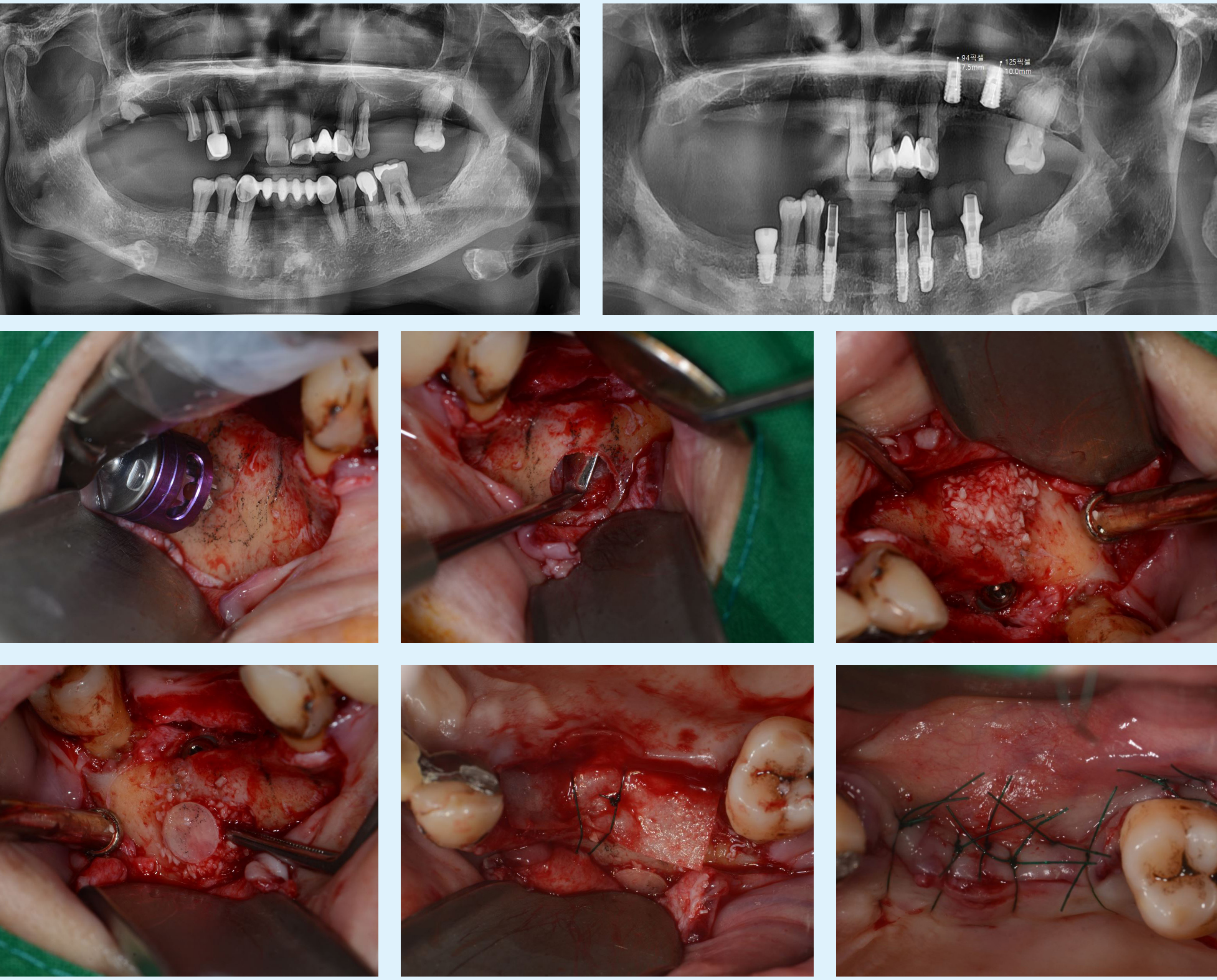
www.jcdd.org

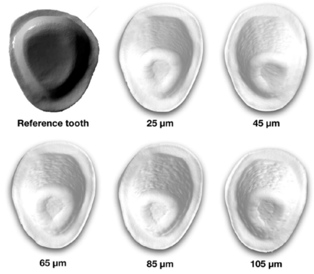
Vol.3. June.2021

JCDD

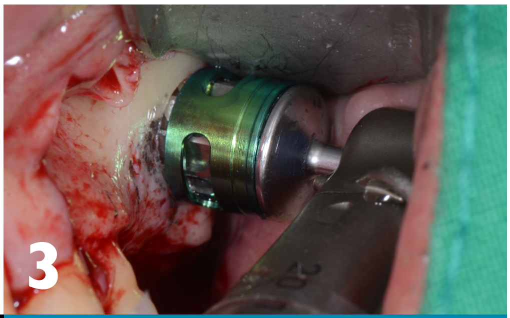
Journal of Clinical & Digital Dentistry



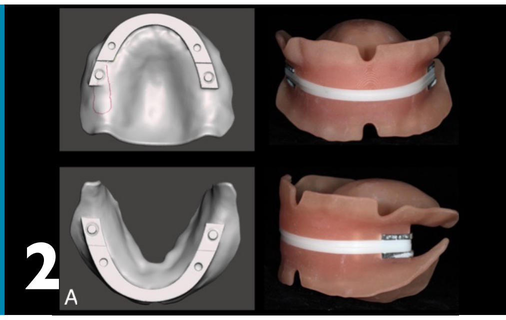
Cover Images from Choi YK. (J Clin Digit Dent 2021;3(2):20-30)



Journal of Clinical & Digital Dentistry



Journal of Clinical & Digital Dentistry



Journal of Clinical & Digital Dentistry

TABLE OF CONTENTS

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

Digital, digital, and digital...

Digital dentistry, which was applied to restorative dentistry, has already expanded to all areas of dentistry. In the early days, ceramic restorations using CAD-CAM were not popularly used due to inaccuracies in their margin and unnatural occlusal shape. I did not like my first zirconia crowns in 2007 because their fit was not as accurate compared to that of gold crowns or PFMs . I still cannot forget about the looseness of the zirconia crowns. Later, implant surgical guides were fabricated digitally, and clear aligner orthodontic systems were started to be used in minor orthodontic treatment.

The development of 3D printing, CAD software, milling machine, and oral scanner has led to their current use in most dental practices: implant surgical treatment planning, implant surgery, inlay, onlay, crowns, and clear aligner orthodontic treatments of any kind of malocclusion.

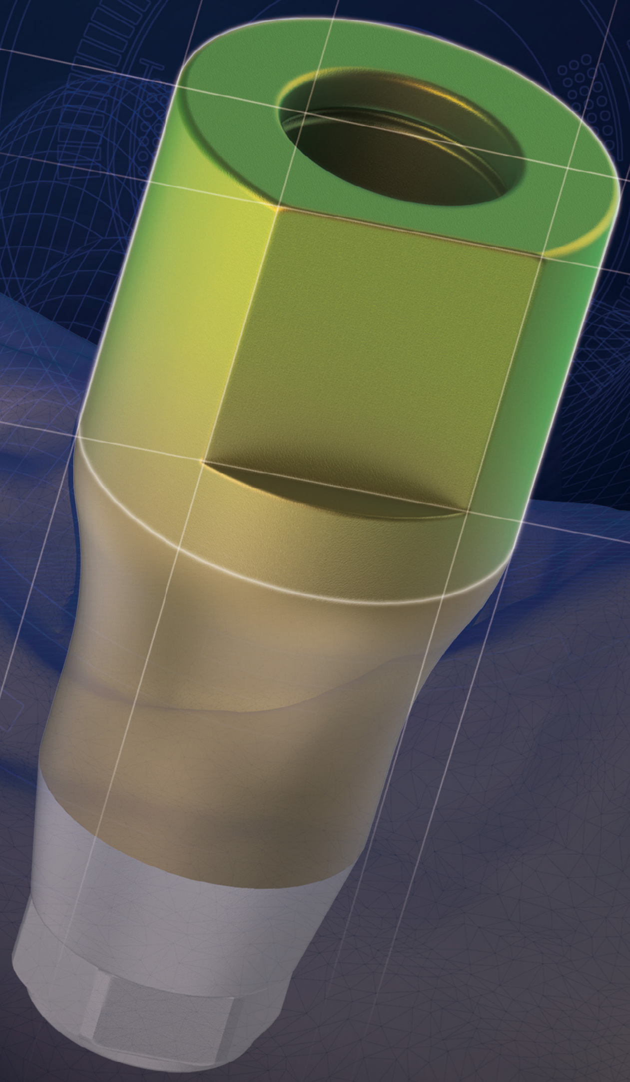
This issue of JCDD contains an article on the overall procedure of digital complete denture , an article about accuracy of die spacer amounts when producing zirconia crowns, and a case report on implant surgery using CAD-CAM surgical guide and maxillary sinus elevation with an open lateral window and a bone graft.

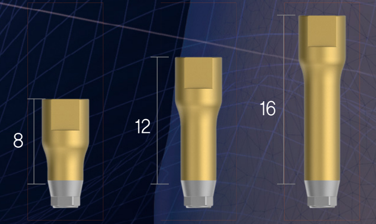
I believe that this issue of JCDD will provide an opportunity to study the application of digital dentistry in implant surgery, and the fabrication of digital complete dentures and zirconia crowns.

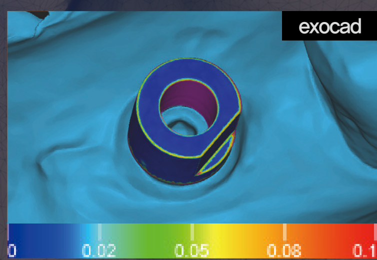
Wongun Chang, DDS MS PhD

DENTIS ScanBody

Remarkable Accuracy!







스캔데이터와 라이브러리가 일치하는 모습
(손쉬운 정합으로 보철물의 정확도 향상)

DENTIS

고객센터 1899-2804

Trueness and precision of die spacer thickness of zirconia single crown made by CAD-CAM milling technology

Seok-Hwan Cho, DDS, MS, MS, CDT · Arndt Guentsch, DMD, PhD, MHBA

Abstract

Purpose

The literature has shown that difficulty exists in the ability to control die spacer thickness. In addition, information on the harmony that exists between the computer aided design parameters for die spacer thickness and milling technology is lacking. The purpose of this study was to investigate both the trueness and the precision of die spacer thicknesses achieved by using both computer aided design as well as milling technology.

Material and Methods

An ivorine maxillary central incisor tooth was prepared for single ceramic crowns. Digital impressions were performed with a chair side intraoral scanner and crowns were fabricated by CAD-CAM technology. For the milled crowns, the die spacer setting was divided into 5 groups with the thicknesses of 25 µm, 45 µm, 65 µm, 85 µm, and 105 µm. A total of 25 zirconia milled crowns were fabricated (n=5/group). The zirconia milled crowns and dentoform tooth were digitized with a structured light scanner and saved in STL format. All STL records were superimposed by a modified best-fit method to achieve a best object-to-object penetration. The internal surfaces of the milled crowns were compared to the reference tooth for trueness and precision by quantitative (RMS in µm) and qualitative (color-coded images) data analysis. Accuracy defined by trueness and precision was measured.

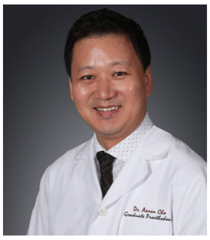
A one-way analysis of variance (ANOVA) was conducted to evaluate the overall statistical significance regarding the dissimilarities among groups at a significance level of α = .05. Scheffe's post hoc analysis was performed to detect differences between groups. Linear regression analysis was also performed to evaluate the relationship between programmed die spacer thickness and measured die spacer thickness.

Results

The deviation from the planned die spacer thickness were 7.6 µm (4.9 µm) for the 25 µm group, 13.4 µm (6.5 µm) for the 45 µm group, 38.2 µm (6.1 µm) for the 65 µm group, 7.6 µm (4.9 µm) for the 85µm group, and 38.2 µm (3.1 µm) for the 105 µm group. The 25 µm and the 85 µm had significantly lower deviations than the remaining groups. The lowest precision was detected in the 45 µm group (16.0 ± 11.1 µm), this was significantly different from the groups with pre-set die spacer thickness of 25 µm (6.0 ± 3.7 µm), 65 µm (6.2 ± 5.2 µm), 85 µm (7.2 ± 4.9 µm), and 105 µm (3.8 ± 2.3 µm).

Conclusions

Within the limitation of the study, CAD-CAM milled zirconia crowns with 25 µm and the 85 µm die spacer thickness showed high trueness and precision.



Seok-Hwan (Aaron) Cho

After graduating from Seoul National University College of Dentistry in 2000, Dr. Cho completed the Advanced Specialty Program in Prosthodontics at Texas A&M University College of Dentistry (former Baylor College of Dentistry), Dallas, Texas. Since then, he has worked at Marquette University School of Dentistry as a Clinic Director of the Graduate Program in Prosthodontics as well as a Pre-doctoral Program Director for Prosthodontics and Biomaterials. Dr. Seok-Hwan (Aaron) Cho is currently an Associate Professor and Program Director of Graduate Prosthodontics at Texas A&M University College of Dentistry.
He is a board certified prosthodontist as well as a master ceramist. He is also a director of Post-Doctoral Implant Placement Program (PDIPP) at Texas A&M University College of Dentistry.

Arndt Guentsch

Dr. Arndt Guentsch graduated from the Friedrich-Schiller-University in Jena, Germany. He completed his certification in periodontics and a PhD at his alma mater and a Master of Health Business Administration at the Friedrich-Alexander-University, Nuremberg, Germany. He is currently the Department Chair of the Department of Surgical Sciences at the Marquette University School of Dentistry in Milwaukee, Wisconsin, USA. His practice is focused on the digital workflow in implant dentistry. Dr. Guentsch authored more than 100 publications, >50 in peer-reviewed journals.

