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RESEARCH AND EDUCATION

Agreement between digitally predicted and clinically verified occlusal contacts in computer-aided design and computer-aided manufacture (CAD-CAM) occlusal devices: A cross-sectional study

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ABSTRACT

Statement of problem. The growing adoption of digital workflows and artificial intelligence (AI)–assisted design has revolutionized occlusal device fabrication, offering improved precision, efficiency, and reproducibility. However, the clinical reliability of digitally predicted occlusal contacts, particularly across different intensity levels and anatomic regions, remains insufficiently validated.

Purpose. This study aimed to evaluate the accuracy and reliability of AI-predicted occlusal contacts in computer-aided design and computer-aided manufacture (CAD-CAM) occlusal devices fabricated through a fully digital workflow, with comparisons stratified by contact intensity and anatomic region.

Material and methods. A cross-sectional observational study was conducted with 53 occlusal devices (45 maxillary, 8 mandibular) fabricated using intraoral scanning, AI-based CAD software program (Medit Link v3.2.2; Medit), and 3-dimensional (3D) printing. Predicted occlusal contacts were automatically generated by the software program and compared with clinical markings obtained using articulating paper during the initial adjustment session. Agreement rates were calculated by contact intensity (low, medium, high) and anatomic region (anterior, posterior). Statistical analyses included descriptive statistics, the Friedman test for repeated-measures comparisons across intensity levels, Bonferroni-adjusted post hoc tests, and intraclass correlation coefficients [ICC(2,1)] to assess internal consistency among continuous measurements within each device (α=.05).

Results. Agreement between digitally predicted and clinically verified contacts increased systematically with intensity, with mean coincidence rates of 59.4%, 69.7%, and 79% for low-, medium-, and high-intensity contacts, respectively. Low-intensity contacts showed the greatest dispersion, while high-intensity contacts displayed the most stable agreement values. Internal consistency among the 3 continuous agreement measurements was supported by ICC(2,1) values ranging from 0.797 to 0.867. Region-specific analyses demonstrated clearer separation among intensity levels in the anterior region, whereas medium- and high-intensity contacts overlapped more extensively in the posterior region.

Conclusions. AI-assisted CAD-CAM workflows demonstrated progressively higher predictive accuracy as occlusal contact intensity increased, with high-intensity contacts showing the most consistent correspondence with clinical markings. In contrast, the reduced accuracy and greater variability observed for low-intensity contacts—particularly in posterior regions—underscore the continued necessity of clinical verification during device adjustment. (J Prosthet Dent 2026;136:250-257)

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Clinical Implications

The findings indicate that AI-driven CAD-CAM workflows can reliably identify high-intensity occlusal contacts, which are the most critical for achieving functional stability in device therapy. However, because subtle low-force contacts remain less predictable, clinicians should continue to perform conventional verification to ensure precision and avoid undetected interferences.

Temporomandibular disorders (TMDs) are heterogeneous musculoskeletal conditions of the masticatory system, characterized by pain, joint noises, and limited mandibular movement, often impairing quality of life.[1,2] Bruxism has been defined as masticatory muscle activity during wakefulness or sleep, involving repetitive or sustained tooth contact or mandibular thrusting and is not considered a disorder but a motor activity that may act as a risk or protective factor depending on frequency and consequences.[3–5] The management of TMDs and sleep bruxism prioritizes conservative approaches, with the stabilization device as the criterion standard for joint stabilization, the redistribution of occlusal forces, and the protection of dentition.[6–9]

Conventional device fabrication involves multiple manual steps and polymethyl methacrylate processing, with limitations such as dimensional instability and patient discomfort.[7,9,10] Digital workflows using computer-aided design and computer-aided manufacture (CAD-CAM) have been reported to improve accuracy, reproducibility, and efficiency through intraoral scanning, virtual design, and 3-dimensional (3D) printing or milling.[9,10] However, the clinical validation of digitally predicted occlusal contacts remains challenging. Despite sensor-based methods, articulating paper is still widely used but is subjective. Platforms (Medit Link v3.2.2; Medit Corp) apply artificial intelligence (AI) algorithms to generate occlusal schemes, raising concerns about accuracy and reproducibility. Comparing digital predictions with clinical findings is thus essential to validate their reliability and to guide integration into clinical practice.[11–14]

Recent advances in digitally assisted dentistry have progressively incorporated AI components into CAD-CAM workflows, particularly for tasks involving surface detection, occlusal analysis, and automated design steps.[15–21] Digital systems apply computational algorithms to identify occlusal surfaces, generate virtual contact maps, and assist in the initial design of prosthetic and occlusal devices.[9–12] Although the use of digital workflows in device fabrication has been well established and associated with improved reproducibility, accuracy, and efficiency compared with conventional methods, scientific evidence specifically addressing AI-assisted occlusal device design remains limited.[9,10,18,22–26] Platforms use AI-driven features to align arches, evaluate occlusal surfaces, and generate a preliminary device proposal with color-coded occlusal contacts.[11,12] However, these automated predictions have not yet been comprehensively validated against clinical findings, especially regarding different contact intensity levels and anatomic regions.

