Study About the Precision of Surgical Guides Used in Implantology

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The purpose of this study was to detect the precision of inserting dental implants using 3 types of surgical guides on 3 groups of patients according to the degree of implantologist experience. In this study, 27 patients were taken, in 3 groups of 9 patients, who addressed to dental offices in which were implantologists with 1 year (group A), 6 years (group B) and 11 years (group C) of experience in surgery. Lot A, operated by a 1-year physician with experience in implantology, had the smallest deviation, demonstrating the increased attention that he had to the interventions. Comparing B and C lots, the smallest deviations were recorded for group C, operated by implantologist with greater experience in implantology. By comparing the deviations according to the type of surgical guide used, the smallest deviations at the apex and prosthetic platform were made in patients where the implants were inserted with a bone supported guide, followed by dental-gingival and mucosal guide. In terms of axis of implantation, the lowest values were recorded for the dental-gingival guide, followed by the bone and mucosal guide. The study has a number of limitations (low number of patients undergoing study, low dispensation period), which requires more extensive future studies to validate the results.

Keywords: dental implant, surgical guide, CBCT, SimPlant®

Computerized tomography, introduced as a method of diagnosing and monitoring dental treatment in the late 1980s, made it possible to produce guides that allowed physicians to insert dental implants with a high precision. [1]

Guided surgery is a procedure that has been successfully used for more than 10 years, as shown by clinical trials [1, 2] and systematic reviews [3-5].

Initially, the use of guided surgery techniques was limited to complex cases, especially for totally edentulous patients; in fact, patients were subjected to conventional computerized axial tomography, involving exposure to significant amounts of ionizing radiation, to obtain information about bone anatomy [3-5].

By serigraphy or thermoforming a surgical guide is obtained, which has metal tubes with predefined diameter and angulation to allow the incision of the mucosa, the drilling and the insertion of the implants at the desired angulation and depth.

The purpose of this study was to detect the precision of inserting dental implants using 3 types of surgical guides on 3 groups of patients according to the degree of implantologist experience.

Experimental part

In this study, 27 patients were taken, in 3 groups of 9 patients, who addressed to dental offices in which were implantologists with 1 year, 6 years and 11 years of experience in surgery.

The inclusion criteria in the study were: the age of patients over 18 years, general health that did not contravene oral surgery, the availability of presentation at treatment sessions and the acceptance of preoperative CBCT and post-operative control on the same CT scanner.

Each patient signed informed consent, and the study was conducted in compliance with the Helsinki Declaration on Ethical Standards [6].

The three dental offices were rated 1, 2 and 3, and the three lots A, B and C în a period of three years. After the treatment with the SimPlant® software and the surgical guides, the interventions were performed.

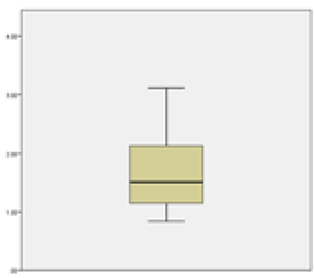
Each patient performed a new CBCT scan on the same device after surgery and the images obtained were superimposed virtually in the Simplant® software and measurements were performed to assess deviations from the initial planning.

The results were centralized into a table and statistically processed with the IBM SPSS Statistics 22 software.

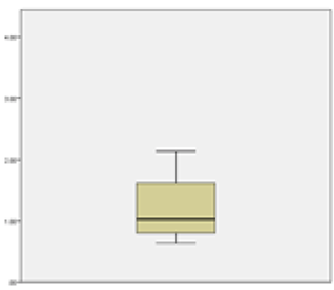
Results and discussions

For each of the 121 inserted implants, was calculated deviation from the apex, deviation from the prosthetic platform and deviation from the axs of implantation.

At group patient A, implantation deviation ranged from 0.84 - 3.11 mm, with a median value of 1.76 mm (graph 1). Deviation at the prosthetic platform ranged from 0.64 mm - 2.14 mm, with a median of 1.21 mm (graph 2). Deviation from the axis of implantation ranged from 0.69 ° to 2.13 ° with a median of 1.35 ° (graph 3).



Graph 1-Apex deviation in A group



Graph 2 - Prosthetic platform deviation in A group

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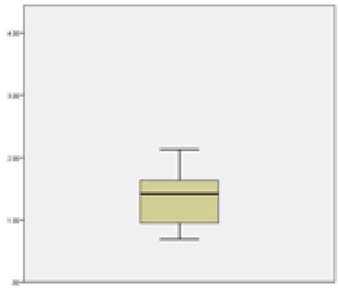
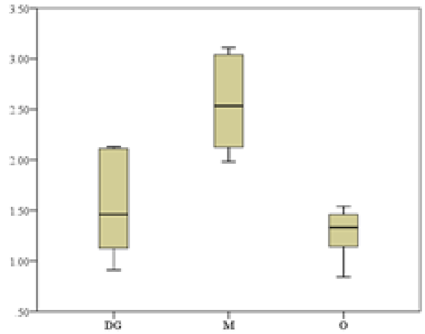
All authors have equal contributions to the study and the publications.



