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Digital Comparison of Occlusal Vertical Contacts Between Direct Composite and Indirect Cad/Cam Restorations: An in vivo quantitative assessment

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ABSTRACT

Objective: Clinical assessment of the static occlusal vertical contacts for direct composite and indirect Cad/Cam restorations, and evaluation of the clinical experience level's effect on contact registration.

Methods: Sixty restorations on maxillary and mandibular molar teeth were investigated. Postgraduate students performed indirect Cad/Cam restorations (Cerasmart, GC Corp., n=20), and both undergraduate and postgraduate students performed direct composite restorations (Ganeial A'chord, GC Corp., n=20 for each). A single supervisor digitally analyzed the occlusal vertical contacts immediately after by using an intraoral scanner (iTero Element-5D, AlignTech) and OrthoCAD software. The tightness of contacts was assessed by counting the pixel numbers in Photoshop CC (Adobe) software. The statistical analyses were performed by Shapiro-Wilk, One-way ANOVA, Tamhane's T2 test, Kruska-Wallis test, and Dunn tests ($p<.05$).

Results: No significant differences were found for the contacts closer than the yellow code (<0.4mm) among the operator/restoration types ($\geq.05$). Whereas, significant differences were found between the undergraduate direct and postgraduate indirect restorations for the yellow contacts and the lighter ones ($p<.05$). Additionally, no significant contact differences were found either between the direct restorations of undergraduate and postgraduate students or between the direct and indirect restorations of postgraduate students ($p\geq.05$ for both). Considering red, orange, and yellow code contact types together, no significant differences were observed among the operator and restoration types ($p=.069$).

Conclusion: The restoration type was not effective in registering the occlusal vertical contacts for clinicians with equal clinical experience levels. Clinical experience was also not effective in occlusal contacts of direct restorations. Whereas, when the advantages of indirect Cad/Cam restorations are combined with the clinical experience, tighter occlusal vertical contacts might be registered. The potential effects of additional parameters such as the restorative material and the dental technician on the occlusal vertical contacts should be investigated.

Keywords: Clinical experience, cad/cam, direct restoration, indirect restoration, occlusion, vertical contacts

1. INTRODUCTION

Dental occlusion is defined as a static relationship between the occlusal/incisal surfaces of the upper and lower teeth (1). Whereas, it is defined as not only static but also dynamic relationship more recently (2). The contact of all the posterior teeth should be set simultaneously and the occlusal loads should be distributed homogeneously to obtain an ideal, tension-free, balanced occlusion (2). Otherwise, inappropriate occlusal forces on the teeth can lead to the traumatic occlusion mainly due to the primary contacts which may occur following restorative, prosthetic, or orthodontic treatments. However, due to the high occlusal variability of the patient, static and dynamic occlusion patterns are not considered constant and reproducible (2). The imbalanced destructive forces may cause damages on pulp and periodontal tissues, masticatory muscles, temporomandibular joint (TMJ), and also dental hard tissues (3). Therefore, an accurate occlusal analysis before, during, and even after the treatment is very important to avoid such damages, clinically.

The occlusal analysis can be affected by several factors including age, gender, craniofacial morphology, periodontal tissue support, TMJ disorders, presence of pain, the operator/device performing the analysis, and the parameters related to the positioning during the analysis procedure (1,4,5). Moreover, the intensity and location of the occlusal contact can be affected by the position of the mandible which can also be affected by the whole body position of the patient (6).

In terms of restorative dentistry, the type of restoration may have an effect on the occlusion discrepancy of a restoration.

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However, there are only a few scientific evidences in literature for the clinical comparison of the occlusal analysis between direct composite and indirect Cad/Cam restorations. Although some previous studies considered no difference between these two types of restorations regarding the occlusal contacts/relations (7-9), especially larger Cad/Cam restorations (including at least one cusp coverage) can be more advantageous compared to the direct composite restorations, due to the ability of the digitally driven contact guidance clinically.

