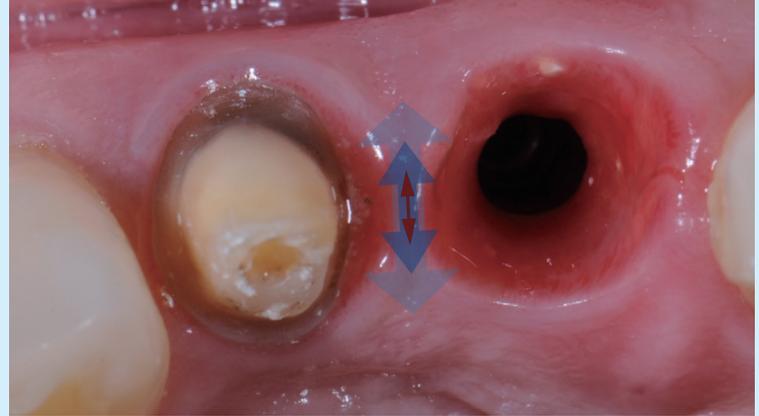


# JCDD

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

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# Editorial

## Let us all cheer up again.

A few days ago, I had dinner with my dental colleagues after a long time since the outbreak of the coronavirus disease 2019 pandemic. When my friends arrived at the place, they sat down with a big sigh, not smiling. I asked, "why are you sighing?". Everyone responded similarly. "It is not fun at all. I do not like treating patients anymore. My eyes are dim, so I cannot focus on treatment, and I do not like providing lip services to young patients one by one."

It has been approximately 30 years since we became dentists. In addition, everyone is a respected dentist, excellent clinician, and teacher in their dental specialty. However, seeing them discouraged, I thought other dentists would have the same feeling.

Being a dentist is a challenging job. This is because when treating all patients, I have to focus personally on treating them with my hands. However, Dentistry is rewarding and valuable because it is a specialty that does spectacular things. Apart from God, who else can make patients eat properly and beautify their faces as I do with my hands?

Let us all cheer up again. JCDD supports our readers and makes all patients happier; therefore, I hope it will make you cheerful, full of joy, and not get discouraged.

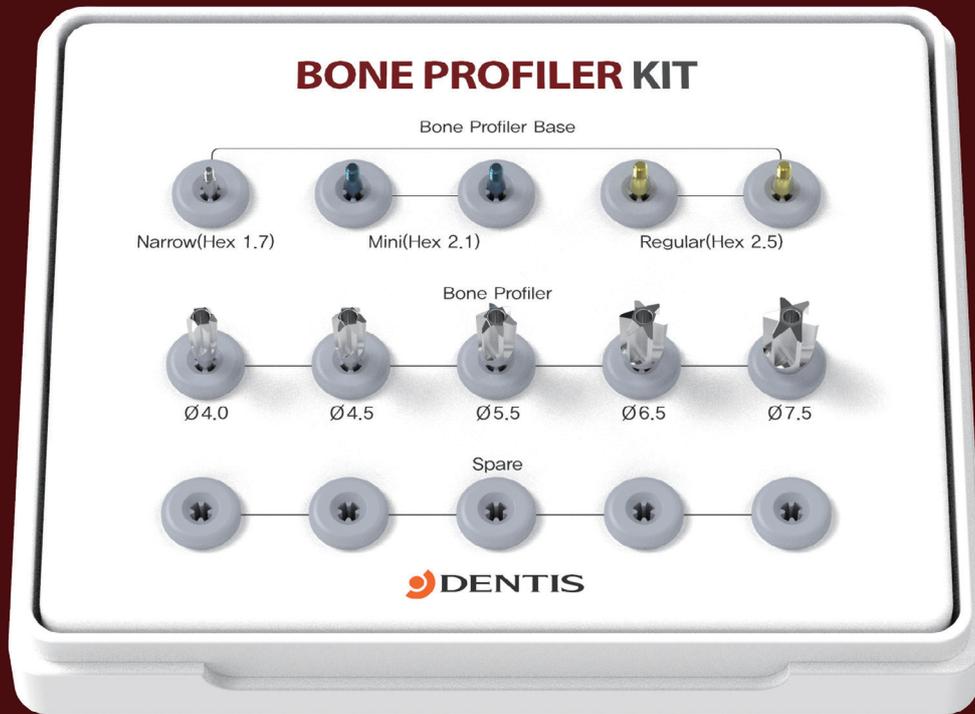


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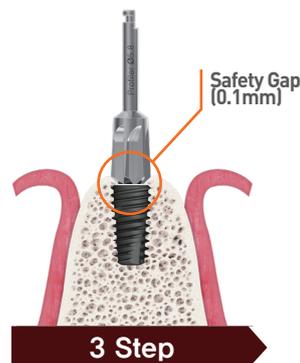
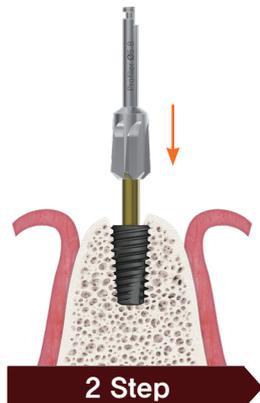
Wongun Chang, DDS MS PhD

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# Prosthetic approach for Asymmetric Black Triangle in dental implant treatment

Woohyun KIM, DDS

## Introduction

Restoring a black triangle defect in the upper anterior segment through the surgical approach is difficult. When the black triangle appears between two central incisors, restoring the long contact between the two teeth by applying Dr. Tarnow's rule could be a viable solution.

Although the central incisors are square shaped, they are still aesthetically pleasing owing to their symmetry.

However, it is a challenge when the papilla between the central and lateral incisors is lost unilaterally. Restoring the teeth to reproduce a long contact between the central and lateral incisors does not appear aesthetic because there is a loss of symmetry among the left and right sides.

Herein, we discuss a theoretical approach to treat the asymmetric black triangle that appear between the upper central and lateral incisors.

Prosthetic approach for asymmetrical black triangle:

1. Asymmetry of the lateral incisor:
2. Distal rotation of the lateral incisor:
3. Trickle-down economics of pink esthetics.
4. Subcritical contour of the abutment design affects the gingiva line.

A black triangle is an aesthetic challenge. The position of the papillae is determined by the bone, soft tissue, and teeth. Bone plays the most important role in papilla formation; however, in some cases, soft tissue and teeth may also have a major influence (Fig. 1, 2).

Depending on the location, the black triangle between the two central incisors can be aesthetically resolved by restoring them into a square shape or using an unprepared laminate (Fig. 3, 4).



Fig. 1

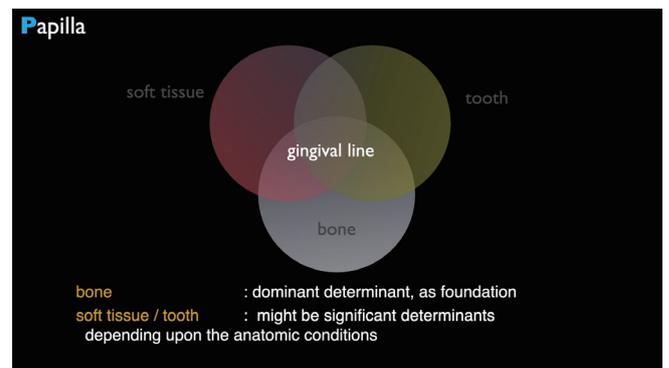


Fig. 2



**Woohyun KIM**

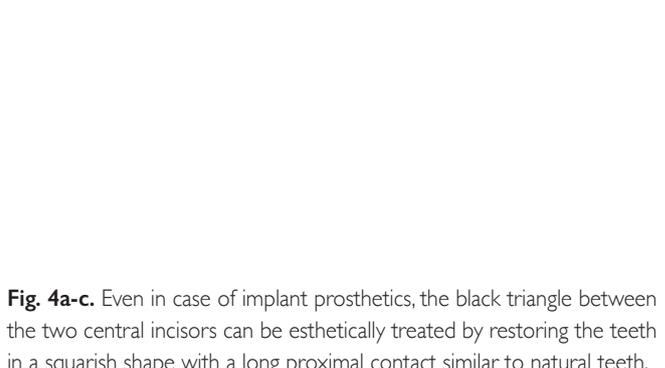
Dr. Kim graduated from Seoul National University College of Dentistry in 1998.

After that, he majored in periodontology for 3 years at the same university. Also he majored in advanced prosthodontics for 3 years at USC in USA.

He has lectured nationally and internationally on periodontal and prosthetics aspect of esthetic dentistry .



**Fig. 3a-d.** The black triangle between the two central incisors can be aesthetically treated by restoring the teeth in a squarish shape.



**Fig. 4a-c.** Even in case of implant prosthetics, the black triangle between the two central incisors can be esthetically treated by restoring the teeth in a squarish shape with a long proximal contact similar to natural teeth.

However, in case of a black triangle present unilaterally, the squarish shaped teeth can lead to asymmetry, thus making the smile unaesthetic (Fig.5-10).

There could be two forms of final restoration from the provisional restoration depicted in fig. 7. One is a square-shaped tooth which leads to the imbalance among the left and right sided teeth of the arch. The other is a harmonized result due to the balance in the left and right side of the arch.



Fig. 5a-b. Female patient in her twenties, high lip line, #11 root fracture. #12 apical lesion. Thin biotype



Fig. 6. 1 wk after implant placement. On-going papilla loss is already seen.

Fig. 7. 4 month after implant placement. More papilla loss is observed.

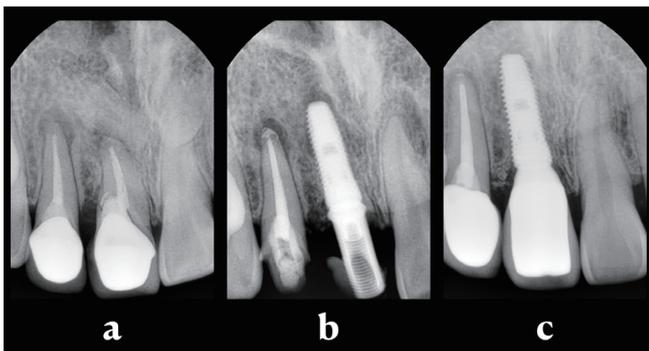


Fig. 8a-c. (a) Before surgery  
(b) Right after surgery  
(c) Final restoration



Fig. 9. When the contact point is lowered in the cervical direction, a square shaped tooth form emerges, resolving the black triangle. However, the shape of the left and right teeth varies, thus breaking the balance.



Fig. 10. The soft tissue is molded by changing the shape of the prosthesis. The black triangle is resolved while balancing the left and right sides.

**Fact 1 - Laterals are not symmetrical in natural dentition.**

The central incisors are symmetrical in the natural dentition. On the other hand, the lateral incisors are not symmetrical in the natural dentition. However, the laboratory technician fabricates them to have symmetry. If the lateral incisors are shaped to be symmetrical, it leads the observer to focus on the defects or limitations. Therefore, in case of unilateral treatment, it is better to restore the lateral incisor in a way that it appears different from the other teeth in terms of size or shape (Fig. 11).

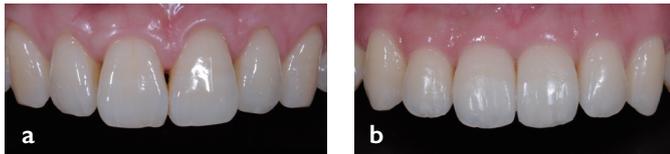


Fig. 11a-d. Asymmetrical lateral incisors.

