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Article type : Original Research

# Accuracy of flapless immediate implant placement in anterior maxilla using computer-assisted versus freehand surgery: a cadaver study

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**Running title:** Computer-assisted versus freehand surgery for immediate implant placement

**Key words:** dental implants, computer-assisted implant dentistry, stereolithography, mental navigation, immediate implant placement

**ABSTRACT**

**Objective:** To compare the accuracy of computer-guided surgery and freehand surgery on flapless immediate implant placement (IIP) in the anterior maxilla.

**Material and Methods:** In this split-mouth design, 24 maxillary incisors in 8 human cadaver heads were randomly divided into two groups: computer-guided surgery (n=12) and freehand surgery (n=12). Preoperatively, cone-beam computed tomography (CBCT) scans were acquired, and all implants were planned with a software (Blue Sky Plan3). Then, two types of surgeries were performed. To assess any differences in position, the postoperative CBCT was subsequently matched with the preoperative planning. For all the implants, the angular, global, depth, bucco-lingual, and mesio-distal deviations between the virtual and actual implant positions were measured.

**Results:** A significant lower mean angular deviation (3.11±1.55°, range: 0.66–4.95, $p$=0.002), as well as the global deviation at both coronal (0.85±0.38 mm, range: 0.42–1.51, $p$=0.004) and apical level (0.93±0.34 mm, range: 0.64–1.72, $p$<0.001) were observed in the guided group when compared to the freehand group (6.78±3.31°, range: 3.08–14.98; 1.43±0.49 mm, range: 0.65–2.31, and 2.2±0.79mm, range: 1.01–4.02). However, the accuracy of these two approaches was similar for the depth ($p$=0.366). In the buccal direction, the mean deviations of both groups showed a general tendency of implants to be positioned facially, occurring more in implants of the freehand group.

**Conclusion:** In flapless IIP, computer-guided surgery showed superior accuracy than freehand surgery in transferring the implant position from the planning. However, even with the help of a guide, the final fixture position tends to shift towards a facial direction.

## INTRODUCTION

Immediate implant placement (IIP) gained popularity among clinicians and patients, due to its shorter treatment time, fewer surgeries, and similar survival rate to delayed placement (Lang et al. 2012). When performing IIP, a flapless approach is recommended for the preservation of blood supply to the facial bone and providing better soft tissue healing as well as patient comfort (Mazzocco et al. 2017). However, the benefits of flapless IIP could turn into an aesthetic disaster when peri-implant mucosal recession happen (Chen & Buser 2014). This recession may be influenced by several factors and one of which is the facial malposition of implants (Chen & Buser 2009; Cosyn et al. 2012). It has been claimed that implants with a buccally-positioned shoulder showed three times more recession than those with a lingually-positioned shoulder (Evans & Chen 2008).

With the advent of three-dimensional (3D) imaging and implant planning software, preoperative design for a "prosthesis-driven" implant position becomes a reality. The accurate transfer of an ideal implant position from virtual planning to the actual implant site is essential for protecting vital structures as well as optimizing esthetic and functional outcomes (Van Assche et al. 2012). In clinical practice, three different approaches are available for this transfer: freehand, computer-guided, and computer-navigated surgery (Noharet et al. 2014). The freehand approach, also called mental navigation, is a scenario in which the clinician manually transfers the CT planned implant position to the surgical site while having access to the virtual software planning during surgery (Vercruyssen et al. 2014). Computer-guided surgery involves the use of a computer-aided manufactured surgical template to keep drills and/or implant in a certain direction. Computer-navigated surgery requires the application of a system which provides real-time information of implant placement, although it has not yet been considered as a common approach.