Recent investigations comparing digitally assisted and conventional devices, assessing clinician variability in interpreting articulating paper, and evaluating differences between digital occlusal analysis systems further underscore the need for objective and reproducible methods of validating occlusal contact prediction.[27–29] Therefore, this study aimed to evaluate the accuracy and reliability of AI-predicted occlusal contacts in CAD-CAM occlusal devices fabricated through a fully digital workflow, with comparisons stratified by contact intensity and anatomic region. The null hypotheses were that no difference in the level of agreement would be found between digitally predicted and clinically verified occlusal contacts across the 3 intensity categories (low, medium, high) and across anatomic regions.

MATERIAL AND METHODS

This investigation was conducted as an observational, cross-sectional, and comparative study. The research protocol had been reviewed and approved by the Research Ethics Committee of the School of Dentistry of Ribeirao Preto - University of Sao Paulo under registration number 76595123.3.0000.541.

The study sample consisted of 53 occlusal devices fabricated using a CAD-CAM system based on intraoral digital scans and produced via 3D printing. Participants had been recruited from the TMDs and Orofacial Pain curricular unit. Inclusion criteria comprised patients requiring maxillary or mandibular occlusal devices and presenting at least 8 teeth in the arch where the device would be installed. Exclusion criteria encompassed devices for which the software program failed to automatically generate the digital design through AI algorithms, as well as devices that presented significant difficulties during clinical adaptation and required extensive intaglio adjustments.

Before data collection, all operators underwent calibration for the key steps of the workflow, including intraoral scanning, the interpretation of AI-generated occlusal maps, and the clinical adjustment of devices using articulating paper. Calibration was conducted through supervised training sessions and repeated assessments on pilot treatments until operators applied the diagnostic and adjustment criteria consistently.

Digital scans of the dental arches were obtained using an intraoral scanner (CEREC; Dentsply Sirona). A standardized protocol was followed to ensure accuracy and reproducibility. Participants were positioned appropriately, and the dental surfaces were dried with an air jet to minimize the presence of saliva and avoid artifacts. The maxillary and mandibular arches were scanned separately to achieve complete capture of the dentition. The maxillomandibular relationship was registered by performing an occlusion scan in maximum intercuspation. The intraoral scanner used had a trueness in the range of 17 to 23 μm and a precision of 16 to 22 μm according to the manufacturer's specifications.

The standard tessellation language (STL) files were imported into an AI-based CAD software program (Medit Link v3.2.2; Medit), where the occlusal device was designed. The initial design was automatically generated by an AI algorithm integrated into the software program. Manual refinements were subsequently made to optimize adaptation and functionality. Specific parameters included maintaining a uniform thickness of 2 to 3 mm, ensuring complete arch coverage without interference and distributing occlusal contacts to promote balanced force distribution and stabilization. Once finalized, the design was exported in STL format for 3D printing.

Additive manufacturing was carried out using a printer (MARS 4 DLP 3D; Elegoo), with a biocompatible resin specifically developed for occlusal devices (3D BIO SPLINT; Prizma). Printing was performed under preestablished parameters to provide high accuracy and structural integrity. All devices were printed at a 45-degree orientation, as recommended by the manufacturer. The printed devices were cleaned in isopropyl alcohol, postpolymerized in an ultraviolet (UV) chamber, and their support structures removed. Final surface refinement was performed to smooth edges and ensure patient comfort.

During the first clinical session, the occlusion was verified and the device adjusted. Occlusal contacts were marked with articulating paper (CHECK FILM II, Caicedo Group Inc) to identify premature or high-pressure areas, which were selectively adjusted by grinding. A clinical photograph was made immediately after the first marking to allow comparison with the occlusal contact map predicted by the software program's AI algorithm.

The methodological workflow is shown in Figure 1. Digital scans of both arches were obtained, and the maxillomandibular relationship was recorded in maximum intercuspation. Occlusal contacts were automatically predicted by the AI software program, and the device was virtually designed and 3D printed. Predicted contacts were then compared with clinical markings obtained using articulating paper. Figure 2 presents the predicted contact maps, clinical markings, and regional coincidence analysis, allowing the assessment of predictive accuracy across intensities and anatomic regions.