**Fact 2 - Rotate the lateral incisor distally.**

By rotating the lateral incisor, the black triangle between the central and lateral incisor appears to be smaller (Fig. 12-15).



Fig. 12a-c. Frontal view does not reveal the black triangle between the central and lateral incisor. When observed from a more distal view, the black triangle is seen.



Fig. 13. Lateral incisor is larger bucco-lingually than mesio-distally.

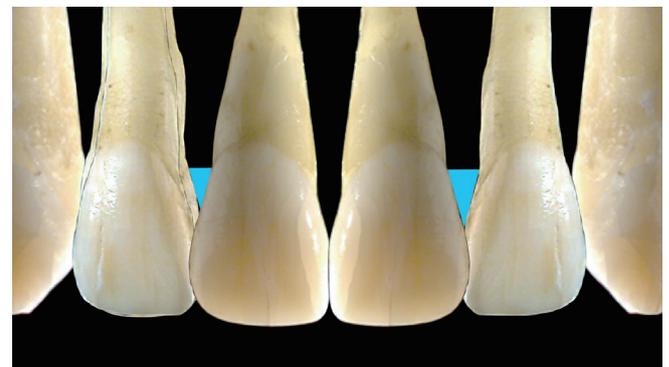


Fig. 14. Black triangle appears smaller when the lateral incisor is rotated distally.

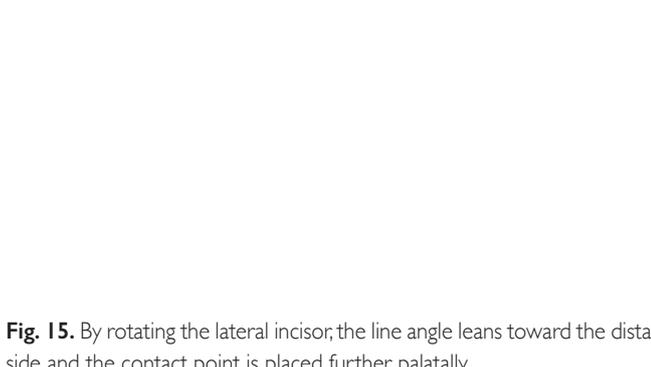
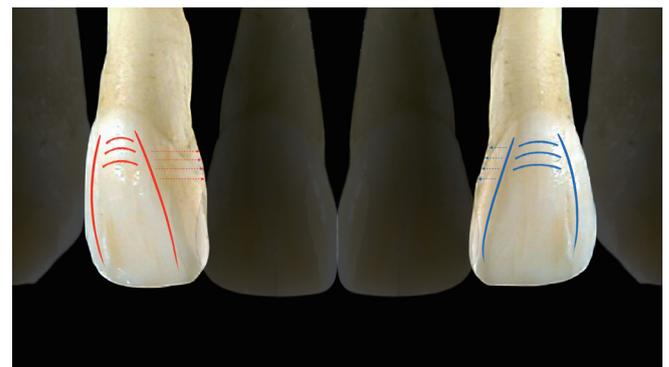


Fig. 15. By rotating the lateral incisor, the line angle leans toward the distal side and the contact point is placed further palatally.



**Fact 3 - Trickle-down economics of pink esthetics**

In case of a mid-buccal gingival recession, the decision to perform the grafting procedure (or not) for coverage depends on its proximal tissue. If the tissue is intact, it can provide 100% root coverage. This finding has been documented by Dr. Miller as early as 1985.

The proximal tissue has a larger volume than the mid-buccal tissue. Moreover, the grafted tissue from the interproximal tissue ( papilla ) has enough blood supply to survive if it has enough tissue volume ( height ) (Fig. 16-19).

The author took this concept one-step further to describe the natural phenomenon occurring in the interproximal tissue.

When there is any defect, let us focus on the upper-level tissue. For example, in case of mid-buccal tissue recession, when the papilla is intact, a mid-buccal defect can be covered. In the case of a buccal papilla defect, we can observe that the buccal papilla is separated from the palatal papilla. In such cases, the buccal defect can be solved by connecting.

Trickle-down economics is a colloquial term for supply-side economic policies. Trickle-down theory more specifically advocates for a lower tax burden on the upper end of the economic spectrum. Supply-side economics is a macroeconomic theory that postulates economic growth can be most effectively fostered by lowering taxes, decreasing regulation, and allowing free trade. According to supply side economics, consumers will benefit from greater supplies of goods and services at lower prices, and employment will increase.

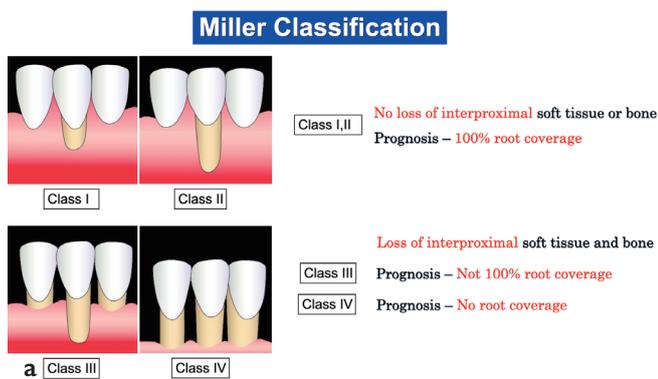


Fig. 16a-b. Miller's classification. When there is no loss of inter proximal soft tissue and bone, 100 % root coverage could be attained.

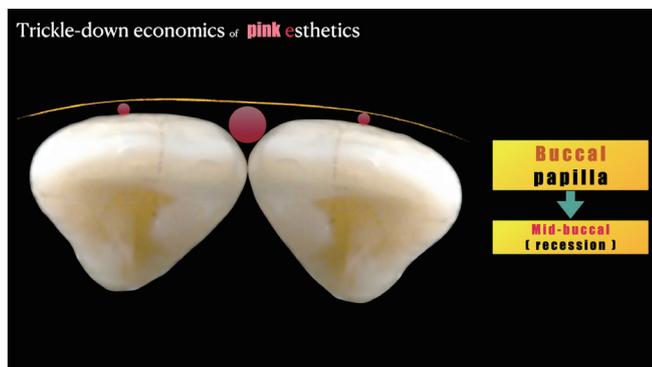


Fig. 17. Inter proximal tissue has greater volume than mid-buccal tissue.

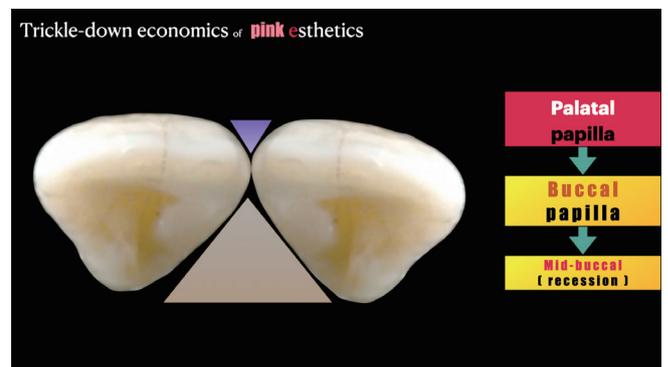


Fig. 18. Palatal papilla has greater volume than buccal papilla according to its corresponding tooth form.

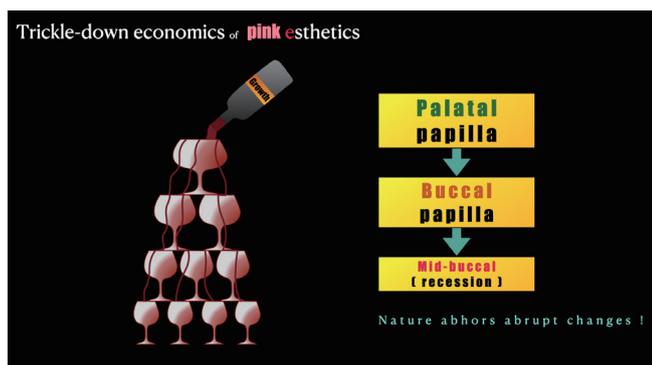


Fig. 19. Phenomenon of trickle-down economics could be used to describe the flow (support) of soft tissue.

As observed in **fig.20**, several factors could contribute to the gingival margin inflammation, such as biologic width violation, ill-fitting margins of restorations, and poor oral hygiene. Let us put aside all these concepts and apply the concept of trickle-down economics of tissue. The inflammation may be due to the separation of buccal papilla from palatal papilla.

Once the crowns were removed, the buccal papilla was seen to have separated from the palatal papilla (**Fig. 21**).

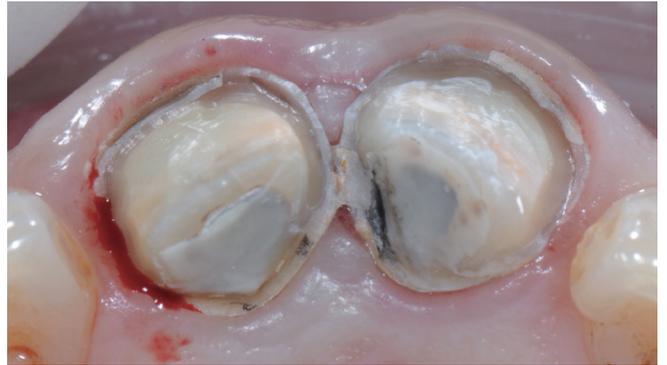
The author removed some tooth structure (**Fig. 22**).

The impression was made on the same day (**Fig. 23**).

After 2 weeks, definitive restorations were fabricated and cemented. The buccal papilla received support from the palatal papilla ( trickle-down economics of tissue ), and the papilla filled the black triangle (**Fig. 24-25**).



**Fig. 20.** Gingival inflammation on buccal papilla between the splinted crowns on #11, #21



**Fig. 21.** After crown removal



**Fig. 22**



**Fig. 23**



**Fig. 24**

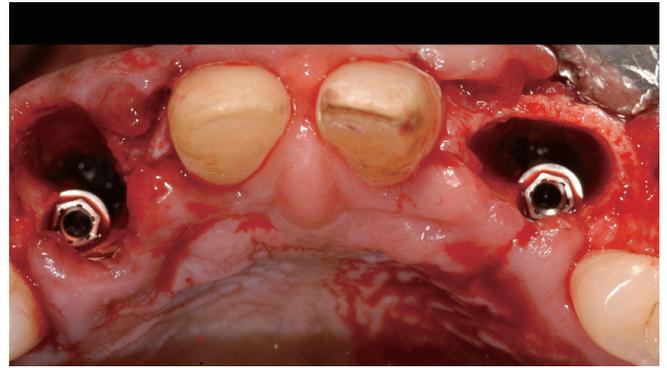


**Fig. 25**

Another example of applying the trickle-down economics of tissue concept (**Fig. 26-32**).