The accuracy of computer-guided implant surgery can be influenced by each step from image acquisition to implant insertion. In recent years, different meta-analyses (Schneider et al. 2009; Jung et al. 2009; Van Assche et al. 2012; Bover-Ramos et al. 2017) have reported its deviations: global deviation at both entry (mean: 0.88-1.44mm) and apex (mean: 1.11-1.91mm); angular deviation (mean: 2.39-4.30°); depth deviation (mean: 0.47-0.83mm). Similarly, the accuracy of mental navigation has also been reported in fully (Gillot et al. 2014a; Vercruyssen et al. 2015) or partially edentulous sites (Noharet et al. 2014; Van de Velde et al. 2008; Vermeulen 2017). However, there is scarce literature comparing guided surgery and freehand approach (Noharet et al. 2014; Vermeulen 2017). Besides, most of the literature only described the deviations in 3D terms (global, angular and depth deviations) and did not provide information in clinical-related directions (bucco-lingual and mesio-distal). In the process of IIP in the anterior maxilla, due to the morphology of the socket, drills and implants are likely to follow the pathway with the least resistance, which results in an implant position facial to the plan. It should be noted that this shift may occur even with the help of surgical guides (Van Assche & Quirynen 2010; Schneider et al. 2015), yet to the best of our knowledge, only one article (Koticha et al. 2012) assessed this phenomenon in IIP. In Koticha's study, implant drilling procedures were guided by a thermoplastic drill template and facial displacement was measured using a periodontal probe together with a measurement stent. Little is known on how implant 3D position deviates when freehanded or computer-guided surgery approaches are employed for the implant placement in anterior extraction socket.

The purpose of this pilot cadaver study was to compare the accuracy of freehand and computer-guided surgery on flapless immediate implant placement in the anterior maxilla.

## MATERIAL AND METHODS

### Specimen Screening

The present study has been approved by the Institutional Review Boards of the University of Michigan (Study ID: HUM00134643). In order to mimic the clinical situation as closely as possible, we used fresh cadaver heads without formaldehyde. All the fresh specimens involved in this study were obtained from the Division of Anatomic Sciences at the University of Michigan Medical School. After harvested from the donors, the heads were kept frozen at -20 ℃, and were defrosted before the initiation of the experiment. The selection of the specimens was based on the following inclusion criteria: 1) at least one maxillary incisor and its contralateral tooth were present and intact; 2) no clinical mobility or crowding; 3) enough adjacent teeth for tooth-supported guide design; 4) adequate apical bone of study tooth for implant primary stability (confirmed by preoperative CBCT); 5) no buccal/palatal dehiscence or fenestration around the study tooth (confirmed by preoperative CBCT and probing after tooth extraction) and 6) no restoration or root canal filling material on the rest upper teeth. A total of 8 out of 30 specimens fulfilled the criteria, and potential implant sites were 24.

**Implant planning**

All the 30 cadaver heads were scanned by an experienced operator using a cone-beam computed tomography scanner (3D Accuitomo 170, J Morita, Kyoto, Japan). The setting for exposure was 5 mA and 90 kVp for 17.5 s. The field of view (FOV) was 140*100mm, and the voxel size was set at 0.27mm. A customized head stent was used to stabilize the specimen, and cotton rolls were used to separate upper and lower teeth. Images were then converted into DICOM files. After specimen screening, impressions for involved heads were taken by alginate impressions (Jeltrate Plus, Dentsply Caulk, Milford, DE). Diagnostic plaster casts were poured (Microstone; Whip Mix Corp, Louisville, KY), and scanned by an optical scanner (Nobel Procera scanner; Nobel Biocare, Zurich, Switzerland) to generate STL files. DICOM and STL files were imported into Blue Sky Plan3 (Blue Sky Bio; LLC, Grayslake, IL) software, and the STL file was registered to the 3D model created with manual segmentation of DICOM file. Specifically, data registration was performed by maximization of the mutual anatomical structures, during which at least one landmark was placed in the anterior region, and two in each of the right and left posterior regions. The goodness of superimposition of the two files was checked in the cross-sectional view. Then, virtual implant planning was performed on 24 incisors. Only one representative size of implants from Zimmer implant system was used for all study sites (3.7 x 13 mm, Tapered Screw Vent; Zimmer/Biomet3i, West Palma Beach, FL). Before allocation, all implant position was planned according to the criteria described by Buser et al. (2004) and in the cingulum axis of the extracted tooth (Koticha et al. 2012). During the planning, we used the original tooth crown as a future prosthetic crown. Then, stereolithographic guides were fabricated by a 3D printer (Form 2 SLA 3D printer; Formlabs, Somerville, MA) using a liquid photo-polymerized resin (Clear; Formlabs, Somerville, MA). After the template was printed, it was washed twice with isopropyl alcohol and dried. Surgical sleeves (4.2 Guide Tube; Blue Sky Bio, LLC, Grayslake, IL) were inserted and press-fitted into the corresponding position in the surgical guide. The guide then underwent final polymerization.



