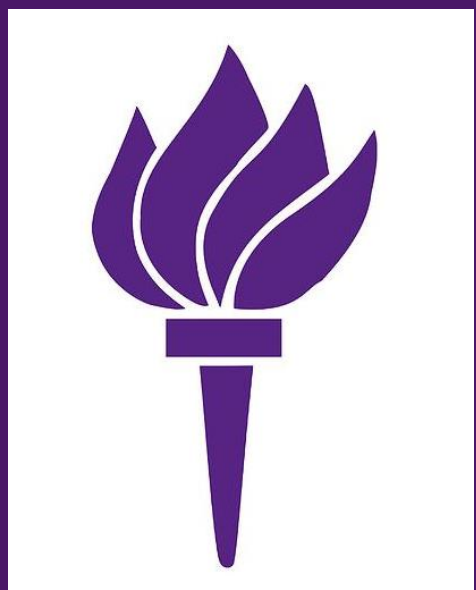




Accuracy and Precision of an AI program for locating maxillomandibular relationships in digital scans

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Introduction

Accurate dental cast articulation and proper transfer of the maxillomandibular relationships are essential elements in providing functional and esthetic outcomes.¹ Conventional methods using mechanical articulators rely on physical impressions and can be time-consuming and technique-sensitive. ² Digital articulation with virtual models can reduce clinical time and improve reproducibility.³ In establishing maxillomandibular relationships, two main approaches exist: bite registration-based and AI-driven algorithmic methods.^{4,5} While AI offers streamlined workflows through machine learning⁶, evidence on its accuracy and precision compared to conventional methods remains limited.⁷

Purpose

Evaluate the accuracy and precision of an AI-based software in locating maxillomandibular relationships from digital scans compared to traditional hand-mounted casts, VPS bite registration, and intraoral scan (IOS) methods.

Methods

Four groups were evaluated: the Control group (hand-articulated casts) and three test groups—(1) VPS bite-registered casts, (2) IOS scans with occlusal registration, and (3) Bite Finder® AI-articulated digital models. Dental casts were fabricated and scanned 10 times, while 10 IOS scans were acquired from participants. Inter-arch linear measurements between anatomical landmarks from the test groups were compared to the control group. Accuracy was assessed by comparing inter-arch measurements with a reference dataset. Precision was evaluated across repeated trials. Data were tested for normality (Shapiro-Wilk), with accuracy analyzed by two-way ANOVA and precision by the generalized linear model.

Results

The results demonstrated no significant differences in maxillomandibular relationships between the Control and Intraoral Scan (IOS) groups across all measured landmarks, indicating comparable accuracy in establishing inter-arch relationships. Normality was confirmed by the Shapiro-Wilk test (all $p > 0.05$), and non-parametric two-way ANOVA similarly revealed no significant group differences. The general linear model showed a main effect of landmark location ($p < 0.001$), but no significant group or interaction effects. Comparisons with VPS bite registration and AI articulation software yielded identical measurements with zero variance, highlighting high internal consistency but precluding further statistical testing. Overall, all methods demonstrated equivalent diagnostic performance.

Table 1. Shapiro-Wilk Test for Normality

Groups	Std Dev	Variance
Hand Articulated Casts (Control) VPS Bite-Registered Casts (Group 1)	0.036 mm	0.025 mm
Hand Articulated Casts (Control) IOS Scans With Occlusal Registration (Group 2)	0.588 mm	0.378 mm
Hand Articulated Casts (Control) Bite Finder® AI-articulated Digital Models (Group 3)	0.456 mm	0.205 mm

