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AIMS AND SCOPE

The Journal of Korean Academy of Osseointegration is the official peer-reviewed, quarterly publication of The Korean Academy of Osseointegration (KAO). The Journal publishes original research papers, clinical observations, review articles, viewpoints, commentaries, technical note, case reports, and letters to the editor in subjects relating to clinical practice and related basic research on dental implant including other reconstructive procedures for maxillofacial areas. Eventually, the journal aims to contribute to academic advancement of dentistry and improvement of public oral and general health.

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Esthetic restoration of implant prosthesis for traumatic maxillary anterior teeth using digital technology

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Advances in digital technology have made the fabrication of dental prostheses more efficient in terms of time and cost. This technology also enables more information to be communicated to the technician, which was not possible with previous technologies, resulting in more accurate prosthetic designs. In this case, we would like to present a case involving the placement of dental implants and prosthetic restoration for the maxillary anterior teeth. We combined facial scanning and intraoral scanning to efficiently achieve the patient's desired aesthetics. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2023;15(1):1-5)**

Key words: Digital dentistry, Esthetic, Implant, Facial scan, Intraoral scan

INTRODUCTION

Advancements in digital technology have enabled the integration of a wide range of equipment and materials into dental treatments. Traditionally, the creation of wax patterns and casting was a manual process, but now, it can be designed using computerized CAD programs and machined. Manual methods necessitate a substantial amount of additional materials, such as plaster and resin, along with dedicated physical space and equipment for work. Moreover, they require more time to produce a physical result, such as a model, before proceeding to the next step. Given that the traditional method relies on the technician's visual and tactile skills to shape the materials, results can vary significantly based on the technician's expertise.

Fabrication of the maxillary anterior prostheses is more challenging than the posterior teeth due to their visibility, where even slight variations in shape, such as length and angle, can be noticeable. According to Dawson[1], maintaining proper anterior guidance is crucial for fixed prosthetic restorations. Therefore, in cases where anterior guidance is lost during the mandible's eccentric movements, it becomes necessary to establish the correct anterior guidance through anterior restorations. The following factors must be communicated: the degree of labial surface exposure below the upper lip, the teeth's rounded or angular shape, and their color, as well as the extent of exposure during a patient's smile. Adjustments and determinations are required for the horizontal and vertical overlap of the mandibular teeth and the anterior and lateral angles of the condylar pathway. These adjustments should be made in the provisional restoration and transferred to the final prosthesis to ensure consistency. Digital technology allows us to accurately replicate the teeth's shape through the scanning and superimposition process[2].

To create an aesthetically pleasing prosthesis, it's crucial to harmonize it with the patient's facial appearance. While various methods have been introduced for this purpose, such as using photographs of the patient's face, they are limited by their two-dimensional nature[3]. When working with information like a tooth-shaped model and a face-bow indicating the patient's maxillary position and occlusal plane, along with photographs, achieving the desired outcome can be challenging due to the lack of three-dimensional information about the patient's facial structure[4]. Furthermore, in the case of face-bows, it can be difficult for the technician to identify incorrect acquisition or deformation during the transfer process. However, digital facial scanners overcome these limitations by enabling the acquisition of three-dimensional images.

We would like to introduce a patient with a partially edentulous maxillary anterior region. In this case, implants were precisely placed using digital guidance in the desired area. Subsequently, a prosthesis was fabricated to achieve both the desired

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aesthetics and optimal function, utilizing intraoral and facial scans for precise measurements.

CASE REPORT

A 53-year-old female patient came to clinic due to an traffic accident. At the time of the accident, teeth #11 and #21 were slightly compressed in their original positions, and following the repositioning of #11 and #21, the anterior teeth from #13 to #23 were splinted using dental resin and wire (Figure 1). After the accident, the patient experienced persistent spontaneous pain in teeth #11 and #21, leading to endodontic treatment and several months of follow-up. As a result of the noise in the right temporomandibular joint (TMJ) that developed after the accident, she was diagnosed with temporomandibular joint derangement and treated with an occlusal splint, along with regular physical therapy.

After 6 months of follow-up, tooth #11 was extracted due to persistent pain, and TMJ arthrocentesis was performed to address ongoing TMJ pain and restricted mouth opening. At the 11-month follow-up, teeth #12 and #21 exhibited increased mobility and pain. X-rays showed no abnormalities in #12 and #21, and they still had pulpal vitality, but the pain had intensified. Despite the administration of analgesic and anti-inflammatory medication to alleviate TMJ symptoms, there was no improvement. Therefore, additional extractions were performed based on the patient's complaint (Figure 2).

One year after the trauma, temporary dentures were placed following the extraction of #12 and #21. The TMJ pain and mouth opening showed varying improvement, but the anterior region pain was completely resolved. After confirming the absence of pain, Digital CT (DCT) and modeling were performed to plan implant placement in the anterior region using Implant Studio software (3Shape®, Copenhagen, Denmark). A 3-unit fixed prosthesis was planned with the implantation of #12 and #21 (Figure 3). The second surgery took place 4 months after the implant fixture (TS III mini, Osstem Implant Co., Ltd., Busan, Korea) was inserted. One month later, an impression was taken using an oral scanner, Medit i700 (Medit, Seoul, South Korea), for the fabrication of a fixed temporary prosthesis (Figure 4). Initially, a customized abutment and an upper PMMA (polymethyl methacrylate) temporary prosthesis were fabricated to evaluate the overall shape and function.

After the placement of the temporary prosthesis, the patient

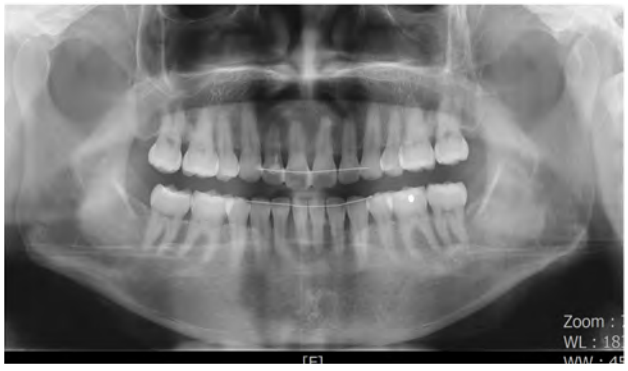

Figure 1. Diagnostic panoramic view.

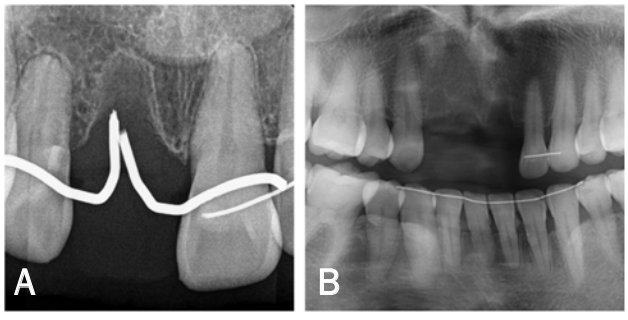

Figure 2. Extraction of teeth. (A) Right maxillary incisor site. (B) Additional extraction of adjacent teeth due to persistent pain.

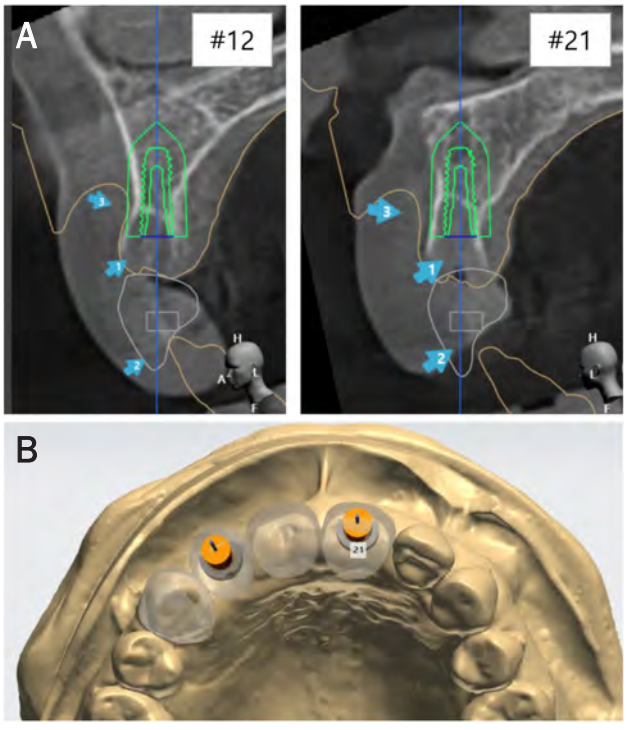

Figure 3. Implant planning. (A) Sagittal view of the implant fixtures placed in the planned area, (B) Planned implant position.

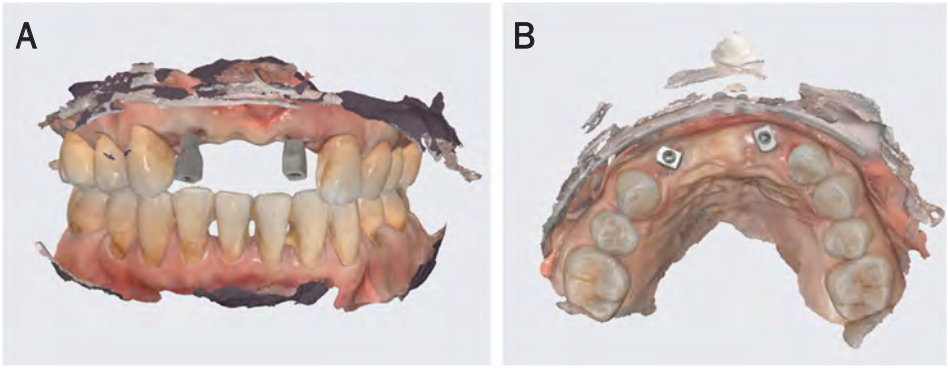

Figure 4. Intraoral scan. (A) Anterior side view with scan body, (B) maxillary occlusal view.

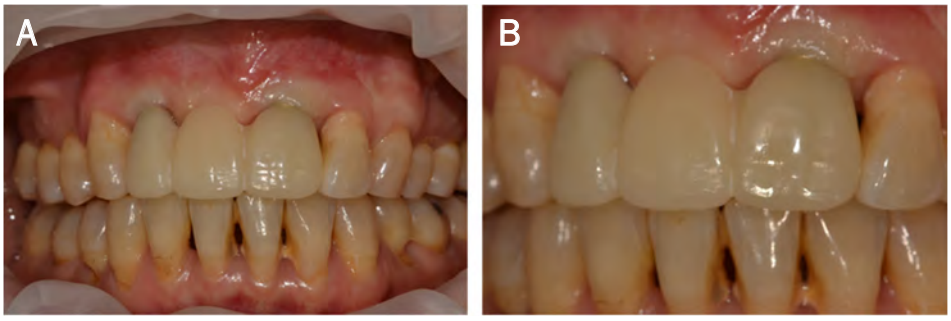

Figure 5. Provisional restrotation. (A) Anterior view, (B) Closer view showing gingival bleaching immediately after delivery of prosthesis.

was satisfied with the gingival appearance but experienced pronunciation discomfort. Upon intraoral examination, we observed an asymmetry in the lingual surface form and a misalignment in the horizontal overjet bite. The asymmetry in the horizontal overjet was attributed to the asymmetry in the mandibular dentition. Ultimately, we confirmed the crown form desired by the patient and made necessary adjustments (Figure 5). Along with the abutment-level impression and temporary bridge impression, we also acquired a facial scan (RAYface®, Raymedical, Seongnam, Korea) and sent it to the dental laboratory.

In the exocad CAD software program (exocad GmbH, Darmstadt, Germany), the facial scan file, model scan file, intraorally adjusted temporary bridge scan file, and customized abutment scan images previously stored in the library were loaded and aligned. Through the facial scan, we were able to assess the patient's lip shape, teeth exposure, smile line, and teeth arrangement from the front view. The scan provided alignment from the bottom to the top of the jaw, including the nose, maxilla, and mandible, allowing us to confirm the arrangement of the teeth. We observed asymmetry in the cervical contour between the area with the implant abutment, #21, and the pontic area without the fixture and abutment, #11, due to the presence or absence of the fixture. To achieve the closest possible match in shape, we made adjustments and replicated the adjusted occlusal surface condition within the oral cavity (Figure 6).

The definite zirconia fixed prosthesis was fabricated by milling, and after confirming the fit in the oral cavity, it was ultimately cemented using implant-specific cement (cem-implant). The patient expressed a high degree of satisfaction with the aesthetics, and during the 6-month follow-up, no inflammation or functional issues were detected, indicating that the prosthesis was well-maintained (Figure 7).

DISCUSSION AND CONCLUSION

This is a case involving a middle-aged female patient with relatively healthy dentition, who unfortunately lost a tooth due to an accident. The loss of maxillary anterior teeth in younger patients can be psychologically devastating and can also limit their social activities. The patient is eager for a rapid restoration to resume her normal daily life.

Digital technology offers the advantage of achieving a more aesthetically pleasing and faster restoration by simplifying the prosthetic process and enhancing result predictability. It facilitates easier communication with the technician, allowing you to visually convey your specific instructions. Unlike traditional methods that only replicated the shape of the teeth, facial scanners now enable the inclusion of soft tissue appearance and CAD-designed

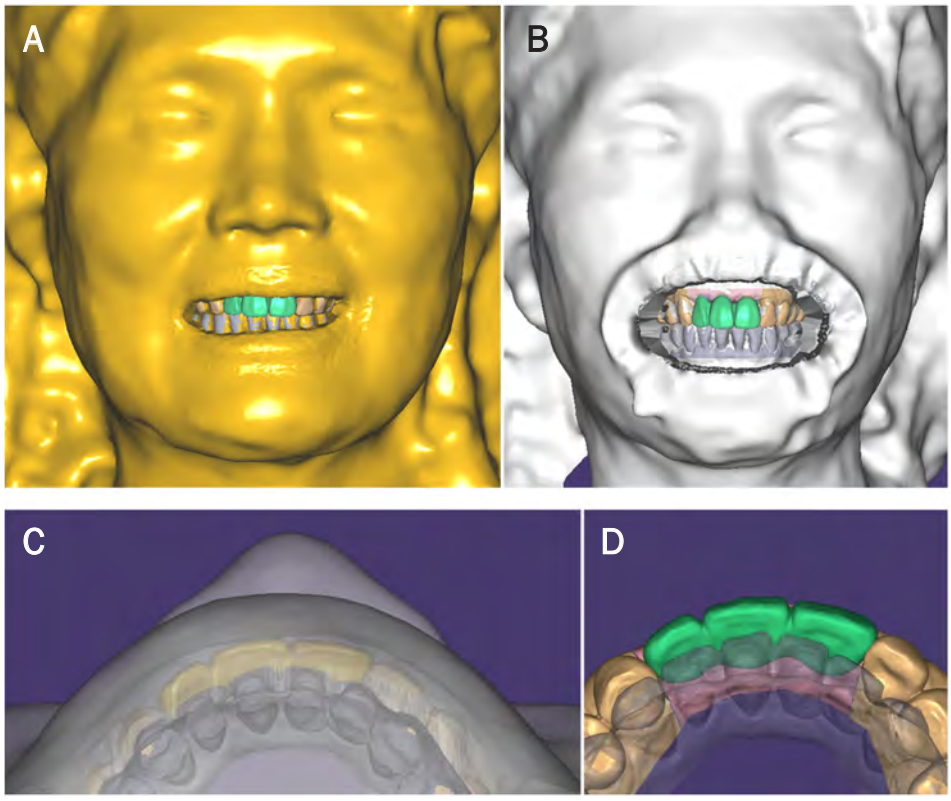

Figure 6. Digital wax–up on the virtual patient. (A) Wax up on the superpositioned model, (B) Successful matching of facial scan teeth and model scan teeth. (C) Inferior site view of the vertical axis showing the relationship between wax up and soft tissue. (D) Virtual wax up showing appropriate overjet.

