

Guided Surgery

1. **AK** Tatakis DN, Chien HH, Parashis AO. Guided implant surgery risks and their prevention. *Periodontol 2000*. 2019 Oct;81(1):194-208. doi: 10.1111/prd.12292.
2. **TV** Chackartchi T, Romanos GE, Parkanyi L, Schwarz F, Sculean A. Reducing errors in guided implant surgery to optimize treatment outcomes. *Periodontol 2000*. 2022 Feb;88(1):64-72. doi: 10.1111/prd.12411.
3. **DL** Laederach, V., Mukaddam, K., Payer, M., Filippi, A., & Kühl, S. (2017). Deviations of different systems for guided implant surgery. *Clinical Oral Implants Research*, 28(9), 1147–1151
4. **CM** Sittikornpaiboon, P., Arunjarosuk, S., Kaboosaya, B., Subbalekha, K., Mattheos, N., & Pimkhaokham, A. (2021). Comparison of the accuracy of implant placement using different drilling systems for static computer-assisted implant surgery: A simulation-based experimental study. *Clinical Implant Dentistry and Related Research*, 23, 635– 643
5. **VX** Chen, Z., Li, J., Ceolin, P., Galli, M., Mendonça, G., & Wang, H. L. (2022). Does guided level (fully or partially) influence implant placement accuracy at post – Extraction sockets and healed sites? An in vitro study. *Clinical Oral Investigations*, 26, 5449–5458.
6. **RH** Tahmaseb, A., Wu, V., Wismeijer, D., Coucke, W., & Evans, C. (2018). The accuracy of static computer-aided implant surgery: A systematic review and meta-analysis. *Clinical Oral Implants Research*, 29, 416– 435
7. **NL** El Kholy, K., Ebenezer, S., Wittneben, J. G., Lazarin, R., Rousson, D., & Buser, D. (2019). Influence of implant macrodesign and insertion connection technology on the accuracy of static computer-assisted implant surgery. *Clinical Implant Dentistry and Related Research*, 21(5), 1073–1079
8. **MS** El Kholy, K., Janner, S. F. M., Schimmel, M., & Buser, D. (2019). The influence of guided sleeve height, drilling distance, and drilling key length on the accuracy of static computer-assisted implant surgery. *Clinical Implant Dentistry and Related Research*, 21(1), 101–107.
9. **AK** El Kholy, K., Lazarin, R., Janner, S. F. M., Faerber, K., Buser, R., & Buser, D. (2019). Influence of surgical guide support and implant site location on accuracy of static computer-assisted implant surgery. *Clinical Oral Implants Research*, 30(11), 1067–1075.
10. **TV** Balaguer-Martí JC, Canet-López Á, Peñarrocha-Diago M, Romeo-Rubio M, Peñarrocha-Diago M, García-Mira B. Influence of Splint Support on the Precision of Static Totally Guided Dental Implant Surgery: A Systematic Review and Network Meta-analysis *Int J Oral Maxillofac Implants*. 2023 Jan-Feb;38(1):157-168

Topic: guided implant surgery

Authors: Tatakis DN, Chien HH, Parashis AO

Title: Guided implant surgery risks and their prevention.

Source: *Periodontol 2000*. 2019 Oct;81(1):194-208. doi: 10.1111/prd.12292.

DOI: 10.1111/prd.12292

Reviewer: Amber Kreko

Type: review

Keywords: guided implant surgery, conventional implant surgery, risks, errors

Purpose: To summarize information on the accuracy and efficacy of static guided implant surgery with special emphasis on the risks and potential problems of every step in the process.

Discussion:

Overview of guided implant surgery

- Advantages and disadvantages of guided implant surgery
 - o Advantages – involvement of all dental care providers ensuring comprehensive care, flapless implant placement, reduced operating time, allows placement of larger diameter/longer implant, improved presentation to the patient of the treatment plan.
 - o Disadvantages – additional cost of guide fabrication, requires 10 more minutes of planning time, additional cost for purchase of software, hardware, drills, etc.
- Guided implant surgery outcomes compared with conventional implant placement
 - o Guided had greater accuracy, less post op pain, less swelling, and less surgery time but at higher financial costs.
 - o No difference in terms of implant success or clinical parameters.

Guided implant surgery-associated risks and errors

Step/process	Risk	Prevention and management
Cone beam computed tomography/ computed tomography scanning	• Dimensional (linear and volumetric) and/or positional inaccuracies • Poor image quality (eg, metal artifacts)	• Proper use of up-to-date equipment, experienced operator • Eliminate from field of interest metal restorations that could create artifacts and interfere with image quality
Patient positioning/ movement	• Inadequate/incomplete image • Poor image quality	• Oversee patient during scanning to confirm absence of movement • Use of occlusal bite index to stabilize lower jaw and scan prosthesis • Review images obtained to assess possible need to rescan
Treatment planning software	• Improper/inadequate virtual implant positioning	• Knowledge of limitation(s) and accuracy level of specific software used • Experience with virtual implant positioning and thorough understanding of chosen software
Surgical guide manufacturing and guide type	• Improper fit of surgical guide • Surgical guide fracture • Difficulties associated with particular guide type	• Choose experienced guide manufacturer • Opt for most accurate and reliable manufacturing process • Select most accurate guide possible for each case (tooth- or mucosa-supported versus bone-supported) • Careful guide design and handling to prevent fracture or distortion during use
Surgical guide stabilization/ positioning	• Improper guide positioning • Guide movement during procedure	• Use appropriate fixation (three mini-screws) to stabilize mucosa- or bone-supported guides • Special attention needed when using bone-supported guides (confirm good fit and stability) • Attention to anesthesia injection location (avoid mucosal swelling that could alter positioning of mucosa-supported guide) • Frequently reconfirm proper guide positioning during procedure
Anatomic location	• Inadequate space to fit guide and/or other components during drilling/ implant placement	• Proper pretreatment clinical assessment of available space, particularly in posterior areas (adequacy of mouth opening)
Drilling, drill components, and implant placement	• Improper drill use • Drill overuse and wear; increased tolerance between components • Inadequate irrigation; bone overheating • Deviation(s) from planned position	• Avoid eccentric drilling through tubes, keys • Frequent replacement of drills and keys • Copious and continuous irrigation, frequent drill withdrawal and reinsertion, use of drills with internal irrigation • Implant insertion using the guide (avoid freehand placement)
Operator experience	• Poor knowledge and/or understanding of process, steps, complexities and limitations • Inability to anticipate/identify risks	• Obtain advanced training and surgical skills before using guided implant surgery • Have appropriate training, surgical skills, and equipment, if needed to convert to conventional implant placement