**Fig. 26.** Previously fabricated 6-unit FPD.



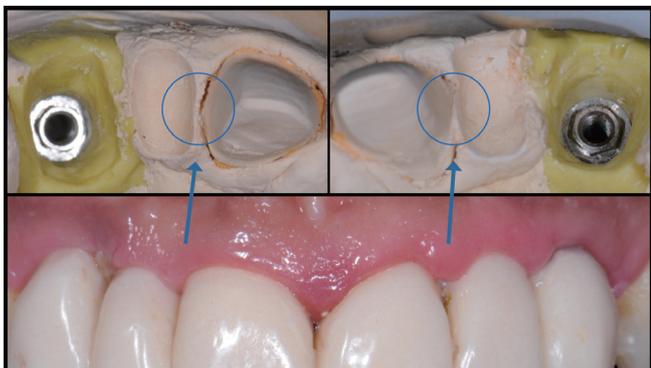
**Fig. 27.** Implant placement on #13, #23



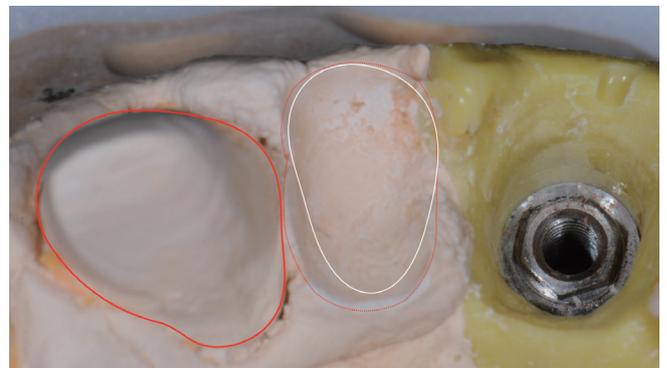
**Fig. 28.** Provisional restoration. The papilla between #11/12 was intact but the papilla between # 21/22 was not.



**Fig. 29.** Once provisional restoration was removed, it showed that the #22 pontic was too close to #21 and the buccal papilla was separated from the palatal papilla (no trickle-down economics of tissue).



**Fig. 30.** No trickle-down economics of tissue on the papilla (#21/22) as seen on the master cast.



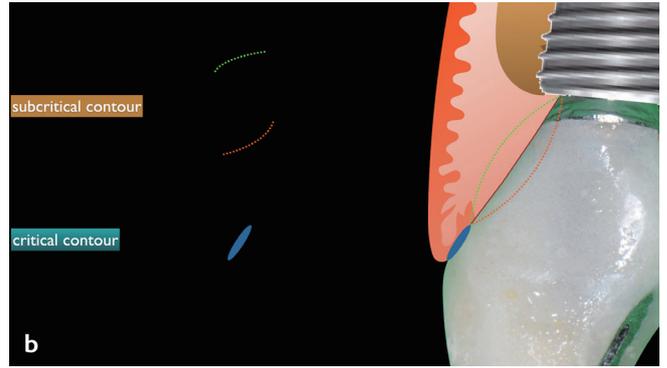
**Fig. 31.** The pontic design was modified to an ovate shape to facilitate the tissue support from the palatal papilla to the buccal papilla.



**Fig. 32a-b.** Before modification of the pontic design and after modification of the pontic design.

**Fact 4 - Controlling subcritical contour in abutment design affects the gingival line (Fig. 33).**

Let us apply fact 1,2,3,4 to get the results shown in **fig. 34** to **fig. 35**.



**Fig. 33a-b.** Gingival margin could be adjusted by modifying the critical and subcritical contour. Modifying critical contour leads to change in tooth shape. Modifying subcritical contour does not change the tooth form.

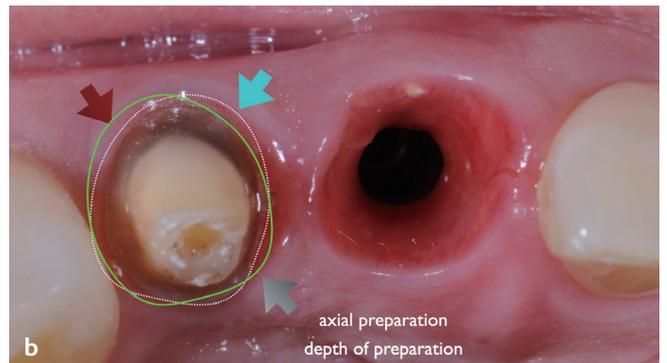
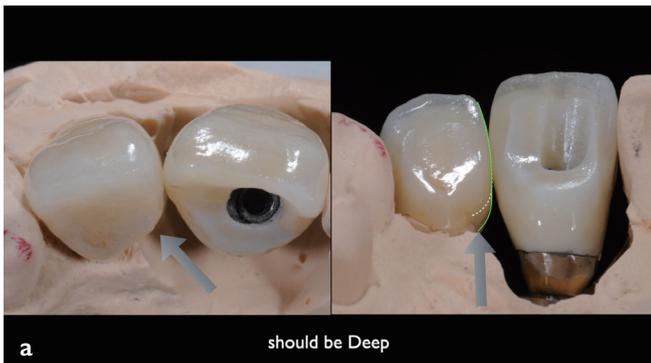


**Fig. 34.** Provisional restoration showing black triangle.

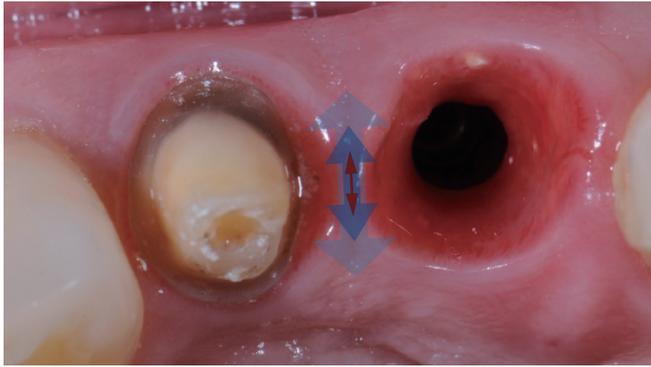
**Fig. 35.** Definitive restoration without black triangle with no damage to tooth form.



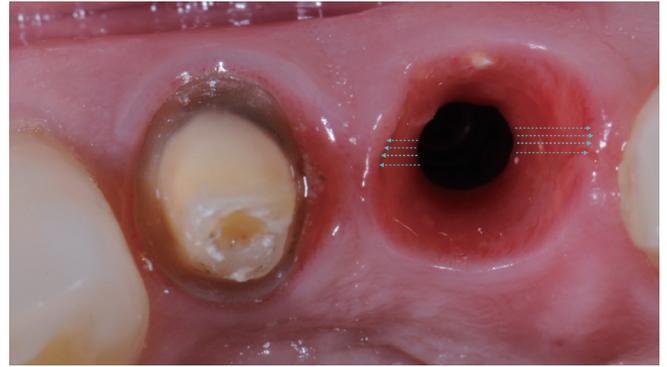
**Fig. 36a-b.** Provisional restoration was removed. Now fact 1-4 will be applied.



**Fig. 37a-b.** #12 Could be prepared to have a distally rotated form. The distolingual line angle preparation should be deep.



**Fig. 38.** Consider trickle-down economics of tissue.



**Fig. 39.** There is enough room to manage the gingival margin by modifying the subcritical contour.



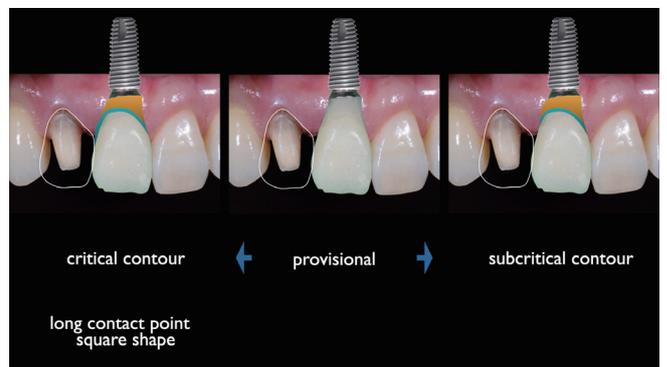
**Fig. 40.** Implant provisional restoration is superimposed.



**Fig. 41.** Critical contour is used to block the black triangle which leads to a square shaped tooth form (# 11)



**Fig. 42.** Subcritical contour change pushes the tissue inferiorly, thus filling the black triangle.



**Fig. 43.** Two choices are possible, which are controlling the critical contour and subcritical contour to block the black triangle.

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SQ SINUS  
GUIDE

# 이제, 사이너스도 디지털 가이드로.

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- ☑ 특별한 드릴 디자인과 저속 드릴링으로  
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- ☑ 불규칙한 골형태에서도 3차원 거상 가능  
(3 dimensional elevation)
- ☑ 가이드 장착한 상태로 본 그래프팅 및  
사이너스 거상까지

# Dental considerations in patients taking osteoporosis drugs and bone-modifying agents (BMAs)

## : Part (2) – Practical Approach for General dental practitioners

Wonse Park, DDS, MSD, PhD

### Introduction

In Part 1, the basic knowledge on medication-related osteonecrosis of the jaw (MRONJ)-associated osteoporosis and cancer was reviewed. In particular, when osteoporosis is left unattended, incident fractures can deteriorate the patient's quality of life and lead to death, and indications for using anti-resorptive drugs in patients with malignant tumors have been described. Anti-osteoporotic drugs can be largely divided into drugs that inhibit bone resorption and promote bone formation, such as bisphosphonates (BP), denosumab, selective estrogen receptor modulators, parathyroid hormone (PTH), and romosozumab. In Part 2, we will explain the criteria for the treatment of patients taking anti-resorptive drugs in clinical practice.

### Dental treatment strategies

#### Dental treatment strategies for patients taking anti-osteoporotic drugs

The dental treatment plan for patients taking anti-osteoporotic drugs can be broadly divided into the following three steps:

- 1<sup>st</sup> step: History Taking & Physical Examination
- 2<sup>nd</sup> step: Consultation
- 3<sup>rd</sup> step: Classify Drugs & Patient Category



**Wonse Park**

After graduating from Yonsei University College of Dentistry, Wonse Park completed an internship and training course at the Department of Oral and Maxillofacial Surgery at Yonsei University Dental Hospital. After serving as a public health doctor, he again served as a lecturer and full-time clinical instructor at the Department of Oral and Maxillofacial Surgery, College of Dentistry, Yonsei University. Since 2006, he has served as an assistant clinical professor, clinical associate professor, associate professor, and professor at Advanced General Dentistry, Dental Hospital, and Yonsei University, which were first established in Korea. He served as a visiting scholar at the Department of Oral Surgery and Pharmacology at the University of Pennsylvania and is currently the head of the Department of Advanced General Dentistry, Yonsei University School of Dentistry.

## 1<sup>st</sup> step : History Taking & Physical Examination

The first step for all patients with systemic diseases is history taking and physical examination. History taking involves asking the patient or guardian questions to collect relevant information pertaining to the disease, and physical examination is conducted to assess the symptoms of the disease.

For osteoporosis patients, the following must be assessed: 1) time of osteoporosis diagnosis; 2) T-score or Z-score and fracture risk at the time of diagnosis; 3) prescribed or administered drugs; and 4) improvement of clinical course after treatment. The most important question is #3 on prescribed or administered drugs. This may be a challenging question as there are many drugs with the same brand names as those of BP with expired patents, and most patients are old and unaware of the drugs that they are taking. In addition, the treatment drug may be changed after a long period. Thus, drugs that the patients are currently taking may not necessarily be the same as that from years ago.

For instance, if a patient is currently taking only vitamin D and calcium preparations at the time of 1st visit, he/she may be not a high-risk group for MRONJ. However, that patient may have taken BP for over 5 years and changed the drug recently with vitamin D and calcium preparations after the bone density improved. In this case, the patient may belong to the high-risk group for MRONJ.

