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A Ten-Year Observation of a Case in Which High-Concentration Ozonated Water and Ozonated Glycerol Paste Were Effective in Implant Treatment

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Case Report

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A Ten-Year Observation of a Case in Which High-Concentration Ozonated Water and Ozonated Glycerol Paste Were Effective in Implant Treatment

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Abstract

In this case, based on the diagnostic findings, implant treatment was performed at the sites corresponding to the mandibular right second premolar and the distal root of the mandibular right first molar. During the procedure, the surgical field was continuously irrigated with ozonated water (OW), and at wound closure ozonated glycerol paste (OG) was applied to the extraction socket and to the inner surface of the elevated full-thickness flap. As a result, the use of OW and OG reduced surgical invasiveness, protected the blood clot within the extraction socket and promoted its replacement by connective tissue, and enabled early closure of the wound surface accompanying regeneration of the mucosal epithelium, thereby preventing collapse of the extraction socket. Consequently, favorable augmentation of bone tissue occurred in the extraction socket, and it was confirmed that long-term stability of the implant prosthesis could be achieved.

Key words: ozonated water (OW), ozonated glycerol paste (OG), implant treatment, long-term observation

Introduction

It has been reported that dissolving ozone in water to produce ozonated water (OW) improves both the efficacy and the safety of ozone [1]. However, the ozone contained in OW has a shorter half-life than ozone gas [2]. In particular, OW is known to be a potent inactivating agent against bacilli, fungi, protozoa, and viruses [3], and it has been suggested that it exerts antibacterial effects even as running water in actual clinical practice [4]. To date, using a portable dental ozonated-water irrigation device capable of producing 5 ppm suitable for dental treatment (Ozone Oral Irrigator), we have sought to establish the evidence base (EBM) for ozonated water with respect to its antibacterial action, prevention of nosocomial infection, hemostasis, wound healing, whitening, halitosis suppression, and safety through both basic and clinical research [5]. Ozonated glycerol, as its name indicates, is a glycerol gel containing ozone [6]. OG has a long half-life [6], is safe for the skin, eyes, and oral mucosa [7,8], and has been reported to exert antibacterial [6,9] and hemostatic [10] effects. Recently, we reported favorable results of adjunctive therapy using ozonated water (OW) and ozonated glycerol paste (OG) for a chronic apical periodontitis lesion that could be regarded as chronic granulomatous apical periodontitis [11]. In this report, we present a long-term follow-up of a case in which the use of high-concentration OW and OG was effective in implant treatment.

Case Presentation

The patient was a 68-year-old woman who presented with gingival swelling and occlusal pain in the region of the mandibular right first molar as her chief complaint. Two years earlier, the distal root of the same tooth had been extracted by root separation, and at the first visit a temporary bridge made of self-curing resin, supported by the mandibular right teeth (the second molar–first molar–second premolar–first premolar region), had been placed. Dental radiography revealed a vertical bone defect extending to near the root apex on the distal aspect of the mesial root of the mandibular right first molar (Fig. 1).



Fig. 1 Dental radiograph at the first visit.

The tooth was judged to be non-restorable, and it was explained to the patient that extraction

would be carried out after anti-inflammatory treatment of the gingival swelling. Several prosthetic options for the post-extraction defect were subsequently presented, and the patient elected implant-supported prosthetic rehabilitation for the edentulous mandibular right premolar–molar (5–6) region. She further requested that the number of surgical procedures be minimized and that postoperative surgical invasiveness be reduced. Accordingly, after the inflammation at the site had resolved, full-mouth initial periodontal therapy was performed, and a three-dimensional examination using dental cone-beam computed tomography (CBCT) was carried out at the site to plan implant placement. The examination confirmed that sufficient existing bone was present to allow implant placement at the sites corresponding to the mandibular right second premolar and the distal root of the mandibular right first molar (Fig. 2).

