CLINICAL ASPECTS OF RECORDING OCCLUSAL CONTACTS USING CONVENTIONAL METHODS AND INTRA-ORAL SCANNING

Simona Iacob[1], Diana Cadar[1], Andrea Chisnoiu[1,*], Antonela Berar[1], Mirela Fluerașu[1], Rareș Buduru[2], Manuela Manziuc[1], Smaranda Buduru[1]

[1]"Iuliu Haţieganu" U. M. Ph.- Cluj-Napoca, Romania, Faculty of Dentistry, Department of Prostodontics,
[2]Stomestet Private Dental Clinic, Cluj-Napoca, Romania

Corresponding author; *e-mail:* maria.chisnoiu@umfcluj.ro

ABSTRACT

Aim of the study. The aim of the current study was to analyze and compare the registration of the occlusal contact points using three intraoral scanners and articulation paper. **Material and methods.** The static occlusal contact points in maximum intercuspation of ten subjects (3 women and 7 men), were analyzed using three different scanners: Cerec Omnicam (CEREC® Sirona, Germany), Medit i700 (MEDIT® Seoul, Republic of Korea), Trios 3 (3-SHAPE® Copenhagen, Denmark) and articulating paper 200 µm (Dr. Jean Bausch Gmbh & Co. KG, Germany). All the contact points obtained on each arch were counted and statistically evaluated. **Results.** The highest number of contacts was identified with Omnicam Scan (564 contact points) followed by the contacts obtained with occlusal paper (528 contact points). Contact obtained with Medit i700 were 483 and the fewest points of contact were identified with Trios 3 (477 contact points). However, no statistically significant difference was observed between the different types of examination (p> 0,005). **Conclusions.** Intraoral cameras represent a useful and reliable tool for the analysis of occlusal contact points. However, for the precise diagnosis and treatment of occlusal imbalance, a correlation between the conventional and digital methods of occlusal analysis may provide superior results.

Key words: intraoral scanning, dental occlusion, articulating paper

INTRODUCTION

The functionality of the masticatory system is optimal when the dentition is intact with adequate contacts between the opposing teeth (Bohzkova et al, 2021, Buduru et al. 2021, Iacob et al. 2022). Without an in-depth analysis of occlusal contacts, the risk of iatrogenic occurrences rises exponentially. Currently there are several methods of performing a complex and detailed occlusal analysis. Although many practitioners use conventional semi-adjustable mechanical articulators in obtaining prosthodontic restorations (Pruden 1960, Phoenix et al 2003, Teteruk et al, 1967, Buduru et a., 2020), computerized diagnostic methods are gradually entering the dental area (Buduru et al, 2020, Duret et al 1988, Beuer et al 2008). For years, occlusal contacts have been studied, to determine their exact location and to identify various materials and methods for their registration such as conventional methods (paper foil, silk, shim stock foil) and digital systems (Bohzkova et al 2021).

Conventional methods (articulating foil, paper, spray, and silk trips) are based on a qualitative evaluation, combining the examiner's subjective visual assessment of the marks morphology with the proprioception of the patient to find a balanced contact distribution and a load equilibrium (Kerstein et al 2014, Iftene et al 2016). An articulating foil is the most used method to reach this goal, because it has reduced thickness, good resistance and adaptation to the oral environment and the characteristics of occlusal

DOI : 10.6261/RJOR.2024.3.16.28

surfaces (Carossa et al 2000, Millestein et al. 2001, Silva et al. 2016). Nevertheless, there is insufficient literature on the relationship between the load exerted on the tooth and occlusal mark variations (Millstein et al. 2001, Silva et al. 2016, Carey et al. 2007). The disadvantage of this method is that it depends on the examiner subjective interpretation and the teeth with glazed porcelain or metal crowns cannot be accurately verified (Sulun, 2024, Iftene et al. 2016). The difficulty of marking glazed porcelain may be overcome by first using blue very thick articulating paper and then red articulating paper. Sometimes, when used alone, articulating paper can satisfactorily register the occlusal contacts if the surfaces are lightly coated with Vaseline (Sulun, 2024). There are also some more limitations regarding articulating papers: patients need to bite several times to obtain full arch contacts, the bite sequence cannot be analyzed, and saliva can also interfere on results promoting the creation of false positives and false negatives recordings (Sulun, 2024).