Introduction

In order to allow space for the luting agent between the fixed restoration and the prepared tooth, clearance is needed. One of the most popular methods to accomplish this is to apply paint-on die spacer before waxing. Die spacers have been used as a popular method for providing internal space for a number of years.[1-4]

Previously written literature has shown that the use of die spacers improves marginal fit between the restoration and the tooth preparation while decreasing the risk for plaque accumulation and recurrent caries.[5] In addition, the thickness of the die spacer has an affect on the fracture strength of a ceramic restoration, as well as its retention and marginal gap.[6,7] One study showed that ceramic crowns had a higher fracture strength when the mean internal gap was less than 73 µm, while a lower fracture strength was indicated when the mean internal gap was larger than 122 µm at the axial wall.[6] Interestingly, the literature is inconclusive with regards to the influence of die spacer thickness and retention. Eames and colleagues[7] used an experimental design involving extracted human teeth and fabricated crowns by using a technique that closely resembled clinical and laboratory procedures in order to improve the seating of castings. Their findings indicated that castings which had four layers of die spacer were 25% more retentive than similar crowns which did not have spacer applied.

However, Hembree and Cooper[8] designed a study to investigate the effect of die spacer thickness on the retention of cast crowns and inlays. Their results revealed that there was no statistical significance between crowns made with or without four layers of die spacer after cementation with three different cements. Vermilyea et al[9] also explored the effect of die spacer relief on retention of full coverage crowns cemented onto extracted human molars. They noted that there was a 32% decrease in retention of gold copings constructed on dies which were coated with two layers of 20-25 µm layers of die spacer, compared with the copings constructed on dies with no spacer after cementing with zinc phosphate cement.

Despite these findings, Marker et al[10] found that 55% of castings constructed on dies coated with four layers of spacer exhibited an increase in retention in comparison of those copings which were unspaced. There is more regularity in the literature when assessing the effect of die spacer thickness on marginal gap.[1,11,12] Grajower et al1 noted that the magnitude of marginal gap without die spacer was 649 µm. This gap was significantly improved from 479 µm to 38 µm as the die spacer thickness was increased from a single layer to eight layers.[1,7,11]

Even though there has been another problem related with inconsistency of the ideal die spacer thickness,[4,11,13] the most difficulty is that there is still a failure to regulate die spacer thickness by the manual application method. Computer-aided design (CAD) technology allows for virtual design of restorations and programming of die thickness. The virtually created coping can be produced by milling and 3D printing. Internal gaps obtained from CAD/milling technology have been investigated by a number of authors.[14-16] Hoang et al[17] investigated the die spacer thickness reproduction by CAD and 3D printing technology with resin printed copings. The copings were cemented onto their respective dies and the internal gap was measured at five different locations after the die was sectioned. The study showed the inability of the 3D printer to reproduce a uniform internal gap for all samples within the assigned group.

There is limited information available regarding the consistency and compatibility between CAD parameters for die spacer thickness and milling technology. The purpose of this study was to evaluate trueness and precision of the die spacer thickness achieved by the combination of CAD and milling.

This research investigation was carried out to achieve two objectives. The first objective was to test the trueness of CAD/milling by comparing various measured internal gap thicknesses with the prescribed values of 25 µm, 45 µm, 65 µm, 85 µm, and 105 µm. Trueness was defined as the closeness of the internal surface of the milled crowns to the reference dies spacer thicknesses.[17] Trueness was quantitatively evaluated by the root mean square (RMS) and the resulting internal gap thicknesses were compared to the reference values. The second objective of this study was to measure the precision. Precision was defined as the ability of the CAD/milling combination to reproduce the same die spacer thickness for each of the samples in the assigned group. The trueness null hypothesis was that there was no overall difference between the CAD/milling achieved internal gap thicknesses and the programmed die spacer thicknesses. The precision null hypothesis was that there was no difference in the reproducibility of the milling machine among varying die spacer thicknesses.

Material And Methods

An ivorine maxillary central incisor (T1560; Columbia Dentoform Corp) was prepared for an all ceramic crown. Then, a digital impression technique was performed with an intra-oral scanner (Lava Chairside Oral Scanner; 3M ESPE). Without making physical casts, the scanned data was transferred to a commercial dental laboratory in order to fabricate CAD/milled crowns. For the milled crowns, the die spacer setting was divided into 5 groups: 25 μm, 45 μm, 65 μm, 85 μm, and 105 μm (Dental Premium System; 3Shape). All setting values were same except the extra cement gap. The setting of the die spacer was: distance to margin line = 1 mm; extra cement gaps were 25 μm, 45 μm, 65 μm, 85 μm, and 105 μm. A power analysis was completed by recently published data resulted in a sample size per group of n = 5.[18]

After sintering process, a total of 25 zirconia milled crowns (Jensen XT Zirconia; Jensen Dental) were fabricated (n=5/group) by a 5-axis milling machine (Lava CNC 500 Milling Machine; 3M ESPE). The zirconia milled crowns and dentoform teeth were digitized by a light scanner developed by the Fraunhofer Institute for Applied Optics and Precision Engineering IOF (Flex 3A; Otto Vision Technology GmbH). The scanner featured a measurement-uncertainty of <5 μm and a homogenous measuring-point-distance of 5 μm (data according to manufacturer) and saved in stereolithography (STL) format. All STL records were superimposed by using a modified best-fit method.[18] To compare congruent areas, surfaces of the virtual preparation were inverted. Afterwards, STL records of the preparation and restorations were superimposed one on the other by computing all possible orientations and selecting the one with the best object-to-object penetration. Since in reality the restoration cannot penetrate the preparation, the virtual alignment of the best-fit model was corrected in all axes.[19-21] The internal surfaces of the milled crowns and the prepared surfaces of the dentoform tooth were compared for accuracy and precision (Qualify 12; Geomagic GmbH). A recently introduced method allows the quantitative and qualitative three-dimensional analysis of dental materials, including restorations, impressions, or casts.[22] Dimensional differences between both crowns and the reference tooth were computed. The mean deviation root mean square (RMS) of the virtual reference object (prepared tooth) in comparison to the test objects (crowns) was used to estimate the congruency of two superimposed records by the following formula[18]

$$RMS = \frac{1}{\sqrt{n}} \cdot \sqrt{\sum_{i=1}^{n} (x_{1,i} - x_{2,i})^2}$$

where x1,i is measuring point i on reference, x2,i is measuring point i on duplicate, and n is total number of measuring points per specimen.

Means, standard deviations, and 95%-confidence intervals were calculated for the root means square, trueness, and precision. All statistical computations were done in IBM SPSS Statistics 25 (IBM SPSS Inc., Chicago, IL, USA).

Trueness was determined as difference between actual and planned (reference) thickness with each n=5 measurements per group. Precision was calculated as difference between each crown within a group (n=10 values per group). The correlation variance (CV) was calculated as CV= SD/mean x 100% to determine how reliable the CAD/milling technology was in producing the same die spacer thickness for every sample in a group.[18]

A one-way analysis of variance (ANOVA) was conducted to assess the overall statistical significance of differences among different groups. Scheffe´s multiple comparisons were used to test the differences between the groups. Statistical significance was accepted at $p < .05$.

Results

Table 1 shows the main finding of the study with the RMS values, trueness, and precision of each group. Trueness, as difference to the planned values showed the lowest measurements (highest trueness/accuracy) for the 25 μm group (7.6 ± 4.9 μm) and 85 μm group (7.6 ± 4.9 μm), respectively. The highest difference from the planned value (and therefore the lowest trueness/accuracy) was detected for the 65 μm group (38.2 ± 6.1 μm) and the 105 μm group (38.2 ± 31 μm), respectively. Both groups showed significantly higher values than the other three groups.

Precision measured the difference among the crowns in each group. The lowest deviation (highest precision) was detected for the crowns with 105 μm pre-set die spacer thickness (3.8 ± 2.3 μm). The highest deviation (lowest precision) was seen in the group with 45 μm die spacer thickness (16.0 ± 11.1 μm). High trueness and high precision was detected in the groups with 25 μm and the 85 μm die spacer thickness.

Table 1. Root mean square (RMS) as mean ± SD (standard deviation) of 5 groups. Trueness (difference between planned and actual thickness) and precision (difference among crowns) as mean ± SD and 95% Confidence intervals (95% CI). Correlation variance (CV)

Group	RMS (in µm)	Trueness (in µm)		Precision (in µm)		CV (in %)
	Mean ± SD	Mean ± SD	[95% CI]	Mean ± SD	95% CI	
25	32.6 ± 4.9	7.6 ± 4.9[b,e]	[1.5 – 13.7]	6.0 ± 3.7[b]	[3.3 – 8.7]	15.12
45	36.8 ± 13.5	13.4 ± 6.5[c,e]	[5.3 – 21.5]	16.0 ± 11.1[a,c,e]	[8.1 – 23.9]	36.78
65	45.6 ± 5.6	38.2 ± 6.1[a,b,d]	[2.7 – 30.7]	6.2 ± 5.2[b]	[2.5 – 9.9]	12.27
85	46.8 ± 6.1	7.6 ± 4.9[c,e]	[1.5 – 13.7]	7.2 ± 4.9	[3.7 – 10.7]	12.94
105	66.8 ± 3.1	38.2 ± 3.1[a,b,d]	[34.3 – 42.1]	3.8 ± 2.3[b]	[2.1 – 5.5]	4.67
ANOVA		p<.001 F=45.74		p=0.01 F=5.79		

Scheffe's post-hoc comparison: significant different (p<0.05) to a=25 µm group, b=45 µm group, c=65 µm group, d=85 µm group, and e=105 µm group

Table 1. Root mean square (RMS) as mean ± SD (standard deviation) of 5 groups. Trueness (difference between planned and actual thickness) and precision (difference among crowns) as mean ± SD and 95% Confidence intervals (95% CI). Correlation variance (CV)

For qualitative evaluation, color-coded difference images were compared (Fig. 1), where yellow-red indicates contact areas and blue indicates gaps. The 65 µm group demonstrated the most balanced distribution followed by the 85 µm group, However the 25 µm group showed larger inner spaces. Qualitative differences of the inner surface of the crowns were detectable with increasing die spacer setting (Fig. 2). Figure 3 shows the overall mean internal gap (root mean square) versus the prescribed die spacer thickness.

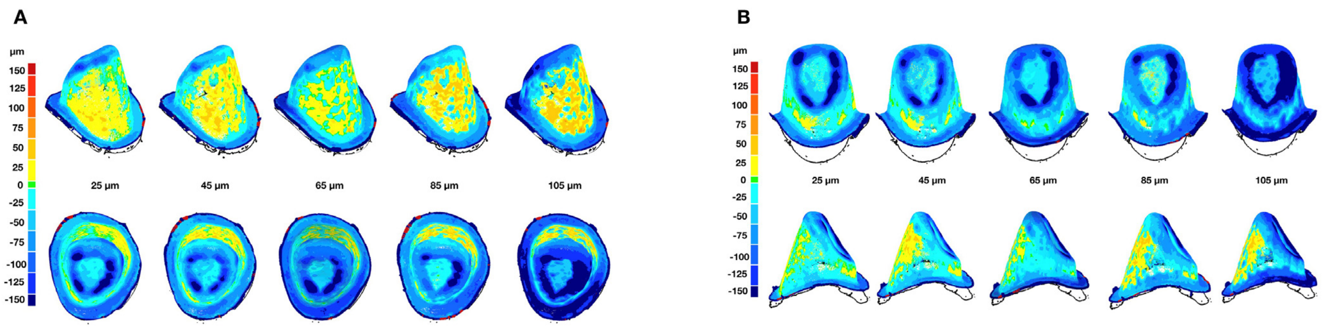


Fig 1. Color-coded images. (A) Buccal and occlusal view and (B) lingual and proximal view.
Note: Yellow denotes contact areas, blue indicates gap areas and green is zero µm gap.

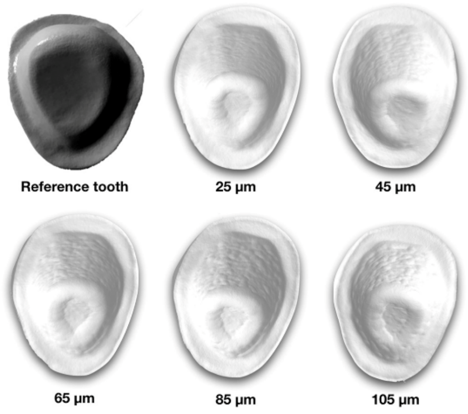


Fig 2. Reference tooth with crown preparation and representing samples of crowns with die spacer thickness of 25 – 105 µm. Milling pattern of each group correspondents with qualitative images in Fig. 1.

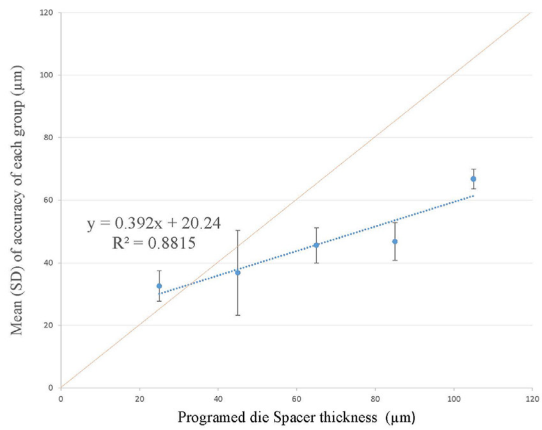


Fig 3. Scattered graph of measured means for each group and standard deviations. Trend line equation and R^2 value.

Discussion

The primary purpose of this study was to evaluate trueness and precision of the die spacer thickness achieved by the combination of CAD and milling. The overall statistical analyses rejected the accuracy null hypothesis of no difference for the groups of 25 µm, 45 µm, 65 µm, 85 µm, and 105 µm that were assessed. This study demonstrated that the programmed die spacer thickness values differed from the measured internal gaps of all groups. The CAD/milling system was unable to produce the same die spacer thickness for all groups. However, the 25 µm and 85 µm die spacer groups demonstrated the highest accuracy among the groups.

