

Literature Review – December 17th, 2018

A randomized controlled study on the accuracy of free-handed, pilot-drilled, and fully guided implant surgery in partially edentulous patients

Introduction

- Ample studies have shown great survival and clinical success rates for implants for various indications
- The correct 3D positioning of an implant is considered a pre-requisite for an optimal esthetic outcome
- Thus, implant placement should be prosthetically driven, with anatomical limitations and bone availability taken into account
- Emergence and widespread availability of low-dose CBCT images along with implant planning software has led to better pre-implant visualization and planning
- Dynamic guided surgery – guided surgery with real-time information on position of drill
- Static Guided Systems – template based
- One study showed the accuracy of different templates, bone- vs. mucosa- vs. tooth-supported, with tooth-supported to be the most accurate
- Fully Guided – based on a surgical guide, which assists clinician in every step
- Half-Guided – all steps leading up to implant placement with guide, final implant placement free-handed
- Pilot-Drilled Guided – makes use of surgical guide for initial pilot hole

Materials and Methods

Patient Selection

- Between March 2015 and November 2016
- Inclusion criteria as follows: good general health, good OH, partially edentulous space of at least 2 neighbouring teeth, signed informed consent
- Exclusion criteria as follows: systemic diseases, history of radiotherapy in head/neck, untreated periodontal disease, caries, pregnancy

Virtual 3D Implant Planning and Randomization

- CBCT acquired – all participants underwent same procedure to obtain CBCT
- Polyether impression of maxilla, alginate of mandible obtained
- Prosthetic wax up completed for each case
- Virtual planning performed on all implants based on: vertical position, buccopalatal position, and inclination
- This planning served as the 'ideal position' for each case
- Patients randomly assigned to one of the three treatment groups: free-handed (FH), pilot-drilled guided (PG), and fully guided (FG).

Surgical Procedures

Pre-Operative Instructions

- All patients instructed to take Amoxicillin and Ibuprofen 1 day and 1 hour prior to surgery, respectively
- After administration of LA, 0.12% chlorhexidine rinse for 30 seconds
- Then surgery was performed by one surgeon, and all implants were OsseoSpeed EV of various dimensions

Free-Handed Surgery

- Only images from software planning and some rough distance calculations allowed as reference
- Crestal and sulcular incisions made, full-thickness flap raised on buccal and palatal side
- Subsequent osteotomies prepared according to manufacturer's guidelines
- Implants installed according to manufacturer's guidelines
- If insertion torque failed to reach 15 Ncm, cover screw placed and flap closed on top
- If insertion torque >15 Ncm achieved, healing abutment placed, then careful recontouring of palatal mucosa and soft tissues
- Non-resorbable monofilament sutures used at all times

Pilot-Drilled Guided Surgery

- Performed without flap elevation
- Fit of surgical guide checked and adjusted
- First osteotomy performed with surgical guide in place
- Drill stop ensured correct depth
- Subsequent osteotomies performed free-handedly
- Implants installed in same way as free-handed surgical technique

Fully Guided Surgery

- Performed without flap elevation
- Fit of surgical guide checked and adjusted
- All osteotomies performed with surgical guide in situ
- For each drill, a removable corresponding drilling tube inserted into guiding sleeves to allow fluent guiding of drill
- Markings on drills related to depth
- Implants placed with surgical guide in situ
- Implants installed in a one- or two-stage procedure depending on primary stability

Postoperative Instructions

- Cold packs administered immediately after surgery
- Continue course of antibiotics, and analgesics if deemed necessary
- In addition, 0.12% chlorhexidine solution advocated 2x/day for 7 days
- Sutures removed after 7 days

Postoperative CBCT

- Implants left to integrate for 12 weeks

- After removing healing abutments or after uncovering implants and removal of cover screw, second CBCT exposed at same settings

Accuracy Analysis

- Completed by one experienced process engineer
- Based on pre-op and post-op CBCTs
- Difference in spatial coordinates of both compared and resulted in distances in three dimensions

Statistical Analysis

- Each set of data was examined three times
 - Once by an experienced engineer, followed by a one week later, then a second engineer analyzing the data
- Data analysis performed using intention-to-treat approach

Results

Patient Selection

- Minimum of 16 implants to be installed in FH and FG group
- Each patient to receive at least 2 implants, minimum of 11 patients per group considered mandatory
- 11 patients in FH, 11 in PG, 10 in FG
- Every patient fully complied with protocol until study termination

