



Passivity Comparison of Implant-Supported Protheses Fabricated from Digital Scanning Techniques: Scan Body, Scan Gauge, and Photogrammetry

Gustavo López Gómez, DDS*; Frank Tuminelli, DMD, FACP
VA NY Harbor Healthcare System

Abstract

This in vitro study compared the passivity of fit of complete-arch fixed implant protheses fabricated using conventional scan bodies (Nobel/Elos), scan gauges (Nexus), photogrammetry (IMetric4D iCam), and analogue impressions.

Each data acquisition technique was used to acquire implant positions from master casts and then used to fabricate full-arch protheses. From there, 19 prosthodontic clinicians/residents evaluated each prosthesis for passivity of fit on its corresponding master cast.

A consensus on passive fit was achieved for the maxillary frameworks fabricated using iCam. When assessing for passivity of fit, scan bodies (0%) and analogue impressions (37.50% and 12.50%) were reported to have the lowest passivity.

These results suggest that photogrammetry (iCam) may offer advantages in achieving passivity of fit, which is critical for long-term prosthetic success.

Purpose Statement

The purpose of this in vitro study was to assess and compare the passivity of protheses fabricated using the following techniques:

1. Intraoral scanning with conventional scan bodies (Nobel/Elos)
2. Intraoral scanning with a scan gauge system (Nexus)
3. Extraoral scanning using photogrammetry (iCam)
4. Analogue impressions

Background

The passivity of fit of a complete-arch fixed implant prosthesis is essential for preventing biological and mechanical complications. Prosthetic fabrication requires the master cast to accurately replicate implant positions.

While conventional scan bodies are commonly used with intraoral scanners for the fabrication of single-unit restorations, the scanning process relies on image stitching which can accumulate errors influenced by increased inter-implant distances commonly encountered in full-arch protheses.

To overcome stitching errors seen when using scan bodies, this in vitro study investigated two alternative scanning methods:

- Nexus Scan Gauges
Provides a continuous scan with unique landmarks over the inter-implant distance.
- Photogrammetry (iCam)
Captures the spatial relationship of multiple implants simultaneously.

This study aimed to assess if these advanced digital methods yield a clinically superior passive fit compared to conventional scan bodies and traditional analogue impressions.

Materials and Methods

Master Cast Fabrication

Four Type IV gypsum master casts were fabricated: two maxillary casts with four MUA analogues, and two mandibular casts with six MUA analogues. All analogues were placed approximately 0.5 mm subgingival to the gingival mask.

Implant Position Data Acquisition

Implant positioning was acquired using the following techniques:

(1) Analogue Impression

2-phase, 1-stage approach utilizing Dentsply Sirona Reprosil Heavy and Regular Body impression materials.

(2) Nobel/Elos scan bodies Intraoral Digital Scans



(3) NEXUS scan gauges Intraoral Digital Scans



(4) IMetric4D iCam (photogrammetry) Extraoral Digital Scans



Technique (1) used one set of maxillary and mandibular casts, and techniques (2), (3), and (4) used the other set.

Prosthesis Fabrication and Control

Two protheses (one maxillary and one mandibular) were fabricated from each of the techniques using the following materials:

- Chromium-cobalt screw-retained bars from the (1) analogue impression and (2) Nobel/Elos scan bodies
- Titanium screw-retained bars from the (3) Nexus scan gauge system
- Zirconia screw-retained protheses from the (4) iCam photogrammetry system

One additional chromium cobalt bar with intentional misfits was fabricated to serve as a negative control.

Framework Evaluation

Nineteen evaluators, consisting of 5 prosthodontists and 14 prosthodontic residents, independently assessed the bars. The evaluators were provided with the nine bars, corresponding maxillary and mandibular master casts, MUA screws, and a hand driver. They evaluated each bar and provided their responses to three specific questions:

- **Question 1**
Does the bar visually pass the Sheffield test?
- **Question 2**
Does the bar fit passively?
- **Question 3**
Is the bar clinically acceptable?

Result

Control Assessment

The intentional misfit bar served as the negative control to validate the evaluators' ability to identify a misfitting prosthesis. Five evaluators, all residents, reported passivity for the intentional misfit bar, suggesting these evaluators' assessments may be invalid. The evaluation reports from these five evaluators were removed from the final statistical analysis.

Passivity Assessment

For **Question 2** ("Does the bar fit passively?"), the respondents answered in agreement as follows:

- 100% iCam maxilla
- 93.75% iCam mandible
- 93.75% NEXUS maxilla
- 75.00% NEXUS mandible
- 37.50% Analogue maxilla
- 12.50% Analogue mandible
- 6.25% Scan body mandible
- 0% Scan body maxilla

Conclusions/Summary

This in vitro study demonstrated that protheses fabricated using iCam photogrammetry achieved the highest degree of consensus on passive fit in complete-arch implant simulations.

This suggests that **iCam photogrammetry may provide a reliable and accurate method for capturing multi-unit abutment positions necessary for passive framework fabrication.**

Limitations and Future Directions

The primary limitation of this study was the small group of evaluators. Additionally, bias may have been introduced by the proprietary look and feel of protheses with which the respondents may already be familiar.

Increasing the number of participants and standardizing the material and fabrication process will improve the reliability of the results.

References

- Sahin S, Cehreli MC. The Significance of Passive Framework Fit in Implant Prosthodontics: Current Status. Implant Dent. 2001
- Papaspyridakos P et al. Digital vs Conventional Full-Arch Implant Impressions: A Retrospective Analysis of 36 Edentulous Jaws. J Prosthodont. 2023
- Rutkūnas et al. EPA Consensus Project Paper: Accuracy of Photogrammetry Devices, Intraoral Scanners, and Conventional Techniques for the Full-Arch Implant Impressions: A Systematic Review. Eur J Prosthodont Restor Dent. 2023