Traditionally, optical- or scanning electron microscopy were used to evaluate marginal and internal adaption. Limitations of these methods were specimen sectioning [23] or indirect data acquisition.[24,25] A novel three-dimensional procedure was employed from our group that generated more clinically relevant information.[18,22]

Many authors have previously studied the average internal gaps obtained from CAD/milled crown. Acceptable fit-discrepancies have been reported to range from 50 to 150 µm.[22] Moldovan et al investigated the internal gap of zirconia copings made by CAD/Cercon and CAD/Cerec technologies.[14]

The programmed die spacer thickness for CAD/Cercon was 10 - 20 µm and CAD/Cerec was -100 µm; the mean values of the internal gaps obtained were 100 - 130 µm and 60 -70 µm, respectively. Kokubo et al investigated the internal gaps of In-Ceram crowns made by CAD/milling technology ranged from 165.9 - 200.3 µm which were 3 - 4× greater than the programmed die spacer thickness (50 µm).[15]

Several studies regarding CAD/printing technology and internal gap exist within the literature. Bhaskaran et al18 reported on the marginal and internal gap of Co-Cr copings cast from 3D printed resin patterns to be 27.22 µm and 36.15 µm. Hoang et al[18] showed the average internal gaps was 75 µm, which was 3× greater than the programmed die spacer thickness value (25 µm). In this present study, the average internal gaps of CAD/milled zirconia crowns ranged from 32.6 - 66.8 µm, which indicated much smaller internal gaps were produced in comparison with previous studies.

Figure 3 demonstrates the relationship between the programmed die spacer setting and measured internal gap (accuracy) of each group. It also shows the trend line equation ($y=0.392x+20.24$), which indicates, at a setting of no die spacer thickness ($x = 0$ µm) in the CAD system, a 20 µm internal gap would be produced. In addition, the trend line indicates that the value of the internal gap appears skewed down with the setting of die spacer thickness increasing. If 25 µm ($y = 25$) is intended to produce the internal gap, 12 µm of die spacer setting should be programmed based on the trend line. In addition, the graph indicates the average values of measured internal gap skewed down. This means that 25 µm group showed that actual measured value (32.6 µm) of the internal gap was greater than 25 µm, while 45 µm group showed that actual measured value (36.8 µm) of the internal gap was less than 45 µm. The graph shows the actual internal gap will become less than the programmed setting value over the point of around 30 µm.

From the qualitative analysis (Fig. 1), it can be concluded that the 25 μm die spacer setting resulted in a non-fitting crown. The dark blue area which represents an internal gap of more than 100 μm at the cusp suggests that the crowns were not completely seated. In the settings 45 μm and greater, the contact area (yellowish colors) increases which may correlate with better fitting of the respective crowns.

Precision was used to determine the reproducibility of the internal gaps. A large value indicates low precision. Since a precision value less than 10% is considered reasonable[26], the precision of the CAD/milling combination used in this study was acceptable except the group of 45 μm. The precision null hypothesis was rejected for all the groups except the group of 105 μm. Hoang et al[17] explored the precision of CAD/printing combination; the precision (CV) for all printed resin copings was within the range 14 - 33%, which relates to a low precision. In addition, Campagni et al[4] reported on the precision of manual application of die spacer material; the CV ranged from 25.6 - 53.2% for 6 layers and 2 layers, respectively. In the present study, the precision for all groups were within the range 4 - 36%, which can be compatible with CAD/printing method and manual method.

There are several limitations of this research with respect to measurement, materials, and technology used. Errors may have occurred in any step of the process chain beginning with the lab scanning and milling process. In addition, it is prudent to understand that the measurements obtained were specific to this software/hardware combination (CAD and milling). The results may not be applicable to other software/hardware combinations. Thus, further studies will be needed to investigate the accuracy and precision for other comparative technologies. There were no crowns made conventional method as a control because it was hard to make zirconia crowns by the conventional method. In the future, we predict that there will be further advancement in technologies with improved accuracy for both the scanning and printing systems.

Conclusion

Within the limitation of the study, for the trueness evaluation, the programmed die space thickness of CAD/ milled zirconia crown showed statistically significant and different values from the measured internal gaps of the all groups. Among the 5 groups, CAD/ milled zirconia crowns with a 25 μm and 85 μm die spacer setting appeared highest in trueness based on the RMS value and the resulting internal gap thicknesses compared to the reference values. For the precision assessment, the group of 105 μm indicated the highest precision and the group of 45 μm the lowest precision. Thus, indicating a variability of 4 - 16 μm of the milling technology in reproducing a uniform internal gap within the same group.

Acknowlwdgement

The authors want to express thanks to Drs. Mina D. Fahmy and Hongseok An for their efforts and time toward this research project.

Refrences

1. Grajower R, Zuberi Y, Lewinstein I. Improving the fit of crowns with die spacers. J Prosthet Dent 1989;61:555-63

2. Passon C, Lambert R, Lambert R, et al. The effect of multiple layers of die-spacer on crown retention. Oper Dent 1992;17:42-9

3. Gegauff AG, Rosenstiel SF. Reassessment of die-spacer with dynamic loading during cementation. J Prosthet Dent 1989;61:655-8

4. Campagni W, Preston J, Reisbick M. Measurement of paint-on die spacers used for casting relief. J Prosthet Dent 1982;47:606-11

5. Psillakis JJ, McAlarney ME, Wright RF, et al. Effect of evaporation and mixing technique on die spacer thickness: a preliminary study. J Prosthet Dent 2001;85:82-7

6. Tuntiprawon M, Wilson PR. The effect of cement thickness on the fracture strength of all-ceramic crowns. Aus Dent J 1995;40:17-21

7. Eames WB, O'Neal SJ, Monteiro J, et al. Techniques to improve the seating of castings. J Am Dent Assoc 1978;96:432-7

8. Hembree Jr J, Cooper Jr E. Effect of die relief on retention of cast crowns and inlays. Oper Dent 1979;4:104

9. Vermilyea SG, Kuffler MJ, Huget EF. The effects of die relief agent on the retention of full coverage castings. J Prosthet Dent 1983;50:207-10

10. Marker VA, Miller AW, Miller BH, et al. Factors affecting the retention and fit of gold castings. J Prosthet Dent 1987;57:425-30

11. Carter SM, Wilson PR. The effect of die-spacing on crown retention. Int J Prosthodont 1996;9;21-9

12. Wang C-J, Millstein PL, Nathanson D. Effects of cement, cement space, marginal design, seating aid materials, and seating force on crown cementation. J Prosthet Dent 1992;67:786-90

13. Campbell SD. Comparison of conventional paint-on die spacers and those used with the all-ceramic restorations. J Prosthet Dent 1990;63:151-5

14. Moldovan O, Luthardt RG, Corcodel N, et al. Three-dimensional fit of CAD/CAM-made zirconia copings. Dent Mater 2011;27:1273-8

15. Kokubo Y, Nagayama Y, Tsumita M, et al. Clinical marginal and internal gaps of In-Ceram crowns fabricated using the GN-I system. J Oral Rehabil 2005;32:753-8

16. Bhaskaran E, Azhagarasan N, Miglani S, et al. Comparative Evaluation of Marginal and Internal Gap of Co–Cr Copings Fabricated from Conventional Wax Pattern, 3D Printed Resin Pattern and DMLS Tech: An In Vitro Study. J Indian Prosthodont Soc 2013;13:189-95

17. Hoang LN, Thompson GA, Cho S-H, et al. Die spacer thickness reproduction for central incisor crown fabrication with combined computer-aided design and 3D printing technology: An in vitro study. J Prosthet Dent 2015;113:398-404

18. Akkus A, Akkus A, Roperto R, et al.: Evaluation of mineral content in healthy permanent human enamel by Raman spectroscopy. J Clin Exp Dent 2016;8:e546-9

19. Schaefer O, Decker M, Wittstock F, et al.: Impact of digital impression techniques on the adaption of ceramic partial crowns in vitro. J Dent 2014; 42: 677-83

20. Schaefer O, Kuepper H, Sigusch BW, et al.: Three-dimensional fit of lithium disilicate partial crowns in vitro. J Dent 2013; 41: 271-7

21. Schaefer O, Kuepper H, Thompson GA, et al.: Effect of CNC-milling on the marginal and internal fit of dental ceramics: a pilot study. Dent Mater 2013;29:851-8

22. Schaefer O, Watts DC, Sigusch BW, et al.: Marginal and internal fit of pressed lithium disilicate partial crowns in vitro: a three-dimensional analysis of accuracy and reproducibility. Dent Mater 2012;28:320-6

23. Keshvad A, Hooshmand T, Asefzadeh F, et al.: Marginal Gap, Internal Fit, and Fracture Load of Leucite-Reinforced Ceramic Inlays Fabricated by CEREC inLab and Hot-Pressed Techniques. J Prosthodont 2011;20:535-40

24. Moldovan O, Luthardt RG, Corcodel N, et al.: Three-dimensional fit of CAD/CAM-made zirconia copings. Dent Mater. 2011;27:1273-8

25. Luthardt RG, Bornemann G, Lemelson S, et al.: An innovative method for evaluation of the 3-D internal fit of CAD/CAM crowns fabricated after direct optical versus indirect laser scan digitizing. Int J Prosthodont 2004;17:680-5.

26. Oehman C, Baleani M, Viceconti M: Repeatability of experimental procedures to determine mechanical behaviour of ligaments. Acta Bioeng Biomech 2009;11:19-23

How to cite this article: Cho SH · Guentsch A . Trueness and precision of die spacer thickness of zirconia single crown made by CAD-CAM milling technology *J Clin Digit Dent.* 2021;3(2):6-12. www.jcdd.org

The New Paradigm of 3D Printer

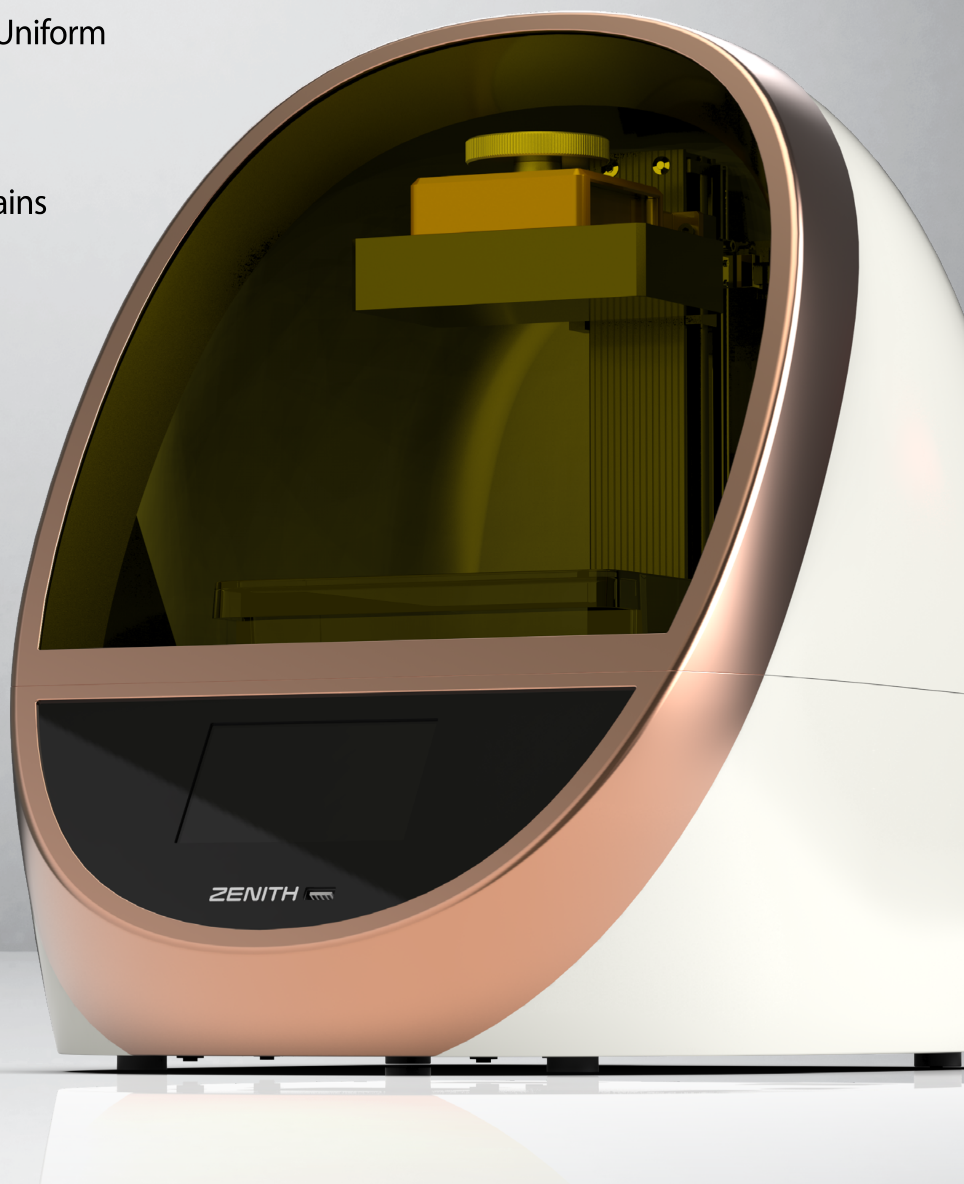
ZENITH

- DLP LED Light System That Enables Uniform Printing
- High-resolution Printing System
- A Self-heated Resin Tank That Maintains A Constant Internal Temperature
- Innovative and Stylish Design
- Ideal Application to Various Areas

GOOD DESIGN 산업통상자원부선정

reddot award

WORLD CLASS PRODUCT OF KOREA 1 세계일류상품

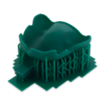


Surgical Guide

Dental Model

Temporary

Cast coping & Partial Frame



Bite Tray

COMING SOON

Splint

IDB Tray

Implant the Smile DENTIS

Head Office (Korea)

Tel +82 53 589 3528 E·mail colin@dentis.co.kr Web·site www.zenith3d.co.kr/eng

Application and clinical considerations of digital technology for removable complete denture fabrication

Jungjin Lee, DDS, MSD, PhD

Introduction

Functional rehabilitation of edentulous patients using complete dentures requires many clinical procedures, and satisfactory outcomes can be achieved only when each process is accurataely performed based on cooperative communication between the dentist and the dental technician.[1] We are now furnished with "digital" equipment and data. Since the introduction of computer-aided designing/computer-aided manufacturing (CAD-CAM) technology in dentistry, digital technology has had a significant impact on dental treatments, which has led to considerable changes in the outlook of clinicians and in the treatment process. Digitization is being applied in impression taking using an intraoral scanner, fabrication of prosthesis and surgical guides for implant placement using CAD-CAM, and removable prosthodontic treatment. Digital technology can simplify the treatment process remarkably (Fig. 1). Since Maeda et al.[2] introduced a method of complete denture fabrication using digital technology in the 1990s, digital technology has played an important role in improving the clinical results and convenience in removable prosthodontics and reducing the possibility of errors by simplifying the clinical and laboratory processes. Therefore, in this article, we introduce the application of digital technology, discuss the clinical considerations, and compare the digital and conventional techniques in complete denture fabrication.