Similarly, a patient taking denosumab may have taken the same drug from the beginning. Denosumab is known as a full reversal agent so after a 6-month injection, the risk for MRONJ may be lower. However, the patient may have taken BP for over 5 years and switched to denosumab due to possible risks of complications, such as atypical femur fracture or MRONJ. In this case, the patient may be a high-risk group for MRONJ.<sup>1,2</sup>

So throughout the history of medication should be considered. These problems must be confirmed in the second step of consultation; however, it is essential to obtain as much information as possible in the history-taking step.

There are different ways to determine the drug taken by the patients during the history-taking process.

The easiest way is to ask how often do the patients take the drugs. Oral bisphosphonates are taken once a week or a month. IV formulae of bisphosphonate are administered once every 3 months or 1 year, and Prolia, a low-dose denosumab, is administered once every 6 months. PTH is administered daily or weekly and romosozumab is administered once every month for 1 year. Thus, although not completely accurate, it is possible to speculate the kind of drug taken by the patient based on the duration of administration.

The second way is asking about the precautions related to drug administration.

BP administration may cause gastrointestinal trouble, and other drinks and food ingested with drugs may lower the absorption of the drugs. Hence, patients are advised to take oral bisphosphonate in the morning on an empty stomach with a lot of water and not lie down for at least 30 minutes after taking the medication. In addition, the patients are instructed to maintain an empty stomach for 1 hour after taking an oral bisphosphonate. The drug must only be consumed with water, and intake with tea, coffee, soft drinks, and milk is not recommended.<sup>3,4</sup>

PTH is a self-injected hormone preparation that must be stored at 2–8°C in a refrigerator but not be frozen.<sup>5,6</sup> The effects of low-dose denosumab decrease after 6 months. Thus, if the patient was instructed to take the drug every 6 months, it is highly likely that the drug was Prolia, a low-dose denosumab.<sup>7,8</sup>

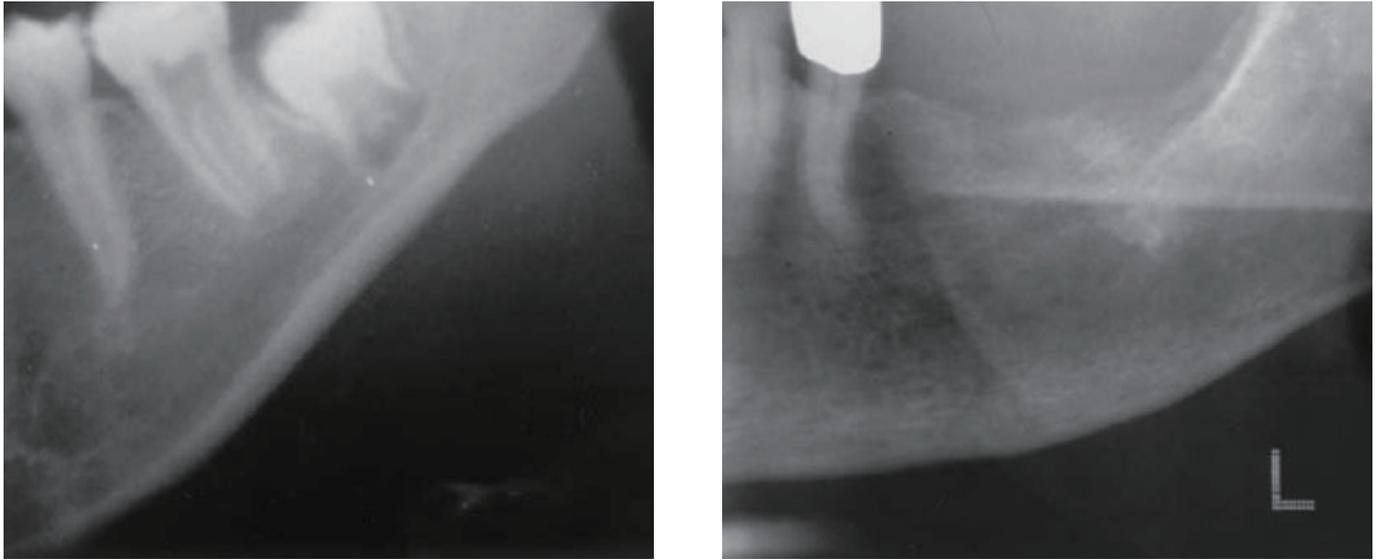
Although osteoporosis mainly affects women, elderly men can also develop osteoporosis. Hence, elderly men must be evaluated for possible osteoporosis. Furthermore, secondary osteoporosis can occur in patients with rheumatoid arthritis or organ transplants and in those with systemic lupus erythematosus taking steroids for a long period. Therefore, these patients must be carefully assessed for secondary osteoporosis even at a young age. If the patient has a history of fractures or joint surgery, it is important to consider whether osteoporosis was the cause.

The most characteristic feature during the physical examination is the patient's posture. A curved back with age may be a sign of osteoporosis. Thus, if the patient has a slouched posture and shows a recent decrease in height, osteoporosis may be suspected. Additionally, walking in an unnatural form or using a cane may be symptoms related to osteoporosis.

As osteoporosis is asymptomatic, patients are often unaware of whether they have it. Dental radiographic evaluation can help detect asymptomatic osteoporosis at an early stage.

Many studies reported that changes in the thickness or shape of the cortical layer of the mandible on panoramic radiography may indicate osteoporosis. Additionally, if the cortical layers of the inferior alveolar nerve are not clearly visible or if the marrow pattern of the mandible is similar to that of the maxilla, osteoporosis may be suspected, and it is advised to see a doctor undergo a bone density test.

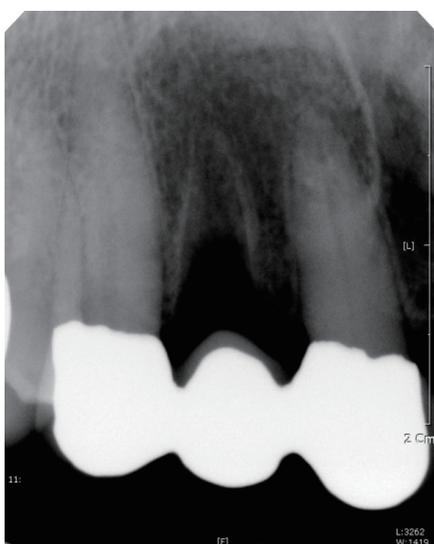
Periapical radiographs may also reveal findings related to the use of drugs for osteoporosis. A long-term intake of bisphosphonate may lead to the thickening of the lamina dura. If the thickening in the lamina dura does not disappear in the long term after tooth extraction, MRONJ may be suspected.



**Fig. 1.** Osteoporosis findings on panoramic radiographs. In the normal left image, the lower margin cortical bone of the mandible was clearly observed, and an inferior alveolar nerve was observed. But in the right osteoporosis patient, the lower margin cortical bone of the mandible was not clearly observed and observed as a scalloping pattern. The inferior alveolar canal is also not clearly visible.



**Fig. 2.** Osteoporosis findings on cone-beam computed tomography. It was clearly observed that the cortical bone of the lower margin of the mandible was resorbed and showed an irregular pattern on the cone-beam CT of the osteoporotic patient (right) compared to the normal (left) and the osteopenia (middle).



**Fig. 3.** An apical radiograph showing signs of bisphosphonate use. 5 months after tooth extraction, the lamina dura of the maxillary right lateral incisor was clearly observed, and MRONJ was diagnosed.

When a cancer patient visits the dentist, the dentist must check the cancer patient's bone metastases.

Bone metastasis can be treated with various methods such as surgery, radiation therapy, bisphosphonate, or administration of high-dose denosumab, Xgeva. Even if there is no bone metastasis, anti-resorptive therapy can be administered as an adjuvant therapy, that is, as a method to prevent bone metastasis, in patients with frequent bone metastases such as breast or prostate cancer. Therefore, patients with tumors with a high tendency to bone metastasis, especially breast and prostate cancer, should consult about anti-resorptive therapy before starting dental treatment.<sup>4,9</sup>

## 2<sup>nd</sup> step : Consultation

After history taking and physical examination, the hospital in which the patient received drug treatment should be contacted. The purpose of this is not to avoid legal liability for MRONJ in the future, but instead to obtain accurate and objective information.

Although history taking is the most important method for identifying systematic diseases, the patient or guardian may not remember accurately, and false information could be given on purpose. Some patients/guardians may not reveal certain information about their systemic conditions before dental treatment, assuming that it is not relevant.

Therefore, to obtain accurate information, cooperation with the attending physician is essential. Particularly, as the pathophysiology of MRONJ is not clearly understood, the answers from medical doctors may be obscure.

### Consultation Form for osteoporotic patient

- 1) Fracture risk associated with osteoporosis
- 2) T/Z score before treatment and recent T/Z score after osteoporosis drug treatment
- 3) Information on osteoporosis drugs that have been administered from the start of treatment until now and the timing of administration
- 4) Whether the anti-resorptive drug can be discontinued and an alternative drug prescribed when discontinued
- 5) Period of discontinuation and resumption of anti-resorptive drugs in relation to dental surgery such as tooth extraction and implant
- 6) MRONJ risk evaluation

**Table. 1.** Osteoporosis consultation form

Patients with multiple myeloma and Paget disease may have received anti-resorptive therapy. Hence, it is important to check the history of medication by consulting the attending physician. As described in recent studies, anti-resorptive therapy may be administered in patients with osteoclast-related intraosseous lesions such as giant cell granuloma. Thus, patients must be screened and consulted for accurate assessment prior to dental treatment.

Furthermore, cancer patients receiving chemotherapy and anti-angiogenic drugs may develop MRONJ. Therefore, it is important to consult with the attending physician before performing dental treatment in these patients to adjust the medications associated with osteonecrosis or consider postponing the dental treatment.

As compared to medical doctors, dentists may have more awareness and knowledge regarding the risk of MRONJ.

Primarily, it is important to discuss the history of drugs, the status of osteoporosis/malignancy, and whether current medications may have to be temporarily suspended (drug holiday) or changed.

The most important information is the medication history, and it is vital to ask for accurate information regarding the medication period as well as the name of the medications taken in chronological order.

The forms for the consultation process for patients with osteoporosis and malignant tumors are described in table 1 and table 2 :

### Consultation Form for cancer patients

- 1) Stage of the tumor
- 2) Life expectancy
- 3) Whether BMA such as zoledronate, pamidronate, or denosumab is administered
- 4) Whether BMA can be discontinued and for how long
- 5) Anti-angiogenic drug administration
- 6) MRONJ risk evaluation

**Table. 2.** Malignant tumor consultation form

### 3<sup>rd</sup> step: Classify Drugs & Patient Category

After completing the consultation, it is important to understand the mechanism of the drug.

Although the name of the drug, such as bisphosphonate, denosumab, or teriparatide, is important, it is also necessary to classify it to understand whether the medication is an anti-resorptive agent or a bone-forming agent.

Patients taking anti-resorptive agents are at a risk of MRONJ. On the other hand, the risk of MRONJ is low in those taking teriparatide among other bone-forming agents.

Romozosumab is also a bone-forming agent and is associated with a low risk of MRONJ; however, there is a lack of evidence for a clear conclusion.