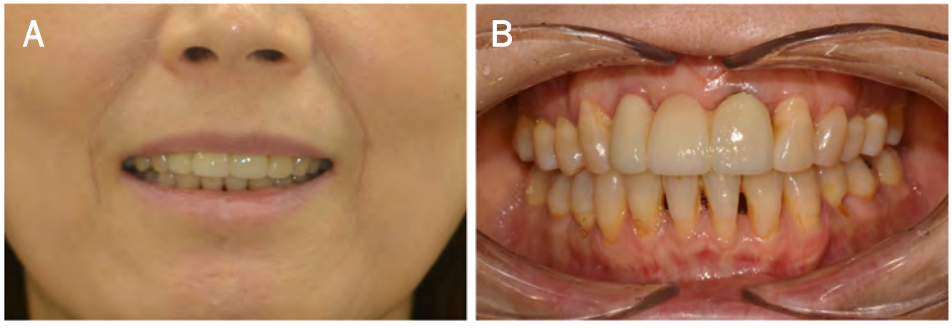

Figure 7. Photographs after the placement of definitive prosthesis. (A) Extraoral view with smile, (B) Intaroal view.

dental restoration into a virtual patient, resulting in a prosthesis that harmonizes with the patient's facial features[5].

Three-dimensional virtual diagnostics serve as a valuable visual aid, promoting effective communication among the dentist, patient, and technician. The creation of a 3D virtual diagnostic model using digital techniques efficiently supports the diagnosis of visible and predictable prosthetic restorations in a shorter timeframe, ultimately enhancing treatment satisfaction and the quality of the prosthesis design.

The initial step in fabricating an implant prosthesis for both aesthetic and functional purposes is the precise placement of the implant fixture. One approach to determining the fixture's position is known as 'prosthetic-driven implant placement,' which prioritizes the implant prosthesis in the planning process. For this purpose, implant surgical guides based on plaster models have been in use for an extended period. However, recent advancements in technology, such as cone-beam computed tomography (CBCT), oral scanners, model scanners, and impression body scanners, have made it possible to create three-dimensional reconstructions of the patient's oral cavity. This three-dimensional reconstruction allows for precise implant fixture placement through computer-guided implant placement simulation and surgical guidance, resulting in significantly improved outcomes[6]. A study conducted by David et al.[7] compared the planned and actual placement errors of fixtures in the alveolar ridge crest. They found that traditional implant guides resulted in a 1.5 mm

error, which was reduced to 0.9 mm when using surgical guides.

While dental implants are susceptible to lateral forces, anterior teeth in the maxilla can also experience lateral forces during eccentric mandibular movements. When implants are subjected to lateral forces, stress tends to concentrate at the alveolar ridge crest. Consequently, it is crucial to be attentive when achieving an occlusion that protects the implant during anterior guidance, while also allowing for disclusion in the posterior teeth. Misch[8] suggested that by adjusting the occlusion to evenly distribute the load between the implant and natural teeth in the dental arch when strong occlusal forces are applied, it is possible to reduce the typically concentrated force on the implant. Hence, it is crucial to pay close attention to the occlusal setting and adjustment of the anterior teeth, which should be thoroughly verified during the provisional phase. It's essential to transfer the occlusion data obtained from the provisional as accurately as possible to the technician, and digital techniques facilitate a more realistic final prosthetic design. As time passes, natural teeth can shift both vertically and horizontally due to wear and mesial drift. Since implants do not change position, the balance can be easily disrupted. Therefore, for anterior implant prosthetics, regular check-ups and adjustments are even more crucial[9].

In this case, a digital approach was employed, starting from the planning of implant placement to the acquisition of impressions in the maxillary anterior region. This allowed for precise implant placement in the desired location, enabling the prompt placement of the prosthesis in the edentulous area. The provisional restoration's shape was accurately replicated and easily communicated, resulting in patient satisfaction with the prosthetic process and its alignment with their facial features. This process is becoming routine in most clinics, and in the future, it will continue to expand with the increasing availability of additional digital resources and the ease of use of existing equipment. To achieve this, it is expected that clinicians will continue to be required to acquire proficiency in the equipment currently being widely introduced and be open to embracing new devices.

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Clinical efficacy report of LIVE PURE DIA whitening gel

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In this study, the effect of the experimental bleaching gel (LIVE PURE DIA Whitening Gel, [LAV, Inc., Gangnam, Korea, Brand: Liveorals]) containing 3% hydrogen peroxide was evaluated. Fifty people used the bleaching gels for half an hour daily. The color was measured at baseline and 3 days, 1 week, 2 weeks after treatment using the Shade eye-NCC colorimeter and Vita Classical Shade Guides organized by value. The shading change of the entire teeth was so large ($P < 0.05$) that it could be easily perceived. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2023;15(1):6-9)**

Key words: Bleaching gel, Safety, Effectiveness, Hydrogen peroxide, Clinical study

INTRODUCTION

With the increasing aesthetic demands of the modern society, the desire to improve teeth shades is growing, which has led to the development of aesthetic dentistry[1-3]. Teeth are highly exposed parts of the body, and their shapes and colors can have significant impact on appearance, which can change first impressions. The factors that cause tooth discoloration can be divided into congenital and acquired. Congenital tooth discoloration can be caused by ingestion of fluoride in concentrations higher than 1.5 parts per million (ppm) during childhood, when teeth are still forming, or by maternal use of antibiotics containing tetracyclines during the prenatal period. Acquired discoloration can be caused by tobacco and food staining, as well as by external impact, where a sudden large force is applied to the tooth, causing the capillaries to become damaged and bleeding to spread to the surrounding tissues, making the blood visible[4]. Currently, hydrogen peroxide is being used as a material for teeth whitening, and the bleaching mechanism has been known as a decolorization process that decomposes and removes organic substances that are attached to the outside of the teeth and cause discoloration through the oxidation of generated oxygen. Teeth whitening can be categorized into three main types: professional whitening performed in the office by a dentist; home whitening performed at home by a patient with a dentist's prescription; and at-home whitening performed by an individual without a dentist's prescription. Professional whitening uses 15% hydrogen peroxide, takes about an hour, and is effective in just one to two treatments. In the case of professional whitening, distinct effects can be seen within a short period, but due to high concentration, gum damage and dryness symptoms may appear, and if not cared for properly, may not have a lasting effect. In the case of self-whitening, dentists make teeth molds for whitening that fits each individual's teeth, or standardized molds are used. After adding whitening gel, it takes two weeks to whiten the teeth. 3.5~5.4% hydrogen peroxide is used, and the relatively low concentration results in few side effects. In the case of at-home whitening using non-medical products, there are gel types that are placed in trays containing hydrogen peroxide, adhesive types that attach patches to teeth surface, and coating types that are applied to teeth surface. According to the standards of the Korean Ministry of Food and Drug Safety, products containing more than 3% hydrogen peroxide cannot be used, and previously used products have disadvantages such as having to wear a mouth opening device, difficulty in activities due to the adhesion of the patch, and difficulty in adhering hydrogen peroxide to the teeth. In order to improve these shortcomings, this study adopted the method of applying hydrogen peroxide gel to a silicone mouthpiece developed by LAV, Inc. and measured its convenience and efficacy. This study aimed to evaluate the clinical efficacy of a whitening gel containing 3% hydrogen peroxide. Fifty healthy adults wore the mouthpiece with the test whitening gel for 30 minutes daily, and the efficacy of the whitening gel was evaluated by repeated measurements on the third, seventh, and fourteenth day of use VISIA-CR, a facial photography and image analysis program, and Vita Shade Guide.

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MATERIALS AND METHODS

1. Research subjects

For this study, 50 men and women aged 20 to 60 years old were selected for this clinical trial at Live Dental Hospital Incheon, located in Incheon Metropolitan City, and were excluded if they had inappropriate dentition for teeth whitening, resin and porcelain restorations in the anterior teeth, inflamed pulp due to tooth decay or tooth wear, hypersensitivity symptoms due to gingivitis and periodontitis, excessive discoloration due to medication or congenital developmental abnormalities, and if it had not been three years since they had undergone a teeth whitening procedure in the past. The subjects were categorized according to their age as Group A for those in their 20s, Group B for those in their 30s, Group C for those in their 40s, Group D for those in their 50s, and Group E for those in their 60s.

2. Study design

Mouthpieces with gel containing 3% hydrogen peroxide (LIVE PURE DIA Whitening Gel) were used for 2 weeks. Before the test, teeth were brushed and any remaining oral moisture was removed. Teeth were rinsed thoroughly with water as the mouthpieces were removed. Whitening gel was used for 30 minutes daily. Teeth color and shades were evaluated at the point of fifth, seventh, and fourteenth days after use. Each measurement was taken in the same location at the same light level to minimize measurement error. The main ingredients of the whitening gel used in the study are shown in Table 1.

3. Research methods

Subjects were invited to clinic on weekdays during the test period with whitening gel-applied mouthpieces delivered to confirm its application. Subjects were asked to remove it after 30 minutes. On weekends, subjects were given 2-day supplies of whitening gel and mouthpiece. Two weeks later, they were asked to revisit the clinic at the same time to evaluate the efficacy and side effects by measuring the color in the same way as before the test.

Table 1. Whitening gel primary ingredients

LIVE PURE DIA whitening gel	– Hydrogen peroxide 35% – Xylitol – Lettuce extract – Polysorbate 80 – Povidone – Citric acid – Sucralose – Glycerin – Ethanol – Sodium citrate hydrate – Mixed fragrance (apple mint flavor BSA13001) – Polyethylene glycol 400 – Colloidal silicon dioxide – Purified water

4. Efficacy evaluation

1) Vita Shade Guide

The series of colors was selected as A, B, C, D, and the brightness was selected on a scale of 1~4 to measure the change of teeth color by color contrast.

To measure the change in teeth tone, the Vita Shade Guide (VITA classical shade guide, VIDENTTM, CA, USA) was used. The color standard has 16 levels (B1, A1, B2, D2, A2, C1, C2, D4, A3, D3, B3, A3.5, B4, C3, A4, C4) with color tabs referring to Table 2. The closer to 1, the brighter the color, and the closer to 16, the darker, with B1 being 1 and C4 being 16 in points. After each measurement, it is necessary to look at the sky or trees in the distance to relieve color fatigue.

2) Face photo taken with VISIA-CR

VISIA-CR (Canfield Imaging System, USA) was used to image the subjects' faces with a cross-polarized mode. The VISIA-CR is equipped with a specially designed chin rest and forehead fixture to maintain a constant angle during the shoot, and the distance between the subject and the camera is always constant. For each measurement, a strobe mounted inside the device was used to stabilize the shooting

Table 2. Stages of shade by VITA classical Shade Guide

Lightest								Darkest							
B1	A1	B2	D2	A2	C1	C2	D4	A3	D3	B3	A3.5	B4	C3	A4	C4
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Table 3. Color changes with Vita Shade Guide of all teeth by bleaching periods

Group	Time		
	3 days	7days	14 days
A	2.8	5.9	7.1
B	4.6	7.7	7.6
C	5.5	8.1	7.5
D	4.2	6.9	7.8
E	3.9	5.4	7.9
Average	4.2	6.8	7.6
Variance	0.975	1.32	0.097
Standard deviation	0.987	1.149	0.311

conditions. Changes in teeth color brightness were measured using an image analysis program (Image-Pro Plus, USA), and the mean of V value was earned. V-value is a factor related to brightness, and an increase in V-value means an increase in brightness. The rate of increase in V value was calculated using the formula below.

- Percentage increase in V value (%)

$$= \frac{\text{Measurements after product use} - \text{Measurements after product use}}{\text{Measurements before product use}} \times 100$$

In addition, the percentage of study subjects with an increase in the measurement result after the application of the product was calculated using the formula below.

- Percentage of study subjects with increased V-value (%)

$$= \frac{\text{No. of subjects with improved results}}{\text{Total number of subjects}} \times 100$$

3) Self-reported symptoms and adverse effect assessment

Researchers monitored the subjects for adverse effects and graded them according to severity. If identified, it was further evaluated by a specialist in accordance with the regulations for handling adverse effects.

To evaluate the adverse effects caused by the use of the whitening gel, symptoms were investigated through questionnaires on the 3rd, 7th, and 14th days of use. Symptoms were categorized into three levels: high, medium, and low, with high being unable to continue the experiment, medium being painful but able to continue, and low being irregular mild pain.

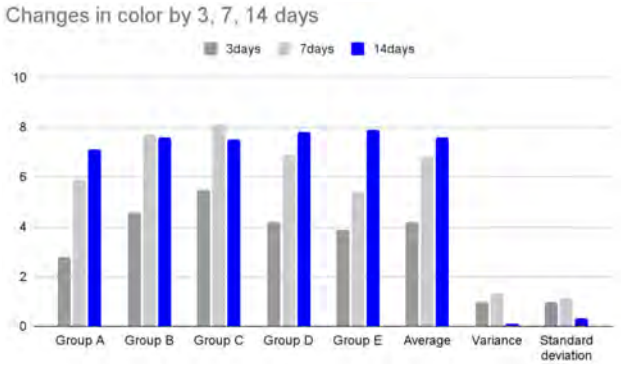

Figure 1. Shade changes by the bleaching procedure is measured using Vita Shade Guide by bleaching periods.

Table 4. In-object effectiveness test results (before and after comparison)

F	Degree of freedom	Probability *P*
3.458	2, 98	0.041

Probability *P* (repeated measures ANOVA, Significant: $*P < 0.05$, sphericity assumption).

EXPERIMENTAL RESULTS

1. Validation

1) Measuring teeth color change over time with Vita Shade Guide

Table 3 and Figure 1 show the amount of shade changes after 3, 7, and 14 days, respectively, using the Vita Shade Guide. There was no significant difference in the hue measurements taken before the whitening experiment, but after 3 days of whitening, there was a significant effect in all groups, but with a difference in degree of whitening between groups. After 14 days, there was no difference between the groups, and all groups showed a significant change with an average change of 7.6 shades.

