scaling, root surface planing, adaptation or replacement of oversized fillings and prosthetic restorations, treatment of caries with radicular evolution, extraction of root rests that represent local irritating factors), required endodontic (re)treatments, curettage of periodontal pockets, determination of bacterial spectra in the periodontal

pockets, antibiotic therapy targeted on existing periodontal germs, evaluation of tooth mobility and dento-dental immobilization (when needed), elimination of static and dynamic occlusal interferences, fabrication of trays for bruxomanic patients (1,2).

Characteristics relevant to alveolar bone regeneration using pulsed short waves

Using pulsed short waves is beneficial for cells, stimulating the release of increased amounts of energy, required for repair processes. The biological and therapeutic effects of pulsed short waves are explained by an activation of cellular enzymatic reactions and the connective vascular system. The important biotrophic effect is represented by an improvement of intra/extra and transmembrane ion mobility, leading to a rebalancing of the Na+ and K+ pump, of the associated ATP-ase activity and implicitly, of all active transport systems, which results in the prevention or elimination of residual depolarized states, with the restoration of the physiological resting membrane polarity (4).

Pulsed short waves are perceived to have a non-thermal effect on human tissues; research demonstrates that these may have caloric effects in certain stages of treatment. The long duration of the pause in relation to the duration of impulses allows the caloric effects of this high energy to disperse or even disappear, so that the biological effects have a longer duration and decrease more slowly. The frequency of the impulses was calculated so that each impulse overlaps a persistent biological effect produced by the preceding impulse. Thus, the biological effects cumulate over a certain time period (5). Research confirms the fact that pulsed short waves can also be used safely at higher intensities, even in the presence of metals inside tissues [Seiger and Draper (2006)] (6,7). The effects of pulsed short waves are the cellular biotrophic effect, stimulation of local cellular activities, reduction of inflammatory processes, reduction of edema, stimulation of collagen and fibrin deposits, tissue regeneration (8). Some studies also provide solid evidence of the “non-thermal” effects on the cell membrane (Luben 1997, Cleary 1997).

The main effects of the pulsed magnetic field seem to occur in the cell membrane and involve ion transport along the membrane. As regards the influence on alveolar bone processes, the following main effects were taken into consideration: the increase in white blood cells, histocytes and fibroblasts in a wound, and the improved rate of edema dispersion. Induction of hematoma absorption and reduction of the inflammatory process contribute to the rapid orientation of fibrin, stimulating collagen deposition. At the same time, they contribute to collagen stratification in an early stage, stimulating osteogenesis (4).

Objectives

To report the cases of three patients aged between 50 and 78 years who had chronic marginal periodontitis and type 2 diabetes mellitus, and who underwent pulsed short wave procedures as an adjuvant therapy to periodontal treatments, for alveolar bone regeneration and remineralization.

Hypothesis

The research aims to evidence alveolar bone remineralization and regeneration in the absence of associated bone augmentation treatment.

Material and method

The study was conducted based on the approval of the Ethics Committee of the Iuliu Hațieganu University of Medicine and Pharmacy Cluj-Napoca, as well as on the subjects’ informed consent.

Research protocol

In the period 2015-2017, the patients presented to the dental office, requiring complex oral rehabilitation. Among other dental diseases, they had chronic marginal periodontitis in the context of the presence of type 2 diabetes mellitus, with which this is frequently associated due to polymorphonuclear (PMN) defects and alterations occurring in microcirculation (1,9). Diabetic pathology was followed up by a specialist in diabetes and nutritional diseases, being within normal limits in the period of dental treatments. Following local therapy, the patients were referred to the rehabilitation service of the Medical Clinic II in Cluj-Napoca for pulsed short wave procedures targeted on the lower face, on the areas where teeth affected by periodontitis were present.

Medical history data

a. Subject no. 1. Patient C.F. aged 50 presented to the dental office on 10.11.2014 for gingival bleeding and persistent pain in the maxillary front teeth, as well as difficult mastication.

The patient was multiparous, a non-smoker, she worked in pastry, she did not perform physical exercise and did not strictly follow the diets indicated by her treating doctor.

General disorders – type 2 diabetes mellitus diagnosed at the age of 45 years, followed up by the treating diabetologist.

Tests applied

1. Examination of the mucosae

The mobile and passive-mobile mucosae were supple, elastic, pink, without clinically detectable pathological masses. The marginal gingiva was hyperplastic, bleeding on minimal contact (e.g. during mastication, tooth brushing, etc.).

2. Examination of the salivary glands

The salivary glands were permeable, and saliva was in sufficient amounts; no present or previous hyposialia, xerostomia or hypersialia episodes were found.

