A Study of a Custom-Made Surgical Guide for Dental Implant Insertion in Free-End Saddle Sites

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Abstract

Aim: The success of an implant-supported restoration mainly depends on implant placement with correct angulations and occlusal relationship. The aim of this study was to assess the effectiveness of a custom-made template to guide implant insertion in maxillary and mandibular free-end saddle areas. ***Methods:*** The study sample was drawn from patients with a unilateral and/or bilateral free-end saddles (Kennedy Class I and II) who attended at the Military Hospital, Diyarbakir, and Gülhane Military Medical Academy, Ankara, Turkey, between 2004 and 2008. Inclusion criteria were no uncontrolled systemic diseases, non-smoker, at least 10 mm distance between the alveolar crest and the inferior dental canal at all mandibular implant recipient sites, and good oral hygiene. Customised surgical templates were constructed on study casts and were used during the surgery for implant placement. The implants were loaded with fixed prostheses at 6-8 weeks after surgery. The patients were followed up for at least three years. ***Results:*** Fifty-eight implants were placed in 29 patients (17 men, 12 women). Thirty implants were placed in free-end saddles in the maxilla and 28 in free-end saddles in the mandible. ***Conclusions:*** The present study indicates that the customised surgical template, which allows reduced patient radiation exposure, is an economical and simple technique. It suggests that a custom-made surgical template improves predictability in implant placement and is useful for accurate implant placement with correct angulation and occlusal relationship.

Key Words: Dental Implant, Surgical Guide, Free-End Saddles

Introduction

Dental implants have been an increasingly used procedure in treatment of partially or fully edentulous patients for the last three decades. Prior to dental implant insertion, a full clinical assessment of the patient is mandatory so that appropriate techniques can be selected. When there is no distal abutment, implant-retained fixed crown(s) or bridge(s) may be the best treatment option [1-6]. However, accurately transferring the proper position of the implant abutments for the planned prosthesis/prostheses to the laboratory can be difficult [7]. In addition, angulation of mandibular free-end saddles may affect the pressure from the prosthesis on the abutments, so as to cause high stress concentrated in some areas; this may easily lead to implant failure [8].

Although implant placement in jaws is a surgical procedure, reports on this topic, using a surgical guide, while inserting an implant, are sparse. The angulation and depth of implants can be planned with the help of computer tomography (CT) or conventional radiographic tomography. To identify accurate implant placement pre-surgically, various kinds of surgical templates have been proposed. Such templates can be constructed from a wax-up, by duplicating the patient's existing denture. They may be custom-made, on a study cast, or through computer-aided design [9]. Although it is thought to be important to use templates, the authors could find no published literature on their accuracy [10].

Aim

The aim of this study was to assess the effectiveness of a custom-made template to guide implant insertion in maxillary and mandibular free-end saddle areas.

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Methods

This study was carried out in patients with a unilateral and/or bilateral free-end saddles (Kennedy Class I and II) who attended at the Military Hospital, Diyarbakir, and Gülhane Military Medical Academy, Ankara, Turkey, between 2004 and 2008 and who had implants placed in their free-end saddle areas. Inclusion criteria were:

- No uncontrolled systemic diseases.
- Non-smoker.
- At least 10 mm distance between the alveolar crest and the inferior dental canal at all implant recipient sites.
- Good oral hygiene.

Custom-made surgical guide templates (CST) were used to treat the resulting sample of 29 (17 male, 12 female) patients with unilateral and/or bilateral free-end saddles *(Figure 1)*.

In order to produce the templates, study casts with fully extended vestibular borders of the edentulous space were prepared. They were articulated to enable the prostheses and surgery to be planned.

Figure 1. *Pre-operative intra-oral view of patient.*

After the subsequent production of working casts, temporary removable prostheses were then produced *(Figures 2a* and *2b)* to the resulting articulated casts and the location and orientation of the definitive implant sites were determined. The customised templates were then produced by removing the buccal aspect of the temporary removable prosthesis and cutting guide planes in the acrylic teeth *(Figures 2c* and *d)*.