Guided implant surgery accuracy: clinical implications

- When guided surgery is used, most important inaccuracy is in the vertical dimension with inaccuracy in M-D or B-L direction being less.
- Safety distance of 2.0-2.5mm should always be kept between implant and important adjoining anatomic structures

Conclusions: Guided implant surgery can be accurate and advantageous, but errors can occur at each step affecting the accuracy of implant placement.

Topic: Guided implant surgery

Authors: Chackartchi T, Romanos GE, Parkanyi L, Schwarz F, Sculean A

Title: Reducing errors in guided implant surgery to optimize treatment outcomes

Source: Periodontol 2000. 2022 Feb;88(1):64-72

DOI:10.1111/prd.12411

Reviewer: Tam Vu

Type: Review

Keywords: guided implant surgery, errors, deviations, cone beam, software, planning

Purpose: to review guided implant surgery and how to optimize treatment outcomes

Discussion:

Dynamic vs Static Guides

- Static: prefabricated surgical template which instruments drill through preplanned positions
 - Does not allow for intra-operative modification of implant position
- Dynamic navigation: 'real-time' guidance during drilling
 - Optical bur tracking
 - Sensors to track and show virtual 3-D positioning
 - Operator can change implant position during sx
- Equal failure rates. Dynamic more expensive and complicated

Calibration

- Calibration = verify virtual and clinical arena
 - Need accuracy from transformation of data from clinical field to digital platform and from digital planning to physical environment of pt's mouth
- Patient to software:
 - Impression = STL (stereolithography) file
 - Imaging = CBCT
 - Accurate merging of CBCT + STL is prerequisite for planning position of implants
 - Accuracy decreases with missing teeth/edentulous
- Potential errors from software to patient
 - Stable and secure fit is essential for accurate transformation of planned implant position
 - Fit of surgical guide is better on dentate than on edentulous ridges,
 - Dentate = rigid

Challenges in fully edentulous cases

- Edentulous = mobile, compression of soft tissues → lifting of guide
 - Can counteract with radiopaque resin markers or implants with ball attachments
- Fixation pins and screws
 - Initial positioning of guide on soft tissue in correct position, then fixation pins inserted to avoid pressure on guide that may lead to soft tissue compression and lifting of guide

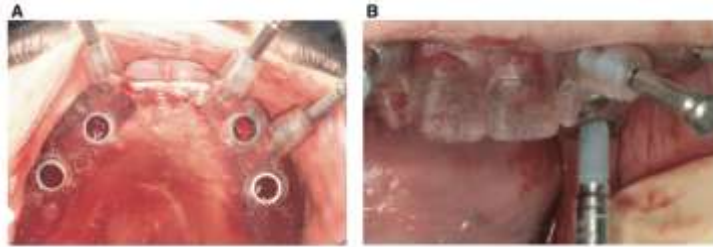


FIGURE 5 A guide for a full edentulous jaw with the use of fixation pins

- Temporary implants
 - Micro/mini/temporary implants as rigid reference points
 - High level of accuracy achieved when mini-implants used to support CT scan and surgical guide
 - Advantage:
 - Superimposition during data registration and transfer from pt to software
 - Anchor for guide positioning during surgery
 - Disadvantage:
 - Perforating bone
 - Limited by height of atrophic ridge
 - Loosening of provisional implants (soft bone, lateral forces)
 - Recommend to minimize time between provisional implant placement and implant sx