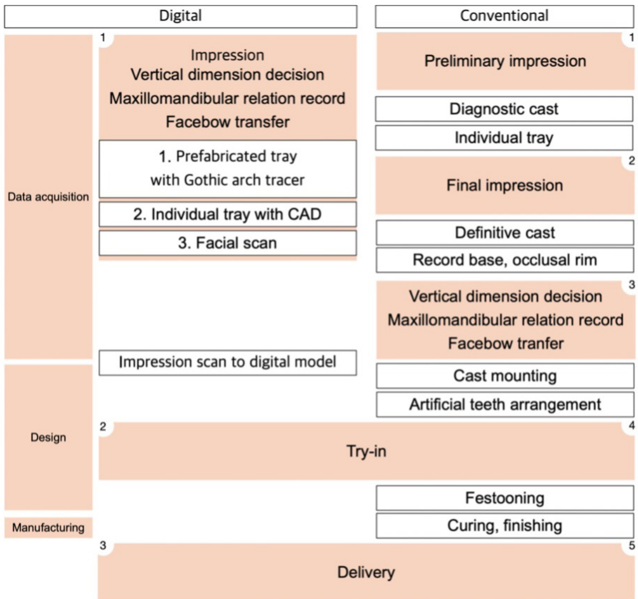


Fig 1. Digital and conventional workflow for fabrication of removable complete denture.

Jungjin Lee

Department of Prosthodontics and Institute of Oral Bioscience, School of Dentistry, Jeonbuk National University
567 Baekje-daero, Deokjin-gu, Jeonju-si, Jeollabuk-do, 54896
Republic of Korea
Email: wjdwls04@gmail.com

Case Report

1. Data acquisition

1) Impression taking

An ideal impression for complete denture fabrication should be incorporate the residual alveolar ridge and the border areas during function. Therefore, the impressions should reflect the functional movements of the perioral muscles, which is possible by understanding the anatomical structure, method of impression taking, and properties of used materials. The most frequently used concept in impression taking for complete dentures is the selective pressure technique, which delivers functional pressure to areas suitable for pressure bearing and reduces the application of excessive load to the relief area.

For digital complete denture fabrication, a digital model can be obtained by taking an impression of the residual alveolar ridge using an intraoral scanner. The use of an intraoral scanner leads to greater patient satisfaction by reducing the required time and inconvenience in impression taking than that of conventional methods.[3,4] Most intraoral scanners operate in non-contact mode and use various optical principles to join continuously captured images, thereby generating 3D data. It is easy to scan the static and irregular teeth. However, inaccurate sticking of alveolar ridge or palate images as they are smooth and devoid of features can be occurred.

In addition, as the border tissues change their configuration and position depending on the extent and direction of muscle movement or retraction, there are some practical limitations in performing edentulous digital scans (Fig. 2). Various approaches [5-7] for easily and accurately scanning the alveolar ridge and palate have been introduced, but scanning of border areas is practically challenging. The use of an intraoral scanner enables non-pressure impression taking. This is especially useful for impression taking of flabby tissues where no pressure should be applied.[8] However, impression taking using the selective pressure technique is impossible. Therefore, recording the border areas in muscular function with appropriate functional pressure is difficult using digital technology.

As obtaining an ideal complete denture impression using the current intraoral scanner technology is difficult, alternate strategies are being searched; one is scanning the impression taken by the conventional method . This can be done using various methods. In the first method, the impression is recorded using a prefabricated tray designed for the fabrication of digital dentures, and a digital model is obtained by scanning the impression. A gothic arch tracer or bite block is attached to the prefabricated tray to record the vertical dimension and maxillomandibular relation and the impression simultaneously. In the other method, a preliminary impression is taken using irreversible hydrocolloid material, and a digital model is fabricated by scanning the impression using an intraoral or a model scanner (Fig. 3).

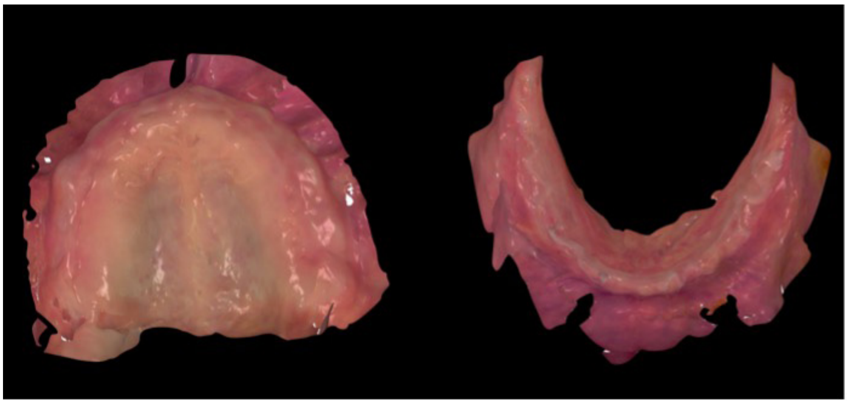


Fig 2. Edentulous scan with intraoral scanner (Trios 3; 3shape A/S)

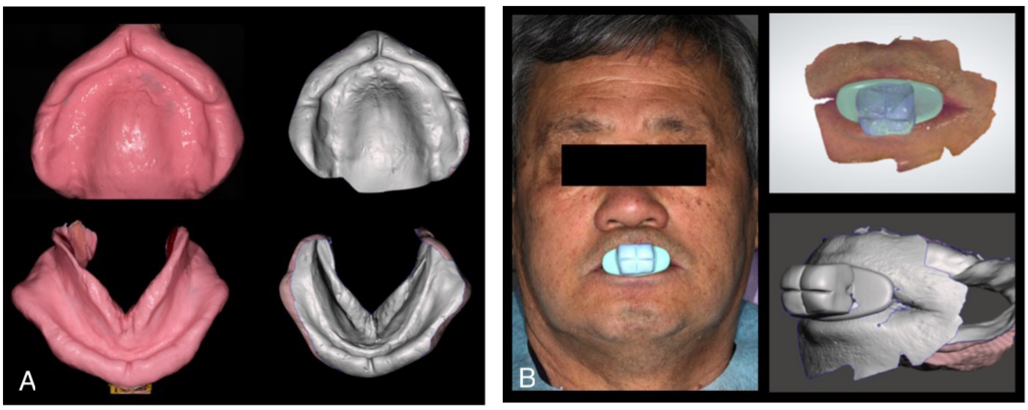


Fig 3(a-b). (a) Preliminary impression was scanned using intraoral scanner.
(b) Tentative maxillomandibular relation was recorded with centric tray (Ivoclar vivadent).

Individual trays are designed using a CAD program, and the digital model is fabricated using subtractive or additive manufacturing. If necessary, it is designed such that a gothic arch tracer can be attached to the tray. After border molding, a final impression can be made and scanned to obtain the final digital model (Fig. 4). In the third method, the existing denture, if present, is used to obtain a final impression, which is scanned to obtain the digital model. This method can be used only in the absence of any problem with the fit or occlusion of the existing denture.

2) Registration of vertical dimension and jaw relation and facebow transfer

In the conventional method, the record base and occlusal rim are fabricated on the final model using resin and wax. The occlusal rim is placed for try-in in the patient's mouth, the vertical dimension is determined, and the maxillomandibular jaw relation is recorded. Thereafter, facebow transfer is performed to mount the models on an articulator.

In the digital method, the maxillomandibular relation is recorded by scanning the maxilla and mandible, scanning the maxillomandibular jaw relation from the buccal surface, and aligning with reference to the scans.[9] Scanning the maxillomandibular jaw relation and alignment is easy for dentulous scans, but edentulous scans pose some limitations.

While scanning the maxillomandibular relation, maintaining the three-dimensional (3D) position of the mandible with respect to the maxilla without an occlusal rim is difficult. If the mandible is unstable during scanning, the accuracy of the scan will be compromised. Second, since the edentulous alveolar ridges are smooth and devoid of irregular features, aligning the ridges with the maxillomandibular relation record scanned from the buccal surface is difficult. Therefore, most methods of digital denture fabrication are a simultaneous registration of impression using prefabricated materials and of maxillomandibular relation.

Facebow transfer is the process of transferring the position of the maxilla with respect to a reference plane to the articulator. Virtual articulators can be used in digital processes. Some manufacturers provide a facebow to transfer the position of the maxilla with respect to a reference plane to the virtual articulator. In addition, a 3D scanner is used to scan the face, and the conventional intraoral impression and digital impression are aligned to be used as a reference for occlusal plane determination and artificial teeth arrangement. Additionally, a Digital Imaging and Communications in Medicine (DICOM) file obtained using cone-beam computed tomography with a wide field of view can be converted into a 3D data file for use. This can evaluate not only the soft tissue but also the position of the condyle, but has the disadvantage of unnecessary radiation exposure, which hinders its active utilization.

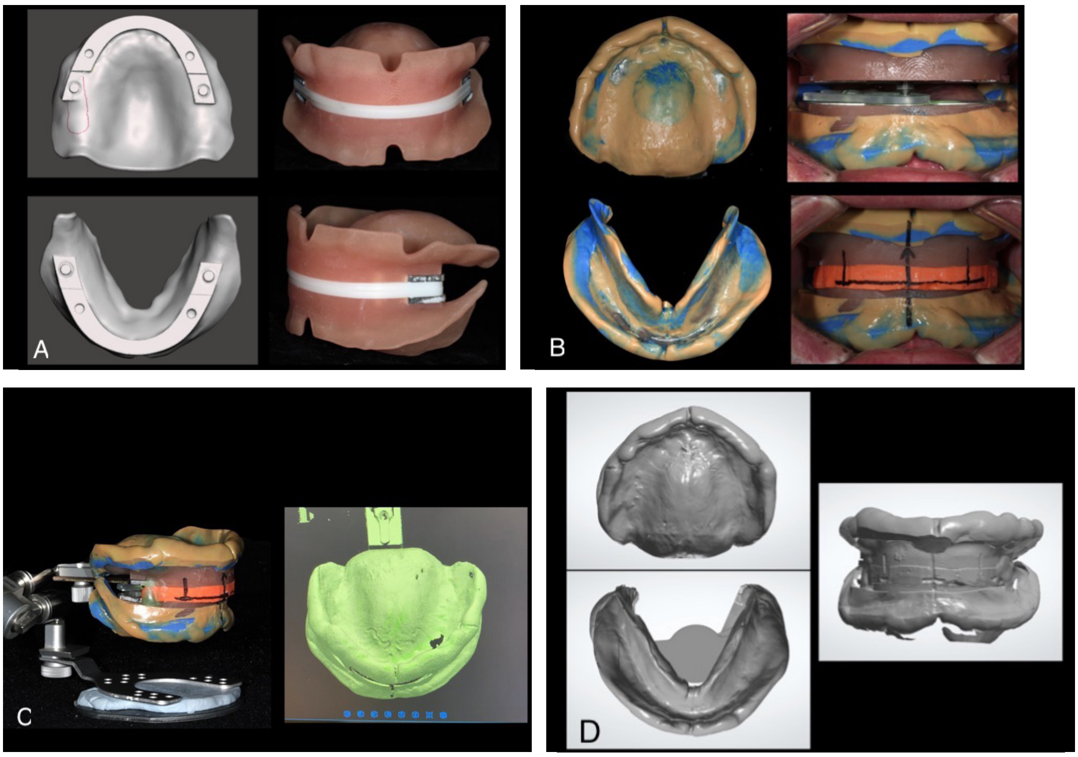


Fig 4(a-d). (a) Individual tray with gnathometer CAD (Ivoclar vivadent) was fabricated with additive manufacturing.
(b) Final impression and maxillomanibular relation record were taken in the same visit.
(c) Impression was scanned using laboratory scanner.
(d) Definitive digital model.

2. Design – teeth arrangement and festooning

The artificial teeth are selected by referring to the patient's facebow record and arranged by estimating the position of the previous teeth by referring the anatomical landmarks on the model. The same principles and processes apply in digital complete denture fabrication. However, the difference is that the teeth arrangement is performed on a digital model by clicking on a mouse and selecting teeth from the artificial teeth library rather than with wax and a sculpting knife. The occlusal plane is determined, and appropriate artificial teeth are selected in the CAD program. the artificial teeth are roughly arranged according to the anatomical landmarks. The positions and inclination of the teeth are adjusted according to the maxillomandibular and alveolar ridge relations, patient characteristics, and soft tissue support. Then, the denture border is determined, and the denture base is contoured using various digital sculpting tools. In the traditional method, when the position of one tooth is changed, the positions of all other teeth and the gingival contour must also be changed.

However, in the CAD program, the positions of artificial teeth can be changed with a simple mouse click, and hence, correcting the positions of other teeth, when the position and inclination of individual teeth are changed, is easy.

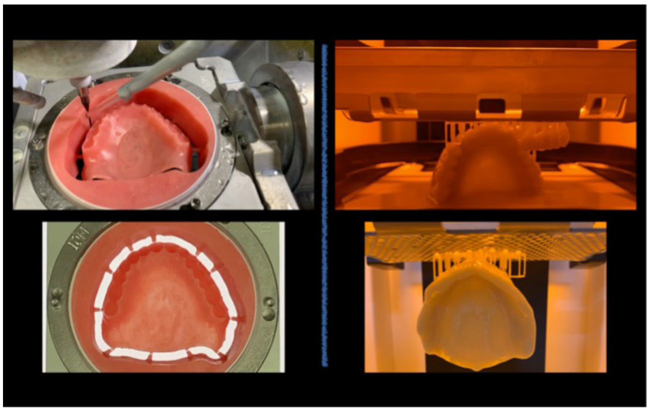


Fig 5. Subtractive (left) and additive (right) manufacturing for denture base.

