Accuracy of a Newly Developed Integrated System for Dental Implant Planning

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Introduction

Since 1997 different approaches for computer aided dental implantology (CAI) are available. These systems comprise different technologies for 3D visualization of the patient’s anatomy, virtual dental implant position planning and conversion. The present study was performed to evaluate the transfer accuracy of the first cone-beam CT (CBCT)-based system for dental implant planning and computer-numerically controlled (CNC) surgical template production (SICAT, Bonn, Germany).

Materials and Methods

10 partially edentulous anatomical patient equivalent models (fig. 1a) were equipped with prosthetic wax-up proposals (fig. 1b). Prosthetic proposals were transferred into so called scan prostheses (fig. 1c) with radio-opaque teeth and a registration plate. After CBCT scanning virtual implant positions were planned with respect to available bone and prosthetic crown positions (fig. 1d). Planning data and scan prostheses were sent to the surgical guide manufacturer (SICAT, Bonn, Germany) utilizing CNC technology transferring our virtual planning data to the corresponding sleeve positions in the final surgical template. Two different types of guidance were assessed: For assessment of the SICAT system inherent accuracy vendor’s titanium sleeves of 2.0 mm internal diameter and 5 mm in length were utilized for pilot drills. The guide sleeves of the NobelGuide system (Nobel Biocare, Göteborg, Sweden) were implemented for fully guided implant insertion (fig. 1e and 1f). Deviations perpendicular to the implant axes at the crestal and apical end, as well as the angle deviations between the virtual planning data and the surgical results were measured utilizing follow-up CBCT investigation and referential marker based registration (fig. 2 and 3).

Results

The SICAT system inherent mean deviation rates for the drilled pilot osteotomies determined to be smaller than 500 µm even at the apical end. Lower angle deviations of 1.18° were measured. Utilizing the NobelGuide sleeve-in-sleeve system for fully guided implant insertion in combination with the investigated template technology enabled to insert dental implants with the same accuracy. Crestal deviations in general were significantly lower than the apical deviations (table 1).

Conclusion

Although hardly comparable due to different study designs and measuring strategies the investigated SICAT system inherent accuracy corresponds to the most favourable results for CAS systems published so far. Investigations deviations most presumably can be drawn back on the necessary leeway between internal diameter of the guiding sleeves and the outer diameter of the surgical drills. The CNC-based conversion from virtual planning to corresponding surgical templates delivers reliable and predictable transfer accuracy. In combination with the NobelGuide surgical set for fully guided implant insertion this highly accurate transfer level could be maintained from the pilot drill to the final implant position.