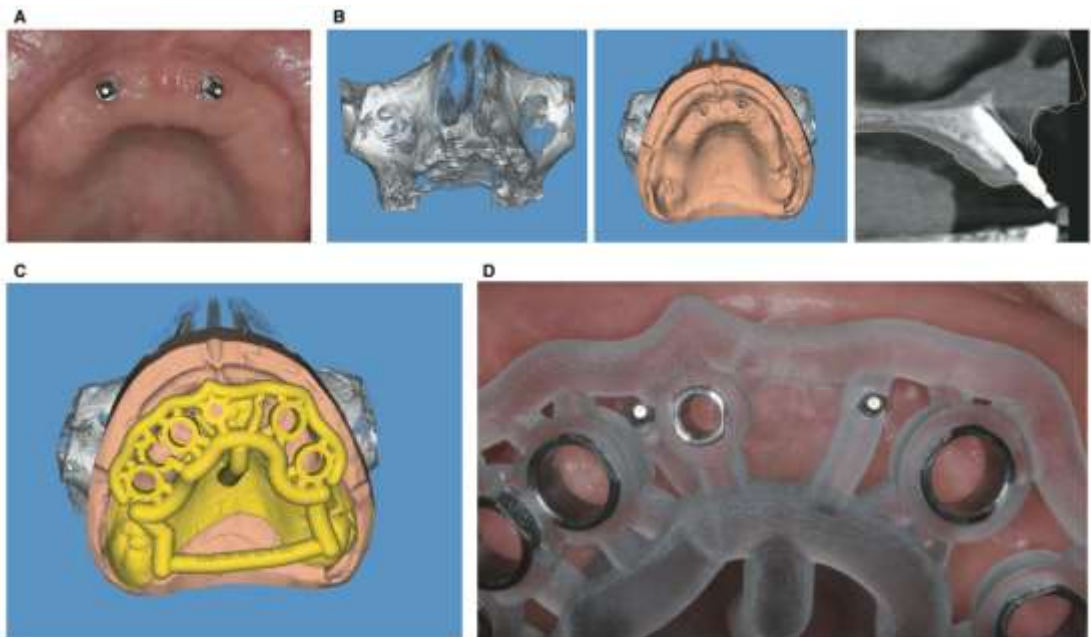


FIGURE 6 Temporary implants can be used as an addition of rigid reference points for both patient to software and software to patient in full edentulous cases. A, Temporary implants will be inserted prior to computed tomography scan. B, The patient will have a cone-beam computed tomography scan, and an impression will be taken and scanned to produce an STL file. The temporary implants will serve as reference points for the calibration of data on the software. C, The designed template (guide) will be supported by the temporary implants as rigid components in addition to the thick, soft tissue

- Staged extractions –
 - 1st stage: Using stable teeth as rigid support for guide
 - 2nd stage: Securing guide to implants and insert remaining implants

- Guide design:
 - Mucosa-supported surgical guides
 - Bone-supported surgical guides (on bone after mucoperiosteal flap)
 - Highest accuracy

Drilling Process

- Most common intraoperative complication: fracture of guide
 - May result from improper force on template
- Drill should be first inserted --- and then motor can be activated
 - Centric position and parallel to internal wall of sleeve



FIGURE 8: The drill should first be inserted in the sleeve, keeping a centric position and parallel to the internal wall of the sleeve. Only then is the motor activated

- Modification of shank of drill to fit guide sleeve – eliminated need for guide spoon → reduced tolerance and improved accuracy of implant positioning in all dimensions
- Depth control prevents intrusion into vital anatomic structures (Mx sinus, IAN)
 - Final implant insertion should be guided

Conclusion: Deviations and errors still occur with computer-guided implant placement. Clinical surgical knowledge still needed with guided surgery. Need for greater experience and understanding of potential process errors to minimize deviations and achieve accuracy and stable long-lasting results.

Topic: Guided Implant Surgery-deviations

Authors: Laederach V, Mukaddam K, Payer M, Filippi A, Kühl S.

Title: Deviations of different systems for guided implant surgery.

Source: Clin Oral Implants Res. 2017 Sep;28(9):1147-1151.

DOI: 10.1111/clr.12930

Reviewer: Daeoo Lee

Type: Comparative (Lab-tabletop)

Keywords: accuracy, drill guide, guided surgery, sleeve, tolerance

Purpose: To evaluate and compare the influence of the tolerance of different systems on the accuracy of guided implant surgery (GIS)

Material and methods:

- Four (4) different drilling systems for GIS and their appropriate sleeves were used:
 - CamlogGuide (CG; Camlog, Basel, Switzerland)
 - Straumann Guided Surgery (SG; Straumann AG, Basel, Switzerland)
 - SICGuide (SIG; Schilli Implantology Circle SIC, Basel, Switzerland)
 - NobelGuide (NG; Nobel Biocare, Goteborg, Sweden).

- Three (3) specific sleeves for each system with different heights and distances to the cavity preparation site were placed on the top of a plexiglass box and fixed by clamping in the predrilled holes



Fig. 3. Image taken by digital camera showing the resulting cavity after drilling in the centric position (a) and after applying eccentric forces (b).

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- Followed manufacturers guidance on appropriate sleeve and drill.
- First drilling using centric position -> image -> eccentric drilling -> image
 - Repeated 3 times
- After drilling, digital imaging and image analysis

Results:

- Coronal deviation
 - Centric drilling
 - CG: lowest (0.00mm)
 - SG
 - SIG: lowest (0.00mm)
 - NG: highest (1.10mm)
 - Eccentric drilling
 - CG
 - SG
 - SIG: lowest (1.10)
 - NG: highest (1.60mm)
- Apical deviation
 - Centric drilling
 - CG: lowest (0.00mm)
 - SG
 - SIG: lowest (0.00mm)
 - NG: highest (2.19mm)
 - Eccentric drilling
 - CG
 - SG
 - SIG: lowest (0.01mm)
 - NG: highest (3.20mm)
- Angular deviation
 - Centric drilling
 - CG: highest (4.48°)

- SG: lowest (0.00°)
- SIG: lowest (0.00°)
- NG
- Eccentric drilling
 - CG: highest (5.64°)
 - SG: lowest (0.00°)
 - SIG
 - NG

Conclusions:

Eccentric drilling is possible in GIS. This resulted in inaccuracies, with maximum deviations of up to 1.6 mm in the coronal part, up to 3.2 mm in the apical part, and a maximum angular deviation of 5.6°.

Topic: Different drilling systems for sCAIS

Authors: Sittikornpaiboon P., Arunjaroensuk S., Kaboosaya B., Subbalekha K., Mattheos N., Pimkhaokham A.