In addition, the method is time-conservative because some gingival contouring is automatically performed. In addition, by superimposing the facial scan data or 2D images, artificial teeth can be selected and arranged according to the patient's facebow record. Furthermore, the digital model can be viewed from all directions, and the positional relationship between the teeth and alveolar ridges can be evaluated in cross-section and confirmed through objective measurements. In this way, digital technology facilitates smooth communication between dentists and dental technicians.

3. Manufacturing

Digital dentures are fabricated using subtractive or additive manufacturing (Fig. 5). Digital complete dentures can be fabricated using various materials and manufacturing methods (Fig. 6). The denture designed using the CAD program is exported as a stereolithography(STL) file, and the CAM program for subtractive manufacturing or the slicing program for additive manufacturing is used to perform the calculations required for manufacturing. The denture base and artificial teeth can be manufactured either separately and joined (duolithic) or as a single body (monolithic). In duolithic dentures, artificial teeth arrangement is performed such that there is no undercut at the tooth-bonding site. The bond strength between the artificial teeth and denture base should be increased by bonding and surface treatment to prevent debonding of the teeth from the denture base. In addition, while bonding artificial teeth, the tooth positions may change, which may lead to occlusal problems in the final denture. A jig should be used for bonding in such cases. The problems associated with artificial tooth bonding are minimal in monolithic dentures, but the artificial teeth and denture base must be of the same material and color. For dentures with esthetic teeth and gingival region, multi-layer polymethyl methacrylate (PMMA) discs can be used for manufacturing, or staining and resin veneering can be considered (Fig. 7). Several manufacturers are introducing various strategies to address these mechanical and esthetic limitations. Therefore, these problems are expected to be resolved in the near future.

Fig 6(a-b). Various digital denture could be fabricated using subtractive and additive manufacturing.

Fig 7. Monolithic digital denture with stain and resin veneering.

The materials used in various methods of denture fabrication have their respective merits and demerits. In subtractive manufacturing, a denture is fabricated by milling PMMA discs. PMMA discs are cured to a high level and compressed; therefore, they have few bubbles or internal defects and excellent mechanical strength and are biologically stable because of the low residual monomer content.[10] Additionally, as the denture is manufactured after the resin is cured, there is no shrinkage due to curing, leading to excellent accuracy.[11,12] However, a considerable amount of material is wasted using this method depending on the size of the disc or equipment, and if the denture is too large or has severe undercuts, manufacturing could be difficult.

In additive manufacturing, a 3D structure is formed through layer-by-layer deposition of a liquid photopolymer resin. Depending on the light source and module, various types of 3D printers such as SLA, DLP, and LCD are available. Compared with subtractive manufacturing, it can reproduce shapes that are more complex and less material is consumed during the process. However, because curing is performed using a light source, the final product may undergo shrinkage, and post-processing procedures such as washing and post-curing are required. In addition, few long-term clinical outcomes have been documented for the material and biological aspects.

Discussion

For conventional complete denture fabrication, 5-6 patient visits and multiple festooning processes are required. In contrast, 2-3 visits are required and the time required for completion is reduced in digital denture fabrication. The reduction in the number of visits and laboratory processes increases the satisfaction of dentists, dental technicians, and patients alike. With the application of digital technology, the denture fabrication process is simplified, multifaceted diagnosis and design are possible through the integration of various digital data, and easier and faster treatment is possible. Dentists and dental technicians are aware of the possible errors and problems with conventional methods of complete denture fabrication. Various attempts have been made to reduce these errors, and the adoption of digital technology has enabled remarkable achievements. However, digital technology should not be regarded as a panacea because simplification of the process does not necessarily lead to superior clinical outcomes. Digital technologies should be seen as tools for predictable and better outcomes, rather than considering the technology itself as an achievement.

References

1. Cunha TR, Vecchia Della MP, Regis RR, et al. A randomised trial on simplified and conventional methods for complete denture fabrication: Masticatory performance and ability. J Dent. 2013;41:133–142.
2. Maeda Y, Minoura M, Tsutsumi S, et al. A CAD/CAM system for removable denture. Part I: Fabrication of complete dentures. Int J Prosthodont. 1994;7:17–21.
3. Yuzbasioglu E, Kurt H, Turunc R, et al. Comparison of digital and conventional impression techniques: evaluation of patients' perception, treatment comfort, effectiveness and clinical outcomes. BMC Oral Health. 2014;14:10.
4. Yoon HI, Lee SM, Park EJ. Comparison of patient satisfaction with digital and conventional impression for prosthodontic treatment. J Korean Acad Prosthodont. 2016;54:379–386.
5. Lee JH. Improved digital impressions of edentulous areas. J Prosthet Dent. 2017;117:448–449.
6. Fang JH, An X, Jeong SM, et al. Digital intraoral scanning technique for edentulous jaws. J Prosthet Dent. 2018;119:733–735.
7. Fang JH, An X, Jeong SM, et al. Development of complete dentures based on digital intraoral impressions—Case report. J Prosthodont Res. 2018;62:116–120.
8. Hong SJ, Lee H, Paek J, et al. Combining conventional impressions and intraoral scans: A technique for the treatment of complete denture patients with flabby tissue. J Prosthodont. 2019;28:592–595.
9. Russo Lo L, Ciavarella D, Salamini A, et al. Alignment of intraoral scans and registration of maxillo-mandibular relationships for the edentulous maxillary arch. J Prosthet Dent. 2019;121:737–740.
10. Baba NZ, AlRumaih HS, Goodacre BJ, et al. Current techniques in CAD/CAM denture fabrication. Gen Dent. 2016;64:23–28.
11. AlHelal A, AlRumaih HS, Kattadiyil MT, et al. Comparison of retention between maxillary milled and conventional denture bases: A clinical study. J Prosthet Dent. 2017;117:233–238.
12. Steinmassl O, Dumfahrt H, Grunert I, et al. CAD/CAM produces dentures with improved fit. Clin Oral Investig. 2018;22:2829–2835.

How to cite this article: Lee JJ. Application and consideration of digital technology for removable complete denture: A case report. *J Clin Digit Dent.* 2021;3(2):14-18.www.jcdd.org

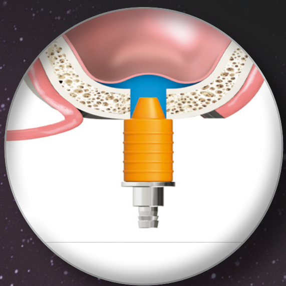
DENTIS
IMPLANT
SINCE 2005

SAVE SINUS KIT

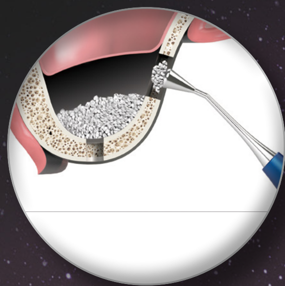
어느 방향에서도 접근이 가능한 통합 SINUS KIT

#CRESTAL & LATERAL

▸ Crestal Approach + Aqua System



▸ Lateral Approach



#상악동 거상술을

#안전하고 #빠르게

Sinus Floor Elevation using by Dentis SAVE SINUS Kit : Lateral Window Technique

Yongkwan Choi, DDS, MSD, PhD

Introduction

Caldwell-Luc Operation (CLOP) is a traditional method for gaining access to inside of maxillary sinus by drilling both lateral wall of maxillary sinus and sinus membrane (Figure 1). Tantum et al.(1977) and Boyne et al.(1980) proposed an alternative approach for access similar to the traditional CLOP but without involving drilling or damaging of the maxillary sinus membrane and elevating the membrane intact. After the membrane elevation, bone grafting is performed between the maxillary sinus membrane and sinus inferior border. Since the publication of these methods, the similar methods of lateral approach has been widely employed to date.

In terms of incision, as shown in Figure 2, the inferior crestal incision where the incision line is located slightly more toward the palatal side than the crestal incision with incision line located in the medial side of the alveolar crest (yellow line) should be selected, since this involves less amount of elevation of thick palatal side flap, enabling easier operation. For vertical incision, the extended incision with the incision line located at one or two anterior teeth should be selected.

As shown in Figure 2, after sufficient elevation of the flap of the surgical site, it is critical to mark the surgical site using sanitized pencils. In performing osteotomy for the lateral window, a low speed straight bur is used in order to avoid sinus membrane perforation.

A carbide bur is used in the initial stage of osteotomy, and when enough of the lateral wall is removed, a diamond bur is used to reduce perforation of the membrane (Figure 3).

At this point, the palatal side of the lower lip may become injured from the bur's connecting part. Therefore, to prevent damage to the lower lip, the ring finger of the right hand is used for sufficient retraction of the upper lip while performing osteotomy (Figure 4). In some cases of lateral wall osteotomy, an ultrasonic device is used to prevent damage of the maxillary sinus membrane (Figure 5). This method is not favored by the author since the cutting rate of osteotomy is considerably slower with this method than the osteotomy with rotary instrument. However, it is considered as a viable option for those performing the lateral wall osteotomy for the first time. The author mostly uses the LAD (Lateral Approach Drill) from the Dentis SAVE SINUS kit, and when the size of the lateral window to be created is relatively small, the carbide bur and diamond bur are used selectively to perform the lateral elevation method.

It is a general rule to create the lateral window where the implant will be placed, and as shown in Figure 6, locating the window border 2-3 mm away from the maxillary sinus inferior border and anterior border is advantageous for elevating the membrane later in the procedure.

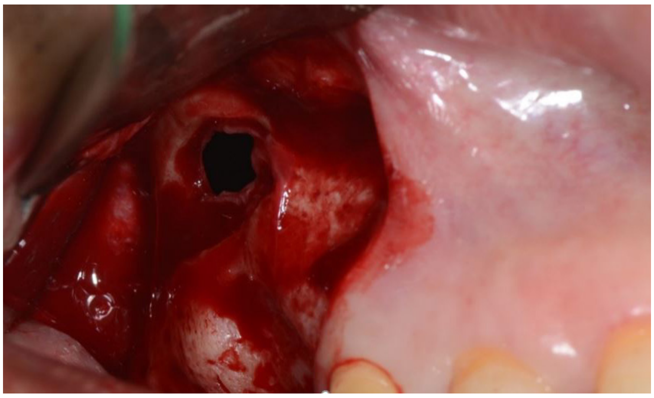


Fig 1. CLOP approach

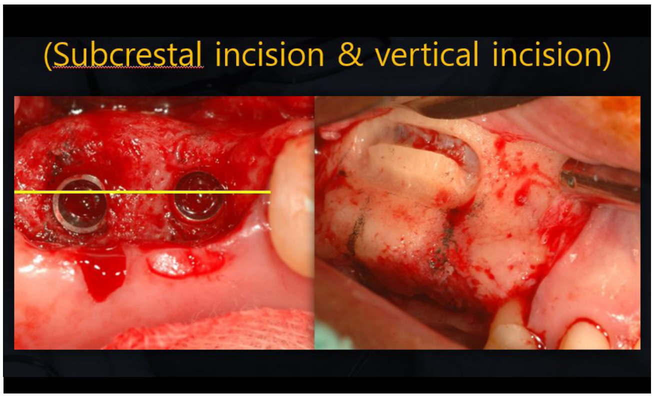


Fig 2. Incision line

Yongkwan Choi

Dr.Yongkwan Choi graduated from Dankook University School of Dentistry. He received MSD and PhD in his almamater. He completed a residency training at the Department of Oral and Maxillofacial surgery in Dankook University Dental Hospital. His clinical focus is a sinus surgery, implant surgery, and a digital dentistry nowadays. His goal is to become a good mind excellent surgeon. He practices at LA Dental Clinic, Seoul, Republic of Korea.

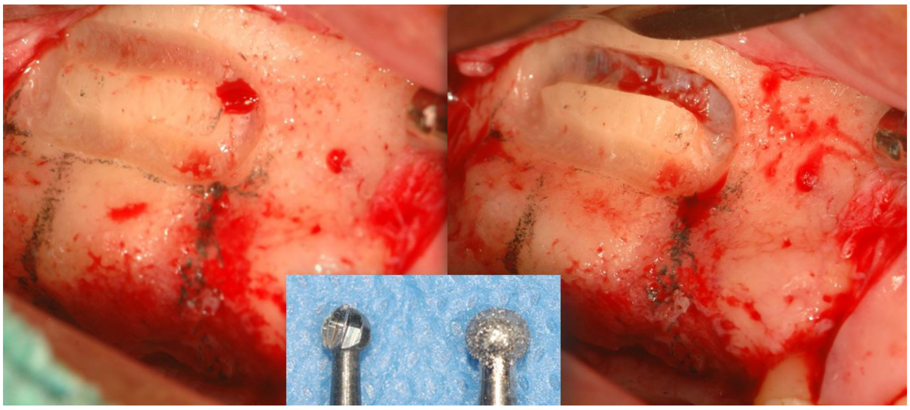


Fig 3. Osteotomy line

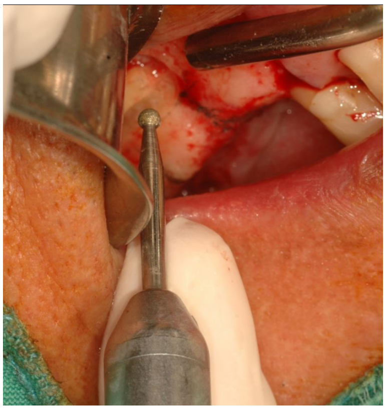


Fig 4. Lip retraction by finger

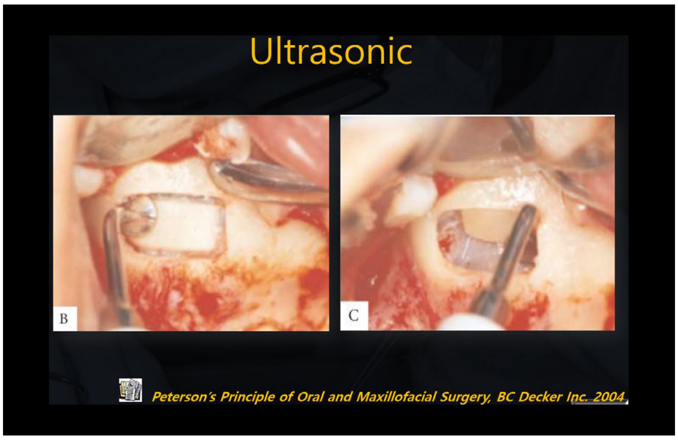


Fig 5. Osteotomy by Ultrasonic device

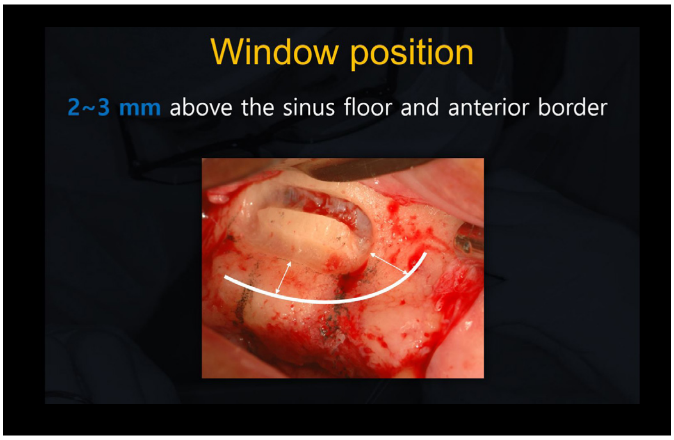


Fig 6. Osteotomy borderline

When the osteotomy is completed, the bone fragments that have been formed during surgery must be removed carefully. At this stage, a curette dedicated for use in elevating the maxillary sinus must be placed between the bone fragments formed in the lateral window and membrane, the two should be fully detached, and the bone fragments are removed.