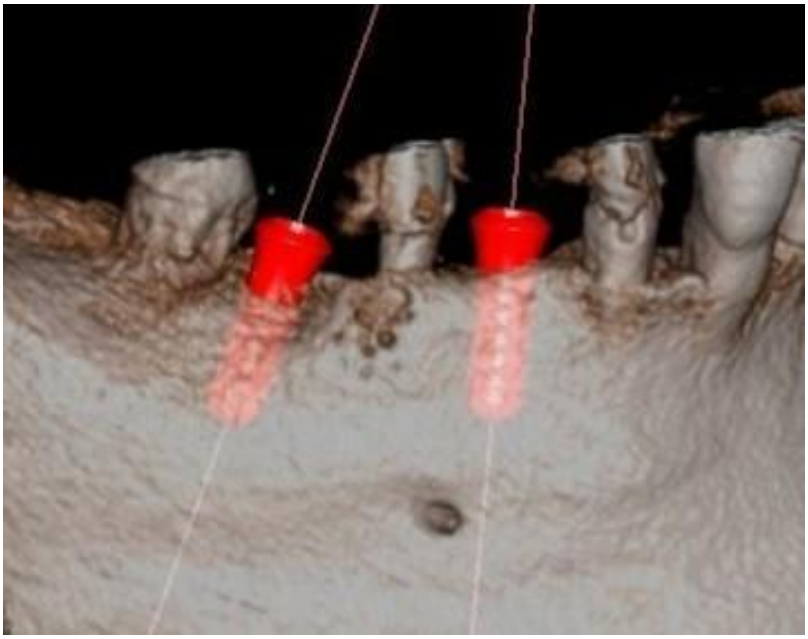


Fig. 2 Three-dimensional image of the implant placement plan.

In formulating the implant placement plan, with the aim of reducing the number of surgical procedures, we planned to place two tissue-level implants simultaneously with extraction of the mesial root of the mandibular right first molar: a Tapered Swiss Plus® Implant, φ3.8 mm × 12 mm, narrow platform (ZimVie, USA) at the mandibular right second premolar site, and a Tapered Swiss Plus® Implant, φ4.8 mm × 10 mm, standard platform (ZimVie, USA) at the first molar site. To reduce surgical invasiveness, we decided to irrigate the surgical field continuously with ozonated water and, at wound closure, to apply ozonated glycerol (OG) paste to the extraction socket and to the inner surface of the elevated full-thickness flap, thereby aiming to reduce postoperative discomfort. The study was carried out with due attention to the protection of the participant in accordance with the Declaration of Helsinki, and appropriate ethical considerations, including informed consent, were observed.

Materials and Methods

Local anesthesia was administered to the gingiva at the site using 1.8 mL of a lidocaine hydrochloride and adrenaline (epinephrine) bitartrate injection (Ora® Injection Dental Cartridge 1.8 mL; GC Showa Yakuhin, Tokyo, Japan). An incision was made at the center of

the alveolar crest with a No. 15C replaceable-blade scalpel. A full-thickness flap was then elevated with a periosteal elevator, and the mesial root of the mandibular right first molar was extracted together with the unhealthy granulation tissue present around it. To prevent postoperative infection of the extraction socket, the chronically persistent inflammatory granulation tissue that had formed in the socket was thoroughly removed. During this procedure, in order to achieve hemostasis and disinfection of the surgical field, the site was frequently irrigated using an ozonated-water generator capable of producing high-concentration ozonated water at 5 mg/L from purified water (Ozone Oral Irrigator; Kashiwazaki U.S.Tech Ltd., Niigata, Japan); the chronically persistent inflammatory granulation tissue within the jawbone was removed and the granulation-derived exudate was rinsed away (Fig. 3).



Fig. 3 Removal of unhealthy granulation tissue from the extraction socket; the surgical field was continuously irrigated with OW to keep the view clear.

Next, in accordance with the treatment plan, drilling for implant placement was performed as specified at the mandibular right second premolar and first molar sites. Because cutting debris generated during drilling may remain in the osteotomy, the sites were thoroughly irrigated with OW to remove it. The implant bodies were then placed in their designated positions, and when the cover caps were attached to the implant heads, the screw holes were also irrigated with OW before the caps were seated (Fig. 4).



Fig. 4 The screw hole is irrigated with OW before the cover cap is seated.

