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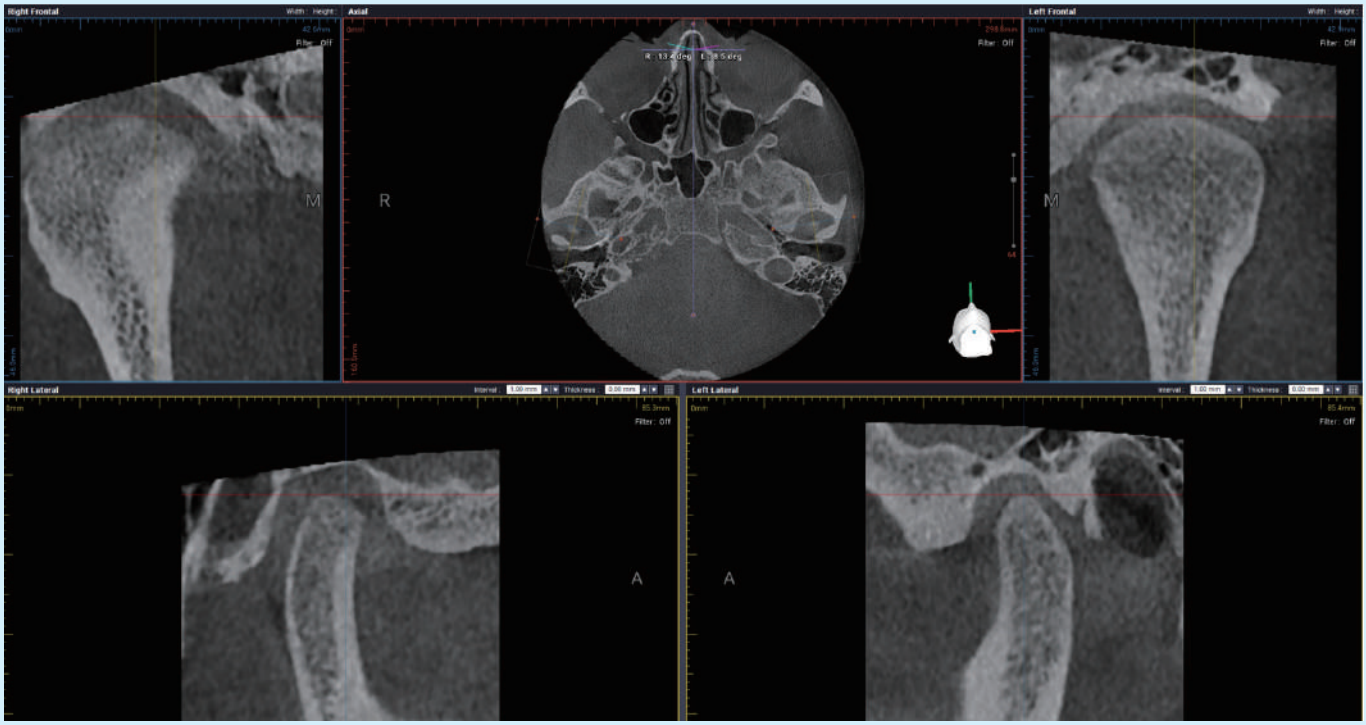
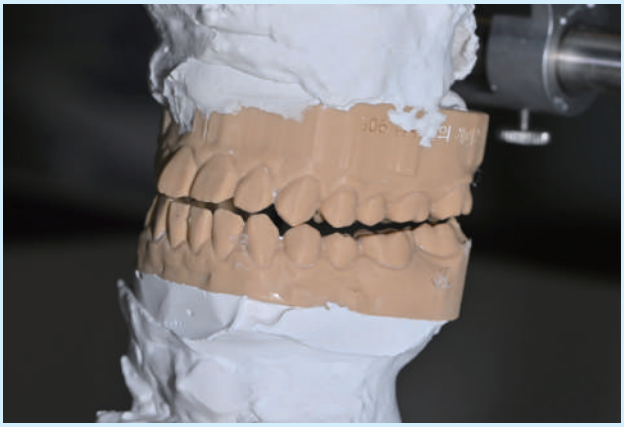
JCDD

Journal of Clinical & Digital Dentistry





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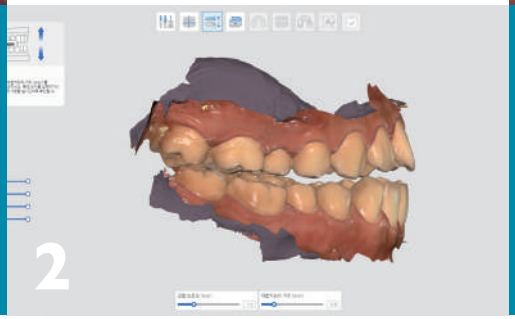

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Journal of Clinical & Digital Dentistry

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About the Journal

The Journal of Clinical and Digital Dentistry are published four times (March, June, September, and December) annually since May 2019. The abbreviated title is "J Clin Digit Dent". In the journal, articles concerning any kind of clinical dentistry such as prosthodontics, orthodontics, periodontics, implant dentistry and digital dentistry are discussed and presented.

Aims and scope

This journal aims to convey scientific and clinical progress in the field of any kind of clinical and digital dentistry.

This journal publishes

- Original research data and high scientific merit in the field of clinical and digital dentistry.
- Review articles.
- Case reports in implant dentistry including GBR, digital dentistry, 3D printing, and prosthodontics.
- Short communications if they provide or document new technique and clinical tips.

About the Journal

Editorial Board

Editorial

Optimal Condylar Position

The centric relation position has been a major concern for prosthodontists for over 100 years. This is because dentists have observed that when the temporomandibular joint's position is not stable, various symptoms and unexpected problems can arise even after dental treatment. Additionally, dentists use an articulator to fabricate prostheses in daily practice to accurately reproduce mandibular movements. For this reason, the proper position of the condyle in the centric relation has always been a critical issue.

In 1938, Dr. McLean emphasized that achieving a maximal intercuspal position after sliding from premature contact affects the overall health of the maxillofacial area, including teeth, gums, and temporomandibular joints. He termed this type of occlusion as pathologic occlusion. Since then, there have been many opinions about the centric relation, and the Glossary of Prosthodontic Terms (GPT) has accepted all seven definitions of CR. However, in the 9th Edition of the GPT, released in 2017, centric relation is defined solely as the condyle being in a superior-anterior position to the fossa. Given that the stable position of the temporomandibular joint affects not only the maxillofacial area but also the entire body, this clarification was likely made to avoid further confusion about the definition of centric relation.

This issue of JCDD presents an example of treatment using a CR splint. I hope it will provide an opportunity to reflect on the importance of centric relation. Additionally, two articles on GBR techniques, which significantly impact the long-term success of implant restorations, will also offer valuable insights.

Wongun Chang, DDS MS PhD

Bone Graft Materials

- Ovis BONE BCP (Ampoule & Syringe)
- Ovis BONE HA (Vial)
- Ovis ALLO (Syringe)
- Ovis ALLO-C (Syringe)
- Ovis XENO-B (Ampoule)
- Ovis XENO (Vial)
- Ovis XENO-XP (Vial)

Membrane Materials

- Ovis TRM
- Ovis BCP / COLLAGEN MEMBRANE
- Ovis MEMBRANE-P

Ovis BONE BCP (Ampoule & Syringe)

Ovis Bone HA

Ovis ALLO

Ovis ALLO-C

Ovis XENO-B

Ovis XENO

Ovis XENO-XP

Ovis TRM

Ovis BCP / COLLAGEN MEMBRANE

Ovis MEMBRANE-P

Soft tissue graft techniques to improve esthetics in the anterior region ②

Jonghyuk Lee, DDS

Case report

[Case 1] Immediate implant placement and provisionalization with delayed CTG

A 67-year-old woman was admitted due to prosthesis discomfort in the maxillary anterior region. Severe carries in the abutments of 4-unit fixed partial denture was found and all abutments were considered hopeless. **(Fig. 1)**

Fig. 1. Baseline. Failing fixed partial denture in Mx anterior.

Jonghyuk Lee

Dr. Jonghyuk Lee graduated from Dankook University College of Dentistry and He studied and participated in Society of Korea Clinical Dentistry(SKCD) since 2011. He maintains a private practice in Seoul Rapha Dental Clinic

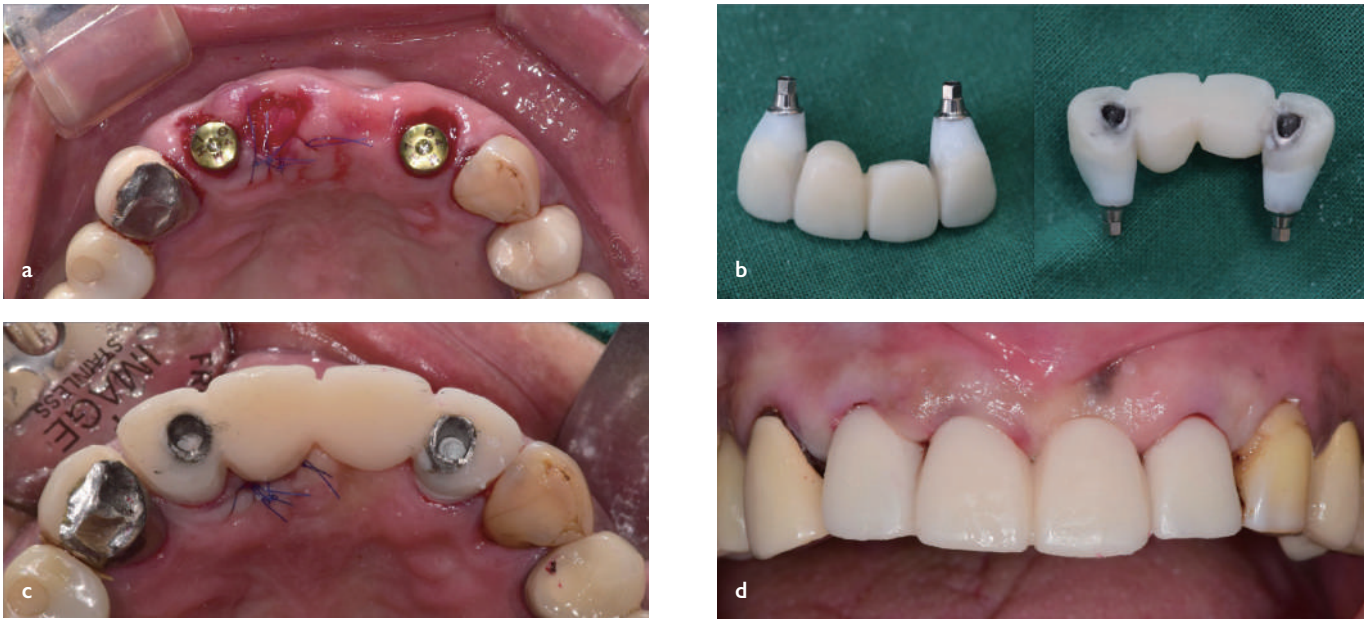


Fig. 2.
(a) Immediate fixture placement and socket preservation
(b) Immediate provisional restoration 7
(c) Occlusal view of immediate placement and provisional restoration
(d) Frontal view of immediate placement and provisional restoration

To address the issue, tooth extraction, immediate implant placement, and alveolar socket bone graft preservation were planned.

Additionally, fabrication of an immediate provisional restoration mirroring the outer shape of the existing restoration was scheduled. Following anesthesia, the prosthesis was removed, and the residual root extracted. A silicone impression of the removed prosthesis was taken, and resin was injected into the inner surface of the impression to create the provisional restoration. After curettage of the extraction socket, the integrity of the buccal plate was assessed, and the implant fixture was immediately placed. Simultaneously, socket preservation was carried out for the extraction socket where the pontic was intended. Following fixture placement, bone grafting was performed to fill the extraction socket gap.