For each device, agreement percentages between predicted and clinically verified contacts were calculated for the 3 intensity categories. Because these represent repeated measures, comparisons were performed using the Friedman test, followed by Bonferroni-corrected pairwise post hoc analyses when a global effect was detected. A 2-way random-effects ICC (ICC [2,1], absolute agreement)

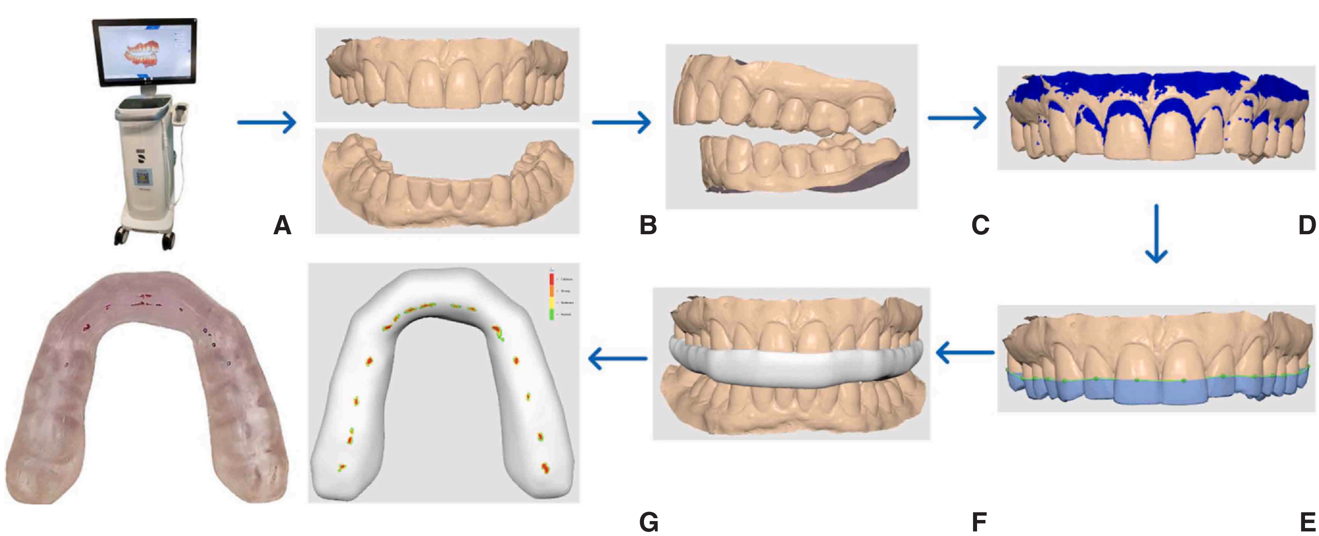

Figure 1. Digital workflow for design and fabrication of CAD-CAM occlusal devices. A, Intraoral scanner (CEREC; Dentsply Sirona) used for acquisition of digital scans of maxillary and mandibular arches. B, Three-dimensional STL files generated after scanning. C, Registration of maxillomandibular relationship. D, Virtual analysis of occlusal surfaces with automatic detection of contact areas. E, Identification of occlusal contact points and digital alignment. F, Final design of stabilization device using AI-based CAD software (Medit Link v3.2.2; Medit). G, Occlusal device virtually positioned on the maxillary arch with maxillary and mandibular STL files articulated in maximum intercuspation (MIH), demonstrating the digital alignment and occlusal relationship prior to manufacturing. H, predicted occlusal contacts displayed by software program and corresponding clinical verification on 3D printed device. AI, artificial intelligence; CAD-CAM, computer-aided design and computer-aided manufacturing; STL, standard tessellation language.