**Tooth extraction and implant placement**

This study followed a randomized split-mouth design. One maxillary central (and/or lateral) incisor and the contralateral tooth from each specimen were selected as a study site. Each site was randomly assigned to one of two groups so that each specimen received at least one implant from each group. For the freehand group, the surgeon was allowed to manipulate the cross-sectional images and 3D reconstruction in the computer to obtain better views of anatomic structures as well as planned implant position. After tooth extraction, a pilot drill was used to perforate cortical bone on palatal socket wall to reduce the resistance. Then the implant was placed according to the manufacturer recommended procedures (Figs 1A-1C), with the reference of neighboring teeth and maximal 3D radiographic information. For the guided group, following tooth extraction, implant site preparation was performed using commercially available surgical guide kits and instruments (Zimmer Surgical Kit and Tube Adapter Kit; Zimmer/Biomet3i, West Palma Beach, FL) (Figs 1D-1F). During implant site preparation, the metal sleeve served as the guidance for drill key which was inserted into the sleeve. After the osteotomy, an implant was placed without the guide (Fig 1G & H).

**Validation of the Technique**

Following implant placement, a second CBCT scan was applied with the settings identical to those in the first one. Subsequently, the postoperative data was matched with the preoperative planning by a 3-D voxel-based registration that is based on multimodality image registration using maximization of the mutual information (Maes et al. 1997). With the aligned data sets, the actual implant positions were compared with the virtually planned positions, and deviations were determined in three dimensions (Fig. 1I and 2). The global deviation was defined as the 3D distance of coronal/apical center between the actual and virtual implant position. The angular deviation was calculated as the 3D angle between the centerlines of the placed and planned implant (α). The global deviation was decomposed in a part along the axis of the implant (the depth deviation) and a part perpendicular to it (the lateral deviation). In order to find out the exact deviation in bucco-lingual and mesio-distal directions, the lateral deviation was subdivided into a part along the buccal/lingual axis and a part perpendicular to it (the mesio-distal deviation). Regarding the depth, bucco-lingual and mesio-distal deviations, the absolute value of these deviations was reported. Also, in order to illustrate these deviations in exact directions, a negative value was used when the actual position was coronal/lingual/distal to the planned position, and a positive value corresponded to apical/buccal/mesial placement compared with the plan. Besides, perforations of the incisive canal or apical buccal bone were assessed in postoperative CBCT images.

All matching process and measurements were performed by one observer (ZZC) twice to estimate intra-observer variability. For the evaluation of inter-observer variability, a second examiner (JYL) randomly selected 3 pre- & post-operative CBCT images to perform matching and accuracy calculation of global, angular, depth, bucco-lingual and mesio-distal deviations. The intraclass correlation coefficient (ICC) for intra-and inter-observer reliability ranged from 0.85 to 0.94, representing a high agreement.

