

# AN INSTRUMENT FOR THE OPTIMAL GUIDING OF OSSEOINTEGRATED DENTAL IMPLANTS

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## KEY WORDS

Single stage dental implant  
Surgical guide template  
Implant placement  
Parallelism

The purpose of this study was to design an instrument for the optimal guiding of osseointegrated implants intraoperatively to achieve parallelism or desired angulations. Seven patients (4 males and 3 females) were enrolled in the investigation. They ranged in age from 44 to 61 years. Using an instrument designed by the senior author that permitted optimal guiding of the osteotomy instruments (33 Osteofix Oy, Oulu, Finland) we placed in these patients, root form, single stage implants. The difference in angulations between the first and the remaining implants was measured using the abutment replicas on the working models. It was found that the mean deviation angle between the first and the adjacent implant replicas was  $2.2^\circ$  (SD =  $0.4^\circ$ ). The largest deviation angles were  $2.3^\circ$  (SD =  $0.5^\circ$ ) and  $3.1^\circ$  (SD =  $0.8^\circ$ ). The study indicated that the instrument had been designed in a functional manner and that all implants in such relationships can be inserted into their desired positions, either parallel to one another or with the desired angle for the planned prostheses.

## INTRODUCTION

The optimal positioning of oral implants ensures good biomechanical, functional, esthetic, and phonetic results.<sup>1</sup> Oral implants serve as apical extensions of the restorations which they support; therefore, the direction of force delivered to the future prosthesis should be in relative conformity with the angulations of the implants. Implants to be used as overdenture abutments function most successfully when they are parallel to one other. This ensures good attachment retention and prevents premature wear of compo-

nents.<sup>2</sup> During implantation, it is sometimes difficult to determine the optimal implant position according to the prosthesis.<sup>3</sup> Therefore, implant placement is planned preoperatively on plaster jaw models using wax modeling, orthopantomograms, or CT scans.<sup>4,5,6</sup> Locations of the implants are critical because the position of the future prosthesis in the dental arch is dependent on those factors.<sup>7</sup> To facilitate accurate implant positioning, the authors have developed a new template. There are radiologic,<sup>1,8-12</sup> surgical, and combined templates<sup>13,14</sup> currently in use. However, using templates intraoperatively introduces certain problems. The greatest

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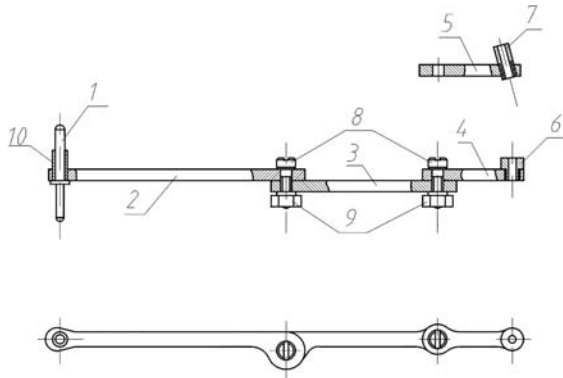


FIGURE 1. Instrument for optimal guiding of dental implants. 1, Supporting axis. 2, 3, Horizontal bars. 4, Horizontal marginal bar with parallel drill guiding bushing (6). 5, Horizontal marginal bar with angled drill guiding bushing (7). 8, Screws. 9, Nuts. 10, Bushing for instrument fixation on the supporting axis (1).

among them is template instability in cases where no neighboring teeth exist.<sup>1,12</sup> Another difficulty arises because implant position (even when using CT scans) is planned on plaster models or on virtual pictures of the jaw without the benefit of visual evaluation of the possible abnormalities of the planned host sites. Finally, danger of overheating the bone arises because the presence of the template may hinder the direct flow of coolant.<sup>15,16</sup>

It is relatively easy to choose the optimal implant positions in cases where there is sufficient bone, such as the anterior mandible. This is facilitated by studying the qualities of the jaw on plaster models and radiographs. Despite these studies, without the use of templates it is difficult to keep the implants parallel to one another during surgery. Although "flags" and other indicators of direction are used for that purpose, these methods also lack accuracy.<sup>17</sup>

The purpose of this study, therefore, was to design an instrument for ensuring parallelism between the implants and their abutments.