Subsequently, a temporary cylinder was attached to the fixture, and the prepared provisional shell was accurately positioned. After securing the shell with light-cured flowable resin, both the shell and temporary cylinder were removed and firmly connected externally. Next, the appropriate running-room contour was sculpted, followed by high-polishing. The fixture was then inserted into the mouth, and occlusal adjustments were made as needed. The lingual aspect of the restoration was removed to prevent loading. **(Fig. 2)**

The CTG was scheduled approximately 2 months after placement. Large-scale GBR was not performed and MGJ distortion was not significant; however, a horizontal ridge defect in #21 22 was recognized. Accordingly, it was determined that the esthetic goal could be achieved by CTG using a tunnel technique . To minimize scarring, an incision was made on the inner surface of the pontic base and the running-room of the implant, and the area was dissected to create the tunnel flap. It's important to note that undermining of the inferior aspect of the MGJ is necessary to create space for placing the connective tissue; however, caution should be exercised as excessive undermining may lead to MGJ-line distortion toward the alveolar ridge. Once the appropriate tunnel flap is completed, the graft (de-epithelialized free gingiva) can be securely fixed even with a simple suture, thus minimizing scarring. Subsequently, impression taking was performed approximately two weeks later to allow for healing, and the final provisional restoration was installed. CTG using the tunnel technique reduces surgical trauma on the lateral gingiva, facilitating early impression taking and installation of the final provisional restoration in preparation for the definitive restoration. **(Fig. 3)**

Fig. 3.
(a) ridge evaluation for soft tissue graft
(b) planning of incision line and recipient site preparation(cyan line : incision yellow undermining for tunnel flap)[2]
(c) Connective tissue from palate(De-epithelialized free gingiva)
(d) Preparation of tunnel shape flap for soft tissue graft[2,3]
(e) Occlusal view of final provisional restoration (note cyan arrow #21,22 labial volume is augmented properly)
(f) frontal view of final provisional restoration (note cyan arrow #21,22 MGJ and keratinized gingiva are harmonious)

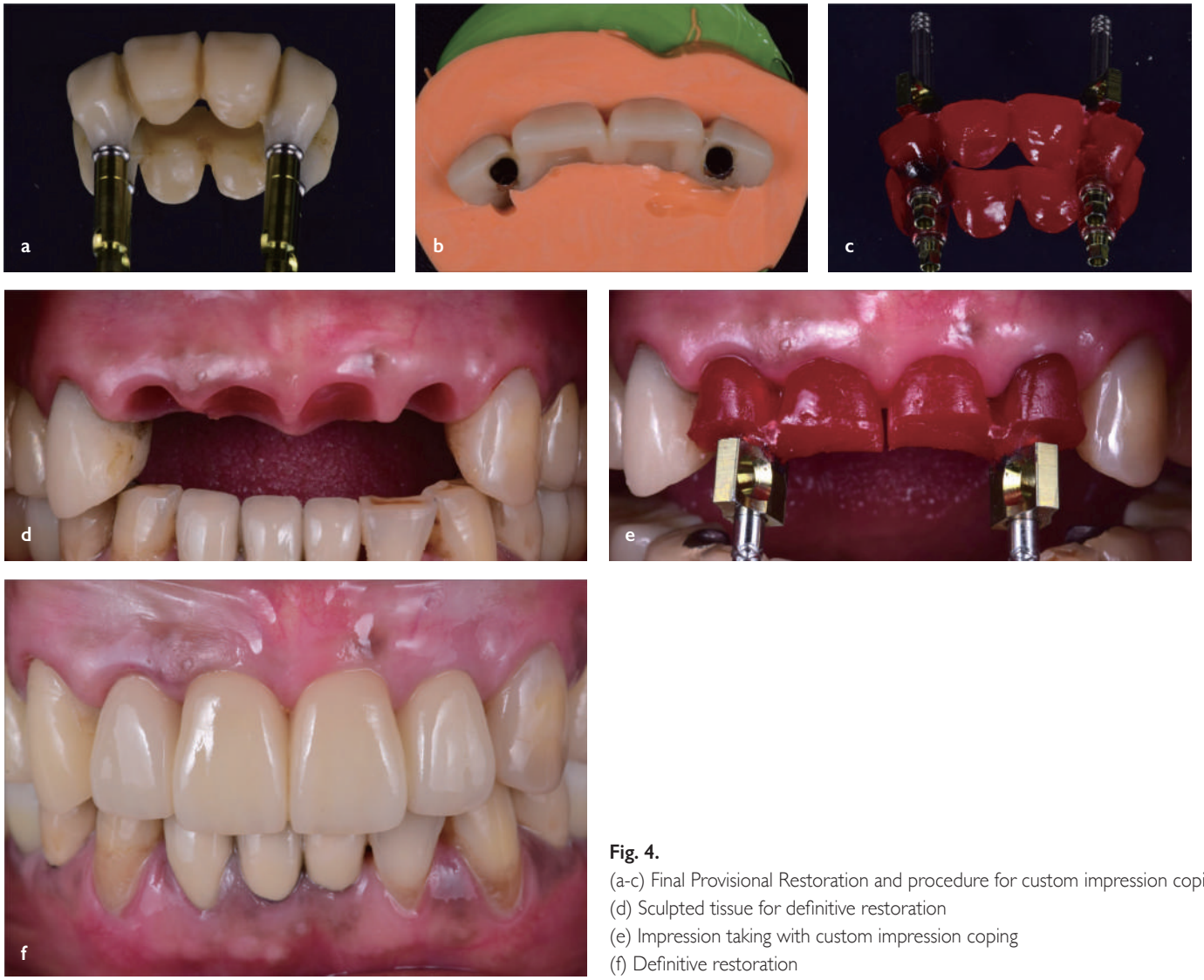


Fig. 4.
(a-c) Final Provisional Restoration and procedure for custom impression coping[5]
(d) Sculpted tissue for definitive restoration
(e) Impression taking with custom impression coping
(f) Definitive restoration

Tissue molding for the final provisional restoration was conducted, followed by impression taking for the fabrication of the definitive restoration. The provisional restoration played a crucial role in preparing the custom impression coping to transfer the molded tissue to the final model without any deformation. Subsequently, the custom abutment was crafted to ensure sufficient support for the tissue in the running-room. Finally, the definitive restoration, with appropriate tissue support, was installed. **(Fig. 4)**

[Case 2] Delayed placement with CTG

A 42-year-old man was admitted with the primary complaint pain in the maxillary left lateral incisor. The tooth was extracted in a hopeless state due to crown-root fracture, and because initial fixation could not be achieved due to periapical lesion, fixture placement was performed approximately 5 months after socket preservation. After approximately 3 months, a second surgery comprising horizontal and vertical ridge augmentation was planned.

The tunnel flap was created by tissue undermining following gingival sulcus resection of both adjacent teeth and slit incision on the alveolar ridge. Subsequently, CTG harvested from the palatal side was placed by suturing. The graft was placed with half of the width on the alveolar ridge side and the other half on the lingual side for slight vertical augmentation. The graft was then sutured by placing a knot on the lingual side to prevent unnecessary scarring. The cover screw was finally removed through the slit formed on the alveolar ridge, and the provisional restoration was installed. The definitive restoration was installed after allowing sufficient time for healing. **(Fig. 5)**

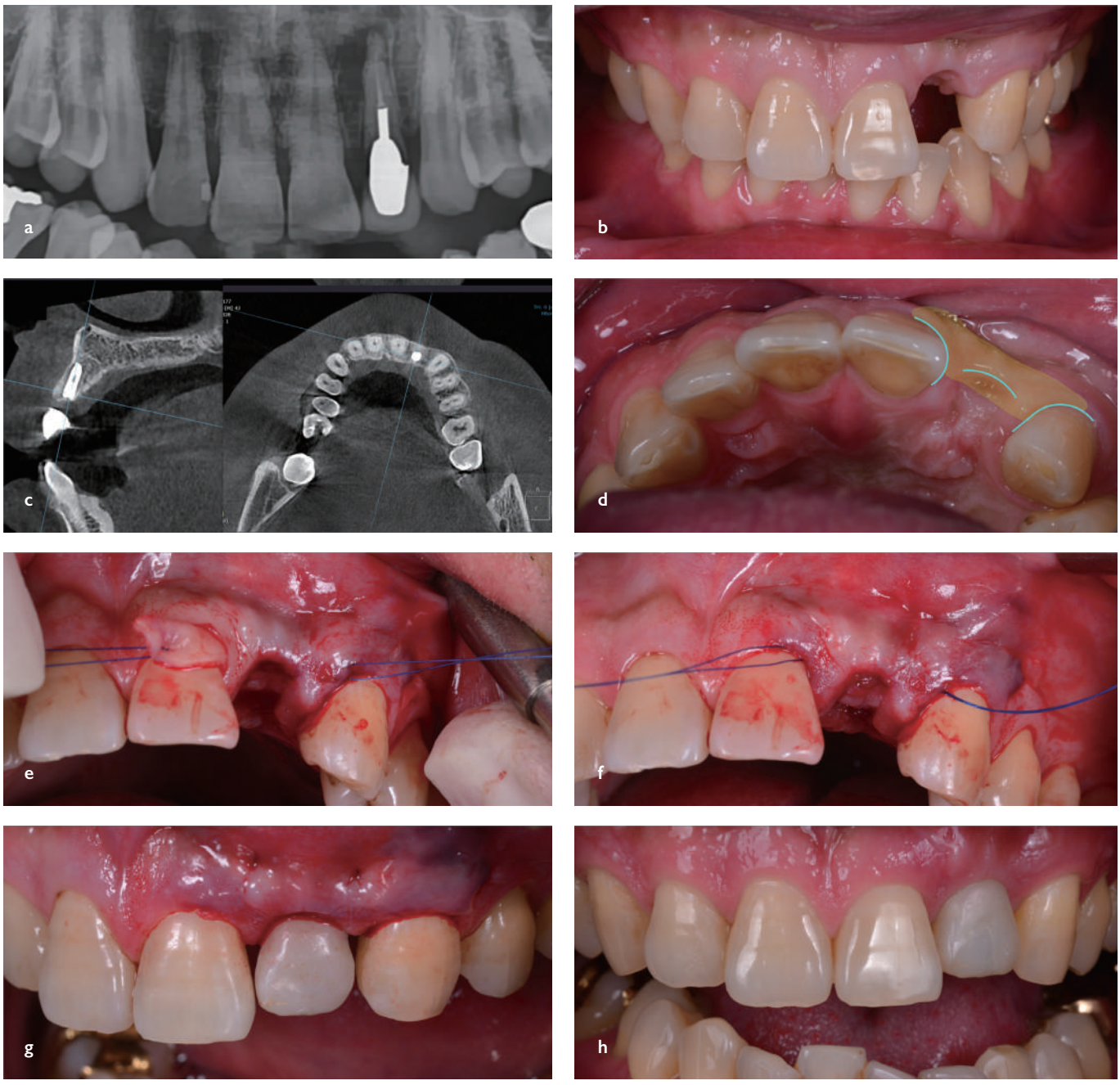


Fig. 5.
(a) Root fracture of the Mx lateral incisor
(b-c) Delayed fixture placement and timing of CTG.[2]
(d) Incision line and range of tissue undermining for CTG.
(e-f) CTG (de-epithelialized free gingiva) by tunneling technique.[4,12]
(g- h) Provisional restoration
(i) Definitive restoration.

[Case 3] Root coverage with tunnel technique[4,13]

A 29-year-old man was admitted for esthetic improvement in the maxillary anterior region. Additionally, the patient reported hyperesthesia attributed to exposed gingiva. The scope of root coverage encompassed two central incisors, necessitating adequate space for flap manipulation to accommodate CTG using the tunnel technique. Consequently, tissue undermining was executed to encompass both maxillary lateral incisors following gingival sulcus resection. Subsequently, suturing was conducted to insert the CTG into the tunnel flap. A wet gauze was utilized to apply pressure, and sutures were employed as needed for fixation.[4] **(Fig. 6)**

Fig. 6.
(a) Baseline gingival recession can be seen in both Mx central incisior
(b) Sulcular incision and undermining to make tunnel flap and insert the De-epithelialized free gingiva.[13]
(c) Just after CTG with tunnel technique
(d) 1 month after surgery roots are covered with minimal scar

[Case 4] Root coverage with tunnel technique

A 37-year-old female was admitted with the primary complaint of gingival exposure in the mandibular central incisor, which developed during orthodontic treatment. Examination revealed a satisfactory interproximal bone level, but gingival recession extended beyond the MGJ. A diagnosis of Miller's class 2 gingival recession was made, suggesting the feasibility of root coverage.

Consequently, a thin biotype was utilized for root coverage, extending to the adjacent right mandibular central incisor, which showed potential for future gingival exposure. Gingival sulcus resection was performed from the mesial aspect of the right mandibular lateral incisor to the mesial aspect of the left mandibular lateral incisor, and a tunnel flap was created prior to commencing tissue undermining. Subsequently, undermining initiated from each tooth was connected to facilitate insertion of the harvested de-epithelized free gingival connective tissue. Dissection was carried out adequately beyond the MGJ to ensure seamless insertion of the harvested tissue. After 1 month, root coverage was achieved with minimal scar tissue. **(Fig. 7)**