Title: Comparison of the accuracy of implant placement using different drilling systems for static computer-assisted implant surgery: A simulation-based experimental study

Source: Clin Implant Dent Relat Res. 2021;23:635–643.

DOI: 10.1111/cid.13032

Reviewer: Cyrus J Mansouri

Type: In vitro

Keywords: accuracy, computer-assisted implant surgery, dental implant, drilling system, guided surgery

Purpose:

To compare the accuracy of implant placement using five differed sCAIS drilling systems, differing in drill stabilization configuration.

Material and methods:

The following sCAIS drilling systems were used:

Group A: Sleeve-in-sleeve system (Straumann Guided Surgery, Straumann AG, Basel, Switzerland)

Group B: Sleeve-in-sleeve with self-locking system (Straumann VeloDrill Guided Surgery, Straumann AG, Basel, Switzerland)

Group C: Mounted sleeve-on-drill system (Astra Tech Implant System EV Guided surgery, Dentsply Sirona, Pennsylvania, United States)

Group D: Integrated sleeve-on-drill with metal sleeve system (Dentium Guide Kit, Dentium, Seoul, South Korea)

Group E: Integrated sleeve-on-drill without metal sleeve system (Dentium Guide Kit, Dentium, Seoul, South Korea).

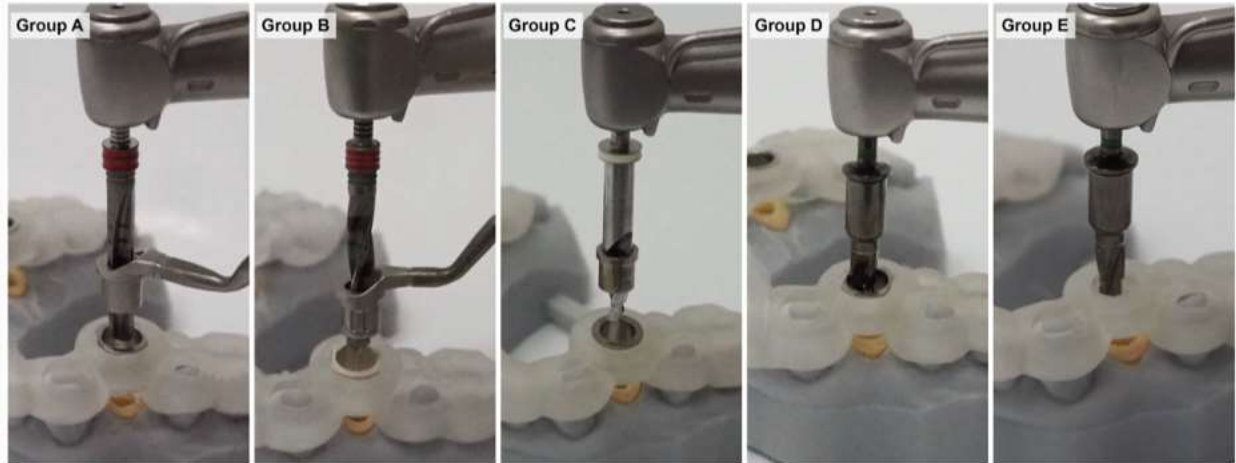


FIGURE 3 The configuration of each drilling system used with the final drill in display. Group A: Sleeve-in-sleeve system with handheld drill key inserted into the metal sleeve within the surgical guide template. Group B: Sleeve-in-sleeve with self-locking system, modified from group A. The sleeve and drill key possess a self-locking function. Group C: Mounted sleeve-on-drill system with a drill sleeve insert into the metal sleeve within the surgical guide template. The drill sleeve is mounted on the drill during the osteotomy. Group D: Integrated sleeve-on-drill with modified shape of the drill incorporating the sleeve. The shank part of the drill is modified to fit in the metal sleeve in surgical guide template. Group E: Integrated sleeve-on-drill without metal sleeve modified from group D

Partially edentulous study casts were printed with missing first premolars. Edentulous sites were hollowed and replaced with polyurethane block of 0.32g/cm^3 density to simulate cancellous bone of low-to-medium density. This is a standard material used to simulate mechanical properties to human bone in orthopedic instrument testing by the American Society for Testing Materials. A total of 25 models were made and arranged into five groups for the five filling protocols.

Models were scanned and 50 implants were virtually planned (10 for each drilling protocol). Surgical guides were printed in uniform thickness according to the CAIS protocol designated for the drilling protocol. Implants were placed according the manufacturers recommendations and postop CBCTs were made.

Pre-op CBCTs with virtually planned implants and post-op CBCTs with implants placed were superimposed and 3D deviation of implant platform, apex, and angular deviation were measured.

Results:

Mean platform deviation for each of the five groups from A-E were: 0.56 ± 0.19 , 0.42 ± 0.12 , 1.18 ± 0.19 , 1.09 ± 0.12 , and 0.81 ± 0.15 mm, respectively.

Means of apex deviation A-E: 0.83 ± 0.32 , 0.76 ± 0.22 , 1.70 ± 0.41 , 1.95 ± 0.48 , and 1.73 ± 0.23 mm, respectively.

Mean angular deviations A-E were: 2.70 ± 1.37 , 2.50 ± 0.89 , 4.37 ± 1.34 , 5.13 ± 1.86 , and 5.30 ± 1.04 mm in all groups, respectively.

Groups A and B demonstrated the second lowest and lowest 3D deviation at the platform and apex and angular deviation, significantly lower than group C and D for platform deviation, C, D, and E for apex deviation, and D and E for angular deviation.

Deviation positionally was found in the palatal direction at the apex and platform level.