Moreover, the occlusal analysis technique as well as the level of experience of the clinician may also influence the final occlusion of a restoration. The analysis of occlusion can be done by conventional or digital methods. The conventional method is generally performed by an articulating paper or occlusal spray, while the digital method is performed by the T-Scan analysis system (3). In addition to the digital method, the dental Cad/Cam systems can be used for the occlusal analysis. Thereby, it is also possible to digitally evaluate the estimated occlusion at the design stage before the restorative procedure begins (3). However, there is only a limited number of scientific studies in the literature regarding the use of Cad/Cam systems for the occlusal analysis.

The aims of this clinical study were to digitally evaluate the level of static occlusal vertical contacts in direct composite and indirect Cad/Cam restorations, and also to evaluate the effect of the clinical experience on registration of the occlusal contacts. The null (h_0) hypotheses of the study were; [1] the level of occlusal vertical contacts (contacts, close contacts, and intense contacts) are similar for direct composite and indirect Cad/Cam restorations, among clinicians with similar clinical experience, [2] the clinical experience has no effect on registration of the occlusal vertical contacts.

2. METHODS

This clinical study was conducted with the approval of a local ethics committee (Protocol number: 2023/140). Informed consent was obtained from each patient.

Thirty-three patients out of the entire daily routine undergraduate and postgraduate doctor appointments in the university department of restorative dentistry were selected for the evaluations in this clinical study. The gender and age of the patient were not considered a variable in the study therefore the patients were selected randomly but only with no local or systemic disorders or TMJ disorders that could prevent the bite. A total of 60 posterior restorations (molar teeth involving mesial-occlusal or distal-occlusal surfaces) including the occluding tooth in the counter-arch and with at least one cusp coverage were selected. The undergraduate and postgraduate students in a university clinic performed the restorations. The direct composite restorations (n=40) were performed by the undergraduate and the postgraduate students whereas, the indirect Cad/Cam restorations (n=20) were performed by only the postgraduate students at the same clinic. A nanohybrid composite, Gaenial A'chord (GC Corp., Japan) was used for all the direct restorations. Cerasmart hybrid blocks (GC Corp.) were used for the indirect restorations by using the iTero Element 5D intraoral scanner. All the restorative steps and the final restorations are routinely checked by an experienced clinical supervisor for both undergraduate and postgraduate students at the university clinics. A single supervisor checked and approved all the involved restorations in this study before the occlusal analyses. The occlusal vertical contacts of the restorations were digitally analyzed, immediately after the approval by the supervisor.

The digital impression of each restoration and occluding tooth was taken by using an intraoral scanner (iTero Element 5D, Align Technology, USA) for the analyses. The scanner was used in 'restorative mode' with enhanced intra-oral camera resolution for the study. The occlusal surface of the restoration, the occluding tooth, and the inter-occlusal relations were recorded as a .stl file for each restoration. The .stl data were then processed using the OrthoCAD software (Align Technology, USA) to measure the vertical occlusal contacts quantitatively. OrthoCAD software categorizes the occlusal contacts by specific color codes from tight (0.0 mm) to loose (1.2 mm) contacts such as red (0.0 mm), orange (0.0-0.2 mm), yellow (0.2-0.4 mm), green (0.4-0.6 mm), cyan (0.6-0.8 mm), light blue (0.8-1.0 mm), blue (1.0-1.2 mm), respectively, in 0.2 mm increments for each color code (Figure 1) (10). In terms of the color codes in the OrthoCAD software program, the red color code was defined as the contact; orange and yellow codes were defined as close contacts; green and cyan color codes were defined as intense contact; and light blue and blue color codes were defined as light contacts (3).

Through the OrthoCAD software, 7 different screenshots in .jpeg picture format were provided for each restoration at the same plane, corresponding to the specific color codes for the contact types. In this research, each color code corresponds to a specific occlusal contact type, and every lighter contact overlapped the closer contact/contacts (Figures 2 a-g) (11). For instance yellow code includes the occlusal contacts of yellow and red, while the orange code includes the occlusal contacts of orange, yellow, and red. Then the images were loaded into the Adobe Photoshop CC (Adobe, USA) software program to measure the vertical occlusal contact areas, quantitatively. Starting from the picture of the red color code, each contact type was encircled by using the quick selection tool in the software. Then the number of pixels inside the encircled area was measured by using the histogram tool (Figures 3 a, b). The collected pixel numbers were saved for each contact type.