Generic Name	Brand Name	Indication	Nitrogen Containing	Dose	Dosing Method
Alendronate	Fosamax	Osteoporosis	Yes	10mg/day, 70mg/week	Oral
Risedronate	Actonel	Osteoporosis	Yes	5mg/day, 35mg/week	Oral
Ibandronate	Bonviva	Osteoporosis	Yes	2.5mg/day, 150mg/month	Oral
				3mg every 3 months	IV
Pamidronate	Aredia	Bone metastasis	Yes	90mg/3 weeks	IV
Zoledronate	Zometa	Bone metastasis	Yes	4mg/ 3 weeks	IV
	Reclast	Osteoporosis	Yes	5mg/year	IV
Denosumab	Xgeva	Bone metastasis	No. Humanized monoclonal Antibody	120mg/4 weeks	SQ
	Prolia	Osteoporosis		60mg/6 months	SQ

Fig. 4. Agents that cause medication-related osteonecrosis of the jaw 1

Generic name	Brand Name	Indication	Mechanism
Sunitinib	Sutent	Gastrointestinal stromal tumor; renal cell ca, pancreatic neuroendocrine tumor	Tyrosin Kinase Inhibitor
Sorafenib	Nexavar	Hepatocellular ca, Renal Cell ca.	Tyrosin Kinase Inhibitor
Bevacizumab	Avastin	Metastatic colorectal ca, non-squamous non-small cell lung ca, Glioblastoma, metastatic renal cell ca.	Humanized monoclonal Antibody
Sirolimus	Rapamune	Organ Rejection in Renal Transplant	Mammalian target of rapamycin pathway

Fig. 5. Agents that cause medication-related osteonecrosis of the jaw 2

2007 & 2009	2014
Current or previous treatment with a bisphosphonate	Current or previous treatment with antiresorptive or antiangiogenic agents
Exposed bone in the maxillofacial region that has persisted for more than 8 weeks	Exposed bone or bone that can be probed through an intraoral or extraoral fistula in the maxillofacial region that has persisted for more than eight weeks
No history of radiation therapy to the jaws	No history of radiation therapy to the jaws or obvious metastatic disease to the jaws

Fig. 6. Changes in the definition of MRONJ in the AAOMS position paper

Previous studies recommended dividing patients who ingested BP into four groups to establish a treatment strategy.

The rationale for this strategy was that oral preparations have a relatively low risk of causing MRONJ, and MRONJ is mostly caused by intravenous preparations. Thus, the patients were divided into four groups before and after using PO preparations and IV preparations, respectively.

In other words, as IV preparations are associated with a high risk of MRONJ, it is recommended to perform dental treatment before administering IV drugs and to actively extract teeth that may cause complications, similar to Pre- RTx dental care.

After IV drug administration, invasive dental surgeries should be avoided if possible, and conservative treatments are recommended. There are no treatment modifications required before administering PO preparations.

As there are many concerning issues pertaining to patients who have previously taken or are currently taking PO preparations, more studies must be conducted on this topic.

	PO	IV
Pre	Hygienic Care	Like PreXRT Dental Care
Post	Needs More Study	Avoid Invasive Tx Conservative Tx

Fig. 7. 2 by 2

However, this classification is not relevant to the current clinical setting because a wide variety of drugs are used.

First, it cannot be said that patients who received injections are necessarily at high risk for MRONJ. Injection can be administered by intravenous and subcutaneous (SQ) methods, and a bone forming agent independent of MRONJ is also administered by SQ.

Second, the risk of MRONJ also varies depending on the dose of the injectable drug. Since cancer patients often receive higher doses of drugs than the dosage regimen for osteoporosis treatment, the risk of MRONJ also varies.

Third, because new concepts are introduced into the treatment method of MRONJ. Osteogenic agents such as teriparatide are not only effective in the treatment of osteoporosis, but there are increasing reports that they help treat MRONJ in osteoporotic patients. However, while these osteogenic agents can be used in patients with osteoporosis, they should not be used in patients with malignant tumors as they may accelerate tumor progression.

In other words, since MRONJ occurring in osteoporosis patients can be treated with teriparatide, it is better to eliminate the cause of inflammation than to avoid teeth that cause pain due to inflammation in patients who have been given bisphosphonate for a long time for the purpose of treating osteoporosis. This is because a strategy of treatment using teriparatide can be established. However, since teriparatide cannot be used in patients with malignant tumors, if MRONJ occurs, only conservative therapy should be performed.

Fourth, although clinical findings may be similar, MRONJ and denosumab by BP are different from a pathogenesis point of view.

When osteoclasts ingest bisphosphonates from the bone surface, apoptosis is induced, which inhibits bone resorption. During apoptosis, bisphosphonates from osteoclasts reattach to the bone surface and the effects of bisphosphonates are long-lasting. Due to the characteristics of these drugs, the problem of MRONJ related to bisphosphonate is that it is not possible to know the exact details of how long the bisphosphonate has an effect, whether the effect decreases when the drug is stopped, and whether the risk of developing MRONJ is changed accordingly.

On the other hand, low-dose denosumab, Prolia, is a reuptake inhibitor with a half-life of about 32 days. Therefore, the risk of MRONJ is high at the beginning of Prolia administration, but the effect is not observed after 6 months. In other words, even if MRONJ develops, the results of treatment with MRONJ may be good because the drug loses its effectiveness over time.<sup>10</sup>

In a report on the position of the American Association of Oral and Maxillofacial Surgeons published in 2014, treatment strategies were described in five categories:<sup>3</sup>

1. Patients about to initiate IV anti-resorptive or anti-angiogenic treatment for cancer therapy
2. Patients about to initiate anti-resorptive treatment for osteoporosis
3. Asymptomatic patients receiving IV BP or anti-angiogenic drugs for cancer
4. Patients receiving anti-resorptive therapy for asymptomatic osteoporosis
5. Patients who have already developed drug-related osteonecrosis

Based on the aforementioned categories, the strategies including the recently developed drugs, such as denosumab, teriparatide, and romosozumab, are as follows:

### **1) Patients about to initiate IV anti-resorptive or anti-angiogenic treatment for cancer therapy**

Pamidronate, zoledronate, and Xgeva, a high-dose denosumab, are indicated in patients who are scheduled for BP administration.

Patients who are scheduled to receive BP must be managed according to protocols that ensure the prevention of osteoradionecrosis. The treatment goal is to minimize the risk of osteonecrosis, and it is recommended to postpone BP administration until the patient has optimal dental health in accordance with the patient's general health. Based on the previous data on osteoradionecrosis, if the patient is in a good condition, according to the tumor stage, metastasis/cancer status, and general systemic condition, the administration of bone-resorption inhibitors or angiogenesis inhibitors can be postponed by 14–21 days until adequate healing of the soft tissue of the extraction socket and bone has been achieved.

### **2) Patients about to initiate anti-resorptive treatment for osteoporosis**

This point was newly established in the 2014 position paper: Patients belonging to this group must be managed to prevent their current condition from deteriorating. Patients taking oral medications do not necessarily need to undergo aggressive dental treatment that involves tooth extraction. However, those undergoing treatment with anti-resorptive agents for more than 4 years must be educated regarding the potential risk of MRONJ, and the goal must be to maintain the patient's oral health during and after the treatment.

Although the number of patients receiving anti-resorptive injections for osteoporosis treatment is lesser than that of cancer treatment, active dental treatment is necessary before osteoporosis treatment, but it may vary depending on the drug being administered.

BP administration increases the risk of MRONJ. Thus, it is important to actively treat unhealthy teeth and extract them if necessary. However, denosumab does not have any effects after 6 months; thus, although there is no clear evidence, teeth extraction may be performed at 4–5 months when the efficacy of the drug is low. However, since denosumab may be changed to BP in patients using it for a long period, it is recommended to extract the teeth with poor prognosis before conversion to BP if possible.

Teriparatide and romosozumab, which are administered SQ, may not be related to MRONJ, and teeth may be extracted during treatment with these two preparations. Thus, it is not necessary to complete extraction before their administration. However, teriparatide and romosozumab can be used for up to 2 years and 1 year, respectively, following which, other drugs, mainly BP, are used. Therefore, it is favorable to complete the dental treatment while the patient is undergoing treatment with teriparatide and romosozumab.

However, since denosumab is an anti-resorptive agent, it may be administered first if there is multiple myeloma with severe bone resorption (e.g., hypercalcemia), there is a risk of MRONJ, or Xgeva administration would be beneficial for the patient. In other words, if the treatment of skeletal disorders associated with cancer is urgent, denosumab may be administered first to control tumor progression and related complications in order to start dental treatment.

Preventive treatment, management of dental caries, and conservative treatment are essential to maintain healthy teeth, and their requirement must be monitored continuously in patients. Patients wearing partial or full dentures should be evaluated for mucosal trauma, especially at the lingual flange of the denture, and adequately educated for oral hygiene management and regular dental examinations. The patients must also be instructed to inform the medical staff in case of pain, swelling, or bone exposure. Oncologists are recommended to evaluate and manage these patients in a manner similar to that of patients undergoing head and neck preradiation therapy. This protocol for preventing osteoradionecrosis is known to most oncologists and dentists.

### **3) Asymptomatic patients receiving intravenous bisphosphonates or anti-angiogenic drugs for cancer**

It is essential to maintain and manage oral health, and procedures that may directly cause bone damage need to be avoided. These patients must be given conservative care. If the tooth cannot be restored, the crown should be removed, and root canal treatment must be performed for the remaining root in order to avoid extraction. As reported in the 2007 and 2009 position papers, implant placement is not indicated in these patients.

#### 4) Patients receiving anti-resorptive therapy for asymptomatic osteoporosis

Despite the great interest of dental clinicians in this category of patients who often visit dental clinics, reliable recommendations in clinical researches for those taking BP are lacking. As the level of evidence for the recommendations is not high, osteoporosis patients who have been treated with long-term medications must be treated carefully. Recommendations are expected to be revised as more data and high-quality studies are conducted in the future.

In these patients, planned alveolar surgery is not contraindicated. Although less than 1% of patients experience healing problems and the incidence of MRONJ is low, the risk increases if the medication has been taken for more than 4 years (more than 3 years in the previous position paper). This period is shortened further if the patient is taking chronic steroid preparations or angiogenesis inhibitors. If the patient has a good general condition, based on the severity of osteoporosis and start of drug treatment, it is recommended to discontinue the drug from 2 months before to 3 months after invasive dental treatment to prevent MRONJ (3 months before and after the procedure as recommended in the previous position paper). In 2007, Marx et al. suggested C-terminal telopeptide (CTX) level as a systemic bone turnover marker to evaluate the preoperative risk. However, recent studies showed that CTX has low efficacy as a marker; hence, the 2014 position paper does not recommend the use of bone turnover markers such as CTX.

(4-1) For individuals who have taken oral bisphosphonates for less than 4 years and have no clinical risk factors

It is not necessary to change the schedule or postpone treatments or minor oral surgeries. However, implant placement may fail in the long term, and the patients must be informed that there is a low risk of osteonecrosis if medications are continuously administered. The patients must be screened on a regular basis, and if possible, the physician who prescribed oral BP must be consulted to adjust the dose of the drug, initiate a drug holiday, or recommend the administration of an alternative drug.

(4-2) For patients who have taken oral bisphosphonates for less than 4 years along with corticosteroids or anti-angiogenic medications

If the patient is in good general condition, it is recommended to discontinue the drug at least 2 months before performing oral surgery. After the surgery, it is recommended to discontinue the drug until the bone has healed; however, there is a lack of long-term prospective studies to verify the effects of discontinuing these drugs.

(4-3) For patients who have taken oral bisphosphonates for more than 4 years with or without any concomitant medical therapy

If the patient is in good general condition, the drug must be discontinued at least 2 months before performing oral surgery. After the surgery, the drugs should not be taken until the bone has healed.