3. Prosthetic diagnosis

Maxilla – termino-latero-lateral T-L,L edentation (Costa's classification), treated prosthetically by a semi-physiognomic metal acrylic bridge from 1.3 to 2.7 with distal extension to two teeth, i.e. 1.4;15 (P.P.F X-X-1.3-1.2-1.1-2.1-2.2-2.3-X-2.5-X-2.7). Treatment was performed ten years before; at the time of presentation, the prosthetic restoration no longer corresponded to the tooth neck adaptations (Fig. 1).

Mandible – total edentation – a resorbed bone ridge with a sharp margin, which is specific to edentation due to periodontal disease. A removable denture was placed about ten years before; during this period, the prosthetic restoration became inadequate because of bone resorption (Fig. 1.).

4. Dental, endodontic and periodontal diagnosis established after removal of FPD

Crown destruction was of carious etiology in teeth: 1.3;1.2;2.1; 2.2;2.3;2.5. No tooth migration was found considering that the teeth were immobilized using the bridge body.

Gingival retraction was calculated from the level of the gingival margin to the FPD, evidenced circularly in 2.5 and 2.7, with a 3 mm degree of retraction.

The bacterial plaque index was 2 (Silness and Löe), with a plaque retention index of 2 (Löe), the calculus index was 1 according to Marthaler (2), the periodontal inflammation index according to Russel was 6, the Műhlemann papillary bleeding index was 3 (2).

The presence of periodontal pockets and tooth mobility was in close correlation with bone demineralization (which is also obvious in Fig. 1).

Evaluation of the probing depth and tooth mobility: 1.3 periodontal pocket 8.5 mm on the mesial surface assessed by periodontometry at a constant pressure, tooth mobility grade 1; 1.2 chronic apical periodontitis with constant acute episodes, tooth mobility grade 3 accompanied by axial mobility greater than 3 mm (1,2); 1.1 crown destruction, chronic apical periodontitis, distal periodontal pocket 11.5 mm, mobility grade 2; 2.1 mobility grade 0; 2.2 chronic apical periodontitis, mesial periodontal pocket 8 mm, mobility grade 1; 2.3 chronic apical periodontitis, mesial periodontal pocket 3 mm, mobility grade 1; 2.5 mesial periodontal pocket 5 mm, mobility grade 0; 2.7 periodontal pocket 3.5 mm on the mesio-vestibulo-distal surfaces, mobility grade 1, furcation involvement grade 0 (1).

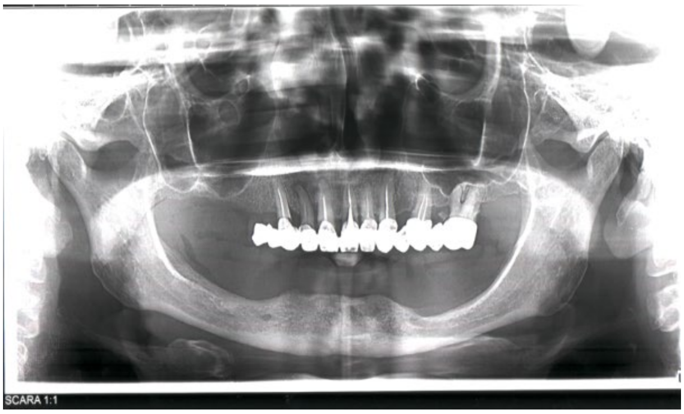


Fig. 1. Initial OPT X-ray, which indicates T-L,L maxillary edentation and total mandibular edentation, respectively, demineralization of alveolar bone septa, especially in 1.3, 1.1, 2.1, 2.2, 2.5, 2.7, and the presence of apical reaction in 1.2.

Complex oral rehabilitation was required, for which the following were performed:

Supra- and subgingival scaling, as well as oral hygiene instruction, provided before removal of the prosthetic restoration, which was followed by extraction of tooth 1.2.

Dental and endodontic treatments

Softened dentin removal, as well as endodontic retreatment in teeth 1.1, 2.1, 2.2, 2.3 was performed. Corono-radicular reconstruction was carried out in teeth: 1.3, 1.1, 2.1, 2.2, 2.3, 2.5.

Surgical and periodontal treatments

Given the long duration of chronic marginal periodontitis, initiation of periodontal therapy immediately after endodontic therapy was chosen (3); antibiotic therapy with clindamycin 600 mg 3x1/day for five days was also administered.

Periodontal therapy consisted of irrigation of periodontal pockets with antiseptic chlorhexidine gluconate solution (10). An open periodontal approach was used, which consisted of scaling and root planing using both ultrasound loops and manual Gracey curettes; with the same curettes, the inner epithelium of periodontal pockets was also curetted (11).

Considering tooth mobility, throughout the duration of treatment, the teeth were stabilized in order to favor tissue healing. Immobilization was performed using a provisional acrylic FPD, which could be removed whenever needed.

After 7 days, apical resection of the teeth with chronic apical periodontitis: 1.1; 2.2; 2.3 was performed.