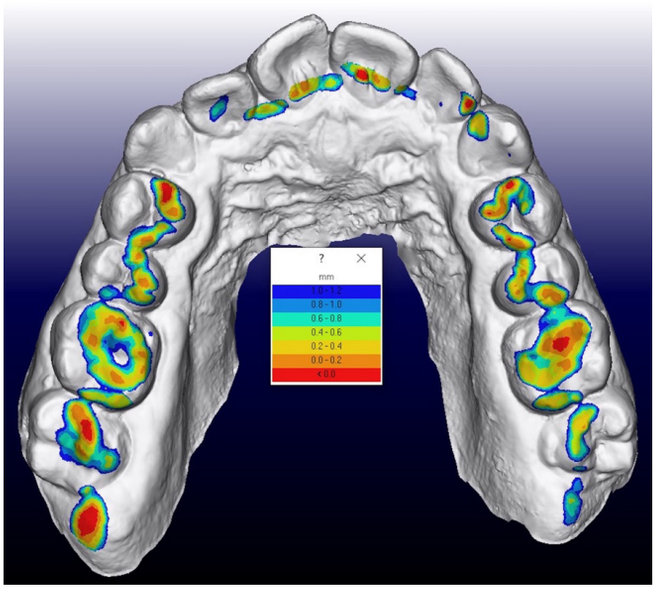
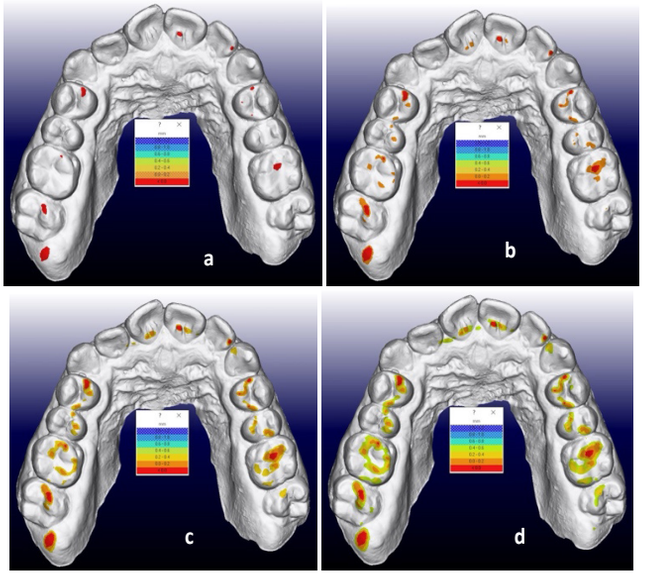
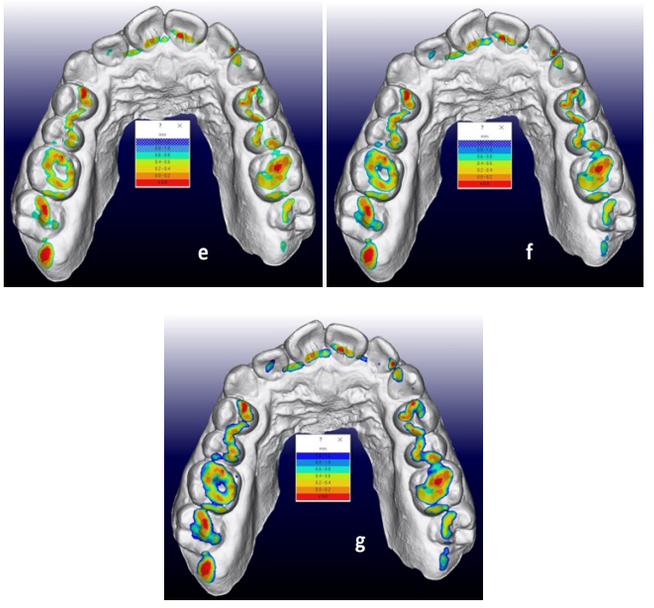


