

DENTAL TECHNIQUE

Fabricating a reduction guide for parallel guiding planes with computer-aided design and computer-aided manufacturing technology



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Guiding planes are defined as 2 or more vertically parallel surfaces on abutment teeth and/or fixed dental prostheses oriented in the path of insertion of a removable partial denture (RPD).¹ The functions of guiding planes include providing a path of insertion for an RPD, thereby eliminating detrimental strain to abutment and framework components; ensuring the intended actions of reciprocal, stabilizing, and retentive components; and eliminating large food traps between the abutment and components of an RPD.²⁻¹⁰ Although establishing parallel guiding planes is essential for the success of an

ABSTRACT

Preparing appropriate guiding planes is essential for the success of a removable partial denture. Owing to the difficulty of determining the location and dimension of proximal reduction, establishing optimal guiding planes may challenge even skilled clinicians. This article introduces a digital workflow for fabricating a reduction guide to establish parallel guiding planes. (J Prosthet Dent 2019;121:749-53)

RPD,²⁻¹⁰ only 6% of clinicians reported preparing guiding planes frequently, and only 7% claimed to do so occasionally.³

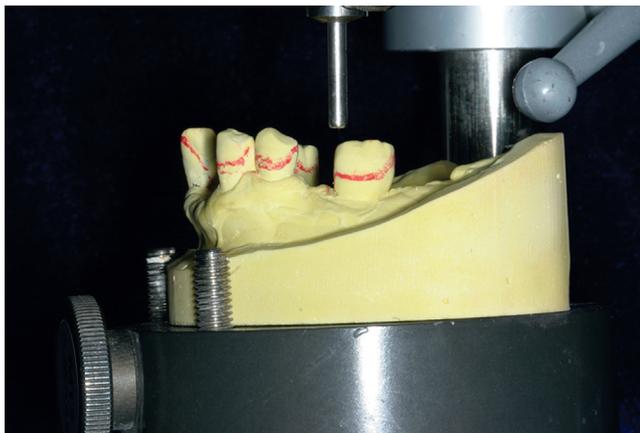


Figure 1. Survey lines on diagnostic cast. Note high survey lines on proximal surfaces of right canine and left first premolar.



Figure 2. Marks on preparation of proximal surfaces of right canine and left first premolar.

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Figure 3. Software view of survey lines and marks on diagnostic cast.

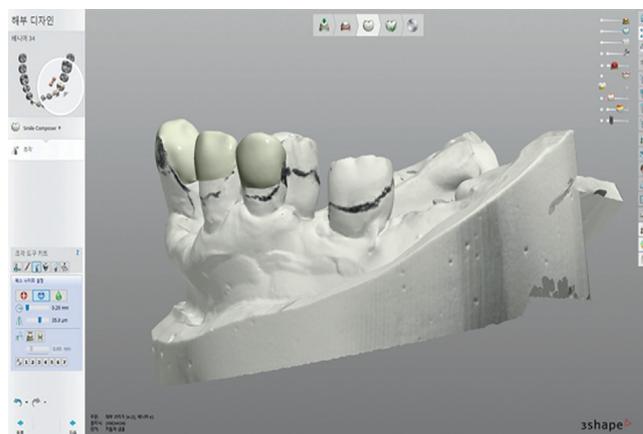


Figure 4. Software view of definitive design of reduction guide.



Figure 5. Placed reduction guide on diagnostic cast.

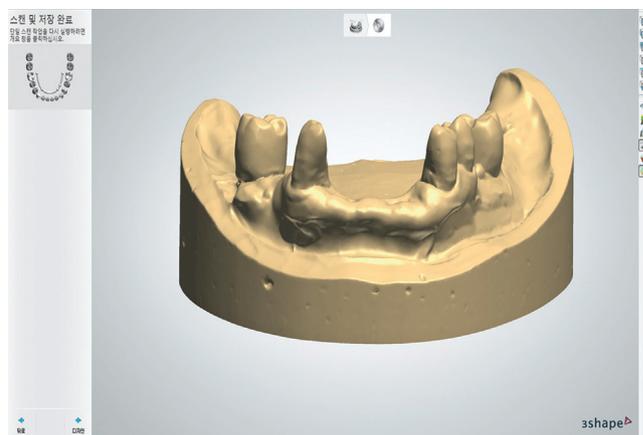


Figure 6. Software view of diagnostic cast.

