Evaluation of the Precision Obtained with a Fixed Surgical Template in the Placement of Implants for Rehabilitation of the Completely Edentulous Maxilla: A Clinical Report

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The fabrication of a complete maxillary implant-supported prosthesis in a patient with slight resorption of the alveolar ridge and a high lip line presents a professional challenge. The implants must be placed with high precision to achieve good esthetics, phonetics, and function. A fixed surgical template using microimplants has been developed for this purpose. The objective of this investigation was to compare a fixed surgical template (FST) to a conventional movable surgical template (MST) for the precise placement of implants in the slightly resorbed edentulous maxilla. Three patients (28 implants), edentulous in the maxilla, with slight ridge resorption, in whom the implants were placed with an FST, were compared with 5 controls having the same characteristics and implants placed with an MST (35 implants). After completion of the prosthesis, occlusal photographs (1:1) were taken, and these images were scanned and transferred to a drawing program in which the contours of the teeth, the ideal emergence position of the occlusal hole of the abutment screw, and its real position were drawn. A blind evaluation was made using the following variables: frequency of location of the abutment screw hole outside of the tooth contour, and the relative measurements of the area of coincidence between the circle that represents the ideal position and real position. A significantly smaller frequency of implants outside the tooth contour was seen with the FST (7%) than with the MST (46%) ($P < .0008$). Also, a significantly higher relative area of coincidence was observed between ideal position and real position in the FST (0.61) than in the MST (0.38) ($P < .003$). This study revealed that considerably higher precision was associated with the use of an FST. (Int J Oral Maxillofac Implants 2000;15:272–277)

Key words: *completely edentulous patient, esthetics, fixed surgical template, implants, microimplants, osseointegration, profile surgical template*

The intraoral fixation of a surgical template, an essential requirement for its precision, has been achieved in the partially edentulous patient.[1–13] However, for the completely edentulous patient, this presents a major problem.[7,8,14–17] Except for a few rare exceptions, the need for a surgical template in the treatment of the edentulous mandible is very infrequent, but when rehabilitation of the maxilla is undertaken, the use of a template is important.

Rehabilitation of the completely edentulous maxilla with an implant-supported prosthesis is an extremely complex process.[18] It requires function compatible with good esthetics and phonetics, without compromising hygiene maintenance. These objectives can be easy to achieve, depending on the resorption pattern in each case. As the maxilla is resorbed, the residual alveolar ridge moves superiorly and medially in a more palatal and cranial position relative to the location of the future tooth replacements. There is, however, extensive variability from patient to patient,[19] and as a consequence,

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it is necessary to determine the degree of existing resorption during preoperative diagnosis, so as to determine the ideal type of prosthesis for each situation and informing the patient.[19]

Several authors have attempted to systematize the decision-making process in prosthesis design for patients who are completely edentulous in the maxilla.[18–20] The essential orientation criteria include: the possibility of placing implants in an ideal position, the smile line of the patient, the need for additional lip support because of the horizontal loss of ridge volume, and the possible requirement of a palatal flange to accommodate vertical ridge resorption.

Thus, 4 different types of restoration could be considered for the rehabilitation of a completely edentulous maxilla:

1. An overdenture[19,21]
2. A hybrid removable prosthesis with precision-milled bar[19,20,22,23]
3. A fixed prosthesis with space beneath for oral hygiene and a removable labial resin veneer[18]
4. A fixed prosthesis with the design of a fixed partial denture[19]

To select the type of surgical template to be used, 2 options are available:

1. Implant-supported dentoalveolar prosthesis. Restoration types 1, 2, and 3 are included here. A common finding in these patients is considerable resorption of the residual alveolar ridge, which for esthetic, hygienic, or phonetic reasons must be replaced with a prosthesis, incorporating a removable labial resin veneer or the vestibular and palatal flanges of a hybrid prosthesis or an overdenture. In these patients, the position of the implants will be covered by the vestibular flange. The precision of implant placement to achieve a good tooth-implant relationship will not be so necessary, and, as a consequence, the implants can be placed with greater freedom, allowing the surgeon to select the sites where the best bone is available. A profile surgical template stabilized by a removable acrylic resin base is indicated.[1]
2. Implant-supported dental prosthesis. This category corresponds to the fixed prosthesis with the design of a fixed partial denture mentioned above. The candidates for this type of prosthesis are those who have lost their teeth but have not suffered significant resorption of the residual alveolar ridge; as a result, the restoration will have to replace the teeth only. In these situations, which are extremely difficult when the smile line is high, both precision of implant placement and good tooth-implant relation are essential. Since teeth are not available for template retention, bone anchorage is necessary. Previous studies have suggested intraoral use of cortical miniscrews,[24] as well as the use of transmucosal implants.[25] Based on these experiences, a miniature implant has been designed to fix the profile surgical template in the completely edentulous maxilla with the precision and comfort characteristic of the partially edentulous patient.

The objective of the present study was to compare the precision of placement of implants in patients edentulous in the maxilla, with slight alveolar ridge resorption, who have been rehabilitated with implant-supported dental prostheses, using surgical templates fixed with microimplants to the precision of a conventional movable template.

The clinical sequence for the application of this technique is as follows. A preoperative wax-up study is made, from which a conventional surgical template is fabricated (labial resin veneer). Once the possible locations for implant placement are decided upon, 4 positions for the transmucosal placement of the microimplants (Fig 1a) are chosen. These normally are those that correspond to the maxillary lateral incisors and the first or second molars (Fig 1b). After placement of the microimplants, impression copings are inserted into them and an alginate impression is made. With the help of the corresponding laboratory microplant analog, a master cast is made. Using this master cast, the definitive wax-up is made, and the profile surgical template, supported by the 4 microimplants, is fabricated (Fig 1c). Following template fabrication, an appointment is made for placement of the definitive implants. Inflammation, both facially and around the microimplants, is generally minimal. Surgery can be carried out without the need to remove the template from the mouth, with complete comfort both for the surgical team and the patient (Fig 1d). Once the surgery has been completed, the microimplants are removed with a simple manual square screwdriver and, after suturing, normal healing is achieved. Accuracy of the implant placement can be observed in the finalized restoration (Fig 2).

METHODS

Eight consecutive patients, edentulous in the maxilla, with slight ridge resorption and a high smile line, restored with implant-supported dental prostheses, were selected. Three of these were treated using a fixed surgical template (FST) secured by the use of microimplants, and 5 were treated using a movable surgical template (MST).

Fig 1a Placement of the microimplants.

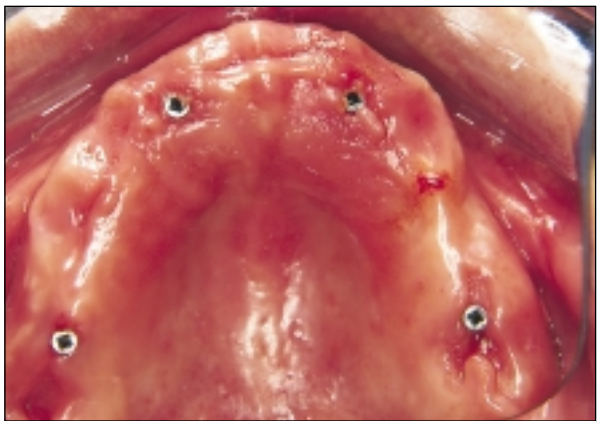

Fig 1b The 4 microimplants in position.

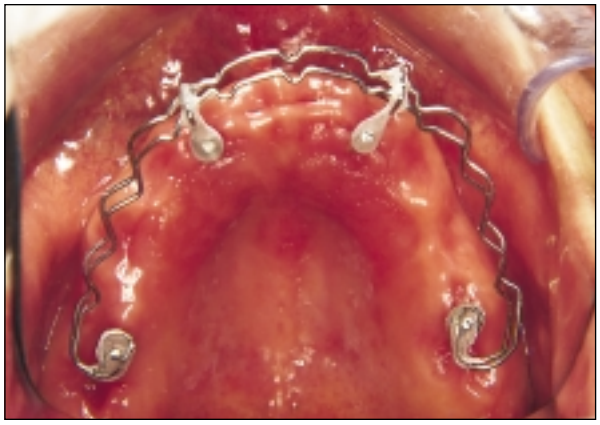

Fig 1c The fixed template is placed on the microimplants.

