DIGITAL ASSESSMENT OF DENTAL OCCLUSION

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ABSTRACT

Aims of the study The purpose of this study was to evaluate the agreement of the Medit i700 scanner in determining the number and position of occlusal contacts, comparing its results with those obtained by 100 μm articulating paper. **Materials and methods** The present study was conducted on a total of 10 patients aged between 20 and 25 years old. Occlusal contact areas were determined in maximum intercuspation position using both 100 μm articulating paper (Bausch Progress 100) and the Medit i700 scanner software (MEDIT). The contact areas were photographed using Nikon D7200 DSLR with AF-S MICRO 105 mm 1:28 G ED lens and overlapped using Adobe Photoshop (Adobe Photoshop®) and the number of contacts whose position coincided with those of the articulating paper was determined. **Results** The results have shown statistically significant differences ($p<0.05$) between the number of contacts identified using articulating paper and those determined by the software of the Medit i700 intraoral scanner, especially in the posterior area. **Conclusions** Within the study's constraints, when determining occlusal contact points in maximum intercuspation position, the utilization of articulating paper exhibits higher numbers of contacts points over employing the Medit i700 intraoral scanner in posterior areas, and similar in anterior ones.

KEYWORDS: dental occlusion, Medit i700 intraoral scanner, articulating paper, maximum intercuspation

INTRODUCTION

One of the functional occlusion criteria refers to the static relationship between the contact surfaces of the upper and lower teeth, which needs to be balanced for optimal results.[1] Simultaneous contacts of all posterior teeth and equally distributed occlusal forces are mandatory for the ideal occlusion. [2,3] Over time, the means of evaluating and investigating dental occlusion have undergone a series of modifications and improvements, with a wide range of devices non available, each presenting numerous characteristics along with a series of advantages and disadvantages. [4]

Occlusal indicators are most commonly divided into two categories based on the information they provide: quantitative and qualitative. Quantitative methods provide data about the number and distribution of contact points and are represented by: articulating paper and foil, Mylar-Shimstock paper, silk strips, wax, impression materials, occlusal spray, dental floss, and high spot indicators. [5,6]

Articulating paper currently represents the most widely used method for quantitative assessment of contacts both clinically and

DOI : 10.6261/RJOR.2024.3.16.45

in dental laboratories.[7] It is manufactured by a wide variety of producers, in different forms. The characteristic mark of a contact point is represented by a central area lacking coloration surrounded by an intensely pigmented area. Its main disadvantage is the increased number of false-positive results due to the thickness and ease of pigment distribution.[8]

For a long time, articulating paper was considered to be usable as a qualitative indicator as well, with more intensely marked contact points thought to experience greater occlusal forces, while less colored ones were attributed to lower force intensities.[9] Multiple studies have shown these assertions to be incorrect based on comparisons with digital assessment methods. [10,11]
Intraoral scanners (IOS) represent a widespread method for evaluating occlusal contact areas. The positioning of the jaws in occlusion is achieved by correlating both right and left side of the previously scanned upper and lower arches with a recording of the buccal surface of the teeth in maximum intercuspation. [12,13] Different results have been highlighted over time regarding their performance depending on the scanner and software used. Several studies have demonstrated that IOS have satisfactory capacity in identifying the position and size of contacts but have poor performance in determining their intensity. [14,15]

Purpose

The aim of this study was to evaluate the agreement of the Medit i700 scanner in determining the number and position of occlusal contacts, comparing its results with those obtained by 100 µm articulating paper from Bausch. This study was conducted in order to validate the use of the intraoral scanner over articulating paper, for the purpose of incorporating the contact point assessment into the digital workflow. The main null hypothesis tested was that there are no statistically significant differences between the two methods regarding the number and location of contact points.

At this point the two secondary null hypotheses were also established, namely:
1. There are no statistically significant differences in terms of number and position of contact points in the posterior area using the two methods;
2. There are no statistically significant differences in the anterior area regarding the number and position of contact points provided by the two registration methods.