2) Measurement of teeth color change over time with VISIA-CR

The results of teeth brightness (V-value) measurement using VISIA-CR photo and image analysis program, statistical analysis and percentage increase including average (AVE), variance (VAR) and standard deviation (STDEV) are as follows (Table 4~7, Figure 1, 2).

A within-subject effect test was conducted on V values before

Table 6. Average of individual growth rates (%) for V values

	3 days after	7 days after	14 days after
%	0.931	0.800	0.562

Table 7. Percentage of study subjects with increased V value (%)

	3 days after	7 days after	14 days after
%	76.667	86.010	84.952

Table 5. Technical statistics and object-to-in-residence test results (comparison by point in time)

	Before application	3 days after	7 days after	14 days after
AVE±STDEV	194.278 ± 8.536	195.278 ± 8.632	195.814 ± 8.722	195.360 ± 8.706
Probability *P*	–	0.029*	0.033*	0.046*

Probability *P* (repeated measures ANOVA with contrast test significant: $*P < 0.05$).

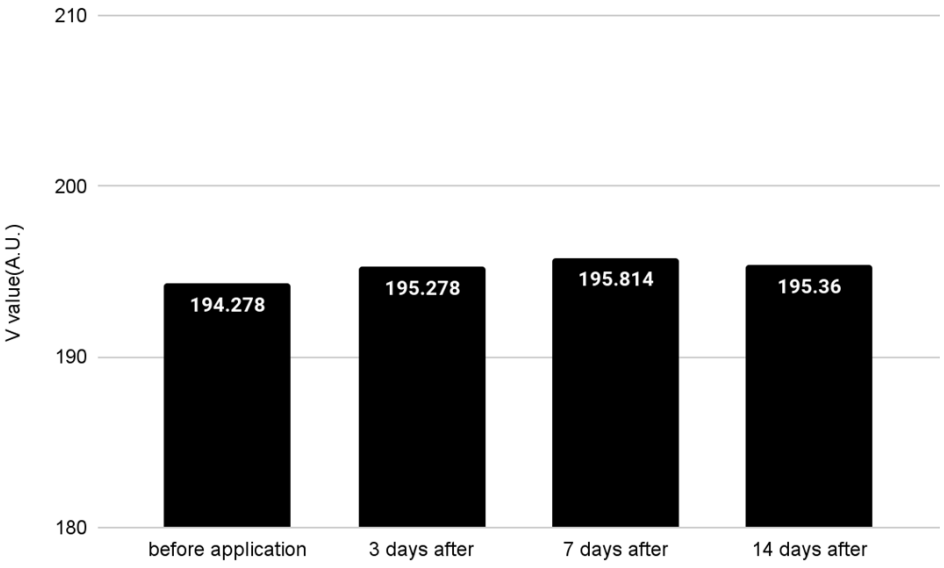

Figure 2. V value measurement result.

and after product application using VISIA-CR photo and image analysis program. The results showed a statistically significant difference ($P < 0.05$) in V values.

The within-subject contrast test showed that V increased at a statistically significant level ($P < 0.05$) after 3 days, 7 days, and 14 days of application compared to before application, with increases of 0.931%, 0.800%, and 0.562%, respectively (Table 4~7, Figure 1, 2).

As shown in Table 7, 76.667%, 86.010%, and 84.952% of the subjects showed an increase in V-value after 3 days, 7 days, and 14 days, respectively.

2. Skin adverse effects

1) What researchers say

Adverse effects were evaluated by researchers and no specific symptoms (adverse effects) related to skin reactions were observed during the study.

CONCLUSION AND SUMMARY

A study was commissioned by LAV, Inc. to conduct an internal trial to evaluate the effectiveness of the LIVE PURE DIA whitening gel made by Liveorals in improving teeth whitening with 50 subjects. After analyzing the measurements of teeth brightness using Vita Shade Guide, the incremental increase was statistically significant ($P < 0.05$) after 3 days, 7 days, and 14 days of application compared to before application, with an increase of 4.2 shades, 6.8 shades, and 7.6 shades, respectively. According to the analysis of brightness measurements of teeth area using VISIA photo and image analysis program, V value increased at a statistically significant level ($P < 0.05$) after 3 days, 7 days, and 14 days of application compared to before application of the product, with an increase of 0.931%, 0.800%, and 0.562%, respectively. Therefore, it is concluded that LIVE PURE DIA Whitening Gel helps improve teeth whitening after 3 days, 7 days, and 14 days of application. The product also did not cause any significant adverse skin reactions (side effects) during the evaluation period.

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An implant-assisted removable partial denture in a severely resorbed partially edentulous mandible; A case report

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An implant-assisted removable partial denture have some advantages for stabilizing the removable partial dentures in vertical direction, providing comfort, maintaining oral hygiene and alveolar ridge, and increasing masticatory satisfaction. The objective of this article is to present a case report of a mandibular implant-assisted removable partial denture in a severely resorbed partially edentulous patient. In this case, a 47-year-old male patient showed mobile mandibular anterior teeth and several missing teeth. The implant-assisted removable partial denture with surveyed prostheses was determined to rehabilitate mandibular teeth. With implant surveyed prostheses in left and right side, the stability of removable partial denture was increased and the patient was satisfied with the treatment. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2023;15(1):10-17)**

Key words: Implant, Removable partial denture

INTRODUCTION

Implant-supported fixed restorations are predictable treatment options and have a good prognosis for partially edentulous patients[1]. However, in situations with multiple missing teeth, severe alveolar bone loss, financial limitations, or systemic conditions, these are not always primary treatment options[2]. For the situations, a removable partial denture using dental implants can be an effective alternative option[3-5]. It is called as an implant-assisted removable partial denture (IARPD)[6]. There are some advantages for using implants, such as stabilizing the removable partial dentures in vertical direction, providing comfort, maintaining oral hygiene and alveolar ridge, and increasing masticatory satisfaction[5,7]. The implants could be used with healing abutment and attachments[8]. Also, implant surveyed prostheses are another option, providing support and retention[9]. Moreover, some prospective clinical studies recommend the use of the implant surveyed prostheses for RPD over that of conventional RPD, as improving chewing capacity and patient satisfaction[10,11].

The objective of this article is to present a case report of a mandibular implant-assisted removable partial denture in a severely resorbed partially edentulous patient.

CASE REPORT

A 47-year-old male patient presented Prosthodontics clinic in Seoul St' Mary's Hospital of Catholic University of Korea with the chief complaints of extraction on his mobile anterior teeth and to rehabilitate maxillary and mandibular teeth (Figure 1). The patient's medical history was irreversible dilated cardiomyopathy, heart failure, hyperlipidemia and atrial fibrillation. According to intraoral examination and radiographic examination, it was found that there were root remnant of mandibular first premolar on the right, alveolar bone loss and grade 3 mobility on mandibular canine on the right, grade 2 mobility of mandibular central incisor, and grade 3 mobility of mandibular lateral incisor on the left. The patient had a maxillary provisional denture and provisional crowns on maxillary right second molar and maxillary right canine. Moreover, there was no implant prosthesis over implant abutment on mandibular right second molar implant fixture.

There were two treatment options on mandibular restoration; mandibular IARPD or mandibular fixed partial denture. As for the maxillary restoration, conventional removable partial denture with #17, 13 crown was planned. First

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of all, #44, 43, 31, 32 teeth were extracted (Figure 2) and #45 implant provisional crown and mandibular provisional denture were fabricated (Figure 3). After 3 months, CBCT was taken and implant guide program (One-guide, Osstem) was used for determining treatment plan and position of the implants and fabricating stent for guide surgery (Figure 4). As the narrow bucco-lingual width on mandibular anterior was observed, mandibular IARPD with #45, 46, 47 implants was decided as the final treatment plan. The Osstem TSIII SA 5.0 x 10.0 mm fixtures were placed on #46 and 47 area with guide stent and instrument. After 3 months of osseointegration period, the restorative procedures were performed. The final impressions for #17, 13 surveyed crown, #46, 47 implant surveyed bridge, and #45 implant surveyed crown were performed. The wax-up for the crowns were tried to the patient for checking the fit, vertical dimension, and esthetics (Figure 5). The final prostheses for the crowns were fabricated (Figure 6). With the final surveyed crowns, the final impression for maxillary RPD and mandibular IARPD were performed (Figure 7). The maxillary RPD design included full palatal plate major framework, #17 mesial rest, #13 cingulum rest, #17 mesial Akers clasp, #13 distal combination clasp, and guiding plane on #13 distal and mesial, and #17 mesial. The mandibular implant-retained removable partial denture design included linguoplate major framework, #47i distal rest, #46i mesial rest for indirect retainer, #45i mesial rest, #33 cingulum rest, #34 mesial rest for indirect retainer, #35 mesial rest for indirect retainer, #37 mesial rest, #47i distal Akers clasp, #45i mesial RPA clasp, #33 mesial combination clasp, and #37 distal Akers clasp. The removable partial denture framework was examined for adaptation and centric relation was recorded. The artificial teeth were arranged and evaluated intraorally (Figure 8). The maxillary RPD and mandibular IARPD were completed and delivered after occlusal adjustment (Figures 9, 10). The patient showed satisfaction regarding the retention and function of the denture.

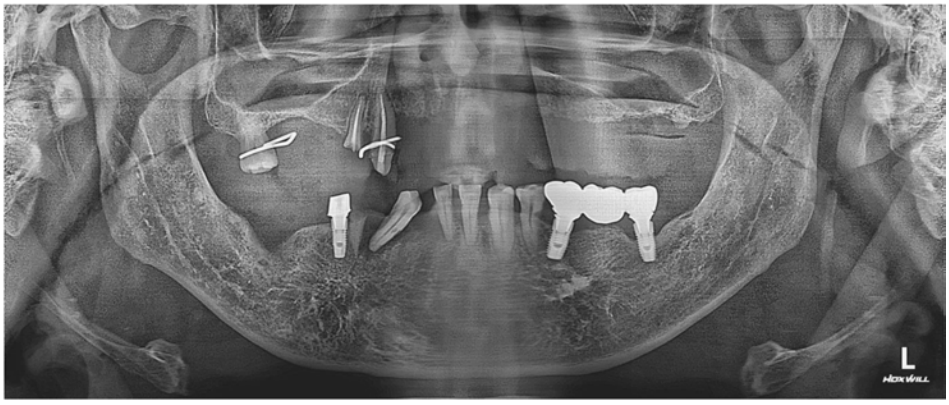


Figure 1. Panoramic radiograph on the first visit.

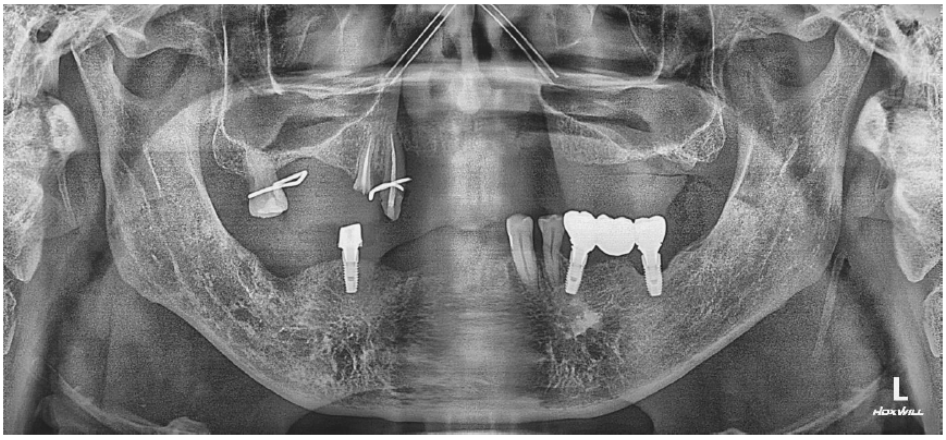
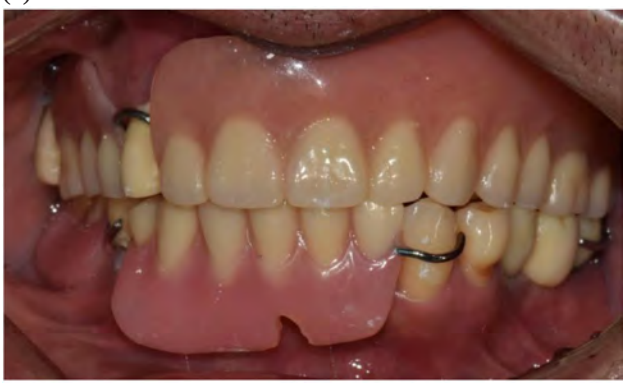
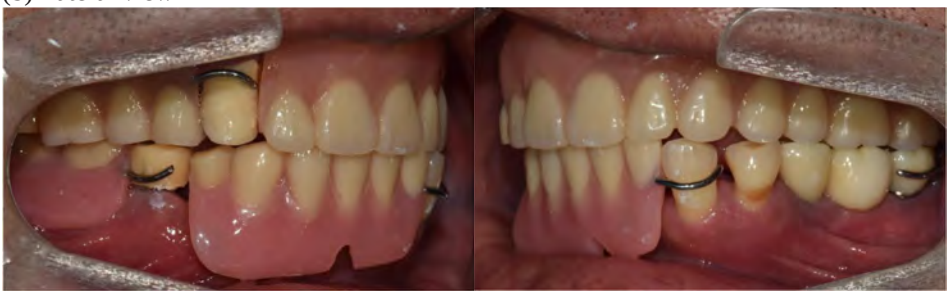


Figure 2. Panoramic radiograph after extraction of #44, 43, 31, 32 teeth.

(a) Frontal view



(b) Lateral view



(c) Occlusal view

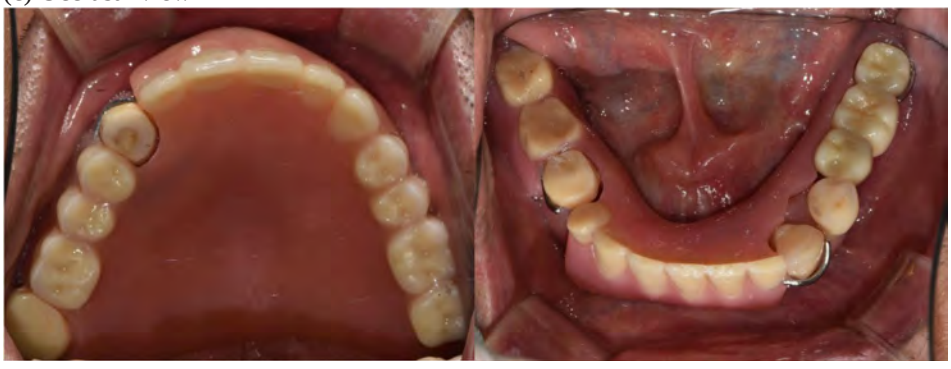


Figure 3. Maxillary and mandibular provisional denture.