Graph 3- Deviation from the axis of implantation in A group

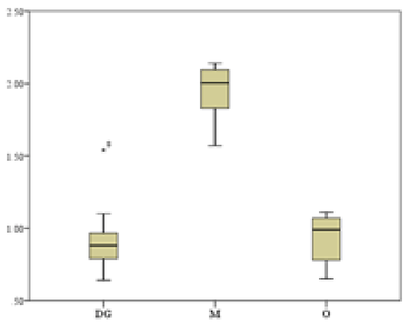
For the A group of patients, 5 surgical guides with dento-gingival support, 2 surgical guides with bone support and 2 surgical guides with mucosal support were used.

Deviations have been calculated by type of guide. At apex of implants, mean deviation were 1.56 mm for guides with dental-gingival support, 2.56 mm for guides with mucosal support, and 1.28 mm for bone support surgical guides (graph 4).



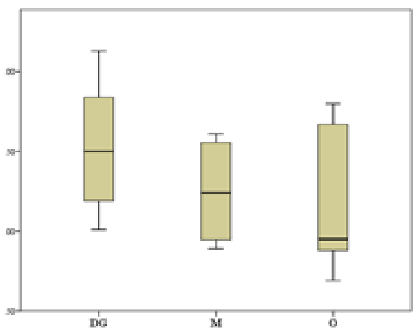
Graph 4- Apex deviation calculated according to the type of support of surgical guides used in group A (DG = guides with dental-gingival support, M = guides with mucosal support, O = guides with bone support)

In group A, median deviations recorded at the prosthetic platform were 0.92 mm for guides with dental-gingival support, 1.95 mm for surgical guides with mucosal support and 0.91 mm for bone support surgical guides (graph 5).



Graph 5- Deviation at prosthetic platform level based on support type of surgical guides used in group A

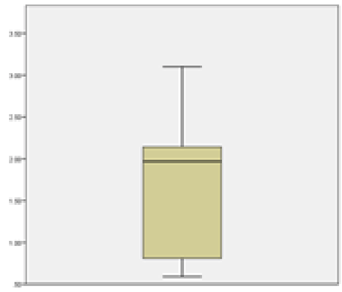
At the implant axis, for patients in group A, in the case of surgical guides with dental-gingival support we found a deviation between 1.01 - 2.13°, with a median of 1.53°, in the case of surgical guides with mucosal support we found a deviation between 1.12 and 1.38°, with a median of 1.25°, and in the case of bone support surgical guides, the deviation was between 0.69 and 1.8° with a median of 1.22° (graph 6).



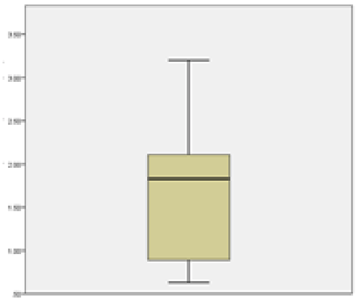
Graph 6 - Deviation at the implant axis according to the type of support of surgical guides used in group A

For group B, the deviation at the implant apex ranged from 0.59 mm to 3.1 mm (graph 7), deviation at the prosthetic platform ranged between 0.63 mm - 3.2 mm (graph 8) and at the implant axis the deviation varied between 1.49 - 3.61° (graph 9).

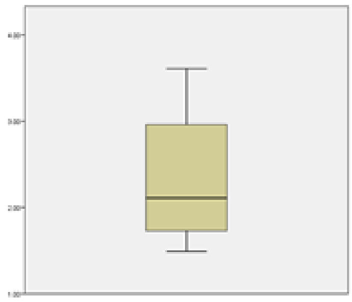
For group B, 4 surgical guides with dental-gingival support, 3 bone support surgical guides and 2 guides with mucosal support were used. Apex deviation was for guides with dental-gingival support between 1.85 mm - 2.01 mm, between 2.01 mm - 2.7 mm for guides with mucosal support and between 0.59 mm - 3.10 mm for guides with bone support (graph 10).