#### MATERIALS AND METHODS

Seven patients (4 males and 3 females) were enrolled in this

investigation. Their ages ranged from 44 to 61 (mean age = 52). All of their mandibles were edentulous. Their classifications of atrophy were types C and D.<sup>18</sup> Implantation in the anterior mandible between the mental foramina was performed using 33 Osteofix Oy (Oulu, Finland) single-stage implants. Their diameters were 3.8 mm and 4.2 mm, respectively, and their lengths were 12 mm and 14 mm, respectively.

The implantations were planned preoperatively on plaster jaw models using wax modeling, orthopantomograms, and, for the more complicated cases, CT scans. After having assessed the dimensions and the degrees of atrophy, the angulations and the implant numbers were planned on the plaster models. The final implant positioning, however, was performed during the surgical operation. After elevation of mucoperiosteal flaps, the bone was evaluated visually and marks were made with a round bur at the prospective implant sites. A safe distance was maintained between the most distal implants and the mental foramina or the loops of mandibular canals. This was followed by selection of the optimal implant direction as de-

termined by the exercises performed on the plaster models. The new instrument (Stilus Optimus Company, Kaunas, Lithuania) for optimally guiding the osteotomies was used to set the angulations (Figure 1). The bars of the instrument were expanded and placed on the alveolar process of the jaw so that bushings 6 and 10 matched precisely the positions of the most distal implants (Figure 2). They will fill the important role of setting the angulations for future implants. The optimal angle of the implants was selected by changing the angle of inclination of bushings 6 and 10 labiolingually. The first osteotomy was made with a pilot drill placed in bushing 10 (Figure 3). This was followed by enlarging with a 2-mm drill (Figure 4). Horizontal bar 2 was then put on that axis, and bars 3 and 4 were hinge-connected to it. The drill used in bushing 6, the axis of which was parallel to supporting axis 1, was placed in marginal bar 4. If the implant was to be placed at an angle, nut 9 was loosened from screw 8 and marginal bar 4 was changed to bar 5, which had represented the angle of the drill guided into bushing 7.

All the bars were connected with supporting axes by means of placing them in bushing 10, which had been affixed to bar 2, which, in turn, was put on the supporting axis. In this way the bar-hinge connection to supporting axis 1 was mobile, permitting it to move in one plane. When the instrument was fixed on the alveolar process, the next vital point on the alveolar process could be reached, but only by means of 3 additional mobile junctions accessible between the bars. Guided by the new instrument, the holes were drilled one after another from patient right to left (Figure 5). In cases of vertical

