

Comparative Evaluation of Accuracy of a New Bite Registration Material with Conventional and Intraoral Digitally Scanned Bite Registration: An In-Vivo Study

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ABSTRACT

Background: Accurate bite registration is essential in prosthodontics to ensure proper occlusion, function, and longevity of dental restorations. With advancements in digital dentistry, materials such as scannable vinyl polysiloxane (VPS CAD) and intraoral digital bite records have emerged as alternatives to traditional methods. This study aimed to evaluate and compare the accuracy of a new VPS CAD bite registration material with conventional VPS and intraoral digitally scanned bite records.

Methods: This in vivo cohort comparative study included healthy individuals aged 20–30 with complete dentition. Bite registrations were obtained using three techniques: conventional VPS material, VPS CAD material, and intraoral scanning via Medit i500. A standard 2 mm interocclusal separation was maintained using a leaf gauge. All bite records were converted into digital files and analyzed using GOM Inspect 2018 software to evaluate 3D surface deviations. Data were statistically analyzed using ANOVA, Tukey's post hoc test, and independent t-tests.

Results: The mean surface deviation values between the three groups showed no statistically significant differences on both right ($p = 0.707$) and left ($p = 0.186$) sides. Pairwise comparisons between VPS, VPS CAD, and digitally scanned bite records revealed no significant variation, indicating comparable accuracy.

Conclusions: There is no significant difference in the accuracy of bite registration among VPS, VPS CAD, and digitally scanned methods. All three techniques provide clinically acceptable results and may be used interchangeably depending on clinical preference or workflow requirements.

Key Words: Bite registration, VPS CAD, digital dentistry, intraoral scanner, occlusion.

INTRODUCTION

Accurate bite registration is a cornerstone in prosthodontics, essential for achieving optimal occlusion, functional harmony, and long-term success of restorations. Malocclusion resulting from inaccurate bite records can lead to discomfort, temporomandibular joint disorders, impaired mastication, and prosthetic failure^[1, 2].

Conventional materials for interocclusal records include waxes, impression plaster, zinc oxide eugenol, and elastomers such as polyether and addition silicone (polyvinyl siloxane, VPS). Among these, VPS is widely preferred for its dimensional stability, fine detail reproduction, and minimal resistance during closure^[3-5]. However, the conventional approach is subject to potential distortions during setting or handling.

With the advent of digital workflows in dentistry, intraoral scanners (IOS) and scannable bite registration materials have become increasingly integrated into clinical practice. VPS CAD, a scannable variant of VPS, incorporates opacifiers such as zirconium dioxide or titanium dioxide to improve intraoral scan detectability^[6,7]. These advancements enable clinicians to capture virtual interocclusal relationships with minimal material distortion, reducing chairside time and streamlining laboratory communication^[8,9].

Despite growing adoption of digital methods, evidence comparing the accuracy of digitally scanned bite records with traditional and scannable VPS materials in vivo remains limited. Most existing studies are in vitro and often lack clinical validation^[10-12]. This study was undertaken to evaluate and compare the

surface deviation of bite records made with conventional VPS, VPS CAD, and intraoral digital scanning. The use of GOM Inspect 3D analysis software allowed for precise quantification of occlusal relationships, offering meaningful insights into the clinical interchangeability of these materials and methods.

Methods

Study Design and Setting

This in vivo cohort comparative study was conducted at the Department of Prosthodontics, Hitkarini Dental College and Hospital, Jabalpur, Madhya Pradesh, India. Ethical approval was obtained from the institutional ethics committee, and all participants provided informed consent before participation.

Participants

A total of 36 healthy volunteers aged 20–30 years were recruited through random sampling. Participants were selected from individuals attending the outpatient clinic of the department.

Inclusion Criteria:

- Age between 20 and 30 years
- Full complement of permanent dentition
- No malalignment of maxillary or mandibular teeth
- Good oral hygiene and healthy periodontium
- Willingness to participate in the study.

