

Comparative evaluation of accuracy of conventional interocclusal record vs digital interocclusal record made using two different intraoral scanners in articulated casts with no posterior occlusal stop: An *in vitro* study

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Abstract

Objective: To evaluate and compare the accuracy of conventional interocclusal records and digital interocclusal records made using two different intraoral scanners in articulated casts lacking posterior occlusal support.

Method: This *in vitro* experimental study included 60 articulated cast samples divided into Group C (control/master model), Group A (conventional interocclusal record), Group B (Digital Group) divided into Group B1 (Virtuo Vivo scanner), and Group B2 (Trios 3 scanner), with 20 samples per subgroup. A modified Columbia jaw set with missing posterior support was used. Conventional bite registration was performed using polyvinyl siloxane under a standardized 37 N occlusal force. Digital bite records were obtained using Virtuo Vivo and Trios 3 intraoral scanners followed by virtual articulation using Exocad software. Interarch distances were measured using a Bruker Alicona uCMM Vision Inspection System. Data were analysed using Shapiro-Wilk test, Wilcoxon Signed-Rank test, Kruskal-Wallis H test, and Intraclass Correlation Coefficient analysis.

Results: The conventional group demonstrated measurements closest to the control group. Mean interarch distances were 11.066 ± 0.0032 mm for Group C, 10.856 ± 0.0036 mm for Group A, 10.209 ± 0.0034 mm for Group B2, and 10.010 ± 0.0038 mm for Group B1. Significant differences were observed among all groups ($p < 0.001$). Posterior discrepancies were greater than anterior discrepancies in all groups. Overall ICC was 0.137, indicating poor reproducibility.

Conclusion: Conventional PVS interocclusal records demonstrated superior accuracy compared with digital interocclusal records in articulated casts without posterior occlusal stops. Among digital systems, Trios 3 showed better accuracy than Virtuo Vivo.

Keywords Interocclusal record; Digital bite registration; Intraoral scanner; Polyvinyl siloxane; Virtual articulation

How to cite this article: Deore JM, Darekar A, Arjun M, Kamble S, Deshmukh S, Momin M. Comparative Evaluation of Accuracy of Conventional Interocclusal Record vs Digital Interocclusal Record Made Using Two Different Intraoral Scanners in Articulated Casts with No Posterior Occlusal Stop: An In Vitro Study. *Int J Drug Deliv Technol.* 2026;16(60s):783-790. DOI: 10.25258/ijddt.16.60s.90.

Introduction

Accurate reproduction of maxillomandibular relationships is fundamental for successful fixed prosthodontic

rehabilitation.

Errors during interocclusal recording may result in premature contacts, restoration misfit, occlusal instability,

and repeated chairside adjustments.

These errors become more critical in distal extension cases lacking posterior occlusal support because mandibular stability is compromised during closure [1-6]. Conventional interocclusal recording techniques commonly use elastomeric materials such as polyvinyl siloxane because of their dimensional stability and accurate reproduction of occlusal surfaces.

Conventional articulation also provides tactile verification of occlusal contacts and mandibular relationships. (7-10) Digital dentistry has transformed prosthodontic workflows through intraoral scanners, CAD/CAM systems, and virtual articulation software.

Digital interocclusal records provide advantages including patient comfort, elimination of material distortion, simplified storage, and improved laboratory communication.

However, their accuracy remains controversial in unsupported distal extension situations where stitching errors and lack of posterior stability may compromise articulation [11-17]. Among available scanners, Trios 3 and Virtuo Vivo are widely used systems with different image acquisition technologies.

Previous studies have demonstrated variations in scanner trueness and precision, particularly in full-arch and long-span restorations [18-22]. Therefore, this study aimed to compare the accuracy of conventional interocclusal records with digital interocclusal records made using two different intraoral scanners in articulated casts without posterior occlusal support.

Methodology

- **Study design:** It is a quantitative experimental In-vitro study.
- **Study setting:** Conducted in Department of Prosthodontics and crown and bridge.
- **Study population:** This study involves no human investigations
- **Sampling Technique:** Simple random sampling technique.
- **Inclusion criteria**
 - A. Modified jaw set with tooth preparation done with respect to 25,27,35,37 (for PFM crown)
 - B. Missing teeth with respect 26,28,36,38
- **Exclusion criteria**
 - A. 3D printed models with less surface details
 - B. Defective 3D printed models with posterior occlusal contact
 - C. models with 0 reference points captured in it

Groups: 4 groups, n = 20 each.