Conclusion:

Significant differences in accuracy of implant placement from the virtually planned position was found, suggesting drilling protocol and design could significantly influence the accuracy of implant placement. Protocols with sleeve-in-sleeve with or without self-locking design showed significantly less deviation.

Topic: Guided Surgery

Author: Chen, Z., Li, J., Ceolin, P., Galli, M., Mendonça, G., & Wang, H. L.

Title: Does guided level (fully or partially) influence implant placement accuracy at post – Extraction sockets and healed sites? An in vitro study

Source: Clinical Oral Investigations, 2022, 26, 5449–5458.

DOI: 10.1007/s00784-022-04512-y.

Type: In vitro Study

Reviewer: Veronica Xia

Keywords: fully guided, partially guided, free handed, implant placement

Background:

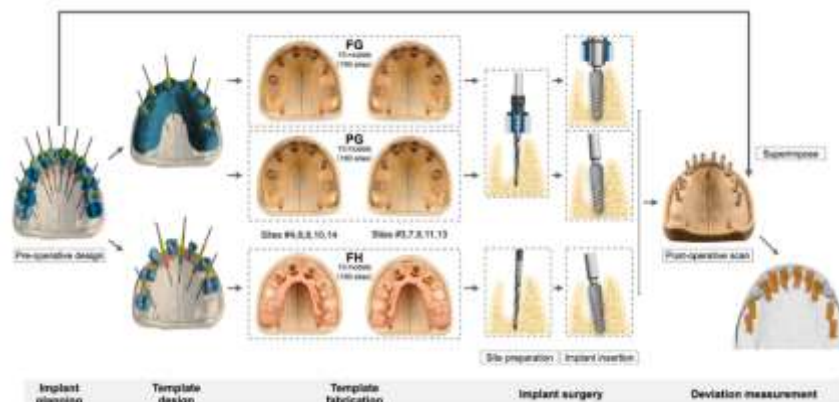
- Static computer aided implant surgery (sCAIS)
 - template generated from preop digital planning
- Partially guided: template use only for drilling (pilot or full drill)
- fully guided: site preparation and final implant placement under guidance

Purpose:

- Compare accuracy of fully guided, partially guided (full drill sequence), and free-handed implant surgery in immediate implant placement
- Investigate deviation difference of static computer aided implant surgery (sCAIS) between the post-extraction socket and healed site

Materials and Methods:

- Study conducted on bone models including 6 extraction sockets and 4 healed sites
- Models randomized into fully guide (FG), partially guided (PG), and free handed (FH)
- 10 models in each group with 100 implant sites
- CBCT scans, digital planning and waxup complete
- Surgical templates made with surgical guide resin with 3D printer
- Surgical procedure (SIN Implant system guide)
 - FG: osteotomies and implant insertion with surgical guide
 - PG: osteotomies with guide, implant insertion not guided
 - FH: all surgeries without guidance, however did have template mimicking adjacent teeth and digital plannings on laptop for orientation
- Deviation of position analyzed by superimposing preop with postop scan



Results:

- Implant accuracy at extraction sockets

- FG/PG had higher accuracy in positioning with all measurements than FG
 - FH had twice mean crestal and apical global deviation values (distance from crest/apex of virtual implant and actual implant)
 - 50-65% greater angular deviations
- FG had better results in all deviations than PG □ FG better accuracy (esp in coronal part during immediate implant placement)
 - SIG diff in coronal global deviations: 0.74mm (FG) vs 0.91mm (PG)
 - SIG diff in horizontal deviations: 0.69mm (FG) vs 0.86mm (PG)
- Implant accuracy at healed sites
 - FG/PG similar in all deviation values, but both showed more accuracy than FH
 - NSSD in depth deviation

Deviations (mean ± SD)			
Fresh sockets	FG (n = 60)	PG (n = 60)	FH (n = 60)
3D deviation at crest (mm)	0.74 ± 0.15	0.91 ± 0.22	1.21 ± 0.50
3D deviation at apex (mm)	1.19 ± 0.35	1.37 ± 0.52	1.91 ± 0.86
Horizontal deviation at crest (mm)	0.69 ± 0.15	0.86 ± 0.20	1.07 ± 0.54
Horizontal deviation at apex (mm)	1.16 ± 0.36	1.32 ± 0.51	1.81 ± 0.86
Depth (mm)	0.21 ± 0.14	0.26 ± 0.17	0.45 ± 0.27
Angulation (°)	2.36 ± 1.14	3.20 ± 2.01	6.55 ± 3.61
Healed sites	FG (n = 40)	PG (n = 40)	FH (n = 40)
3D deviation at crest (mm)	0.39 ± 0.16	0.36 ± 0.18	0.71 ± 0.35
3D deviation at apex (mm)	0.67 ± 0.31	0.68 ± 0.33	1.55 ± 0.56
Horizontal deviation at crest (mm)	0.31 ± 0.15	0.28 ± 0.15	0.68 ± 0.37
Horizontal deviation at apex (mm)	0.62 ± 0.31	0.64 ± 0.32	1.53 ± 0.57
Depth (mm)	0.20 ± 0.14	0.19 ± 0.15	0.13 ± 0.11
Angulation (°)	1.57 ± 0.83	1.83 ± 0.95	4.60 ± 1.86

- Accuracy between immediate and delayed implant placement
 - Implants in extraction sockets have SS more deviation than those in healed sites
 - FG: immediate vs healed
 - Immediate had 50% higher global/horizontal deviation at crest (0.74mm/0.69mm) and apex (1.19mm/1.16mm)
 - VS**
 - Healed: better accuracy in global/horizontal deviation at crest (0.39mm/0.31mm) and apex (0.67mm/0.62mm)
 - PG: more deviations at immediate sites (~2x the deviation of healed sites)
 - FH: difference of 2 degrees in angulation between immediate vs healed

Conclusion:

- FG can sig increase accuracy esp at immediate sites
- NSSD between FG/PG at healed sites
- FG/PG provide more precision than FH

Topic: Computer-aided implant surgery

Author: Tahmaseb, et al.