MATERIALS AND METHODS

Subjects

The present study was conducted in the Department of Prosthodontics and Dental Materials University of Medicine and Pharmacy ”Iuliu Haţieganu” Cluj-Napoca, from May to June 2024 on a total of 10 patients (6 male, 4 female) aged between 20 and 25 years old. Inclusion criteria:

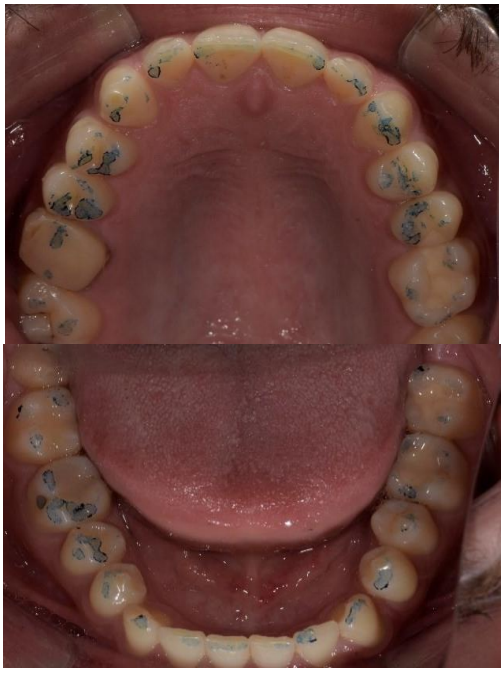

Figure 1-Maxillary arch and mandibular arch

DOI : 10.6261/RJOR.2024.3.16.45

- complete dentition,
- no applied prosthetics,
- no subjective temporo-mandibular joint issues,
- no ongoing orthodontic treatment,
- good general health.

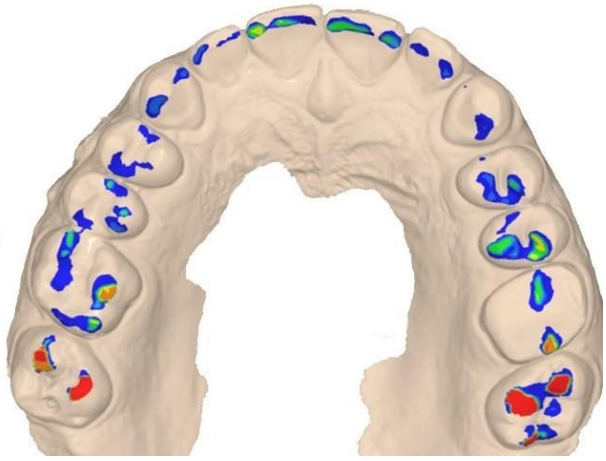

Figure 2-Maxillary contact points

This study was conducted in accordance with the declaration of Helsinki and approved by the Ethics Committee of "Iuliu Haţieganu" University of Medicine and Pharmacy Cluj Napoca (DEP 151/29.05.2024). The participation was voluntary, patients having signed the consent form prior to participating in this study.

Occlussal points determining

Occlusal contact areas were determined in maximum intercuspation position using both 100 µm articulating paper and the Medit i700 scanner software.

The patient was seated in an upright position in the dental chair with the head firmly pressed on the head rest and the movement of opening and closing of the oral cavity was practiced. Afterwards, the surfaces of both arches were dried, then the articulating paper was placed on the lower arch and the patient was asked to close his mouth in maximum intercuspation for recording repeatedly for three times.

Subsequently, intraoral photographs were taken using Doctoreyes occlusal mirror no. 12 (Doctorseyes GmbH) and lip retractors, both the maxillary and mandibular arches were photographed using Nikon D7200 DSLR with AF-S MICRO 105 mm 1:28 G ED lens (Figure 1). These were carried out by the same operator to increase repetability.

Immediately after, the patient was scanned with the Medit i700 intraoral scanner. The same scanning protocol was followed for each patient: initially the maxillary arch, then the mandibular arch, and finally the buccal surfaces for occlusion assessment.