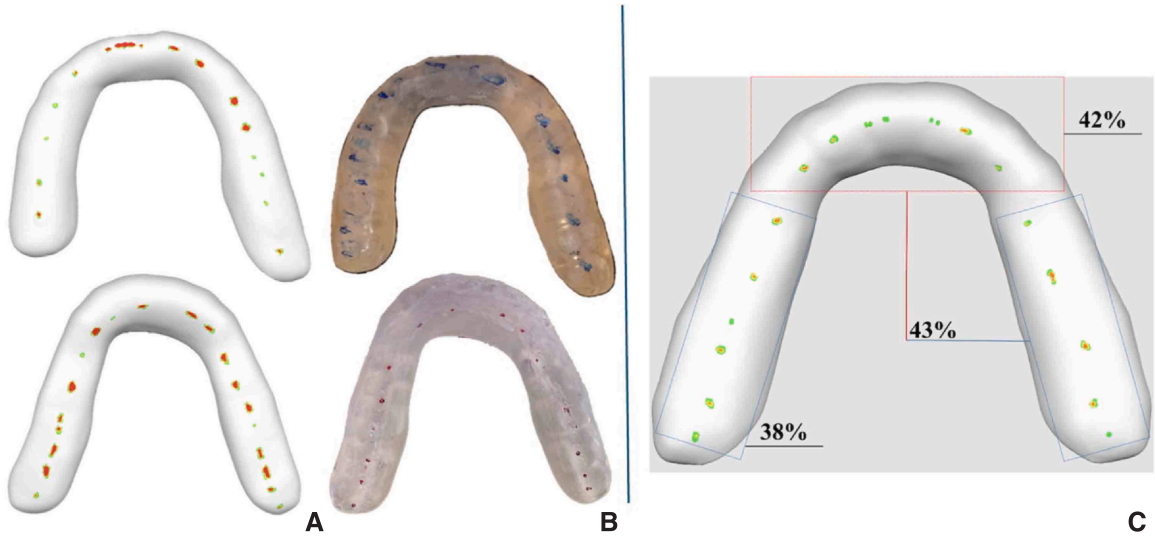

Figure 2. Comparison between digitally predicted and clinically verified occlusal contacts. A, Virtual mapping of occlusal contacts by intensity (green=low, yellow=medium, red=high). B, Clinical verification of occlusal contacts on 3D printed device using articulating paper (blue and red markings). C, Overlay and regional distribution of contact coincidence showing percentage agreement across anterior (42%), posterior left (38%), and posterior right (43%) regions.

assessed reliability across the 3 continuous measurements. All analyses were made with a statistical software program (IBM SPSS Statistics, v26.0; IBM Corp) using the device as the unit of analysis (α=.05).

RESULTS

A total of 53 devices (45 maxillary and 8 mandibular) were included in the analysis, distributed according to the clinical indication and anatomic characteristics of each patient. As shown in Table 1, agreement values varied according to contact intensity. Low-intensity contacts showed a mean coincidence of 59.42%, medium-intensity contacts reached 69.72%, and high-intensity contacts demonstrated 79.01% agreement.

When occlusal contacts were stratified by anatomic region, distinct patterns of agreement emerged. As shown in Figure 3, the repeated-measures comparison using the Friedman test revealed differences among intensity levels in the anterior region, with post hoc pairwise analyses with Bonferroni correction indicating higher agreement for high-intensity contacts compared with both low-intensity (P=.004) and medium-intensity contacts (P=.03). In the posterior region, medium- and high-intensity contacts showed similar agreement patterns, with no statistically significant difference between these 2 categories (P=.50), whereas low-intensity contacts remained the least consistent. When anterior and posterior regions were analyzed together, post hoc comparisons continued to show greater agreement for high-intensity contacts relative to low-intensity contacts (P=.001) and for medium-intensity contacts relative to low-intensity contacts (P=.005).

Reliability among the 3 continuous percentage measurements (low-, medium-, and high-intensity agreement) within each device was examined using a 2-way random-effects intraclass correlation coefficient, ICC (2,1), and absolute agreement. The ICC values ranged from.797 to.867 (Table 2).

Figure 4 provides a descriptive schematic of the device, displaying mean agreement percentages across anatomic regions for each contact intensity. Overall, low-intensity

Table 1. Agreement between predicted occlusal contacts (AI-based CAD software [Medit Link v3.2.2; Medit]) and clinically verified contacts in CAD-CAM occlusal devices, stratified by intensity levels

Contact Intensity (Color Code)	*N*	Mean Agreement (%)	Standard Deviation	Minimum	Maximum	Median
Low (Green)	53	59.42	29.07	15.38	100.00	60
Medium (Yellow)	53	69.72	22.96	15.38	100.00	80
High (Red)	53	79.01	23.06	13.33	100.00	80

AI, artificial intelligence; CAD-CAM, computer-aided design and computer-aided manufacturing.

Low (green), medium (yellow), and high (red) categories correspond to contact intensity levels defined by AI-based CAD software (Medit Link v3.2.2; Medit). Agreement calculated as percentage coincidence between digitally predicted contacts and those verified with articulating paper during initial device adjustment. Data presented as descriptive statistics (mean, standard deviation, minimum, maximum, and median).

Values represent mean percentage coincidence between virtual and clinical records, with standard deviation, minimum, maximum, and median for each color-coded intensity category. N, number of devices analyzed (total = 53).