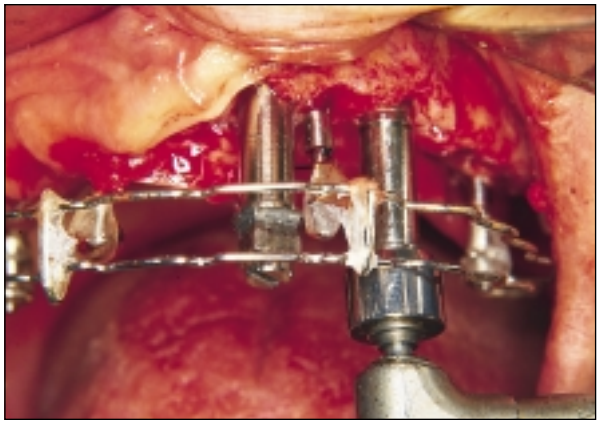

Fig 1d The placement of 8 implants is carried out without the need for removing the template during the procedure. Placement of the 4 implants that correspond to the right side of the maxilla is illustrated in the photograph.

In the first group (FST), 2 of the patients were female, the mean age was 45, and 28 implants were placed; in the second (MST), 3 patients were female, the mean age was 50, and 35 implants were placed.

For all patients, the final prostheses were fabricated according to the previous wax-up, and no angulated abutments were used. Once the prosthesis was finalized, an occlusal photograph, with standard magnification, was taken (Fig 2a). The images were then incorporated into a drawing program (Aldus FreeHand 7, Macromedia, San Francisco, CA); the contours of the teeth were drawn; and the real positions (RP) of the abutment screw holes were represented by means of a circle with a standard diameter (Fig 2b).

Each image was then duplicated, and the circle that represented RP was removed; a second examiner, blinded to the procedure, proceeded to place a circle of the same diameter in the ideal position (IP) that the abutment screw hole should have (in the center of the occlusal face of the premolars and molars, and in the cingulum of the anterior teeth) if the surgeon successfully placed the implants according to the wax-up (Fig 2c). Following these, both images were superimposed, and the area of intersection between the circles, which represented RP and IP of the abutment screw, was obtained (Fig 2d).

The area of coincidence was later measured using the Global Lab Image 2.10 program (1993) (Data Translation Inc and Automatix Inc, Marlborough, MA). The measurements were expressed in relative values (relative area of coincidence), giving a value of 1 to the total coincidence and a value of 0 when the circles drawn did not possess common points. Simultaneously, starting from the image corresponding to RP, the number of cases in which the abutment screw hole invaded the contour of the corresponding tooth for each group was recorded.

Fig 2a Occlusal photograph of a patient in the study.

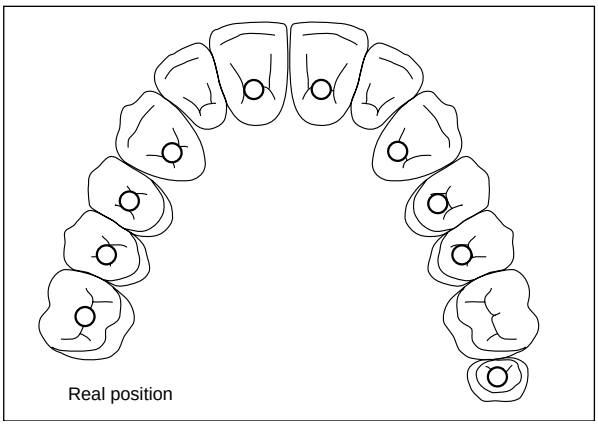

Fig 2b Representation of the profile of the teeth from an occlusal view. The real position of the abutment screw hole is shown.