**Statistical analysis**

For the description of data, number of observations, mean, minimum (Min), maximum (Max) and standard deviation (SD) were presented. All statistical analyses were performed using a software package (SPSS, version 23.0, SPSS Inc., Chicago, IL, USA). Normal distribution of data was evaluated by the Kolmogorov-Smirnov test, and the equality of variance was checked by Levene's Test. Independent-samples t-test was used to compare deviation parameters between the computer-guided and freehand groups. The numbers of anatomical perforations (incisive canal or apical buccal bone) were compiled for both groups and compared with Fisher's exact test. All reported *p* values are two-sided, and the level of significance was set at 0.05.

## RESULTS

Adequate primary stability with an insertion torque≥40 Ncm was achieved in all 24 implants. The parameters for the guided and freehand groups are summarized in Tables 1 and 2 for all implants. The box plots illustrating the differences between these two techniques are shown in Figure 3(A-D). In Table 1, the global (coronal and apical), angular, and depth deviations are presented. The statistical test found significant differences in accuracy in favor of computer-guided group for the deviations of global (coronal: $p$=0.004; apical: $p$<0.001), and angle ($p$=0.002). However, no significant difference was found for the depth deviation ($p$=0.336).

The lateral, bucco-lingual, and mesio-distal deviations were presented in Table 2. The lateral deviations were significantly larger in the freehand group in both coronal (*p*=0.007) and apical (*p<0.001*) level when compared with the guided group. For the absolute value of bucco-lingual deviations, greater deviations were found in freehand group at both coronal (*p*=0.033) and apical (*p*=0.003) level. Then, when considering the exact direction, the results showed that the actual implant positions of both groups were buccal to the plan. Smaller mean values of buccal shift at the coronal and apical level were found in the guided group (0.32±0.32 mm, 0.33±0.51 mm) compared with those in the freehand group (0.46±0.86 mm, 0.71±1.45 mm), but none of these differences were statistically significant (p=0.640; p=0.403). For the absolute value of mesio-distal deviations, greater deviation was found in freehand group at apex (*p*<0.001). In mesio-distal direction, no obvious tendency towards either mesial or distal was found in both groups at apex and hex points.

As a consequence of the malposition, perforations of incisive nerve canal or buccal bone fenestration were seen in 33.3% (8/24) of the implant locations (Table 3) when checked in all postoperative CBCT images. These were located in 16.7% (2/12) sites of the guided group and 50% (6/12) of the freehand group. Incisive nerve canal invasions were seen in 12.5% (1/8) in the guided group, and 37.5% (3/8) in the freehand group. Apical buccal bone perforations were observed in 8.3% (1/12) in the guided group and 25% (3/12) in the freehand group.

## DISCUSSION

This study showed that computer-guided surgery was more accurate than freehand one in IIP for both global (coronal and apical) and angular deviations. This was in accordance with previous studies comparing these two approaches in partially or fully edentulous sites (Table 4) (Noharet et al. 2014; Vermeulen 2017; Vercruyssen et al. 2014). Regarding the guided group, the average deviations were 0.85±0.38 mm (range: 0.42–1.51mm) for the coronal deviation, 0.93±0.34 mm (range: 0.64–1.72mm) for the apical deviation, and 3.11±1.55° (range: 0.66–4.95°) for the angular deviation (Table 1). Although no previous study assessed 3D deviations regarding computer-guided immediate implant surgery in the anterior maxilla, studies in partially edentulous zones using tooth-supported stereolithographic guides showed similar results when compared with the present study (Noharet et al. 2014; Vermeulen 2017; Ersoy et al. 2008; Ozan et al. 2009; Van Assche et al. 2010). Regarding the freehand group, it is difficult to compare our results to previously published data due to different methodologies used in these studies (Table 4) (Van de Velde et al. 2008; Vercruyssen et al. 2014; Gillot et al. 2014). However, all these studies showed the actual position of installed implants with the freehand approach differ significantly from their planned position, even though neighboring teeth and 3D radiographic information could be used as a reference.