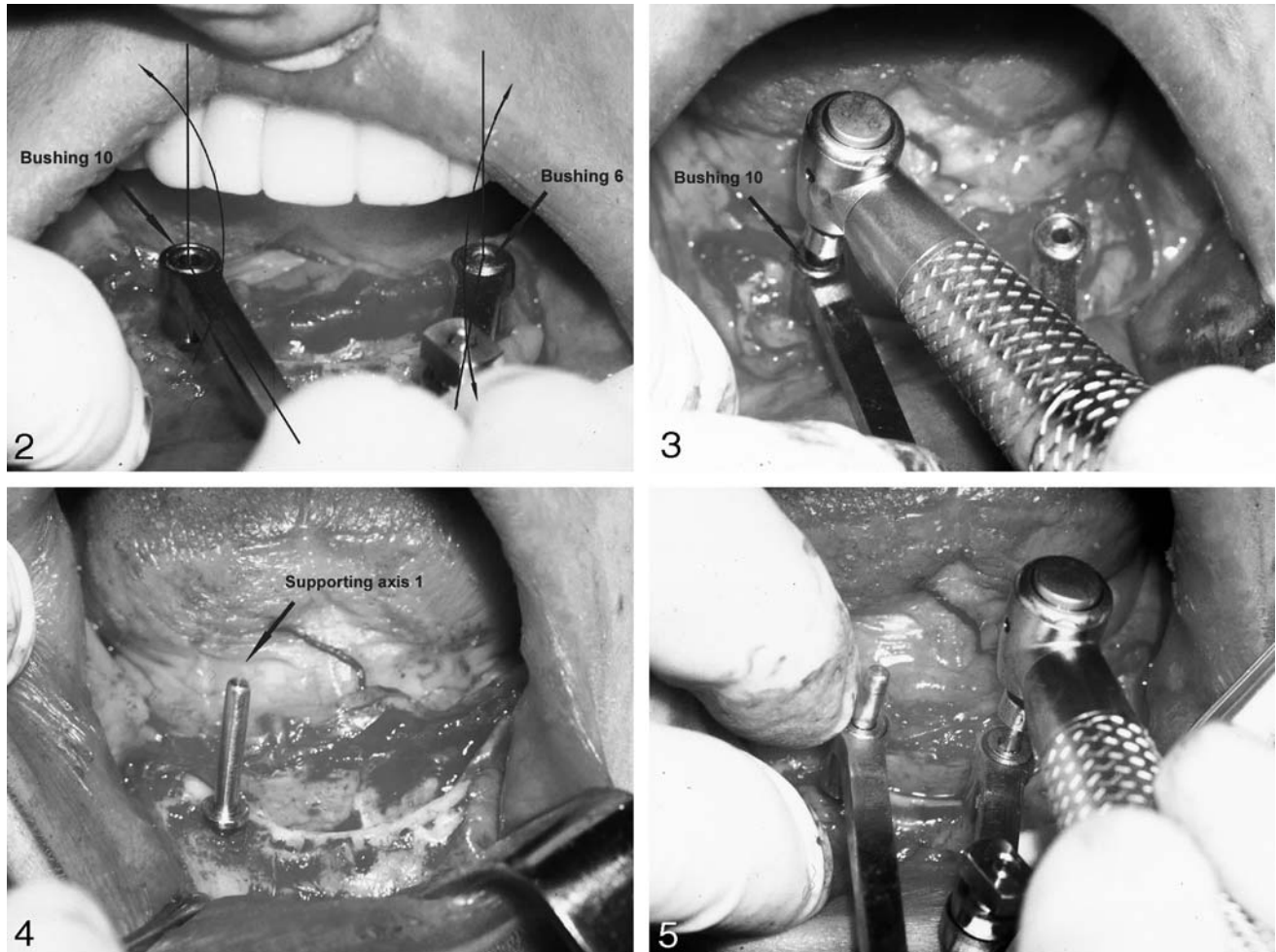


FIGURE 2. Bars of the instrument are expanded and placed on the alveolar process of the jaw so that bushings 6 and 10 precisely match the positions of the 2 distalmost implants. The optimal angle of the implants is selected by changing the angle of inclination of bushings 6 and 10 in labiolingual and mesiodistal directions. FIGURE 3. First clinical osteotomy placed for implant insertion is completed with a 2-mm diameter pilot drill placed in bushing 10. FIGURE 4. Supporting axis 1 is placed rigidly in the prepared 2-mm osteotomy that had been made through bushing 10. FIGURE 5. Using the guidance of the new surgical instrument, the osteotomies are made one by one from patient right to left.

alveolar irregularities, which blocked movement of the instrument, a corrective alveoloplasty was performed. This ensured free movement of the bars and simplified the construction of the future prosthesis, affecting both the functional and esthetic results. The available bushings are exchangeable because, in the process of drilling, the diameter of the bushing in use may no longer assure firm guidance of the drills; this results in poorly aligned, inaccurately sized, or nonparallel osteotomies. However, based on

the proper application of the bushings and the constancy of parallelism of the supporting axis with them, all the implants will be either parallel to one another or angulated in the presurgical plan.