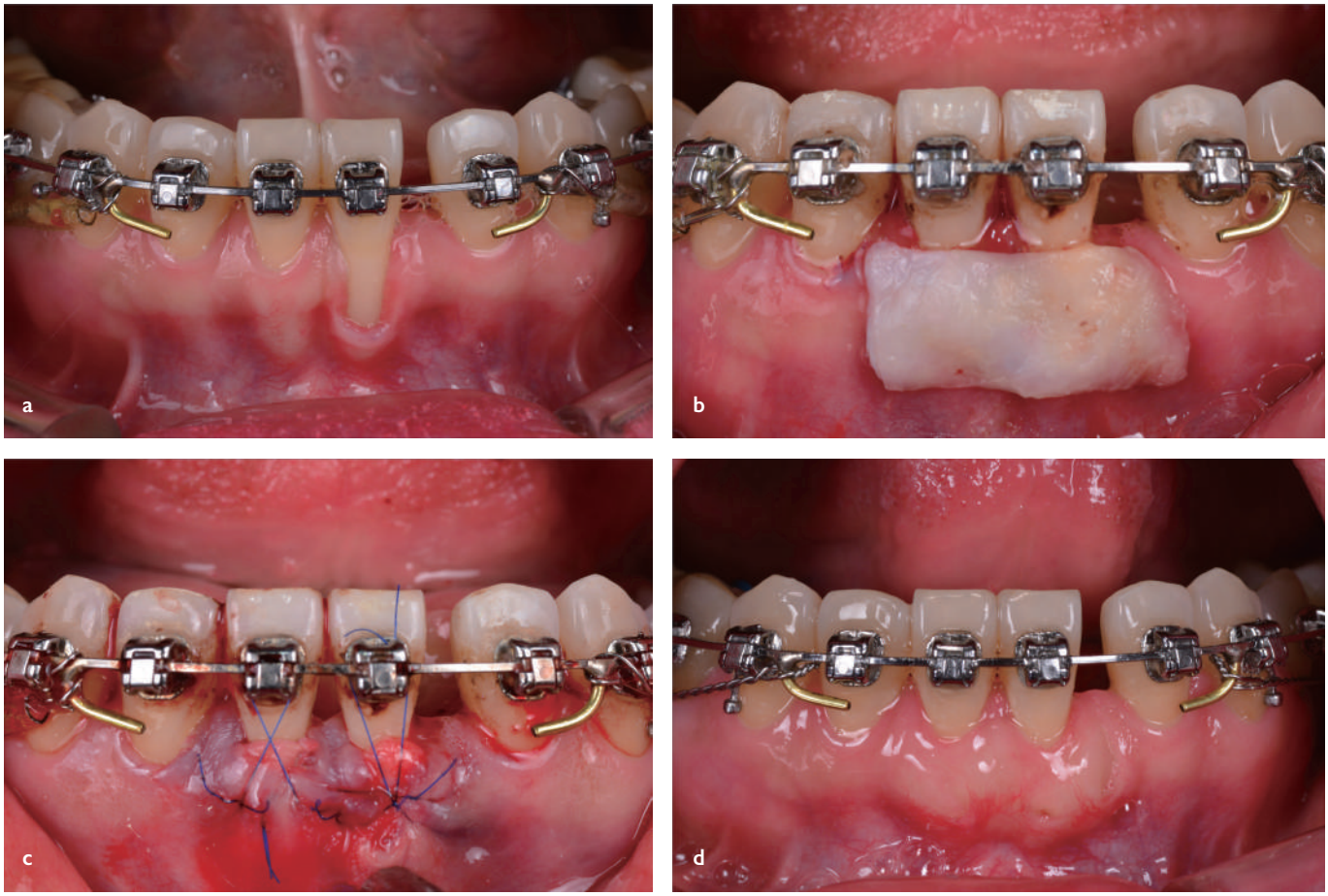


Fig. 7.
(a) Baseline. Gingival recession can be seen in Mn central incisior during orthodontic treatment.
(b) Sulcular incision and undermining to make tunnel flap and insert the De-epithelialized free gingiva.[13]
(c) Just after CTG with tunnel technique
(d) 1 month after surgery roots are covered with minimal scar.

Harvesting of the connective tissue

In the CTG procedure, harvesting the connective tissue from the donor site is crucial. Often, the donor site for connective tissue is the palate. The palatal fibromucosa comprises orthokeratinized epithelium, with a thickness of approximately 0.3 mm, overlaying dense connective tissue (lamina propria) below. Between the palatal fibromucosa and periosteum lies the submucosa, which includes adipose and glandular tissues.

The submucosa in the canine-premolar region tends to be relatively thick, with thickness gradually decreasing toward the molar region. Conversely, the thickness of the lamina propria increases as one moves toward the posterior palate.[9] **(Fig. 8)**

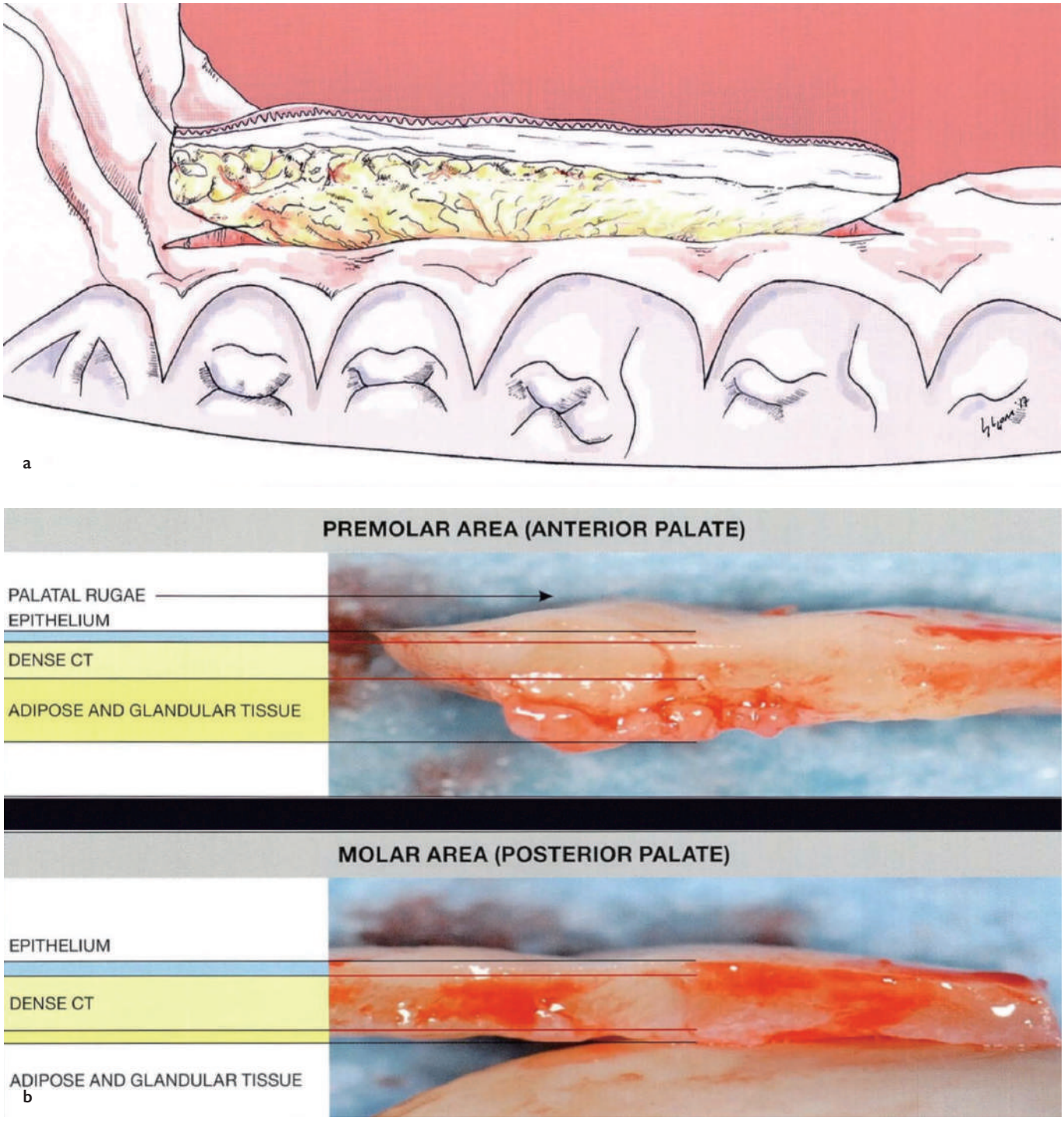


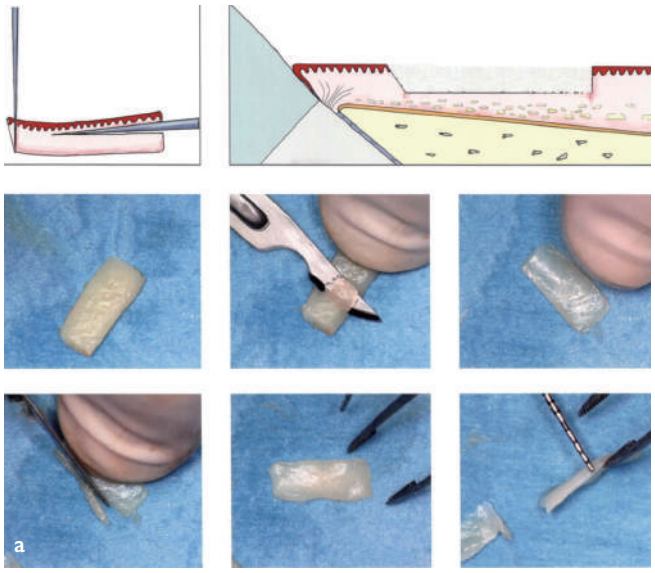
Fig. 8.
(a) Diagram of the cross section of the palatal gingiva
(b) Cross section of the palatal Free Ginigiva (note the difference of dense CT and adipose and glandular tissue between the anterior and posterior palate)

Connective tissue harvesting is divided largely into two types.[10]

1. De-epithelialized free gingival harvesting: Donor site healing occurs by secondary intention.
2. Sub epithelial connective tissue harvesting (trap door or single incision or L incision): Donor site healing occurs by primary intention with preservation and suturing of the access flap.

Method 2, as described above, is often preferred to minimize discomfort associated with postoperative pain and bleeding. However, the level of post-surgical pain is more influenced by the depth of graft harvesting and the apico-coronal dimension rather than the type of healing.[11] De-epithelialized free gingival grafting further enhances the reduction of postoperative pain and bleeding, primarily due to its shallower incision depth. This method facilitates the harvesting of tissues with more precise shape and size compared to techniques involving trap door or single incisions. In cases when harvesting subepithelial CTG (SCTG) from the posterior palate, significant bleeding may be caused if the branches of the greater palatal artery are damaged;[7] as such, harvesting SCTG from this area is not recommended. Conversely, de-epithelialized free gingival grafts offer a wider harvesting range similar to FGG, enabling the extraction of a larger tissue area. Moreover, the harvesting technique for de-epithelialized FGG is simpler than SCTG, thereby alleviating the clinician's burden.

Furthermore, de-epithelialized FGG provide an advantage in that a substantial portion of the harvested tissue comprises the lamina propria (dense connective tissue), which exhibits less absorption and is easier to manipulate.
In contrast, SCTG harvesting leaves a significant portion of the lamina propria in the access flap, resulting in harvested tissue predominantly composed of adipose and glandular tissues, which diminishes manipulability and increases absorption. Consequently, de-epithelialized free gingival grafting for CTG offers several advantages. **(Fig. 9)**



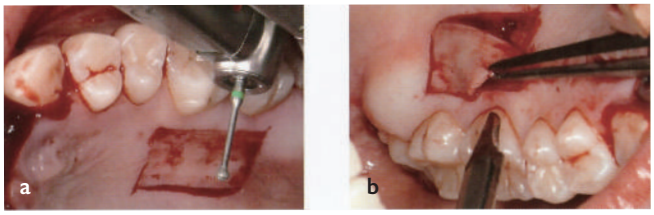


Fig. 9.
(a) De-epithelialized free gingival harvesting after harvesting the FGG, the epithelial layer (0.3–0.5 mm) is removed with a scalpel.
(b) De-epithelialization with diamond bur (depth approximately 0.3–0.5 mm) and free gingiva harvesting.

Conclusion

Soft tissue grafting has evolved to address various alveolar mucosal issues, including gingival recession in natural dentition, restoration of defects in edentulous alveolar ridges, and enhancement of peri-implant gingiva. In the current era where aesthetic restoration holds significant importance, the demand for and significance of soft tissue grafting continues to rise. Consequently, we have presented relevant cases to illustrate these points. For cases involving a staged approach with major GBR for continuous defects in the anterior region, selecting a technique capable of controlling the position of the MGJ is essential. Techniques such as the combination onlay-interpositional grafting,[1,2] which considers MGJ distortion and responds accordingly, are advisable in such scenarios. Additionally, in cases of immediate placement or single-tooth restoration that predominantly require horizontal ridge augmentation, the use of CTG may offer advantages. In such cases, using tunneling[4,6] or enveloping[8] techniques that can avoid unnecessary scarring can be helpful to achieve esthetic improvement. Regarding the method of connective tissue harvesting, de-epithelialized free gingival harvesting stands out as it allows the extraction of lamina propria (dense connective tissue), which is favorable for grafting procedures. This method can prove useful in achieving optimal results during soft tissue grafting procedures.

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How to cite this article : LEE JH. Soft tissue graft techniques to improve esthetics in the anterior regiond② *J Clin Digit Dent.* 2024;6(2):6-15. www.jcdd.org

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Evaluation and Diagnosis of the Temporomandibular Joint Position in Patients with TMD Using Digital Evenbite Splint: a Case Report

Kyunghwan Bang, DDS

Introduction

If there is malocclusion due to congenital factors or during the growth process, or a mismatch of teeth during prosthetic treatment of multiple teeth, it can lead to decreased masticatory function, facial asymmetry, and sometimes discomfort in the temporomandibular joint (TMJ). The optimal TMJ position has long been debated. Recently, a stable muscle position with minimal joint discomfort and stable opening and closing has been suggested as a reliable TMJ position during treatment.

However, in cases with existing teeth, the TMJ position is based on the current occlusion; therefore, various methods should be developed to evaluate the muscle stability of patients with long-term incorrect maximum intercuspation position (MICP). Among these methods, an Evenbite splint, which excludes the current occlusion by providing a flat plane to eliminate posterior occlusal interferences, is widely used clinically to evaluate the TMJ position.

With the increasing use of intraoral scanners and 3D printers in dental practices, it has become common to take impressions of final prosthetics with an intraoral scanner and fabricate temporary crowns or surgical guides in-house using a 3D printer. For comprehensive patient information collection before treatment, intraoral scanners and 3D printers are increasingly used to create diagnostic models if necessary.

This study aims to report on a case where the TMJ position of a patient with TMJ discomfort was evaluated using an intraoral scanner and 3D printer, and how this was incorporated into the treatment plan.