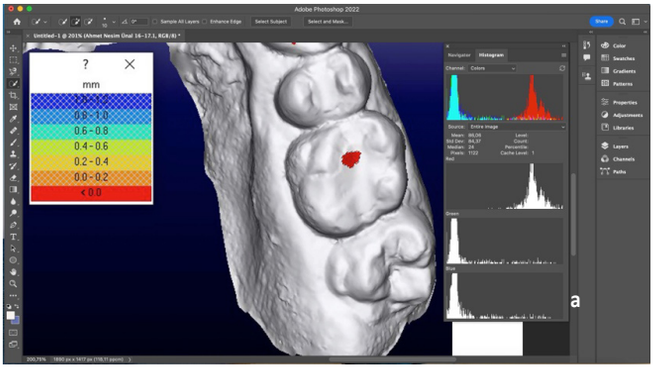
Figure 1. *Occlusal contact color codes in OrthoCAD software program.*

The data were analyzed with the IBM SPSS V23 software program. The distribution of the data was evaluated Shapiro-Wilk test. The normally distributed data were analyzed by One-way ANOVA and Tamhane's T2 test. The rest were analyzed by Kruskal-Wallis test and the Dunn test. The conformity of the contact points and operator groups was analyzed by the conformity analysis. The results were presented as average±standart deviation and median (minimum–maximum). The deemed significance was set at <.05.





Figures 2 *a-g. Collected 7 respective screenshots per restoration, corresponding to each one of the occlusal contact types.*



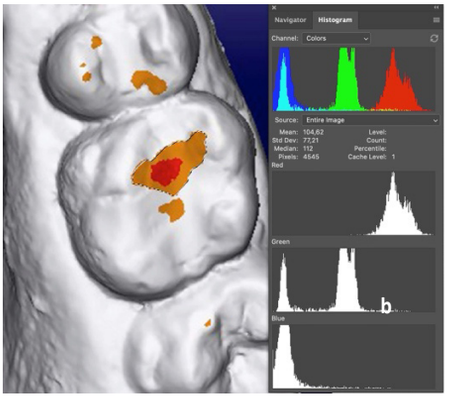


Figure 43a, *b. Measurement of the number of pixels inside the encircled area by using the histogram tool. (a) Measurement of the red code area, (b) Measurement of the orange code area, close-up view.*

3. RESULTS

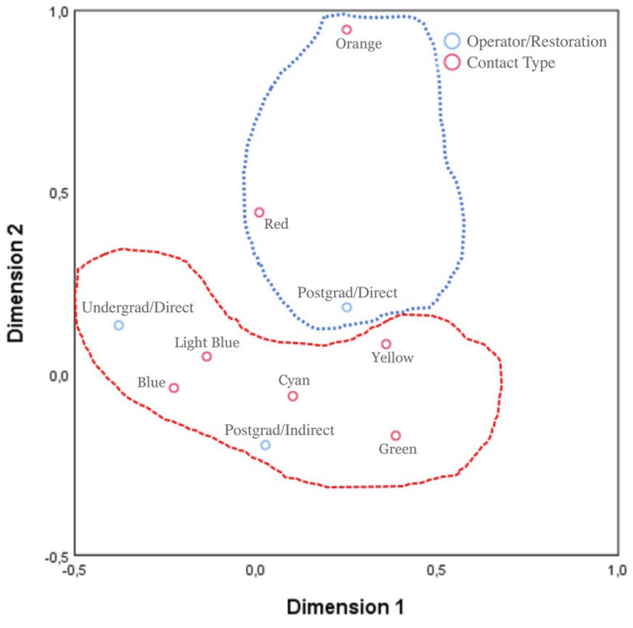


Figure 4. *Map of conformity regarding the distribution of contact types among operator/restoration types.*

According to the map of conformity, red and orange contact types were mostly presented in direct restorations of postgraduate students. Whereas, yellow, green, cyan, light blue, and blue contact types were mostly presented in direct restorations of undergraduate students and indirect restorations of postgraduate students (Figure 4).