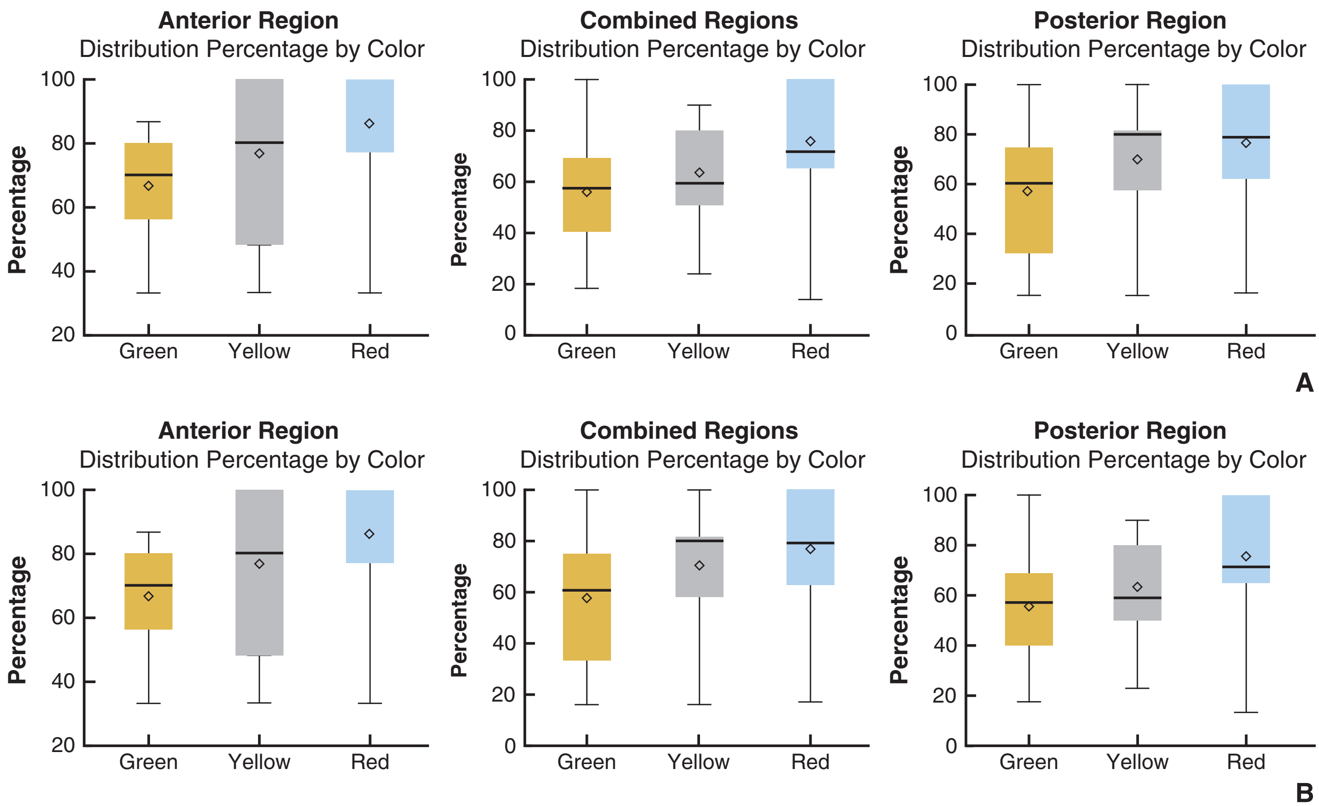

Figure 3. A, Boxplots representing percentage agreement between digitally predicted occlusal contacts (AI-based CAD software program [Medit Link v3.2.2; Medit]) and clinical verification with articulating paper, stratified by contact intensity (green=low, yellow=medium, red=high). Data shown for anterior region (top left), posterior region (bottom left), and combined anterior–posterior regions (right). Each boxplot displays median, interquartile range, minimum and maximum values (*whiskers*), and mean (*diamond marker*). Comparisons among intensity levels were performed with the Friedman test, with Bonferroni-adjusted post hoc analyses. B, Comparative boxplots showing percentage agreement between digitally predicted occlusal contacts and clinical verification across anatomic regions (anterior, posterior, and combined), stratified by intensity (green=low, yellow=medium, red=high). Median, interquartile ranges, whiskers, and mean values represented.

contacts showed the lowest agreement, whereas medium and high intensities demonstrated progressively higher values. Agreement in the posterior region was modestly higher than in the anterior region for medium and high intensities, while low-intensity contacts consistently demonstrated uniformly low agreement.

DISCUSSION

The findings of this study support rejecting the null hypotheses, as agreement between digitally predicted and clinically verified occlusal contacts differed significantly across intensity categories and anatomic regions. The main results revealed a trend: higher agreement rates were observed for contacts of greater intensity, with variations influenced by anatomic location and predicted contact level. These results indicated that, although the digital workflow demonstrated good predictability for functionally relevant contacts, it remained limited in detecting low-intensity contacts, particularly in posterior regions where contact distribution was complex.