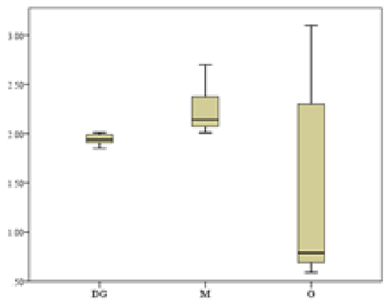
Graph 7- Apex deviation in B group



Graph 8 - Prosthetic platform deviation in B group



Graph 9- Deviation from the axis of implantation in B group

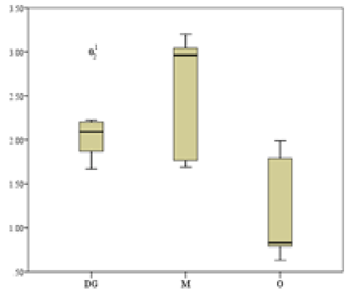


Graph 10 - Apex deviation calculated according to the type of support of surgical guides used in group B

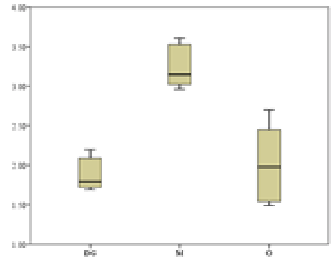
The deviation at the prosthetic platform was for guides with dental-gingival support between 1.67 mm - 3.01 mm, between 1.69 mm - 3.2 mm for guides with mucosal support and between 0.63 mm - 1.99 mm for guides with bone support (graph 11).

The deviation of the implant axis ranges for guides with dental-gingival support between 1.7 - 2.2°, between 2.96 - 3.61° for the guides with mucosal support and between 1.49 - 2.7° for the guides with bone support (graph 12).

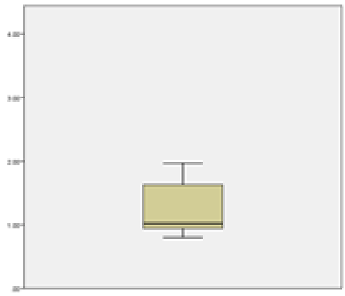
At C group, apex deviation ranged from a minimum of 0.8 mm to a maximum of 1.97 mm, with a median of 1.25 mm and a standard deviation of 0.42 mm (graph 13).



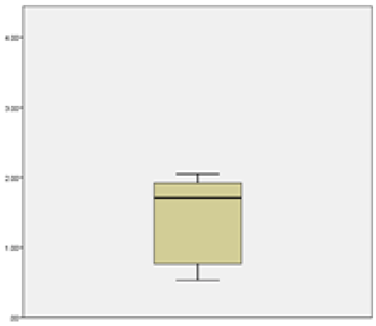
Graph 11- Prosthetic platform deviation calculated according to the type of support of surgical guides used in group B



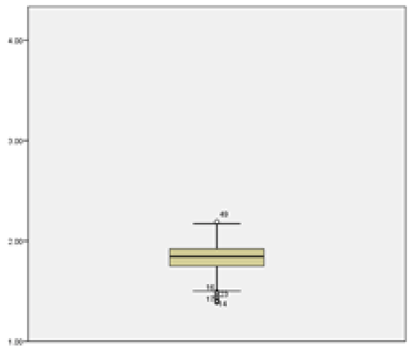
Graph 12- Deviation at the implant axis calculated according to the type of support of surgical guides used in group B



Graph 13 -Apex deviation in C group



Graph 14-Prosthetic platform deviation in C group



Graph 15-Deviation from the axis of implantation in C group

Deviation at the prosthetic platform varied for group C between a minimum value of 0.53 mm and a maximum value of 2.05 mm, with a median of 1.4 mm (graph 14).

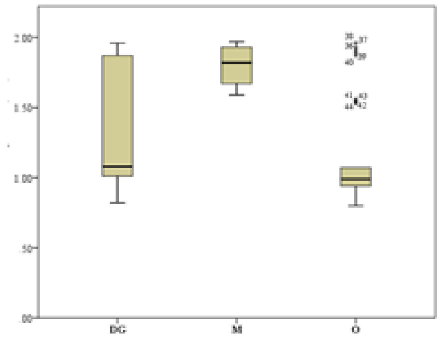
Deviation at the axis of implantation for patients in group C varied between a minimum of 1.39° and a maximum of 2.19° with a median value of 1.83° (graph 15).

For group C, four surgical guides with dental-gingival support, four surgical guides with bone support and one mucosal support guide were used.

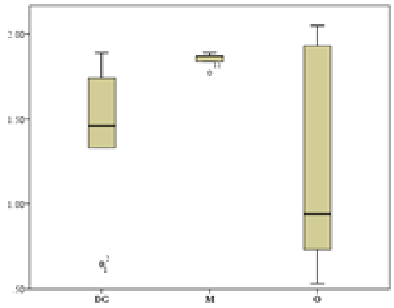
At this group, apex deviation ranges between 0.82 mm - 1.96 mm for guides with dental-gingival support, between 1.59 mm - 1.97 mm for the guide with mucosal support and between 0.8 mm - 1.96 mm for the guides with bone support (graph 16).

Apex deviation ranges for guides with dental-gingival support between 0.64 mm - 1.89 mm, between 1.77 mm - 1.89 mm for the guide with mucosal support and between 0.53 mm - 2.05 mm for the guides with bone support (graph 17).