The depth deviation has been discussed in 2 papers (Noharet et al. 2014; Vercruyssen et al. 2014) comparing guided and freehand techniques. Both studies found no significant difference between the two approaches, which were comparable with the results of the present study. From our data, implants were placed in a more coronal position for both groups compared to their virtual plan. These implants were inserted without a guide so that the depth deviation may be estimated as a consequence of different reference landmarks chosen in CBCT and clinical situation. Also, the flapless procedure tends to increase the difficulty of site preparation and implant insertion depth control due to the lack of visibility (Oh et al. 2007).

Besides parameters (global, angular, and depth deviations) normally used in previous studies, we presented two additional parameters (bucco-lingual and mesio-distal deviations) that are more clinically relevant. The deviation in the buccal direction may have a major influence on the buccal bone recession, hampering esthetic or functional outcomes; while mesio-distal deviation can lead to the invasion of surrounding anatomical structures (i.e., incisive nerve canal, and adjacent roots). Therefore, it is crucial to estimate the risk of malposition in both mesio-distal and buccal-lingual directions. Some studies reported these two deviations at entry points in fully edentulous sites (Verhamme et al. 2013; Vercruyssen et al. 2014, 2015), and found no tendency towards any particular directions. In accordance with the above studies, the present results showed no obvious tendency towards either mesial or distal in both groups. When considering the absolute value of mesio-distal deviation, the deviation at apex was found to be significantly larger in the freehand group compared with that in the guided group ($p<0.001$), possibly explaining why a higher rate of incisive canal invasions occurred in the freehand group (Table 3).

Regarding the absolute value of bucco-lingual deviation, greater deviations were found in the freehand group compared with the guided group at both coronal ($p$=0.033) and apical ($p$=0.003) level, favoring computer-guided surgery. It should be noted that, in the buccal direction, results of the mean deviations demonstrated that the implants placed in both groups tended to move buccally at entry and apex points during surgery (Table 2). This apex/entry buccal deviation may be caused during the processes of drilling and implant placement (Figure 4). For the implant site preparation, drills are more likely to slide along the palatal wall of the socket, which creates a tendency of moving buccally at the apex. When comparing the buccal deviation between the guided and freehand group, a greater mean value was found at the apex point, showing a more buccal shift in the freehand group. This result is in an agreement with a higher rate of buccal bone fenestration in the freehand group (Table 3). It should be noted that during implant site preparation in socket sites, it is crucial yet can be difficult to keep the drill in a central and parallel position with regard to the drill key (Van Assche & Quirynen 2010). This passive fit of drills, as well as the tolerance of surgical components (resin-to-sleeve, sleeve-to-drill key, and drill key-to-drill), can introduce inaccuracy into actual implant sites (Koop et al. 2013). The stability of drills can be increased by selecting a longer drill key and sleeve, shorter drill, and by reducing the distance between the sleeve and the bone if possible. This can be considered when implant planning and guide design are performed (Van Assche & Quirynen 2010). In addition, penetration of the socket wall with a round bur can be performed before the drilling procedure to minimize buccal movement of the drill during osteotome preparation. According to the results, a buccal deviation was present in both groups, but tend to be less in the guided group. This buccal deviation can partially raise from the manual insertion of implants because the implant always tends to follow a more buccal pathway which has less resistance (Figure 4b). Adaptation of full-guided system, during which both the drilling and inserting are under guidance, may minimize this deviation.

The results should be interpreted with caution due to the limited sample size. In addition, an increase in deviation might be caused by real-life clinical elements, such as limited interocclusal distance, poorer visual control, possible movement of the patient, and the presence of blood and saliva (Jung et al. 2009), some of which the present cadaver study can’t reflect.

## CONCLUSION

Within the limitations of the present study, implants in immediate implant placement have a tendency towards buccal direction even under computer-guided surgery. For non-guided surgery, the inaccuracy is significantly higher in most of the parameters when compared to guided surgery.