Pulsed short wave treatment

Pulsed short wave therapy in this case was initiated 7 days after periodontal curettage and started on the day of apical resection, four hours before the intervention. A therapeutic course of 10 daily pulsed short wave sessions was conducted. An impulse frequency of 80/s during the first 2 sessions and 160/s for the rest of the sessions was used, with penetration steps ranging between 1 and 2 (4).

The locating emitter was placed at a minimum distance of 1 cm from the left anterolateral region of the lower face.

Advanced remineralization of the maxillary bone structure was observed three weeks after initiation of pulsed short wave therapy and apical resection, four weeks after completion of closed periodontal curettage, respectively.

Radiological aspects at three weeks: the marginal alveolar bone defects were visibly remineralized, the bone defects resulting from apical resections were minimally visible in the apex of tooth 2.3. The bone defect resulting after extraction of tooth 1.2 was minimally remineralized considering local as well as general pathology.

A total physiognomic metal-ceramic FPD was placed in the patient's maxilla, accompanied by an acrylic removable partial denture. In the mandible, an acrylic removable complete denture was placed.

Tooth mobility clinically improved up to physiological limits (1) (mobility grade 0) (given that FPD was made of three components in order to stabilize the removable partial denture), without the presence of depth on periodontal probing.

b) Subject no. 2. Patient C.R., female, aged 78, presented to the dental office on 18. 03.2015, complaining of tension in the jaw bones and teeth, gingival bleeding during tooth brushing, perceptible tooth mobility, mastication difficulties, hesitation in cutting and grinding food.

General disorders – type 2 diabetes mellitus diagnosed at the age of 70 years, followed up by the treating diabetologist, trigeminal neuralgia diagnosed at the age of 40, Biermer anemia diagnosed at the age of 77 years.

The patient was nulliparous, a non-smoker, retired (a former civil engineer), she performed physical exercise regularly considering her age and systemic diseases, she constantly followed the indicated diets and the prescribed medication.

Tests applied

1. Examination of the mucosae

The mobile mucosa was atrophic and glossitis was present (12), both the tongue and the mucosa showed linear lesions secondary to vitamin B12 deficiency (13,14,15), the burning sensation, candidosis and xerostomia occurred quite rarely given the periodic treatments administered and strictly followed, symptoms were transient with a tendency to periodic recurrence (15). The marginal gingiva showed no hyperplastic appearance, but tended to bleed during tooth brushing.

2. Examination of the salivary glands

The salivary glands were permeable; however, the amount of saliva was reduced.

3. Prosthetic diagnosis – Maxilla - termino-terminal edentation (Costa's classification), treated by a total physiognomic metal-ceramic FPD from 1.1-1.2-1.3-(1.4) 1.4-distal extension, and FPD in 2.1 and 2.2, as well as by an acrylic removable partial denture.

Mandible – left uniterminal edentation (Costa's classification) without a prosthetic restoration, single tooth metal-ceramic FPD in 3.5; 3.4; 4.4; 4.5; 4.6; 4.7 (Fig. 2).

The prosthetic treatments had been performed seven years before as part of complex oral rehabilitation.

4. Periodontal, dental and endodontic diagnosis

The degree of gingival retraction in the teeth covered with FPD was calculated from the margin of the prosthetic restoration, and for the teeth without prosthetic restorations the distance from the enamel-cement junction to the gingival margin was measured (1).

Periodontal pocket depth was measured using periodontometry at a constant pressure, with conventional periodontal probes having a 0.5 mm blunt tip and an 11.5 mm long active part (2).

In the maxillary frontal area, gingival retraction of 3 mm was found in 1.3, 1.2, 1.1, 2.1, and of 1 mm in 2.2.

In the mandible, gingival retraction was present in the frontal area in 3.3, 3.2, 3.1, 4.1, 4.2, 4.3 vestibular 3.5 mm, lingual 3.3, 3.2, 4.2, 4.3 1 mm, 3.1, 4.1 3.5 mm. In the lower premolars 3.4, 3.5, 4.4, 4.5, gingival retraction was 2 mm circular, and in the