The red contact type (0.0 mm) was the lowest number for each operator/restoration type and there was no significant difference among all (p=.401) (Table 1). The yellow contact type (0.0-0.2 mm) was the second lowest number for each operator/restoration type and there was no significant difference among all (p=.438). The orange contact type (0.2-0.4 mm) was the third lowest number for each operator/restoration type. The contact area of direct restorations of undergraduate students was significantly lower than the indirect restorations of postgraduate students (p=.017). However, no significant difference was found among the direct and indirect restorations of postgraduate students (p≥.05). The green contact type (0.4-0.6 mm) was the fourth lowest number for each operator/restoration type. The contact area of direct restorations of undergraduate students was significantly lower than the direct and indirect restorations of postgraduate students (p<.001), of which two were found similar (p≥.05). The cyan contact type (0.6-0.8 mm) was the third highest number for each operator/restoration type. The contact area of direct restorations of undergraduate students was significantly lower than the indirect restorations of postgraduate students (p=.002). However, no significant differences were found among the direct and indirect restorations of postgraduate students (p≥.05). The light blue contact type (0.8-1.0 mm) was the second highest number for each operator/restoration type. The contact area of direct restorations of undergraduate students was significantly lower than the indirect restorations of postgraduate students (p=.003). However, no significant differences were found among the direct and indirect restorations of postgraduate students (p≥.05). The blue contact type (1.0-1.2 mm) was presented as the highest number for each operator/restoration type. The contact area of indirect restorations of

Table 1. *Comparisons between the operator/restoration types and contact types*

Operator/Restoration Type								
Contact Type	**Undergrad/Direct**		**Postgrad/Direct**		**Postgrad/Indirect**		**Test Stat.**	**P**
	Average±SD	Median(Min-Max)	Average±SD	Median(Min-Max)	Average±SD	Median(Min-Max)		
Red	205.5±4028	0.0(0.0-1418.0)	317.8±548.1	0.0(0.0-2097.0)	406.4±1170.0	0.0(0.0-4919.0)	1.826[1]	.401
Orange	1009.9±1119.6	651.0(0.0-3462.0)	1824.0±1734.7	1765.5(0.0-6084.0)	1834.9±2306.5	864.0(0.0-7407.0)	1.649[1]	.438
Yellow	2391.2±2133.5	1879.0(0,0-6839.0)[a]	4549.4±3434.8	4428,(336.0-13397.0)[ab]	6205.1±5309.4	4217.0 (375.0-15574.0)[b]	8.141[1]	**.017**
Green	3942.4±2983.0[a]	3733.0(0.0-11459.0)	7614.7±4881.4[b]	7057.5(1311.0-18531.0)	11316.9±7426.3[b]	11112.0(2381.0-25067.0)	10.615[2]	**<.001**
Cyan	6464.8±4821.5	5897.0(0,0-17201.0)[a]	10364.4±6257.0	8589.0(2886.0-23545.0)[ab]	15735.9±8712.3	17165.0(3711.0-28113.0) [b]	12.445[1]	**.002**
Light Blue	9651.7±6648.3	8274.0 (491.0-23883.0)[a]	13399.6±7679.1	11182.0(3647.0-29027.0)[ab]	20595.7±10795.0	20456.0(4908.0-38252.0) [b]	11.362[1]	**.003**
Blue	11969.2±8141.5	10490,0 (731.0-29662.0)[a]	15622.8±8387.7	14235.0(5027.0-32893.0)[a]	25374.4±12690.3	25840.0(6985.0-51628.0) [b]	13.187[1]	**.001**

[1]*Kruskall Wallis H test,* [2]*One-way ANOVA, a-b: No significant difference between the groups with the same letter.*

Table 2. *Comparisons between the operator/restoration types in terms of the tight contacts*

Contact Type	Undergrad/Direct		Postgrad/Direct		Postgrad/Indirect		Test Stat.	P
	Average±SD	Median (Min-Max)	Average±SD	Median (Min-Max)	Average±SD	Median (Min-Max)		
Red+Orange+Yellow	3606.6±3396,6	2848.0 (0.0-11258.0)	6691.3±5414.6	6193.0 (336.0-20371.0)	8446.4±8133.5	4766.0 (484.0-26243.0)	5.353	.069

**Kruskall Wallis H test, a-b: No significant difference between the groups with the same letter.*

postgraduate students was significantly higher than the direct restorations of undergraduate and postgraduate students (p=.001), of which two were considered similar (p≥.05).