Kyunghwan Bang

Dr. Bang Kyung-hwan graduated from Pusan National University School of Dentistry in 2009 and and received a master degree from Ulsan University Graduate School of Medicine. He has been running Bang Kyung-hwan Donghaeng Dental Clinic since 2022. He is a regular member of the Society of Korea Clinical Dentistry (SKCD), Co-founder of WAVE dental study club, and a board member of Busan-Ulsan-Gyeongnam branch of Korean Academy of Esthetic Dentistry.

Chief Complaint & Initial Diagnosis

The patient is a 21-year-old man with mandibular teeth deviated to the left. The primary symptoms are limited mouth opening and a clicking sound in the jaw. Despite awareness of a malocclusion, the patient was more concerned about discomfort during mouth opening than aesthetic issues. Upon close examination of the initial panoramic radiograph **(Fig. 1)**, a midline discrepancy was observed. Checking for midline alignment in a panoramic radiograph is a crucial step in diagnosis. However, the continuity of the teeth is well maintained, and there are few prosthetics or restorations present, indicating good oral hygiene.

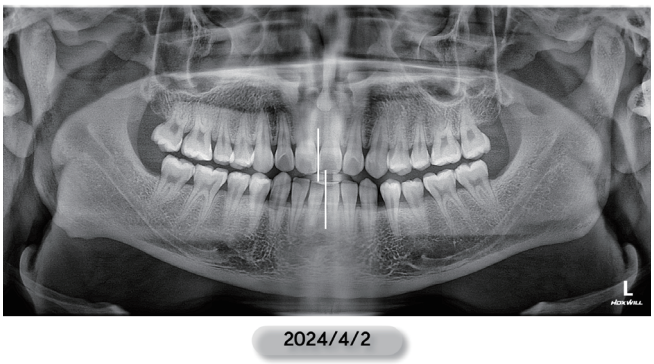


Fig. 1. Initial panoramic radiograph of the patient

The initial cephalometric radiograph **(Fig. 2)** shows significant left–right deviation and skeletal class III mandibular malocclusion. Cephalometric radiographs are useful for understanding the patient's skeletal and occlusal situation, despite not undergoing orthodontic treatment. This tool is used for patients undergoing extensive prosthetic treatment. The initial intraoral images **(Fig. 3)** show a clear midline discrepancy, with crossbite observed in teeth #22 and #32 and on the left posterior side. Identifying posterior disclusion in class III malocclusion is difficult. For patients like this with TMJ symptoms, a TMJ computed tomography (CT) scan **(Fig. 4)** is performed to check the position of the mandibular condyle whether the teeth are clenched. The cone-beam CT (CBCT) obtained while the teeth were clenched shows a slight posterior deviation of the left TMJ in the closed-mouth position, which should be compared with a CBCT taken in a muscle-stable position later. The TMJ questionnaire **(Fig. 5)** reveals that the patient has difficulty opening wide, experiences jaw noises and locking, and occasionally suffers from headaches. Maximum mouth opening was 48 mm, with left deviation during opening, suggesting condyle locking on the left side.

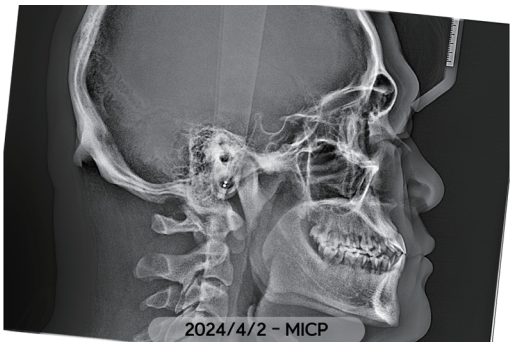


Fig. 2. Initial MICP cephalometric radiograph of the patient

Fig. 3. Initial intraoral photograph of the patient

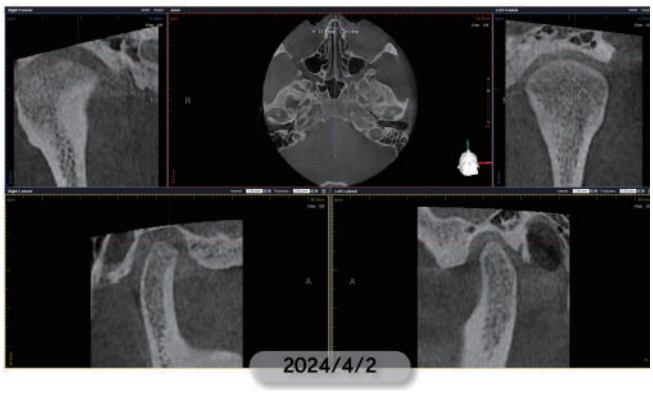


Fig. 4. Initial TMJ CT scan of the patient

Table 1

	Question		Answer
1	Is it difficult to open your mouth wide?	1	Yes
2	Do you experience your jaw clicking or getting stuck sometimes?	1	Yes
3	Have you ever been unable to close your mouth because you opened it too wide?	2	No
4	Do you experience any noise when opening or closing your mouth?	1	Yes
5	Do you experience stiffness or discomfort in your jaw after eating?	2	No
6	Do you experience pain when chewing something hard or when opening your mouth wide?	1	Yes
7	Do you experience pain in or around your ear or near your ear?	2	No
8	Do you occasionally suffer from headaches?	1	Yes
9	Is there any focal point of discomfort in your face, jaw, throat, temple, or head?	2	No
10	Do you have a painful tooth?	0	

Joint pain

Clicking	Right	Left
Spontaneous pain	☐	☐
Biting pain	☐	☐
Oppressive pain	☐	☐
Opening pain	☐	☐
maximum mouth opening	48mm	

Clicking

Clicking	Right			Left		
	early	Middle	Late	early	Middle	Late
Open	☐	☐	☐	☐	☐	☐
Close	☐	☐	☐	☐	☐	☐

Crepitus

Crepitus	Right			Left		
	early	Middle	Late	early	Middle	Late
Open	☐	☐	☐	☐	☐	☐
Close	☐	☐	☐	☐	☐	☐

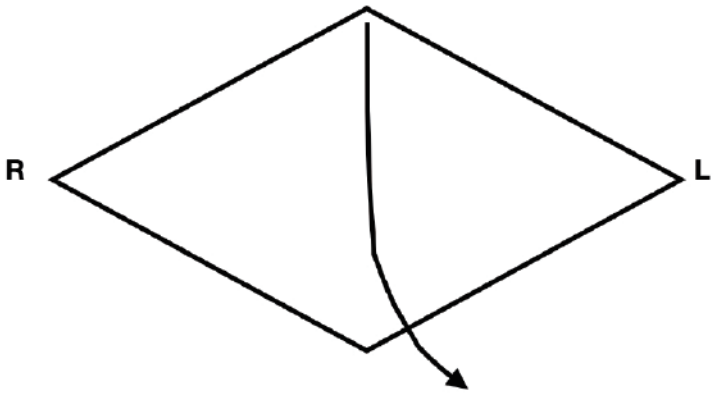


Fig. 5. Initial TMD chart of the patient

Evenbite Splint Fabrication, Application, and Observation

Typically, making an Evenbite splint involves taking upper and lower jaw impressions, mounting them, and using resin to fabricate the splint. Sometimes a direct method using an Omni-Vac device to make an upper model and adding orthodontic resin intraorally is used. However, acquiring the impressions and making the plaster models, along with additional impressions for articulator mounting, makes creating a diagnostic splint and convincing the patient challenging. Using an intraoral scanner, we obtained the patient's oral scan data and original MICP bite. Using the MEDIT SPLINTS app, an app in Medit's 3D program Medit Link, the bite was raised to create a splint with appropriate thickness **(Fig. 6).** It is necessary to raise the bite to a level that can withstand occlusal force without excessively increasing the posterior occlusion. Here, we aim to secure a thickness of approximately 0.8–1 mm.

After 3D printing, the splint can be easily adjusted externally; therefore, it was designed to cover the entire dentition, making it relatively easy to design **(Fig. 7).**

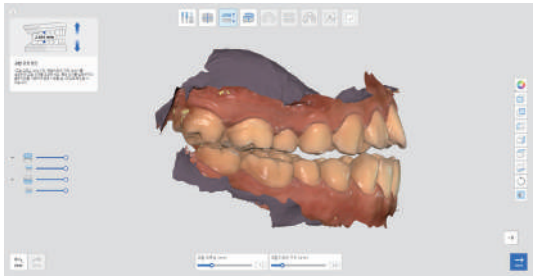


Fig. 6. Occlusal elevation using Medit Link's Medit Splints program

Fig. 7. Design of the Evenbite splint using Medit Link's Medit Splints program

The printed splint was adjusted intraorally to avoid contact with the mandibular anterior teeth by trimming the relevant area and ensuring that the occlusal surface made even contact with the mandibular premolars and molars on both sides **(Fig. 8).** To examine muscle stability, the patient was instructed to wear the splint often, excluding meal times, during the day and while sleeping.

Fig. 8. Adjustment of the anterior section of the splint and wearing after occlusal adjustment

On the third day of wearing the splint, the patient reported discomfort as the mandible, previously constrained by an anterior crossbite, shifted to the right near the midline **(Fig. 9a).** Early contact was noted on the right side, requiring occlusal adjustment to achieve even bilateral contact during splint use. Nine days after wearing the splint, the mandible moved closer to the midline **(Fig. 9b)**, and overjet and overbite **(Fig. 10)** were adjusted close to edge-to-edge contact during occlusal raising. This suggests that the malocclusion resulted from the anterior crossbite developed during the growth process.

Fig. 9a-b. Comparison of midline changes after 9 days of wearing the device

Fig. 10. Observation of overjet and overbite changes after 9 days of wearing the device

Significant improvement was observed in the rightward deviation of the mandible during opening and closing, and many TMJ symptoms that had been previously reported were alleviated. To document this, the temporomandibular disorder (TMD) chart **(Fig. 11)** was updated. The questionnaire results showed that most of the previously reported TMJ discomfort had resolved. However, to examine the occlusal relationship in a muscle-stable position, it was decided to acquire a bite registration using paraffin wax for muscle stability.

Table 1

	Question	Yes	No
1	Is it difficult to open your mouth wide?	☐	✔
2	Do you experience your jaw clicking or getting stuck sometimes?	☐	✔
3	Have you ever been unable to close your mouth because you opened it too wide?	☐	✔
4	Do you experience any noise when opening or closing your mouth?	☐	✔
5	Do you experience stiffness or discomfort in your jaw after eating?	☐	✔
6	Do you experience pain when chewing something hard or when opening your mouth wide?	☐	✔
7	Do you experience pain in or around your ear or near your ear?	☐	✔
8	Do you occasionally suffer from headaches?	☐	✔
9	Is there any focal point of discomfort in your face, jaw, throat, temple, or head?	☐	✔
10	Do you have a painful tooth?	☐	✔

Joint pain

Clicking	Right	Left
Spontaneous pain	☐	☐
Biting pain	☐	☐
Oppressive pain	☐	☐
Opening pain	☐	☐
maximum mouth opening		

Clicking

Clicking	Right			Left		
	early	Middle	Late	early	Middle	Late
Open	☐	☐	☐	☐	☐	☐
Close	☐	☐	☐	☐	☐	☐

Crepitus

Crepitus	Right			Left		
	early	Middle	Late	early	Middle	Late
Open	☐	☐	☐	☐	☐	☐
Close	☐	☐	☐	☐	☐	☐

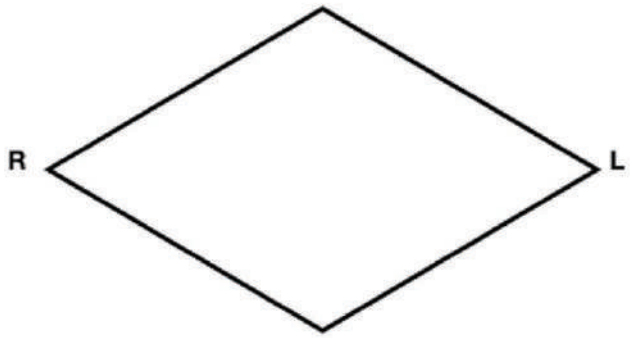


Fig. 11. Reassessment of TMJ symptoms

CR Bite Acquisition & Articulator Mounting

There are various methods for centric relation (CR) bite acquisition, but we primarily use the unguided technique with paraffin wax. The patient must continue wearing the Evenbite splint and visit the clinic. In a comfortable upright posture, paraffin wax thick enough to raise the posterior teeth is placed on the anterior teeth, and the patient lightly opens and closes their mouth repeatedly. As the mandible is guided to a stable position, paraffin wax is lightly bitten, and bite material is applied to the posterior teeth. After CR bite acquisition using the unguided technique, the wax is removed to confirm the midline, and an image is taken **(Fig. 12).** The bite was found to be maintained in almost the same position as in the image taken a week earlier with the Evenbite splint.

Fig. 12. Confirmation of midline after CR bite acquisition

Initial CBCT scanning of the TMJ suggested a posterior displacement of the left condyle. For accuracy, a CBCT **(Fig. 13)** in the CR state is needed to check for changes in the TMJ position. It was suspected that there was a slight posterior displacement in MICP, but it was confirmed to have moved relatively anterosuperiorly. If comparing the positions of both mandibular condyles in the two images **(Fig. 14)**, there was no significant change in the right condyle position, but a significant change was observed in the left condyle position. This indicated that as the pressure on the posterior disc tissue was relieved, most of the patient's TMJ symptoms were resolved. It confirmed that the displacement of the left mandibular condyle due to malocclusion caused the opening limitation, clicking sounds, and right deviation during mouth opening.