Title: The accuracy of static computer-aided implant surgery: A systematic review and meta-analysis

Source: Clin Oral Impl Res. 2018;29(Suppl. 16):416–435

DOI: 10.1111/clr.13346

Reviewer: Ryan Higgins

Type: Systematic Review

Keywords: static, computer-aided, implant surgery

Purpose:

- To survey the literature on the accuracy of implant surgery with the aid of computer-assistance

Materials and Methods:

- 20 studies were included in the review
 - o 1 RCT, 8 uncontrolled retrospective synthesis, 11 uncontrolled prospective studies
- 471 patients, 2,238 implants placed with static guides
- For fully edentulous cases:
 - o Mucosa supported guides, with and without fixation pins
 - o Bone-supported guides fixed with stabilization screws

Results:

- Total mean error of 1.2mm (1.04mm to 1.44mm) at the entry point
- Total mean error of 1.4mm (1.28mm to 1.58mm) at the apical point
- Deviation of 3.5°(3.0° to 3.96°)
- Statistical difference in accuracy in favor of partial edentulous cases compared to full edentulous cases

Conclusions:

- Static computer-aided implant surgery is within the clinically acceptable range in the majority of situations
- Greater accuracy in partially edentulous patients than fully edentulous patients
- A safety margin of 2mm should be taken even when using a guide

Topic: Guided Surgery

Authors: El Kholi, K et al.

Title: Influence of implant macrodesign and insertion connection technology on the accuracy of static computer-assisted implant surgery.

Source: Clinical Implant Dentistry and Related Research .2019;21:1073–1079.

DOI: 10.1111/cid.12836

Reviewer: Nicolas Lobo

Type: In Vitro

Keywords: accuracy, computer-aided, computer-assisted, digital, guided surgery, implant, implant design, implant surgery, implantology

Purpose: to evaluate the effect of three different macrodesigns and two different insertion devices on the accuracy of static computer-assisted implant surgery (sCAIS).

Materials and Methods: This study used 30 duplicate acrylic models simulating human bone, with implant placements at FDI positions 15 (4), 12 (7), and 23 (11). The models were scanned using an intraoral scanner and a CBCT. The surgical guides were 3D printed and adjusted to fit. 90 implant replicas with 3 macrodesigns: tissue level (TL), bone level (BL), and bone level tapered (BLT) and two insertion devices: Guided Portable Adapter (GPA) and Handpiece Adapter (GSM) were assessed. Implants were placed following standard protocols, with the same insertion device used for all sites on each model. Postoperative digital impressions were taken, and deviations between planned and actual implant

positions were measured using an implant planning software.

FIGURE 2 Diagrammatic representation of the implant macrodesigns assessed. A, TL, BL, and BLT implants entering the osteotomy. Note that the BLT implant is guided by the osteotomy walls only after the apical portion has entered the osteotomy. B, TL, BL, and BLT implants within the osteotomy. TL, tissue level; BL, bone level; BLT, bone level tapered

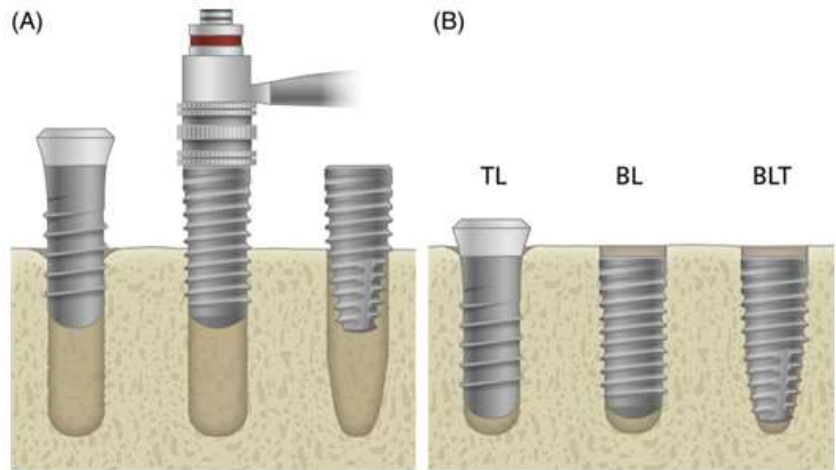


FIGURE 3 Guided insertion devices. A, Guided portable adapter (GPA) fitted onto the standard transfer piece. B, Guided screwed-in mount (GSM) that fits into a handpiece adapter