(a) The position for #46 implant

(b) The position for #47 implant

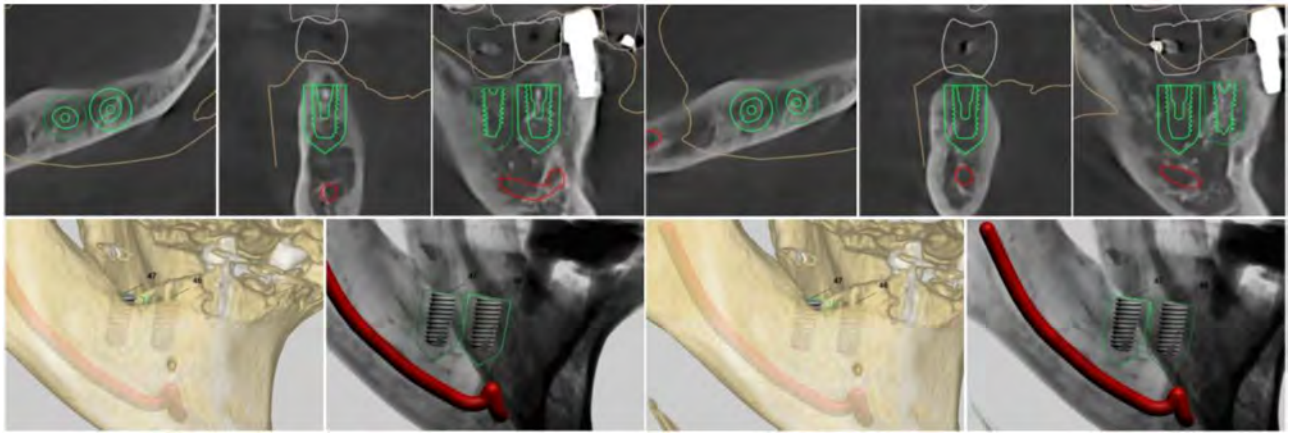
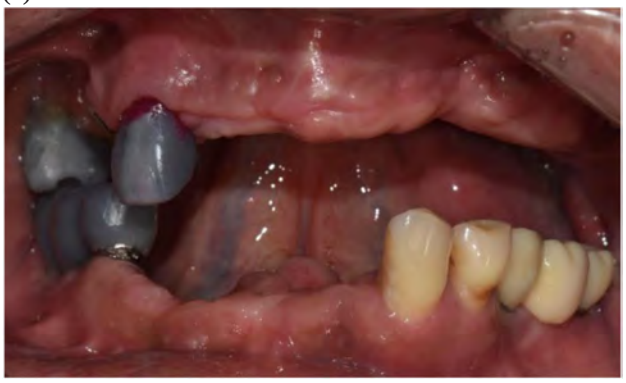
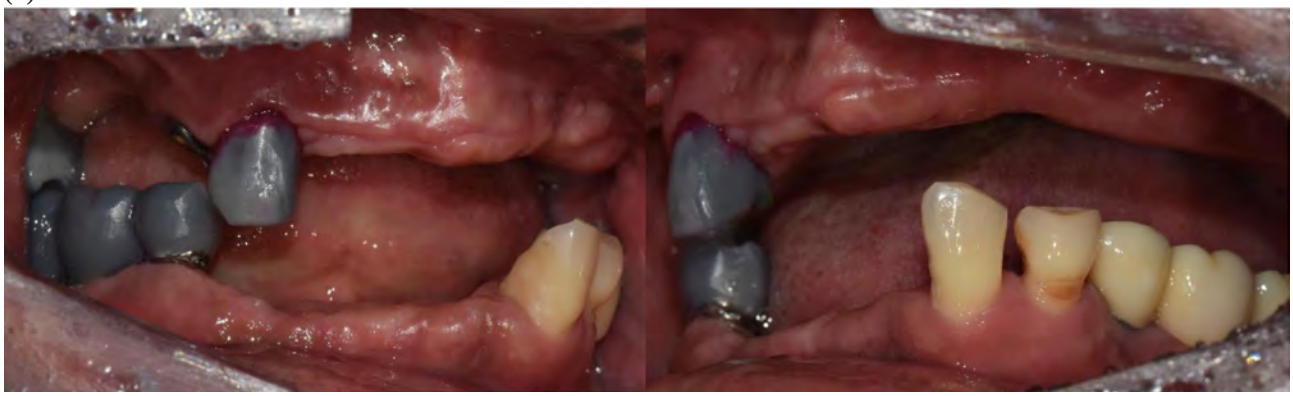


Figure 4. CT image for implant placement planning.

(a) Frontal view



(b) Lateral view



(c) Occlusal view

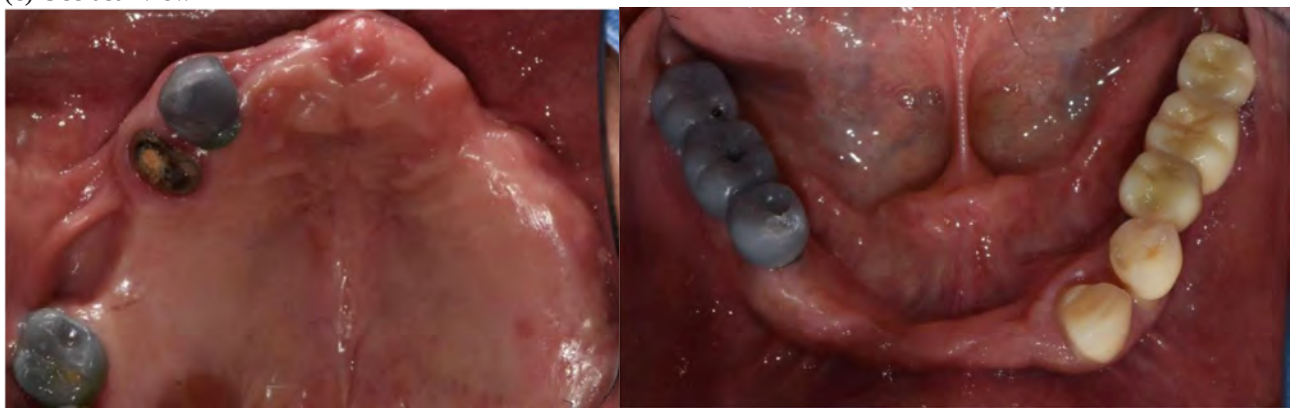
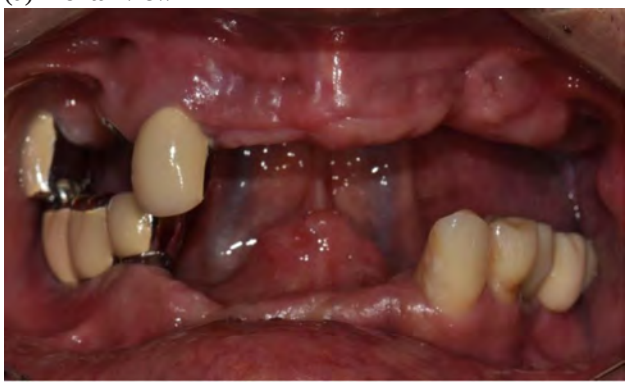


Figure 5. Wax-up crowns try-in.

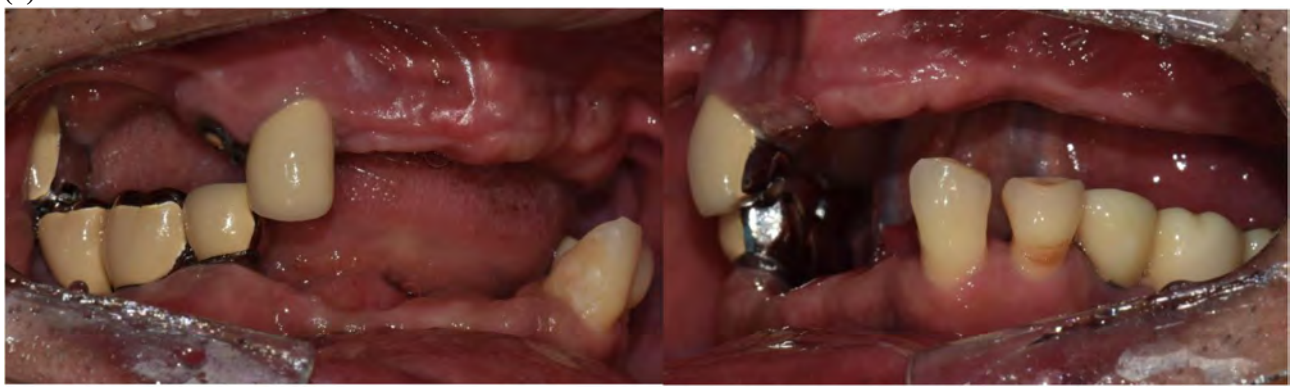
DISCUSSION

Implant-assisted RPDs can improve the stability of RPD and patient satisfaction by increasing supporting teeth and preventing bone resorption. Some studies have reported biological and prosthetic complications of IARPDs with surveyed prostheses[12-15]. Biological complications include sore spots around major connectors and denture bases, loss of opposing teeth due to fracture, alveolar bone resorption below the denture bases, greater marginal bone loss around dental implants with 2 threads exposed, and disintegration of dental implants[12-15]. Prosthetic complications include screw fracture, screw loosening, detached implant-supported surveyed single crowns due to loss of temporary cement, clasp loosening, crown veneer fracture, and fracture of artificial tooth, clasp, and rest of RPDs[12-15]. Moreover, the effective position of implant has been reported. Yuseung et al con-

(a) Frontal view



(b) Lateral view



(c) Occlusal view

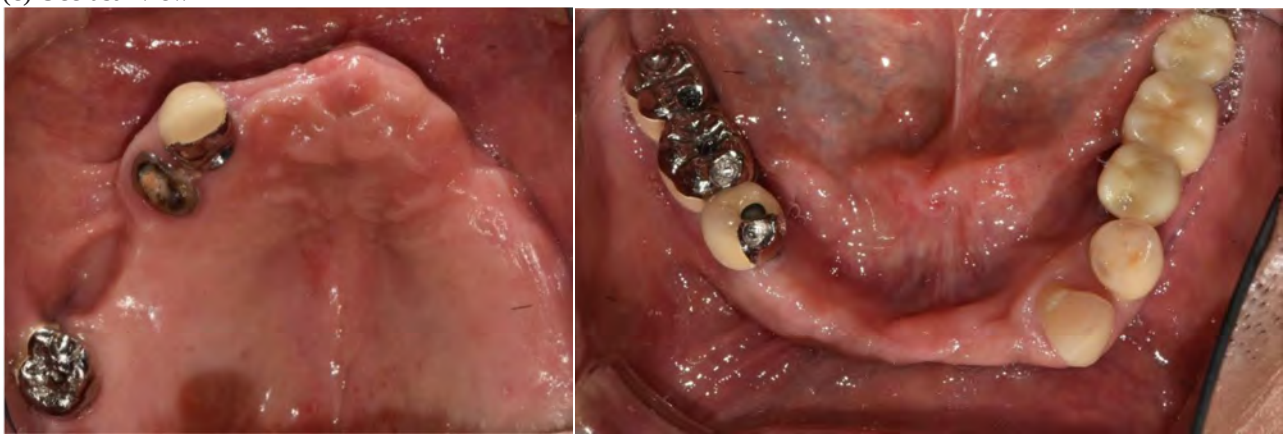


Figure 6. Definitive prostheses of maxillary surveyed crown and mandibular implant surveyed fixed restorations.

cluded implant abutments adjacent to the natural tooth showed higher success rates than those distant from the natural teeth[16]. Octavi et al reported positioning implant in the first molar could improve biomechanical behavior of implant-assisted partial removable dental prosthesis[17].

CONCLUSION

Implant-assisted RPD with supported prostheses could be a predictable and effective treatment option to improving support, stability and patient satisfaction.

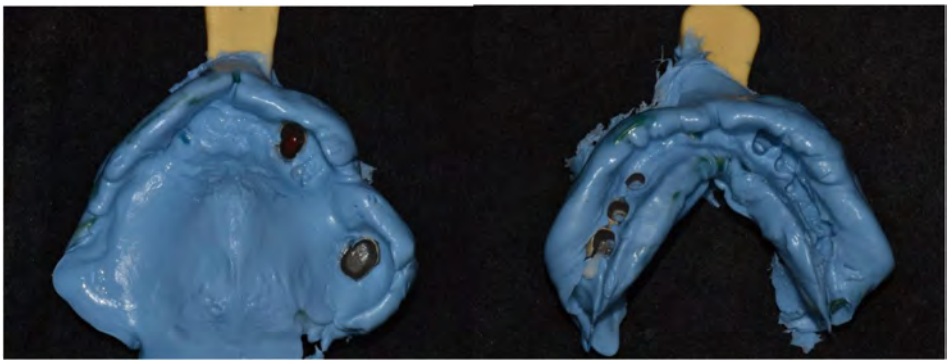
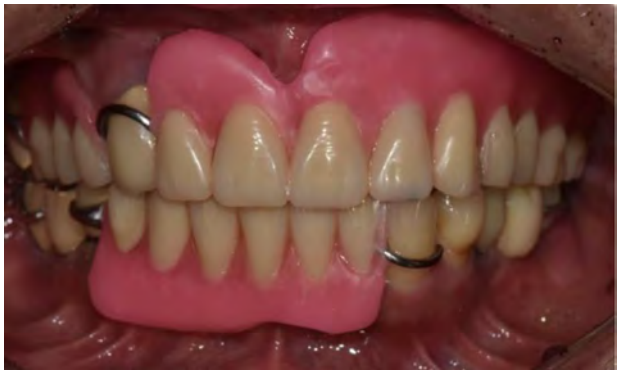
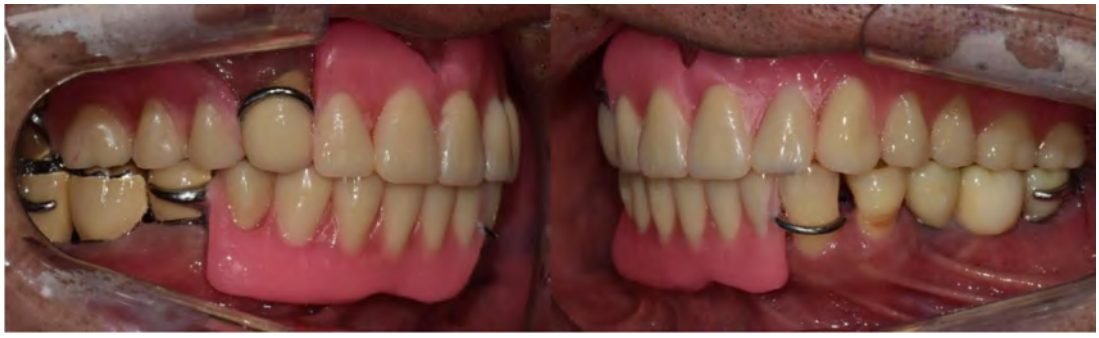


Figure 7. Final impression for maxillary RPD and mandibular IARPD.