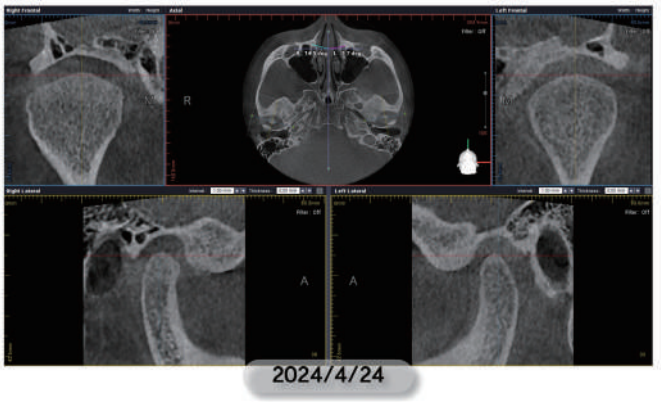


Fig. 13. TMJ CBCT in CR bite

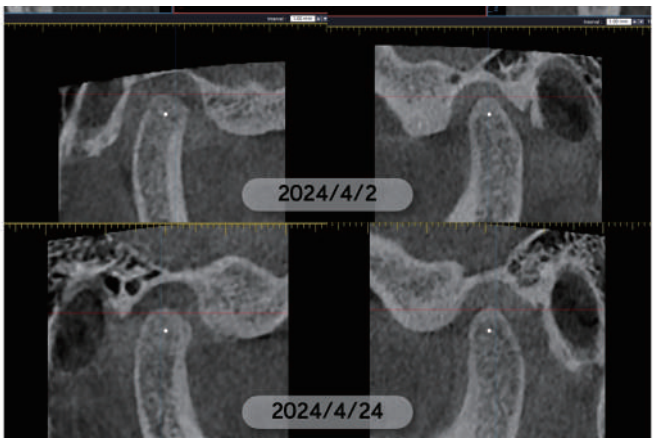


Fig. 14. Comparison of mandibular condyle positions in MICP and CR states

To check for early contact using the patient's CR bite, an articulator mounting was performed. A face-bow transfer was conducted to attach the maxillary model **(Fig. 15).** Since the preparation for virtual articulator mounting was unavailable, the patient's upper and lower models were printed using the oral scan data with a 3D printer. The maxillary model was mounted on the articulator using a face-bow transfer, and the mandibular model was mounted using the CR bite **(Fig. 16).**

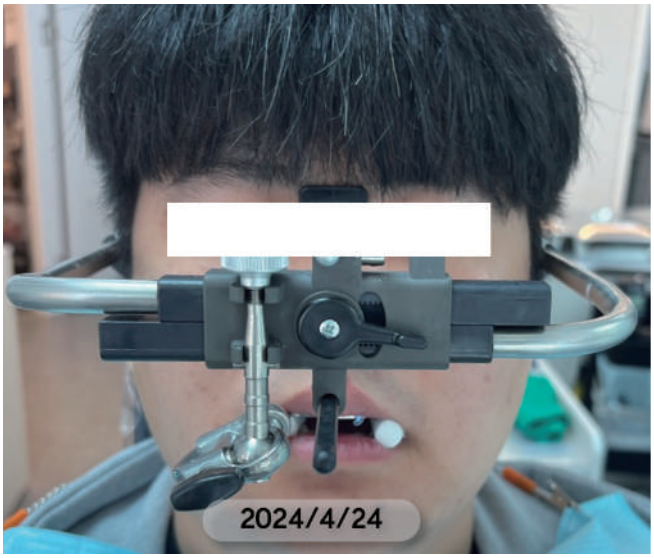


Fig. 15. Face-bow transfer

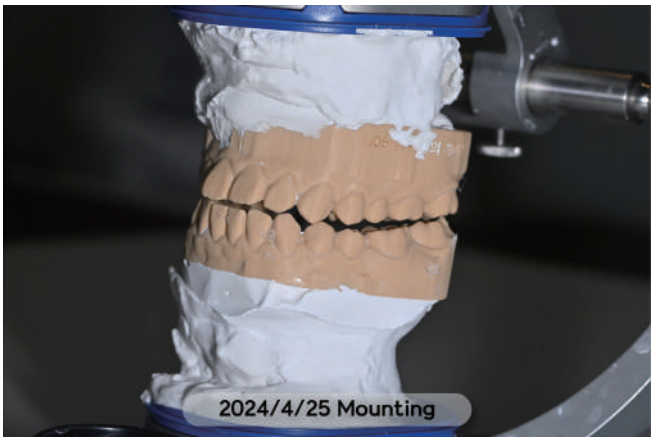


Fig. 16. CR bite mounting on 3D printed models

The incisal pin was removed to check for early contact areas. Early contact was observed between the upper canines and lower first premolars on both sides, with no occlusion on the posterior teeth. The articulator models were rescanned using the oral scanner, and the existing scan data were superimposed digitally to verify early contact relationships **(Fig. 17).** Although the treatment's vertical dimension target was not determined, a comparison of the upper and lower arch sizes showed that the upper arch was significantly narrower than the lower arch **(Fig. 18).**

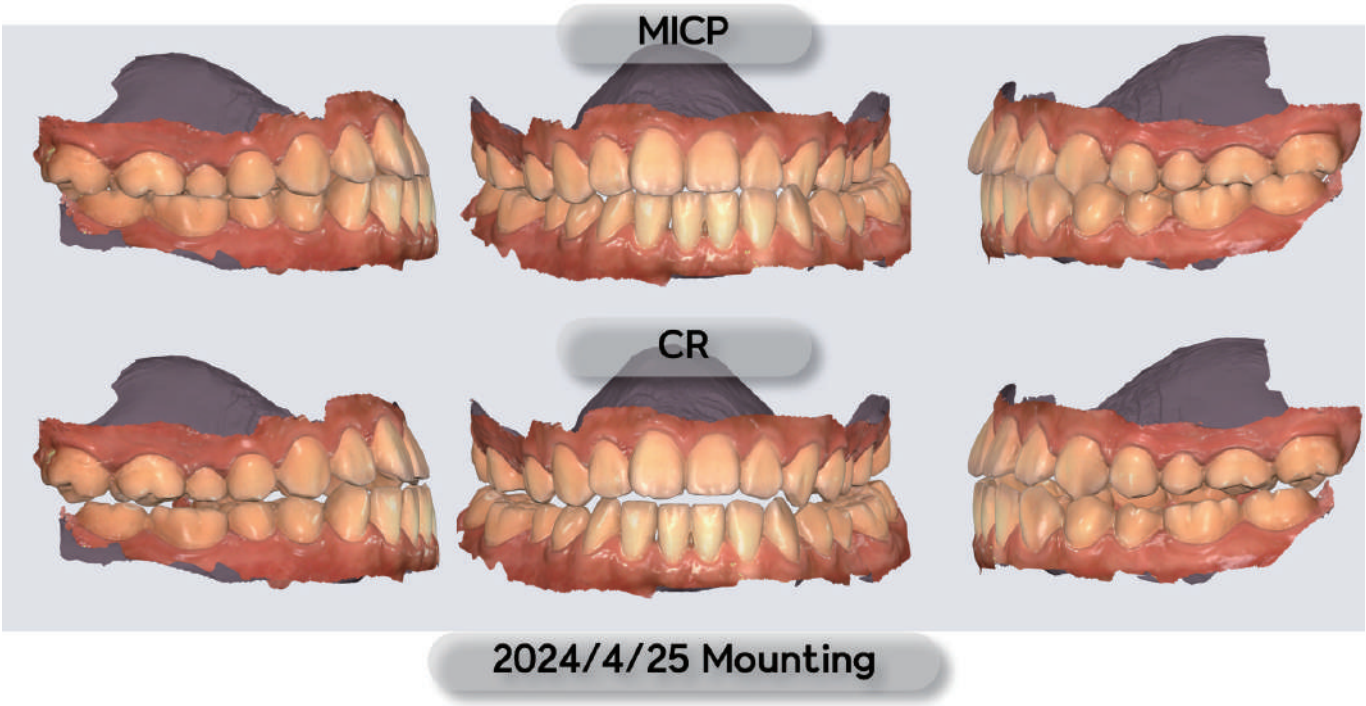


Fig. 17. Comparison of oral scan data in MICP and CR states

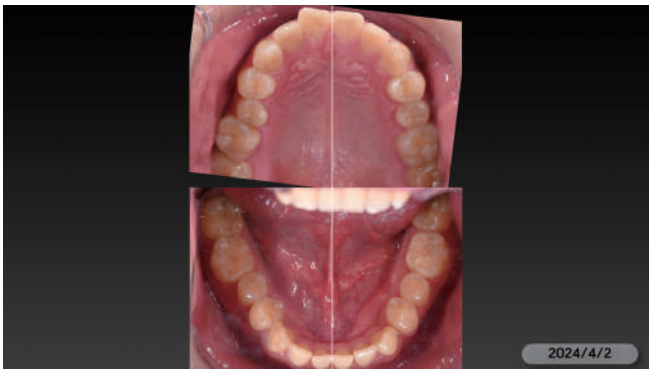


Fig. 18. Comparison of upper and lower arch sizes in the initial photograph

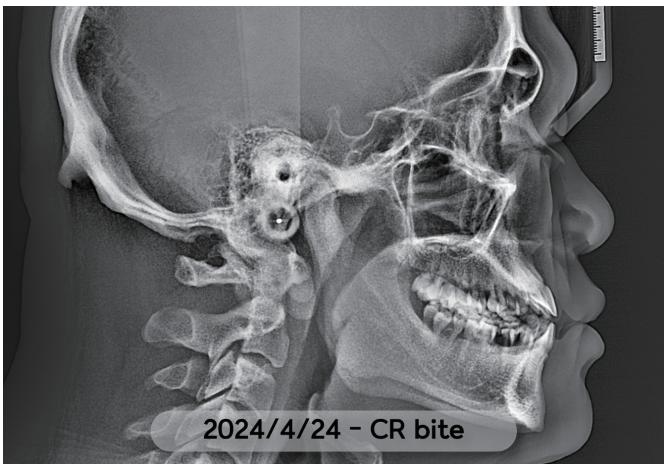


Fig. 19. Cephalometric radiograph in CR bite

Provisional Treatment Plan and Orthodontic Consent

Using the Evenbite splint confirmed a close relationship between the patient's malocclusion and TMD. The cephalometric radiograph in the CR state **(fig. 19)** revealed skeletal class III mandibular malocclusion. The patient's main concern was the TMJ symptoms, which were found to be caused by malocclusion using a simple device. The discrepancy between the upper and lower arches was significant. If the device-wearing period was extended to alleviate symptoms, extensive prosthetic treatment may be necessary to achieve proper occlusion for adequate chewing function. However, orthodontic treatment involving upper arch expansion and lower teeth posterior movement was expected to form proper occlusion in a favorable TMJ position. The patient understood the need for orthodontic treatment after approximately two weeks of wearing the device, readily consented to the treatment, and was referred to the orthodontic department. To ensure the harmony between proper occlusion and TMJ position, active involvement and cooperation in the orthodontic process are planned.

Discussion

In patients without TMD and smooth opening and closing, dental treatment based on the current jaw position may not be problematic despite some malocclusion. However, in patients with severe malocclusion or multiple prosthetic teeth, TMJ displacement and accompanying TMD can occur. It is crucial to identify the patient's permissible stable muscle position and confirm if TMJ symptoms are resolved if this stable position is induced.

Generally, patients chew based on their current dentition; thus, creating a device to exclude patient occlusion is essential to identify this stable joint position. Among such devices, the Evenbite splint, which provides a flat occlusal surface for posterior teeth, is useful for diagnosis.

Previously, making an Evenbite splint required acquiring impressions and creating plaster models, which were costly and involved using external laboratories, making it challenging to convince patients to use such diagnostic devices.

With the widespread adoption of intraoral scanners, we can easily capture a full impression of the patient's mouth within 5–10 min. This allows for the digital diagnosis of various occlusal characteristics without needing to print the impression. Consequently, the use of this technology may increase. Additionally, 3D printers can be used to print models multiple times as needed, and diagnostic splints can be produced in-house at dental clinics with minimal cost and time.

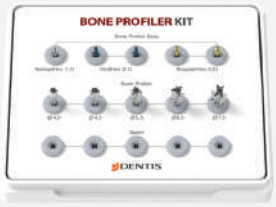
Certain precautions are necessary for device use. It is important to confirm the patient's commitment to overall treatment. In the Evenbite splint, significant changes in the joint position can initially occur, which may cause the patient to feel apprehensive about adapting to the occlusal changes. Additionally, long-term use may prevent the condyle from returning to its previous pathological position, potentially causing permanent occlusal changes. However, if used only for a short period, the occlusion can easily revert to its original state.

For the device to be properly fabricated, the continuity of the teeth and a relatively flat occlusal plane must be maintained. In cases of severe malocclusion or many missing teeth, a thin device may be impossible to create, and an appropriate mandibular position would be challenging to restore. In such cases, occlusal adjustment, the creation of provisional crowns, or temporary orthodontics and implants may be necessary to create suitable conditions for using the device. Using intraoral scanners and 3D printers can simplify the previously cumbersome process of diagnosing muscle stability with the Evenbite splint, as demonstrated in this case. Such diagnostic methods are expected to become more widely used eventually.