The contents are summarized in the following table:

	PO		IV				
			IV - Osteoporosis		IV - Cancer		
	Oral Bisphosphonates		BP	DMAB (Prolia)	Teriparatide / Romo	BP	DMAB (Xgeva)
<b>Pre-Treatment</b>	Maintain Good Oral Hygiene. Periodic Checkup		Similar with Pre-XRT Dental Care, but little bit Conservative		Active Dental Treatment  Consider total maximum injection period (12M to 24M)	Similar with PreXRT Dental Care	
<b>Post – Treatment</b>	Over 4 yrs	Drug Holiday 2M	Avoid Surgery, if possible  If MRONJ occurs, teriparatide therapy could be considered	Perform Surgery 4M-6M, if needed	Consider Further Drug Switching (DMAB / BP)  Finish dental surgery within the injection period	Check Life Expectancy Conservative Management Avoid Invasive Treatment	Check Life Expectancy Conservative Management Consult with Oncologist about Drug Holiday
	Less than 4 yrs	No specific Modification		If MRONJ occurs, Observe and conventional Tx (wait for drug washout)			
	Less than 4 yrs, Other Drug or Diseases	Drug Holiday 2M		Pt Education for continuing DMAB Tx DO NOT switch PTH after DMAB Maybe Switch to BP or Romosozumab			
Always check Patient's Medical Status, Especially change of drugs and disease progression							
No Specific Treatment Modifications for Ca, Vit D, SERM							
Patients Centered Collaboration and Patient Care is more important							

Fig. 8. Summary of contents

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New Horizon of Digital Orthodontic software

# DICANON 4D



# Comparative analysis of traditional techniques and 3D printing techniques in making complete dentures for a single patient

Chan Park, Ph.D · Yina Yun, MSD

## Introduction

Recently, digital technologies based on computer-aided design/computer-aided manufacturing (CAD/CAM) are showing remarkable improvements: from the level of completing single tooth restorations in the early days, these technologies are now expanding into the realms of treating edentulous patients. Three-dimensional (3D) printing in medicine and dentistry uses the additive manufacturing method to reproduce complex structures and to provide customized personal medical devices and replicas to patients.<sup>1</sup>

Specifically for artificial teeth, dentures produced by various 3D printing manufacturers possess some characteristics—such as the simplification of technological procedures, smaller number of visits required from patients, and freedom from polymerization error issues found in polymerized resin—that can be contrasted with complex processes needed for traditional complete dentures, offering better services through such advantages.

According to the protocols of generic 3D printing denture manufacturers, impressions can be prepared on the day of the initial visit, following the adjustment of the plastic tray provided by the manufacturer; which can be done using dental burs. Once the impressions are collected using the trays, they can also be used to record the jaw relation or take impressions according to the needs of the operator. Then, the lip ruler is used to determine the length of the maxillary anterior segment, and the jaw gauge is used to determine the vertical dimensions.

The patient's information, collected through the impression, is used in each manufacturer's software to arrange a hypothetical model of the alveolar ridge and dental implants.

### Chan Park



I graduated and have a master's and doctoral degree in dentistry from Chonnam National University (CNU) School of Dentistry. After the intern/resident course in the Department of Prosthodontics at CNU Dental Hospital, I obtained a prosthodontic specialty. After working as a Fellow and Clinical Professor at CNU Dental Hospital, I was appointed to an Assistant Professor in 2018 and currently serving as an Associate Professor at the Department of Prosthodontics at the CNU School of Dentistry.

I am a member of The Korean Academy of Prosthodontics and an academic advisor. I have also served as a director in various academies such as the Korean Academy of Stomatognathic Function and Occlusion, the Korean Academy of Oral & Maxillofacial Implantology (KAOMI), and the Korean Academy of Digitalized Dentistry.

My major subject is complete denture prosthodontics. Also, I have been particularly interested in 3D-printed digital dentures among many fields of digital dentistry and treating many related clinical cases.

### Yina Yun



I have completed my master's degree at the School of Dentistry, Chonnam National University (CNU). I am currently in the third year of prosthodontic residency to conduct comprehensive examinations and treatment plans for patients under my great professors at CNU Dental hospital. Making an effort to develop my knowledge and skills, I hope to have a fundamental understanding of prosthodontic principles with responsibility.

In most cases, trial dentures are produced using 3D printers that use the photo-curable SLA (stereolithography apparatus) method, to evaluate factors such as the occlusal plane, lip support, and vertical dimensions. If need be, the trial denture can be evaluated through occlusal adjustment or internal wash impression, before the production of the finished denture.

Generic 3D printing denture manufacturers are capable of producing dentures with as few as two visits from the patient—with the final impression and jaw relation information being collected on the first day of visit—and introduce themselves as being capable of providing dentures with enhanced tissue adaptation, since they are free from polymerization shrinkage errors that occur in resins used for traditional complete dentures.

Therefore, in the current case report, two complete dentures will be produced simultaneously for a single patient using digital and traditional techniques to compare each with one another and report their clinical outcomes.

## Case Report

The patient was a 61-year-old male, who visited to get dentures. He had no significant past medical history; all teeth with severe caries or poor periodontal prognosis were extracted. Due to economic issues, complete dentures for the maxilla and mandible were planned for the patient (**Fig. 1**). Since the patient indicated favorable adaptation after 2 months of use with the trial version of complete dentures, production of the finished version of the complete denture was initiated.

For the current case report, MAGIC Denture—product of Cozahn (Seoul, Korea)—was selected for use, from numerous 3D printed denture products available on the market. Among four size options for the trays, the medium size was selected as it secured 3 mm or more space from the alveolar ridge. Using the fit checker (FIT CHECKER ADVANCED, GC, Tokyo, Japan), exposed border components of the tray were removed, and the border length and internal surface were adjusted.

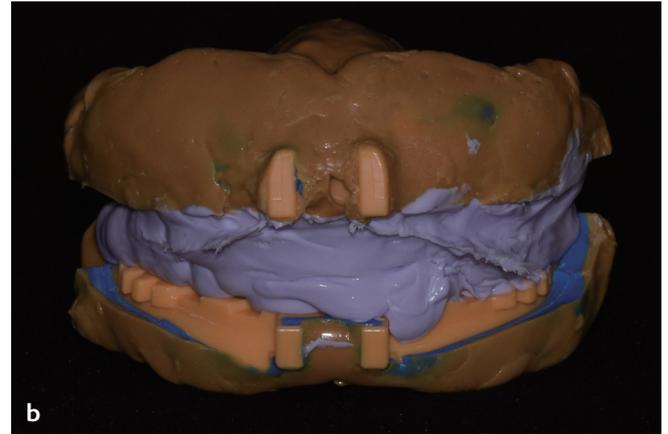
For the border molding procedures, polysiloxane impression materials with high viscosity through conventional muscular motion (Virtual Heavy Body, Ivoclar Vivadent AG, Schaan, Liechtenstein) were used to take the initial impressions, with additional removal procedures conducted for exposed tray border areas, using denture burs. Then, using light body impression materials with low viscosity (Virtual Light Body, Ivoclar Vivadent AG, Schaan, Liechtenstein), the second impression was taken. Finished impression trays were separated at the border between the front and back portions using the #15 blade, and impression materials that were protruding excessively from the upper surface of the tray were removed. The frontal impression bodies of the maxilla and mandible, separated from one another, were placed within the oral cavity to collect information on their jaw relation. The vertical dimensions of the finished denture reflected that of the existing trial denture, since the patient had adapted well to the trial denture.

Vertical dimensions of the trial denture determined through the following measures: the Willis method, securing of the freeway space, normal pronunciation, and aesthetics. Referring to the vertical dimensions of the trial denture, the chin-nose distance was measured using a jaw gauge. Placement of implants in the maxillary anterior segment referred to the distance from the incisive papilla to the lower border of the upper lip, which was measured using a lip ruler. A tracing needle was fixed in place on the mandible tray, which was then adjusted using the vertical dimensions of the trial dentures to determine the final vertical dimensions.

The EZ-tracer was attached on top of the maxilla tray with finished impression, and the impression body was adapted within the oral cavity. The sagittal and lateral movement paths of the mandible were recorded, and interocclusal recording materials (Regisil Rigid, Dentsply, Konstanz, Germany) were applied in the space between the trays to collect information on the jaw relation (**Fig. 2a-b**).



**Fig. 1.** Panoramic radiograph after extraction of teeth with a questionable or poor prognosis

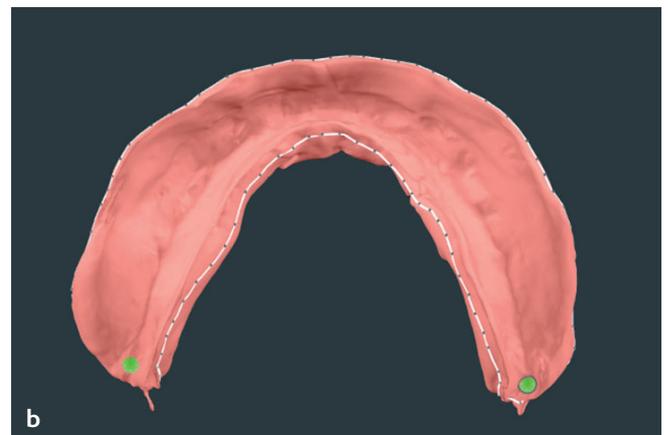
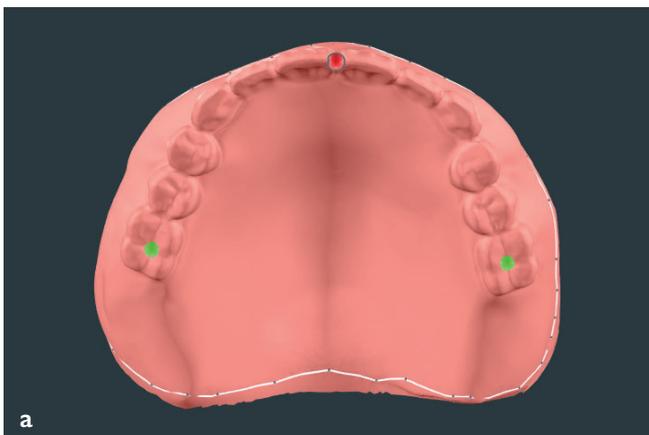