Before suturing the elevated full-thickness flap, OG was packed into the space among the extraction socket, the inner surface of the elevated full-thickness flap, and the alveolar bone surface (Fig. 5).

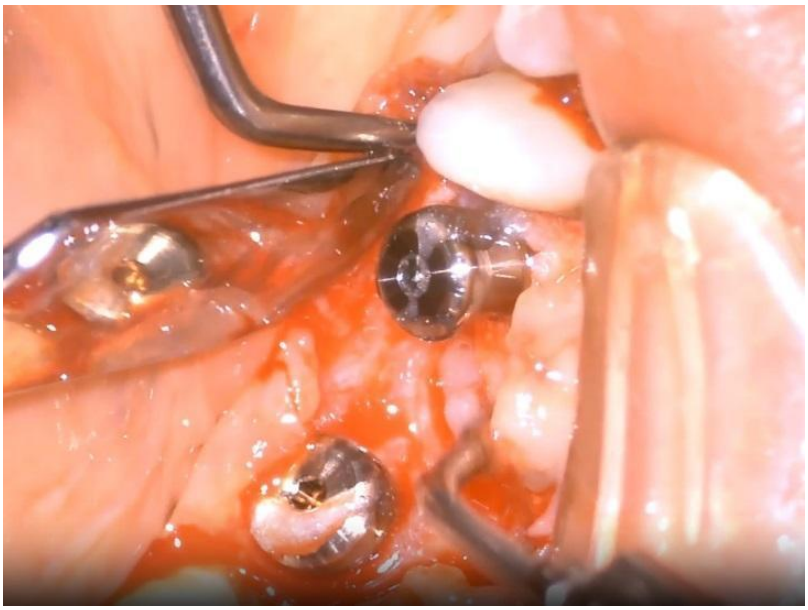


Fig. 5 OG paste is injected into the extraction socket and onto the inner surface of the elevated full-thickness flap.

Simple interrupted suturing was performed using a 3-0 PTFE non-resorbable monofilament suture (CYTOPLAST™ PTFE Suture) (Fig. 6).

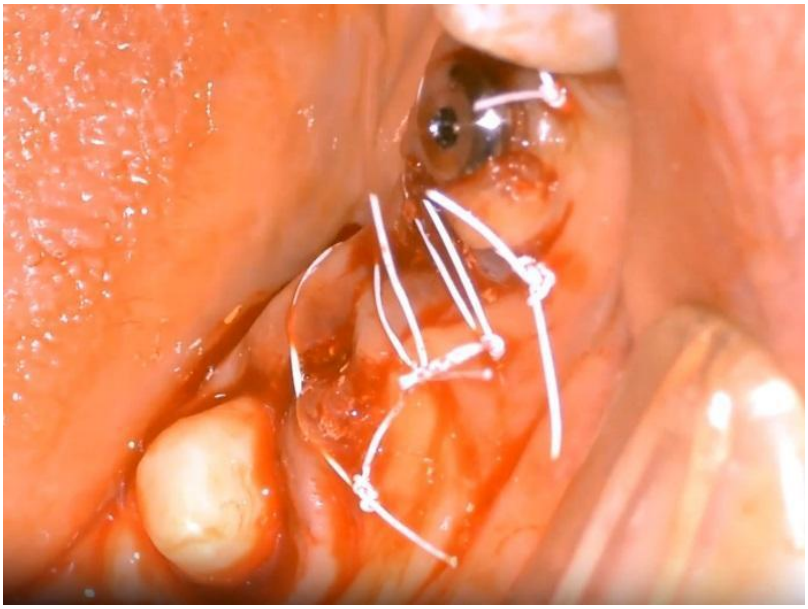


Fig. 6 Tension-free simple interrupted suturing was performed.

No bleeding from the incision was observed immediately after surgery. Postoperative medication consisted of amoxicillin (Sawacillin Tablets 250; LTL Pharma, Tokyo, Japan) 1500 mg per day in three divided doses for three days, and loxoprofen sodium (Loxoprofen Tablets “Kunihiro”; Kokando Pharmaceutical, Hyogo, Japan) 60 mg as needed for three doses. Dental radiography performed immediately after surgery confirmed that implant placement had been carried out as planned (Fig. 7).