How to cite this article: Bang KH. Evaluation and Diagnosis of the Temporomandibular Joint Position in Patients with TMD Using Digital Evenbite Splint: a Case Report
J Clin Digit Dent. 2024;6(2):17-24. www.jcdd.org

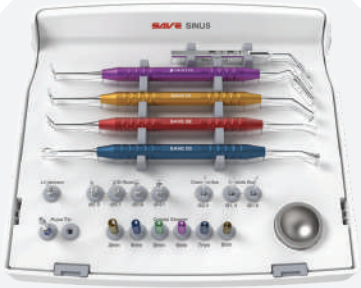
KIT & INSTRUMENTS

- SAVE CRESTAL SINUS KIT
- SAVE GBR KIT
- SAVE-FIX
- SAVE RIDGE KIT
- SAVE SEPTUM DRILL KIT
- SAVE REMOVER KIT
- BONE PROFILER KIT
- SAVE WIDE CAP



BONE PROFILER KIT

SAVE FIX



SAVE CRESTAL SINUS KIT

SAVE GBR

SAVE WIDE CAP

SAVE RIDGE

SAVE SEPTUM

SAVE REMOVER

Auxetic free gingival graft: Technical note and case report

Youngjae Baek, DDS, PhD

Introduction

For many years, the necessity of peri-implant keratinized mucosa and the corresponding minimum amount has been a point of contention. Relatively recent research highlighted that the effect of keratinized mucosa on condition of peri-implant tissues remains unknown.[1] other contemporary studies have also found that the severity of peri implant mucositis worsens with an insufficient amount of keratinized mucosa, and in such condition, the resolution of peri-implantitis is difficult.[2,3]

Recently, systematic reviews and consensus reports by leading research groups commented the necessity of keratinized mucosa to improve the peri-implant environment and ensure long-term stability. Although the 2017 World Workshop of the American Association of Periodontology did not conclude about the impact of the deficiency of keratinized mucosa on the health of peri-implant tissue, they stated that the presence of keratinized mucosa may help to reduce patient discomfort and improve plaque control.[4]

The 2021 consensus statement from the European Association for Osseointegration mentioned that procedures to expand the keratinized mucosa could be recommended to enhance clinical parameters (gingival index and gingival recession) and plaque control in the posterior teeth.[5] The 2022 consensus report from Osteology stated that the decrease of the keratinized mucosa width was related to peri-implantitis, biofilm accumulation, soft-tissue inflammation, mucosal recession, marginal bone loss, and patient discomfort. Moreover, the minimum keratinized mucosa width which reducing the possibility of peri-implant disease was 2 mm.[6]

The 2023 consensus report by the International Team for Implantology stated that a free gingival graft was recommended in posterior area if the patient has difficulty for plaque control and experiences discomfort when brushing their teeth, even if healthy peri-implant environment was currently being maintained with insufficient keratinized mucosa.[7]

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The 2023 clinical practice guideline of the European Federation of Periodontology asked, "in patients with healthy peri-implant tissues, does augmentation of peri-implant soft tissues lower the likelihood of incident peri-implant diseases?".[8] In their response, they claimed that although the quality of evidence was low and the recommendation grade was not high, if the patient complained of discomfort during tooth brushing due to a deficiency of keratinized mucosa, the width of keratinized mucosa should be increased to maintain peri-implant health.

The most widely used method involves exposing the periosteum and transplanting autologous tissue to augment keratinized mucosa. Alternatively, attempts have been made to use commercialized materials, such as acellular dermal matrix (ADM) and collagen matrix, due to the patient's morbidity and the necessity for a second surgical site. However, when comparing the results of keratinized mucosa augmentation, no significant differences have been observed between the method using apically positioned flap (APF) operation alone and other methods, except methods using keratinized autologous tissue.[9]

Several methods for manipulating and modifying the graft have been designed to minimize postoperative discomfort in the donor site. Among these, the most widely known method is the accordion technique[10], which modifying the graft with alternately cutting. With this modification, even harvesting the graft for 60% of the area of recipient site, the same result could be achieved as un-modified graft with 100% of the area.[11] An attempt to augment the width of the keratinized mucosa was successfully achieved by arranging pieces of the graft like column, using the phenomenon that the connective tissue surrounded by keratinized tissue becomes keratinized through secondary healing.[12] Moreover, a recent report showed promising results with a modification of the graft to the mesh-like appearance for expanding by making several cuts within the graft.[13]

Several efforts have been made to create metamaterials/meta-structure, which have enhanced mechanical and physical properties of the original material that cannot be achieved naturally, by modifying the material's structure. Among them, auxetics are the meta-structure which are able to stretch perpendicular to the direction of the tensile force, and achieved from reconstruction of materials with anti-rubber or dilational features. Traditional materials have a positive Poisson's ratio, which means shrinking to some extent perpendicularly to the tensile direction. The term auxetic comes from the Greek word αύξητικός (auxetikos), meaning "that which tends to increase." The auxetic structure (negative Poisson's ratio) was introduced as a concept in 1985 by Kolplakov,[14] and various designs have been proposed since Evans used the term "auxetic" in 1991.[15] Among the two-dimensional structures, a design with rotating square units could be applied to free gingival graft precedure.[16] This paper introduces cases of free gingival graft using modification of graft to auxetic structure.

Technique

A hierarchical kirigami-based auxetic meta-structure design was applied for two-dimensional expansion.[16] It has rectangular units and four rectangular elements forming one unit. **(Fig. 1)** Each component is connected by a hinge point, and the overall length increases when each units rotate. When the graft expands, the hinge points arranged along the central long axis of the entire graft move away from each other, and the others located on the edges of the graft move closer to the central axis. A structure with square elements can increase in length by up to 40%. In a design with rectangular elements, the extent to which could be stretched varies depending on the ratio of the length to the width and the rotational angle. For example, when using the rectangular unit that the width to length ratio is 2:3, the entire length can be increased by about 75% when rotational angle is 90° at hinge point. **(Fig. 2)**

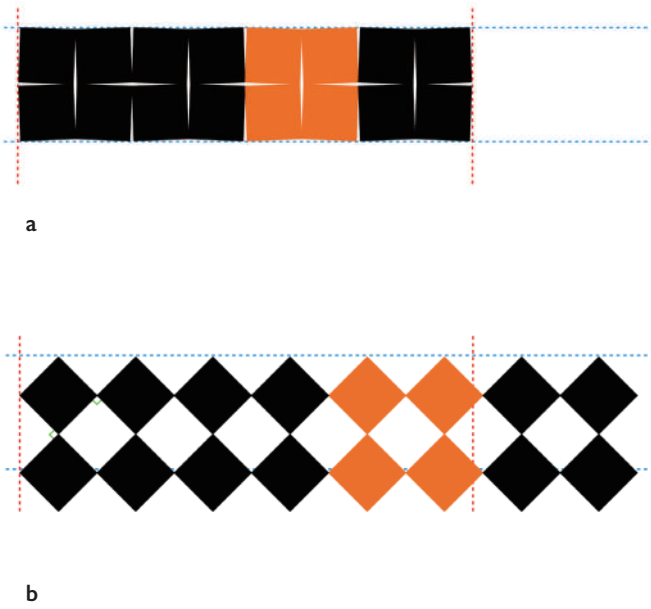
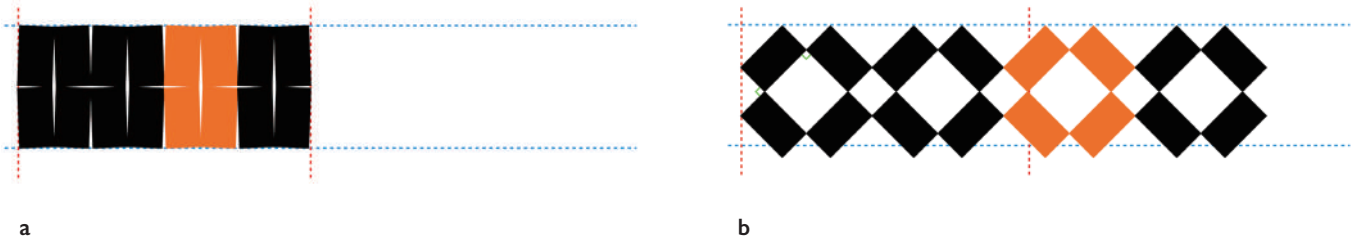


Fig. 1. Square auxetic structure, where an expansion of about 40% is possible
(a) cutting design
(b) expansion.



a b

Fig. 2. Rectangular auxetic structure with an unit has width-to-height ratio of 2:3. An expansion of approximately 75% was achieved when rotated 90 degrees at the hinge point.
(a) cutting design
(b) expansion

General Case Management

The donor site was prepared by block anesthesia (1.8 mL of lidocaine HCL hydrate, 1:100,000 epi.) (Huons Co.; Gyunggi-do, Korea) of the greater palatine nerve and nasopalatine nerve of the ipsilateral palate. In addition, at the recipient area, block anesthesia was applied to the posterior superior alveolar nerve in the maxilla and the inferior alveolar nerve in the mandible.The preparation of the recipient site was performed using Clark's vestibulopathy method.17 The horizontal incision line was designed in keratinized mucosa at the alveolar crest, approximately 1 mm apart the mucogingival junction.The vertical incision was made diagonally to create a trapezoid-shaped flap with a broad inferior aspect. First partial thickness dissection was performed at the sub-epithelium level to free the epithelium from muscle influence. Secondary dissection was done through supra-periosteum level for the periosteal bed preparation. A sufficiently broad recipient site was prepared enough to extend beyond the attachment of the buccinator muscle.

Graft was harvested from the palate, ranging from premolars to molars. Grandular and fatty tissue were trimmed off, following the graft was prepared as uniform thickness (1.0-1.5 mm) as possible. A collagen sheet (Atelocare, Hyundai Bioland Co.; Chungcheongbuk-do, Korea) was applied to the exposed connective tissue of the donor site and stabilized with 6-0 nylon (Blue Nylon, Aille Co.; Busan, Korea).Then, a retainer made of self-polymerizing resin (Trayplast;Vertex, Netherlands) was applied to cover the palate, remaining the occlusal surface exposed.

Iterations was made to allow the graft to expand.Vertical incisions dividing the units were made through full thickness using a 15c blade (Kiato, Germany). Next, iterations were made along the long axis to complete the auxetic structure. To prevent the units from tearing during fixation over recipient site, each component should have a width of >1.5 mm. Iterations should not meet each other, and the hinge point should have a width of >0.5 mm for strength.

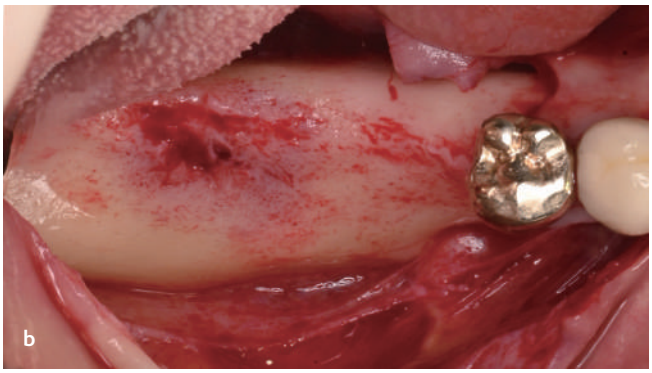
The graft was expanded and applied to the recipient site, and each component was secured to the periosteum with simple interrupted sutures (Monocryl 6-0; Ethicon). In the final step, the mucosal epithelial flap of the recipient site was repositioned in the apical direction. A horizontal mattress suture (Monocryl 5-0; Ethicon) was used, and the part containing the keratinized mucosa was first fixed for reducing the movement of the entire flap. Afterward, additional sutures were applied to create a condition not affected by the movement of the cheeks or lips.

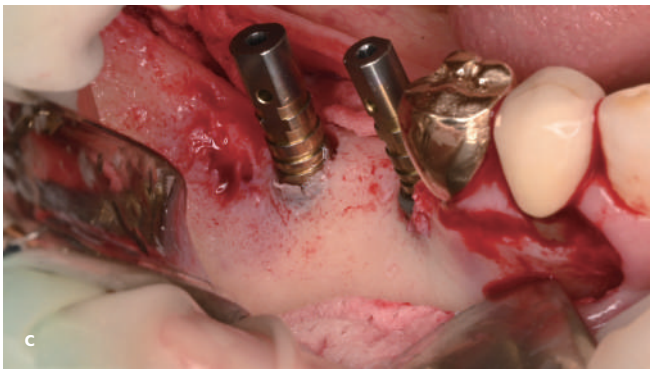
NSAIDs (loxoprofen 60 mg, tid, for 5 days) and antibiotics (amoxicillin 500 mg, tid, for 5 days) were prescribed. Sutures on the donor site were removed 3 days after surgery, and sutures of the recipient site were removed 2 weeks after surgery. Patients were advised to always wear the palatal appliance for 2 weeks and store the equipment for 4 weeks, when re-epithelialization achieve completely through secondary healing. Impressions/scan for prosthetics were performed after 4 weeks.