**Fig. 2a-b.** (a) Gothic arch tracing  
(b) Definitive impression and jaw relation record.

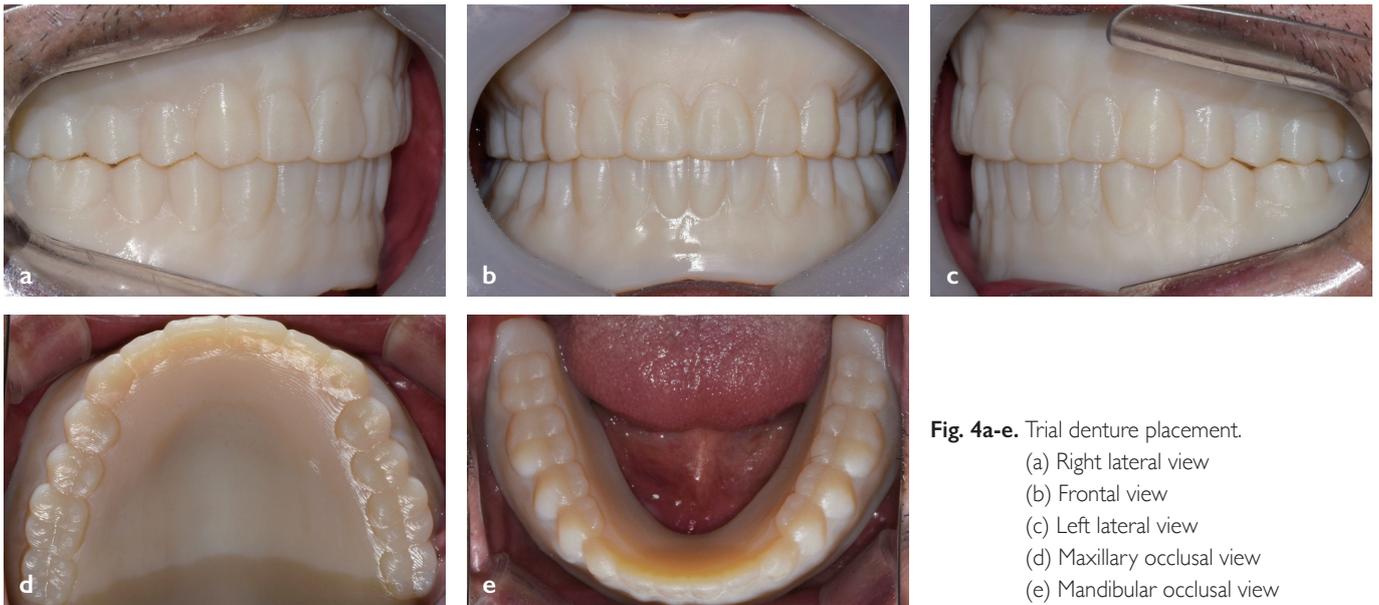
Cozahn's MAGIC Denture dental technology software used scanners (EI scanner; 3 Shape, Copenhagen, Denmark) and scanning software (Scan-It Manager; 3 Shape, Copenhagen, Denmark) to scan the impression bodies of the maxilla and mandible, which were then converted into Standard Tessellation Language files. On DENTCATM CAD/CAM denture website (DENTCA, Torrance, CA, USA), the scanned files were imported; then, using the DENTCA Proprietary Software (DENTCA, Torrance, CA, USA), balanced occlusion was attributed—based on the incisive papilla and hamular notch of the maxilla, and the retromolar pad of the mandible—to lay out the hypothetical implant fixtures (**Fig. 3a-b**).

Trial dentures were printed using the DENTA Zenith 3D Printer and Printing Software (DENTCA, Torrance, CA, USA), placed in the oral cavity, and were assessed to have satisfactory evaluations for the following criteria: morphometrics, lip support, occlusal plane, vertical dimensions, internal adaptability, pronunciation, and deglutition (**Fig. 4a-e**).

To secure the balanced occlusion, occlusal adjustment was performed. The centric relation was measured using Aluwax (Aluwax Dental Products, Allendale, MI, USA). To improve the internal adaptability of the trial denture, 2 mm of the internal surface of the trial denture was removed evenly, and a wash impression was prepared with silicone impression materials (Exadenture, GC Corporation, Tokyo, Japan), using the closed mouth impression technique.



**Fig. 3a-b.** Maxillary and mandibular anatomical landmark for occlusal plane

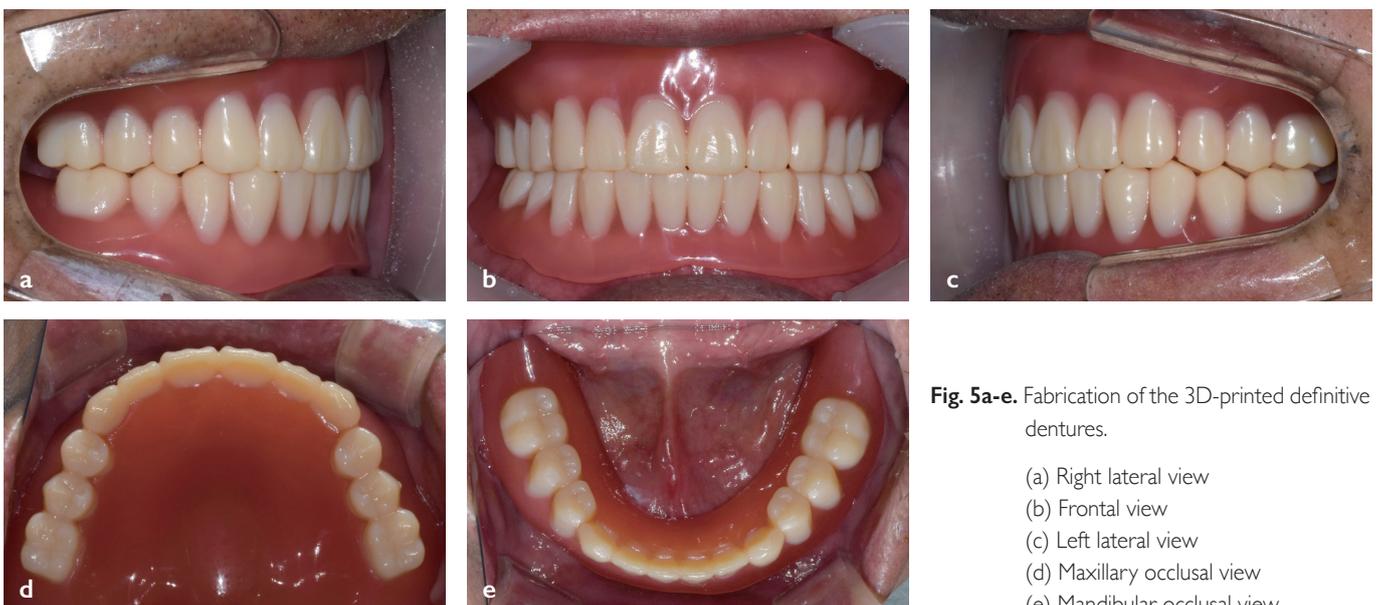


**Fig. 4a-e.** Trial denture placement.  
 (a) Right lateral view  
 (b) Frontal view  
 (c) Left lateral view  
 (d) Maxillary occlusal view  
 (e) Mandibular occlusal view

Denture base color was originally pink, and the dental implant color was A3, and the production of the final denture was requested, reflecting the adjustments made on the trial denture.

Using the above-mentioned software to design the hypothetical denture, the denture base (DENTCA Denture Base II, Torrance, USA) and denture teeth for the anterior and both sides of the posterior (DENTCA Denture Teeth, Torrance, USA) were each printed; after applying the backing with denture base resin, the denture teeth were adhered to the denture base through photo-curing. Following the grinding procedures, the final denture was completed (**Fig. 5a-e**).

Following the placement of the finished denture, the internal adaptability was verified to delete any pressure areas and evaluate occlusion, aesthetic qualities, pronunciation, and deglutition. The patient was advised to visit within 24 h of the denture placement, and the denture was adjusted based on the occlusion and areas of pain. During the routine follow-up examination, the patient expressed satisfaction with the denture's sustainability, mastication, aesthetic qualities, and pronunciation.



**Fig. 5a-e.** Fabrication of the 3D-printed definitive dentures.  
 (a) Right lateral view  
 (b) Frontal view  
 (c) Left lateral view  
 (d) Maxillary occlusal view  
 (e) Mandibular occlusal view

As for the production of traditional complete dentures, a reserve impression was prepared on the day of first visit, using traditional trays and irreversible hydrocolloid impression materials (Cavex impressional, Cavex, Haarlem, Netherlands). A diagnosis model and personal tray were produced.

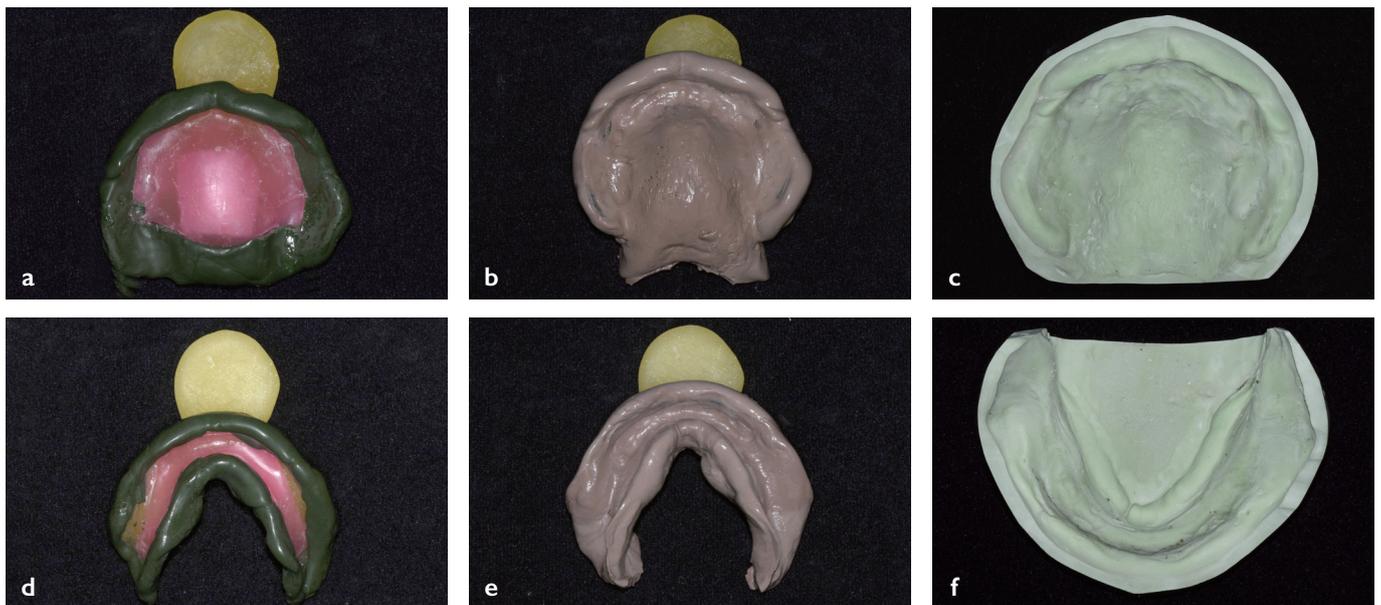
During the second visit, the personal tray was placed using the open-mouth impression technique, using modeling compounds (PERI COMPOUND, GC Co., Tokyo, Japan) for border formation, and polysulfide impression materials (Permlastic, Kerr Manufacturing Co., Romulus, USA) were used to take the final impression; then, a working cast was made using high strength dental stones (**Fig. 6a-f**). Based on anatomical indices, metal frames, record base, and occlusion rim were produced.

During the third visit, the occlusion rim was placed, and the following procedures were conducted using methods identical to the ones mentioned above: determination of occlusal vertical dimensions and the collection of information on the centric relation. After transferring the jaw relation of the maxilla and mandible to the articulator—through the facebow transfer of the maxilla—balanced occlusion was attributed for the placement of denture teeth, and a wax denture was produced (**Fig. 7a-c**).