Table 2. Intraclass correlation coefficients (ICC) assessing internal consistency among the 3 continuous percentage measurements (low-, medium-, and high-intensity agreement) within each device

Comparison	ICC	95% CI Mandibular	95% CI Maxillary	*P*
Green and Yellow	0.861	0.758	0.925	**<.001**
Green and Red	0.797	0.669	0.884	**<.001**
Yellow and Red	0.867	0.758	0.925	**<.001**

CI, confidence interval; ICC, intraclass correlation coefficient.

ICC values reflect internal consistency among 3 intensity-related percentage measurements within devices and do not represent reliability between ordinal categories. All ICC values statistically significant at $P<.05$.

ICC values with 95% confidence intervals (CI) calculated using a 2-way random-effects model, absolute agreement [ICC(2,1)]. Values between 0.75 and 0.90 indicate good internal consistency.

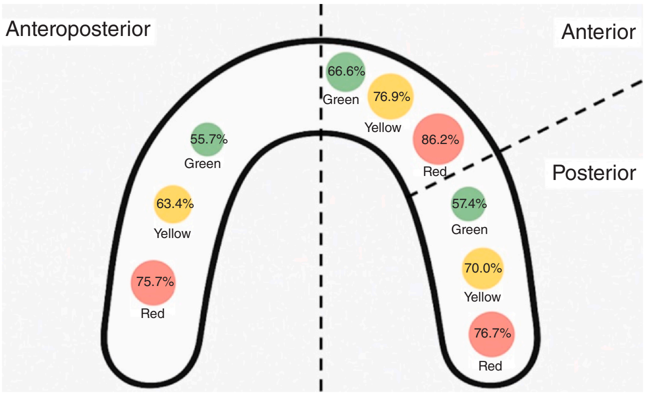

Figure 4. Schematic representation of occlusal device indicating anatomic segmentation used in study. *Dashed lines* separate anterior, posterior, and combined anteroposterior regions. *Colored circles* display mean percentage agreement between digitally predicted occlusal contacts and clinical markings for each region, stratified by contact intensity (green=low, yellow=medium, red=high). Figure provides descriptive visualization only, without inferential statistical comparison among regions.

The better accuracy of the software program in identifying higher contacts can be explained by a combination of physical and optical factors. High-pressure contacts tend to generate broader and deeper imprints on the surface, producing pronounced reliefs that are more easily captured by intraoral scanners.[13] Additionally, intense contacts, often located on functional cusp tips, present surfaces oriented more perpendicularly to the scanner's light path, thereby improving light reflection and enhancing the quality of the 3D surface mapping.[11–13] In contrast, lighter contacts typically occur on flatter or inclined areas, where unfavorable geometry increases susceptibility to artifacts and misalignment.[14]

The interpretation of these results must consider the hybrid nature of current AI-assisted digital workflows. Although Medit Link integrated AI-based algorithms for surface recognition, occlusal analysis, and automatic generation of a baseline device design, these automated steps did not replace the need for clinical judgment.[11,12] Consistent with previous findings, digital systems improved standardization while still requiring refinement to ensure optimal fit and occlusal balance, and manual adjustments were necessary in all devices to optimize thickness, extension, and contact distribution.[18,23–26]

The reduced sensitivity of AI-generated predictions for low-intensity contacts observed in this study aligned with previous evidence demonstrating that intraoral scanners and digital occlusal tools showed lower precision in detecting lighter or more subtle contacts compared with high-pressure ones.[19–22] These limitations were related to the geometric thresholds and surface-mapping algorithms currently used, which rely primarily on static morphological data rather than dynamic occlusal force simulation. As AI technologies continue to evolve, more sophisticated integration of biomechanical modeling may improve the accuracy of predicted contact intensities. Until then, clinician-guided verification remains essential to ensure precise occlusal adjustment.[19,20]

An important gap in the current literature concerns the clinical correspondence of intensity levels represented by the green, yellow, and red codes of digital occlusal maps. Most studies have focused on the overall accuracy of the device, comparisons among registration methods, or clinicians' perceptions of digital tools, with limited attention to the reliability of specific color gradients.[8–12,18] Evidence has shown that while scanners correlate with articulating paper, their precision decreased for low-intensity contacts.[19–22] Other studies indicated that intraoral scanning may even outperform conventional scans under optimal clinical conditions, while additional data confirmed that both methods can be reliable; accuracy and reproducibility, however, varied by system and materials, requiring careful clinical judgment.[20–22]