Data collection

The obtained photographs were saved in JPEG format and the contact points determination function of the MEDIT

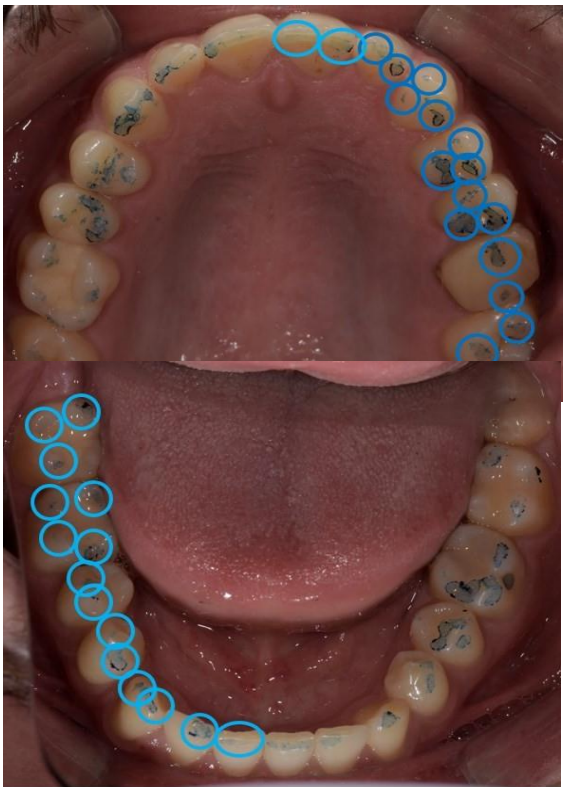

Figure 3-Marking points on the maxillary and mandibular arches

software was used, and images like those in Figure 2 were obtained, which were also

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saved in JPEG format.

Data analysis

The contact points were highlighted both in the photographs of the arches marked with articulating paper and in the scanned ones, as shown in Figure 3. Subsequently, the number of contact areas for each tooth determined in each photograph was counted and noted in the Excel program (Microsoft Excel 365). The contact areas were overlaped using Photoshop® (Adobe Photoshop®) and the number of contacts whose position coincided with those of the articulating paper was observed through opacity variations (Figure 4). At this point, the main limitation of the study emerged, which was the inability to achieve exact superimposition of the two images, particularly in the posterior area. Therefore, a deviation of 1 mm was considered admissible in this study.

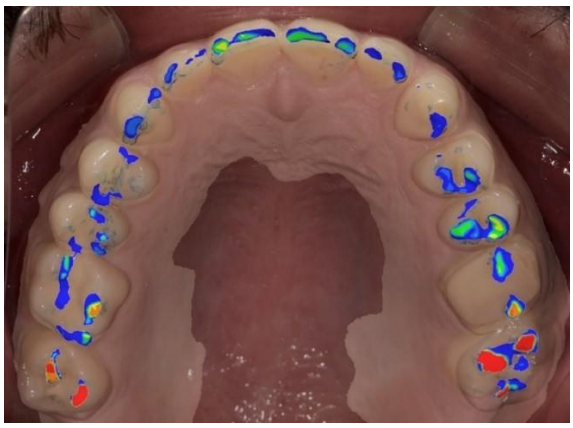

Figure 4-Adobe Photoshop overlapping maxillary arch

Statistical analysis

A total of 277 teeth were analyzed. To quantify the agreement of the Medit i700 scanner, the Student's t-test was applied (with a significance level of 0.05) and the number and position of the contact areas of the entire arches were assessed. Observing the trend of deviation in the posterior area, two areas were subsequently analyzed independently (posterior and anterior).

RESULTS

The results have shown statistically significant differences ($p<0.05$) when it comes to the entire arch between the number of contacts identified using articulating paper and those determined by the software of the Medit i700 intraoral scanner and also for the location.

As observed in Figure 5, using articulating paper resulted in 321 occlusal contacts, while the Medit scanner showed 360 and out of the 321 common contacts analyzed, only 262 overlapped (Figure 6).