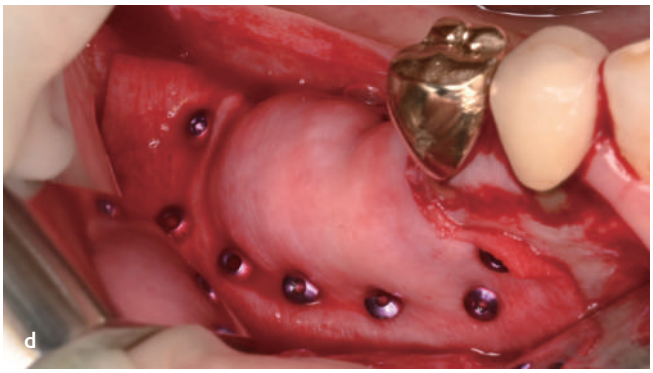
Case Report

[case 1]

In April 2023, a 66-year-old female patient visited the hospital for recovery of the missing mandibular right first molar and mandibular right second molar. She had hypertension and was a non-smoker. In June 2023, Implant fixtures (SQ, Dentis implant; Daegu, Korea) were placed in the mandibular right first molar and mandibular right second molar, and guided bone regeneration procedure was performed. **(Fig. 3)**







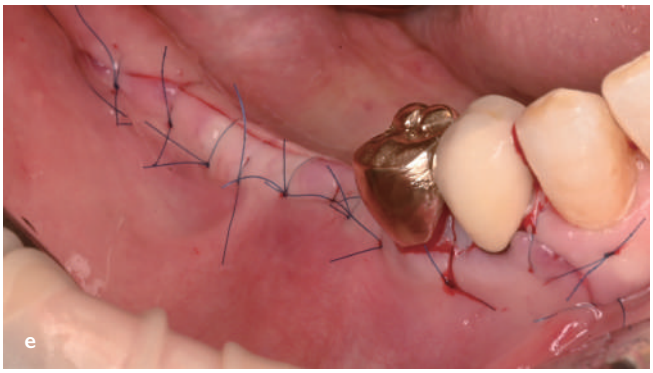


Fig. 3.
(a) Initial status with narrow keratinized mucosal band.
(b) Flap elevation and bone exposure.
(c) The implant was placed, and the dehiscence exposure of fixture was observed.
(d) Guided bone regeneration was performed.
(e) Completed suturing.

In November 2023, free gingival graft for augmenting the keratinized mucosa was performed on buccal mucosa. The graft was harvested from the ipsilateral palate. To expand the graft, iterations applied for making an auxetic structure. A length expansion of approximately 56% was achieved. The graft could be applied to the site from the mandibular right second premolar to the retromolar pad. **(Fig. 4)**

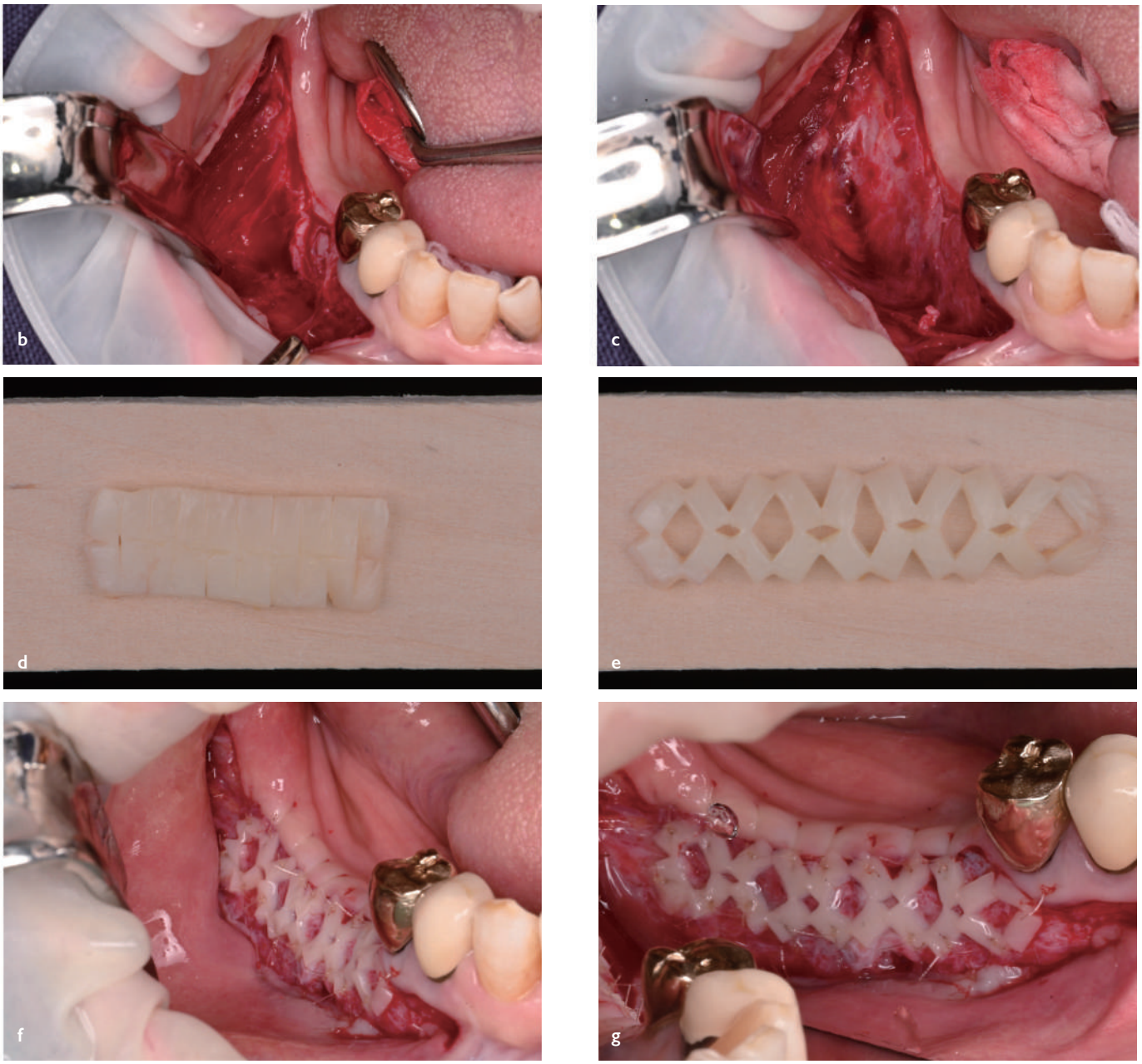


Fig. 4.
(a) Condition before free gingival grafting
(b) Preparation of the recipient site. The epithelial layer was free from muscular influence.
(c) Preparation of the recipient site. Periosteal bed preparation was done.
(d) Design for modification of the graft.
(e) Extension of the graft. Approximately 56% of the length was increased.
(f) The fixation of the graft was completed.
(g) The fixation of the graft is completed (Lateral view).

In January 2024, an apically positioned flap was performed in lingual vestibule and healing abutments were connected. The provisional restoration was installed in March 2024, and the final prosthesis was connected in May 2024 **(Fig. 5).**

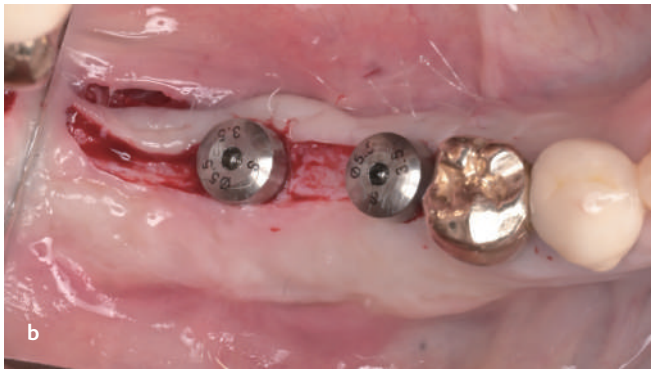


Fig. 5.
(a) 3 months after free gingival grafting.
(b) Lingual apically positioned flap.
(c) Provisional restorations, 4 months after free gingival graft.
(d) Final prosthesis, 6 months after free gingival graft.

[case 2]

In March 2023, a 66-year-old male patient visited the hospital for recovery of the maxillary left first molar and the maxillary left second molar. He had hypertension and was a non-smoker. He had jaw asymmetry and crossbite at left posterior molars. **(Fig. 6)** In July 2023, implants (SQ, Dentis implant; Daegu, Korea) were placed in the maxillary left first molar, and maxillary left second molars, and maxillary sinus lift through a lateral approach and guided bone regeneration procedure were performed. **(Fig. 7-8)**

In November 2023, a wide frenulum extending down to the distal buccal site of the maxillary left second premolar was removed, and free gingival graft was performed to increase the width of the keratinized mucosa. The recipient site was prepared from the maxillary left second premolar to the maxillary left second molar. A long graft was required due to the curved alveolar bone shape. A graft was harvested from the ipsilateral palate. A long and curved graft containing the palatal mucosa of the maxillary left second molar area was harvested. To make the graft flexible, iterations applied and the graft was modified into an auxetic structure. The curved graft could be straightened and fit the curved recipient site well. **(Fig. 9)** The provisional restoration was installed in December 2023, and the final prosthesis was connected in March 2024. **(Fig.10)**

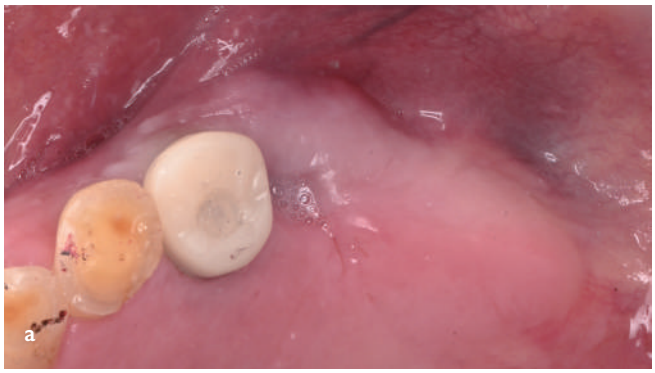


Fig. 6.
(a) First visit. Asymmetry of the jaw and crossbite can be observed in the left posterior teeth.
(b) First visit. The soft tissue of the maxillary left first molar area was depressed.

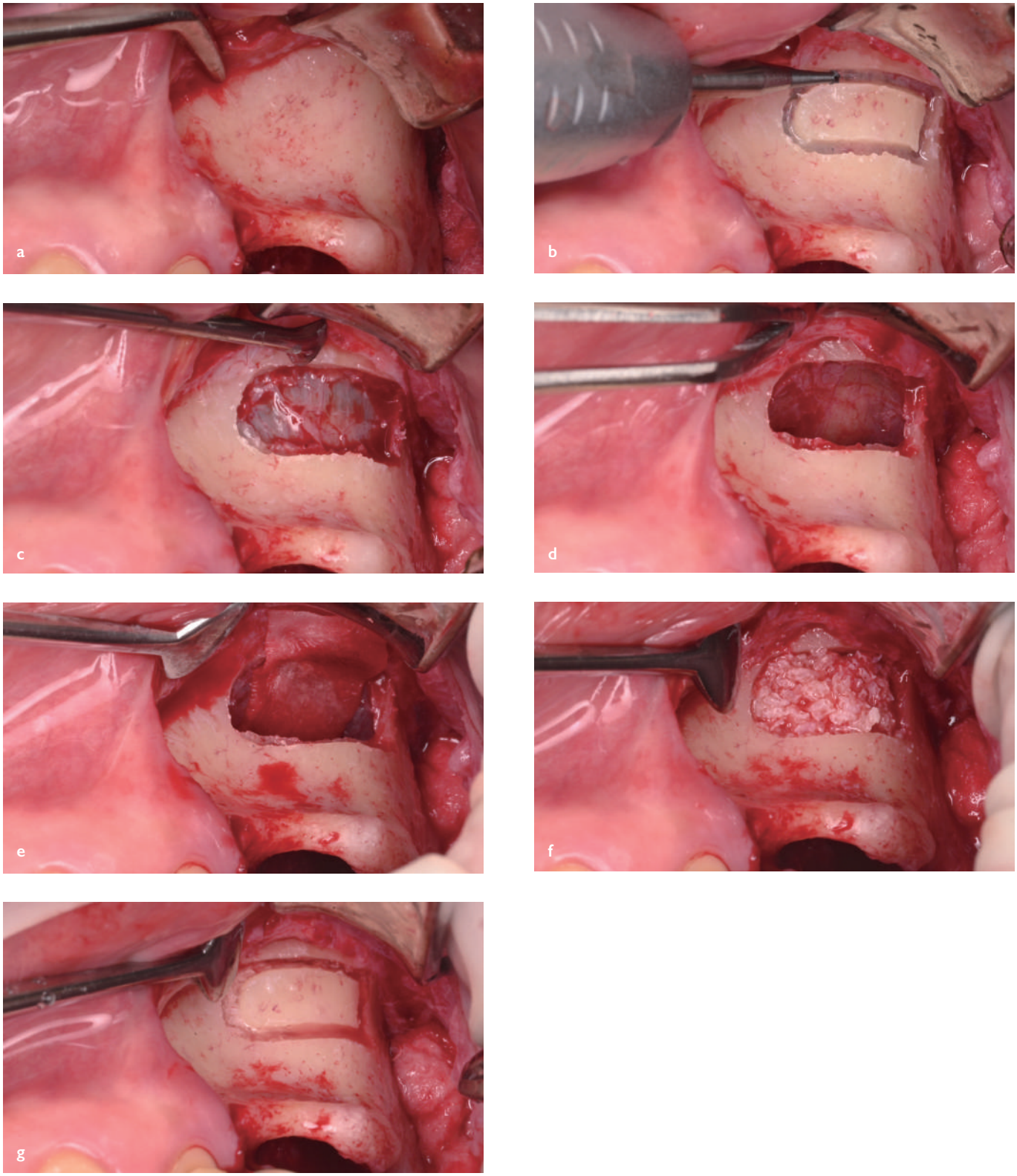


Fig. 7.
(a) The flap was elevated, and the anterior wall of the maxillary sinus was exposed.
(b) A window was created for maxillary sinus augmentation using a lateral approach.
(c) After removing the window, the Schneiderian membrane was exposed.
(d) The Schneiderian membrane was separated from the maxillary sinus wall.
(e) Application of collagen sheet.
(f) Application of bone graft materials.
(g) Repositioning of the window.