Group C: Control/Master model

- **Group A:** Conventional PVS interocclusal record
- **Group B1:** Virtuo Vivo scanner
- **Group B2:** Trios 3 scanner
- **Group C:** Columbia jaw set (master model) modified with cervical reference points on 25, 35, 27, 37. (Fig 1) Inter-arch distance measured 20 times under 37 N force (Fig 2) using uCMM. (Fig 3) Mean = gold standard.



Fig 1: Master Model



Fig 2: Force Application with UTM

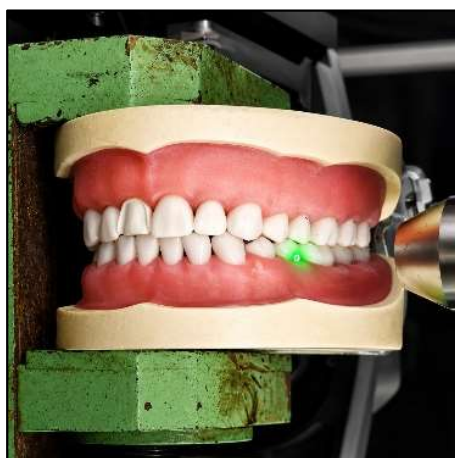


Fig 3: Measurement with Bruker Alicona uCMM Vision Inspection System

Group A: Tooth prep for PFM on 25, 27, 35, 37. Model 3D printed after lab scan. (Fig 4) PVS bite records made under 37 N, articulated on 3-point articulator (Fig 5) Inter-arch

distances between the indentations were measured with uCMM. (Fig 6)



Fig 4: STL Files for Group A

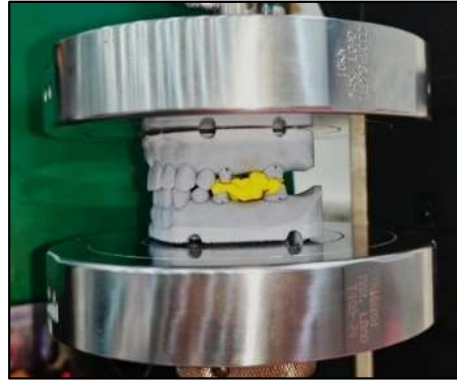


Fig 5: 37 N Force application using UTM

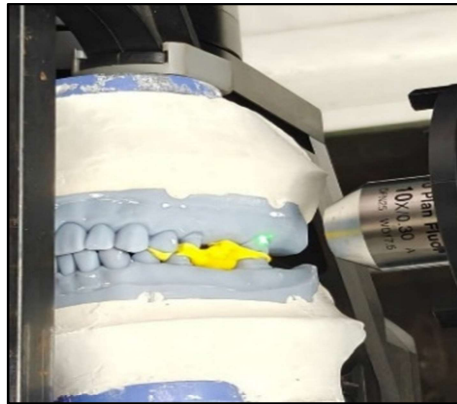


Fig 6: Measurement with Bruker Alicona uCMM Vision Inspection System.

Group B: Prepared model scanned with Virtuo Vivo (B1) and Trios 3 (B2) (Fig 7) 20 scans each. STL files articulated in Exocad, (Fig 8) 3D printed models were made. Inter-arch distances between the indentations were measured with uCMM. (Fig 9)



Fig 7: Scanning with 2 scanners

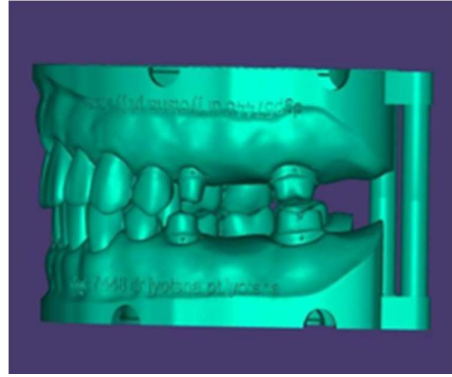


Fig 8: STL Files for Digital



Fig 9: Measurement with Bruker Alicona uCMM Vision Inspection System.

Comparison: Mean inter-arch distances of all groups compared for accuracy.