## ACKNOWLEDGMENT

This study was partially supported by the University of Michigan Periodontal Graduate Student Research Fund. The authors report no conflict of interest related to this study.


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Table 1. Calculated differences between planned and placed implants in terms of global, angular, and depth deviations.

| Deviation Type | | Guided surgery Mean | Guided surgery Min-Max | Guided surgery SD | Freehand surgery Mean | Freehand surgery Min-Max | Freehand surgery SD | p* |
|---|---|---|---|---|---|---|---|---|
| Global deviation | Coronal | 0.85 | 0.42-1.51 | 0.38 | 1.43 | 0.65-2.31 | 0.49 | 0.004* |
| | Apical | 0.93 | 0.64-1.72 | 0.34 | 2.20 | 1.01-4.02 | 0.79 | <0.001* |
| Angular deviation | | 3.11 | 0.66-4.95 | 1.55 | 6.78 | 3.08-14.98 | 3.31 | 0.002* |
| Depth deviation | Absolute value | 0.50 | 0.18-1.00 | 0.26 | 0.60 | 0.09-0.97 | 0.26 | 0.366 |
| | Considering direction | -0.32 | -1.00-0.64 | 0.48 | -0.25 | -0.93-0.97 | 0.63 | 0.757 |

* Independent-Samples T test, α=0.05; Min: minimum; Max: maximum; SD: standard deviation; Negative value means the deviation towards coronal direction.

Table 2. Calculated differences between planned and placed implants in terms of lateral, bucco-lingual, and mesio-distal deviations.

| Deviation Type | | | Guided surgery Mean | Guided surgery Min-Max | Guided surgery SD | Freehand surgery Mean | Freehand surgery Min-Max | Freehand surgery SD | p* |
|---|---|---|---|---|---|---|---|---|---|
| Lateral deviation | Coronal | | 0.62 | 0.27-1.23 | 0.32 | 1.09 | 0.32-1.68 | 0.45 | 0.007* |
| | Apical | | 0.73 | 0.36-1.31 | 0.25 | 2.04 | 1.32-3.96 | 0.78 | <0.001* |
| Bucco-lingual deviation | Coronal | Absolute value | 0.42 | 0.18-0.81 | 0.19 | 0.80 | 0.2-1.56 | 0.51 | 0.033* |
| | | Considering direction | 0.32 | -0.42-0.81 | 0.34 | 0.45 | -0.92-1.56 | 0.86 | 0.640 |
| | Apical | Absolute value | 0.53 | 0.2-0.85 | 0.24 | 1.38 | 0.15-1.79 | 0.76 | 0.003* |
| | | Considering direction | 0.33 | -0.55-0.85 | 0.51 | 0.71 | -1.63-3.20 | 1.45 | 0.403 |
| Mesio- | Coronal | Absolute value | 0.30 | 0.03-0.70 | 0.23 | 0.40 | 0.08-1.01 | 0.26 | 0.334 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| distal deviation | | Considering direction | -0.04 | -0.7-0.66 | 0.39 | 0.22 | -0.51-1.01 | 0.44 | 0.135 |
| | Apical | Absolute value | 0.43 | 0.18-0.95 | 0.26 | 1.12 | 0.34-2.01 | 0.49 | <0.001* |
| | | Considering direction | 0.12 | -0.58-0.82 | 0.50 | 0.10 | -2.01-1.63 | 1.26 | 0.972 |

* Independent-Samples T test, α=0.05; Min: minimum; Max: maximum; SD: standard deviation; Negative value means the deviation towards lingual direction or distal direction.