molars, retraction was 1 mm circular, identical in the molars covered with FPD 4.6, 4.7 and in 3.6, uncovered with FPD.
The degree of tooth mobility was also determined after removal of FPD.
Tooth migration was strictly found in the lower frontal area, where a flaring of the entire group of teeth of 1 mm for lateral incisors and canines and 1.5 mm for central incisors was also found.
The bacterial plaque index was 2 (Silness and Löe), the plaque retention index was 2 (Löe), the calculus index was 2 – according to Marthaler (1), the periodontal inflammation index was 2 according to Russel, the Műhlemann papillary bleeding index was 2 (2).
The crown destruction found both after FPD removal and in teeth without FPD was of carious etiology, as well as attrition at occlusal and incisal level, observed for all teeth without FPD.
Teeth 1.3, 1.1, 2.1, 3.6, 3.4, 3.3, 3.2, 4.3, 4.4, 4.5 showed carious processes.
Evaluation of probing depth and tooth mobility: 1.3 – periodontal pocket 5.5 mm on the disto-palatal surface, tooth mobility grade 1; 1.2 – mesio-vestibular periodontal pocket 3.5 mm, tooth mobility grade 1; 1.1 – distal periodontal pocket 3.3 mm, tooth mobility grade 0; 2.1 – vestibulo-disto-palatal periodontal pocket 5 mm, mobility grade 1; 2.2 – vestibulo-mesial periodontal pocket 3.5 mm, crown reconstruction with a corono-radicular device, mobility grade 2; 3.6 – vestibular periodontal pocket 5 mm, with furcation involvement grade 1 (1), mobility grade 1; 3.5 – vestibular periodontal pocket 5 mm, treated endodontically, corono-radicular reconstruction CRD, tooth mobility grade 0; 3.4 – vestibular periodontal pocket 5 mm, tooth mobility grade 1; 3.3 – vestibulo-mesial periodontal pocket 5 mm, treated endodontically, tooth mobility grade 1; 3.2 – vestibulo-mesial periodontal pocket 5.5 mm, treated endodontically, tooth mobility grade 2; 3.1 – periodontal pocket 6.5 mm, mobility grade 2 with axial mobility 2 mm; 4.1 – periodontal pocket 6.5 mm, mobility grade 3 with axial mobility 2 mm; 4.2 – vestibulo-mesial periodontal pocket 6 mm, disto-lingual physiognomic filling; 4.3 – vestibulo-mesial periodontal pocket 5 mm, treated endodontically, tooth mobility grade 0; 4.4 – vestibular periodontal pocket 3 mm, treated endodontically and incompletely filled, tooth mobility grade 0; 4.5 – mesial periodontal pocket 5 mm, treated endodontically and incompletely filled, tooth mobility grade 2; 4.6 - mesio-vestibulo-disto-lingual periodontal pocket 6.5 mm, with furcation involvement grade 2, treated endodontically and incompletely filled, apical osteolysis of the distal root (without symptoms specific to apical periodontitis), tooth mobility grade 2; 4.7 - mesio-vestibulo-disto-lingual periodontal pocket 6.5 mm, with furcation involvement grade 1, treated endodontically and incompletely filled, apical and interradicular osteolysis (extending to the entire interradicular bone septum), tooth mobility grade 3 (with axial mobility higher than 3 mm).
Observation
The preexisting endodontic treatments could not be restored given the biomaterial used for endodontic fillings and the root canal calcifications due to the age factor, as well as the dental treatments performed over time. The periapical osteolyses present in the teeth that were not extracted did not pose any risk, some of them being due to pathological mobility.

Fig. 2. Initial OPT X-ray performed after ultrasonic scaling and individualized oral hygiene instruction. T-T maxillary edentation and terminal mandibular edentation, resorption of alveolar bone structures and interradicular bone septa are evidenced.
Treatment
Ultrasonic scaling and patient's instruction to use auxiliary oral hygiene methods, an oral irrigator in this case, followed by extraction of the unrecoverable teeth 3.1; 4.1; 4.7, and removal of the existing FPD seven days after the date of the last extraction.
Dental and endodontic treatments
The carious processes were treated in teeth 1.3, 1.2, 1.1, 2.1, 3.6, 3.4, 3.3, 3.2, 4.3, 4.4, 4.5.; endodontic treatments were performed in teeth 1.3, 1.2, 2.1.
Corono-radicular reconstruction was carried out in teeth 1.3, 1.2, 2.1, 3.3, 3.2, 4.2, 4.3, 4.4, 4.5, 4.6. In 2.2, the preexisting CRD was removed and the corono-radicular reconstruction was restored.

Periodontal treatments

Periodontal therapy was initiated after completion of dental and endodontic treatments (3); antibiotic therapy with amoxicillin 500 mg 4x1/day for five days was also administered.

Periodontal therapy consisted of irrigation of periodontal pockets with antiseptic chlorhexidine gluconate solution (10). A closed periodontal approach was used, which comprised dental scaling and root planing using both ultrasound loops and manual Gracey curettes (11); with the same curettes, the inner epithelium of periodontal pockets was also curetted.

Considering tooth mobility, throughout the duration of treatments, the teeth were stabilized in order to favor tissue healing; immobilization was performed with provisional maxillary and mandibular acrylic FPDs.

Pulsed short wave treatment

Pulsed short wave therapy in this case was initiated three days after completion of periodontal curettage. A therapeutic course of 10 daily pulsed short wave sessions was administered. The duration of the first two sessions was 10 minutes, the following eight sessions lasting 15 minutes. An impulse frequency of 80/s during the first 2 sessions and 160/s for the rest of the sessions was used, with penetration steps ranging between 1 and 2 (4).

The locating emitter was placed at a minimum distance of 1 cm from the left and right (alternatively from one session to another) anterolateral region of the lower face.