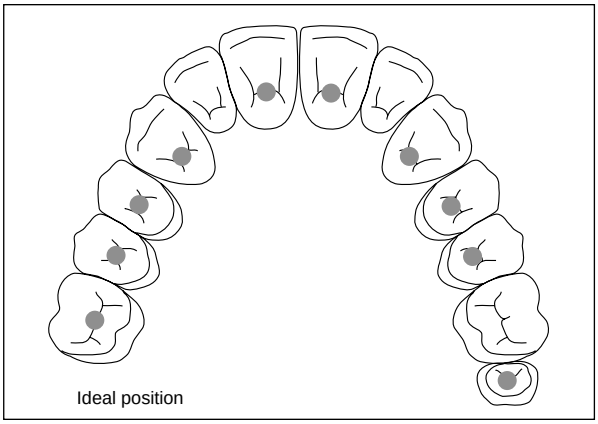

Fig 2c The ideal position, selected by an examiner blended to the procedure, is detailed.

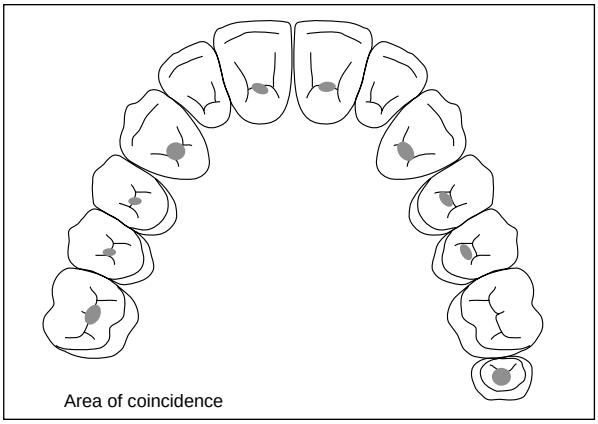

Fig 2d Relative area of coincidence of real and ideal positions.

Statistical analysis was made using SPSS for Windows 6.0 (Chicago, Illinois). The variable "relative area of coincidence" was treated as a quantitative variable, and its possible association with the variable "type of template" was studied using the Student's *t* test. The associated risk of invasion of the contour of the tooth according to the type of treatment was studied using the odds ratio.

RESULTS

In the group treated with the MST, the relative area of coincidence between the circles (which represents the real and ideal positions of the abutment screw hole) was 0.38, significantly smaller than that observed in the patients treated with the FST, where this increased to 0.61 (P = .003). This significant relationship between the variable relative area of coincidence and the type of surgical template presents an intensity of 0.36. The mean difference between both groups was 0.23, whose confidence interval for an alpha risk of 0.05 ranged between 0.08 and 0.36.

In accordance with these data, a significant increment of precision of 61% is associated with the use of the FST, whose confidence interval for an alpha risk of 0.05 ranged between 22 and 101% (Table 1, Fig 3).

In the evaluation of frequency of invasions of the tooth contour by the abutment screw hole, it was seen that these were significantly more frequent (P = .00016) in the patients treated with the MST (16/35, or 45.7%) than in those treated with the FST (2/28, or 7.1%). The intensity of this relationship was 0.42. In accordance with these data, the use of an MST in this type of patient was associated with a risk 10.94 times greater of causing invasion of the tooth contour. In clinical terms, 91% of the risk

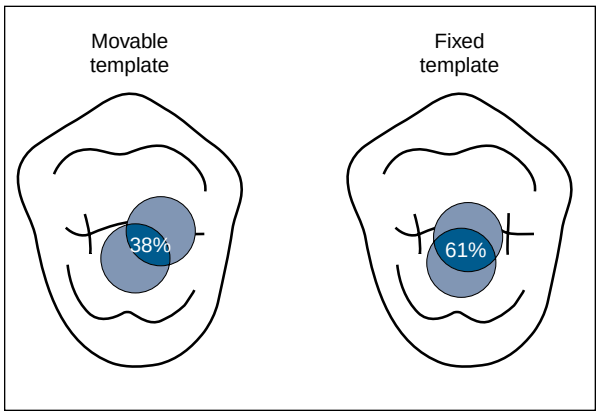

Fig 3 Areas of coincidence between real and ideal positions in the study.