Table 3. Number of perforations divided by surgical approach

| | **Guided surgery** | **Freehand surgery** | **p*** | **Total** |
|---|---|---|---|---|
| **Incisor nerve canal invasion** | 12.5% (1/8) | 37.5% (3/8) | 0.57 | 25.0% (4/16) |
| **Apical buccal bone penetration** | 8.3% (1/12) | 25% (3/12) | 0.59 | 12.5% (3/24) |
| **Total** | 16.7% (2/12) | 50% (6/12) | 0.20 | 33.3% (8/24) |

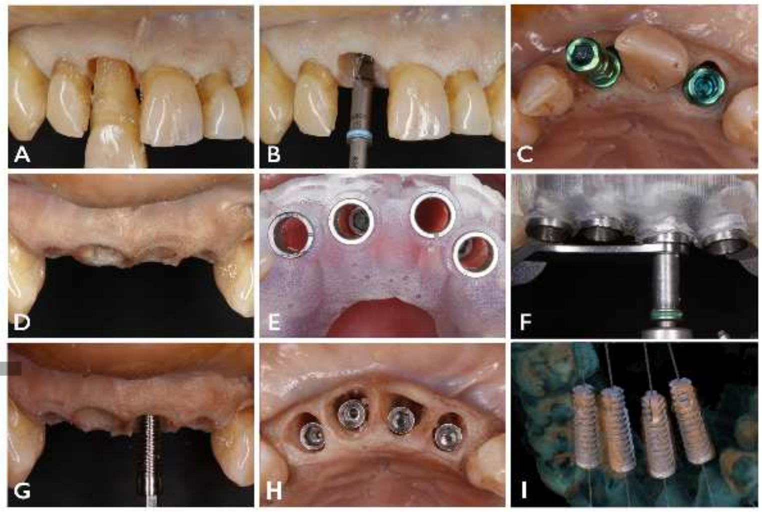
*Fisher's exact test, α=0.05.

Table 4. Summary of 3D deviations between implant planning and placement, with values from the literature involving freehand approach for comparison.

| **Comparison** | **Study (design)** | **Implant site** | **Sample size (n)** | **Deviation: mean (SD)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **Global (mm)** | | **Angular (degree)** | **Depth (mm)** | **Lateral (mm)** | |
| | | | | **Coronal** | **Apical** | | | **Coronal** | **Apical** |
| **Guided vs. Freehand** | Present study (cadaver) | Incisor | G:12 | 0.81(0.40) | 0.93(0.34) | 2.11(1.55) | -0.31(0.48) | 0.62(0.32) | 0.73(0.25) |
| | | | F:12 | 1.32(0.50) | 2.20(0.79) | 6.78(3.31) | -0.25(0.63) | 1.09(0.45) | 2.04(0.78) |
| | Noharet et al. (2014) (cadaver) | Premolar & molar | G:19 | 0.93(0.65) | 1.14(0.89) | 3.99(3.46) | 0.18(0.46) | NA | |
| | | | F:20 | 2.06(1.14) | 2.27(1.24) | 9.18(4.28) | -0.29(1.01) | NA | |
| | Vermeulen et | Anterior | G:40 | NA | NA | 2.19 | 0.54 | 0.42 | 0.52 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | al. (2017) (resin model) | maxilla | F:40 | NA | NA | 7.63 | 0.78 | 1.27 | 1.28 |
| **Freehand only** | Van de Velde et al. (2008) (resin model) | Incisor area | F-specialists: 8 | 3.67(0.66) | NA | 7.74(4.55) | 3.64(0.70) | 0.71(0.34) | NA |
| | | | F-dentists: 8 | 2.65(0.51) | | 11.56(6.34) | 2.54(0.53) | 0.88(0.53) | NA |
| | | | F-students: 8 | 4.15(1.27) | | 5.97(2.23) | 4.03(1.28) | 1.04(0.45) | NA |
| | Gillot et al. (2014) (cadaver) | Full edentulous | F:60 | 1.88(1.02) | 2.33(1.20) | 7.34(3.62) | 0.03(1.15) | NA | |

SD: standard deviation; G: computer-guided surgery; F: freehand surgery; NA: not announced.