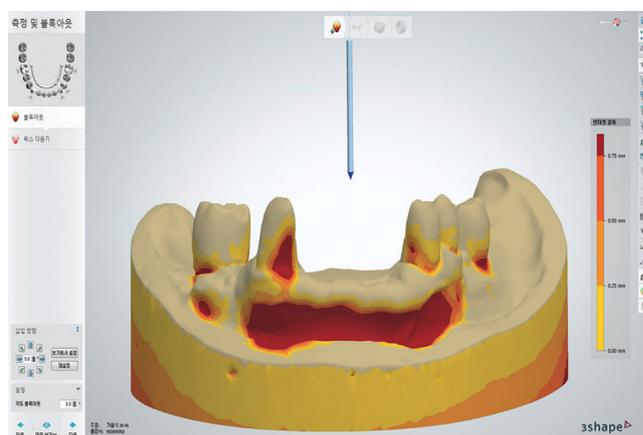


Figure 7. Software view of virtual surveying and path of insertion. Note large mesial undercut at tipped right canine that may result in poor esthetics and food trap.

Numerous techniques have been developed for providing parallel guiding planes.^{8,10-21} In general, clinicians identify the optimal relationship between a dental rotary instrument and tooth with a dental surveyor and attempt to duplicate the relationship intraorally.^{8,10} After intraoral preparation with the freehand technique, a definitive cast is fabricated, and parallelism is evaluated with the surveyor.¹⁰ If a prepared tooth requires additional modifications, the procedure is repeated until acceptable guiding planes are achieved.¹⁰ This approach may not always yield parallelism and is time-consuming.¹² Therefore, to improve on the laboratory procedure, Loney et al²¹ used an intraoral scanner and preparation comparison software. However, an intraoral scanner is required, and their technique cannot be applied to multiple abutments as guiding planes are not compared with each other, but rather with the ideal guiding

plane(s) on the same tooth on the prepared cast.²¹ Verification devices^{11-13,18-20} or intraoral surveyors¹⁴⁻¹⁶ have been proposed to improve intraoral visualization of a planned path of insertion. However, they may not accurately specify the location and extent of proximal reduction. A

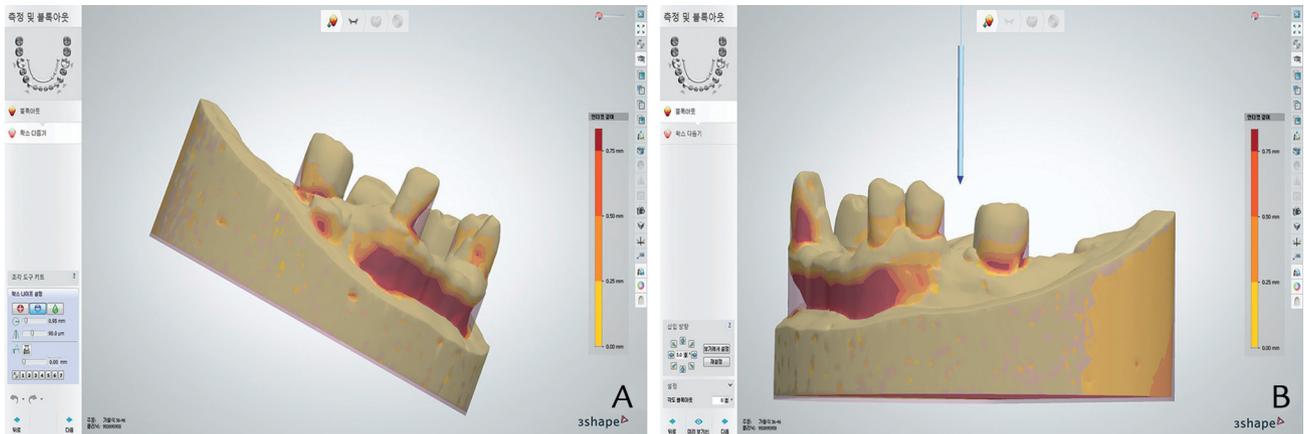


Figure 8. Software view of parallel block out. A, Mandibular right side. B, Mandibular left side.