Clinically, tooth mobility returned to grade 0, which shows mobility within physiological limits (1), depths on periodontal probing being no longer present.

Prosthetic treatments

The patient had a total physiognomic maxillary metal-ceramic FPD placed in 1.3-1.2-1.1-2.1-2.2, accompanied by a Flexite base removable partial denture; in the mandible, total physiognomic single-tooth metal-ceramic FPDs were placed in 3.5; 3.4; 4.4; 4.5; 4.6 (on the patient's written request), and a total physiognomic metal-ceramic FPD was placed in 3.3-3.2-3.1-4.1-4.2-4.3.

c) Subject no. 3. Patient P.0., female, multiparous, aged 59, presented to the dental office on 04.07.2016, complaining of dental pain located in the upper jaw, abundant gingival bleeding during tooth brushing which had started about 12 months before. The patient was a non-smoker, retired, sedentary, strictly complying with the recommended medication, but not completely following the recommended diets.

General disorders – type 2 diabetes mellitus diagnosed at the age of 52 years, followed up by the treating diabetologist.

Tests applied

1. Examination of the mucosae

The mobile and passive-mobile mucosae were supple, elastic, pink, without clinically detectable pathological masses. The marginal gingiva was hyperplastic, bleeding on minimal contact (e.g. during mastication, tooth brushing, etc.).

2. Examination of the salivary glands

The salivary glands were permeable, and saliva was in sufficient amounts; no present or previous hyposialia, xerostomia or hypersialia episodes were found.

3. Prosthetic diagnosis

Maxilla - L,A-L,L edentation (Costa's classification) treated by a semi-physiognomic metal-acrylic fixed complete denture placed about 16 years before in teeth 1.8-X-X-1.3-X-1.1-2.1-2.2-2.2-X-2.5-X-2.8 (Fig. 3).

Mandible – lateral edentation treated by a total physiognomic metal-composite fixed denture placed five years before. 3.8-X-3.5 (Fig. 3).

4. Periodontal, dental and endodontic diagnosis

The degree of gingival retraction in the teeth covered with FPD was calculated from the margin of the prosthetic restoration, and in the teeth without prosthetic restorations the distance from the enamel-cement junction to the gingival margin was measured (1).

Periodontal pocket depth was measured by periodontometry at a constant pressure, using a conventional periodontal probe with a 0.5 mm blunt tip and an 11.5 mm long active part (2).

In the maxilla, gingival retraction was found in 1.8, 1.3, 1.1, 2.3 5 mm circular (at the level of the four surfaces), in 2.1 3.5 mm vestibulo-mesial, in 2.2 5 mm vestibulo-disto-palatal, in 2.5 3 mm mesial, in 2.8 3.5 mm circular.

In the mandible, gingival retraction was found in 3.8, 4.8 5 mm circular, in 3.2, 3.1, 4.1, 4.2, 4.4, 4.5 4 mm circular, in 3.3, 4.3 3 mm circular, in 3.5 6 mm circular.

Tooth migration occurred considering that the patient lost her six-year-old maxillary molars before the age of ten years, while the twelve-year-old molars were lost in early adulthood; thus, the wisdom molars were mesialized, remaining the last support in the molar group. Over the past months, the mandibular front teeth were displaced vestibularly in the form of a fan, the central and lateral incisors losing their points of contact by about 0.5 mm (Fig. 3).

The degree of tooth mobility was determined after FPD removal.

The bacterial plaque index was 3 (Silness and Löe), the plaque retention index was 2 (Löe), the calculus index was 3 according to Marthaler (1), the periodontal inflammation index was 8 according to Russel, the Műhlemann papillary bleeding index was 4 (2).

The crown destruction found both after FPD removal and in teeth without FPD was of carious etiology, as well as attrition at occlusal and incisal level observed for all lower front teeth without FPD.

Periodontal treatments

Observation

Considering the extensive destruction of the alveolar bone structure, dental scaling was carried out, after which antibiotic therapy with clindamycin 600 mg 3x1/day for five days was initiated, followed by endodontic treatment through prosthetic restoration of tooth 1.3; subsequently, the bridge body distal to tooth 1.3 was removed. Tooth 1.8 was detached as soon as the bridge body was transected.

In another session, closed periodontal curettage was initiated, both manual, using Gracey curettes, and ultrasonic, which was carried out during four sessions. In the same period, long-term intracoronal immobilization of mandibular front teeth with metal reinforcement, as well as provisional composite immobilization of teeth 4.8, 4.5, 4.4 was performed (2).

On the day of the last periodontal curettage session, pulsed short wave therapy was introduced and administered according to the adopted protocol. A therapeutic course of 10 daily pulsed short wave sessions was conducted. The duration of the first two sessions was 10 minutes, the following eight sessions lasting 15 minutes. An impulse frequency of 80/s during the first 2 sessions and 160/s for the rest of the sessions was used, with penetration steps ranging between 1 and 2 (4).