Exclusion Criteria:

- Presence of direct or indirect restorations in posterior teeth
- History of temporomandibular joint dysfunction or orthodontic treatment
- Edentulism, dentofacial deformities, or gross attrition
- Pregnant or lactating women
- Hypersensitivity or allergic reaction to dental materials used in the study

Materials Used

- **Conventional bite registration material:** Vinyl polysiloxane (VPS) bite registration material (Imprint Bite, 3M ESPE, Bangalore, India).
- **Scannable bite registration material:** Reflective VPS CAD material (Virtual CAD Bite Registration, Haryana, India).
- **Digital scanner:** Intraoral scanner (Medit i500, Medit Corp., Seoul, South Korea)(FIGURE 3)
- **Other equipment and software:**
 - Leaf gauge (MIK Dental, India).
 - 2% glutaraldehyde disinfectant.
 - Medit Link and Meshmixer software for STL file processing.
 - GOM Inspect (2018, Germany) for 3D surface deviation analysis.

METHODOLOGY

Each participant underwent bite registration using three techniques:

1. Interocclusal Separation:

A 2 mm interocclusal space was established using a calibrated leaf gauge placed between the maxillary and mandibular central incisors, ensuring uniform material thickness and stable condylar positioning^{13,14}.

2. Group A–VPS Material:

Vinyl polysiloxane (VPS) material was dispensed using an auto-mixing gun and applied bilaterally to the mandibular posterior teeth (second premolar to second molar). Participants were instructed to occlude with the leaf gauge in place, and the material was allowed to set for 60 s. The record was then disinfected with 2% glutaraldehyde.(FIGURE 1,2,3)

3. Group B–VPS CAD Material:

Reflective VPS CAD material, containing opacifiers to aid scanning, was applied similarly, with a 45 s set time. Post-setting, the record was disinfected and scanned using the Medit i500 intraoral scanner to generate STL files.

4. Group C–Intraoral Digitally Scanned Bite Record:

Maxillary and mandibular arches were scanned separately. Bilateral buccal bite registrations were captured in maximum intercuspation with the scanner. The scans were aligned and merged via Medit Link and Meshmixer software to form a virtual bite record (VBR).(FIGURE 4)

Comparative Evaluation:

Each digital record from Groups A and B was superimposed onto Group C's record using GOM Inspect 2018 software. The software performed 3D surface deviation analysis, producing color-coded maps and quantitative deviation values (in mm) to highlight discrepancies in occlusal contact and alignment. Both right and left sides were evaluated separately. The 3D superimposition method is well-established in assessing occlusal registration accuracy¹⁵.(FIGURE 5,6,7)



FIGURE 1



FIGURE 2



FIGURE 3

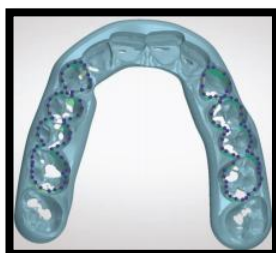


FIGURE 4

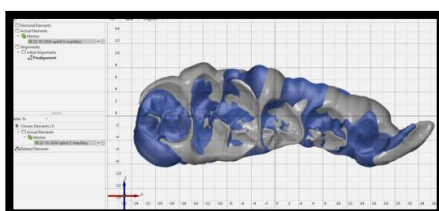


FIGURE 5

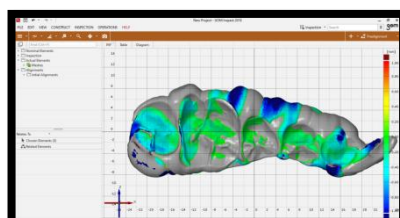


FIGURE 6

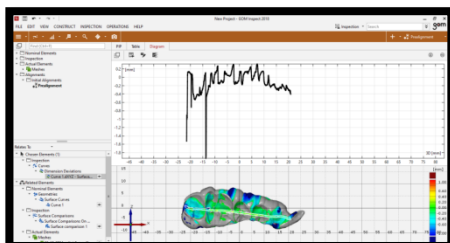
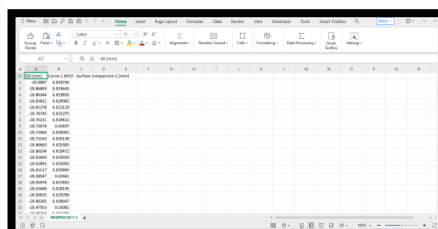


FIGURE 7



Statistical Analysis

All data collected from the surface deviation measurements (in mm) of the three bite registration groups—VPS, VPS CAD, and intraoral digital scan—were compiled and organized using Microsoft Excel (Microsoft Corp., Redmond, WA, USA). The statistical analysis was carried out using SPSS software version 19.0 (IBM Corp., Armonk, NY, USA).