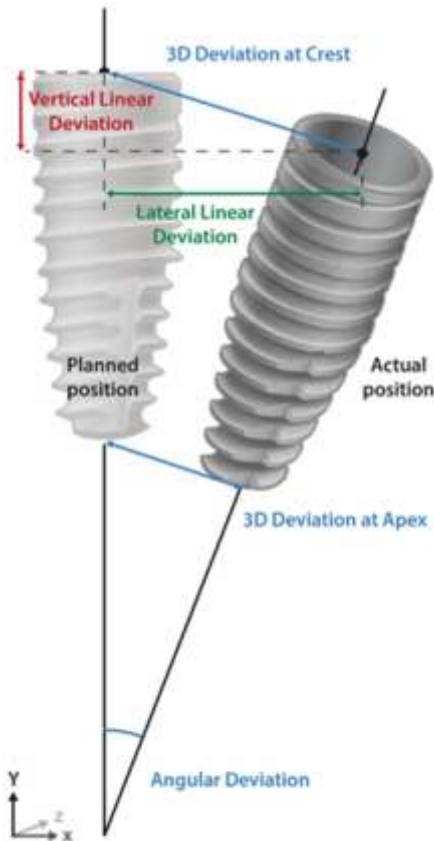


FIGURE 4 Diagrammatic representation of measurements of 3D deviations, at crest and apex, as well as, angular deviations between virtually planned and actual implant positions

Results: The multivariate analysis showed no significant interaction between implant macrodesign and insertion device across measurement categories, allowing for direct comparisons. For implant macrodesign, BLT implants had significantly lower mean 3D deviation values at both the crest and the apex compared to BL and TL implants. BLT implants also showed lower angular deviations, though the differences were not statistically significant.

Regarding the insertion device, no significant differences were found in 3D or angular deviation values between devices.

Conclusions: The macrodesign of dental implants may influence the precision of sCAIS, with tapered designs showing significantly improved positional accuracy over parallel-walled designs.

Topic: Guided surgery

Authors: El Kholy, K, et al.

Title: The influence of guided sleeve height, drilling distance, and drilling key length on the accuracy of static computer-assisted implant surgery

Source: Clinical Implant Dentistry and Related Research, 21(1), 101–107.

DOI: 10.1111/cid.12705

Reviewer: Mahya Sabour

Type: In-vitro study

Keywords: guided surgery, implants, surgical guide

Purpose: to investigate the effects of drilling distance, sleeve height, and drilling key height on the accuracy of implants placed via the static Computer-Assisted Implant Surgery (sCAIS)

Material and Methods:

- 30 acrylic models and 6 implant positions according to the Federal Dentaire Internationale (FDI) placement at 15,12,21,23,25 and 26
- Models scanned with the 3shape intraoral scanner and CBCT taken. A digital waxup and treatment planning was performed after matching all datasets.
- Sleeve heights of 2,4, and 6mm and guided key heights of 1 and 3mm were randomly assigned to 6 groups of 20 models using different combinations:
 - o 1a: 2mm sleeve height and 1mm key height
 - o 1b: 2mm sleeve height and 3mm key height
 - o 2a: 4mm sleeve height and 1mm key height
 - o 2b: 4mm sleeve height and 3mm key height
 - o 3a: 6mm sleeve height and 6mm key height
 - o 3b: 6mm sleeve height and 3mm key height
- The free-drilling-distance (FDD) was measured from the bottom of the guided sleeve to the tip of the surgical drill (bottom of osteotomy) for each group and implants were further classified into 14,16, and 18mm groups according to their FDD length.

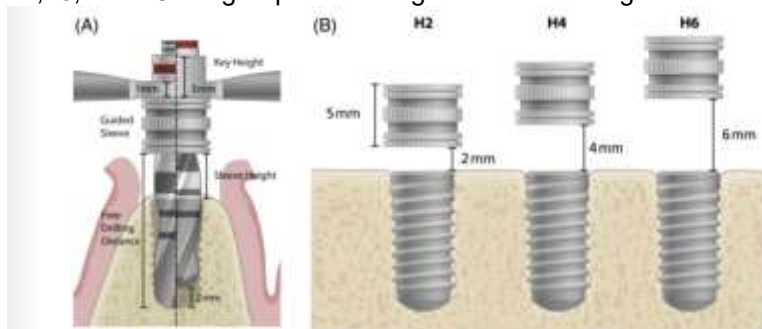


FIGURE 2 Free drilling distance versus osteotomy depth calculation in sCAIS. A, Free drilling distance = drill length - (sleeve length + guided key height). Osteotomy depth = drill length - (sleeve length + guided key height + sleeve height). Osteotomy depth = implant length. B, Sleeve height: Distance from the apical border of the sleeve to the implant shoulder

- Surgical guides were designed, and 3D printed and 4.1x10 mm bone level implants (Straumann) were placed. Scan bodies were placed, and post-op digital scans taken. STL files were used to compare pre-planned and post-surgical implant positions after superimposing files. Angular and 3D deviation at implant crest and apex were measured.



Results:

- Sleeve heights as an individual variable was not significant in terms of 3D or angular deviation for any of the groups ($P > 0.05$), however 3D deviation at crest and apex were significantly influenced by the FDD ($P < 0.01$). Increasing FDD significantly reduces accuracy and increases 3D deviation values.
- The guided key height was inversely proportional to the 3D and angular deviation. Increasing the distance above the guided sleeve due to increasing the length of the drilling key height will decrease 3D and angular deviation. This could be due to the fact that increasing the drilling key height leads to a longer guiding channel through the drilling key.
- No significant impact of drill length or guided sleeve height individually, but when the drilling distance resulting from the combination of the two values in addition to the drilling key height was examined, it had significant impact on accuracy.

Conclusion:

Recommended to choose options with minimum FDD to reduce the deviation between the planned and post-op implant positions. Choosing a shorter drill, lower sleeve height, and longer drill key have more favorable outcomes. These three factors should be collectively evaluated when planning cases.

Topic: computer-assisted implant surgery

Authors: El Kholi, K., Lazarin, R., Janner, S. F. M., Faerber, K., Buser, R., & Buser, D.

