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Technical procedure

Immediate implant loading following computer-guided surgery

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Abstract

Purpose: The aim of this study was to develop and apply a new method for easy intraoperative adjustment of a provisional fixed full-arch restoration, in order to allow immediate implant loading following computer-guided surgery, regardless of any implant positioning errors compared to the virtual planning.
Methods: In accordance with the NobelGuide™ protocol, a provisional restoration for immediate loading of six maxillary implants was prepared prior to surgery. Because small shifts between the planned and the actual implant positions were to be expected, the provisional restoration was not fabricated directly on temporary cylinders as a conventional one-piece superstructure, but was divided into two portions: six custom made abutments and a long span fixed restoration which were left unconnected. After implantation, the custom abutments were attached to the six implants to be immediately loaded, and the superstructure was cemented simultaneously to all abutments using dual cure resin cement. After the excess cement was cleaned and polished, the superstructure was then reseated. Passive fit was achieved between implants and the superstructure.
Conclusion: The superstructure described in this article can be easily seated and adjusted to accommodate any possible shifts in implant positioning occurring during computer-guided surgery. Through this method uneventful immediate implant loading can be achieved in a reasonable operative time.

Keywords: Computer-guided surgery; Immediate loading; Misfit; Adjustable provisional fixed full-arch restoration; NobelGuide™

1. Introduction

There are many reports on successful immediate full mouth loading after computer-guided surgery using the All-on-Four concept (NobelGuide™, Nobel Biocare Japan K.K.) [1–3]. Computer-aided implant surgery minimizes the error in implant positioning compared to manual or conventional surgical guide implant placement [4–7], which allows fabrication of the provisional restoration prior to surgery.

However, it is not always possible to insert the superstructure immediately. Complications may occur during computer-guided surgery [8], like insufficient primary implant stability or misfit of the restoration due to small transfer errors in implant placement from the planned position [9–11], which can hinder immediate loading using a prefabricated prosthesis.

In such cases either loading is delayed or intraoperative adjustment of the superstructure is attempted. Inserting the superstructure in spite of the misfit between implants and temporary cylinders would lead to implant overload with consequent peri-implant bone loss, which in the worst case scenario could result in implant loss. Acrylic provisional restorations allow considerable adjustment to be performed: the temporary cylinders can be removed from the superstructure and reattached intraorally in correct positions, but this greatly extends the operative time. Since self-curing resin is used to connect the superstructure in the mouth, air bubbles may be entrapped, or part of the resin may remain incompletely polymerized, which weakens the junction. Resin monomer may overflow to the wound area, which may affect the healing process. Until hardening of the resin, the superstructure is unstable and must be held by finger pressure. This may allow a slight shift from the planned position, later requiring a lengthy occlusal adjustment. The inner surface of the superstructure may be hard to polish due to the large amount of self-curing

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Fig. 1. Working model, fabricated and articulator mounted using the surgical template as a reference, according to the NobelGuide™ protocol.

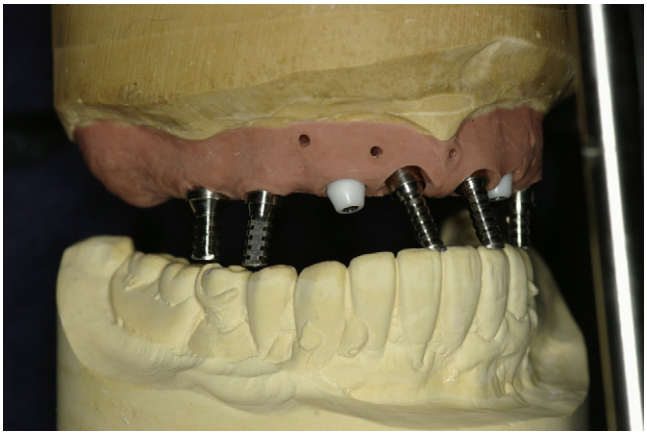

Fig. 2. Multi-unit abutments and prefabricated temporary cylinders attached to the implants replicas on the working model. In the case presented in this figure, two implants which are to be left unloaded were attached healing caps and were not included in the immediate temporary superstructure.

resin used. Insufficiently polished surfaces may enhance plaque retention.

At present, other types of superstructures are employed for immediate full mouth loading following computer-guided surgery. One is constructed using a conventional method: temporary cylinders and superstructure fabricated separately, to be connected in the mouth by the addition of self-curing acrylic resin [12–14]. Through this method, the superstructure can be mounted even if there are some changes in implant position or angulation compared to the virtual treatment plan, but the previously mentioned problems like time consumption, weak junction, plaque retention, etc. remain. A more recent method uses a one-piece superstructure fabricated on self-adjusting guided abutments, to be screw-retained directly onto the implant body [11,15]. However the usage of this type of superstructure is limited to cases with parallel or only slightly divergent implants. In order to overcome the above-mentioned problems, the authors designed and applied a new method for intraoperative adjustment of a provisional fixed superstructure for immediate implant loading following computer-guided surgery. This is a description of the new technical procedure for computer-guided implantation.