Computerized methods attempt to provide a quantitative evaluation of occlusal contacts pressure, using digital sensors to get the information (Carey et al. 2007). The result is a graphic that identifies the position of contacts and the corresponding occlusal pressure intensity (Kerstein, 2001).

These quantitative methods arose from the need to find a more objective occlusal evaluation to help clinicians, especially as far as the balance of occlusion in complex rehabilitations is necessary (Maness et al. 1987, Solaberietta et al. 2017). Thus, over recent years, these methods have been progressively introduced in the clinical practice as a possible aid to adjust occlusion during prosthodontics treatments (Gumus et al. 2013, Lee et al. 2016, Okuma et al. 2002, Lui et al 2015).

Comparative studies between conventional and computerized methods are characterized by heterogeneity of results, mainly due to the use of different methodologies and study designs. Most studies have been performed in vitro, thus not reflecting the biological complexity of the stomatognathic system, as well as not considering for the possible interferences of the oral environment during occlusal recordings (Harvey et al. 1992, Forrester et al 2011, Helms et al 2012). Findings from clinical studies are also inconclusive, justifying the need for more well-designed and clarifying studies on this topic (Koos et al. 2012, Maeda et al. 1989, Baba et al. 2002, Davies et al. 2002).

Based on these premises, the aim of the current study was to compare the amount of occlusal contact points registered using three intraoral scanners (Cerec Omnicam, Medit i700 and Trios 3) and articulating paper.

MATHERIALS AND METHODS

The static occlusal contact points of ten subjects (3 women and 7 men), were analyzed using three different scanners: Cerec Omnicam (CEREC® Sirona, Germany), Medit i700 (MEDIT® Seoul, Republic of Korea), Trios 3 (3-SHAPE® Copenhagen, Denmark) and articulating paper 200 μm (Bausch Gmbh & Co. KG, Germany). The inclusion criteria were: age between 20 and 25 years; complete arch; willing to participate in the study. The exclusion criteria were: presence of implant supported prosthetic restorations; presence of single unit or partial fixed dental prostheses, signs and symptoms of temporo-mandibular dysfunctions, missing teeth, subjects suffering from coordination and other neurological disorders, ongoing orthodontic treatment, history of trauma.

The examination of the dental occlusion in maximum intercuspation position of each subject was carried out in two appointments with an interval of three weeks, always in the

DOI : 10.6261/RJOR.2024.3.16.28

early hours of the morning, at the Prosthodontics department of the Faculty of Dentistry in Cluj-Napoca. The evaluation was carried out by the same operator, initially with the intraoral cameras and then with the articulating paper. For the occlusal recordings, the study participants were seated in a dental chair with the head in a straight position well supported by the head rest. The participants initially received explanations regarding the recording process, and then they underwent the recording procedures. Between the two appointments for analysis, no intra-oral changes were noted in the subjects.

The material used for this study was as follows: Dental examination kit (No. 6 probe, dental mirror and tweezer), OptraGate® oral retractor in Regular and Small size, Cheek retractor, Cotton rolls, Bausch® articulating paper, Camera from Apple® iPhone Xr , Mirror for dental photography, Cerec® Omnicam intraoral camera, 3-shape® Trios 3 intraoral camera, Medit® i700 intraoral camera (Fig.1).

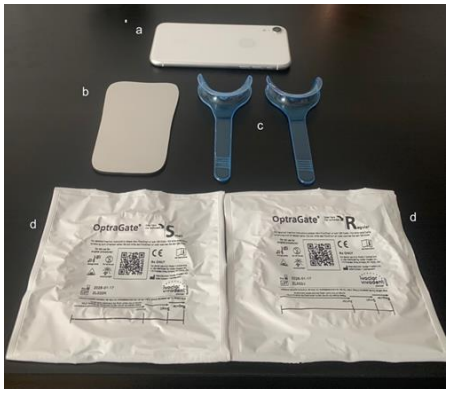

Figure 1. Equipment used for photographs. (a) Apple® iPhone Xr, (b) Occlusal Photography Mirror, (c) Oral Retractors, (d) OptraGate® Oral Retractors.