Use of this new drill-guide instrument permits enlargement of the osteotomies and placement of implants in accordance with the classical technique.<sup>19</sup>

Impressions were taken and working models prepared 3 months postoperatively using implant replicas. Long fastening screws were screwed into the implant

replicas. The working model containing these long screws was mounted on a milling machine with its guide pin placed in alignment with the long fastening screw of the first implant (Figure 6a). Then the angles of the fastening screws in both labiolingual (angle  $\alpha$ ) and mesiodistal (angle  $\beta$ ) directions were made parallel to the first implant's fastening screw by use of the milling machine (Figure 6b and c). The angles between the directions of the first implant and the remaining ones were calculated using an accept-

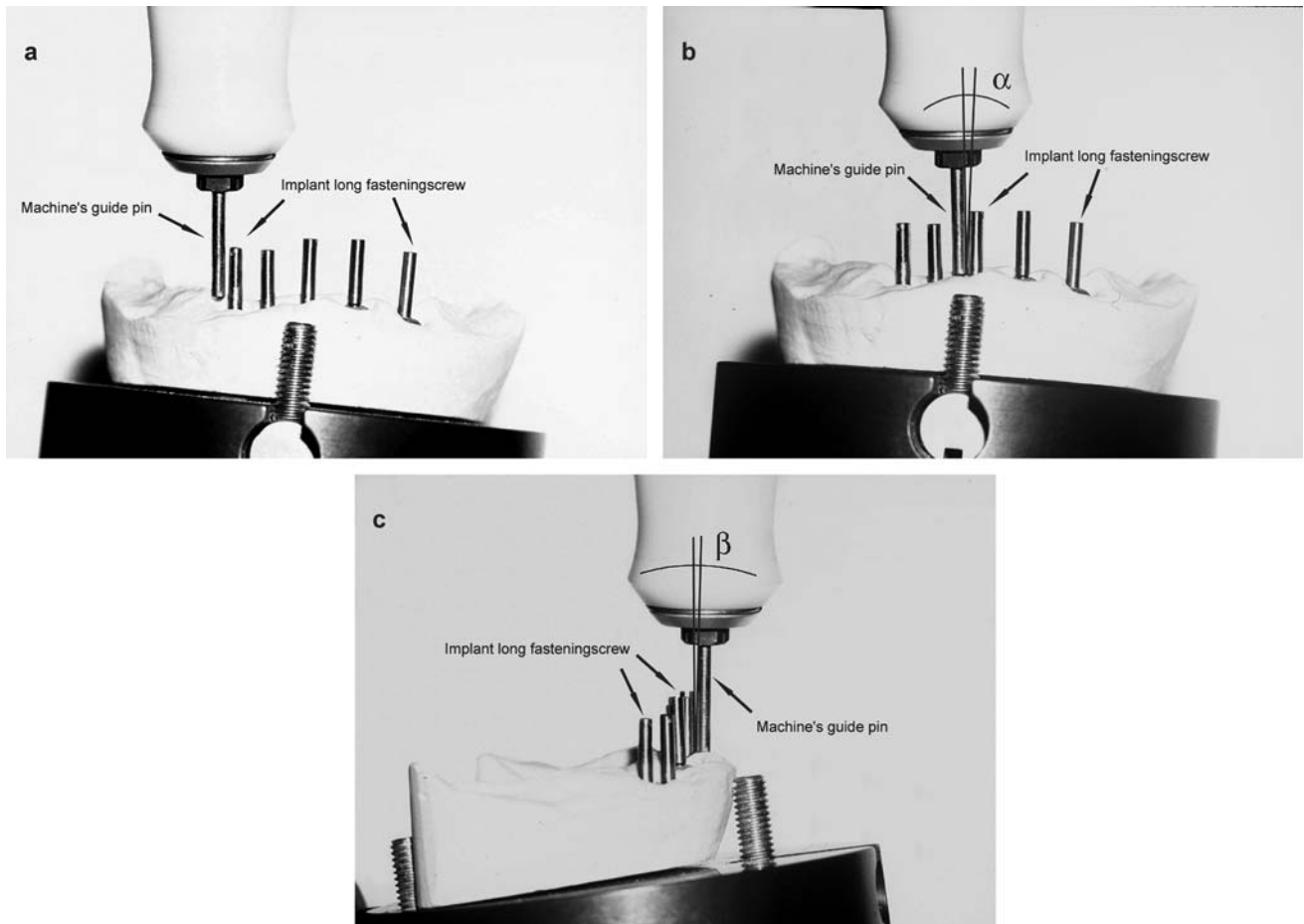


FIGURE 6. Working model with long fastenings screws mounted on a milling machine. (a) Machine's guide pin is set parallel to the first implant's long fasteningscrew. (b) Inclination of long fasteningscrew (angle  $\alpha$  in labiolingual direction). (c) Inclination of long fasteningscrew (angle  $\beta$  in mesiodistal direction). The angles are measured in relationship to the first implant's long fasteningscrew by the milling machine.

ed formula.<sup>20</sup> Statistical analyses were performed using the SPSS/PC+ version 10.0.1 program (SPSS Inc, Chicago, Ill). Standard deviation of the mean was calculated.