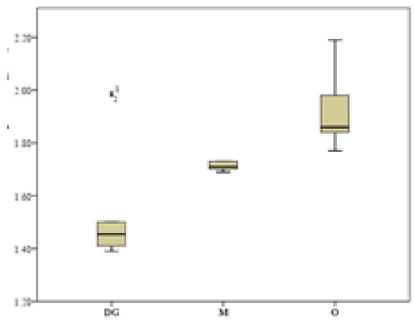
The deviation at axis of implantation ranges for guides with dental-gingival support between 1.39 - 1.99°, between 1.69°- 1.73° for the guide with mucosal support and between 1.77- 2.19° for the guides with bone support (graph 18).



Graph 16 -Apex deviation calculated based on the type of support of surgical guides used in the C group



Graph 17 - Platform deviation calculated based on the type of support of surgical guides used in the C group



Graph 18 - Deviation at the implant axis calculated according to the type of support of surgical guides used in group C

We calculated average and mean square deviation for each group (table 1), the mean global deviation measured in this study compared to literature data (table 2) and we determined the differences between surgical guides using the *t* test (table 3).

The technological advances made it possible to integrate the prosthetic treatment plan with the implant insertion surgery [7].

The implant dentistry and bone regenerative techniques have a major role [8] in order to restore both the continuity of dental alveolar arches and the functions of the stomatognathic system [9, 10]. The demand for complex oral rehabilitation has significantly increased in the late decade due to the high esthetic demands of patients. [11]

Some authors have demonstrated that the use of surgical guides allows for a more accurate osteotomy than for non-guided preparation [12-16]. Most studies that investigated the accuracy of guided insertion of implants have shown that there is an average of 1 mm deviation from the planned

Group	Patients (no)	Inserted implants (no)	Apex deviation (mm)	Platform deviation (mm)	Axis of implantation deviation (grade)
A	9	28	1.76 ± 0.68	1.21 ± 0.52	1.35 ± 0.41
B	9	41	1.78 ± 0.77	1.81 ± 0.80	2.33 ± 0.68
C	9	52	1.25 ± 0.42	1.40 ± 0.57	1.83 ± 0.20

Table 1
AVERAGE AND MEAN SQUARE DEVIATION FOR EACH GROUP

	Patients (no)	Inserted implants (no)	Apex deviation (mm)	Platform deviation (mm)	Axis of implantation deviation (grade)
Mean in this study	27	121	1.55	1.49	1.89
Mean in literature data	-	-	1.63	1.07	5.26

Table 2
THE MEAN GLOBAL DEVIATION MEASURED IN THIS STUDY COMPARED TO LITERATURE DATA

Table 3
THE DIFFERENCES BETWEEN SURGICAL GUIDES USING THE *T* TEST (ACCEPTED ERROR = 5%)

	Apex	Platform	Axis	Reference t value
DG - M	5.25	4.01	2.86	2.003
DG - O	4.85	2.36	2.38	1.985
M - O	25.78	10.89	2.15	1.988

place for insertion of the pilot drill and a deviation of approximately 5 ° from the planned axis. [7]

Obviously, deviation from the planned axis and depth depends on the accuracy of the surgical guide, its stability during neo-alveolar preparation, and the implantologist's experience.

It has been demonstrated on several occasions that operator experience is related to the success rate of treatment [17-25].

In a study by Komiyama et al. [26], the deviation was on average 1.09 mm coronary and 1.56 mm apical in 48 patients with 102 implants. The deviation was on average 0.72 mm at coronary level and 0.46 mm at apical level in a study of 5 corpses by Kuhl et al. [27].

In our study, all surgical guides were stable enough and were positioned slightly on the anatomical support structures.

The mean deviation at the apex of the implant had the lowest values for group C, followed by lots A and B that had roughly similar values. At the prosthetic platform and implant axis the deviations had the lowest values at lot A, followed by the values for C and B lots.

With this database available, we could statistically estimate the effect size by applying the *t* test for samples with different volumes, with a 5% acceptable error. As shown in table 10, all values are higher than the reference values, which means that they are statistically significant.

Conclussions

Lot A, operated by a 1-year physician with experience in implantology, had the smallest deviation, demonstrating the increased attention that he had to the interventions. Comparing B and C lots, the smallest deviations were recorded for group C, operated by implantologist with greater experience in implantology.

By comparing the deviations according to the type of surgical guide used, the smallest deviations at the apex and prosthetic platform were made in patients where the implants were inserted with a bone supported guide, followed by dental-gingival and mucosal guide. In terms of axis of implantation, the lowest values were recorded for the dental-gingival guide, followed by the bone and mucosal guide. The study has a number of limitations (low number of patients undergoing study, low dispensation period), which requires more extensive future studies to validate the results.

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