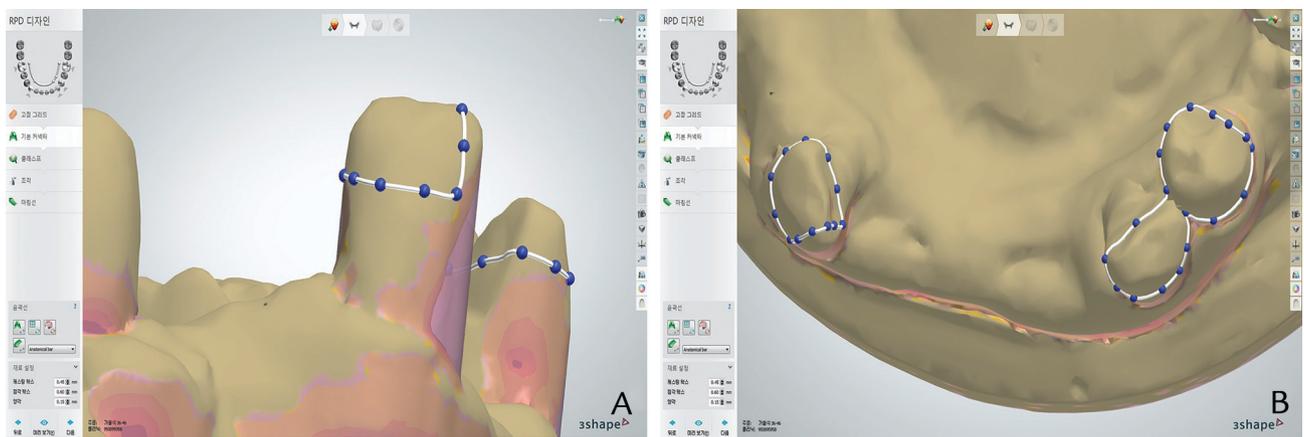


Figure 9. Software view of margins of reduction guide. A, Outline of reduction guide at mandibular right canine, buccal view. B, Outline of reduction guide, occlusal view.

thermoformed matrix technique¹⁷ overcomes this limitation, but it is time-consuming and technique sensitive as the cast must be duplicated.¹⁷

The emergence of digital technologies and materials has led to improved dental techniques.²²⁻²⁵ This article describes the fabrication of a reduction guide for parallel guiding planes with computer-aided design and computer-aided manufacturing (CAD-CAM) technology. The technique makes it possible to overcome the aforementioned limitations efficiently.

TECHNIQUE

Because CAD-CAM RPD systems are a recent development, many laboratories may not possess an RPD module.^{23,24} Therefore, methods for fabricating a reduction guide with both a veneer module and an RPD module are presented.

Method with veneer module:

1. Make a diagnostic cast.
2. Survey the cast to determine the path of insertion of the RPD (Fig. 1).^{2,5,6,26} Examine proximal surfaces that

need to be altered for appropriate guiding planes. In the presented situation, the mesial surface of the right canine and the distal surface of the left first premolar are planned to be adjusted. Prepare guiding planes on the teeth by using a milling machine (AF350; Amann Girrbach AG) and a rotary instrument (HF364XFR-015; NTI-Kahla GmbH). Mark the prepared areas and survey lines using a pencil (Fig. 2).

3. Make an order using CAD software (Dental System 2014; 3Shape A/S). Select icons of the mandibular canines and left first premolar on the screen. Click “Anatomy” and “Onlay/Veneer.” Scan the cast using a laboratory scanner (D800; 3Shape A/S) in which texture scanning is available (Fig. 3).
4. Design a reduction guide with a veneer module. Define proximal margins along the penciled lines and draw the other surface margins on the suprabulge areas (Fig. 4). Transmit the design information to a 5-axis milling machine (Zenotec select hybrid; Wieland Dental) and mill a polymethyl methacrylate block (Vipi Block PMMA Monocolor; Vipi) (Fig. 5). Establish the guiding planes with the reduction guide.

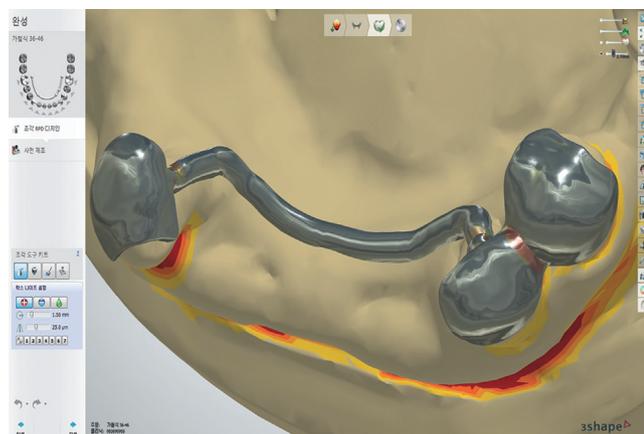


Figure 10. Software view of definitive design of reduction guide.



Figure 11. Milled reduction guide in place.

