

## CLINICAL ARTICLE

# A method of fabricating computer aided design-computer aided manufacturing implant-supported provisional restorations with clear aligner attachments: A technical report

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**Abstract**

**Objective:** To provide a method of fabricating implant-supported provisional restorations with orthodontic attachments by digital technique.

**Clinical consideration:** Polymethylmethacrylate (PMMA) provisional restorations are usually necessary when dental implants are serving as anchors for orthodontic treatments. For clear aligner treatment, it is possible to setup the teeth virtually and determine the final position of the implants, indicating that the provisional restorations can be also predetermined. However, attachments on PMMA restorations have a higher risk of debonding due to low bond strength. To fabricate provisional restorations with predetermined shape and position and no risk of attachment debonding immediately after implant placement, a digital workflow is introduced in this article.

**Conclusions:** By combining “pick-up” technique and prefabricated monolithic PMMA provisional restorations, this technique is recommended for making implant-supported provisional restorations with integrated orthodontic attachments based on the digitally designed positions of the teeth.

**Clinical significance:** The present protocol describes a digital workflow of designing and manufacturing implant-supported PMMA provisional restorations with orthodontic attachments in the predetermined position of implants, which should lead to more reliable and predictable orthodontic treatment outcomes.

**KEYWORDS**

CAD/CAM, dental implant, orthodontic attachment, provisional restoration

## 1 | INTRODUCTION

Provisional restorations are necessary if the teeth are endodontically treated or the implants are serving as anchors when patients' are planning to receive orthodontic treatment. One of the most widely used provisional materials is polymethylmethacrylate (PMMA) polymer, especially when a computer aided design and computer aided manufacturing (CAD-CAM) technique is used. During orthodontic

treatment, brackets and other attachments are bonded on provisional restorations and forces are applied conventionally. However, several studies have revealed that PMMA achieves low bond strength with resin cement or composite,<sup>1-5</sup> indicating that attachments have a higher risk of debonding.

When clear aligner treatment is indicated, virtual setups of the dental arches are usually available. Based on the virtual setups, the positions of implants for missing teeth and the corresponding provisional restorations can be predetermined. If implant placement and immediate provisional restorations are essential prior to clear aligner treatment, it is necessary to

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prepare the provisional restorations before the surgery and place the restorations in desired positions intraorally.

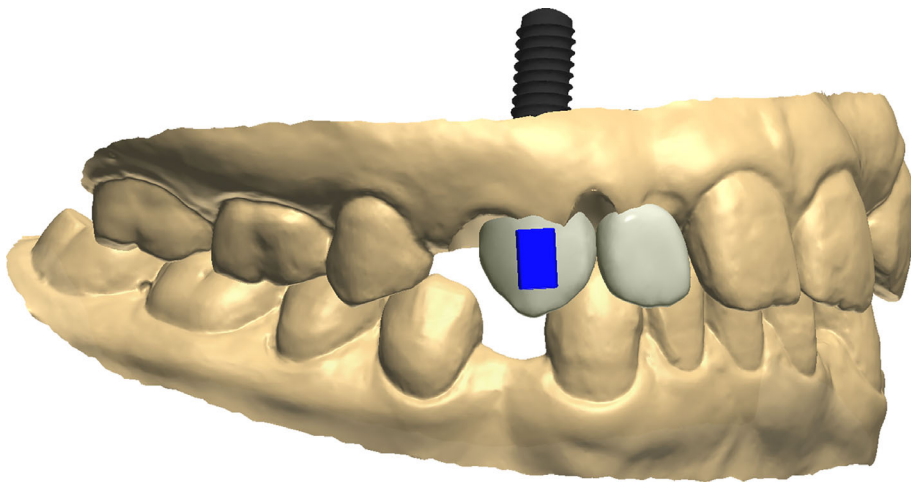
An ideal solution of the two problems is fabricating the provisional restoration and the orthodontic attachment as a whole, especially when the attachment is simple, designable and machinable geometries, and connect the restoration to the abutment intraorally with the help of a position key. The presented technique describes a procedure for designing and fabricating provisional restorations with a clear aligner attachment. Combined with the “pick-up” technique and orthodontic virtual setup, implant-supported provisional restorations can be fabricated immediately after implant placement in accordance with the target position of the surrounding teeth.