No significant differences were observed for the sum of red, orange, and yellow contact types (≤ 0.4 mm) among the operator and the restoration types (p=.069) (Table 2).

4. DISCUSSION

The registration of the occlusion is one of the major challenges during either direct or indirect restoration types. Especially the indirect restorations in which the restoration is cemented in the next appointment may include difficulties in this regard due to the dimensional instability of the impression material, preparation surface changes during the temporary filling, or position changes of the related tooth (7). Even though direct composite restorations have the advantage of a single-visit treatment by preserving the remaining dental tissues more, they may be insufficient to provide proximal and occlusal contacts in cases where tissue loss is excessive (7,12). The proper analysis of the final occlusion should be performed, regardless of the restoration type, to overcome this problem (13). Occlusal analysis can be performed clinically by using conventional and digital methods. The conventional method may only provide the qualitative data that clinically presents the contact point and/or contact area. Although a gold standard has not been defined yet for occlusal analysis, articulating paper is the most common material due to its low cost and ease of use (3,14,15). However, it is not considered a high-sensitivity method because of the physical strength and the thickness of the paper, wet/dry conditions (3,11,16,17).

Digital occlusal analysis methods such as T-Scan and intraoral scanners may provide quantitative and standardized data of the contact point/area and were previously considered relatively more reliable and repeatable methods than the articulating paper (3). T-Scan has widely been used to analyze occlusion in previous studies (11,16-19), but only a few compared it with intraoral scanners regarding accuracy and reliability (3,20,21). The majority of the related studies in the literature were *in vitro* (3). As it was mentioned previously, the thickness of the sensor in T-Scan system might prevent spontaneous closure, and thereby it may misguide the ideal occlusion when used clinically (3). Therefore an intraoral scanner rather than T-Scan was selected for the clinical evaluations. Medina-Sotomayor, P. et al. reported better accuracy for iTero scanner than the Cerec Omnicam in an *in vitro* study even without using iTero with the high-resolution restorative mode (22). In another *in vitro* study Medina-Sotomayor, P. et al. compared the resolution levels for the intraoral scanners. Although they reported the highest resolution for the Cerec Omnicam (79.82 points per mm^2) and the lowest for iTero (34.20 points per mm^2), they used an older version of the iTero scanner in their study (23). Diker and Tak presented no significant difference in trueness between iTero Element 2, Trios 3, Virtuo Vivo, and Prime Scan and in precision among all the scanners used (24). Rene et al. compared intraoral scanners in vitro and presented the order for trueness as 3Shape D800 >iTero >3Shape Trios 3 >Carestream 3500 >Planscan >Cerec Omnicam >Cerec Bluecam and the order for precision as CS3500 >iTero >3Shape D800 >3Shape Trios 3 >Cerec Omnicam >Planscan >Cerec Bluecam (25). However, the exact version iTero scanner they used was not mentioned. With regards to the previous studies, an up-to-date intraoral scanner iTero Element 5D was selected for the present study, for analyzing the occlusal contacts, clinically. The combination of the OrthoCAD (Align Tech, US) and Photoshop CC (Adobe, US) software programs was used to obtain the quantitative contact data. The higher resolution of iTero Element 5D with the restorative mode and direct compatibility with the OrthoCAD software regarding the quantitative calculations of the clinical data were the major reasons for the selection of it in this study.

It was recommended to take the occlusal recordings in the centric relationship when reconstructing a whole new occlusion (26). If the occlusal contact points already exist, the centric relationship may not always occur simultaneously with centric occlusion. Whereas, when the patient bites, the spontaneously provided centric occlusion is a habitual tooth contact and it is the best relationship to record (3). Therefore, in the case of a healthy natural dentition, it is always recommended to consider the centric occlusion contact points as the reference (3,27). Accordingly in the present study, the maximum intercuspation occlusal records were obtained for all the restorations during the centric occlusion with the maximum bite force. It can be argued that the standardization of the bite forces might be controversial among the patients. However, to measure the bite force, sensors should be placed between the upper and lower arches which might prevent the ideal occlusion (28). The

occlusal analysis with the digital systems is based on the principle of opposing jaws in occlusion, therefore, it was not possible to calibrate the bite force clinically in the present study. Moreover, as the inclinations of the patient's head may lead to different occlusal contacts and contact densities (29), the digital recordings were taken from all patients in the same position where the Frankfurt horizontal plane was parallel to the floor, to standardize the head position.