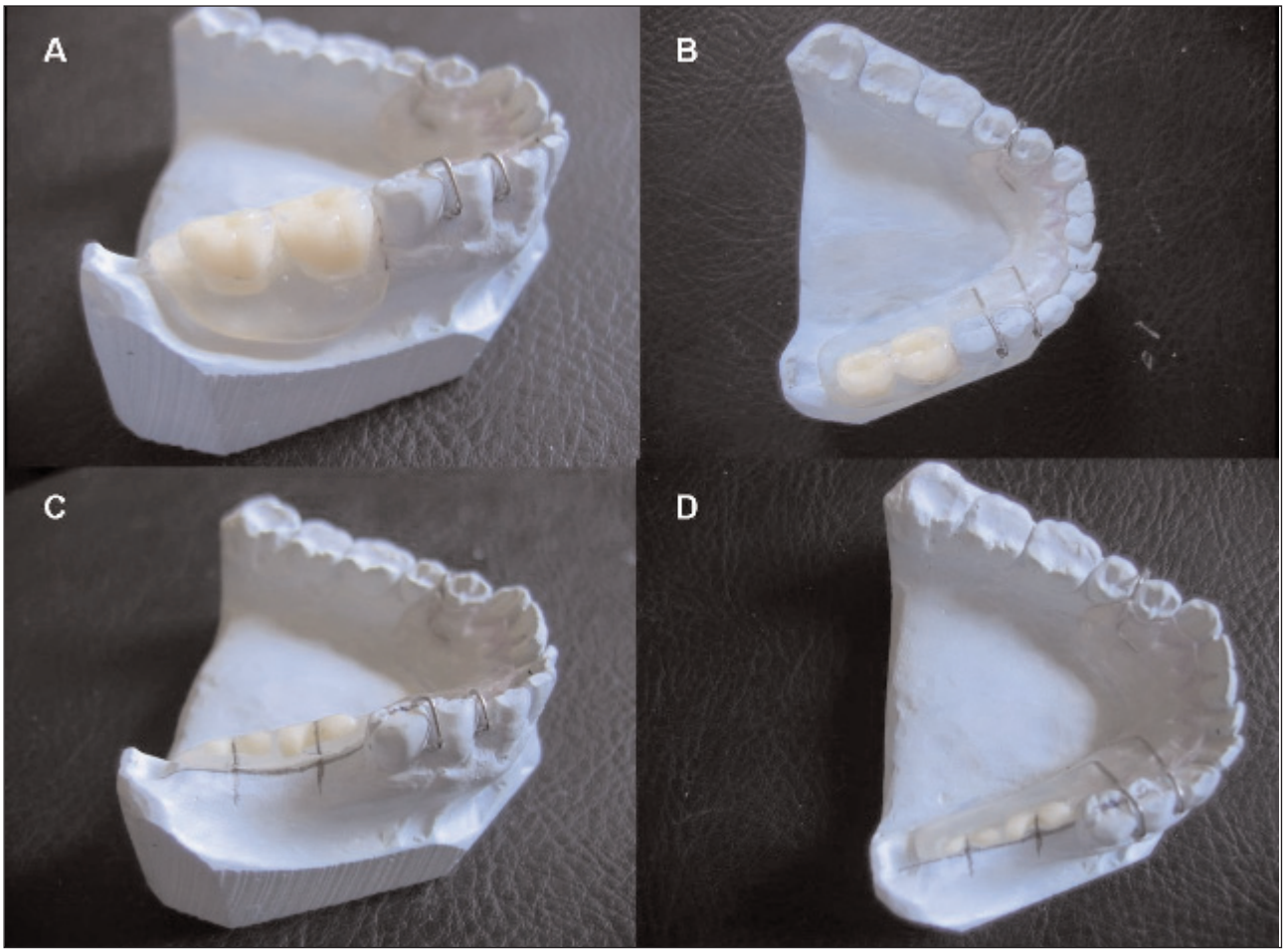

Figure 2a, b. *A surgical template for placing implants at 46 and 47. Please note that the vestibular borders were fully extended.* ***Figure 2c, d.*** *Customised acrylic template after modification of temporary removable prosthesis to provide drill holes and guiding lines to help the surgeon to place implants correctly.*

Table 1. *Details of the patients and implants placed*

Patient number	Age	Gender	Recipient site	Number of the implants inserted
1	47	F	Maxilla	2
2	42	M	Mandible	2
3	56	F	Maxilla	2
4	63	F	Maxilla	2
5	52	M	Mandible	2
6	43	M	Mandible	2
7	45	M	Maxilla	2
8	56	F	Mandible	2
9	77	F	Mandible	2
10	39	F	Mandible	2
11	42	F	Maxilla	2
12	34	M	Maxilla	2
13	54	M	Mandible	2
14	56	M	Maxilla	2
15	57	F	Mandible	2
16	54	F	Mandible	2
17	55	M	Mandible	2
18	50	M	Maxilla	2
19	41	F	Maxilla	2
20	47	M	Maxilla	2
21	43	F	Mandible	2
22	40	M	Maxilla	2
23	54	F	Mandible	2
24	60	F	Maxilla	2
25	62	M	Mandible	2
26	47	F	Mandible	2
27	40	F	Maxilla	2
28	55	M	Mandible	2
29	52	M	Maxilla	2

A standard surgical procedure was used to gain access to the edentulous side. After flap elevation, the bone was drilled using the customised template as a guide, taking precautions not to cause overheating. The implants (International Team for Implantology (ITI), Straumann AG, Waldenburg, Switzerland) of 3.3 to 4.8 mm width and 8-13 mm length were installed consecutively in the 29 patients *(Figure 3).* The implants were loaded with fixed prostheses at 6-8 weeks after surgery *(Figure 4).* The patients were followed up for at least three years,

This study was approved by the local ethics committee of Gülhane Military Medical Academy and School of Medicine. Written informed consent was obtained from all patients.

Results

Fifty-eight implants were placed in 29 patients. Twenty-eight were placed in maxillary free-end saddles and 30 in mandibular free-end saddles *(Table 1).* Seventeen of the patients were male and 12 were female. Their age range was from 34 to 77 years of age, with a mean age 50 years.