(a) Frontal view



(b) Lateral view



(c) Occlusal view

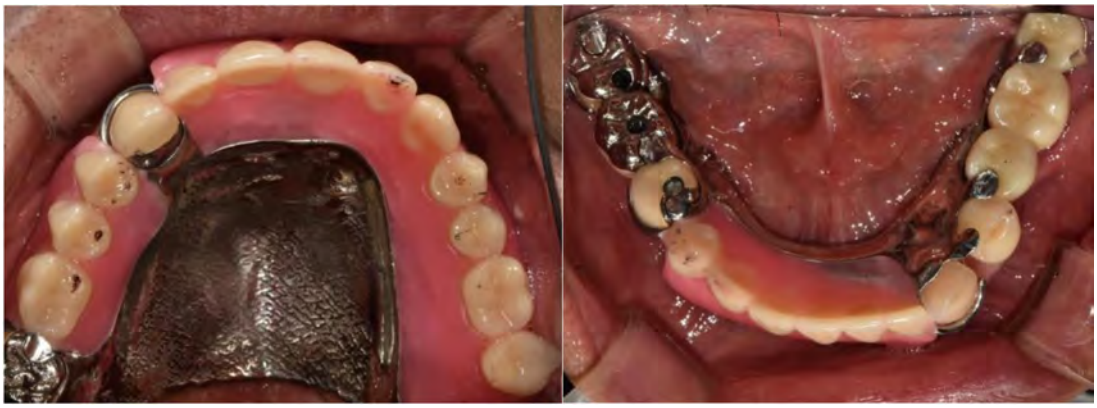
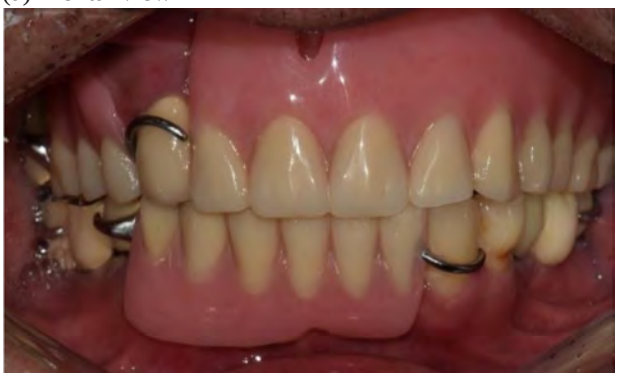
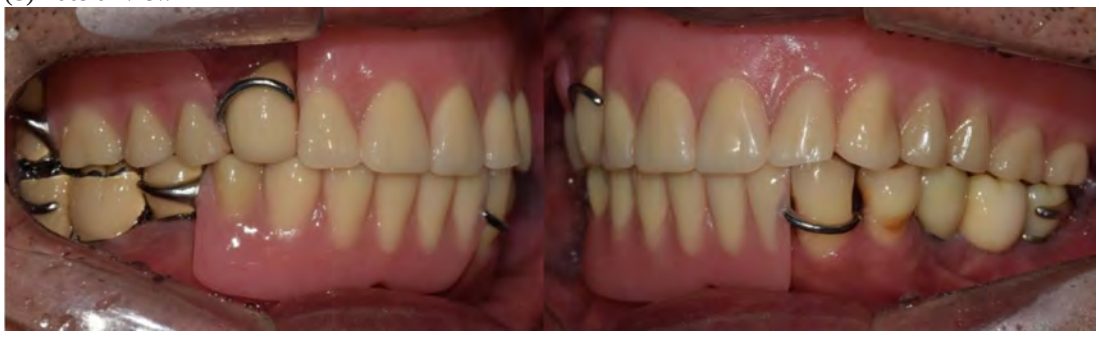


Figure 8. Wax denture try–in.

(a) Frontal view



(b) Lateral view



(c) Occlusal view

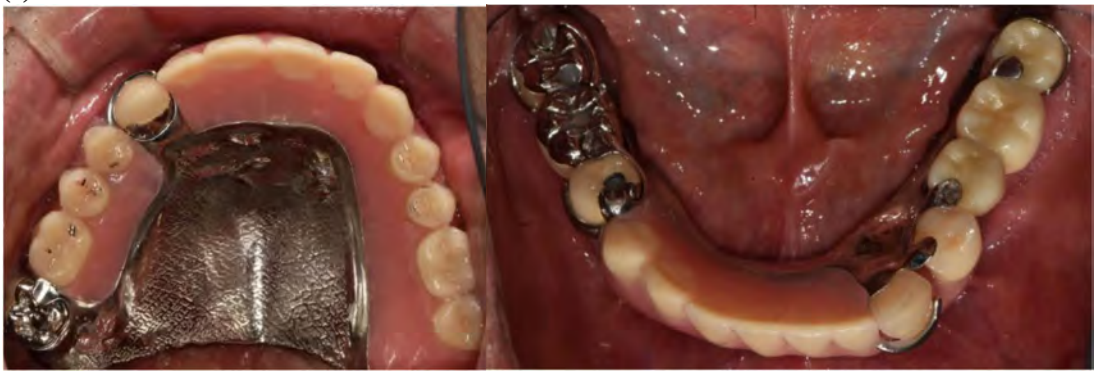


Figure 9. Definitive dentures.

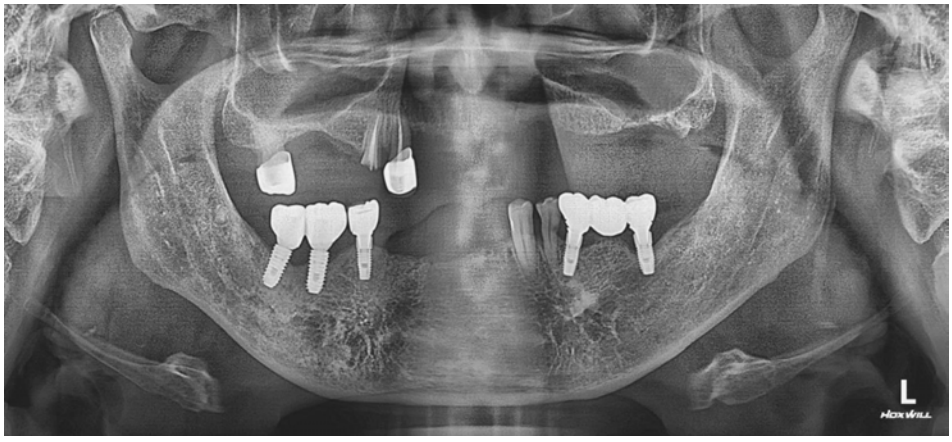


Figure 10. Panoramic radiograph after definitive prosthesis delivery.

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Implant rehabilitation following the resection of medication-related osteonecrosis of the jaw (MRONJ)

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Medication-related Osteonecrosis of the Jaw (MRONJ) poses a significant challenge in dental practice due to its severe impact on oral health. This case report presents a successful implant rehabilitation following wide resection of MRONJ in a single patient. After meticulous removal of necrotic bone and inflammation, bone grafting was performed, followed by the successful placement of dental implants. This case highlights the effectiveness of a comprehensive treatment approach, emphasizing the importance of inflammation removal, bone grafting, and precise implant placement in achieving successful implant rehabilitation after MRONJ-related wide resection. The successful outcome demonstrates the significance of integrating rhPTH therapy in achieving optimal implant rehabilitation after MRONJ-related wide resection. **(THE JOURNAL OF KOREAN ACADEMY OF OSSEOINTEGRATION 2023;15(1):18-21)**

Key words: MRONJ, Implant, rhPTH

INTRODUCTION

Medication-related Osteonecrosis of the Jaw (MRONJ) is a debilitating condition, often necessitating extensive surgical intervention for effective management[1]. In this case report, we present a compelling instance of successful implant rehabilitation following wide resection of MRONJ. MRONJ, associated with prolonged bisphosphonate use, led to extensive necrosis and inflammation in the patient's jawbone. The treatment approach involved meticulous removal of necrotic tissue and inflammation, followed by grafting the affected area to promote optimal bone healing. Subsequently, dental implants were placed with precision, ensuring stable and functional oral rehabilitation.

The primary objective of this case report is to shed light on the intricate process of managing MRONJ and demonstrate the successful outcome achievable through a combination of wide resection, inflammation removal, bone grafting, and dental implant placement. This approach not only addresses the immediate concerns related to MRONJ but also provides a foundation for long-term oral health and improved quality of life for the patient.

There is currently no established guideline in the form of a research paper regarding the possibility of implant placement after the resolution of medication-related osteonecrosis of the jaw (MRONJ)[1,2]. Medication-related Osteonecrosis of the Jaw (MRONJ) poses a multifaceted dilemma in dental care, requiring a sophisticated strategy to tackle the substantial necrosis and inflammation associated with the condition[3]. This case report emphasizes the vital importance of a careful treatment approach post wide resection, concentrating on eliminating inflammation, conducting bone grafting, and ensuring accurate implant placement. These findings offer valuable guidance for dental practitioners dealing with patients affected by MRONJ.

CASE REPORT

A 74-year-old female patient was referred to our clinic from a local dental practitioner due to a maxillary osteolytic lesion. Clinically, the patient exhibited gingival pain & swelling, and pus formation in the left maxillary region, along with mobility of the anterior crown and bridge prosthesis. Radiographic examinations, including panoramic and cone-beam computed tomogra-

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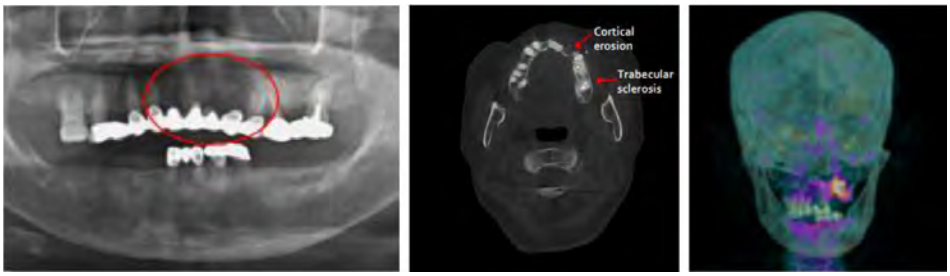

Figure 1. The radiological condition of a first-visit patient.

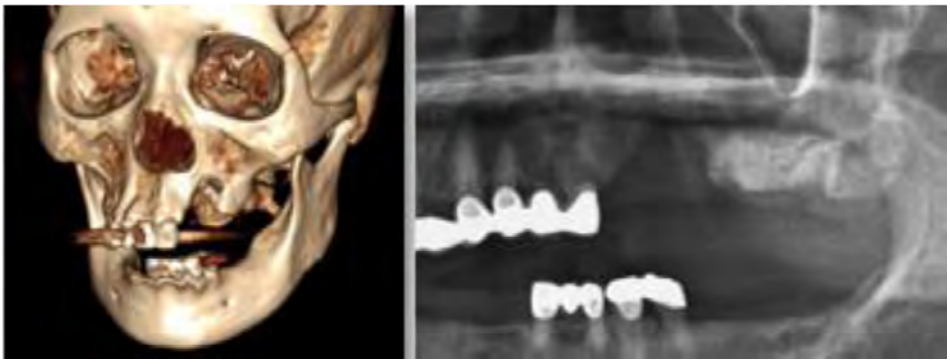

Figure 2. Confirmation of patient's radiological condition 8 months following sequestrectomy surgery.

phy (CBCT), revealed radiolucent lesions in the maxillary bone. To further assess the lesion, a bone SPECT-CT scan was performed (Figure 1). The patient's medical history indicated a 10-year history of Alendronate (oral) and Risedronate (oral) use for osteoporosis, which was switched to Denosumab (intravenous) a year ago. Additionally, the patient had a history of hypertension and stroke.

The patient was diagnosed with Stage III Medication-related Osteonecrosis of the jaw in the left maxilla, confirmed through a bone scan conducted at our clinic to determine the location and extent of the lesion. The ultimate goal was the removal of the necrotic area and oral reconstruction, which was achieved through a three-step treatment approach. Firstly, Frontal Endoscopic Sinus Surgery (FESS) and Resection of the MRONJ lesion were performed, accompanied by MRONJ management through rhPTH injection. Secondly, after 8 months of post-operation observation without recurrence or expansion of MRONJ, Bone Augmentation with A-oss and Extraction of adjacent hopeless teeth were conducted (Figures 2, 3). Finally, following confirmation of stabilization 5 months after the bone graft surgery, implant placement (TS III SOI, Osstem, OneGuide Kit or OneMS Kit, Osstem Global Co., Ltd.) was carried out using a digital guided system (Figure 4). And The prosthesis was completed after 7 months.

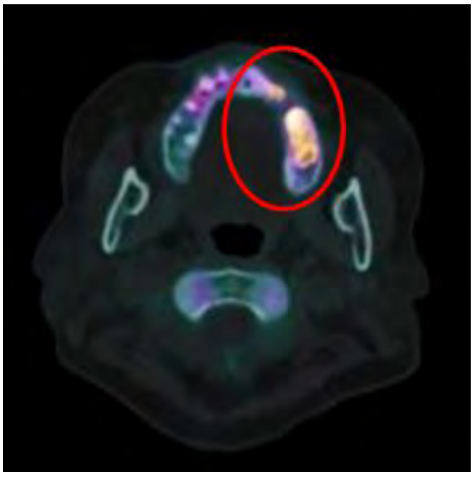

Figure 3. On postoperative day 8 months, the radiological assessment of the surgical site was conducted through Bone SPECT CT imaging. The results revealed decreased intensity at the surgical site, accompanied by gross residual uptake in a known bone lesion located at the maxillary alveolar process.