Photoshop software was previously used to measure the area of different fields that were captured by the digital recordings (30,31). Regarding dental research, it was used to measure the number of pixels corresponding to the excessive cement on dental crowns (32,33) and also to perform the occlusal analysis in terms of the pixel count (3). Image J was previously determined as an alternative measurement software program, while Photoshop was considered more convenient and more effective with its various image processing capabilities (30). Accordingly, in the present study, the occlusal contact points/areas were measured by calculating the number of pixels on the restored side of the occlusal plane (mesial-occlusal or distal-occlusal) through the Photoshop CC software. The quick selection tool of the software gives the capability of precisely encircling contact areas when the surface is even not smooth and defining the differences of the colors between the selected pixels by the histogram tool (Figures 3 a, b) (34).

The clinical studies on the use of intraoral scanners for occlusal analysis are limited in the literature. Moreover, the ones which performed it did not analyze the contact point/areas precisely due to the low sensitivity of the analyzing software used or the low number of color codes selected. Abdulateef used Cerec Omnicam *in vitro* to analyze interocclusal recordings and mentioned that it provides sufficient and accurate data (20). Arslan et al. compared Cerec Omnicam data with data from articulating paper through *in vitro* restoration models and presented similar outcomes for the contact points by both methods (21). Abdulateef et al. defined the accuracy of interocclusal recordings of 100 µm on occlusal surfaces as close proximity and of >100 µm as clearance (20). Owens et al. investigated the relationship between the chewing performance and the interocclusal contact areas during maximum intercuspation, and they defined the areas of ≤50 µm as contact areas and 50 – 350 µm as near contact areas (35). In the present study, seven relative color codes differed by 0.2 mm (200 µm) according to the OrthoCAD program presets and formed contact, close contact, intense contact, and light contact groups, which was partially similar to the previous study designs of Owens et al (35). and Bostancıoğlu et al (3). However, the high number of color codes in our study might have provided more sensitive quantitative data for the occlusal contacts. Bostancıoğlu et al. compared the sensitivity of T-Scan and Cerec Omnicam clinically, at the maximum intercuspal position, through the contact tightness with color codes. They considered red as close contact, green as intense contact (green), and blue as light contact, but their color range was not as high as it was in the present study and, therefore can be interpreted as less sensitive (3). They also analyzed the data in Photoshop software quantitatively and observed the blue color code as the most seen contact type which is similar to our results (Table 1). In this study, for both the operator types and the restoration types, the blue contact was the most seen type on the occlusal planes. The recorded areas for the contacts and close contacts were lesser than the intense and light contacts, and they gradually increased consistent with the outcomes of the previous studies (Table 1) (3,20,35).