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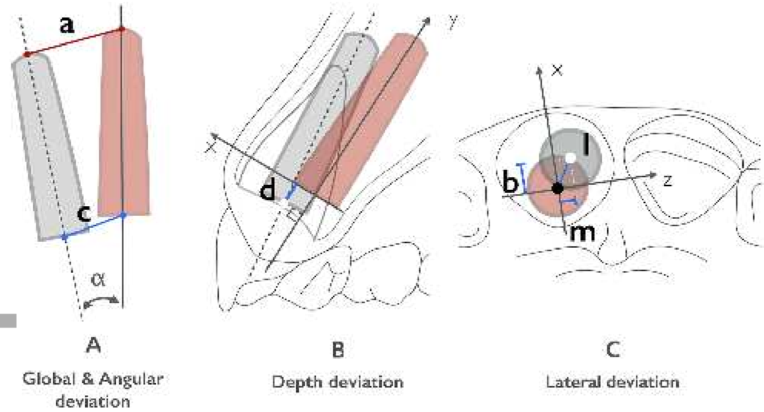


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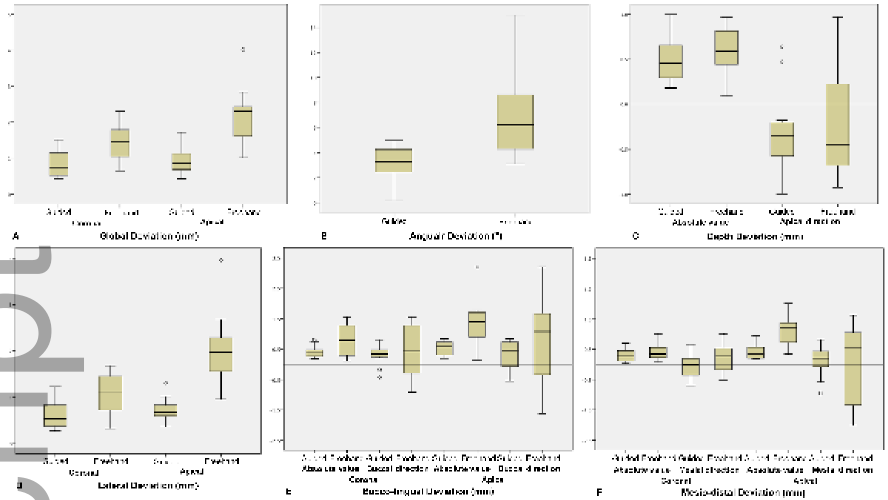


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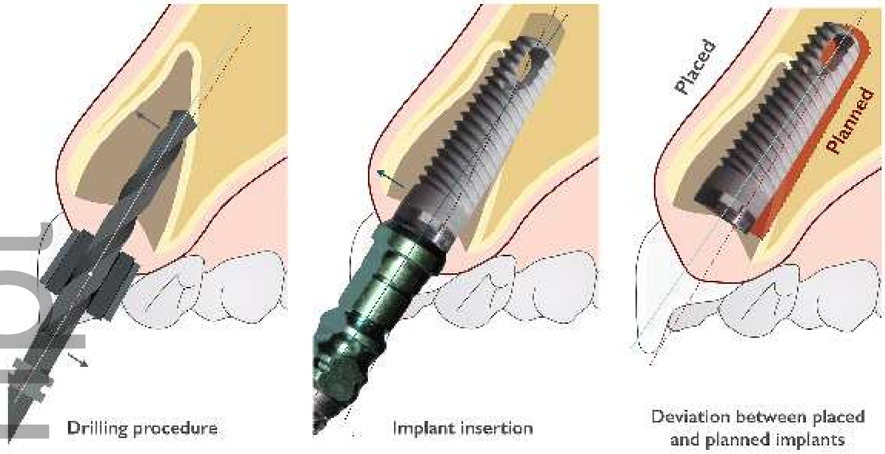


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