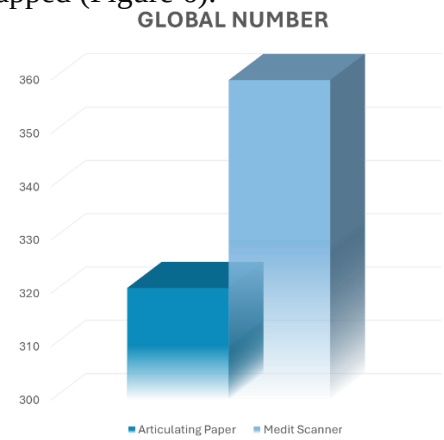

Figure 5-Number of identified contacts

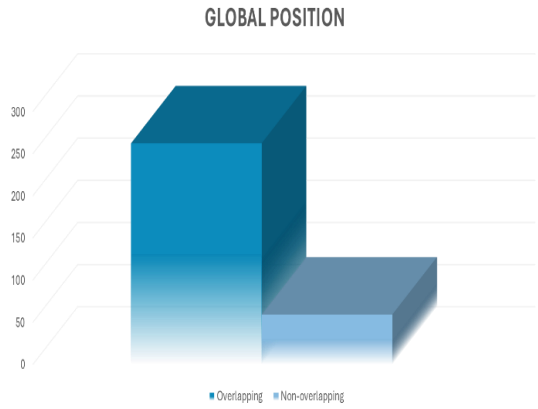

Figure 6- Position of identified contacts

DOI : 10.6261/RJOR.2024.3.16.45

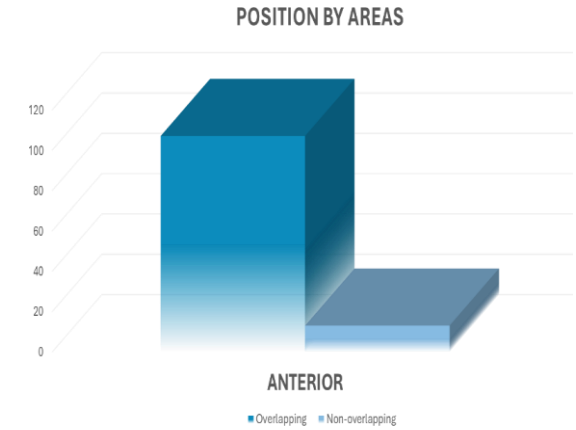

Figure 7-Number of anterior identified

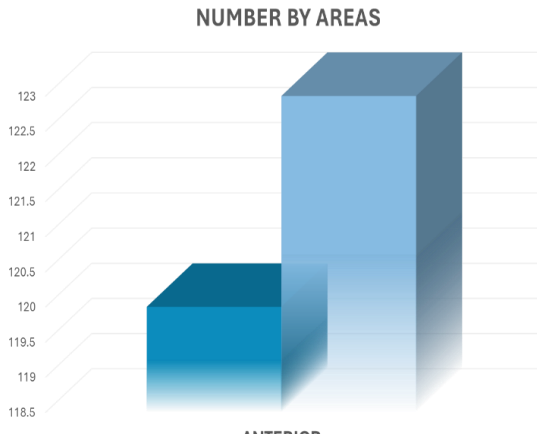

Figure 8- 8-Position of anterioridentified contacts

Subjectively observing the deviation trend of overlapping in the posterior area, we opted for a disjunct analysis of the two