Current evidence indicates that 3D printed devices exhibit greater surface variability, reduced fitting accuracy, and fewer functional contacts than milled or injection-molded devices, potentially compromising predicted occlusal reliability.[23–25] Conversely, digital workflows provide higher reproducibility and require fewer adjustments than conventional methods, supporting their clinical and educational use.[23–26] In the present study, digitally fabricated devices adjusted by predoctoral students consistently reproduced high-intensity occlusal contacts, supporting their pedagogical usefulness and their clinical relevance for functional adjustment. Additional evidence also highlights benefits such as reduced volumetric wear and improved patient comfort, reinforcing the long-term advantages of digital workflows.[26,27]

Despite notable advances, this study presented some limitations that hinder the routine use of digital workflows. Patients excluded because of failure of the software program in automatic design generation or the need for extensive internal adjustments highlighted the dependence on AI algorithms and the variability inherent to additive manufacturing, underscoring the continued need for professional evaluation and manual refinements, particularly in anatomically complex situations requiring precise occlusion.[23–25] Another limitation was the use of articulating paper as the clinical reference standard. Although it has been widely adopted in clinical practice and has thereby enhanced external validity, it remains inherently subjective and cannot quantify force magnitude or contact timing. More objective systems such as the T-Scan device (Tekscan, Inc) offer detailed occlusal force distribution and temporal sequencing, enabling a more comprehensive evaluation of occlusal dynamics.[19–21]

Future research should compare different CAD-CAM platforms to determine whether predictive reliability is universal or platform-specific and should directly assess milled versus 3D printed devices regarding adaptation, accuracy, and patient comfort.[23–27] Additionally, the absence of a control group fabricated using non-AI-assisted CAD-CAM methods represents a further limitation. Previous studies have shown that different fabrication techniques—including injection molding, milling, and 3D printing—exhibit distinct variations in fit, surface accuracy, and functional contact distribution that may influence occlusal reliability.[23–26] Finally, the unequal sample sizes for maxillary (n=45) and mandibular (n=8) devices reflect routine clinical practice, in which maxillary devices are more commonly prescribed;[8] however, this imbalance reduces the generalizability of the findings to mandibular devices.

Refining AI algorithms to improve the detection of low-intensity contacts and developing automated adjustment protocols may further enhance applicability.[11,12] Additionally, systematic evaluation of factors such as articulating paper thickness and operator experience could standardize validation methods, reduce variability, and strengthen the integration of digital and conventional approaches in prosthodontics.[19,20,28] Clinically, these findings indicated that strong, well-defined contacts can be reliably identified by AI-based predictions, supporting their use in guiding adjustments. Low-intensity contacts, however, showed greater variability and still require confirmatory clinical assessment. This distinction helps clinicians integrate digital predictions while maintaining precision through manual verification.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. High-intensity occlusal contacts predicted by the AI-based CAD software program (Medit Link v3.2.2; Medit) showed the highest level of agreement with clinical findings obtained during device adjustment.
2. Medium-intensity contacts showed moderate agreement, while low-intensity contacts presented the lowest concordance and the greatest variability.
3. Reliability analysis confirmed good internal consistency among the 3 continuous agreement measurements within devices.
4. Although the digital workflow proved dependable for identifying stronger, functionally relevant contacts, it was less accurate in detecting subtle occlusal interferences, indicating that clinical verification remains essential.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE MANUSCRIPT PREPARATION PROCESS

During the preparation of this work, the authors used ChatGPT (OpenAI) to support language refinement and improve the readability of the manuscript. After using this tool, the authors carefully reviewed, edited, and adapted all content to ensure accuracy, scientific integrity, and originality and take full responsibility for the content of the published article.