Table 1: Mean and standard Devia

Variables	Mean	Std. Deviation
Anterior Group C	11.012	0.0052
Posterior Group C	11.121	0.0039
Group C	11.066	0.0032
Anterior Group A	10.980	0.0022
Posterior Group A	10.733	0.0066
Group A	10.856	0.0036
Anterior Group B1	10.352	0.0052
Posterior Group B1	9.668	0.0055
Group B1	10.010	0.0038
Anterior Group B2	10.570	0.0046
Posterior Group B2	9.849	0.0037
Group B2	10.209	0.0034

Results

Table 2: Intraclass Correlationb and P-value

Variables	Intraclass Correlation ^b	95% Confidence Interval		P-value
		Lower Bound	Upper Bound	
Group-C & Group-A, Group-B1, Group-B2	.137 ^a	-0.045	0.405	0.079

Reliability is low (ICC = 0.137), indicating poor agreement. The wide CI (-0.045 to 0.405) shows high uncertainty. Not significant (p = 0.079); measurements are inconsistent

Scatter plot Graphs

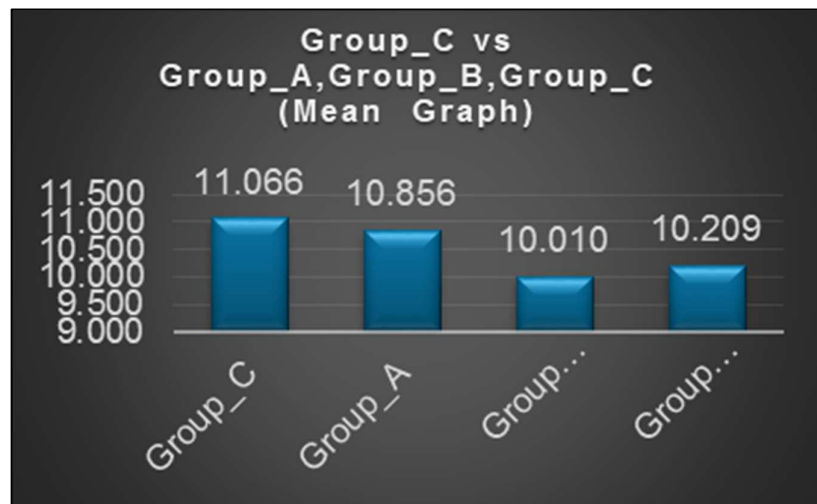
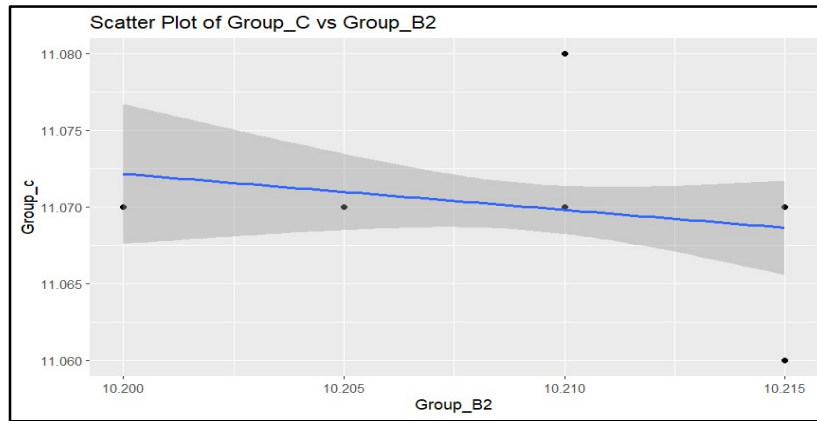


Table 3: Anterior Group Analysis: Wilcoxon Signed-Rank Test

Variables	Median (IQR)	Z-value	P-value	Median Difference
Anterior Group C	11.01 (11.01-11.01)	-4.117	<0.001	0.03
Anterior Group A	10.98 (10.98-10.98)			
Anterior Group C	11.01 (11.01-11.01)	-4.128	<0.001	0.66
Anterior Group B1	10.35 (10.35-10.35)			
Anterior Group C	11.01 (11.01-11.01)	-4.055	<0.001	0.44
Anterior Group B2	10.57 (10.57-10.57)			
Anterior Group A	10.98 (10.98-10.98)	-4.177	<0.001	0.63
Anterior Group B1	10.35 (10.35-10.35)			
Anterior Group A	10.98 (10.98-10.98)	-4.128	<0.001	0.41
Anterior Group B2	10.57 (10.57-10.57)			