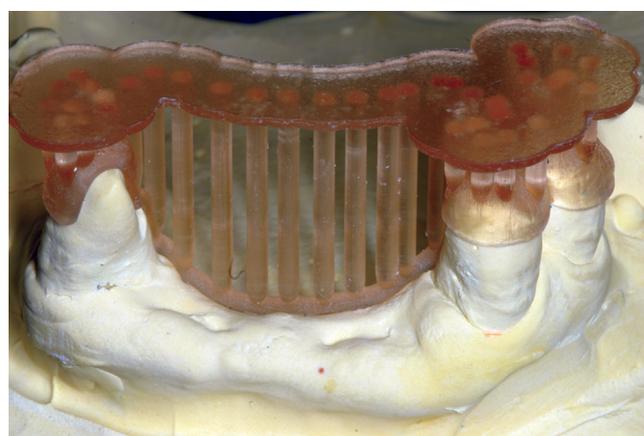


Figure 12. Printed reduction guide in place.

Method with RPD module:

1. Make a diagnostic cast.
2. Create an order using the CAD software. Select icons of the mandibular canines, first molars, and left first premolar on the screen. Click "Removable" and "Bridge." Scan the cast using a laboratory scanner (D700; 3Shape A/S) (Fig. 6).
3. After virtual surveying with the RPD module,²⁷ evaluate the path of insertion (Fig. 7). Set "Block out angle" as zero degrees and perform the parallel block out process. Identify proximal surfaces that need to be modified (Fig. 8).
4. Skip the minor connector design. Go to the major connector session and click "Anatomical bar." Design a reduction guide that covers the occlusal surface and extend the suprabelge area of buccal and lingual surfaces at the canines and left first premolar. Establish parallel proximal margins parallel to the zero-degree block out at the planned surfaces to modify (Fig. 9).^{13,18,19} Go to the clasp session and select "G-Clasp." Connect 2 pieces of the reduction guide with the clasp. Skip the process for finishing lines and save the design data (Fig. 10).

5. Fabricate a reduction guide with a polymethyl methacrylate block and 5-axis milling machine (Fig. 11) or with a biocompatible photopolymer (NextDent SG; NextDent B.V.) and a 3D printer (Bio3D PRO; Bio3D Solution) (Fig. 12). Establish the guiding planes with the reduction guide.

DISCUSSION

Fabrication of the reduction guide for parallel guiding planes was described. In the first situation, the reduction guide was designed with the veneer module, which was provided by default. The combined analog and digital workflow eliminated manual procedures required by the previous methods, except for the conventional surveying and milling procedure on the cast.

In the second situation, an RPD module was used for the complete digital workflow. However, purchase of the RPD module was necessary. In addition, the use of the subtractive method required additional time and material consumption, as skipping the clasp design was impossible.²² Therefore, further development is necessary to improve the flexibility of the RPD module.

SUMMARY

Using CAD-CAM technology, a reduction guide for optimal guiding planes was efficiently fabricated with minimal human error.

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Noteworthy Abstracts of the Current Literature

Assessing the osteogenic potential of zirconia and titanium surfaces with an advanced in vitro model

Rottmar M, Müller E, Guimond-Lischer S, Stephan M, Berner S, Maniura-Weber K

Dent Mater 2019 Jan;35:74-86

Objectives. In recent years, zirconia dental implants have gained increased attention especially for patients with thin gingival biotypes or patients seeking metal-free restoration. While physical and chemical material surface properties govern the blood-material interaction and subsequent osseointegration processes, the organizational principles underlying the interplay of biochemical and biophysical cues are still not well understood. Therefore, this study investigated how the interaction of a micro structured zirconia surface with blood influences its osseointegration potential compared to micro structured titanium with or without additional nanostructures.

Methods. Micro structured zirconia and micro- (and nano) structured titanium surfaces were fabricated via sandblasting followed by acid etching and their topographical as well as physico-chemical features were thoroughly characterized. Following, an advanced in vitro approach mimicking the initial blood interaction of material surfaces upon implantation was applied. Fibrinogen adsorption, human blood coagulation as well as their influence on cell fate decisions of primary human bone and progenitor cells (HBC) were studied.

Results. Obtained surface micro- and nanostructures on titanium surfaces were sharp with rugged peaks whereas zirconia surfaces were less rough with structures being shallower, more round and granular. Compared to titanium surfaces, the zirconia surface showed increased fibrinogen adsorption, higher levels of total accessible fibrinogen γ -chain moieties yielding in increased platelet adhesion and activation and consequently thrombogenicity. Mineralization of HBC on micro structured surfaces was significantly higher on zirconia than on titanium, but was significantly lower compared to titanium surfaces with nanostructures.

Significance. This study provides insights into blood-material interaction and subsequent cellular events that are important for implant surface development.

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