All implants were successfully placed using the customised surgical template. The immediate follow-up period was uneventful. After 6-8 weeks, ceramo-metal implant-supported bridge(s) or crown(s) were fitted for all patients. After a follow-up period of three years, no implant had failed.

Discussion

One of the most challenging aspects of dental implant placement is predictable spatial positioning of the implant in the bone. The surgical guide template is a vital tool during implant treatment. The prosthetic team can aid the surgical team by pro-

Figure 3. *Abutments in place. (Note the placement and angulation of the implants.)*

Figure 4. *Final prosthesis to replace 46 and 47 in situ three months after placement of implants.*

ducing surgical templates. Various designs have been proposed to aid implant placement [11-13]. Several authors have reported the use of computer-aided design surgical guide templates [14-17]. Others have preferred using custom-made surgical templates [11,18-22]. It has been claimed that dental implants placed using surgical guides are more accurately positioned than those placed without a guide [23,24]. Correct angulation and occlusal relationships can be assessed much more easily using dental casts, because the lingual tissues are not obscured by the tongue, than in the patient's mouth [21]. If a dental implant is inserted with correct angulation, the position of abutment will be suitable and will result in a functional and aesthetically pleasing prosthesis [18].

Recently, a new guidance technique called transtomography has been described [14]. It has been claimed that it appears to be as accurate as other guided or navigation systems [14].

Another new treatment method (CADDIMA), which combines both computerised tomography and optical laser-scan data for planning and design of surgical guides, implant abutments, and prosthetic devices, has recently been described [15]. It has been suggested that this new approach gives the operator full control over the design of the implant prosthesis for planning occusal relationships [15]. It has also been suggested, if present, a retained primary molar can be used as a surgical guide for implant insertion [25].

However, a computer-aided design surgical guide template increases the total treatment cost and involves exposing the patients to ionising radiation. A custom-made surgical guide template is cheaper than one that is made to a computer-aided design. It also eliminates the need to expose patients to radiation during its manufacture. This method allows precise placement of a dental implant, abutment, and provisional restoration in a minimally invasive manner [11]. The only disadvantage of a custom-made surgical template is that it is not possible to control the apico-gingival distance of the implant.

The growing interest in minimally invasive surgery, together with the possibility of fitting prostheses with immediate function, has led to the development of software capable of planning and manufacturing a surgical guide and prostheses that can be placed as soon as the surgery has been completed [26]. A very recent evaluation of the surgical and prosthetic complications of implant treatment in 12 patients using the guided surgery technique, reported a success rate of 69.5%, together with patient comfort during and after treatment [26]. A study involving 33 patients with edentulous upper maxillae who received implants which were loaded immediately reported a 91.9% success rate after one-year follow up [27].

Possible errors can occur in manufacturing surgical guides [28]. In the literature, it has been suggested that modelling of anatomical structures of maxilla and mandible through stereolithography is a technique that can be applied when planning surgery for implants [29] Another group of clinicians has proposed a technique for the rehabilitation of the edentulous mandible with osseous integrated implants, using anatomical replicas derived from a computerised tomography scan, linked to the rapid prototyping technique of stereolithography in

reverse planning, producing the definitive fixed prosthesis, with rigid union of the implants on the same day [30]. They have stated that the model in the reverse planning of oral rehabilitations had 100% less difficulty compared to dentate prototypes, which had 83.3% greater difficulty. Another very recently proposed method, based on the integration of a structured light vision system within a CT scan, has been used for pre-operative planning to evaluate the transfer accuracy of CT dental information into a periodontal surgical field [28]. It has been claimed that the use of an optical scanner leads to higher resolution and accuracy than CT scanning [28]. However, both methods are expensive and not available in everyday practice. Therefore it is important to develop methods that are easily available and usable. The authors of this paper therefore recommend the use of CSTs as more feasible and applicable in daily practice.

An earlier study [31] concluded that the stability of a surgical guide is compromised when natural teeth are present and that a surgical guide could be better adapted to the bone in edentulous areas. However, in the present study, teeth supporting the CST improved the stability of the guide and no problem regarding the stability of CST was encountered.

In comparison with previous studies, the retention rate in the current study of 100% for implants three years after their placement was excellent. In common with many of the previous studies cited in this paper, this study reports results for a relatively small number of patients who were followed-up for a relatively short time after implant treatment. As such, it should be regarded as a preliminary study. A larger patient sample followed-up for a far longer period is required before definitive conclusions can be made

Conclusions

Within the limitations of the study, the results indicated that the use of a customised surgical template:

- Led to reduced patient radiation exposure than if a computer-designed template had been used.
- Was an economical and simple technique.
- Allowed the surgeons to place implants with a correct angulation and occlusal relationship.

Contribution of each author

- HAA and MS conceived and designed the study.
- AG gathered the data, participated in its analysis and interpretation, wrote the paper and reviewed the manuscript.
- All the authors read and approved the final manuscript.

Statement of conflict of interests

The authors declare that they have no conflict of interests.

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