REFERENCES

1. International classification of orofacial pain, 1st edition (ICOP). *Cephalalgia*. 2020;40:129–221.
2. Ohrbach R, Dworkin SF, Schiffman E, et al. Temporomandibular disorders: Definition and etiology. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2024;137:8–20.
3. Voß LC, Basedau H, Svensson P, May A. Bruxism, temporomandibular disorders, and headache: A narrative review of correlations and causalities. *Pain*. 2024;165:2409–2418.
4. Schiffman E, Ohrbach R, Truelove E, et al. International RDC/TMD Consortium Network, International Association for Dental Research; Orofacial Pain Special Interest Group, International Association for the Study of Pain. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: Recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group. *J Oral Facial Pain Headache*. 2014;28:6–27.
5. Verhoeff MC, Lobbezoo F, Ahlberg J, et al. Updating the Bruxism definitions: Report of an international consensus meeting. *J Oral Rehabil*. 2025;52:1335–1342.
6. Grymak A, Aarts JM, Ma S, et al. Comparison of hardness and polishability of various occlusal splint materials. *J Mech Behav Biomed Mater*. 2021;115:104270.
7. Patzelt SBM, Krugel M, Wesemann C, et al. In vitro time efficiency, fit, and wear of conventionally - versus digitally -fabricated occlusal splints. *Materials*. 2022;15:1085.
8. Albagieh H, Alomran I, Binakresh A, et al. Occlusal splints-types and effectiveness in temporomandibular disorder management. *Saudi Dent J*. 2023;35:70–79.
9. Nassif M, Haddad C, Habli L, Zoghby A. Materials and manufacturing techniques for occlusal splints: A literature review. *J Oral Rehabil*. 2023;50:1348–1354.
10. Gibreel M, Perea-Lowery L, Vallittu PK, Lassila L. Characterization of occlusal splint materials: CAD-CAM versus conventional resins. *J Mech Behav Biomed Mater*. 2021;124:104813.
11. Popa AD, Vladutu DE, Turcu AA, et al. Aspects of occlusal recordings performed with the T-scan system and with the medit intraoral scanner. *Diagnostics*. 2024;14:1457.
12. Cao R, Xu H, Lin J, Liu W. Evaluation of the accuracy of T-scan system and Cerec Omnicam system used in occlusal contact assessment. *Heliyon*. 2023;9:13476.
13. Brizuela-Velasco A, Alvarez-Arenal A, Ellakuria-Echevarria J, et al. Influence of articulating paper thickness on occlusal contacts registration: A preliminary report. *Int J Prosthodont*. 2015;28:360–362.
14. Alkadi L. A comprehensive review of factors that influence the accuracy of intraoral scanners. *Diagnostics*. 2023;13:3291.
15. Saadat Sarmadi B, Schmidt F, Beuer F, et al. The effect of build angle and artificial aging on the accuracy of SLA- and DLP-printed occlusal devices. *Polymers*. 2024;16:1714.
16. Hassanpour M, Narongdej P, Alterman N, et al. Effects of post-processing parameters on 3D-printed dental appliances: A review. *Polymers*. 2024;16:2795.
17. de Gois Moreira FG, da Silva NR, Bezerra M, et al. Influence of 3D printing system, postpolymerization and aging protocols on resin flexural strength and dimensional stability for printing occlusal splints, models and temporary restorations. *Clin Oral Investig*. 2024;28:604.

18. Lin R, Yan YQ, Sun J, Yu CH. A comparison of the accuracy between a digital fabrication workflow and a conventional fabrication workflow for occlusal appliances: A pilot study. *Int J Prosthodont*. 2023;36:501–507.
19. Esposito R, Masedu F, Cicciu M, et al. Reliabilty of recording occlusal contacts by using intraoral scanner and articulating paper - A prospective study. *J Dent*. 2024;142:104872.
20. Manziuc MM, Savu MM, Almasan O, et al. Insights into occlusal analysis: Articulating paper versus digital devices. *J Clin Med*. 2024;13:4506.
21. Wei D, Yi X, Lin Y, Di P. An innovative evaluation method for clinical comparative analysis of occlusal contact regions obtained via intraoral scanning and conventional impression procedures: A clinical trial. *Clin Oral Investig*. 2024;28:543.
22. Rovira-Lastra B, Khoury-Ribas L, Flores-Orozco EI, et al. Accuracy of digital and conventional systems in locating occlusal contacts: A clinical study. *J Prosthet Dent*. 2024;132:115–122.
23. Marcel R, Reinhard H, Andreas K. Accuracy of CAD-CAM-fabricated bite splints: Milling vs 3D printing. *Clin Oral Investig*. 2020;24:4607–4615.
24. Orgev A, Levon JA, Chu TG, et al. The effects of manufacturing technologies on the surface accuracy of CAD-CAM occlusal splints. *J Prosthodont*. 2023;32:697–705.
25. Wesemann C, Spies BC, Schaefer D, et al. Accuracy and its impact on fit of injection molded, milled and additively manufactured occlusal splints. *J Mech Behav Biomed Mater*. 2021;114:104179.
26. Blasi A, Henarejos-Domingo V, Palacios-Banuelos R, et al. Comparison accuracy of digital and analog method using milled occlusal splints. *J Esthet Restor Dent*. 2023;35:1103–1112.
27. Smail SMS, Abbasgholizadeh ZS, Kahramanoglu E. Evaluation of volumetric wear loss and pain scores of the digitally and conventionally manufactured occlusal splints for individuals with sleep bruxism. *J Appl Oral Sci*. 2025;33:20250052.
28. Kerstein RB, Radke J. Clinician accuracy when subjectively interpreting articulating paper markings. *Cranio*. 2014;32:13–23.
29. Bostancioglu SE, Togay A, Tamam E. Comparison of two different digital occlusal analysis methods. *Clin Oral Investig*. 2022;26:2095–2109.

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