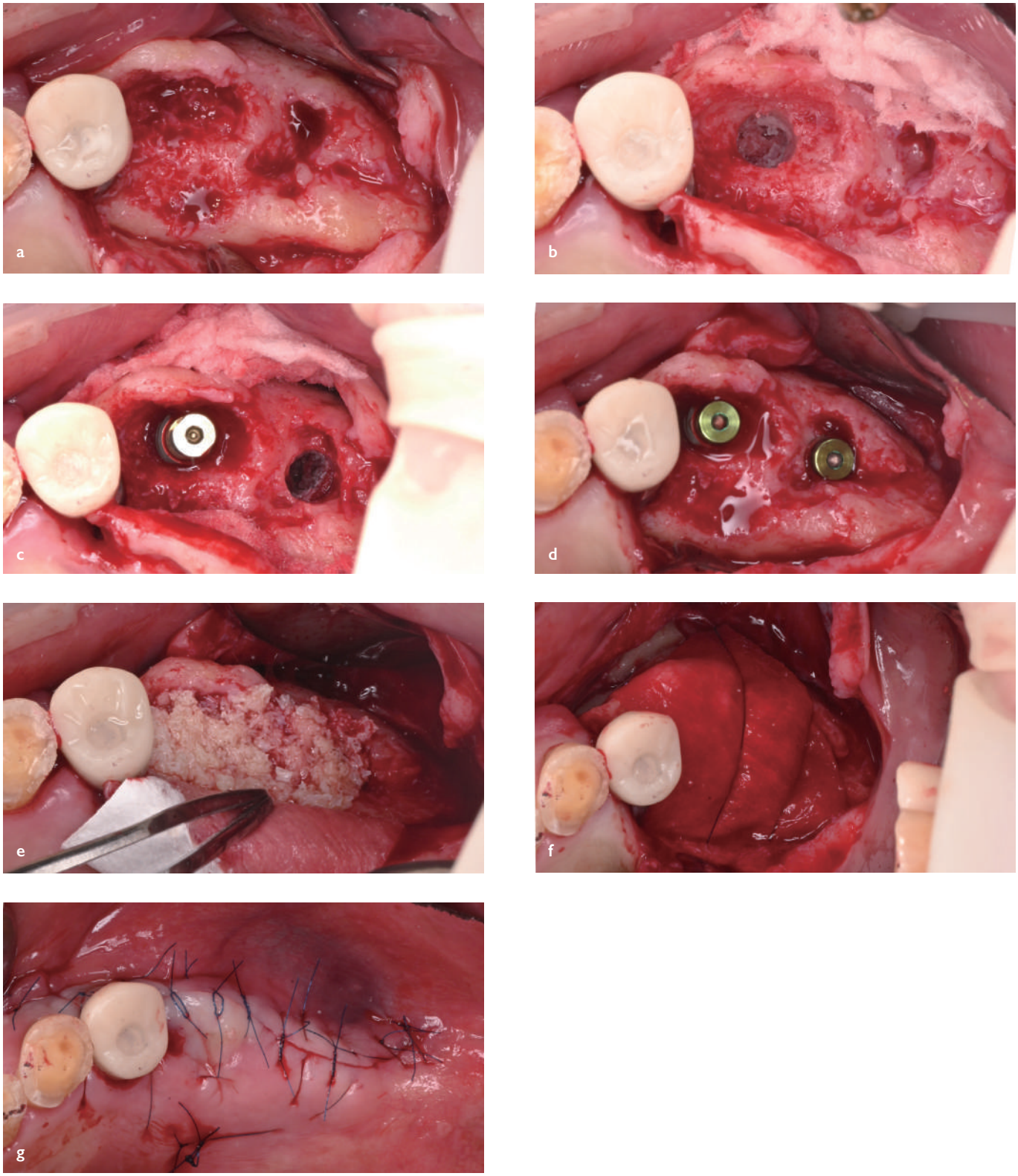


Fig. 8.
(a) View from the occlusal plane.
(b) Drilling was performed for implant placement. Graft materials filled inside the maxillary sinus can be observed. Maxillary first molar site.
(c) Drilling was performed for implant placement. Graft materials filled inside the maxillary sinus can be observed. maxillary second molar site.
(d) The placement of the implant and the cover screw. Exposure of the fixture is observed.
(e) Augmentation of bone graft materials.
(f) The membrane was stabilized with membrane holding suture.
(g) Suturing was completed.

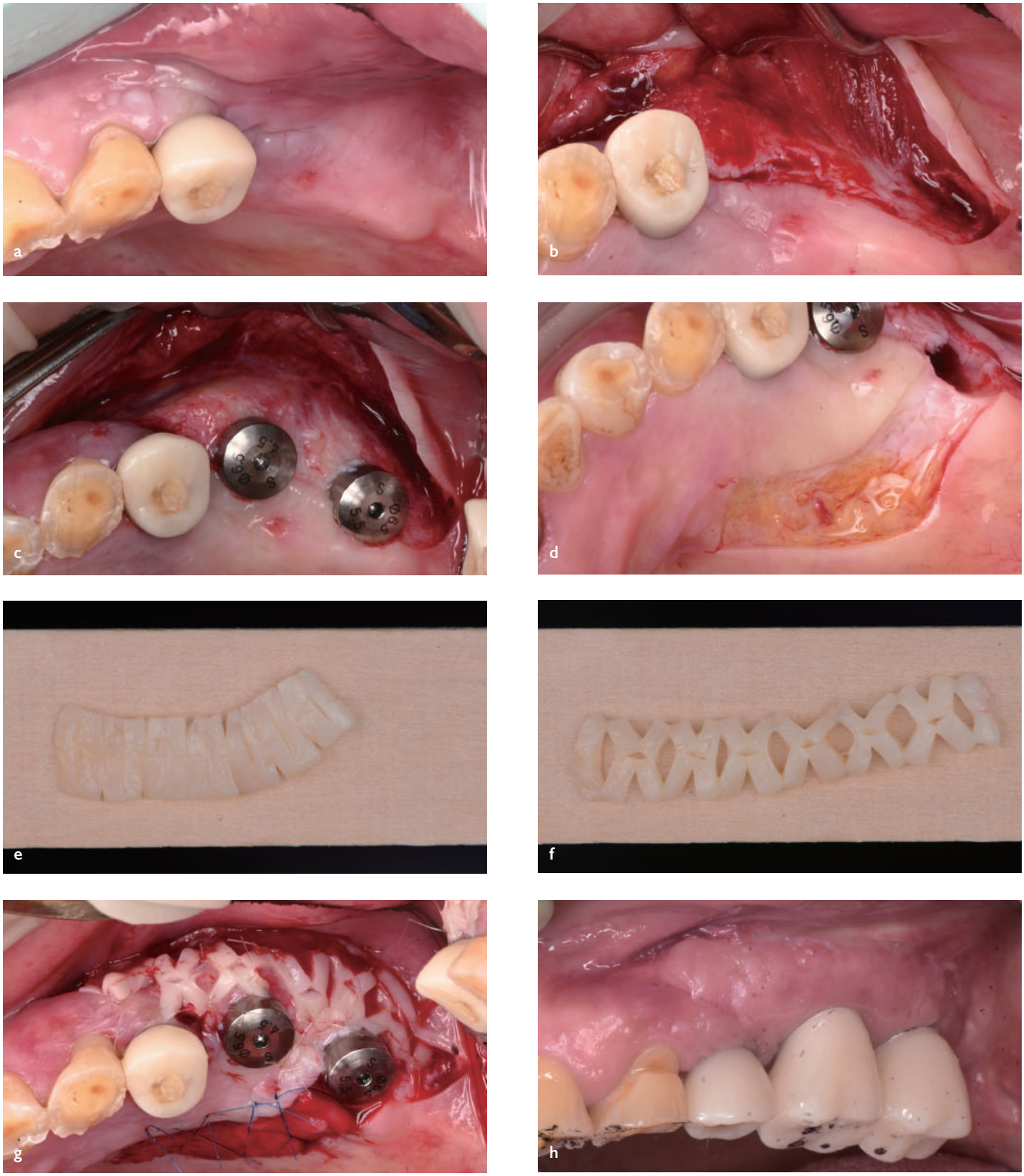


Fig. 9.
(a) Before free gingival graft procedure. Mucogingival junction moved coronally.
(b) Preparation of the recipient site. The epithelial layer was free from muscular influence.
(c) A periosteal bed was prepared, and a healing abutments were installed.
(d) A graft was harvested from the donor site.
(e) Design for modification of the graft.
(f) Extension of the graft. The graft has flexibility.
(g) The fixation of the graft and treatment of the recipient site was completed.
(h) Provisional restoration, 5 weeks after free gingival graft.

Fig. 10.
(a) Final prosthesis, 4 months after free gingival graft (frontal view).
(b) 4 months after free gingival graft(lateral veiw).
(c) 6 months after free gingival graft(lateral veiw).

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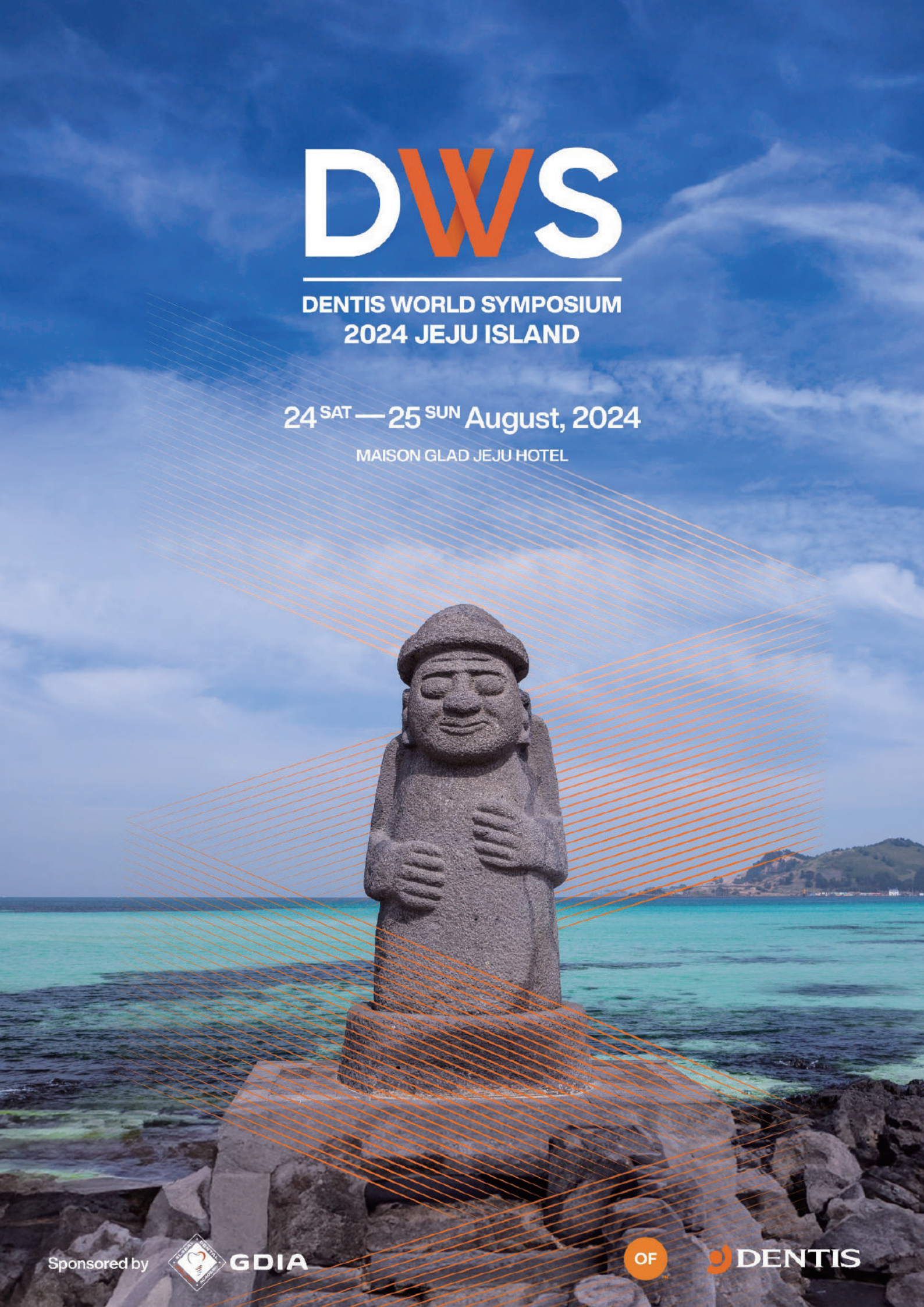
How to cite this article: BAEK YJ. Auxetic free gingival graft: Technical note and case report
J Clin Digit Dent. 2024;6(2):26-36. www.jcdd.org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