If the bone fragment is removed without ensuring the full detachment between the membrane and bone fragment, maxillary sinus membrane is subject to higher risk of perforation (Figure 7).

The removed bone fragments can be used for various purposes, but the author prefers their reposition to window area formed after bone grafting (Figure 8).

Fig 7. Detaching of lateral window bone fragment

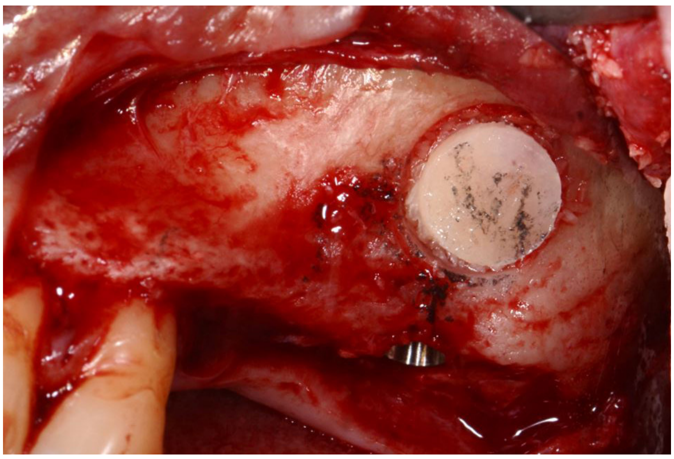


Fig 8. Repositioning of lateral window bone fragment

Once the bone fragments are safely removed from inside of the window and the maxillary sinus membrane is exposed, the membrane in the bone grafting site must be elevated carefully. The specialized curette for elevating the maxillary sinus membrane has a blunt blade end for minimizing damage to the membrane, and there are a variety of curettes available depending on the angle and direction at which the blade is bent. Furthermore, for membrane elevation, an appropriate curette must be used depending on the window's posterior, anterior, superior and inferior borders (Figure 9). At this point, to prevent perforation of the membrane, it is extremely important that the curette is consistently in contact with the inner maxillary sinus bone while using the curette's protruding part in a slightly pushing motion to perform the procedure (Figure 10).

In contrast to the distal side, the mesial side of the membrane is completely hidden from sight, making it most susceptible to perforation. Therefore, it calls for extra need for caution.

The membrane should be elevated sufficiently to ensure full cover of the implant placed in the mesial and distal, buccal and palatal sides. In particular, the depth gauge must be applied to the inside of the preparation site of the implant placement to firmly check that the membrane is elevated enough for the operator's desired implant length to avoid perforation during the placement (Figure 11). Ziccardi et al. reported that implant elevation of more than 2 cm should be avoided as this may induce closure of the ostium.

Once the maxillary sinus membrane is elevated to a sufficient extent, a drill for implant placement must be used at the preparation site, and the SQ Digital Guide can be a great help in placing the implant at an adequate location (Figures 12a-d).

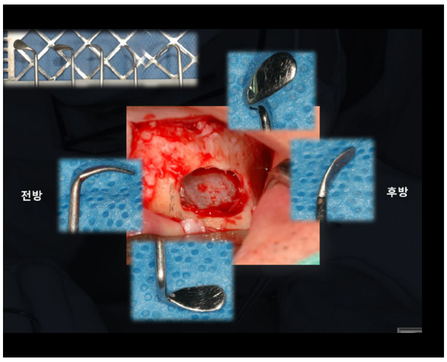


Fig 9. Proper shape of sinus elevation curette

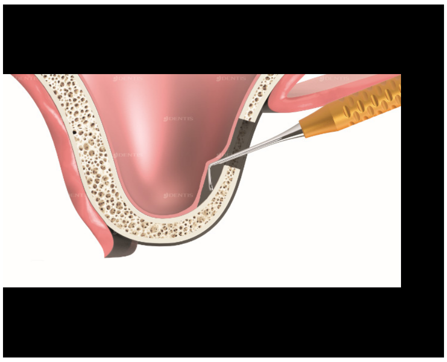


Fig 10. Curette should contact to sinus floor

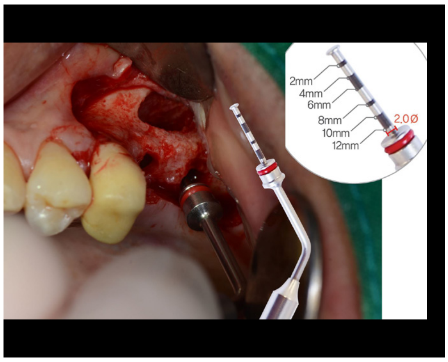


Fig 11. Using a depth gauze to measure amount of membrane elevation.

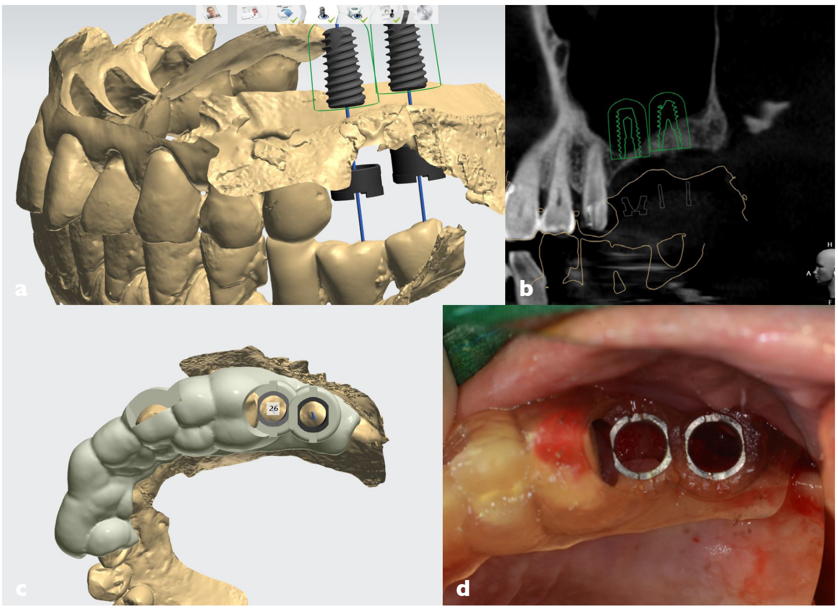


Fig 12(a-d). Digital guided implants placement using Dentis SQ Guide system

After bone grafting is performed on the mesial and palatal sides to a desired level, the implant is placed (Figure 13). Similarly, using the SQ Digital Guide stent prepared in advance can assist in placing the implant at an ideal location (Figure 14). Then, further bone grafting is carried out at the rest of the locations, such as the distal and buccal sides (Figure 15).

If the implant is placed before performing bone grafting on the mesial and palatal sides, these sides will be hidden from the sight covered by the implant, making it extremely difficult to carry out bone grafting. Therefore, the mesial sinus cavity must undergo bone grafting prior to implant placement.

Next, as described above, bone fragments removed from the lateral window are repositioned on the bone graft material to perform suturing (Figure 16).

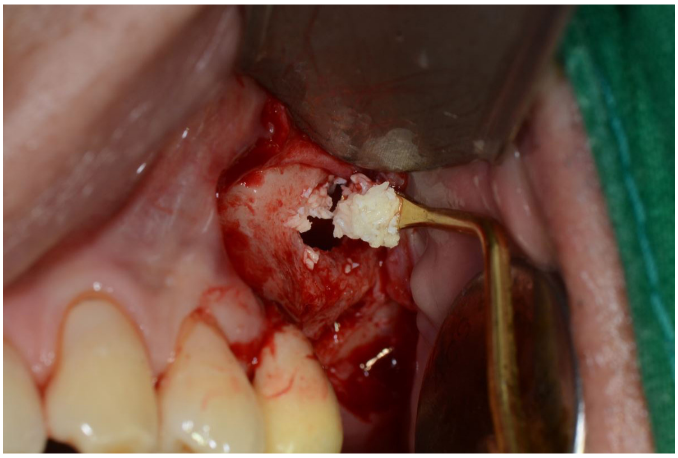


Fig 13. Bone graft within mesial sinus cavity

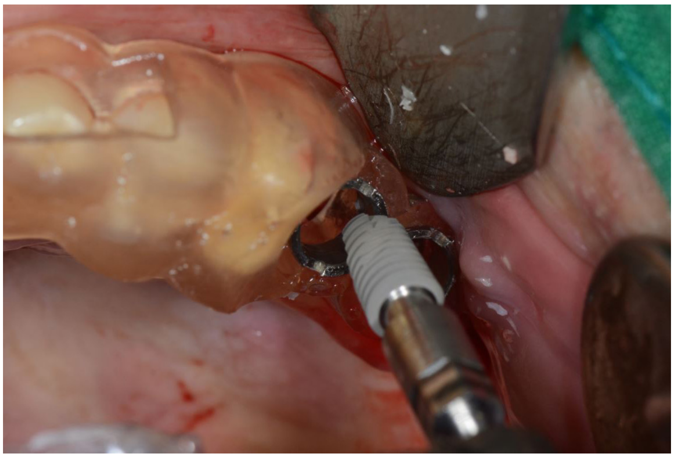


Fig 14. Dentis SQ implant placement using surgical guide stent

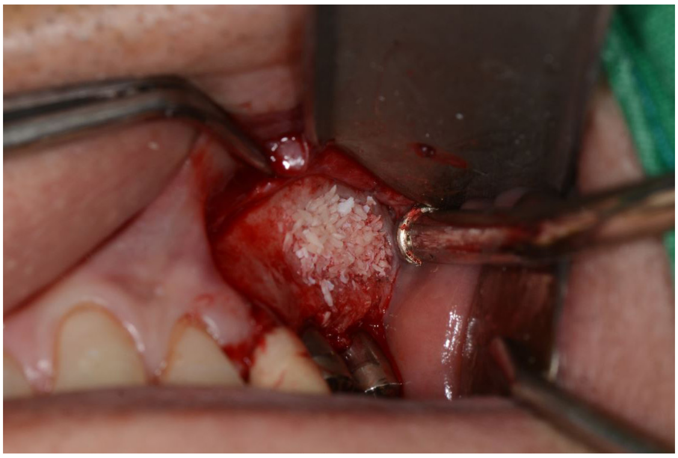


Fig 15. Residual bone graft after implant placement

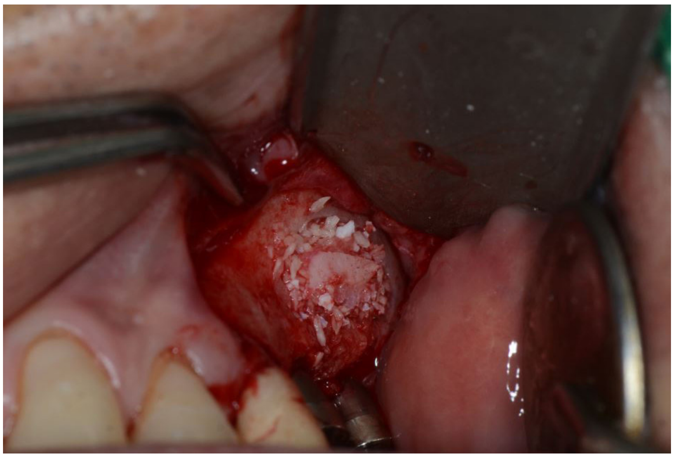


Fig 16. Repositioning of lateral window bone fragment

The criteria that determine the choice between a lateral approach and a crestal approach are described as follows.

Criteria 1: The vertical height of the residual alveolar bone

The most important criteria to take into account on priority is the height of the residual alveolar bone where the implant will be placed.

As mentioned in the previous issue, the method of approach through the alveolar crest was widely employed since the introduction of BAOSFE (Bone-Added Osteotome Sinus Floor Elevation) by Summers in 1994.

Therefore, based on the reference height of 5 mm proposed by Summers, the lateral approach is used if the alveolar bone's height is lower, whereas the crestal approach is adopted if higher. The author follows this criterion as a general guideline, but the final decision on the method of approach is determined upon comprehensive consideration of other factors.

Criteria 2: PSA (Posterior Superior Alveolar a.)

As explained in the first session, if the residual alveolar bone is higher than 5 mm, forming a window for a lateral approach will increase the likelihood of running into PSA, an artery. Thus in this case, opting for the crestal approach is more advantageous. The Figures 17a and 17b represent a case where the height of the residual alveolar bone of the teeth furcation is 6.5 mm. When performing a sinus floor elevation using the lateral approach, there is a high chance of running into the PSA while undergoing osteotomy to form the lateral wall window. Hence, this case shows that after the tooth extraction, the sinus floor elevation was carried out with the crestal approach while simultaneously performing the implant placement.