Surgical Procedures

	FH	PG	FG	Total
Implant diameter platform				
Narrow (3.6 mm)	4 (15.4%)	3 (12.5%)	7 (33.3%)	14 (19.7%)
Regular (4.2 mm)	13 (50%)	15 (62.5%)	10 (47.6%)	38 (53.5%)
Wide (4.8 mm)	9 (34.6%)	6 (25%)	4 (19%)	19 (26.8%)
Implant body type				
Conical	3 (11.5%)	3 (12.5%)	2 (9.5%)	8 (11.3%)
Straight	23 (88.5%)	21 (87.5%)	19 (90.5%)	63 (88.7%)
Implant length				
8 mm	1 (3.8%)	2 (8.3%)	1 (4.8%)	4 (5.6%)
9 mm	4 (15.4%)	5 (20.8%)	4 (19%)	13 (18.3%)
11 mm	11 (42.3%)	9 (37.5%)	9 (42.9%)	29 (40.8%)
13 mm	10 (38.5%)	8 (33.3%)	7 (33.3%)	25 (35.2%)
Number of ill-fitting guides	N/A	0 (0%)	2 (20%)	2 (9.5%)

FG, fully guided; FH, free-handed; N/A, not applicable; PG, pilot-drill guided.

Accuracy Analysis

- AGD considered primary outcome of study, and revealed statistically significant difference between FH and PD, and between FH and FG, with highest accuracy for FG, and lowest for FH

	Free-handed		Pilot-drill guided		Fully guided	
	Mean	SE	Mean	SE	Mean	SE
AD	6.99	0.87	5.95	0.87	2.30	0.92
CVD	0.53	0.09	0.68	0.09	0.43	0.09
CLD	1.27	0.11	0.79	0.11	0.55	0.11
CGD	1.45	0.10	1.12	0.10	0.73	0.10
AVD	0.50	0.09	0.68	0.09	0.43	0.09
ALD	1.97	0.19	1.14	0.20	0.81	0.21
AGD	2.11	0.18	1.43	0.18	0.97	0.19

AD, angular deviation in degrees; AGD, apical global deviation in mm; ALD, apical lateral deviation; AVD, apical vertical deviation; CVD, coronal vertical deviation; CLD, coronal lateral deviation; CGD, coronal global deviation; SE, standard error.

Discussion

- Correct 3D implant position has been pointed out as pivotal factor for optimal aesthetic outcome of implant reconstructions
- Recent study showed nearly half of peri-implantitis cases had been surgically triggered by implant malpositioning
- Results demonstrate huge disparities between the three treatment groups in terms of primary outcome of the study (AGD)
- The fact that 19.2% of implants in FH group had to be restored by means of cement retained restoration may underline the clinical relevance
- PG surgery able to reduce proportion of implants that needed to be restored by cement-retained restorations to 4.2%
- Although results of FG group clearly indicate higher accuracy, PG may not be obsolete
- PG can achieve higher accuracy when compared to FH, specifically in horizontal plane
- Thus, PG can be of particular use in those cases where a FG surgery not feasible (e.g. thin alveolar crest)
- Two guides in the FG group had to be adjusted, and held in place with manual pressure during the procedure
 - Oddly enough, these two cases were the outliers in the study
- Limitations
 - Relevant impact of surgical experience on accuracy of implant placement is to be expected, especially for FH
 - May have been underpowered to detect statistically significant differences between treatment groups in terms of vertical deviations from virtual planning
 - Attempt was made to identify factors besides surgical approach rendering implant placement inaccuracies, but none could be found

Conclusion

- Demonstrates that a high degree of accuracy can be achieved by FG surgery in partially edentulous patients by means of tooth-supported guides
- Pilot guided surgery has lower accuracy than FG, but can be advantageous in certain situations where FG cannot be achieved (or is contraindicated)

- As a result, FG surgery should be seen as the gold standard approach, instead of FH surgery when perfect implant positioning is required

Summary

- The present study looks at the differences in accuracy of three treatment options in implant placement: free-handed, pilot-guided, and fully-guided surgery, in patients that are partially edentulous
- It has shown that fully guided surgeries do return the best results in respect to accuracy according to implant planning, and those of free-handed surgery return the worst
- More studies should be performed, comparing the accuracy, long-term viability, and cost-effectiveness of each surgical technique

Reference

Younes, F; Cosyn, J; De Bruyckere, T; Cleymaet, R.; Bouckaert, E.; Eghbali, A. *A randomized controlled study on the accuracy of free-handed, pilot-drill guided and fully guided implant surgery in partially edentulous patients.* J Clin Periodontol. **2018**. 1-12.