The locating emitter was placed at a minimum distance of 1 cm from the left and right (alternatively from one session to another) anterolateral region of the lower face.

Seven days after completion of periodontal curettage, the prosthetic restoration was removed and a provisional acrylic FPD also playing a restraining role was fabricated.

The patient did not wish to have the mandibular FPD removed, tooth 3.5 being vital and without any symptoms.

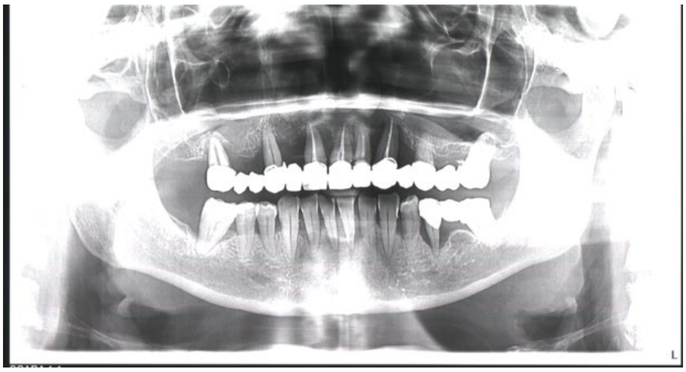


Fig. 3. Initial OPT X-ray performed after ultrasonic scaling and individualized oral hygiene instruction. Severe resorption of both maxillary and mandibular alveolar processes is observed, the supporting bone around certain teeth taking a concave shape.

Tooth mobility and crown pathology in the maxilla could not be assessed initially because the FPD was maintained for a period of seven days after pulsed short wave therapy due to the massive resorption of the maxillary alveolar bone structure. This situation was also found in teeth 3.8, 3.5, where there was a bridge body that the patient did not wish to renounce.

Evaluation of probing depth in the teeth covered with FPD: 1.8 - mesio-disto-palatal 10 mm, centro-vestibular 8.5 mm; 1.3 - disto-palatal 8.5 mm, vestibular and mesial 10 mm; 1.1 - vestibulo-distal 8.5 mm, mesial 3.5 mm; 2.1 - mesial 5 mm; 2.2 - distal 8.5 mm; 2.3 – circular 11 mm; 2.5 - vestibulo-mesial 5.5 mm; 2.8 - mesial 8.5 mm, vestibular 5.5 mm, distal 8.5 mm, palatal 3.5 mm; 3.8 - vestibulo-distal 7 mm, mesial 10 mm; 3.5 – circular 11 mm.

Evaluation of probing depth and tooth mobility in the teeth uncovered with FPD: 3.4 – circular periodontal pocket 5.5 mm, tooth mobility grade 1; 3.3 – vestibulo-disto-lingual periodontal pocket 4.5 mm, attrition grade 2, mobility grade 2; 3.2 – vestibulo-mesio-lingual periodontal pocket 4 mm, attrition grade 2, mobility grade 2; 3.1 – vestibulo-disto-lingual periodontal pocket 4 mm, attrition grade 2, mobility grade 2; 4.1 – vestibulo-disto-lingual periodontal pocket 4.5 mm, attrition grade 2, mobility grade 2; 4.2 – vestibulo-disto-lingual periodontal pocket 5 mm, attrition grade 2, mobility grade 2; 4.3 –periodontal pocket mesial 5 mm, distal 3.5 mm, attrition grade 2, mobility grade 1; 4.4 – circular periodontal pocket 4 mm, mobility grade 1; 4.5 – circular periodontal pocket 2.5 mm, mobility grade 1; 4.8 – circular periodontal pocket 7 mm, mobility grade 2.

Reevaluation of tooth mobility five weeks after initiation of pulsed short wave therapy and complete removal of the maxillary FPD indicated mobility grade 1 in 2.3, the rest of the teeth having mobility grade 0 (1).

In the mandible, except for the front teeth and the teeth included in FPD, tooth mobility was also grade 0.

Dental and endodontic treatments

1.3 - was treated endodontically by prosthetic restoration; five weeks after initiation of pulsed short wave procedures, corono-radicular reinforcement with a glass fiber post was performed.

All endodontically pre-treated teeth underwent corono-radicular reconstruction using fiber glass posts.

2.5 - mesio-occluso-distal caries treated and filled with glass ionomer cement

2.8 – occlusal caries treated and filled with glass ionomer cement

Prosthetic treatments

These were carried out four weeks after completion of pulsed short wave procedures, a period during which the patient had a provisional acrylic bridge placed in order to avoid additional tooth mobilization.

Two total physiognomic metal-composite bridge bodies were placed in the maxilla, in 1.3-X-1.1-2.1-2.2-2.3 and 2.5-X-X-2.8, respectively, to allow balancing of a conventional Flexite base removable partial denture, which comprised the edentulous ridge for hemiarch 1 and the edentulous gap between teeth 2.3-2.5, respectively.