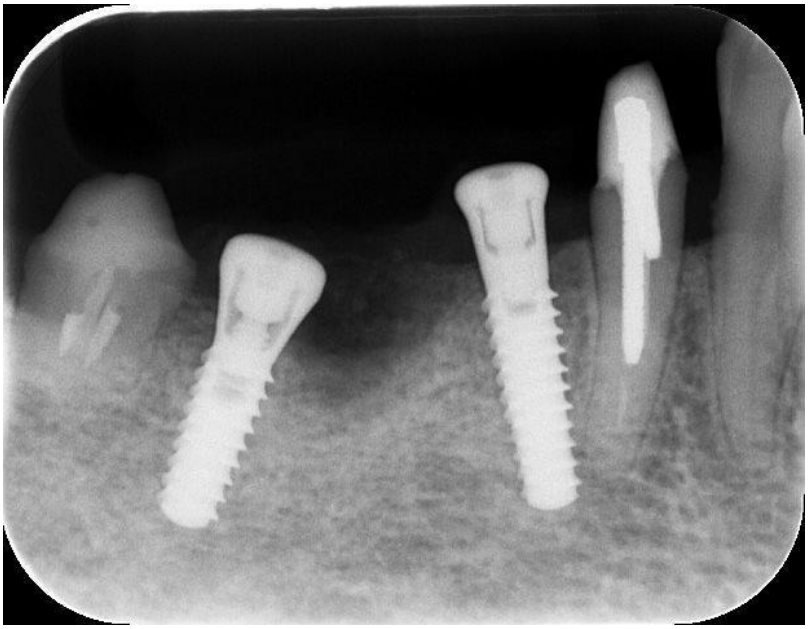


Fig. 7 Dental radiograph immediately after surgery, confirming implant placement as planned.

With regard to postoperative care, in addition to the usual instructions, in-office irrigation with OW and application of OG to the cover caps, the sutures, and the surgical wound surface were performed until the sutures could be removed. After suture removal, the patient herself used a “super-soft-bristle toothbrush” to apply OG paste gently, as if lightly stroking the caps and the wound surface, until one month postoperatively.

Results

On postoperative day 1, the findings were pain (−), swelling (−), bleeding (−), and redness (−); the patient reported taking an analgesic only once, immediately after surgery when the local anesthesia wore off. Although a raised blood clot was observed on the surface of the extraction site, where the wound could not be completely closed, there was no postoperative bleeding, indicating that inflammatory symptoms up to postoperative day 1 were considerably suppressed (Fig. 8).

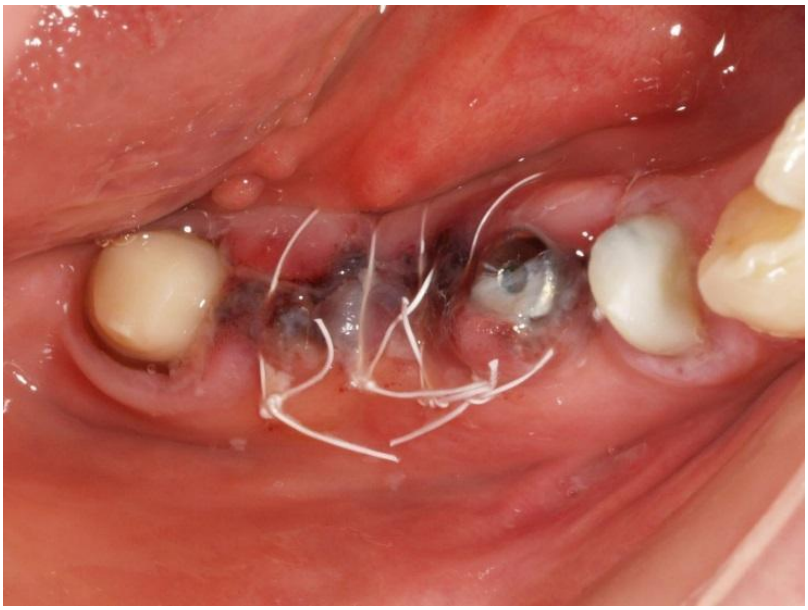


Fig. 8 Condition of the surgical site on postoperative day 1; the open-wound area is filled with a blood clot.