DISCUSSION

The presented case exemplifies the significance of a multidisciplinary approach in the successful rehabilitation of MRONJ-affected patients. It is essential to undertake a thorough approach, including extensive resection and precise elimination of inflammation, to halt the disease's progression and establish an ideal environment for subsequent interventions[4]. Bone grafting plays a

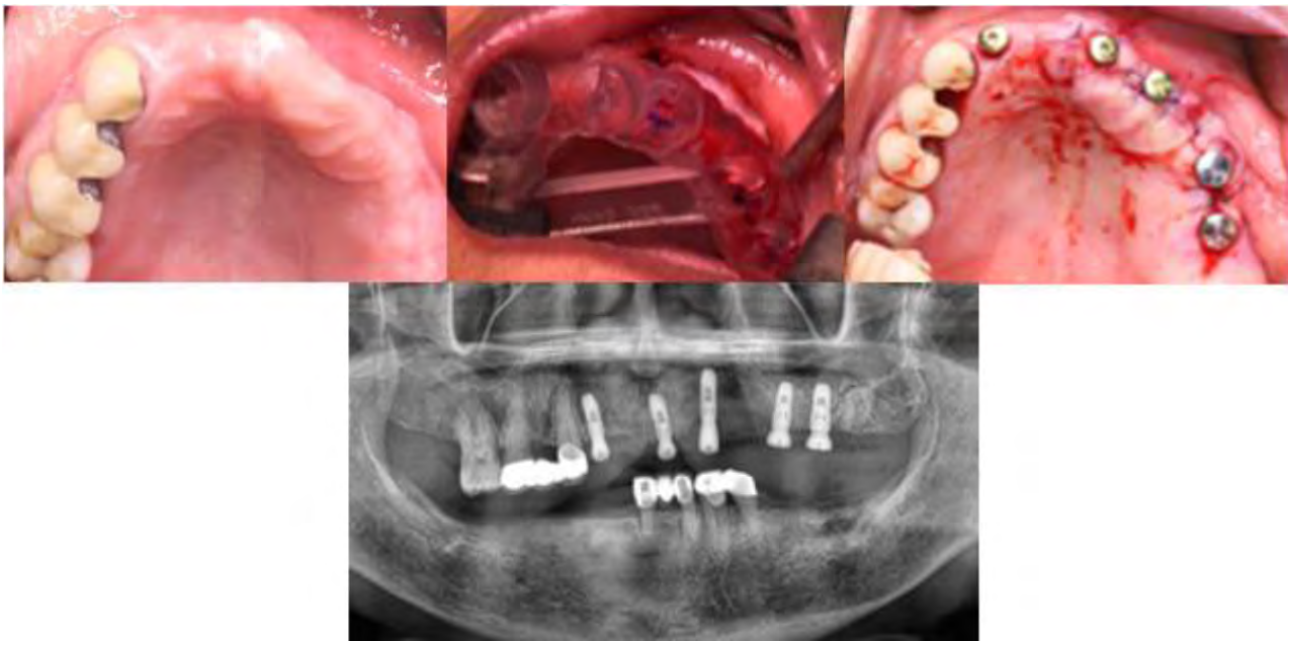

Figure 4. Implantation and bone grafting procedure performed using guided surgery (Osstem oneguide system).

pivotal role in restoring the structural integrity of the jawbone, creating a foundation robust enough to support dental implants[5].

The precise placement of dental implants is a crucial aspect of the rehabilitation process. It ensures not only the functional aspects of oral health, such as chewing and speech, but also contributes significantly to the patient's psychological well-being by restoring their smile and confidence[6,7]. Continued monitoring through regular follow-ups and detailed post-operative care is crucial to assess implant integration and promptly manage any potential complications, as emphasized in the scholarly literature[8-10].

The placement of dental implants in patients undergoing bisphosphonate treatment lacks unanimous consensus in the literature. Despite this, published studies indicate no definitive contraindications for implant placement while patients are orally administered bisphosphonates[11]. Several authors have reported positive outcomes with dental implants in conjunction with antiresorptive therapy, including extensive patient series where implants were successfully placed, experiencing minimal failures or none at all[11-15]. Notably, no elevated risk of medication-related osteonecrosis of the jaw (MRONJ) has been observed concerning dental implant procedures in these cases. Madrid and Sanz's research findings indicate that undergoing dental procedures, including dental implant insertion, while orally taking bisphosphonates for less than five years appears to be safe[16]. Some reports even fail to mention the occurrence of medication-related osteonecrosis of the jaw (MRONJ) in patients with implants after bisphosphonate usage[17]. However, due to the diverse nature of the studies available, there is insufficient published evidence to establish definitive conclusions regarding the insertion of implants in patients undergoing antiresorptive medication treatment or its relation to MRONJ[11].

In conclusion, this case report underscores the feasibility of successful implant rehabilitation following wide resection of MRONJ, emphasizing the integration of rhPTH therapy alongside inflammation removal, bone grafting, and precise implant placement. This innovative approach offers a promising avenue for MRONJ-affected patients, providing them with restored quality of life, oral function, and confidence. Continued research and collaboration among dental and medical professionals are crucial to further refine treatment protocols, making the most of rhPTH and other advanced biomaterials, and ultimately enhancing the overall quality of care for individuals challenged by MRONJ-related complications[18,19].

Additionally, ongoing research initiatives focused on the development of advanced biomaterials and Specialized implant technologies designed for MRONJ-affected patients show potential in significantly improving the long-term outcomes of implant rehabilitation[4,20]. These advancements hold the promise of transforming the field, providing solutions that are not only more effi-

cient but also patient-friendly, thereby enhancing the overall quality of care for individuals dealing with challenges related to MRONJ.

ACKNOWLEDGEMENTS

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Closure surgery using two-flap palatoplasty for oro-nasal fistula after removal of palatal pleomorphic adenoma

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An oro-nasal fistula is an abnormal passage formed between the maxillary sinus and the oral cavity. It is one of the complications that can occur after resection of a benign tumor in the palate, and it can occur despite successful surgery and proper postoperative management abiding by an appropriate protocol. When an oro-nasal fistula occurs, it can cause symptoms such as nasal discharge, reflux of water and food, and maxillary sinusitis. Oro-nasal fistulas that do not heal on their own must be reconstructed through a secondary surgery using palatoplasty. Pleomorphic adenoma is the most common benign tumor in the salivary glands, and when it occurs in the palate, it has an aggressive tendency. Because there is a possibility of recurrence and metastasis to malignancy, complete surgical resection of the tumor is required. In this study, we introduce two cases in which a secondary surgery using palatoplasty was performed to close a bone defect (oro-nasal fistula) that occurred after removal of a pleomorphic adenoma of the palate. The two cases were performed with the goal of: 1. Closing of the defect. 2. tension-free suturing to prevent recurrence. The two-flap palatoplasty technique was used in both patients and is reported because it has been performed successfully without recurrence to date.
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Key words: Pleomorphic adenoma, Oro-nasal fistula, Two-flap palatoplasty

INTRODUCTION

An intact hard and soft palate is important in everyday life for speaking, breathing, swallowing, and eating (chewing, drinking, and swallowing). Defects of the hard and soft palate can be caused by congenital cleft, benign or malignant tumor extraction, trauma, infection, disease, etc[1]. The procedure for closing palatal defects is one of the most difficult techniques in oral surgery, and small defects spanning the hard and soft palate can be successfully closed using a mucoperiosteal flap.

Palatoplasty can be applied to repair large or small congenital or acquired palate defects. Procedures such as von langenback palatoplasty, V-Y pushback palatoplasty, Bardach's two-flap paltoplasty, Fulow double opposing Z-plasty Schweckendiek two-stage repair, Alveolar extension palatoplasy, and Vomer flap have been modified, developed, and used for many years.

Two-flap palatoplasty is a modification of the von Langenbeck procedure and is relatively simple. It is one of the most commonly selected procedures of palatoplasty and has the advantage of being able to close the soft and hard palate in a relatively narrow deformity with a single procedure[2]. In this study, we report two cases of patients who underwent closure of an oronasal fistula that occurred after complete surgical resection of a pleomorphic adenoma, which occurred in the palate when using two-flap palatoplasty.

CASE REPORT

The two patients were an 89-year-old female patient (Case 1) and a 69-year-old male patient (Case 2), both of whom were elderly. There were periods of more than 10 years (Case 1) and over 1 year (Case 2) from the time the patient recognized symptoms until the patient visited the hospital. The size of the lesion from the posterior hard palate to the soft palate was 2 cm (Case 1) and 1.7 cm (Case 2), respectively, and biopsy results obtained through incisional biopsy before surgical resection were all pleomorphic adenomas.

All lesions were painless, grew slowly, had both induration and undulation, and showed no evidence of bone invasion radiologically. In Case 1, the lesion was larger, more elevated, and had clearer boundaries compared to Case 2 (Figure 1A-1, 1A-2). Both

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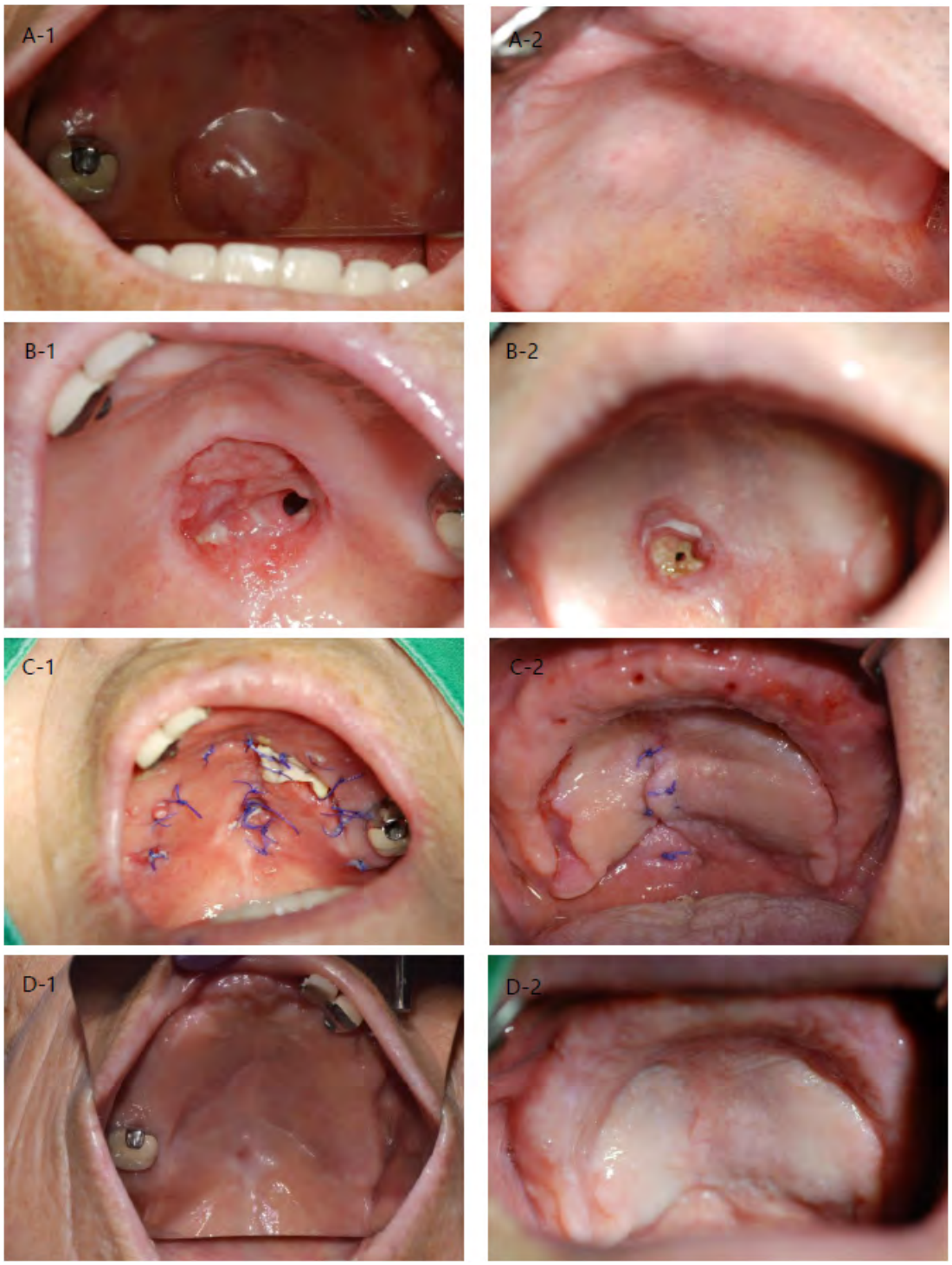

Figure 1. (A) The lesion of palatal on the first visit. (B) Oronasal fistula with a diameter of about 0.5 cm was created on the posterior part of the soft palate. (C) Healing state after two-flap palatoplasty. (D) One month post-operative clinical state (1: Case 1, 2: Case 2).

patients underwent surgical resection, including normal tissue surrounding the lesion, and the final biopsy results after surgery were all pleomorphic adenomas. Patients in Cases 1 and 2 were required to maintain a removable splint or used dentures at all times for 1 week post-operatively. They were discharged after removal. After 19 days (Case 1) and 10 days (Case 2), respectively, a 5 mm diameter oro-nasal lesion appeared in the perioperative area. It was confirmed that a fistula had formed (Figure 1B-1, 1B-2). Both

patients reported that food passed into their noses, and the patient in Case 2 also had nasal sounds. After observing the secondary healing and reduction of the surgical defect, two-flap palatoplasty was performed to close the oro-nasal fistula 6 weeks (Case 1) and 12 weeks (Case 2) postoperatively, respectively (Figure 1C-1, 1C-2). In the case of the patient in Case 2, the follow-up period for sufficient healing was longer due to excessive concerns about surgery.

The process of oro-nasal fistula closure using two-flap platoplasty was performed as follows. The surgical procedure of the Case 2 patient is attached in Figure 2.

1. Mapping & incision

Two flaps were mapped along the circumference of the oro-nasal fistula at intervals of approximately 3~5 mm and along the alveolar bone border. To prevent bleeding, a full-thickness incision was made on both sides towards the back of the alveolar crest after local anesthesia with 2% lidocaine (1/100,000 epinephrine) (Figure 2A).

2. Palatal flap elevation

The oral mucoperiosteal flap was elevated from the anterior to the posterior aspect of the oro-nasal fistula, and dissection was performed on the maxilla and palatal bone. The oral mucoperiosteal plate was lifted with a lifting motion using a periosteal device. At this time, the blood vessels and nerve bundles coming out of the foramen were carefully identified and preserved. The location of the greater palatine blood vessels and nerves was identified through preoperative cone beam CT, and a careful approach was employed to ensure complete dissection from the oral mucoperiosteal plate and palatal bone to maintain the circumference of the blood vessel and nerve bundles (Figure 2B).