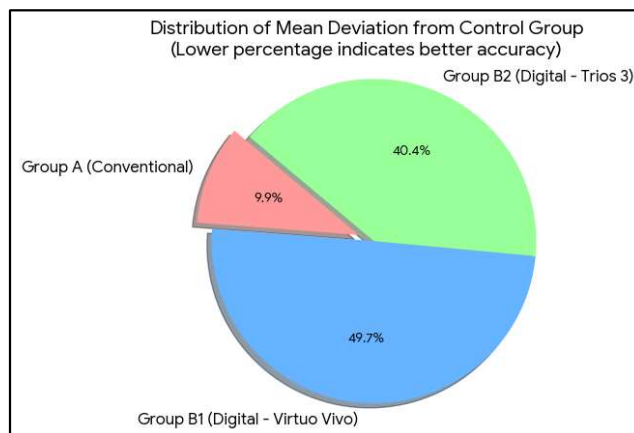
Table 4: Posterior Group Analysis: Wilcoxon Signed-Rank Test

Variables	Median (IQR)	Z-value	P-value	Median Difference
Posterior Group C	11.12 (11.12-11.12)	-4.127	<0.001	0.39
Posterior Group A	10.73 (10.73-10.73)			
Posterior Group C	11.12 (11.12-11.12)	-4.087	<0.001	1.45
Posterior Group B1	9.67 (9.67-9.67)			
Posterior Group C	11.12 (11.12-11.12)	-4.128	<0.001	1.27
Posterior Group B2	9.85 (9.85-9.85)			
Posterior Group A	10.73 (10.73-10.73)	-4.03	<0.001	1.06
Posterior Group B1	9.67 (9.67-9.67)			
Posterior Group A	10.73 (10.73-10.73)	-4.058	<0.001	0.88
Posterior Group B2	9.85 (9.85-9.85)			

Conclusion

Among the tested groups, Group A demonstrated measurements closest to the control group (Group C),

indicating better agreement and accuracy. Group B2 showed moderate deviation, while Group B1 exhibited the greatest difference from the control values.



Discussion

Distal extension FPDs lack posterior occlusal stops, causing mandibular instability and stress on distal abutments, complicating prosthesis design. Accurate impressions are critical. PVS and polyether materials offer excellent dimensional stability and detail for FPDs, with PVS preferred for single units. Jet Bite PVS shows superior accuracy vs wax/ZOE and comparable to digital in some cases due to fast setting and stability. Digital scanners like Straumann Virtuo Vivo and 3Shape TRIOS offer speed, comfort, and CAD/CAM integration. TRIOS has advanced AI features; Virtuo Vivo focuses on anatomy adaptation.

Digital interocclusal records use intraoral scanners to create virtual models, but lack tactile feedback vs conventional articulation. Scanning strategy affects accuracy. Quadrant/segmental scanning is more accurate than full-arch due to reduced stitching errors in distal areas.

In this study, conventional PVS (Group A) showed superior linear accuracy vs digital groups, closest to control (C) with 0.03 mm anterior and 0.39 mm posterior deviation.

Digital groups showed greater deviation. TRIOS 3 (B2) was better than Virtuo Vivo (B1): posterior diff 1.27 mm vs 1.45 mm from control. Posterior regions showed larger errors than anterior for digital scans, consistent with prior reports of stitching errors in unsupported distal areas. ICC = 0.137 and Cronbach's $\alpha = 0.388$ indicate very poor reliability and consistency across all methods due to posterior instability. Absence of posterior stops compromises articulation stability for both conventional and digital techniques, but digital is more sensitive. Conventional articulation allows tactile verification; virtual articulation depends on digital data and algorithms, risking errors.

Limitations

In vitro design, no soft tissue, only two scanners tested, no dynamic occlusion

Conclusion

Within study limitations, accuracy of conventional vs digital

interocclusal records was successfully compared in articulated casts without posterior occlusal stops. A statistically significant difference was found between methods. Conventional PVS records were closest to control, showing superior accuracy. Both digital methods deviated significantly from control. Trios 3 showed lower deviation than Straumann Virtuo Vivo. Scanner type significantly affected accuracy. Trios 3 had moderate deviation; Virtuo Vivo had the greatest deviation. Overall agreement was poor (ICC = 0.137) with low internal consistency (Cronbach's $\alpha = 0.388$). Registration method significantly influences reproducibility when posterior support is absent. Interocclusal record accuracy is method-dependent. Conventional PVS records demonstrated greater accuracy and reliability in this model. Digital workflows are efficient but showed variability between systems. Method selection should prioritize accuracy for complex prosthodontic cases lacking posterior occlusal stop.

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