Results

Remineralization of the alveolar bone structure after initiation of pulsed short wave therapy was obvious in all three cases included in the study, over a short time period, the results exceeding the expectations. Bone regeneration around the teeth subjected to closed periodontal curettage was radiologically visible. The contour of the bone defects surrounding the teeth had a tendency to reorientation of bone trabeculae towards the tooth roots after completion of pulsed short wave treatments (Figs. 4, 5, 6, 7). In other dental areas with vertical bone defects, a higher bone density around the roots and a greater bone volume even in vertical direction were found.

Regarding the first case, patient C.F. had much more intense remineralization of the alveolar bone structure compared to bone remineralization in edentulous areas (Figs. 4, 5).

Case a., patient C.F.

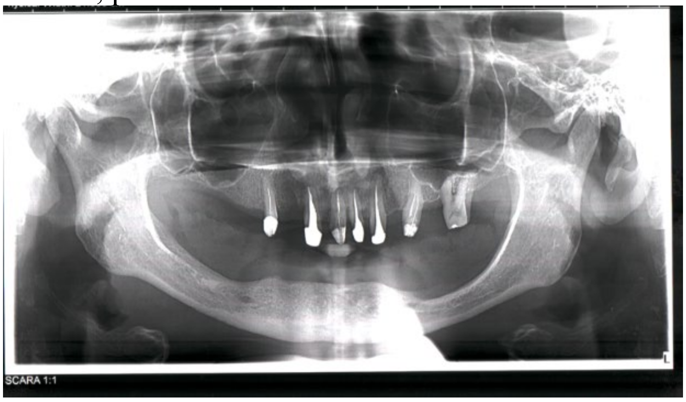


Fig. 4. OPT X-ray performed three weeks after initiation of pulsed short wave therapy. Remineralization of the maxillary alveolar bone structure three weeks after onset of pulsed short wave therapy and apical resection, and four weeks after completion of closed periodontal curettage is seen.

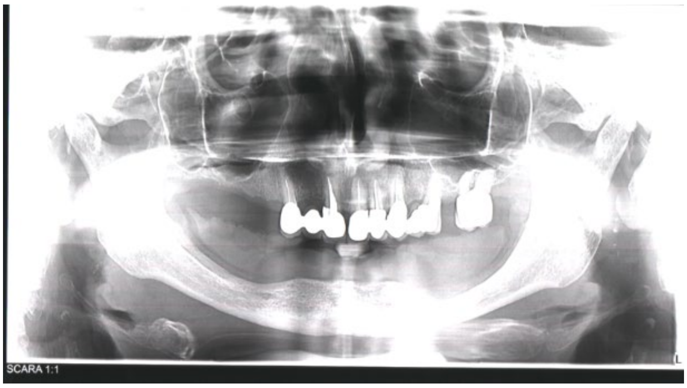


Fig. 5. OPT X-ray performed three years after completion of treatments; completely mineralized alveolar bone can be seen marginally (interdental bone septa) and apically. An exception was the extraction area, which remained hypomineralized.

7

Case b., patient C.R.

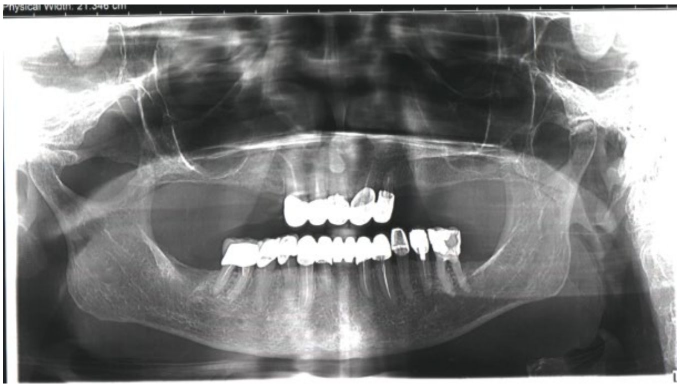


Fig. 6. OPT X-ray. T-T maxillary edentation, T-T mandibular edentation. Radiological image details: the marginal and interradicular alveolar bone defects are visibly remineralized; apically, it is still minimally visible in tooth 4.6 as well as tooth 3.3, where it is slightly more pronounced, which indicates in this case an asymptomatic apical reaction of endodontic etiology. X-ray taken eight weeks after initiation of pulsed short wave therapy.

The X-ray in Fig. 6 shows advanced remineralization of maxillary and mandibular alveolar bone structures eight weeks after the onset of pulsed short wave therapy and closed periodontal curettage.

Case c., patient P.O.