By postoperative day 7, the redness of the incision line had disappeared, and proliferation of connective tissue was observed in the depressed area of the extraction socket (Fig. 9).

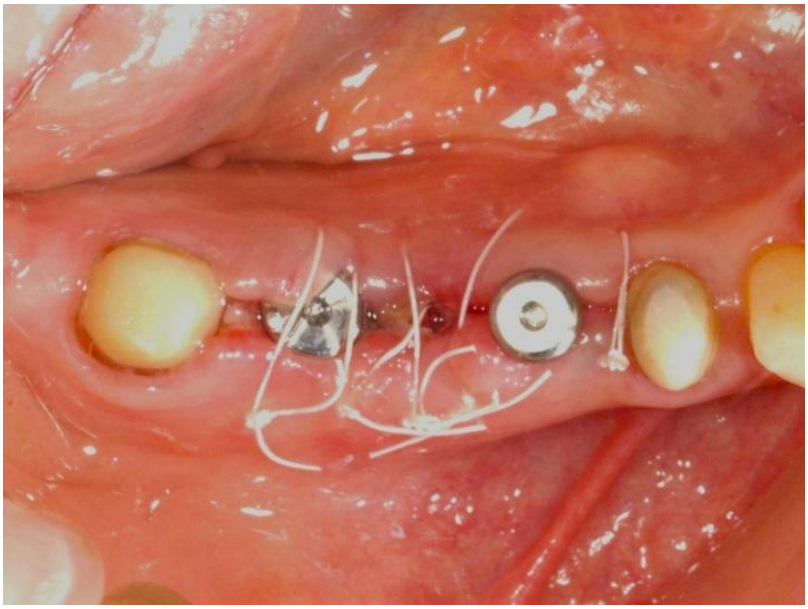


Fig. 9 Postoperative day 7; soft-tissue healing around the cover caps is favorable, with slight depression remaining at the extraction socket site.

At one month postoperatively, the open-wound area, although somewhat immature, was covered by epithelial tissue (Fig. 10).



Fig. 10 One month postoperatively; mucosal healing around the cover caps and at the extraction socket site is favorable.

Dental radiography showed no resorptive image in the bone tissue around the implant bodies, and postoperative bone healing of the extraction socket was also promoted (Fig. 11).

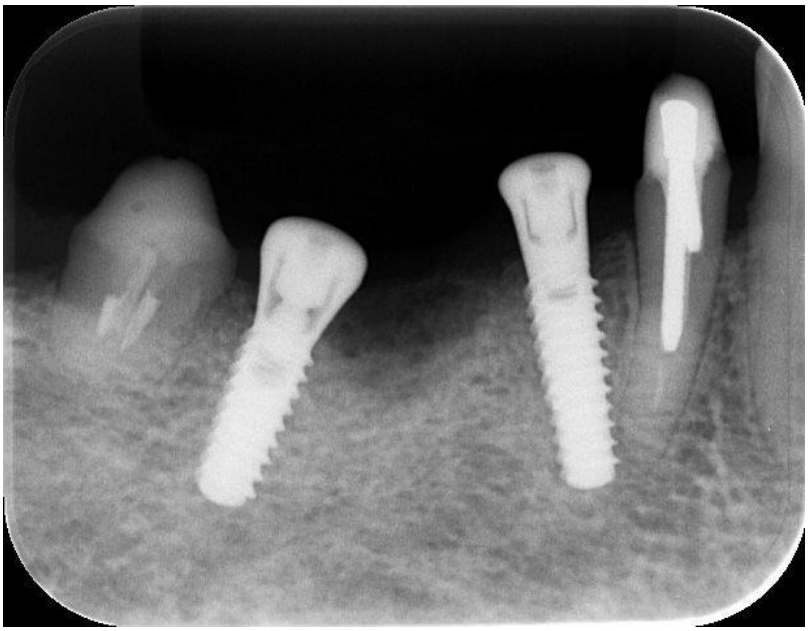


Fig. 11 Dental radiograph at one month; healing is favorable both around the implant bodies and in the extraction socket.