Title: Influence of surgical guide support and implant site location on accuracy of static computer-assisted implant surgery

Source: Clinical Oral Implants Research, 30(11), 1067–1075

DOI: 10.1111/clr.13520

Reviewer: Amber Kreko

Type: clinical study

Keywords: computer-assisted, guide support, guided surgery, implantology, surgical guide

Purpose: To investigate the influence of guide design variables, specifically the number of teeth supporting the surgical guide and the location of the implant site on the accuracy of computer-assisted implant surgery (sCAIS).

Material and methods:

- 85 duplicate dental models with six potential sites for implant placement were used
 - o All models had simulations for a fresh extractin socket, one distal extension situation, and 3 single tooth gap situation
- Digital treatment planning for correct implant positioning done. Divided into 4 different experimental groups based on guide length used

- Group 1 – full arch supported guides – 40 guides made to place 6 implants each for 240 implants total
- Group 2 – partial guides supported by 4, 3, or 2 teeth
 - Group 2a – Guides supported by 4 teeth – 15 models used for 45 surgical guides
 - Group 2b – guides supported by 3 teeth – 15 models used for 45 surgical guides
 - Group 2c – guides supported by 2 teeth – 15 models used for 45 surgical guides
- Deviation values were measured and recorded.

Results:

- Implants placed by a surgical guide supported by 4 teeth had 3D deviation values that were as accurate as those placed with full-arch guides.
- Implants placed by a surgical guide supported by 3 teeth had higher deviations compared to full arch but similar to 2 teeth supported surgical guides
- Implants placed using only 2 supporting teeth had higher deviation values compared to implants using 4 teeth.
- Use of posterior teeth for guide support resulted in SS degree of accuracy compared to anterior teeth.
- Implants placed in distal extension had higher deviations than in sites with mesial and distal tooth support. Deviation values increased as length of unsupported free-end extension of surgical guide increased.
- Implants placed in extraction sockets had 50% higher deviations than implants placed in healed sites.

Conclusions: Number and location of teeth providing support can significantly influence accuracy of sCAIS. In single tooth situations, support by 4 teeth was equal to full arch guide. Implants placed in distal extension situations had higher deviation compared to areas with bilateral support.

Topic: Guided implant surgery

Authors: Balaguer-Martí, José Carlos et al.

Title: Influence of Splint Support on the Precision of Static Totally Guided Dental Implant Surgery: A Systematic Review and Network Meta-analysis

Source: The International journal of oral & maxillofacial implants vol. 38,1 (2023): 157-168

DOI: 10.11607/jomi.9796

Reviewer: Tam Vu

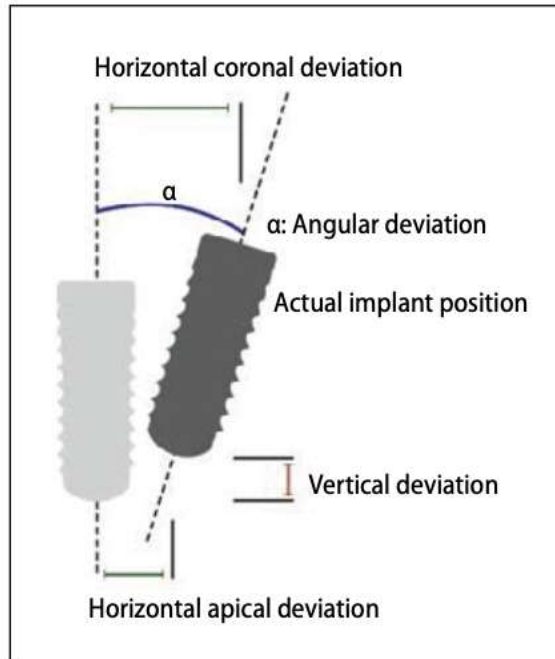
Type: Systematic Review and Meta-analysis

Keywords: guided implant surgery, tooth, mucosa, bone, splint support, accuracy, computer-assisted surgery

Purpose: to evaluate the precision of totally guided implant placement with static surgical guides in different types of support tissues (tooth, mucosa, and bone)

Material and methods: electronic database search (PubMed, Embase, Cochrane)

- Population: pts needing dental implants
- Intervention: implant surgery using static surgical guide
- Comparison: tooth vs mucosa, vs bone splint support
- Outcomes: accuracy based on horizontal coronal deviation, horizontal apical deviation, vertical deviation, and angular deviation



Results:

- 18 articles included for qualitative analysis, 16 for quantitative analysis

Descriptive Statistics

- Overall deviations
 - Horizontal coronal deviation: 1.12 mm
 - Horizontal apical deviation: 1.41 mm
 - Vertical deviation: 0.12 mm
 - Angular deviation: 3.58°

Meta-analysis

Deviation by Type of Support				
	Horizontal coronal	Horizontal apical	Vertical	Angular
Tooth support	1.03 mm	1.35 mm	0.39 mm	3.39°
Mucosa support	1.14 mm	1.47 mm	-0.58 mm	3.65°
Bone support	1.13 mm	1.54 mm	0.47 mm	4.23°

- NSSD between type of splint support and horizontal coronal and apical deviations
- Angular deviation was SSD:
 - Bone support: 1.31° greater deviation than tooth supported
- Accuracy: Tooth > mucosa > bone support
 - Mucosal support may be less stable due to soft tissue resistance and anesthesia influence of mucosal morphology
 - Bone-supported has least accuracy, possibly due to need to raise large flap that can interfere with correct placement

Conclusion:

- Tooth supported guides are significantly more precise than bone supported
- No diff in terms of horizontal coronal, horizontal apical, or vertical deviations among the types of splint support used