Reliability of implant placement after virtual planning of implant positions using cone beam CT data and surgical (guide) templates

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Abstract

- 250 implants in all indications (from single-tooth to fully edentulous) were placed using the coDiagnostiX™ software and gonyX™ surgical templates
- The predictability of the implant size is very high
- Guided surgery was found to be reliable for flapless surgery

Introduction

Recent studies show that computer-guided surgery using drilling templates, such as CT-based templates, can allow high precision in implant placement and subsequently allow for easy restoration.

The aim of this study was to evaluate the clinical reliability of the image-guided coDiagnostiX™ software and surgical templates fabricated with gonyX™ (both formerly IVS Solutions, now Institut Straumann AG).

Materials and Methods

Computer-guided surgery was performed for all patients scheduled to receive implant treatment. For each of the 102 patients (mean age 40.4 years), a prosthesis was fabricated and duplicated in acrylic resin (for prosthetic planning) as a scanning template. Cone-beam computed tomography images were obtained and transferred to coDiagnostiX™ planning software for 3D implant positioning (Figure 1).

Three titanium markers allowed detection of the position of the scanning template (Figure 2). Virtual implant planning could then be transformed into a surgical template using gonyX™. The template was then prepared with tube-in-tubes of varying diameters for different drill sizes for use as a drill guide.

Template fit, handling problems, reliability of the protocol, and implant placement with the template were assessed. Any differences between the planned and actual position of the implants were recorded. The cases were followed until the placement of the superstructure and end of the prosthetic treatment.
A total of 250 implants were planned, most (55.4%) in the posterior mandible, with the majority (81.8%) in the posterior tooth bearing area. The frequencies of the implant indications are shown in Figure 3, most (33.2%) were planned in the free-end gap situation. Flapless surgery was performed for 58.8% of the implants, while alveolar augmentation was required for 41.2% of implant placements.

Results

No problems with fit or intra-operative handling were found for 98.4% of the guide templates, handling was limited in four cases due to reduced interocclusal distance.

All planned cases of flapless surgery were completed successfully, the planned augmentation protocol was altered in eight cases requiring delayed implant placement to be performed. Misinterpretation of the 3D view of the anatomical situation was the main reason for the change in protocol.

The actual angle of the implant differed from the planned angle in only nine cases, where the implants were not completely parallel to the adjacent teeth. No other clinical complications or consequences were detected.

Implant size was highly predictable, with only one case requiring a smaller diameter implant to be placed due to insufficient bone. The procedure also indicated that the anatomical structures (e.g., adjacent teeth, sinus, mandibular canal and mental foramen) could be protected.

Conclusions

▪ The use of a 3D template as a drill guide is a reliable technique
▪ The implant size and position were highly predictable
▪ The anatomical structures were protected in all cases
▪ All indications from single-tooth to fully edentulous were covered
▪ In summary, virtual implant planning and the use of a surgical template can make preoperative assessment simpler and may be indicative of cases suitable for flapless surgery.