Descriptive statistics, including means and standard deviations (SD), were calculated for each group and for both left and right posterior occlusal regions. To evaluate the intergroup differences, a one-way analysis

of variance (ANOVA) was performed. When significant differences were observed, Tukey's post hoc test was applied for multiple pairwise comparisons.

Additionally, independent sample t-tests were used to compare deviation values between the right and left sides within each bite registration group.

A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant for all tests. No formal power calculation was conducted prior to the study; the sample size of 36 participants was selected based on feasibility and consistency with similar previously published comparative prosthodontic studies involving 3D bite registration analysis.

Results

A total of 36 participants completed the study without complications. Each participant underwent bite registration using three techniques: conventional VPS, VPS CAD, and intraoral digital scanning. The deviation values (in millimetres) obtained through 3D surface comparison were used to evaluate the accuracy of each method.

The mean surface deviation values and standard deviations (SD) for each group on both the right and left posterior quadrants are given in table.

Post Hoc and Pairwise Analysis

Tukey's post hoc test showed no statistically significant pairwise differences between any two groups for either side ($p > 0.05$). The independent t-test also showed no significant differences in deviation values between the left and right sides within each group.

Interpretation

Although the intraoral digital scan group (Group C) demonstrated the lowest mean deviation values, followed closely by VPS CAD (Group B), the differences were not statistically significant. This suggests that all three techniques offer comparable accuracy for recording interocclusal relationships.

Intergroup comparison of different bite registration material on surface deviation.

Side	VPS-VPS CAD (Mean±SD)	VPS - Intraoral Scanner (Mean±SD)	VPS CAD- Intraoral Scanner (Mean±SD)	F value	p-value
Right	0.2767±0.10957	0.2983±0.10259	0.2642±0.09020	0.351	0.707
Left	0.2817±0.11175	0.3117±0.09694	0.2375±0.08035	1.768	0.186

Intragroup comparison of different bite registration material on surface deviation

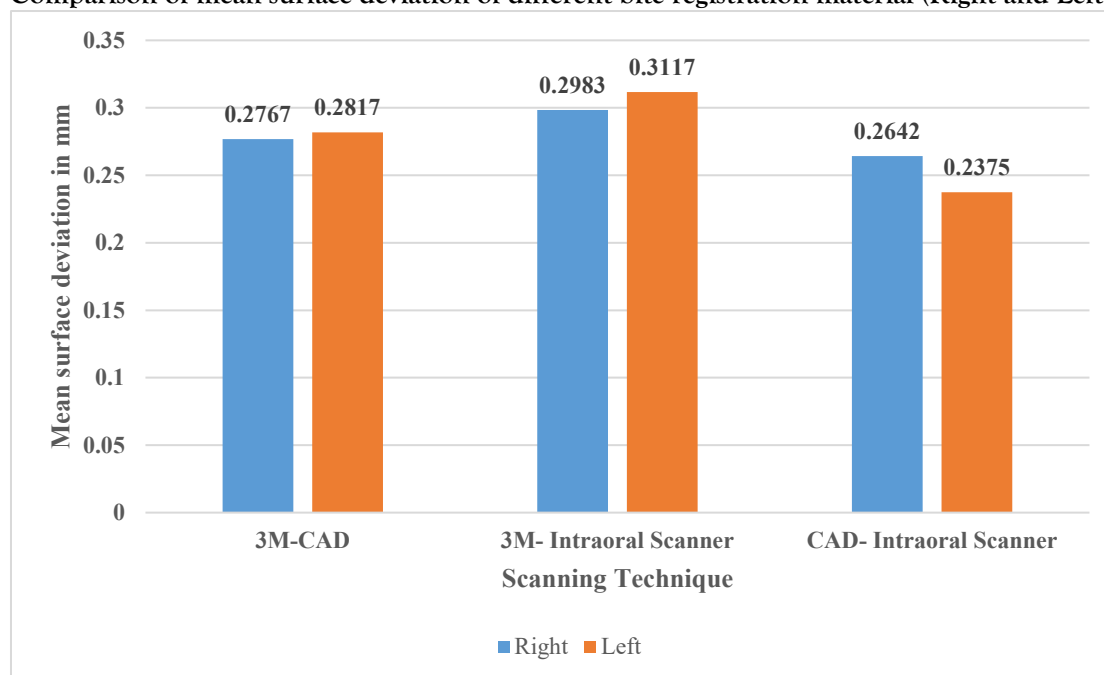
Side	Group (A)	Group (B)	Mean difference	Standard error	p-value
Right	VPS-VPS CAD	VPS-Intraoral scanner	0.02167	0.04128	0.860
		VPS CAD-Intraoral Scanner	0.01250	0.04128	0.951
	VPS-Intraoral scanner	VPS CAD-Intraoral Scanner	0.03417	0.04128	0.689
Left	VPS-VPS CAD	VPS-Intraoral scanner	0.03000	0.03968	0.732
		VPS CAD-Intraoral Scanner	0.04417	0.03968	0.513
	VPS-Intraoral scanner	VPS CAD-Intraoral Scanner	0.07417	0.03968	0.164