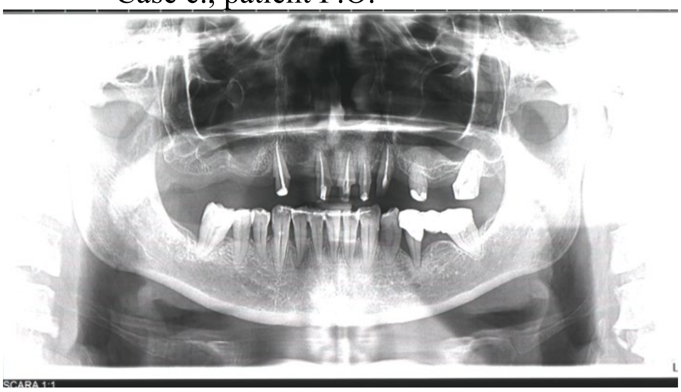
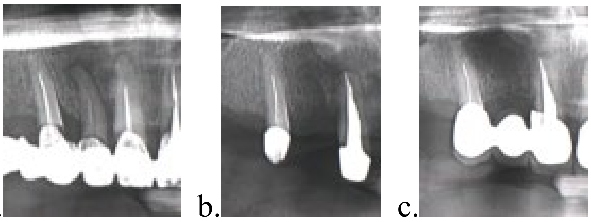


Fig. 7. OPT X-ray performed five weeks after initiation of pulsed short wave therapy. Intense remineralization of alveolar bone structures around the teeth and interdental bone septa can be observed.

Discussions

Regarding the first case, a control panoramic X-ray was also performed after three years (Fig. 5). Although there are studies showing the fact that in diabetic patients positive results persist for a short time period (16,17), here bone remineralization was equally visible radiologically after three years. A major contribution is represented by the patient's motivation to maintain individualized oral hygiene, as well as by visits to the dental office every six months for professional dental cleaning.

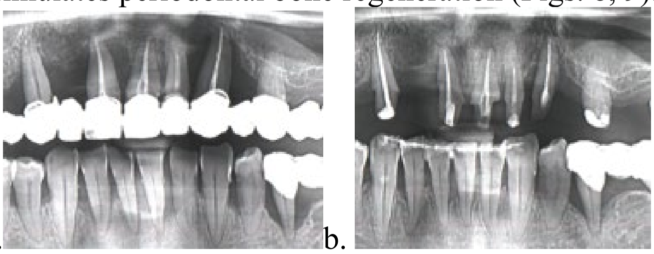


a. b. c.

A stronger independent association between chronic marginal periodontitis and diabetes mellitus is demonstrated; it has been proven that periodontal therapy has a significant systemic effect on endothelial function as well as on glycemic control (18,19). Periodontal treatment reduces glycated hemoglobin (HbA1C) (20), peripheral insulin resistance (21), bacterial exposure and inflammatory markers (22).

The action of pulsed short waves on the bone is represented by the production of microshocks on crystalline bone structures (particularly on collagen), with the production of negative electrical charges that will lead to an increase in osteoblast activity and the deposition of calcium salts in the bone. The effect on osteoblast energy metabolism is not excluded either (4). It considerably accelerates fracture callus formation due to the bone composition, which maintains electrical charges negative for 7-8 days (4). This situation suggests the presence of correlations between the introduction of pulsed short wave therapy shortly after completion of periodontal curettage, considering the more pronounced mineralization of alveolar bone processes, compared to the rest of the jaw bone structures.

Another theory is that according to which teeth are bone growth and development centers (23); in this sense, activation of cellular enzymatic reactions and of the periodontal connective-vascular system stimulates periodontal bone regeneration (Figs. 8, 9).



a. b.

Another aspect evidenced is represented by the importance of dento-dental immobilization in order to maximize the effects of pulsed short waves, a situation recommended including in the case of large joints, particularly in diabetic patients (24,11); there are also publications that mention the efficacy of low intensities for a longer time period (17).

Comparison with other procedures

Regarding ultrasounds, experimental periodontal studies in which bone defects were created report similar results by using low intensity ultrasounds after alveolar bone augmentation (25), compared to the current study, in which pulsed short waves were used in the absence of bone augmentation.

The efficiency of shock waves in improving tooth mobility did not prove to be significant, considering the fact that tooth mobility was identical to the mobility of the control group after treatment, its reduction over time being more rapid compared to the placebo group, which indicates extremely modest effects on alveolar bone regeneration. Experimental shock wave studies report similar results (26,27,28).

In comparison, laser therapy also offers very good results, including in diabetic patients, with respect to alveolar bone regeneration, providing a radiological appearance similar to the use of pulsed short waves assessed at one year (29,30).

Conclusions

Provided that oro-dental hygiene is maintained, results can persist for long time periods.

This protocol that uses pulsed short waves for the treatment of alveolar bone loss in diabetic patients can be a less invasive alternative compared to periodontal flap surgery, even in cases with aggressive bone losses.

Although further studies in this direction are required, pulsed short waves represent a valid therapeutic method, which allowed obtaining alveolar bone regeneration in the case of these patients.

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