The protocol used for analysis of maximum intercuspation position with intraoral scanners included seating of the patient in the dental chair with the head in a straight position well supported by the head rest; drying the dental surfaces using the air spray; registration of the maxillary and mandibular scans according to manufacturer instructions for each scanner. After the scan, the correction of areas which were not recorded was realized by taking a new registration (Figure 2). The occlusal relationship was assessed by asking the participant to close the mouth in maximum intercuspation and maintain dental contact.

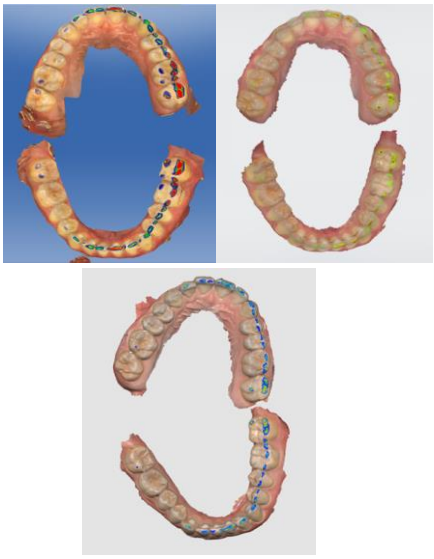

Figure 2. Maximum intercuspation scans with Omnicam Cerec (a), Trios 3 (b), and Medit i700 (c).

The protocol used for the analysis of maximum intercuspation with 200µm blue articulating paper was performed as follows: the patient was explained how to close the mouth with maximum intercuspation. The patient was asked to repeat the mouth closing movement several times to ensure that he was in the maximum intercuspation position; the occlusal surfaces of the teeth were dried using the air spray. The articulated paper was interposed between 1st and 4th hemiarches, then between 2nd and 3rd hemiarches and finally between the maxillary and mandibular anterior teeth, and closing movements were carried out each time, always checking existence of same the position and presence of occlusal contacts on the entire arch. The marking of the occlusal surfaces was checked. The images of the maxillary and mandibular arches were captured using an occlusal dental photography mirror with an Apple® iPhone Xr

DOI : 10.6261/RJOR.2024.3.16.28

photo lens (Figure 3).

Figure 3. Maxillary and mandibular occlusal contacts in maximum intercuspation marked with blue articulation paper 200µm

All the contact points obtained on each arch with the intraoral scanners and with the articulation paper were counted conventionally on the registered images. The data obtained were centralized using a Microsoft Excel chart, analyzed descriptively, and compared. A statistical test (t-test) was carried out, to identify any significant statistical difference between each intraoral camera and the articulating paper and between the cameras. P value <0.05 was considered significant.

RESULTS AND DISCUSSIONS

The average contact points between maxillary and mandibular arch obtained with each method for the 10 subjects are displayed in Figure 4.

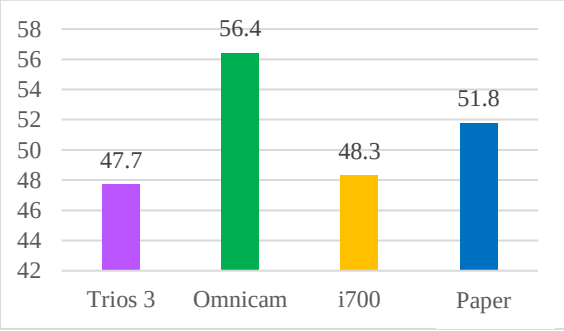

Figure 4. Average number of contact points obtained for 10 subjects on 2 arches for each method

Even though there is no consensus on the reference method for analyzing occlusal status, the articulation paper remains widely used when assessing and comparing new digital devices (Millestein et al. 2001, Dias et al. 2019). Considering that not all dental practices are equipped with intraoral scanners, the reference for the analysis of occlusal contact points was considered the articulating paper and decided to give a rate of 100%. In this way the variations between each scanner and between the scanners and the articulation paper were highlighted (Figure 5).