## 2 | TECHNIQUE

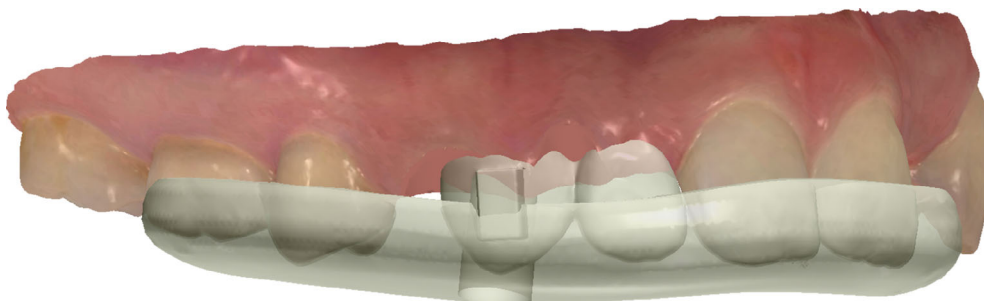
A patient with retained deciduous lateral incisor and canine was planned to replace them with implant-supported cantilever. To achieve optimal esthetic results, a provisional cantilever fixed partial denture was required, followed by orthodontic treatment to align her natural teeth by using a clear aligner. The implant served as anchorage, requiring the attachment to be placed on the provisional restoration.

1. Prepare digital models of commonly used orthodontic attachments as needed. Export the attachment models in standard tessellation language file format.

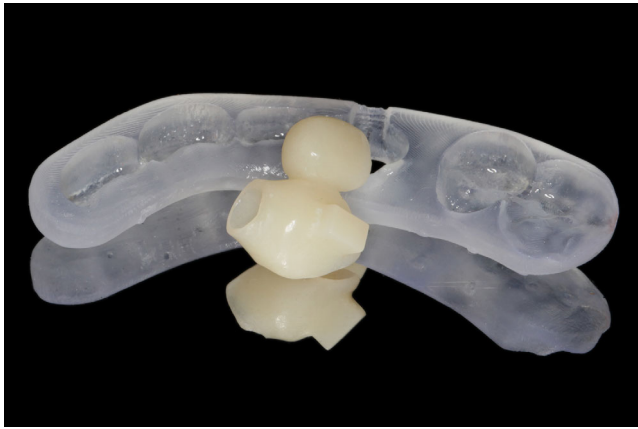
2. Import the attachment models to dental prostheses design software (Dental System; 3Shape A/S, Copenhagen, Denmark). Organize these models as an attachment library.
3. Ask the orthodontist to provide a virtual setup or teeth alignment prescription to help with the determination of the implant's position. Make an implant surgical plan according to the target position of the surrounding teeth (Implant Studio; 3Shape A/S, Copenhagen, Denmark). Fabricate a surgical guide if guided surgery is proposed.
4. Design the provisional cantilever fixed partial denture in Dental System based on the position of the implant in the surgical plan and the orthodontic virtual setup. Enlarge the intaglio and screw hole to provide extra space around the abutment, which will compensate for surgical errors of the implant position.
5. Select a 4 mm\*2 mm\*2 mm rectangular attachment from the attachment library and place it in the required position on the labial surface as per the prescription provided by the orthodontist. Double check the configuration with the orthodontist (Figure 1).
6. Design a position key to help with the intraoral locating of the provisional restoration (Figure 2). Fabricate the position key by using a digital light processing three-dimensional printer (Perfactory Vida; EnvisionTEC, Dearborn, Michigan) (Figure 3).
7. Mill the provisional cantilever fixed partial denture with PMMA disk (PMMA Block; Huge, Shanghai, China). Manually create retention grooves on the intaglio surface to improve mechanical retention. Sandblast the intaglio surface according to the manufacturer's recommendations.



