Accuracy of computer-assisted template-based implant placement using conventional impression and scan model or intraoral digital impression: A randomised controlled trial with 1 year of follow-up

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Purpose

To compare accuracy and complications of computer-assisted template-based implant placement using conventional impression and scan of a physical stone cast or intraoral scanning to rehabilitate partially edentulous patients.

Materials & Methods

Study design : A randomized controlled trial.
Subjects and Outcomes of the study

- **Period** : From May 2016 to March 2017. (F/U 1-year after loading)
- Patients were randomised according to a parallel-group design into two arms
- Fully digital group(intraoral digital impression) : 10 patients with 28 implants
- Conventional group(conventional impression and scan model) : 10 patients with 29 implants
  Implants were placed flapless or with a minimally invasive flap, and conventionally loaded after 5months.
- **Outcome measures**
- Implant failure: The stability of individual implants was assessed during the delivery of definitive crowns by tightening the abutment screw with a torque of 20 Ncm, and then 1 year after implant placement by the percussion test with removed prostheses, and the implant stability quotient (ISQ) was measured in case of any doubt
- Prosthetic failure: A prosthesis was considered a failure if it needed to be replaced by an alternative prosthesis.
- Accuracy: Three deviation parameters (horizontal, vertical and angular) were defined and calculated between the planned and placed implant positions.

Results

No patients dropped out. No implant or prosthesis failed up to 1 year after loading. One implant in the fully digital group was placed freehand due to limited inter-arch space. No biological or mechanical complications were experienced during follow-up. Difference between groups were not statistically significant (P = 0.999).

- The mean error in angle
  Fully digital group : 2.25 $\pm$1.41 degrees (range 0.30 to 5.00 degrees; 95% CI: 1.38 to 3.12 degrees)
  Conventional group : 2.10 $\pm$1.18 degrees (range 0.30 to 5.80 degrees; 95% CI: 1.37 to 2.83 degrees)
- The horizontal plane (mesio-distal) - the mean error
  Fully digital group : 0.52 $\pm$0.30 mm (range 0.10 to 1.10 mm; 95% CI: 0.33 to 0.70 mm)
  Conventional group : 0.44 $\pm$0.26 mm (range 0.10 to 0.90 mm; 95% CI: 0.27 to 0.60 mm)
- The vertical plane (apico-coronal) - the mean error
  Fully digital group : 0.58 $\pm$0.44 mm (range 0.00 to 1.60 mm; 95% CI: 0.31 to 0.85) Conventional group : 0.46 $\pm$0.34 mm (range 0.00 to 1.20 mm; 95% CI: 0.25 to 0.67)
- The mean marginal bone loss (1 year after loading)
  Fully digital group : 0.14 $\pm$0.12 mm (range - 0.10 to 0.40 mm; 95% CI: 0.07 to 0.21 mm)
  Conventional group : 0.18 $\pm$0.13 mm (range - 0.10 to 0.60 mm; 95% CI: 0.09 to 0.26 mm).

Table 1. Main patient and implant characteristics between groups

Characteristic	Conventional	Digital
Number of patients	10	10
Age at implant placement	45.4 $\pm$13.0	43.7 $\pm$15.7
Female patients (n = 11)	5	6
Total number of implants (n = 57)	29	28
Implants placed in the maxilla (n = 33)	18	15
Immediately loaded implants (n = 24)	13	11
Immediately placed implants (n = 5)	4	1
Implants with sinus augmentation (n = 3)	2	1
Complete full-arch restorations (n = 4)	3	1
Single/multiple restorations (n = 30)	8/2	18/2

Table 2. Peri-implant marginal bone levels between groups (mm) [mean $\pm$SD (95% CI)]

	Implant loading	1 year after loading	Difference
Conventional (n = 29)	0.16 $\pm$0.17 (0.06 to 0.27)	0.33 $\pm$0.25 (0.18 to 0.49)	0.18 $\pm$0.13 (0.09 to 0.26)
Digital (n = 28)	0.20 $\pm$0.27 (0.04 to 0.36)	0.34 $\pm$0.33 (0.14 to 0.54)	0.14 $\pm$0.12 (0.07 to 0.21)
Difference	-0.04 $\pm$0.33 (-0.17 to 0.24)	-0.00 $\pm$0.41 (-0.25 to 0.25)	-0.04 $\pm$0.19 (-0.16 to 0.08)
P value	0.555	0.953	0.294

Conclusion

With the limitations of the present trial, implant rehabilitations planned using intraoral digital impressions showed similar results compared to conventional impression and scan model.
In both groups, the maximum 3D deviations (angular, horizontal and vertical) did not exceed the safe offset of the software.
Digital impression may be a viable option for the rehabilitation of partial edentulous patients when computer-guided template-assisted implant placement is used.