3. Double layer closure

The fistula was first closed by suturing the nasal mucosa along the circumference of the oro-nasal fistula using absorbable 4-0 surgisobe suture. The two flaps (oral mucoperiosteal flaps) on both sides that had been dissected were pulled and repositioned to approach the midline and were sutured to form a double layer. The alveolar crest areas on both sides were left exposed without

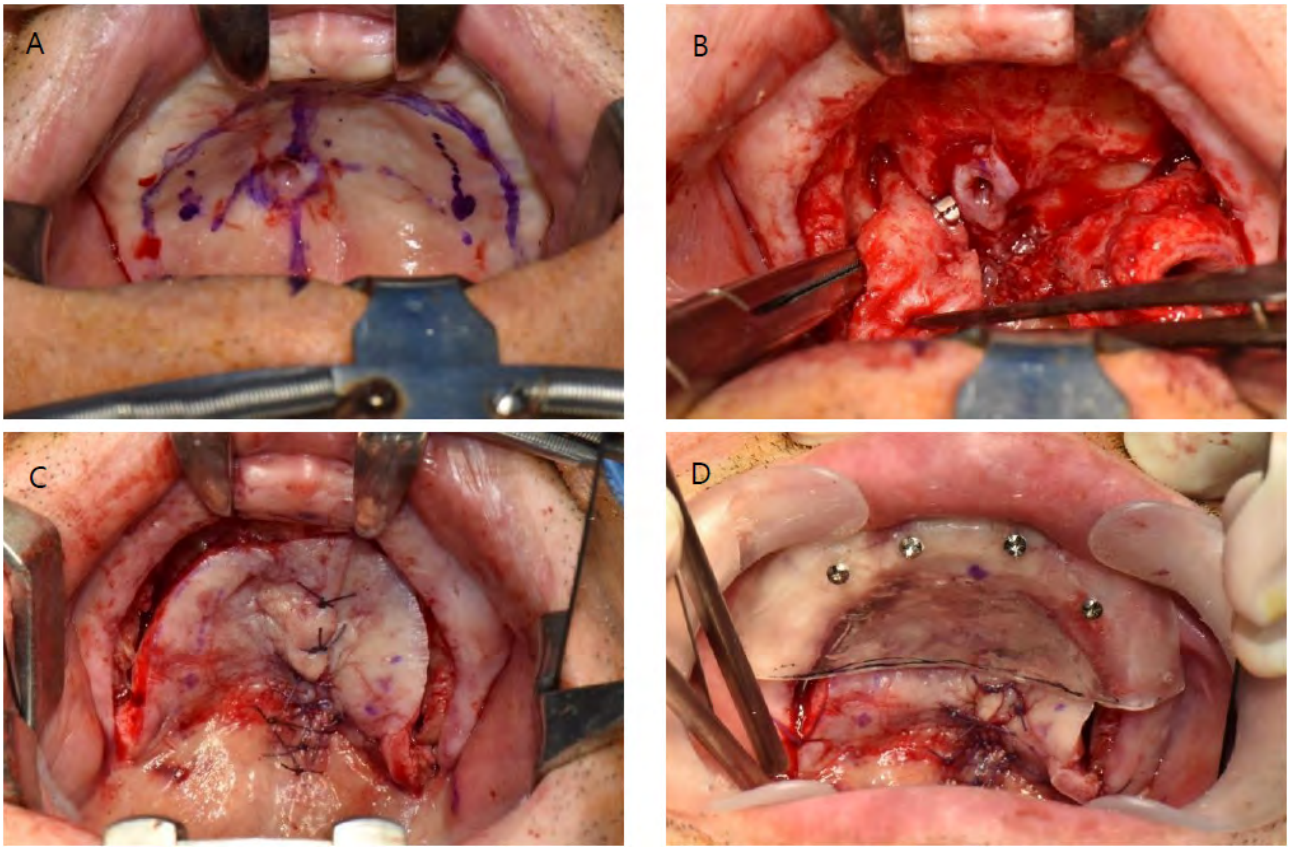

Figure 2. (A) Mapping & incision, (B) flap elevation, (C) double-layer closure, (D) splint fixation.

sutures to ensure a tension-free predicate, allowing secondary healing to wait (Figure 2C).

4. Operation site preservation

Before surgery, a pre-made splint device was fixed to the palatine bone using plate fixation screws to maintain the flap and protect the surgical area. As a result of the postoperative follow-up, both patients had no symptoms of nasal discharge or reflux of foreign substances, the wound area recovered well, and no evidence of recurrence was observed 12 weeks (Case 1) and 6 weeks (Case 2) after the secondary surgery (Figure 2D).

DISCUSSION

Pleomorphic adenoma accounts for 70% of minor salivary gland tumors and occurs in the oral cavity in this order: the palate, upper lip, buccal mucosa, and floor of the mouth[3]. Pleomorphic adenoma is classified as benign, but has a tendency to recur and has the potential to transform into malignancy, thus surgical excision is the basic treatment option. Although they tend to be well encapsulated, pleomorphic adenomas arising in the palate tend to be locally aggressive and often invade surrounding bone, so sufficient surgical resection of the lesion, including the vocal margin, is necessary[4]. Therefore, in the case of pleomorphic adenoma occurring in the palate, a large defect including the hard palate, soft palate, and bone may remain after surgery, and complications such as nasal sound, oro-nasal fistula, and speech abnormalities may occur, and treatment (secondary surgery) is required.

Soft tissue defects formed after complete resection can wait to heal on their own. An oro-nasal fistula is an abnormal passage formed between the nasal cavity (or maxillary sinus) and the oral cavity. When an oro-nasal fistula occurs, it can cause symptoms such as nasal discharge, reflux of water and food, and maxillary sinusitis[5]. If the defect does not close naturally after 4 weeks or if the defect is larger than 4~5 mm, secondary surgery is required for reconstruction[6]. In the two cases in this report, secondary surgery was performed through palatoplasty after 6 weeks (Case 1) and 12 weeks (Case 2) of postoperative observation to close the oronasal fistula that developed as a complication after removal of the pleomorphic adenoma.

The procedure for closure of oronasal fistula was two-flap palatoplasty, the most commonly used surgical method since cleft palate surgery was performed. Two-flap palatoplasty was first described by Bardach in 1976, and is used in various applications such as wardill V-Y palatoplasty, Bardach two-flap palatoplasty, and von langenbeck palatoplasty. The first Bardach two-flap palatoplasty could be used in relatively narrow defects because the oral mucoperiosteal plate was detached at the border of the cleft palate. Later, a modified method of more extensive dissection and additional incisions along the alveolar bone border was introduced, making tension-free suturing possible[7]. Wardrill V-Y palatoplasty (V-Y pushback palatoplasty) has the advantage of extending the length of the palate as the v-shaped flap is sutured into a y shape. However, in this case, extension of the length of the palate was not necessary, so the v-y palatoplasty design was not used.

The process of the two-flap palatoplasty procedure is summarized in Figure 3. The incision is made along the edge of the bone defect and around the alveolar crest, and the end of the valve is rounded, so the v-y pushback design is not used (Figure 3A). The palatal mucoperiosteal flap is completely detached from the maxilla and palatine bone. Since this flap is based on the greater palatine blood vessels, it is important to preserve the greater palatine blood vessels and nerves during the procedure (Figure 3B). Subperiosteal dissection is performed anteriorly and posteriorly to the hard palate such that the nasal mucosa can be sutured without tension (Figure 3C). At the midline, the palatal mucoperiosteal plate is repositioned and sutured, leaving the bilateral alveo-

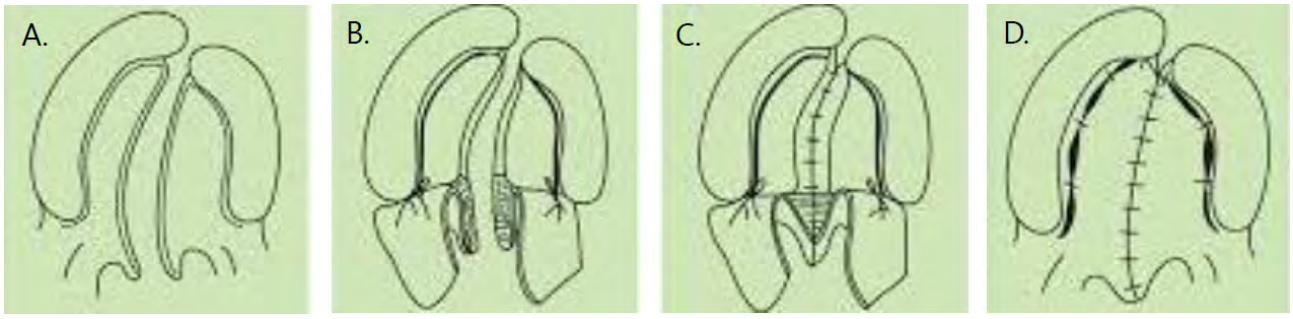

Figure 3. Bardach's two-flap palatoplasty.

lar bone areas exposed.

Emmanouel Koudoumnakis et al. reviewed two-flap palatoplasty performed on 257 cleft patients at the Cranio Facial Anomalies Center of Aghia Sophia Children's Hospital and reported a low recurrence rate of 5.4%. Two-flap palatoplasty has the advantage of effective healing and a low possibility of recurrence as it allows tension-free suturing while minimizing bone exposure through extensive dissection[8]. Therefore, in the case of this study, oronasal fistula closure was performed using two-flap palatoplasty as a procedure for the oronasal fistula that developed after surgical resection of a pleomorphic adenoma in the palatal. The fistula did not recur, and long-term follow-up will be conducted to check for recurrence of pleomorphic adenoma in the future.

CONCLUSION

Pleomorphic adenoma, the most common benign tumor in the palate, has the potential to become malignant, and thus local resection with sufficient margins including the tumor is essential. If natural healing does not occur for soft tissue or bone defects that occur after surgery, secondary surgery is required. Oronasal fistula cause great discomfort to the patient due to symptoms of nasal discharge and reflux of food, so secondary surgery for reconstruction must be performed appropriately. Two-flap palatoplasty can be selected as an effective approach for reconstruction of hard palate defects (oronasal fistula) as in this case due to its technical simplicity, effective healing, and low possibility of recurrence.

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Surgical treatment of root canal filling material displaced into the maxillary sinus and subsequent implant surgery

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Extrusion of the endodontic material is one of the possible complications of root canal treatment. Extruded root canal filling materials can cause inferior alveolar nerve injury in the mandible and inflammatory condition of the maxillary sinus in the maxilla. Additionally affected teeth often need to be extracted, requiring subsequent implant treatment. Therefore, for successful implant treatment, it is important not only to completely remove the displaced root canal material but also to ensure good healing of the surrounding tissue suitable for implant placement postoperatively. This case describes the surgical treatment of chronic maxillary sinusitis caused by migration of root canal filling material into the maxillary sinus with successful treatment outcome and implant surgery.
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Key words: Root canal filling material, Maxillary sinus, Maxillary sinusitis, Dental implant, Modified endoscopic-assisted sinus surgery

INTRODUCTION

Endodontic treatment is one of the important procedures in dentistry. It is performed when the root apex is involved in the lesion that occurs in the adjacent tissue or when dental lesion causes pulpal diseases. It consists of chemo-mechanical elimination of the diseased intrapulpal tissue and filling with the materials. Extrusion of the canal filling material is one of the possible complications of root canal treatment, and it usually can be caused from overinstrumentation during canal preparation or excessive pressure during the application of the filling materials[1-3]. Extruded canal filling materials can lead to neurosensory disturbance of inferior alveolar nerve in lower teeth, and for upper posterior teeth, that can lead to inflammatory condition of the maxillary sinus[3-5]. In addition, affected teeth often need to be extracted, requiring subsequent implant treatment. Therefore, for successful implant treatment, it is important not only to completely remove the displaced endodontic material but also to achieve favorable healing of the adjacent tissue suitable for implant placement postoperatively.

The aim of this study was to describe successful surgical treatment of the maxillary sinusitis caused by displacement of from extrusion of gutta percha (GP) four years ago and subsequent implant treatment.

CASE PRESENTATION

A 31-year-old female patient visited to our department with maxillary sinusitis caused from a foreign body in the right maxillary sinus (Figure 1). Three weeks before coming to the hospital, she felt discomfort in the right maxillary second molar when chewing food. There was no hypersensitivity to cold or hot water, and there was constant discomfort even during her daily activities. She received endodontic treatment and gold crown restoration on the right upper second molar at a local dental clinic four years ago. On oral examination, the maxillary second molar was negative for percussion, mobility, and palpation, while it showed positive on the biting test. The patient complained of spontaneous pain with the purulent discharge around the tooth and surrounding gingiva. There were no clinical symptoms related to the maxillary sinusitis, such as rhinorrhea, post nasal drip or hyposmia. The probing depth of the maxillary second molar was 12 mm on the distal side. The foreign body in the sinus was suspected as the canal-filling material, GP.

At first, surgical extraction of right upper second molar was performed with expectation that the foreign body would be eliminated in one piece with the tooth (Figure 2). However, despite of the try, the foreign body still remained at right maxillary sinus

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and purulent discharge persisted. Computed tomography images were taken to evaluate the location and amount of foreign material in the maxillary sinus, the severity of the maxillary sinusitis, and the influence on adjacent structures. The modified endoscopic-assisted sinus surgery (MESS) was planned for removal of foreign material.

The surgical procedures were performed under general anesthesia (Figure 3). Vestibular incision was made on the region of

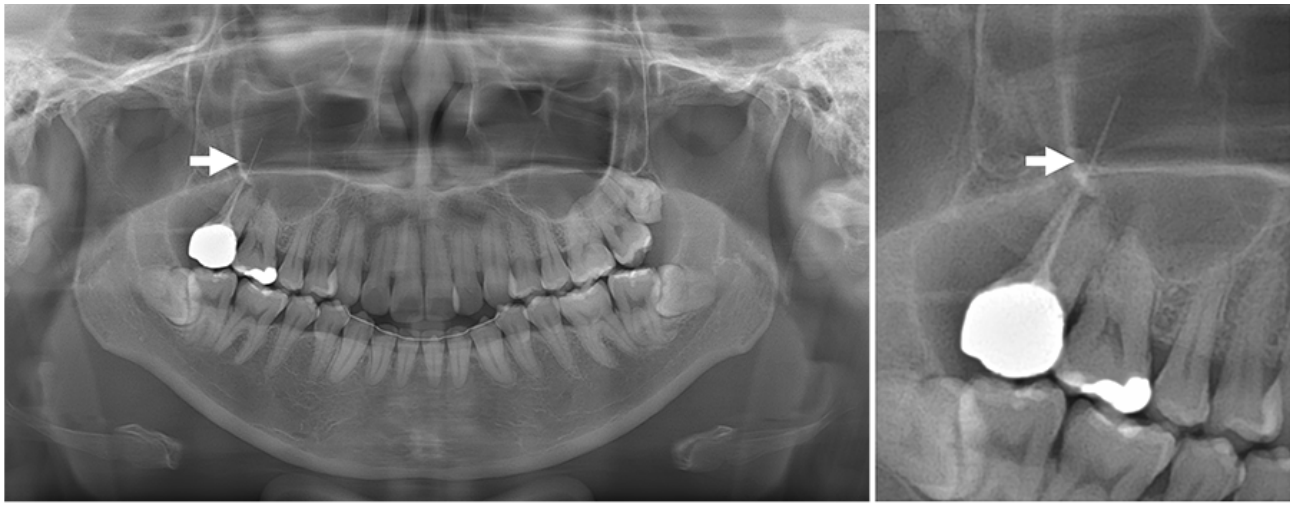

Figure 1. Panoramic radiograph at initial visit. Extended gutta percha was found in the right maxillary sinus (arrows).