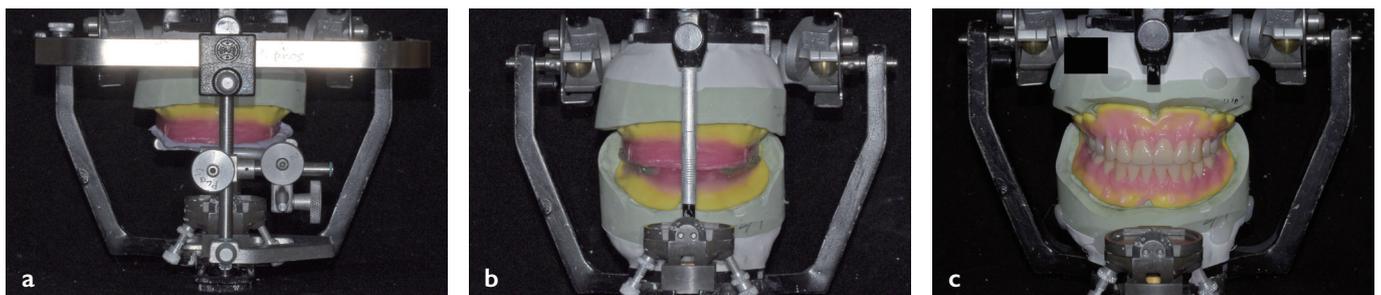
During the fourth visit, the wax denture was placed to ensure satisfactory evaluations from the patient regarding qualities such as occlusion, aesthetic qualities, pronunciation, and deglutition. After the polymerization of the finished denture, laboratory remounting was conducted.

During the fifth visit, the internal adaptability and occlusion of the denture were verified, and the balanced occlusion was formed through reattachment in the clinic (**Fig. 8a-e**).

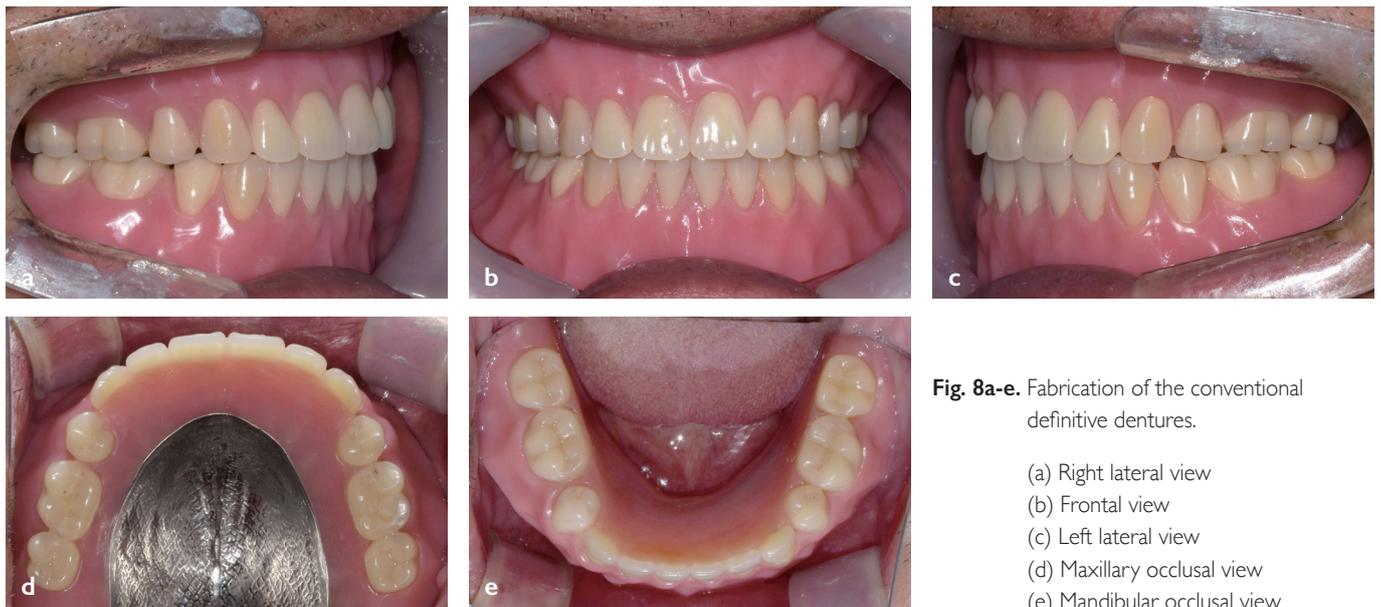
3D-printed dentures, produced using digital methods, required two fewer visits from the patient compared to traditional dentures, that is, in cases that included the production of trial dentures. In addition, satisfactory internal adaptability and sustainability were observed for 3D-printed dentures; however, since it does not use modeling compounds, it had thinner and shorter border components compared to traditional dentures. Since 3D-printed dentures lack a metal base, the patient was notified that it was at a higher risk of fracture in case of negligence. The patient was satisfied with the functional and aesthetic qualities of both dentures.



**Fig. 6a-f.** Border molding, definitive impression and fabrication of master casts



**Fig. 7a-c.** Facebow transfer and master casts with wax denture mounted on the semiadjustable articulators



**Fig. 8a-e.** Fabrication of the conventional definitive dentures.

- (a) Right lateral view
- (b) Frontal view
- (c) Left lateral view
- (d) Maxillary occlusal view
- (e) Mandibular occlusal view

## Discussion

Compared to traditional complete dentures, the 3D-printed denture is free from adjustment errors—caused by polymerized resin—and requires fewer clinic visits for denture production. In addition, if the data of the finished denture have been stored, in case of fracture or loss of dentures, new dentures can be made swiftly and easily.

However, since the number of patient visits are smaller, it is critical that the clinician makes accurate clinical decisions—since the clinician must collect as much information as possible at each step of the process—and it is also possible that the chair-time or the number of patient visits ends up increasing due to the clinician's unfamiliarity with novel techniques. Furthermore, since the border components are relatively thin and short, the margins can end up becoming shorter over the course of scanning the impression body and deleting the border areas of the scanned data.

The trays provided by Cozahn had the advantage of preparing the patient's impression and recording the patient's jaw relation simultaneously during their initial visit; however, since the tracing needle has limited angles of insertion for the mandible tray, difficulty reproducing the centric relation in cases where the tracing needle cannot form a perpendicular angle with the tracing plate of the maxilla could be observed. Also, if there are surplus impression materials remaining on top of the impression trays, they can be problematic for collecting information on jaw relations, since they can come in contact with one another in the posterior region. Other than that, the type of denture is also limited, since it is impossible to insert a metal frame for 3D-printed dentures.

V. Prpić et al. suggest that the denture base resin used in 3D-printed dentures indicates lower flexural strength compared to polymerized denture bases and is more prone to fractures<sup>2</sup>. Choi JJE et al. indicate that 3D-printed dentures have the possibility of denture teeth falling out of their places, in case the adhesive strength between denture teeth and denture base is low.<sup>3</sup>

The current case report was conducted—with the patient's consent—to simultaneously compare traditional complete denture with a 3D-printed complete denture for a single patient. Traditional denture production methods were more familiar for the clinician in various aspects (e.g., selecting tooth shapes, methods of arrangement, and coloration of base resin), and above all, gives a sense of stability from the fact that they have been time-tested and proven for a long time.

On the contrary, 3D-printed complete dentures, first of all, felt significantly different in the coloration of the printing resin materials; also, the tooth arrangement library had shapes and forms that were not the best fit for Korean patients. Above all else, prosthesis clinicians easily handle the discussion and cooperation procedures with dental technologists, thanks to their experiences of first-hand tooth arrangement in the education process, familiarity, and know-hows regarding dental technological procedures. On the contrary, clinicians—who have less exposure for CAD procedures—will inevitably face shortcomings for mutual discussion and cooperation with dental technologists, as they navigate the process of tooth arrangement for 3D-printing production. Nevertheless, the 3D-printed denture market—which has had approximately 10 years since its commercialization—is becoming more active, and the speed of its development is growing at an exponential rate.

If the numerous difficulties (e.g., actualization of medical fee benchmarks, material certification issues, etc.) can be addressed through the policy-level cooperation of various organizations, it can be largely beneficial for the quality of life of complete denture patients—who are at increased risk of socioeconomic difficulties—and future cases similar to the current case report, with patients who receive simultaneous traditional/3D-printed complete dentures, will also be reported in academic journals and associations through continuous observation.

## Conclusion

The current case report compares the clinical outcomes of traditional complete dentures and 3D-printed complete dentures. The patient was satisfied with the aesthetic and functional qualities of both dentures, and clinical observation indicated satisfactory balanced occlusion and internal adaptation in both of the dentures.

However, the thinner and shorter border components of 3D-printed complete dentures can lead to reduced sustainability compared to traditional complete dentures; specifically for patients with severe residual ridge resorption, it is considered that treatment planning should be undertaken with caution.

### Conflicts of interest

The authors declare that they have no competing interests.

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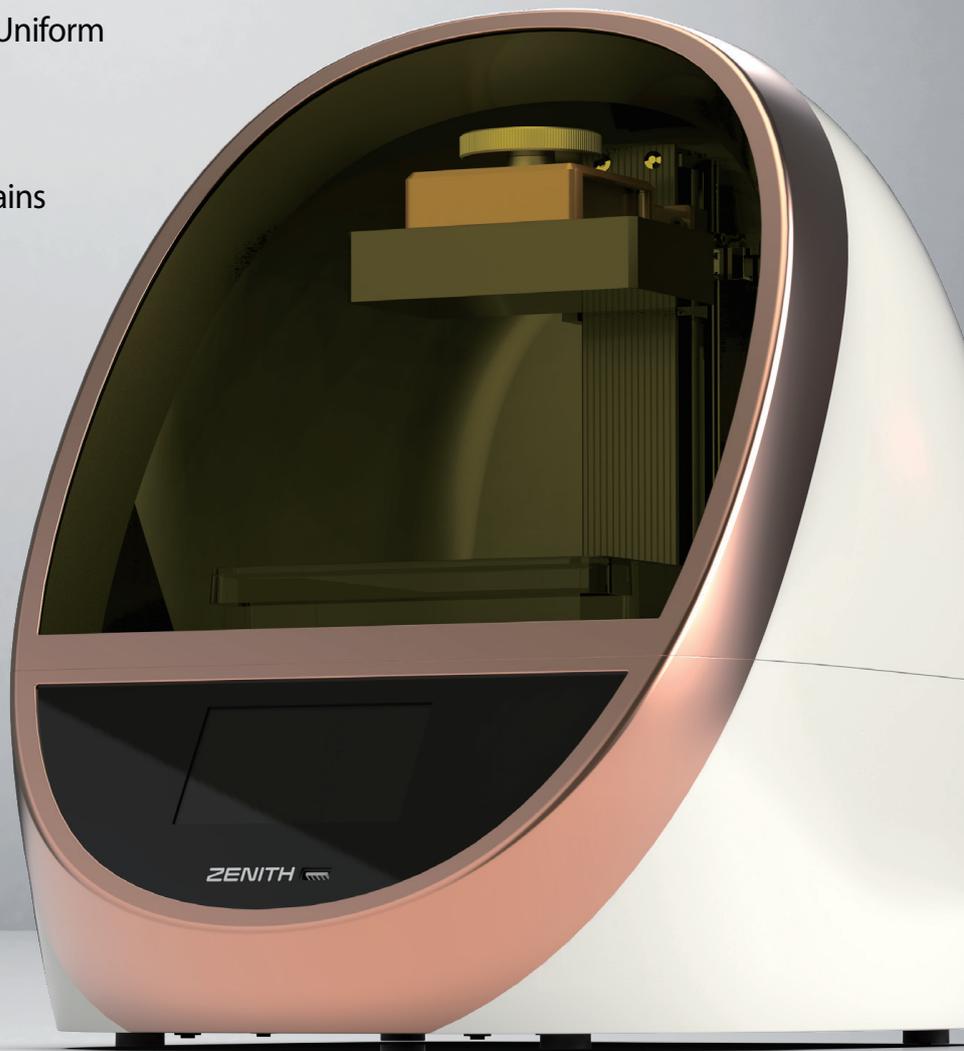
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