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Research Paper
Dental Implants

How does an error in positioning the template affect the accuracy of implants inserted using a single fixed mucosa-supported stereolithographic surgical guide?

M. Cassetta, A. Di Mambro, M.Giansanti, L. V. Stefanelli, E.Barbato
Department of Oral and Maxillofacial Sciences, School of Dentistry, "Sapienza" University of Rome, Rome, Italy

M. Cassetta, A. Di Mambro, M. Giansanti, L.V. Stefanelli, E. Barbato: How does an error in positioning the template affect the accuracy of implants inserted using a single fixed mucosa-supported stereolithographic surgical guide?. Int. J. Oral Maxillofac. Surg. 2014; 43: 85–92.

Abstract. Computer-aided implantology using a single fixed stereolithographic surgical guide involves a sequence of diagnostic and therapeutic events, and errors can creep in at different stages. Taken together, these can be termed the 'total error'. A positioning of the surgical guide on the support surface different to that of the diagnostic template may generate an error that reoccurs with all the implants inserted, and this error can be termed the 'guide positioning error'. The aim of the present study was to measure the deviation between the planned and inserted implants due to this guide positioning error, to evaluate if this error was statistically significant, and concurrently, to assess the influence of the type of arch (upper vs lower jaw) and mucosal thickness on the guide positioning error. Twenty-four subjects were treated and 172 implants inserted. Preoperative and postoperative computed tomography images were compared using Mimics software to determine the total error and guide positioning error. Quantitative data were described; the *t*-test and Pearson correlation coefficient were used. The guide positioning error was found to affect the accuracy, but was statistically significant only for global coronal deviation ($P = 0.038$). Arch of support and mucosa thickness did not affect the guide positioning error.

Key words: computer-aided implantology; implants; stereolithographic surgical guide; position.

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The use of computer-aided implantology (CAI) for the placement of dental implants is designed to reduce errors, provide better control, and eliminate the aesthetic and biomechanical risks that are involved in standard implant surgery.[1,2] One way in which CAI is applied in a clinical setting is through single-type stereolithographic guided systems; this constitutes the focus of the present study.[2–4] The single-type guide consists of a stereolithographic surgical template with guide sleeves for

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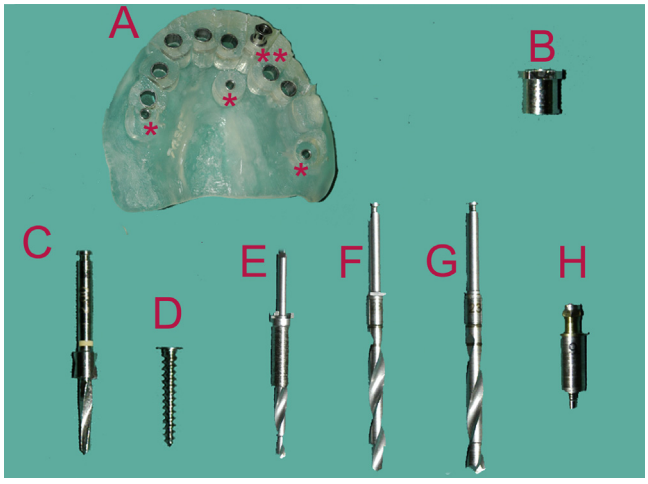

Fig. 1. Surgical components and instruments used in a single stereolithographic guided surgery system (External Hex Safe; Materialise Dental, Leuven, Belgium): (A) stereolithographic surgical guide; (B) internal tube; (C) fixation screw drill; (D) fixation screw; (E) mucotome for flap-less surgery; (F) and (G) diameter and depth calibrated drills for guided osteotomy; (H) implant holder for guided implant insertion. *Guide sleeve for fixation screw installation. **Internal tube inserted in the guide sleeves to guide the drilling procedure.

fixture installation, additional guide sleeves for fixation screw installation, and depth calibrated drills to prepare osteotomies (Fig. 1).[3] The stereolithographic guided surgery system involves a sequence of diagnostic and therapeutic events, and errors can arise at different stages.[1,5–14] In line with the literature, the accuracy of the entire procedure is defined in this paper as the deviation between the position of the implant in the planning (or planned implant position) and the position of the implant postoperatively (or inserted implant position).[8] In this paper we term this deviation the 'total error'.