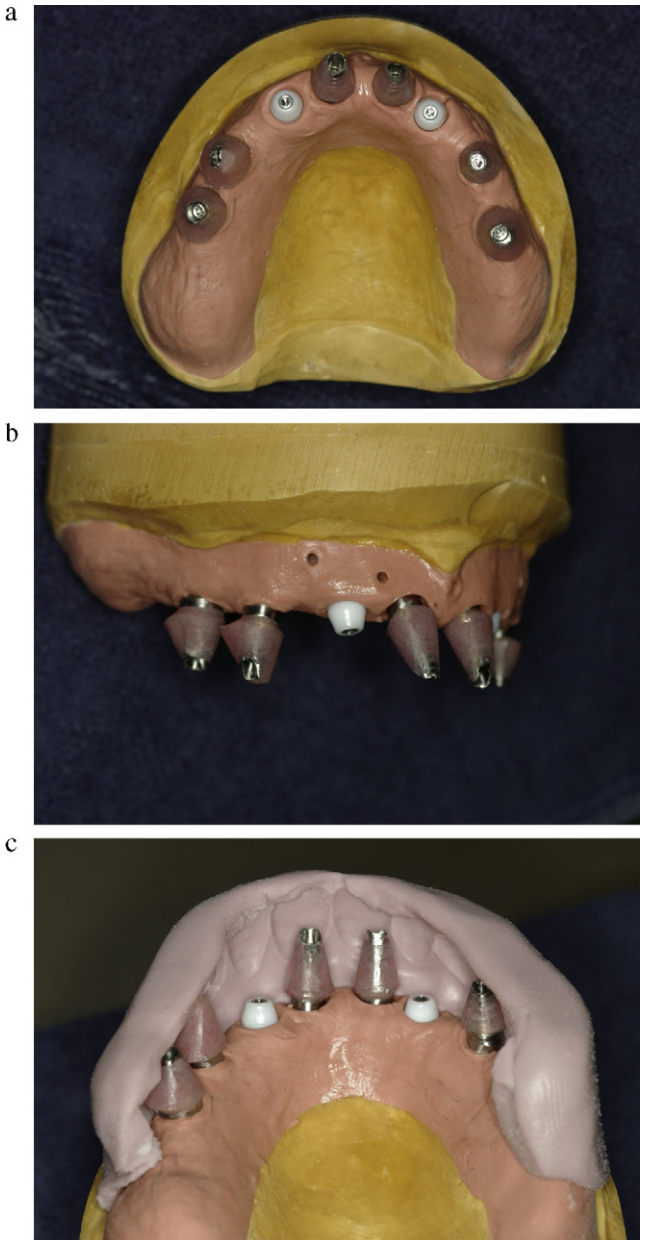

Fig. 3. Prefabricated temporary cylinders coated with acrylic resin and prepared with a taper. (a) Occlusal view. (b) Lateral view. (c) Posterior view showing sufficient clearance within the limits of the silicone index reproducing the buccal shape of the superstructure.

2. Methods

(1) Implant placement and immediate loading were planned in a completely edentulous maxilla according to the NobelGuide™ protocol. The working model was fabricated and mounted in an articulator using the surgical template as a reference (Fig. 1).
(2) Multi-unit abutments and temporary cylinders were connected to the implant replicas and a wax-up of the implant-supported fixed superstructure was made (Fig. 2).
(3) The prefabricated temporary cylinders were coated with acrylic resin and then prepared similarly to abutment teeth for a full-arch fixed restoration (Fig. 3a). They had a taper