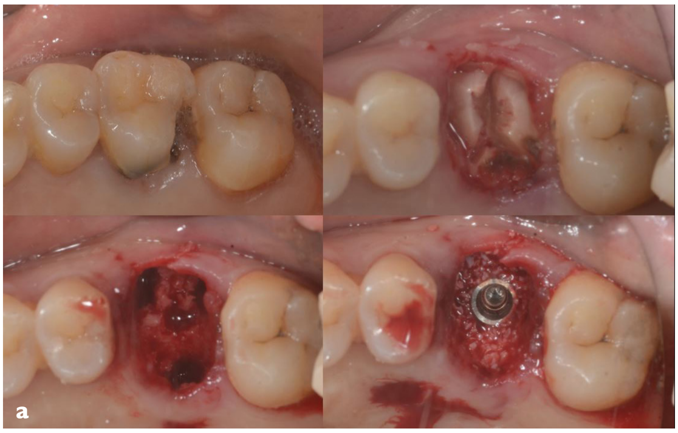
Criteria 3: Systemic condition of the patient

For patients where an invasive treatment may be quite burdensome, such as those with uncontrollable diabetes or osteoporosis patients that with a long-term medication history of bisphosphonates, crestal approach, the less invasive method, can be considered instead of the lateral approach. Figure 18 shows the sinus floor elevation of 8mm or higher with the crestal approach, where the patient was administered with oral bisphosphonates due to osteoporosis. For simultaneous implant placement for both #16 and 17, the crestal approach was selected for a less invasive surgical process.

Criteria 4: Conditions inside the maxillary sinus and pathological factors

The pathology of the inner maxillary sinus was reviewed during the first session, and this is indeed another key factor in determining the adoption of a lateral approach or a crestal approach. If the CBCT scan findings show that the sinus membrane has been thickened, in most cases, this implies that the maxillary sinus has been affected by or is currently with acute chronic inflammation. In such cases, the sinus membrane elasticity is often weakened, requiring high caution when performing the sinus floor elevation. Placing via the crestal approach especially calls for high caution, as often the surgery is performed by relying on the operator's tactile senses instead of directly viewing of the membrane.
There are numerous cases where a septum is present at the placement site. As shown in Figure 19, if there is a septum, it is possible to use the septum's lower alveolar bone to carefully place the implant through the crestal approach.

As can be seen, when deciding between a lateral approach or a crestal approach, it is not as simple as using the residual alveolar bone height as the sole criteria, but it requires a judgment based on a variety of factors. Furthermore, the recent success rate of 7-8 mm implants (under 10 mm) have been reported with positive outcomes. Hence, depending on the situation, when an implant with a thick diameter is used, selecting a shorter implant may reduce the amount of membrane elevation, leading to more comfortable procedure for both the patient and the surgeon (Figure 20).



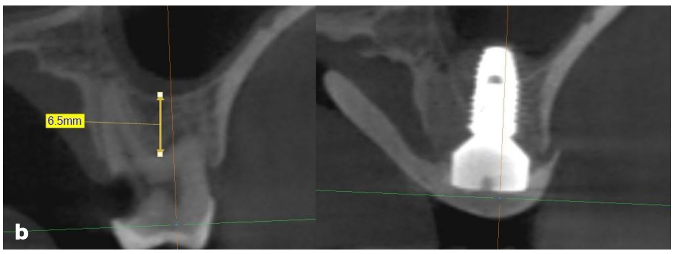


Fig 17(a-b). Immediate implant placement at the same time sinus floor elevation by crestal approach

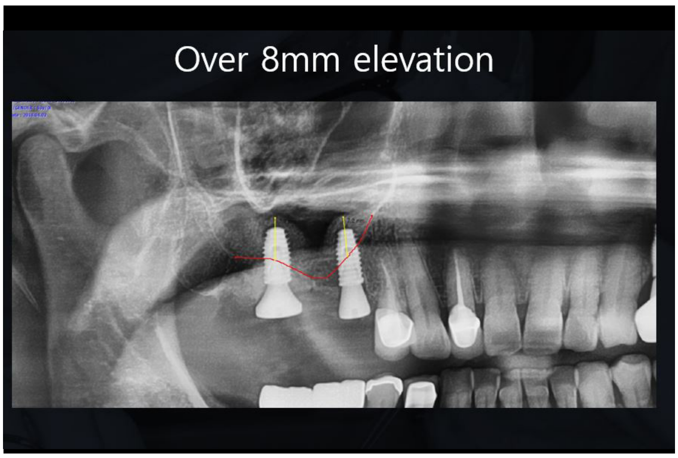


Fig 18. 8mm sinus floor elevation by crestal approach

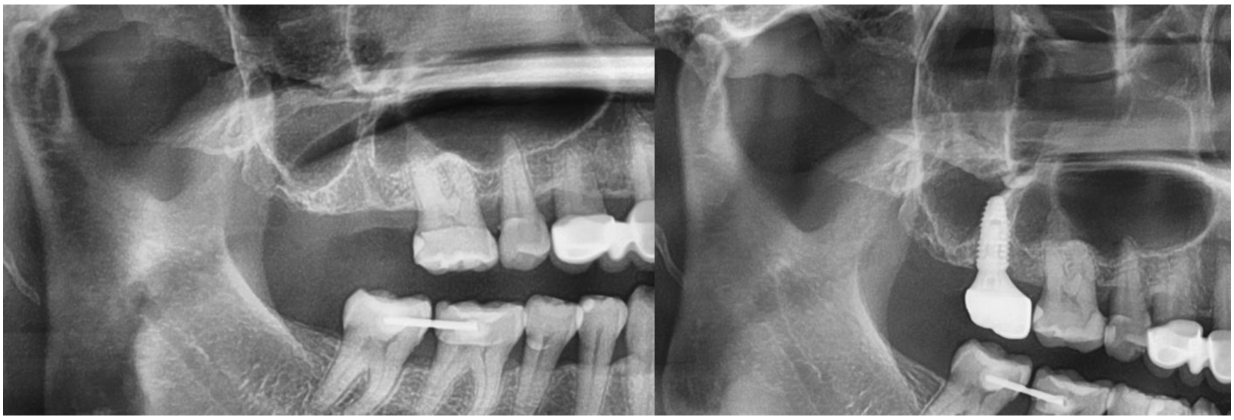


Fig 19. Immediate implant placement at the same time sinus floor elevation by crestal approach

Fig 20. .8mm sinus floor elevation by crestal approach

Case Report

[Case 1]

- The patient is a 61-year-old woman with a medical history of severe high blood pressure and diabetes, and no history of smoking. She visited the hospital with her teeth shaking and severe pain as the chief complaint (Figures 21 a-b).
- By using Dentis SQ Digital Guide and SQ implant, the implant placement was completed immediately after extraction of the teeth on the mandible, and a temporary prosthesis fabricated in advance using CAD/CAM was seated prior to the operation (Figures 22 a-c).
- At locations #24 and #26, the LAD (Lateral Approach Drill) from the Dentis SAVE SINUS Kit was used to form the lateral window (Figures 23 a-b).
- As the size of the lateral window was judged to be inadequate, an extra tool called wall expander was used to expand the window's mesial side (Figure 24).
- The membrane was carefully elevated with the use of a curette dedicated for sinus floor elevation, and after checking the elevation amount, additional drilling was carried out for SQ implant placement (Figures 25, 26, 27).
- The SQ implant was placed within the mesial and palatal sides first after bone grafting (Figures 28,29).
- After completing the bone grafting procedure at the remaining sites, the bone fragments created from the window formation was repositioned (Figures 30, 31).
- Suturing was carried out after performing additional GBR at the bone defect sites of the alveolar crest region (Figures 32, 33).
- From the panoramic view and CBCT scan after surgery, the maxillary sinus membrane with stable elevation and the bone graft material can be seen (Figures 34 a-b).

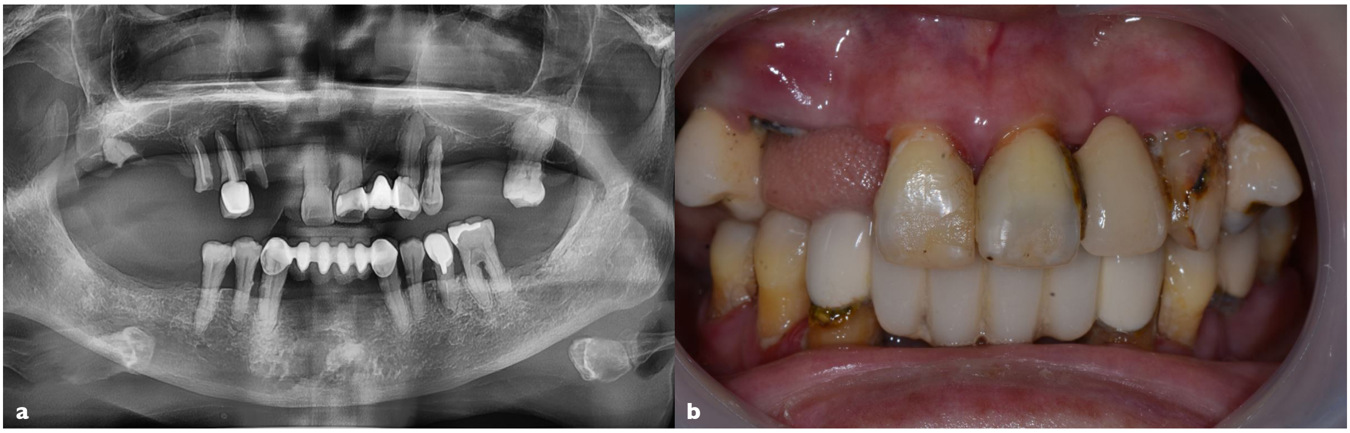


Fig 21(a-b). Initial panorama and intral oral photo

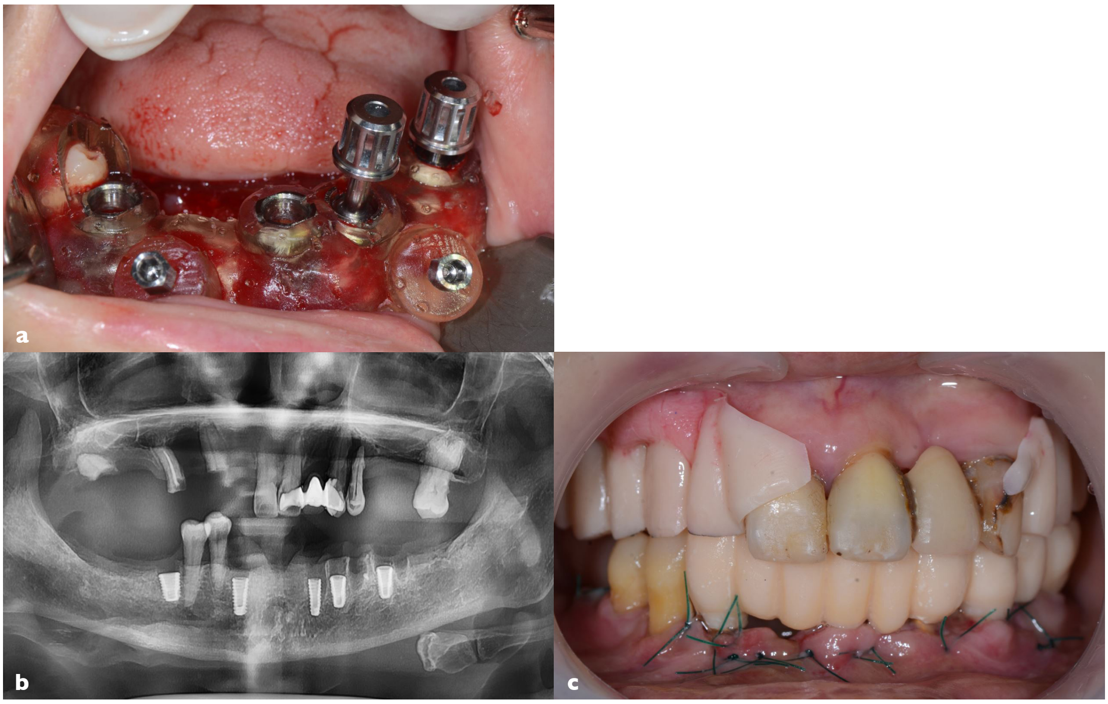


Fig 22(a-c). Dentis SQ implants was placed and prefabricated temporary prosthesis was seated after surgery

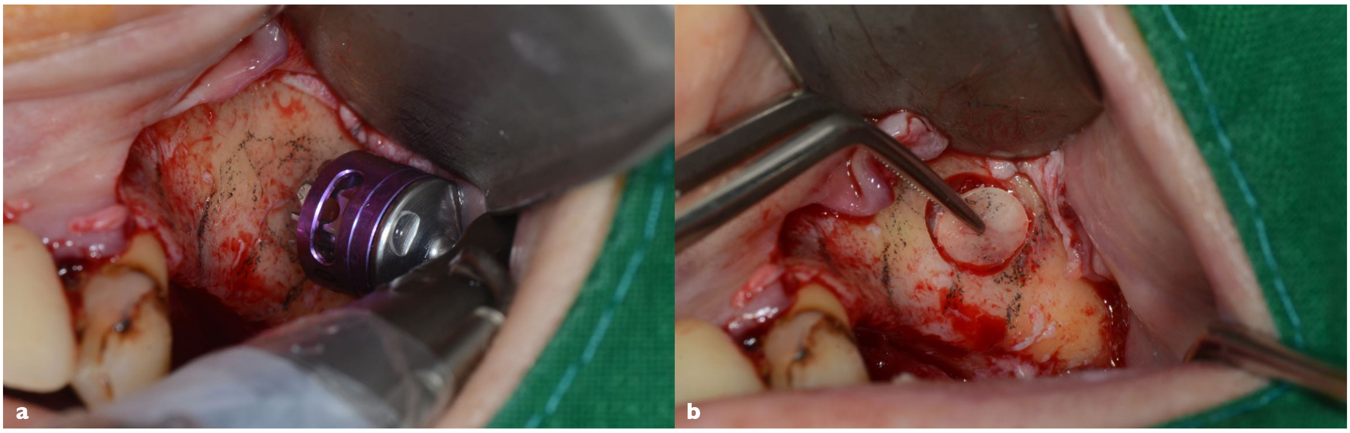


Fig 23(a-b). Lateral window bone fragment was made by LAD (Lateral Approach Drill)