Table 1 Area of Coincidence Between Real and Ideal Positions

Template	n	Mean	SD	SE
Movable	35	0.38	0.34	0.05
Fixed	28	0.61	0.25	
Total	63			

Student's *t* test: t = 3.13; df = 60.84; *P* = .003.
Mean difference = 0.2323; SE = 0.074; 95% confidence interval = 0.084 to 0.381.

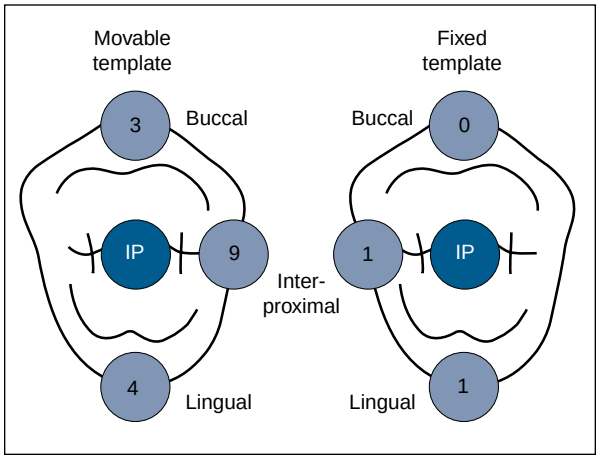

Fig 4 Location and number of invasions of the tooth contour with respect to the type of template used.

Table 2 Invasion of the Tooth Contour with Respect to the Type of Template Used

Template	Invasion	No invasion
Movable	16	19
Fixed	2	26
Total	18	45

Chi-square test = 11.34; df = 1; *P* = .00076. Phi = 0.42; *P* = .00066.
Odds ratio = 10.94; 95% confidence bounds = 1.38 to 19.67.
Odds ratio-1/odds ratio = 0.91 (91% risk of invasion, MST).

of invasion is related to the use of the movable template (Table 2, Fig 4).

In the group treated with the FST, the "abutment screw hole" did not invade the vestibular face of the tooth in any of the patients. This, however, did occur in 3 patients (8.6%) in the group treated with the MST. In the latter group, the contour was invaded in 9 patients (25.7%) in the interproximal spaces, which affects the position and form of the papillae, while this only happened in 1 patient (0.04%) in the group treated with the FST.

DISCUSSION

In accordance with the experience of the authors, application of the profile surgical template fixed with microimplants in the patients with totally edentulous maxillae with implant-supported prostheses satisfies the requirements as established in previously published reports for the partially edentulous patient,[1] allowing adequate precision and comfort. Initially, its use will be indicated in a small group of patients: those with completely edentulous maxillae with minimum resorption and significant esthetic requirements. Its utilization involves minimal additional surgery that rarely presents complications for the patient or the surgeon and only a little extra time in the treatment, which, in this type of patient, may be compensated by the results achieved.

This is a retrospective review; consequently, it is not possible to establish a cause-and-effect relationship between the type of treatment and the variables that represent the precision involved in the implant placement (relative area of coincidence and frequency of invasions of the tooth contour). Therefore, the conclusions must be limited to establishing highly significant associations. However, the careful

selection of controls and the fact that the examiner who determined the ideal position of the abutment screw hole was blinded to the type of treatment given (FST or MST) make potential generalization of the results more feasible.

The precision in the placement of the implants has been analyzed by means of employing 2 variables, which represent the deviation of the surgeon from his ideal objective. From a practical viewpoint, these results appear to relate the use of a fixed template with a clinically significant improvement in the placement of the implants: an increment of precision of 61%, and a risk of invasion of the tooth contour 11 times lower. This represents considerable reduction in the esthetic problems related to incorrect placement of the implants and facilitates the work of the restorative dentist, allowing him or her to achieve the best possible results from the esthetic, hygienic, and phonetic points of view.

CONCLUSION

According to the methodology of the present study, it can be concluded that considerably higher precision is associated with the use of a fixed surgical template in the placement of implants in patients with edentulous maxillae with slight resorption of the alveolar ridge.

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