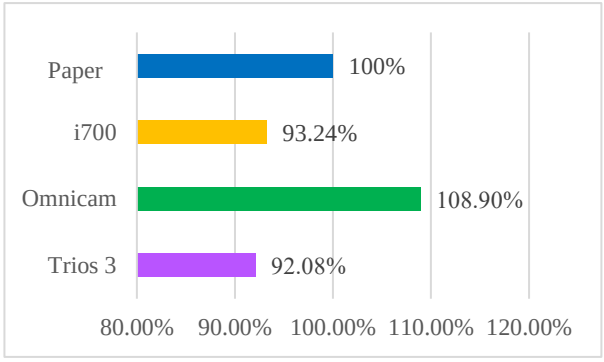

Figure 5. Articulating paper vs. Intraoral scanners

Total number of contacts for the 10 subjects, found by each method, was calculated. The highest number of contacts was identified with Omnicam Scan (564 contact points) followed by the contacts obtained with occlusal paper (528 contact points). Contact obtained with Medit i700 were 483 and the fewest points of contact were identified with Trios 3 (477 contact points).

No significant statistical difference has been observed between the use of the i700, the Trios 3, the Omnicam and the articulating paper (Table 1).

Table 1. Significance threshold when comparing intraoral scanners and articulating paper.

t-test	Significance threshold (p)
Trios 3 vs paper	0,285826

DOI : 10.6261/RJOR.2024.3.16.28

Omnicam vs paper	0,380973
i700 vs papier	0,905812
Trios 3 vs Omnicam	0,094248
Trios 3 vs i700	0,905769
I700 vs Omnicam	0,082672

The Intraclass Correlation Coefficient (ICC) was used to assess the consistency or agreement between the two moments of evaluation of the number of occlusal contacts in maximum intercuspation. Average measure of ICC for each method used was higher that 0.8, meaning almost perfect match between the two moments of evaluation (Trios 3- 0,989; Omnicam- 0,974; i700- 0,938; articulating paper- 0,958).

However, in order to evaluate the accuracy of the contact points registration between the methods used, the 95% Confidence Interval was analyzed (Figure 6).

Narrow confidence interval was observed in case of Trios 3, indicating high confidence that the true reliability is close to the values obtained and the estimate is precise. A slight uncertainty compared to Trios 3, but the still very reliable method was observed in case of Omnicam. The wider confidence intervals for i700 (0.762 to 0.984) and articulating paper (0.836 to 0.990) reflect greater uncertainty in the estimate, indicating that the true reliability might be lower or higher within this range.

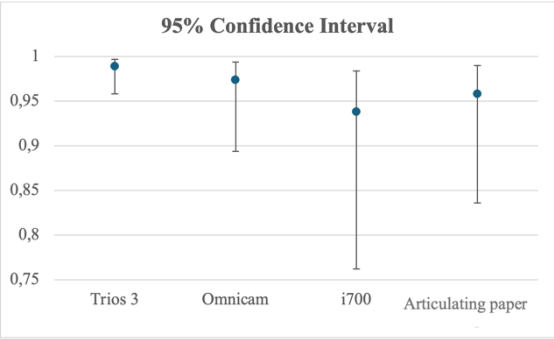

Figure 6. Confidence interval for the intraoral cameras and articulating paper

The contact points were analyzed in maximum intercuspation, and about 8% difference was obtained between the intraoral cameras and the articulation paper. Omnicam intraoral scanner identified most of contact points, while Trios 3 and the Medit i700 provided a lower number of contacts. This does not mean that intraoral scanners have distorted results, in fact the result of the t-test statistical tests never highlighted a statistical difference, moreover the contact point analysis function is intuitive and allows a rapid visualization of the patient's occlusion. Currently, no clear settings exist on the software of intraoral cameras regarding the precision of occlusal analysis.

Concerning the study protocol, even if all the steps have been respected, certain variables must be considered: first, it cannot be ensured that, when recording the occlusion with each method, the subjects closed their mouth in a perfectly similar position even if the maximum intercuspation position is a reproductible dental position (Dias et al. 2019, Buduru et al. 2010).

The experience of the practitioner in handling cameras and articulation paper, the particularity of each clinical case and the sensation perceived by the patient during manipulation must also be considered. Of all these variables, the most important is the role of the practitioner who is responsible for the guidance of the patient to a closing movement as natural as possible. In the current study, the same protocol was carried out as the research by Michelinakis (Michelinakis et al. 2019). Corrections were necessary in both studies, they can be avoidable with training. The measured resulting distortion also includes modification due to the cumulative effect of the image capture, stitching, and post-processing capabilities of different software. It was noted that the STL files obtained with the Trios-3 camera tend to be smoothed by the

DOI : 10.6261/RJOR.2024.3.16.28

software (Wong et al. 2019).