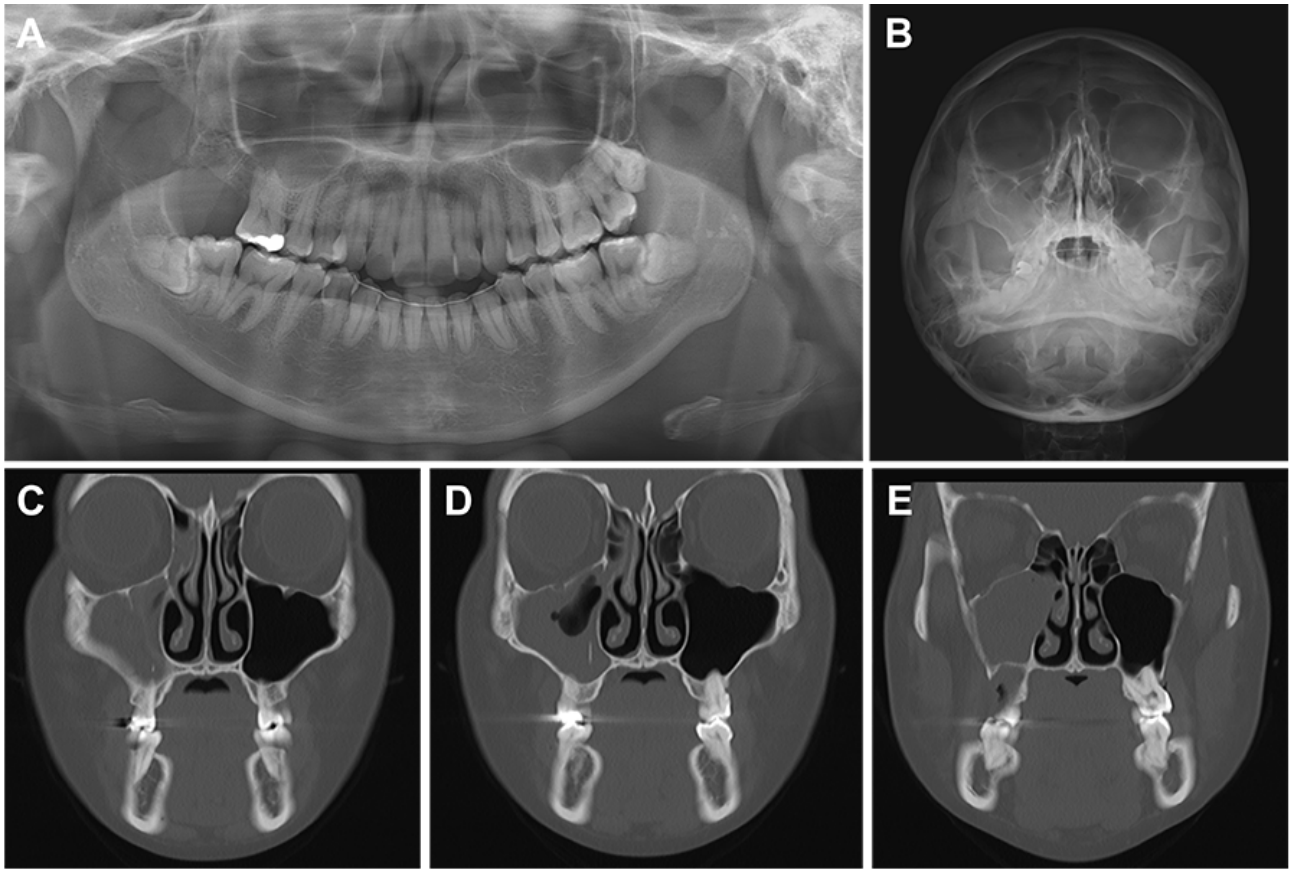

Figure 2. Panoramic radiograph (A), waters view (B), and computed tomography (C~E) after extraction of right upper second molar.

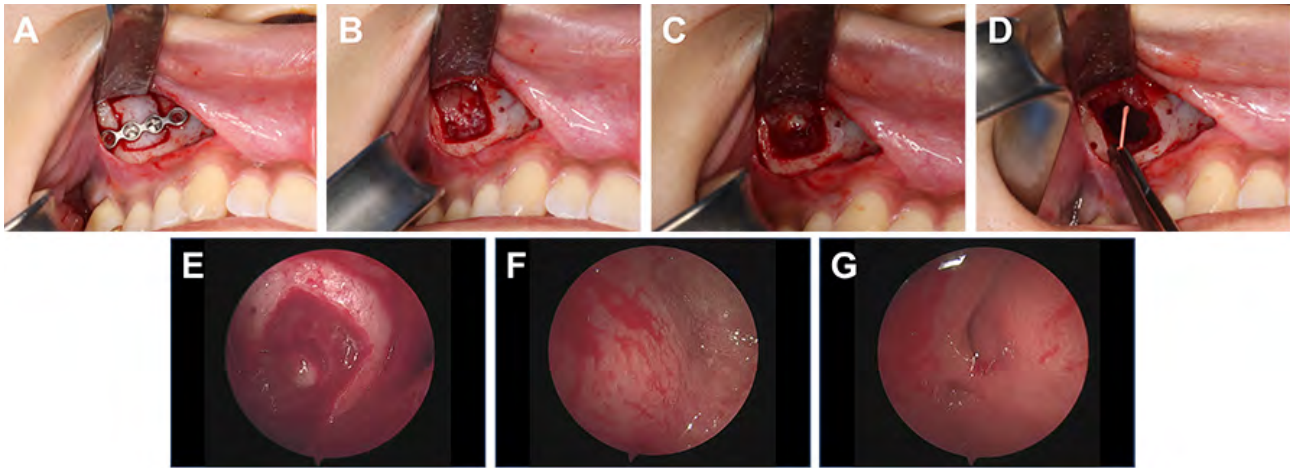

Figure 3. Intraoperative clinical (A~D) and endoscopic photos (E~G) during the modified endoscopic-assisted sinus surgery.

right upper second premolar and first molar area with a length of approximately 3 cm. After elevation of the mucoperiosteal flap, the antero-lateral wall of the maxillary sinus was exposed and the bony window for the access to the sinus cavity was designed. Using a rotary instrument with a 0.5 mm round bur, bony windows was created. To minimize the time it takes to reposition the bony window to its original position, a microplate was secured to the bony window prior to complete separation of the bony window. Particularly, the vertical osteotomy was performed first, followed by fixation of the plate, horizontal osteotomy, and removal of the bony window. After accessing the inside of the maxillary sinus, GP was found and removed with the inflamed sinus mucosa under endoscopic view. To regenerate the maxillary sinus mucosa after surgery, the normal maxillary sinus membrane was preserved as much as possible, and the periosteum beneath the inflamed mucosa was also preserved. After confirmation of the patency of the maxillary ostium using endoscope and CT evaluation, the bony window was repositioned and fixed using the microplate. Wound closure was performed using layer-by-layer technique. Postoperative instruction, such as the conventional instruction after sinus-related surgery, was provided to the patient.

At 6 months after surgery, the microplate used for fixation of the bony window was removed and implant installation (Anyone, Megagen, Daegu, Korea) was performed (Figure 4). During the postoperative follow-up periods, no significant postoperative complications, such as recurrence of the sinusitis, increased haziness, any sensory disturbance related to the infraorbital nerve, and other postoperative complications that can be usually occur after maxillary sinus surgery, were observed.

DISCUSSION

During dental procedures such as root canal treatment, tooth extraction, and dental implant surgery, the maxillary surgery is one of the most important anatomic structures that dentists have to consider. The maxillary sinus is an air-containing space located within the maxilla on both sides and is in contact with the alveolar process of the maxilla inferiorly, the zygomatic bone laterally, and the inferior orbital floor superiorly. There is a possibility of perforation of the maxillary sinus through the root apex during dental treatment of maxillary teeth close to the sinus. The distance between the maxillary sinus and the teeth varies depending on the position of the teeth, and usually the posterior teeth are closer to the maxillary sinus floor than the anterior teeth[6]. According to the previous studies that analyzed the vertical and horizontal distances between the teeth and the maxillary sinus, the first and second molars were close to the maxillary sinus floor in the vertical dimension, so the probability of protruding the root into the maxillary sinus was higher than that of an anterior teeth and premolars[7]. Even at horizontal dimension, the apex of the root of the maxillary posterior teeth is closer to the maxillary sinus cavity, as the lowest point of the maxillary sinus is located between the buccal root and the palatal root. In the patient of this study, it was observed that the root canal filling material invaded the maxillary sinus through the root apex during endodontic treatment of the maxillary second molar. Therefore, it could be recommended that clinicians should be careful at all times, keeping in mind that foreign bodies can be injected through the apex of the tooth due to poor instrumentation or excessive root canal filling during maxil-

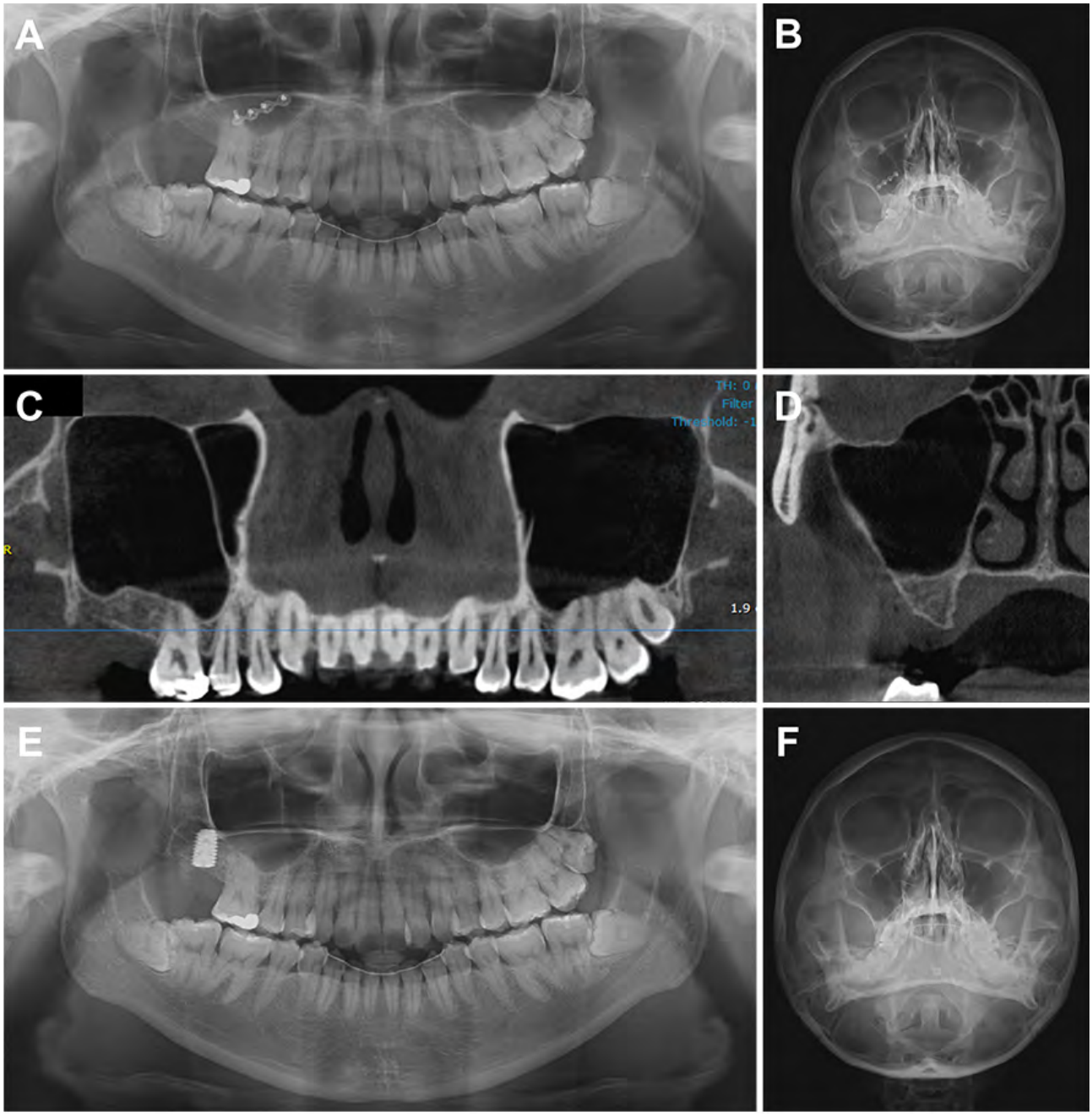

Figure 4. Postoperative radiographic examination. (A, B) 4 months after modified endoscopic-assisted sinus surgery; (C, D) Immediately before implant surgery; (E, F) immediately after implant surgery.

lary posterior root canal treatment.

Foreign bodies that have entered the maxillary sinus, such as tooth fragments, root canal filling materials, or fractured dental instruments, may remain without causing any pathological changes or symptoms, but may also cause various maxillary sinus diseases including delayed healing of gingival granulomas or apical lesions caused by an acute inflammatory response, acute and chronic sinusitis, and fungal infection of the maxillary sinus[1-3,5,8]. Batur and Ersev[1] reported that there were no clinical symptoms and no pathological changes in the maxillary sinus radiologically in a patient who was observed for 5 years without surgery after root canal sealer was leaked into the maxillary sinus. In contrast, in the study by Giardino, et al.[5], overfilling of the root canal sealer led to aspergillosis of the maxillary sinus in healthy patient. Kim, Kim and Han[3] also reported occurrence of chronic maxillary sinusitis after leakage of the calcium hydroxide which is used for

endodontic medicament. In terms of GP, Yamaguchi, Matsunaga and Hayashi[8] reported a case where the GP entered the maxillary sinus during endodontic treatment performed 3 years ago and was surgically removed. In that case report, patient did not any clinically uncomfortable symptoms, however, showed chronic maxillary sinusitis in radiographic examination. In a study by Kobayashi[9], displaced GP resulted to aspergillosis of the maxillary sinus without any clinical symptom. In contrast, in the present study, the patient also had invasion of GP to the maxillary sinus after root canal treatment 3 years ago, but she felt discomfort during the mastication and the causative tooth showed bone resorption with deep periodontal pocket on distal side.

To remove foreign bodies in the maxillary sinus, two surgical approaches can be performed: 1) endonasal endoscopic sinus surgery (ESS); 2) intraoral transmaxillary approach with direct access to the maxillary sinus[3,10]. ESS has become the mainstay in treating maxillary sinus disease, however, it has several limitations in removing foreign bodies located at the floor of the sinus, or in treating odontogenic maxillary sinusitis. Accordingly, in treating odontogenic maxillary sinusitis, the intraoral transmaxillary approach such as the Caldwell-Luc procedure (CLP) have been frequently used. In a study by Brooks and Kleinman[2], GP displaced into the maxillary sinus was successfully removed using the CLP. Tanasiewicz, et al.[11] also successfully removed root canal filling material from the maxillary sinus through CLP. However, CLP may cause several postoperative complications, such as atrophy of the maxillary sinus, hypoesthesia of the midface, occurrence of postoperative maxillary cyst, and bone defect[12]. In addition, the postoperative healing pattern is not predictable, making it difficult to achieve oral rehabilitation including implant treatment.

In the present study, the displaced GP and surrounding inflamed mucosa were removed using MESS. MESS is a procedure that combines the intraoral and endonasal approaches. Briefly, only pathological lesion or foreign body within the maxillary sinus is removed under endoscopic view through intraoral transmaxillary approach, and if the ostium is obstructed, widening of the ostium is performed using endonasal approach[3,10,13]. Another feature is that bony window created to access the maxillary sinus is fixed in its original position using rigid fixation. MESS has been successfully performed to treat various maxillary sinus diseases previously, and favorable postoperative healing after MESS has been reported[13]. In the patients of this study, MESS also resulted in complete bone healing around the bony window and healing of the maxillary sinus membrane without pathological lesions. Based on this, the subsequent implant surgery was also performed successfully.

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