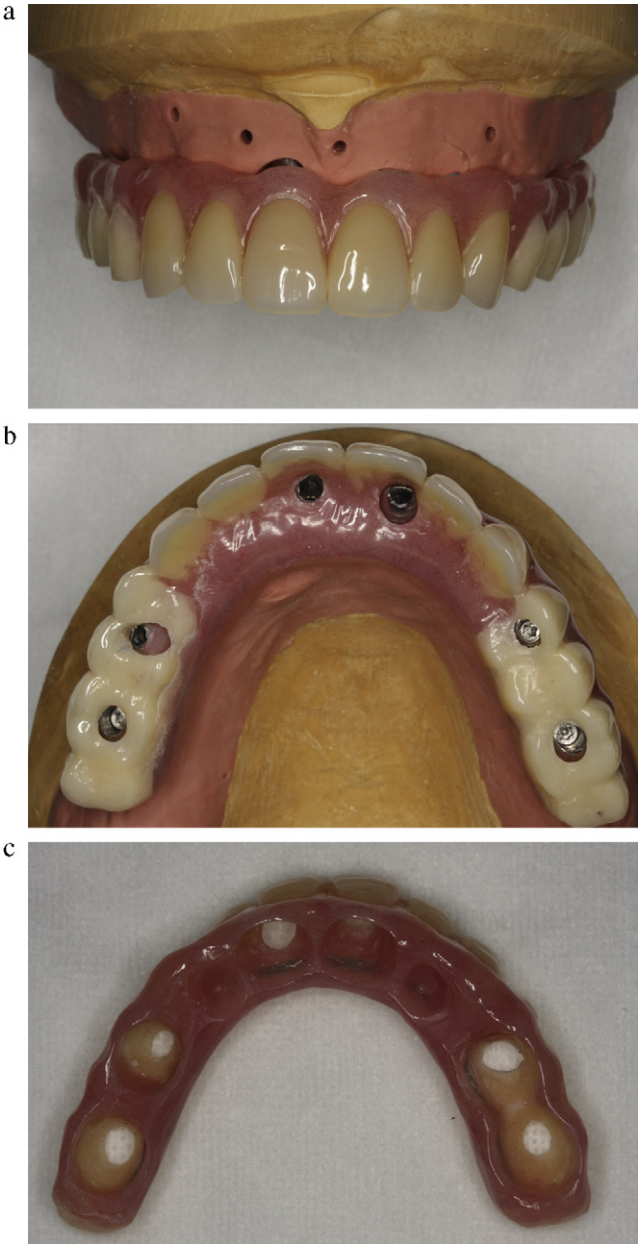

Fig. 4. Acrylic resin superstructure with metal reinforcement: (a) Anterior view. (b) Occlusal view of the superstructure seated on the working model. (c) Mucosal view showing the hollowed-out spaces corresponding to the abutment positions.

(20–40°) for easy insertion of an acrylic resin superstructure (Fig. 3b). A silicone index was used to check the position of the abutments within the final shape of the superstructure (Fig. 3c).

(4) An acrylic resin superstructure with metal reinforcement was completed on the working cast and provided with hollowed-out spaces corresponding to the abutment positions and slightly larger than the size of the previously customized temporary cylinders (Fig. 4). In order to allow easy intraoral adjustment of the superstructure, the prosthesis and temporary cylinders were not connected preoperatively.

(5) After implantation (Fig. 5), multi-unit abutments were attached to the implants to be immediately loaded and tightened to 35 Ncm. Then the customized temporary cylinders were seated on the abutments using a dedicated soft silicone jig, and torqued to 15 Ncm (Fig. 6).

Fig. 5. Intraoral view of the surgical template in place. The implants can be placed precisely as guided by the surgical template.

Fig. 6. Intraoral view of the customized temporary cylinders in place. The customized temporary cylinders were seated on the abutments using a dedicated soft silicone jig, and torqued to 15 Ncm.

(6) Next, the acrylic resin superstructure was seated over the custom temporary cylinders and their fitting was checked. If the superstructure cannot be seated in correct position because of interference with one of the custom temporary cylinders, adjustment can be easily done by grinding its inner surface.

(7) The inner surface of the superstructure was filled with dual cure resin cement (Multi-link; Ivoclar Vivadent, Germany), and the superstructure was immediately seated over the custom temporary cylinders. The cement was semi-cured by exposure to light (2–4 s), the surplus was removed, and then the light curing was completed. The screws of the temporary cylinders were loosened through the occlusal holes left in the superstructure, to allow removal of the superstructure for finishing. The excess cement was cleaned and the mucosal surface of the superstructure was polished. Good fit was achieved between multi-unit abutments and temporary cylinders. The superstructure was then reseated, the screws tightened to 15 Ncm, the occlusal holes of the

Fig. 7. Finished provisional restoration in place. The occlusal holes of the custom temporary cylinders were sealed with cotton balls to avoid resin cement infiltration.

custom temporary cylinders sealed with temporary cement and minor occlusal adjustment was performed (Fig. 7).

3. Conclusions

The superstructure described in this article can solve the problems related to misfit of preoperatively fabricated restorations for immediate implant loading. The method does not require advanced skills, since adjustment and setting of the superstructure are similar to the cementation of a conventional long span bridge. Passive fit is easily achieved due to the resin cement interposed between the segments of the superstructure. Therefore the method is easy to use even for operators not very experienced with computer-guided implant placement. It can be successfully used also in cases with divergent implant placement, because the temporary cylinders can be connected to either straight or angled multi-unit abutments.

After computer-guided surgery a prefabricated conventional provisional restoration may either not fit, or because of low primary stability on part of the implants, the design may need to be modified to avoid loading of these implants. Since the adjustment of a conventional provisional restoration would be very time consuming, a new method for intraoperative adjustment of the superstructure was designed and described in this article. Through this method, uneventful immediate implant loading and passive fit of implant restorations can be achieved in a reasonable operative time.

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