Comparison between left and right side bite

Scanning technique	Right side	Left side	t value	p-value
VPS-VPS CAD	0.2767±0.10957	0.2817±0.11175	-.111	0.913
VPS-Intraoral scanner	0.2983±0.10259	0.3117±0.09694	-.327	0.747

VPS CAD- Intraoral scanner	0.2642±0.09020	0.2375±0.08035	.765	0.453
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Comparison of mean surface deviation of different bite registration material (Right and Left side)



DISCUSSION

Accurate bite registration is critical in restorative and prosthodontic dentistry for achieving optimal occlusal harmony, especially in fixed prostheses. Errors in occlusal records may result in malocclusion, temporomandibular disorders (TMD), uneven wear, and prosthesis failure due to occlusal discrepancies¹⁶. The results indicated no statistically significant differences in surface deviation between the groups ($p > 0.05$), suggesting that all three techniques yield comparable occlusal accuracy, consistent with several previous investigations¹⁷⁻¹⁹. The digitally scanned bite records (Group C) demonstrated slightly lower mean deviation values than the other two methods, aligning with findings from Blum et al. and Camcı et al., where digital systems performed on par with or better than conventional methods in controlled settings²⁰⁻²¹.

The VPS CAD material (Group B), which incorporates opacifiers such as zirconium dioxide and titanium dioxide to enhance scanability, showed deviation values close to those of the digital group. This supports earlier in vitro studies showing that reflective VPS CAD materials maintain dimensional stability and are reliably scannable with modern intraoral systems²²⁻²³. The material's fast setting time, minimal polymerization shrinkage, and compatibility with CAD workflows make it an effective intermediary for clinicians transitioning to digital practice.

Conversely, studies by Wenzel et al. and Alghamdi et al. suggest that digital techniques may underperform in cases with limited scan accessibility, full-arch scanning, or poor intraoral conditions²⁴⁻²⁵. Our study, however, mitigated these limitations by focusing on bilateral posterior quadrants, where scanning accuracy is higher, thus reducing variability.

Some studies argue that conventional techniques still offer superior tactile feedback and stability when handling large restorative cases or where intraoral scanning conditions are suboptimal²⁶. Nevertheless, in this in vivo study setting—with controlled bite thickness using a calibrated leaf gauge and healthy participants—digital scanning matched or exceeded the accuracy of traditional elastomeric records.

Our results reinforce the growing consensus that digital bite registrations are clinically viable. As shown in recent studies by Morsy et al. and Edher et al., virtual bite records are increasingly being validated for their precision, reproducibility, and efficiency in routine dental workflows²⁷⁻²⁸.

Limitations

This study included only one digital scanner (Medit i500) and one scannable VPS material. Results may vary across devices, materials, or in patients with different occlusal complexities. Additionally, bite force standardization was not objectively quantified.

Clinical Implications

Within the limits of this study, clinicians may confidently choose any of the three evaluated bite registration methods depending on their clinical setting and equipment availability. VPS CAD serves as a bridge between analog and digital workflows, offering both dimensional stability and scannability.

CONCLUSION

This in vivo study found no significant difference in the accuracy of interocclusal records obtained using conventional VPS, scannable VPS CAD, and intraoral digital bite registration methods. All three techniques demonstrated clinically acceptable surface deviation values, with intraoral scanning showing slightly lower mean deviations. These findings support the use of scannable bite registration materials and digital methods as reliable alternatives to traditional techniques in prosthodontic practice.

Digital bite registration and VPS CAD offer workflow advantages and accuracy comparable to conventional methods, supporting their integration into routine clinical care. Further large-scale studies are warranted to assess performance across different clinical scenarios and patient populations.

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