Concerning the method of analyzing the number of points of contact, it is very subjective because the camera software sometimes gives large surfaces with color changes depending on the intensity of the contact, there is therefore a very high level of interpretation.

As mentioned in the study of Cristina Fraile et al. there are significant differences when analyzing and recording occlusal contacts in in vivo studies compared with in vitro studies. It is easier to analyze the different variables of occlusal contacts, in in vitro studies, like contact areas or intensity of occlusal contacts. Regarding in vivo studies, all data must be reduced to the simplest level of interpretation due to the large number of variables (Fraile et al. 2022).

The analysis of occlusal contact points in the position of maximum intercuspation has equivalent results with these 4 analysis methods. In fact, no significant statistical difference has been observed between the use of the i700, the Trios 3, the Omnicam and the articulating paper.

The digital approach, using Medit i700 scan, has significantly better accuracy for static interocclusal registration compared to the conventional method in both full and quadrant arch situations (Marta et al. 2023). The findings of this clinical study are in accordance with Iwauchi et al. (Iwauchi et al. 2021) and Ries et al. (Ries et al. 2021) who reported that recording with scanners is more precise than conventional interocclusal record. In addition, the results are in concordance with the studies by Camcı et al. (Camci et al. 2021) and Ayuso-Montero et al. (Ayuso-Montero et al. 2020) who reported better precision for scanners in detecting occlusal contact area compared to conventional interocclusal record. Similarly, a study by Gjelvold et al. (Gjelvold et al. 2016) reported that occlusal registration with scanners can influence the delivery of crowns with better occlusion than conventional record.

Even though there is no consensus on the reference method for analyzing occlusal status, the articulation paper remains widely used when assessing and comparing new digital devices (Milstein et al. 2001, Dias et al. 2019). Considering that not all dental practices are equipped with intraoral scanners, the gold standard for the analysis of occlusal contact points was considered the articulating paper and decided to give a rate of 100%. For the improvement in analysis of the contact points, the use of digital occlusal registration devices (such as T-Scan, TekScan USA) or Jaw tracking devices (ModJaw) can provide supplementary information (Fraile et al. 2022).

The limitations of this study are represented by the low number of participants, the difference in thickness between the intraoral scanners (40 μm) and the articulating paper (200 μm) and the lack of standardization of the occlusal registration methods. Further, it is well known that when doctors subjectively interpret ink markings, errors in interpretation can occur (Mikelinakis et al 2019, Fraile et al. 2022). Nevertheless, to limit this bias in our study, any visible contact was marked as the presence of a contact, thus the intensity of the contact did not influence the choice.

The originality in this study consists of assessing inter-rater reliability concerning the static occlusion in maximum intercuspation position using conventional methods and intraoral scanners.

DOI : 10.6261/RJOR.2024.3.16.28

CONCLUSIONS

1. Intraoral cameras represent a useful and reliable tool for the analysis of occlusal contact points.
2. Trios 3 showed the highest reliability with the most precise estimate, while the i700 method showed good reliability but with more uncertainty in the estimate. All methods demonstrate acceptable reliability, but the confidence intervals provide additional insight into the certainty of each estimate.
3. For the precise diagnosis and treatment of occlusal imbalance, a correlation between the conventional and digital methods of occlusal analysis may provide superior results.

4. When used adequately, following the manufacturer's instructions, all three intra-oral cameras can provide precise results of the occlusal analysis, however they should always be correlated with the data acquired from the clinical examination.