Although the precision and accuracy of the intraoral scanners and the effect of restorative materials were previously studied, there is a lack of clinically published data on the comparison of the distribution of occlusal contacts among direct and indirect restorations (3,36,37). With regards to the higher accuracy and precision of the intraoral scanners mentioned above, and with the advantages of the digitally driven analysis before the restorative production, the occlusal contact points /areas are thought to be tighter and larger clinically in indirect restorations compared to the direct restorations with articulating paper driven occlusions (3,11). However, in the present study, regarding the similar and well-experienced postgraduate students' direct and indirect posterior restorations including at least one cusp coverage, the contacts (red code / 0.0 mm), close contacts (orange and yellow codes / ≤0.4 mm), and intense contacts (green and cyan codes / ≤0.8 mm) on the occlusal plane were larger in indirect restorations, with no significant difference between the restoration types for all codes (Table 1 and Figure 1). A similar outcome was also observed when the contacts and close contacts gathered as one group like Owens et al. did and named as the near contact areas (Table 2) (35). Accordingly, the first hypothesis of the study was accepted due to the clinically observed similar occlusal vertical contacts between the direct and indirect restorations of the postgraduate students. Our findings were consistent with the previous clinical studies in which indirect and direct restorations were rated with similar success in terms of the clinical evaluation criteria (9,38,39). However, this result is observed for the postgraduate students and it might be interpreted that, the indirect restorative procedures may not have an advantage regarding the vertical occlusion when conducted by the clinicians with similar levels of experience. Whereas, the content and properties of the indirect restorative material might be effective in creating the occlusal relationship and therefore using only the Cerasmart hybrid block can be considered a limitation of this study. The occlusal surfaces of the indirect restorations were also not adjusted by bur after cementation in the present study. Therefore, the result might be due to the higher quality of layering and occlusal adjustment procedures for the direct composite restorations than expected, or even due to the lower quality of the occlusal design for the indirect restorations. It is a well-known fact that many restoration designers (dental technicians or dentists) consciously design the vertical occlusion at light contact levels (light blue or blue) to avoid devastating primary contacts during the restoration, thereby minimizing the possible restoration fractures (40). This is supported by the

result that the larger contact areas in the indirect restorations were significant for the light contacts (blue code / ≤ 1.2 mm) in the present study. However, it was inconsistent with the previous reports of Bostancıoğlu et al., concluding that the intraoral scanners might be sensitive only in the diagnosis of close contacts (3). In conclusion, the technicians' use of low-contact designs to eliminate or reduce the occlusal problems due to the tight occlusal relationship after cementation may affect the results. Whereas, if the occlusal adjustment procedures were performed with an abrasive material after the cementation, closer contacts might be created in the present study.

Regarding the comparisons between the direct posterior restorations by undergraduate and postgraduate students, larger contact areas were registered in the direct restorations of postgraduate students for all the contact types, with no significant difference except the ones for the green code (Table 1). Moreover, when the near contact areas (red, orange, and yellow codes) were evaluated, there was no significant difference between the clinicians at two levels of experience (Table 2). Thus, clinical experience had a minor positive influence on the occlusal registration of posterior direct restorations which was not considered significant. In addition, all the contact areas were significantly larger for the indirect restorations of postgraduate students compared to the direct restorations of undergraduate students, except the full contact areas (red code) and the closest contact areas (orange code) (Table 1). Thus it can be concluded that the higher clinical experience in indirect restorations may lead to significantly better results in occlusal registration. Therefore, the second hypothesis of the study was partially rejected. Clinical experience was not considered effective for the registration of the occlusal contacts in terms of direct restorations, whereas it might be effective when the experience is combined with the advantages of the indirect restoration procedures.

Besides providing useful data regarding posterior occlusal registration, this clinical research may have also some limitations. It might be useful to compare and crosscheck the digital quantitative data with T-Scan data and also with a different intraoral scanner in future studies. Additionally, it might be better to assess the occlusal contacts during the dynamic jaw movements not only vertically, for a more accurate outcome. Also, especially for the indirect restorations, the type of the Cad/Cam restorative material might affect the results, therefore different materials might be investigated in future studies (37). The potential effect of dental technicians can be comparatively investigated.

5. CONCLUSION

Smaller near contact areas (red, orange, and yellow codes) were observed at the occlusal planes of the restorations compared to the lighter contact areas (green, cyan, light blue, and blue codes). The direct and indirect restoration types had no difference in terms of occlusal vertical contacts when performed by clinicians with similar levels of clinical experience. The level of clinical experience was not effective in registering the occlusal contacts of the direct restorations. Whereas, when the advantages of indirect digital Cad/Cam restorations are combined with the clinical experience, tighter occlusal vertical contacts might be provided. Further studies should focus on the potential effects of additional parameters such as the restorative material and the dental technician on the occlusal vertical contacts.

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Peer-review: *Externally peer-reviewed.*
Author Contributions:
Research idea: BK
Design of the study: BK
Acquisition of data for the study: EU, GY, CY
Analysis of data for the study: ETB, AAŞ
Interpretation of data for the study: BK
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