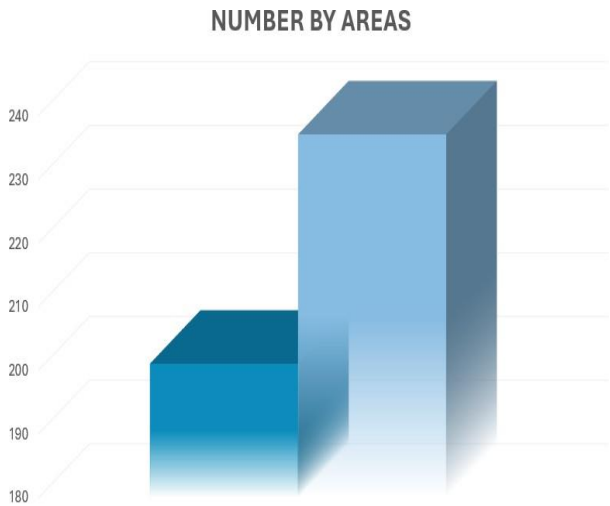

Figure 9-Number of posterior identified contacts

areas. Thus, in the anterior, we obtained 123 contacts with the Medit scanner and 120 with articulating paper (Figure 7), out of which 107 overlapped (Figure 8). The statistical test did not show significant differences, therefore the null hypothesis that there are no statistically significant differences between the two analysis methods ($p>0.05$) was accepted.

Regarding the posterior area (premolars, molars), statistically significant differences were found, rejecting the null hypothesis that there are no significant differences between the scanner and articulating paper ($p<0.05$). A total of 201 were identified with articulating paper, and 237 with the scanner (Figure 9), of which only 155 overlapped (Figure 10).

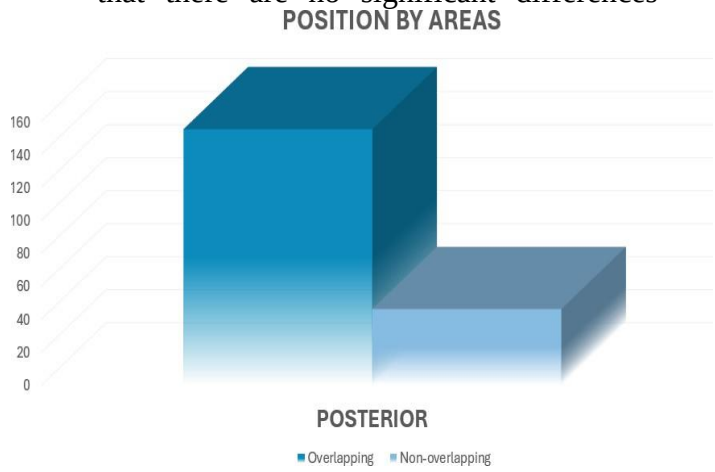

Figure 10-Position of posterior identified contacts

DISCUSSION

There is a variety of classical and modern methods for determining contact points and each practitioner has chosen over time a method that suits them and their working style. [16] But in the digital era, through this study, we aimed at verifying the agreement of one of the devices commonly used in determining contact points (intraoral scanner) and the articulating paper, because in the literature there are numerous data

DOI : 10.6261/RJOR.2024.3.16.45

showing contradictory information regarding their accuracy. [17,18]

In this study the main null hypothesis was rejected; however, interestingly, a consistent deviation trend was observed regarding the differences in position and number in the posterior area. In the anterior area a much higher percentage of overlapping was observed, a fact mentioned in other studies as well.[19] One possible cause could be the much simpler anatomy of the anterior teeth and better access in this area, which makes their scanning easier.[20]

To our knowledge, there is no method that is 100% reliable in this moment and that is why even though the articulation paper is used as the golden standard, as literature calls it [21], one must consider that its interpretation is subjective and depends to a great extent on local conditions and the evaluator's experience. [22,23] Digital methods have the advantage of objectivity, even if the studies are still contradictory regarding to their reliability.

Continuous evolution and the development of now digital devices from the industry open new insights on this subject, questioning the well accepted but still extremely subjective results of the articulating paper. [24,25]

In conducting the study, several limitations arose, with the most significant being the challenge of achieving perfect overlapping between the two obtained images, potentially due to photographic angles alongside the low number of included patients. These are aspects that should be improved in the future for a more comprehensive assessment of the scanner's ability to detect contact points.

CONCLUSIONS

Within the study's constraints, when determining occlusal contact points in maximum intercuspation position, the utilization of articulating paper versus the Medit i700 intraoral scanner shows discrepancies (in number and location of the contact points) especially in the posterior area when compared to the anterior area. Further studies are necessary in the future in order to establish which is the gold standard method in assessing the occlusion.

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