At two months, the cover caps were surrounded by thick epithelial tissue (Fig. 12).



Fig. 12 Sufficient keratinized mucosa has been obtained around the cover caps.

Dental radiography also showed no problems in the bone tissue around the implant bodies or in the extraction socket, and it was confirmed that soft tissue of sufficient depth was present at the implant neck region (Fig. 13).

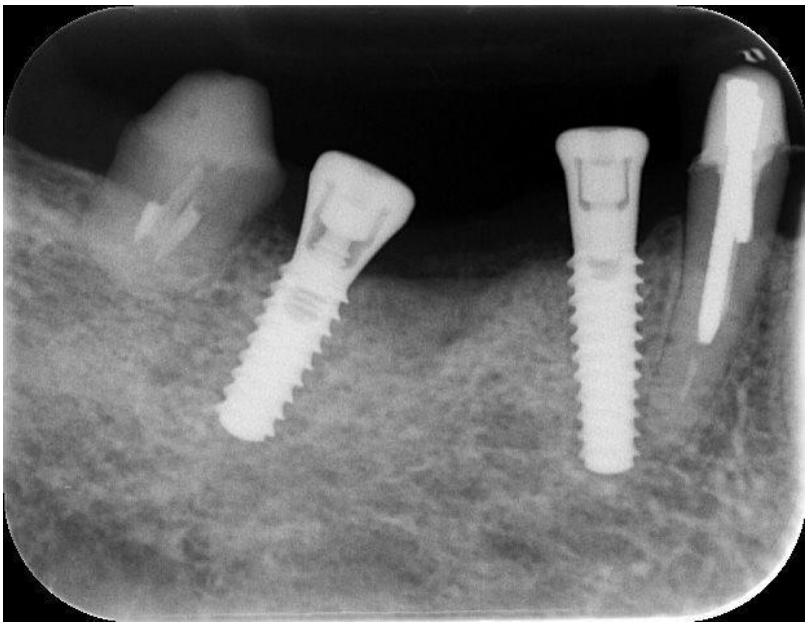


Fig. 13 Dental radiograph at two months postoperatively; marked bone regeneration is seen in the extraction socket.

As favorable healing was confirmed, a superstructure with a supragingival margin and provisional cementation was planned, and a custom abutment was fabricated. After a one-month period of observation with a provisional restoration, the definitive prosthesis was fabricated. Dental radiography three years after placement of the superstructure showed that the extraction socket and the peri-implant bone were in a favorable condition (Fig. 14).

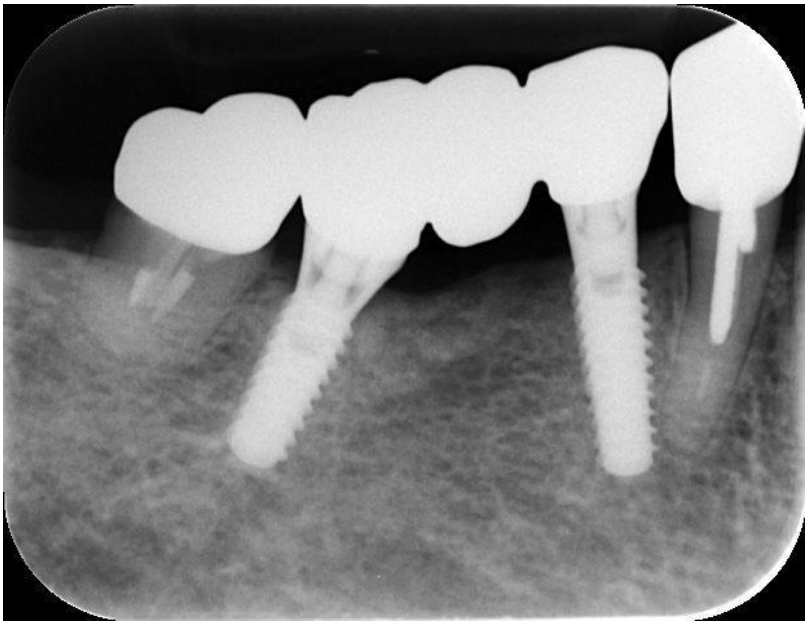


Fig. 14 Dental radiograph three years postoperatively; no marginal bone loss is observed.