**FIGURE 1** Provisional cantilever fixed partial denture with clear aligner attachment



**FIGURE 2** Position key designed to locate provisional cantilever fixed partial denture



**FIGURE 3** Milled provisional fixed partial denture and printed position key



**FIGURE 4** Connect provisional fixed partial denture to temporary abutment intraorally after implant placement



**FIGURE 5** Finished provisional fixed partial denture with clear aligner attachment



**FIGURE 6** Intraoral view of provisional restoration after 3 months

8. After extraction of the deciduous teeth and immediate implant placement (Bone Level Tapered; Institut Straumann AG, Basel, Switzerland), connect, screw, and truncate the temporary abutment. Apply a thin layer of resin adhesive (Single Bond Universal Adhesive; 3M ESPE, St. Paul, Minnesota) on the intaglio surface of the PMMA restoration. Locate the provisional restoration intraorally with the help of the position key. Connect the temporary abutment and the provisional restoration with flowable composite resin (Filtek Z350 XT; 3M ESPE, St. Paul, Minnesota) (Figure 4).
9. Unscrew the provisional fixed partial denture. Polish and finish the provisional restoration extraorally (Figure 5). Fix the provisional fixed partial denture on the implant after adjustments of the occlusal contact points if the primary stability is sufficient for immediate restoration. Otherwise, fix the provisional restoration during the second stage surgery.
10. After osseointegration, refer the patient to the orthodontist for clear aligner treatment (Figure 6). Use the implant-supported restoration as anchorage to assist the movement of natural teeth.

### 3 | DISCUSSION

The protocol presented combines two techniques: (1) The design and fabrication of a provisional restoration with an orthodontic attachment; (2) the “pick-up” technique used for implant-supported restorations. For tooth-supported provisional restorations, only the first technique is necessary if definitive casts are obtained after tooth preparation. For implant-supported provisional restorations, the second technique has been introduced in several studies, which proved its feasibility and reliability.<sup>6,7</sup> The first technique involves setting up the attachment library and inserting the selected attachment to the desired position. The attachment library can be obtained in several ways. It can be provided by the clear aligner manufacturers, reverse engineered from existing attachments on the market, or custom designed according to the orthodontists' instructions. The location of the attachment should be determined by the orthodontist, and be clearly described in the prescription by texts and illustrations to insure that the

prosthodontist and technician can interpret it correctly. In contrast to conventional methods, the elimination of bonding surface between attachment and restoration increases the reliability of the provisional restoration and overcomes the disadvantages of bonding error and composite residual.<sup>8</sup> The only concern might be the wear resistance of PMMA when compared with conventional composite resin.<sup>9</sup> Further observations and investigations are essential to provide more clinical evidence of this workflow.

In this case, tooth implant was selected as anchorage of orthodontic forces for premolar mesialization. The location and angulation of the implant must be carefully determined and precisely operated,<sup>10</sup> which could be realized by virtual set-ups, wax-ups, and surgical guides. The reliability of this method has been reported in several studies and cases.<sup>11,12</sup> The rectangular attachment was chosen for its efficiency and ease of handling. Studies have shown that rectangular attachments are more retentive<sup>13</sup> and effective for bodily tooth movement.<sup>14</sup> During the double check stage between technicians, prosthodontists, and orthodontists, only a short amount of time was consumed as the position of the attachment could be clearly described in the prescription and easily reproduced by the technician.

## 4 | CONCLUSIONS

The present article describes a digital workflow of designing and manufacturing implant-supported PMMA provisional restorations with orthodontic attachments, which should lead to more reliable and predictable orthodontic treatment outcomes. Part of this workflow is also applicable to tooth-supported provisional restorations if digital definitive casts have been made.

### DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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