Although the literature describes different types of error that have occurred in real clinical situations, the clinical significance of each individual type of error has not as yet been determined. However, most sources of error can lead to an error that affects every single implant randomly. In this paper we term this the 'random error'.

Stereolithographic guided surgery systems use a diagnostic template, called a scanno-guide, to determine the prosthesis-driven implant position. The scanno-guide is either a radiopaque replica of the patient's temporary prosthesis, or it is the patient's actual denture (double-scan technique).[15]

The position of the diagnostic template during the computed tomography (CT) scan is taken as a reference guide during the planning phase and must be exactly reproduced by the surgical guide during the surgery. A positioning of the surgical guide on the support surface that is different to that of the diagnostic template may generate an error that reoccurs on each implant inserted with the same surgical guide (Fig. 2). In this paper we term this reoccurring error a 'systematic error'.

It is also to be noted that during the drilling sequence and/or implant insertion for each single implant, the surgical guide itself may slightly rotate or move, and this movement may differ from site to site, resulting in a random error. With the above considerations in mind, the aims of this study were: (1) to measure the systematic error that arises from the positioning of the surgical guide on the support surface if different to that of the diagnostic template, when using a single fixed

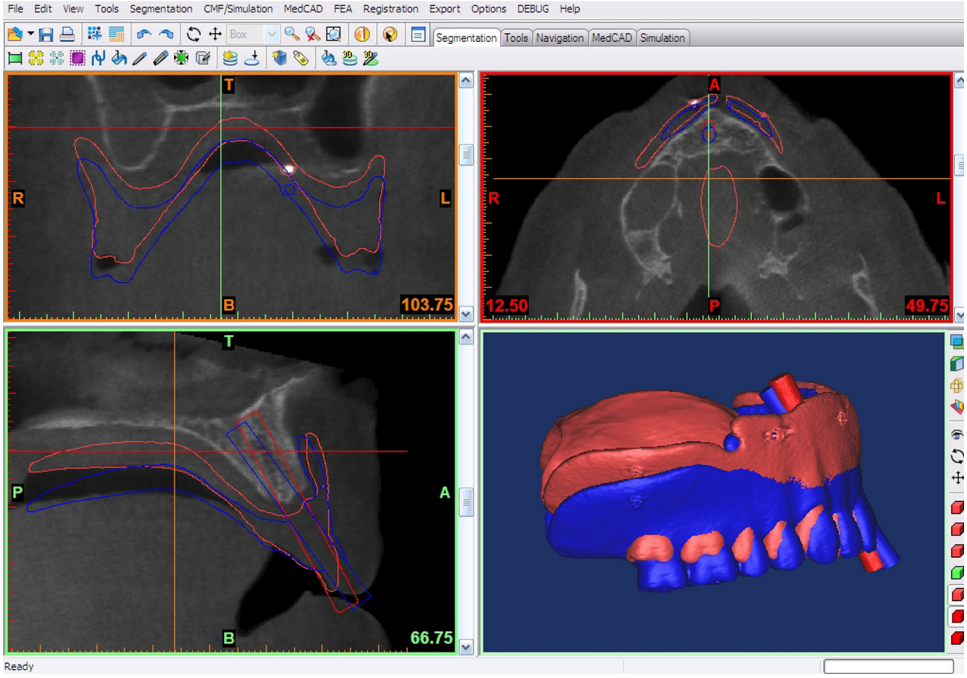

Fig. 2. How the systematic error may occur. Implants are planned using the diagnostic template (in red), but if the surgical guide (in blue) is not placed in the same position as the diagnostic template, the inserted implants (in blue) deviate from the planned implants (in red). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)