10.21608/adjc.2024.260823.1458 Advanced Dental Journal
Volume 6 (2024) | Issue 4| Pages 697-701

Original Article

Fit Of CAD\CAM Frameworks Designed Based on Virtual Implant Positions Versus Actual Implant Positions: A Pilot Invitro Study

Mohamed El-Sayed Kamel[1], Mohamed Amr ElKhashab[2], Iman AbdelWahab Radi[2]

[1]Department of Oral Implantology, Faculty of Dentistry, Cairo University.

[2]Department of Prosthodontics, Faculty of Dentistry, Cairo University.

Email: Mohamed .eletr@dentistry.cu.edu.eg

Submitted: 7-1-2024
Accepted: 14-2-2024

Abstract

Aim: The aim of this study was to evaluate the fit of CAD\CAM frameworks deigned based on virtual implant positions versus actual implant positions.

Subjects and methods: Five models with 20 frameworks were included. Their cone-beam computerized tomographic images were Planmeca Imaging System and their intraoral surface scans with Medit scanner. The data from these two sources were then merged; the volumetric topography of models was constructed and prosthesis/implant planning was performed using RealGuide software. From these plans, fully computer guided surgical templates and screw-retained Final metal prostheses were manufactured before implant placements using computer–aided design/computer–aided manufacturing process. Jdental implants were placed fully guided, the prostheses were inserted and evaluated based on their time spent for construction. The control group was frameworks done by the conventional technique by scanning the scan bodies of actual implant positions after implant placement.

Results showed that the difference between the two groups was not statistically significant was reported between two groups regarding fit of frameworks.

Conclusion: Preoperative frameworks have the same fit as the postoperative frameworks.

Keywords: CAD\CAM , Prefabricated frameworks, Free end saddle, Implants, Guided surgery.

Introduction

Computer assistance in implant dentistry has been accepted in daily practice and is becoming a hot topic in dental implant research. The accuracy of implant position using computer-guided templates has been validated clinically and proven superior to free hand implant placement. Systemic reviews, scientific consensus and textbooks on this topic are available (**Hämmerle et al., 2015; Ganz 2015; Lee et al, 2012; Oh et al., 2019)** . Ganz in particular has been studying

this field for more than two decades (**Ganz 201**).

In Free end partial edentulous arches, once implants have been placed fully guided and immediate loading is feasible, there are several methods of fabricating definitive crowns/bridges either directly or indirectly using actual implant positions as the reference. In other words, temporary prostheses made post-operatively involve the physical recording of the implants, their abutments and peri implant tissues, which arephysically manipulated in the fabricating process.

With advances in all aspects of digital techniques, precise preoperative planning for implant surgery and prefabricated implant-supported prosthesis has become fit **(D'haese et al., 2017)**. Prefabricated prostheses can better achieve aesthetic and functional outcomes at the time of surgery(**Laleman et a., 2016; Marinis et al., 2022**). Data obtained using cone-beam computerized tomography (CBCT) can be imported into implant planning software programs to analyse the surrounding vital anatomic structures to determine the ideal implant locations **(Ma et al., 2018).** Intraoral scanning devices help create a more realistic view of the intraoral soft tissues **(Oh et al., 2019).** Optimal prosthetic-driven implant placement can be scheduled virtually before surgery using a scanning template (**Albiero and Benato, 2016**). Digital data from CBCT and intraoral scans can be directly transferred to the manufacturer of surgical templates and final prostheses **(Ma et al., 2018; Tahmaseb et al., 2014)**.

Subjects and Methods

Stone cast of bilateral free end saddle mandibular jaw model was scanned and radiographed using CBCT. The design of the surgical guide was carried out on implant planning software then printed using LCD 3D printer.

After checking the seating of the surgical guided stent on the models. Drilling was initially performed using drills of diameter size of 2.3 mm (pilot drill), followed by 2.8mm drills and followed by 3.4 mm then finally 3.8 mm drills for the placement of implants 3.7x10mm in dimension[1]. The drilling site was cleaned and the fixture installed in place carefully and tightened using contra angled hand piece and a torque wrench.

I. Pre-operatively fabricated frameworks : (Intervention group)

This group was restored using pre-operatively fabricated frameworks. The virtual scan bodies of the multi-unit abutments were exported to the designing software, the design of the frameworks were done and then exported for CNC computer aided machining.

II. Post-operatively fabricated frameworks: (Control group)

After the implants installed in the anterior and premolar areas. The multi-unit abutments screwed to the implants. A digital impression using a intra-oral scanner at multi-unit abutment level[2] was carried out by using scan bodies[3] which connected to the six installed implants on the reference cast (control) by hand tightening.