The present case has now been followed for ten years. During this period, maintenance has been performed every three months without exception, and no complications related to the various aspects of implant prosthetic rehabilitation have occurred (Figs. 15 and 16).



Fig. 15 Dental radiograph ten years postoperatively; bone apposition is observed around the implant necks.



Fig. 16 Intraoral condition at ten years postoperatively.

Discussion

In current implant placement surgery, including immediate implant placement, a healing process via an open wound is increasingly being chosen. The primary reason is the demand, from both patient and surgeon, to reduce the number of surgical insults as patients age. Another advantage is that procedures for establishing favorable peri-implant tissue conditions for the subsequently fabricated superstructure can be carried out at the same time. However, it is rarely mentioned that a prerequisite for obtaining these advantages is considerable suppression of postoperative inflammation. We have previously presented cases demonstrating that the use of OW and OG suppresses postoperative inflammation in various types of intraoral surgery. Here, we discuss the effects that these two agents exerted during the present surgical procedure.

1. In the curettage and removal of granulation tissue formed within the jawbone, suppression of bleeding, which impairs the surgical field of view, is important. Thorough removal of the chronically persistent inflammatory granulation tissue influences not only the suppression of inflammation but also the achievement of favorable healing of the bony defect. In the present case as well, early and favorable healing of the extraction socket was obtained. Although the surgical wound surface is generally recommended to be irrigated with physiological saline, it is considered that, for a small wound surface, the use of OW—which is prepared from purified water—does not suppress healing.

2. If cutting debris generated during preparation of the implant osteotomy remains in the site, problems may arise with placement of the planned implant body. It is therefore necessary to irrigate the prepared implant osteotomy thoroughly. In addition to its cleansing effect, an advantage of using OW for this irrigation is that the healing-promoting effect of ozone may promote osseointegration with the implant body.

3. When attaching the healing cap, cover cap, intermediate abutment, and provisional prosthesis after implant placement, these components must be screwed onto the implant body.

It has been reported that there is a correlation between the number of times such parts are attached and detached and the occurrence of marginal bone resorption around the implant body. However, there have been no reports on whether any measure can be taken before attachment. Before screwing the components, we irrigate the screw hole of the implant body with OW for the purpose of disinfection and then tighten the screw with the hole filled with ozonated water. To date, no metallic corrosion of the titanium caused by OW has been observed.

4. A point to consider at the stage of surgical wound closure is that, when suturing the elevated full-thickness flap, it is important to suture with attention to the position of the flap to promote the augmentation of keratinized mucosal epithelium. Such flap closure increases the area of the open wound, so maintenance of the blood clot covering that area becomes important. To maintain the blood clot, it is desirable to avoid impairment of flap stability due to postoperative swelling of the mucosal flap. As a countermeasure, we apply OG between the elevated full-thickness flap and the bone surface immediately before suturing. The rationale is that the presence of a hematoma on the inner surface of the flap after suturing—a cause of postoperative swelling—is said to induce postoperative infection. Because infection control by postoperative OW irrigation is impossible at this site, the only available option was pharmacotherapy such as antibiotics and anti-inflammatory agents. A characteristic of OG is that it can maintain its ozone concentration for several days. We have experienced, in cases other than the present one, that the same method of using OG is effective in suppressing swelling during the early postoperative healing process in surgery that is allowed to heal under a closed wound.

5. Using OW and OG, the blood clot within the extraction socket was protected and its replacement by connective tissue was promoted, and early closure of the wound surface accompanying regeneration of the mucosal epithelium prevented collapse of the extraction socket. As a result, favorable augmentation of bone tissue occurred in the extraction socket, and it was confirmed that long-term stability of the implant prosthesis could be achieved.

In the future, to clarify the usefulness of OW and OG more clearly, we consider it necessary to conduct follow-up observation in a variety of cases.

Conflict of Interest: Gotaro Shiota is a director of Mediplus Pharma, Inc. The other authors declare no conflicts of interest.

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