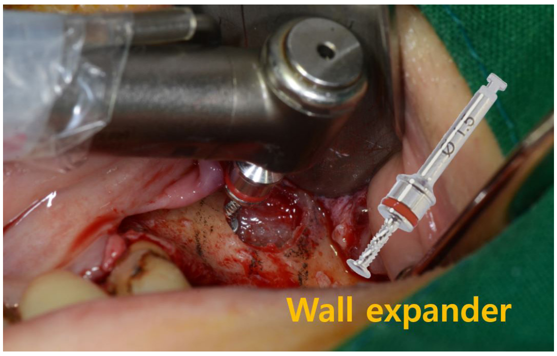


Fig 24. Lateral window was expended by wall expender

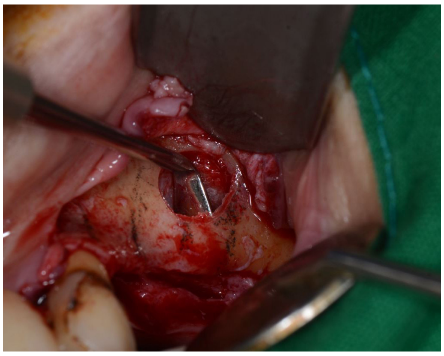


Fig 25. Sinus membrane elevation

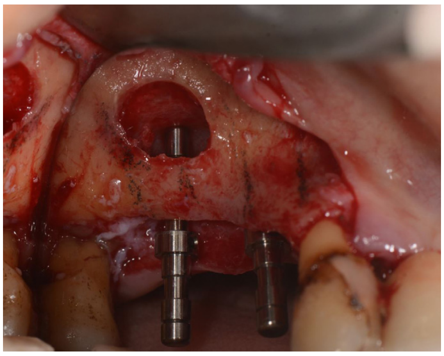


Fig 26. Check the depth and drill position

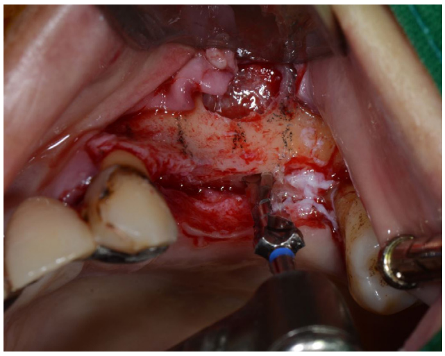


Fig 27. Drilling for Dentis SQ implant placement

Fig 28. Bone graft within mesial sinus cavity

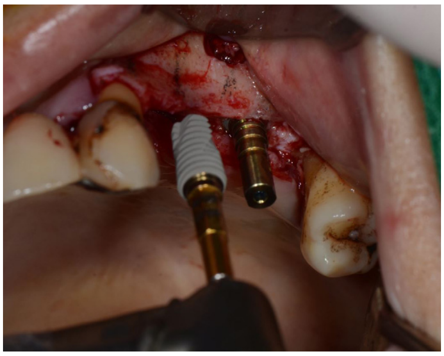


Fig 29. Bone graft within mesial sinus cavity

Fig 30. bone graft at remained space

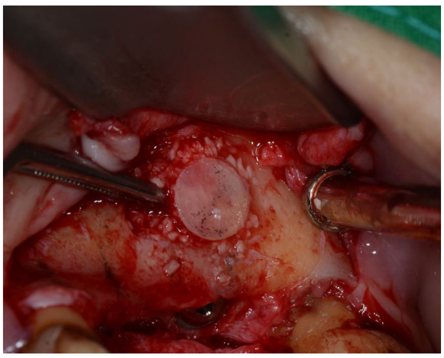


Fig 31. Repositioning of window bone fragment

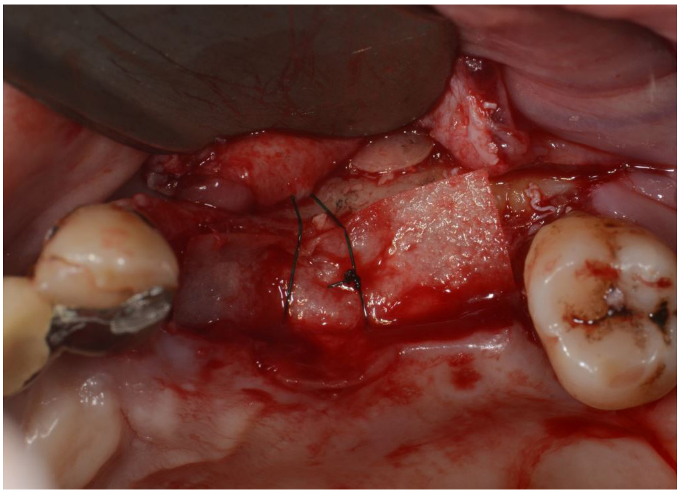


Fig 32. Additional GBR

Fig 33. Suture

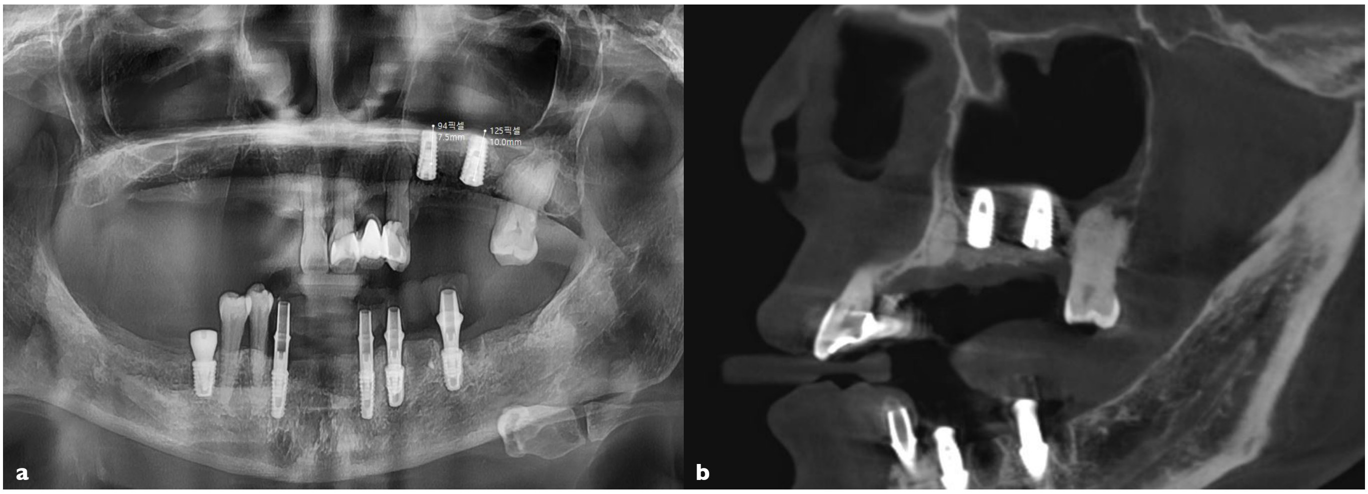


Fig 34(a-b). Post-operative x-ray f/u

[Case 2]

-The patient is a 49-year-old man with no special medical history, and with a severe smoking history. He visited the hospital with his teeth shaking and severe pain as the chief complaint (Figure 35).

- The LAD (Lateral Approach Drill) of the Dentis SAVE SINUS Kit was used to form the lateral window (Figure 36).

-The window was formed in lateral wall of the maxillary sinus (Figure 37).

- As described above, the membrane was elevated, Dentis SQ implant was placed, and the window bone fragments were repositioned (Figure 38).

- After prosthetic restorations, the implant and bone grafting material in the inner maxillary sinus can be seen in a good condition of maintenance in the 3-year follow-up panoramic view (Figure 39 a-c).

Fig 35. Initial panorama

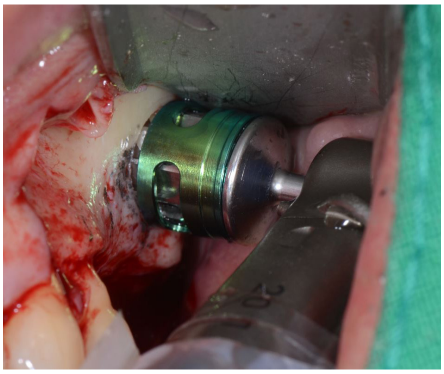


Fig 36. Lateral window bone fragment was made by LAD (Lateral Approach Drill)

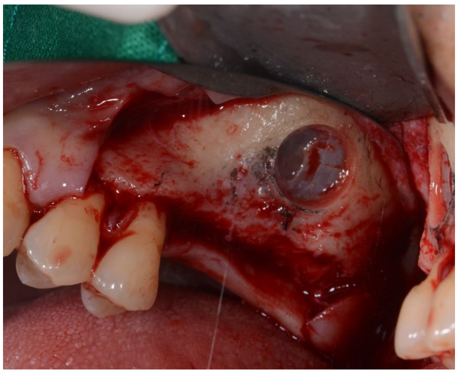


Fig 37. Lateral window formation

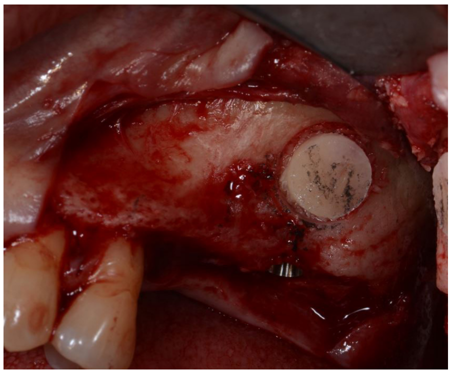


Fig 38. Repositioning of window bone fragment

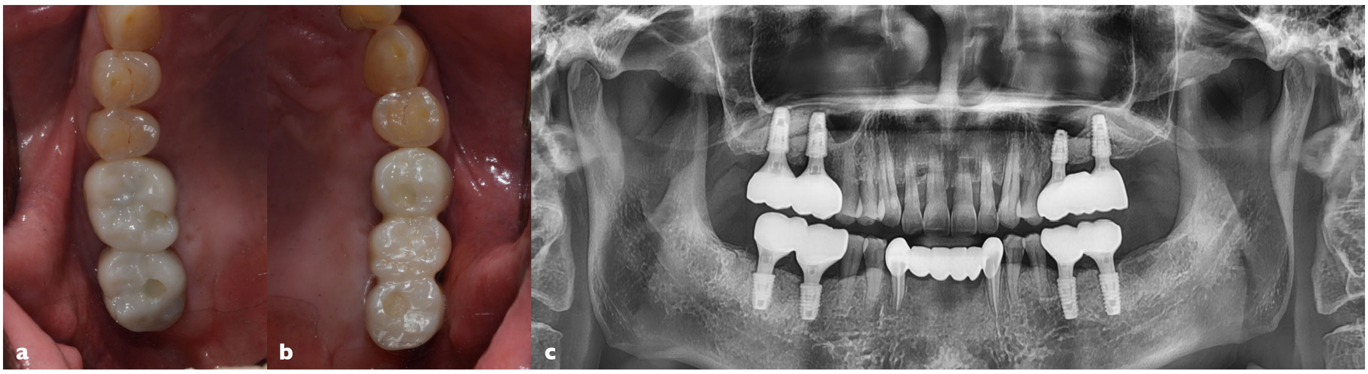


Fig 39(a-c). (a) Right side restorations
(b) Left side restorations
(c) 2 years f/u panorama

Conclusion

The access to the inner part of the maxillary sinus is obstructed, blocking direct visual observation.

Therefore, since the sinus floor elevation with a lateral approach allows the surgical area to be visible compared to the crestal approach, it is thought to be a more accurate surgery method. However, since the patient undergoes higher level of surgical trauma than the crestal approach, it is also a method that many clinicians find it difficult to adopt in clinical practice. As introduced above, the appropriate use of the SAVE SINUS kit in performing sinus floor elevation with not only the crestal approach but also the lateral approach is expected to guide the surgeon to a successful outcome in the maxillary sinus elevation for implant placement in most cases.

Reference

1. J P van den Bergh et al. Anatomical aspects of sinus floor elevations. Clin Oral Implants Res. 2000 Jun;11(3):256-265.

2. Yi-Wei Chen et al. A paradigm for evaluation and management of the maxillary sinus before dental implantation. Laryngoscope. 2018 Jun;128(6):1261-1267

3. H Tatum Jr. Maxillary and sinus implant reconstructions. Dent Clin North Am. 1986 Apr;30(2):207-229.

4. Oh et al. Clinico-Anatomycal Study of Septum in the Maxillary Sinus. J Korean Assoc Oral Maxillofac Surg 1998; 24(2): 208-212

5. Kim et al. Arterial arcade of the maxillary sinus related to sinus bone graft in korean population : A preliminary study using computed topographies. J Korean Assoc Oral Maxillofac Surg 2008; 34(4): 475-479

6. Massimo Del Fabbroet al. Systematic review of survival rates for implants placed in the grafted maxillary sinus. Int J Periodontics Restorative Dent. 2004 Dec;24(6):565-577.

7. A. Griffa et al. Mucociliary function during maxillary sinus floor elevation. J Craniofac Surg. 2010 Sep;21(5):1500-1502.

How to cite this article: Choi YK. Application and consideration of digital technology for removable complete denture: A case report. *J Clin Digit Dent.* 2021;3(2):20-30.www.jcdd.org

New Horizon of Digital Orthodontic software

DICAON 4D

DENTIS

JCDD

Journal of Clinical & Digital Dentistry

www.JCDD.org

6 Centerpoint Dr.La Palma, CA 90623.USA | JCDD@JDCC.org