The digital volumes have been exported as STL files and transferred to the designing software. The design then transferred to the computer aided machine.

Fit assessment:

The fit assessment was binary by applying screw resistance test to the frameworks.

Results

All data were collected in an excel sheet for statistical analysis. Since they were all qualitative, they were presented as frequencies

[1] JDental, Italy
[2] Medit I 600 lab scanner
[3] JDental, Italy

and percentages. Fisher's Exact test was used to compare between the two groups. The significance level was set at P ≤ 0.05. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

The results showed that no significant difference between the preoperatively and postoperatively fabricated frameworks regarding fit as seen in table 1 and figure 1.

Table (1). Results of Fisher's Exact test for comparison between overall fit of frameworks

Group	Overall fit	N	%		
Group prefabricated	yes	9	90	0.100	NC
	no	1	10		
Group Postopertively	yes	10	100	NC	NC
	no	0	0		

%: percentage, *: Significant at P ≤ 0.0, N: number, NC: not computed because of constant variable, OR: Odds ratio

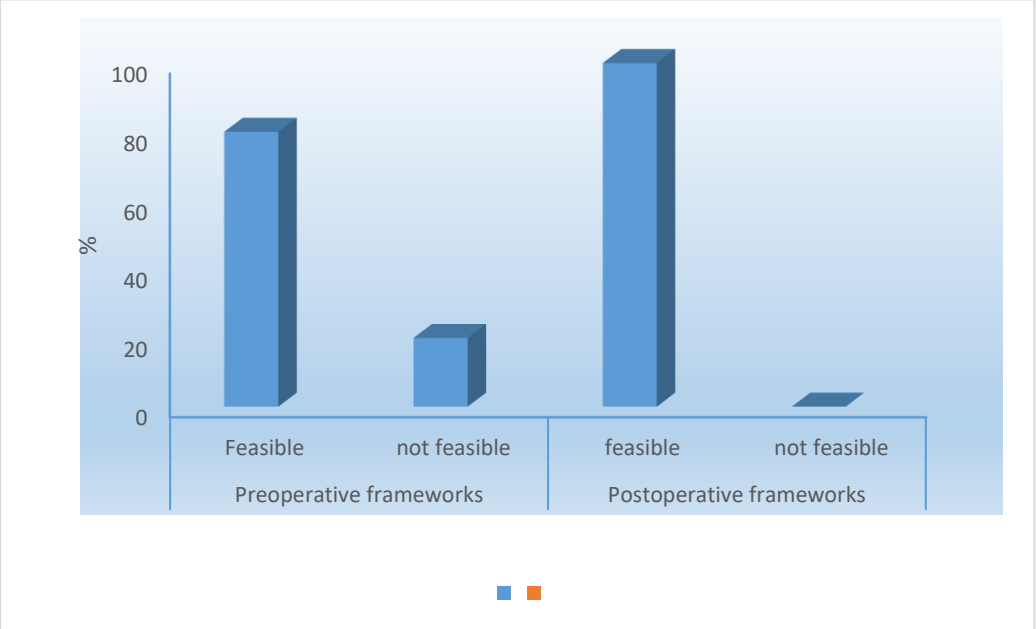

Figure1. Bar chart representing fit findings.

Discussion:

This in vitro study compares the fit between the frameworks fabricated before and after implant placement using complete digital workflow.

The need of pre operatively fabricated frameworks is increasing to save time, cost and effort. Also, it encourages the clinicians to adopt the completer digital workflow which facilitates the fabrication of implant supported frameworks with less errors than the conventional techniques,

The merge between the CBCT and intra oral scanning increase the precision of the outcome of the procedure **(Chen et al., 2022)**. The use of guided implant placement with computer aided and manufacturing makes fabrication of prefabricated frameworks more precise **(Ganz, 2015).**

The frameworks that were done postoperatively need digital scans after implant placement while this step was skipped in the other group. The step of taking physical or digital impression will save the time and will be more convenient for patients with gagging reflex or allergy to the impression materials **(Oh et al., 2019).**

The postoperatively fabricated frameworks need 10 minutes for scanning step and importing the scan to the designing software while the computer aided machining for both groups was the same. The preoperatively group need more adjustments for complete seating of the frameworks. While the postoperative group needed less adjustments which saved more time.