REFERENCES

1. Bozhkova T, Musurlieva N, Slavchev D, Dimitrova M, Rimalovska S. Occlusal Indicators Used in Dental Practice: A Survey Study. Biomed Res Int. 2021 Nov 3;2021:2177385. doi: 10.1155/2021/2177385.
2. Pruden WH. The role of study casts in diagnosis and treatment planning. J Prosthet Dent. 1960;10:707-710.
3. Buduru S, Prigoana A, Valean A, Manziuc M, Iacob S, Bacali C, Chisnoiu A, Pacurar M, Negucioiu M. Correlations between dental occlusion and upper cervical spine. Roman J Oral Rehabil, 2021, 13 (3), 51-58.
4. Iacob SM, Chisnoiu AM, Objelean A, Fluerasu MI, Moga RR, Buduru SD. Correlation between bruxism, occlusal dysfunction and musculo-articular status. Roman J Oral Rehabil, 2022, 14 (3), 48-55.
5. Phoenix RD, Cagna DR, Defreest CF. Stewart's Clinical Remavable Partial Prosthodontics. Chicago: Quintessence Publishing Co; 2003: pp. 98-143.
6. Teteruck WR, Lundeen HC. The accuracy of an ear face-bow. J Prosthet Dent. 1966;16:1039-1046.6. Hickey JC, Lundeen HC, Bohannan HM. A new articulator for use in teaching and general dentistry. J Prosthet Dent. 1967;18:425-437.
7. Buduru S, Finta E, Almasan O, Fluerasu M, Manziuc M, Iacob S, Culcitchi C, Negucioiu M. Clinical occlusion analysis versus semi-adjustable articulator and virtual articulator occlusion analysis. Med. Pharm. Rep. 2020, 93, 292–296.
8. Ifteni G, Apostu A, Tanculescu O. Dental occlusion and the importance of its proper investigation-part I. Rom J. Oral Rehab. 2016, 8(2):94-100
9. Ifteni G, Apostu A, Tanculescu O, Dental occlusion and the importance of its proper investigation – part II: Roman J Oral Rehabil, 2016; 8(4); 17-22
10. Duret F, Blouin JL, Duret B. CAD-CAM in dentistry. J Am Dent Assoc. 1988;117:715–720.
11. Beuer F, Schweiger J, Edelho D. Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. Br Dent J. 2008;204:505-511
12. Kerstein R , Radke J. Clinician accuracy when subjectively interpreting articulating paper markings. Cranio. 2014;32:13-23.
13. Carossa S, Lojacono A, Schierano G, Pera P. Evaluation of occlusal contacts in the dental laboratory: influence of strip thickness and operator experience. Int J Prosthodont. 2000;13:201-204
14. Millstein P, Maya A. An evaluation of occlusal contact marking indicators. A descriptive quantitative method. J Am Dent Assoc. 2001;132:1280-1286:quiz 319