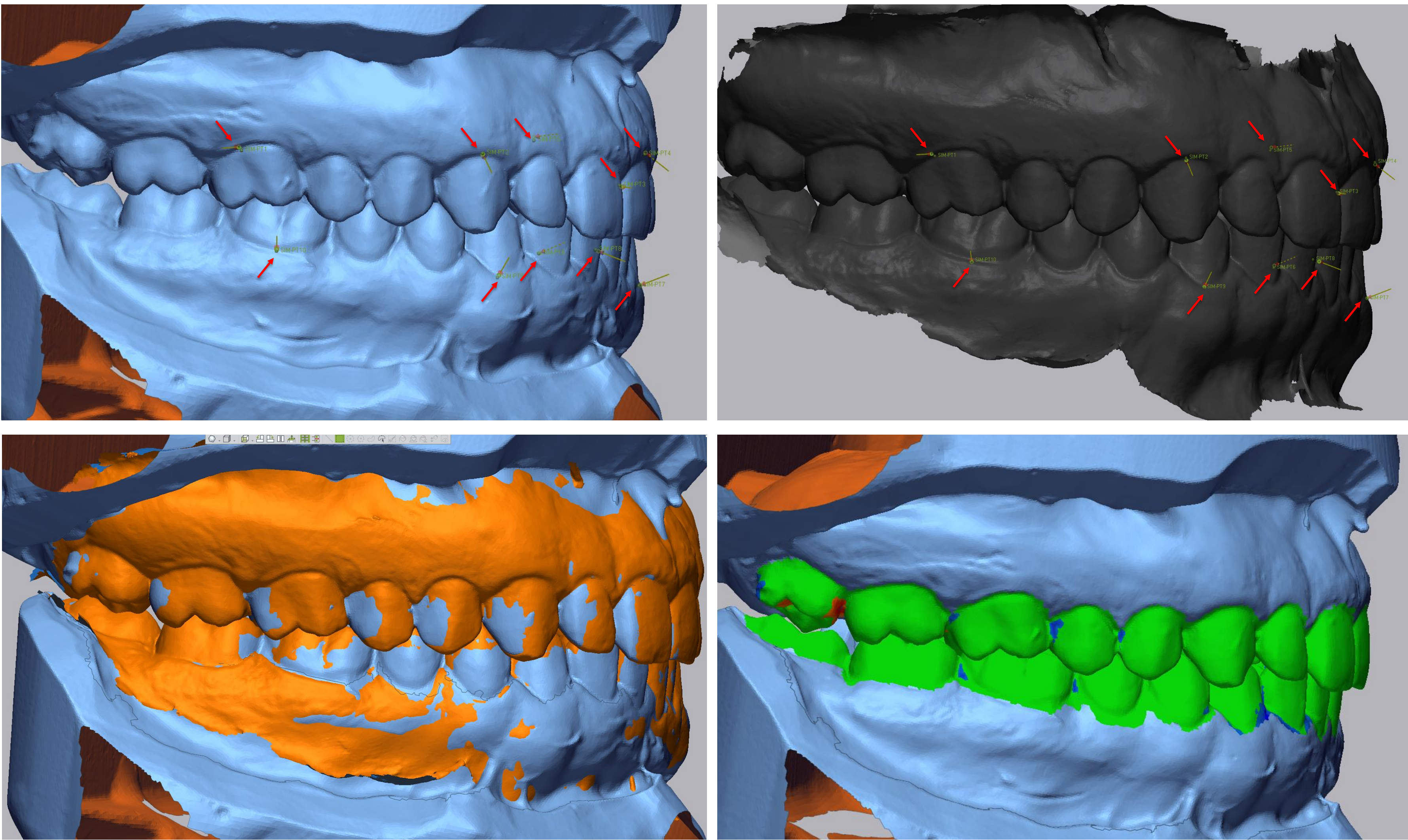


Fig 1 (Top left): Digitized analog casts with measurement points

Fig 2 (Top Right): Intra-oral scan with measurement points

Fig 3 (Bottom left): Merged STL files of the control group with the test sample

Fig 4 (Bottom Right): 3D comparison of merged control group and test sample showing no significant deviation (Green color map)

Discussion

This study compared artificial intelligence (AI) articulation with conventional and digital methods for establishing maxillomandibular relationships. Results showed no significant differences between control and test groups. Comparable measurements across control, VPS, and AI groups indicated strong reproducibility, suggesting AI can match the accuracy of traditional and digital techniques while offering efficiency and automation. These findings align with Revilla-León et al. (2024), who reported similar trueness and, in some cases, greater precision with AI, though performance may be affected by scan completeness. Advances noted by Lobo et al. (2025) and Risciotti et al. (2024) also support AI's potential to enhance precision and standardization. However, as Lal et al. (2025) emphasized, algorithm transparency, bias, and population validation remain barriers. Expanding studies to partially edentulous cases and diverse occlusal schemes is essential. Clinically, AI articulation may streamline workflows, reduce chairside time, and maintain reliable accuracy.

Conclusion

AI-based articulation software demonstrated accuracy and precision comparable to conventional and IOS-based methods in establishing maxillomandibular relationships. These findings support the clinical integration of AI-driven digital workflows as reliable alternatives, offering improved efficiency without compromising diagnostic quality.

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