The cost needed for the both groups considered to be same except for the scanning step. The scanning step is important to transfer the actual positions of the multiunit of the implants which lead to more accurate frameworks. This reduces the need to adjustments and the time of adjusting the frameworks while for the prefabricated frameworks, they need more adjustments which increase time and cost for production of accurately fabricated frameworks. But in the whole procedure of production and adjusting of prefabricated frameworks takes less time than the postoperatively fabricated frameworks.

Conclusion:

Within the limitations of the study, we concluded that the preoperatively fabricated frameworks have same feasibility than conventional fabricated frameworks.

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Ethics:

This study protocol was approved by the ethical committee of the faculty of dentistry-Cairo university on:26\5\2020

References

1. **Albiero, A.M. and Benato, R.** (2016) 'Computer-assisted surgery and intraoral welding technique for immediate implant-supported rehabilitation of the edentulous maxilla: case report and technical description', *The International Journal of Medical Robotics and Computer Assisted Surgery*, 12(3), pp. 453-460.
2. **Chen, C., Lai, H., Zhu, H. and Gu, X.** (2022) 'Digitally prefabricated versus conventionally fabricated implant-supported full-arch provisional prosthesis: a retrospective cohort study', *BMC Oral Health*, 22(1), pp. 1-9.
3. **D'haese, J., Ackhurst, J., Wismeijer, D., De Bruyn, H. and Tahmaseb, A.** (2017) 'Current state of the art of computer-guided implant

surgery', *Periodontology 2000*, 73(1), pp. 121-133.

4. **Hämmerle, C.H., Cordaro, L., van Assche, N., Benic, G.I., Bornstein, M., Gamper, F., Gotfredsen, K., Harris, D., Hürzeler, M., Jacobs, R. and Kapos, T.** (2015) 'Digital technologies to support planning, treatment, and fabrication processes and outcome assessments in implant dentistry. Summary and consensus statements. The 4th EAO consensus conference 2015', *Clinical oral implants research*, 26, pp. 97-101.
5. **Ganz, S.D**. (2015) 'Three-dimensional imaging and guided surgery for dental implants', *Dental Clinics*, 59(2), pp. 265-290.
6. **Laleman, I., Bernard, L., Vercruyssen, M., Jacobs, R., Bornstein, M.M. and Quirynen, M.** (2016) 'Guided Implant Surgery in the Edentulous Maxilla: A Systematic Review', *International journal of oral & maxillofacial implants*, 31.
7. **Lee, C.Y., Ganz, S.D., Wong, N. and Suzuki, J.B.** (2012) 'Use of cone beam computed tomography and a laser intraoral scanner in virtual dental implant surgery: part 1', *Implant dentistry*, 21(4), pp. 265-271.
8. **Ma, B., Park, T., Chun, I. and Yun, K.** (2018) 'The accuracy of a 3D printing surgical guide determined by CBCT and model analysis', *The journal of advanced prosthodontics*, 10(4), pp. 279-285.
9. **Marinis, A., Papaspyridakos, P., Sicilia, E., Bernardes, S.R., Touloumi, F., Chochlidakis, K. and Weber, H.P**. (2022) 'Digital workflow for double complete arch zirconia prostheses utilizing a novel scan body', *Journal of Prosthodontics*, 31(1), pp. 4-8.
10. **Makarov, N., Pompa, G. and Papi, P.** (2021) 'Computer-assisted implant placement and full-arch immediate loading with digitally prefabricated provisional prostheses without cast: a prospective pilot cohort study', *International journal of implant dentistry*, 7(1), pp. 1-9.
11. **Oh, J.H., An, X., Jeong, S.M. and Choi, B.H.** (2019) 'A digital technique for fabricating an interim implant-supported fixed prosthesis immediately after implant placement in patients with complete edentulism', *The Journal of prosthetic dentistry*, 121(1), pp. 26-31.
12. **Richert, R., Goujat, A., Venet, L., Viguie, G., Viennot, S., Robinson, P., Farges, J.C., Fages, M. and Ducret, M.** (2017) 'Intraoral scanner technologies: a review to make a successful impression', *Journal of healthcare engineering*, 2017.
13. **Tahmaseb, A., Wismeijer, D., Coucke, W. and Derksen, W.** (2014) 'Computer technology applications in surgical implant dentistry: a systematic review', *International Journal of Oral & Maxillofacial Implants*, 29.
14. **Yuzbasioglu, E., Kurt, H., Turunc, R. and Bilir, H**. (2014) 'Comparison of digital and conventional impression techniques: evaluation of patients' perception, treatment comfort, effectiveness and clinical outcomes', *BMC oral health*, 14(1), pp. 1-7.