DOI : 10.6261/RJOR.2024.3.16.28

15. Silva P, Motta L, Silva S, Ferrari R, Fernandes K, Bussadori S . Computerized analysis of the distribution of occlusal contact s in individuals with Parkinson's disease and temporomandibular disor-der. Cranio. 2016;34:358-362
16. Carey JP, Craig M, Kerstein RB, Radke J. Determining a relationship between applied occlusal load and articulating paper mark area. Open Dent J. 2007;1:1-7. doi: 10.2174/1874210600701010001. Epub 2007 Jul 23. PMID: 19088874; PMCID: PMC2581523.
17. Sülün, T. (2024). Establishing Occlusal Relationships. In: Şakar, O. (eds) Removable Partial Dentures. Springer, Cham. https://doi.org/10.1007/978-3-031-47083-7_13
18. Kerstein R. Current applications of computerized occlusal analysis in dental medicine. Gen Dent. 2001;49:521-530
19. Maness W, Benjamin M, Podoloff R, Bobick A, Golden R. Computerized occlusal analysis: a new technology. Quintessence Int. 1987;18:287-292.
20. Solaberrieta E, Etxaniz O, Otegi J, Brizuela A, Pradies G. Customized procedure to display T-Scan occlusal contacts. J Prosthet Dent. 2017;117:18-21
21. Gumus H , Kilinc H, Tuna S, Ozcan N. Computerized analysis of oc-clusal contact s in bruxism patients treated with occlusal splint ther-apy. J Adv Prosthodont. 2013;5:256-261.
22. Lee S, Le e J. Computerized occlusal analysis: correlation with occlu-sal indexes to assess the outcome of orthodontic treatment or the severit y of malocculusion. Korean J Or thod. 2016;46:27-35.
23. Okuma K, Hirano S, Hayakawa I. A clinical application of the T-Scan II system-usefulness for evaluating occlusal contac ts of complete denture wearers. Kokubyo Gakkai Zasshi. 2002;69:277-284
24. Liu C, Chang Y, Shen Y, Hong H. Using the T-scan III system to ana-lyze occlusal function in mandibular reconstruc tion patients: a pilot study. Biomed J. 2015;38:52-57.
25. Harvey W, Osborne J, Hatch R. A preliminary test of the replica-bility of a computerized occlusal analysis system. J Prosthet Dent. 1992;67:697-700.
26. Forrester S, Presswood R, Toy A , Pain M. Occlusal measurement method c an affect SEMG activit y during occlusion. J Oral Rehabil. 2011;38:655-66 0.
27. Helms R, Katona T, Eckert G. Do occlusal contact detection prod-ucts alter the occlusion? J Oral Rehabil. 2012;39:357-363.
28. Koos B, Holler J, Schille C, Godt A. Time-dependent analysis and representation of force distribution and occlusion contact in t he mastic atory c ycle. J Orofac Orthop. 2012;73:204-214.
29. Maeda Y, Ohtani T, Okada M, et al. Clinical application of T-scan System. 1. Sensitivity and reproducibility and its application. Osaka Daigaku Shigaku Zasshi. 1989;34:378-384
30. Baba K, Tsukiyama Y, Clark G. Reliability, validity, and utility of various occlusal measurement methods and techniques. J Prosthet Dent. 2000;83:83-89
31. Davies S, Gray R, Al-Ani M. Inter- and intra-operator reliability of the recording of occlusal contacts using 'occlusal sketch' acetate technique. Br. Dent. J. 2002, 193, 397–400.
32. Millstein, R.; Maya, A. An evaluation of occlusal contact marking indicators: A descriptive quantitative method. J. Am. Dent. Assoc. 2001, 132, 1280–1286.
33. Dias RAB, Rodrigues MJP, MessiasAL, Guerra FADA, Manfredini D. Comparison betweenconventional and computerised methods in the assessmentof an occlusal scheme. J Oral Rehabil.2019;00:1–8
34. Buduru S, Almasan O. Notiuni practice de ocluzologie. Napoca Star. 2010.
35. Michelinakis G, Apostolakis D, Tsagarakis A, Kourakis G, Pavlakis E. A comparison of accuracy of 3 intraoral scanners: A single-blinded in vitro study. 2019;
36. Wong KY, Jean Esguerra R, Ai Ping Chia V, Tan YH, Tan KBT. Three-Dimensional Accuracy of Digital Static Interocclusal Registration by Three Intraoral Scanner Systems. :9.
37. Fraile C, Ferreiroa A, Romeo Rubio M, Alonso R, Pradíes Ramiro G. Clinical study comparing the accuracy of interocclusal records, digitally obtained by three different devices. Clin Oral Investig. 2022 Jun;26(6):4663-4668. doi: 10.1007/s00784-022-04542-6. Epub 2022.
38. Marta R-L, Abdul B. Barmak, Hani Tohme, Burak Yilmaz, John C. Kois, Miguel Gómez-Polo. Factors that influence the accuracy of maxillomandibular relationship at maximum intercuspation acquired by using intraoral scanners: A systematic review. J Dent,138, 2023,104718.

DOI : 10.6261/RJOR.2024.3.16.28

39. Iwauchi Y, Tanaka S, Kamimura-Sugimura E, Baba K. Clinical evaluation of the precision of interocclusal registration by using digital and conventional techniques. J Prosthet Dent. 2021 doi: 10.1016/j.prosdent.2021.01.021.
40. Ries JM, Grünler C, Wichmann M, Matta RE. Three-dimensional analysis of the accuracy of conventional and completely digital interocclusal registration methods. J Prosthet Dent. 2021 doi: 10.1016/j.prosdent.2021.03.005.
41. Camcı H, Salmanpour F. A new technique for testing accuracy and sensitivity of digital bite registration: a prospective comparative study. Int Orthod. 2021;19:425–432. doi: 10.1016/j.ortho.2021.06.008.
42. Ayuso-Montero R, Mariano-Hernandez Y, Khoury-Ribas L, Rovira-Lastra B, Willaert E, Martinez-Gomis J. Reliability and validity of T-scan and 3D intraoral scanning for measuring the occlusal contact area. J Prosthodont. 2020;29:19–25. doi: 10.1111/jopr.13096.
43. Gjelvold B, Chrcanovic BR, Korduner EK, Collin-Bagewitz I, Kisch J. Intraoral digital impression technique compared to conventional impression technique. A randomized clinical trial. J Prosthodont. 2016;25:282–287. doi: 10.1111/jopr.12410.

DOI : 10.6261/RJOR.2024.3.16.28