## RESULTS

The inferior border of the mandible was not perforated during the implantation operation in any of the patients, and all 33 of the implants placed were suitable for prosthesis fabrication 3 months postoperatively. After the working models were prepared and the parallelism of the implant-replica, long fastenings screws was

assessed, it was found that the mean deviation of the angles between the first and next replica was  $2.2^\circ$  (SD =  $0.4^\circ$ ). The largest deviation between angles of the first and the fourth and fifth long axes was  $2.3^\circ$  (SD =  $0.5^\circ$ ) and  $3.1^\circ$  (SD =  $0.8^\circ$ ), respectively (table).

## DISCUSSION

Most implant, overdenture abutments, and related components require parallelism within  $10^\circ$  to function properly.<sup>21</sup>

One of the most common methods of ensuring correct implant angulation is the use of

surgical templates.<sup>1,9-14</sup> As discussed in earlier paragraphs, the use of templates may be responsible for bone overheating, difficulty in stabilization of the guide, or poor visualization of the planned host bone.

The use of "flags" and direction indicators<sup>17</sup> to affirm the parallelism of implants is also limited because their presence makes it difficult to drill adjacent osteotomies with precision, and in some instances, local conditions prevent placement of such markers.

The newly designed instrument described and pictured herein is meant to optimize the

positioning of implants during their surgical placement. This surgical guide is designed to allow all the planned implants to be inserted into their desired positions, either parallel to one another or at preconceived angulations. Thus, the final positions of the implants can be visualized (ie, with respect to bone quality and quantity) in advance of performing the first osteotomy. This instrument was employed on 7 patients who had undergone implant procedures in the interforaminal region of the mandible. It can be used as well in other areas of the jaws where multiple implants are planned.

The instrument described in Materials and Methods permits optimal placement of multiple adjacent implants and is rather precise. It was found that the mean deviation of the angulations of multiple implant abutment replicas on our working models was  $2.2^\circ$  (SD =  $0.4^\circ$ ). The greatest deviation was between the first and the last 2 implant replicas. This may be explained by the realization that the first osteotomy into which the supporting axis of the instrument had been inserted enlarges a bit under the pressure of the drilling, causing the position of the entire instrument to change. To minimize this event, we have been drilling 2 or 3 osteotomies and moving the supporting axis forward into the most recently created site. Nevertheless, when using our instrument, the largest deviation we found between the first and the adjacent replicas has been only  $4.1^\circ$ . By comparison, when the same procedures were completed using traditional surgical templates, the largest deviations were found to be as much as  $14.5^\circ$ .<sup>20</sup>

In conclusion, the instrument described in this article for im-

TABLE 1  
Data regarding patients, number of implants and difference of angulation

	Gender	Age (years)	Number of implants	Angulation (degrees)					Mean	SD
				1	2	3	4	5		
Patient 1	male	55	5	0	1,2	1,5	1,7	2,3	1,7	0,5
Patient 2	male	61	5	0	1,0	1,7	1,9	3,0	1,9	0,8
Patient 3	female	47	4	0	2,0	1,9	2,4		2,1	0,3
Patient 4	female	51	5	0	2,1	2,3	3,2	4,1	2,9	0,9
Patient 5	male	54	4	0	1,8	2,2	2,7		2,2	0,5
Patient 6	female	44	5	0	1,5	1,8	2,0	2,5	2,0	0,4
Patient 7	male	52	5	0	1,8	2,1	2,4	3,8	2,5	0,9
Total			33							
Mean		52			1,6	1,9	2,3	3,1	2,2	
SD		55			0,4	0,3	0,5	0,8	0,4	

plant placement offers precise results and facilitates placement by savings of time and effort.

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