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Patient Comfort Assessment of Intraoral Scanners

Ağız İçi Tarayıcıların Hasta Konforu Açısından Değerlendirilmesi

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ABSTRACT

Objective: This clinical study aimed to assess the comfort level between two intraoral scanners by comparing satisfaction scores from 30 patients who underwent full arch scans of their upper and lower jaws.

Method: A total of 30 participants, consisting of two groups who had received bleaching treatment by a dentist in the last 6 months (n=15) and who never had a bleaching treatment before (n=15), were examined using two scanners with different designs and features (Trios 3, 3Shape, Denmark; CEREC Omnicam, Dentsply Sirona, USA). Upper and lower jaw scans were conducted by a single clinician with 4 years of clinical experience, simultaneously on two consecutive days with a 24-hour interval, under identical clinical conditions. After completing intraoral scans, participants scored for scanners in a 6-parameter comfort questionnaire based on a 5-point Likert satisfaction scale (5: very satisfied, 1: very dissatisfied). The comfort parameters were: 1-lingual discomfort, 2-buccal discomfort, 3-tooth discomfort, 4-mouth opening discomfort, 5-scanning time, and 6-general satisfaction. Wilcoxon and Mann-Whitney U tests were used for statistical analysis. The significance level was set at $P<.05$.

Results: No statistically significant difference was detected between the two scanners in any comfort parameters regardless of bleaching treatment ($P>.05$). Likewise, no significant differences were found for any parameter between participants who had received bleaching treatment and those who had not ($P>.05$).

Conclusion: The different scanner designs or features of intraoral scanners with constantly developing technologies do not affect patient comfort.

Keywords: CAD/CAM systems, intraoral scanner, patient satisfaction, patient comfort

ÖZ

Amaç: Bu klinik çalışmanın amacı, üst ve alt çenelerinin tam ark taramaları gerçekleştirilen 30 katılımcının memnuniyet skorlarına göre iki farklı ağız içi tarayıcının konfor açısından değerlendirilmesidir.

Yöntem: Son 6 ay içerisinde diş hekimi tarafından beyazlatma tedavisi uygulanmış (n=15) ve daha önce hiç beyazlatma tedavisi uygulanmamış (n=15) iki gruptan oluşan toplam 30 katılımcının üst ve alt çene taramaları, tarayıcı ucu farklı tasarımlara ve farklı özelliklere sahip iki farklı tarayıcı (Trios 3, 3Shape, Danimarka; CEREC Omnicam, Dentsply Sirona, Almanya) ile 4 sene klinik tecrübeye ve her iki tarayıcıya dair kullanım bilgisine sahip aynı hekim tarafından 24 saat aralıkla ardışık iki günde aynı klinik koşullar altında tamamlanmıştır. Katılımcılar, taramalar sonrasında 6 alt başlıktan oluşan bir konfor anketinde her iki tarayıcıyı da Likert Memnuniyet Ölçeğine göre 1 ve 5 arasında (1-hiç memnun değilim, 5-çok memnunum) skorlamıştır. Bu parametreler, 1-lingual konfor, 2-bukkal konfor, 3-diş konforu, 4-ağız açıklığı konforu 5-tarama süresi ile ilgili konfor ve 6-genel memnuniyet şeklindedir. Normal dağılıma uymayan ölçek puanlarının karşılaştırılmasında Wilcoxon Testi, beyazlatma uygulanma durumuna göre normal dağılıma uymayan ölçek puanlarının karşılaştırılmasında Mann Whitney U Testi kullanılmıştır. Önem düzeyi $P<,05$ olarak alınmıştır.

Bulgular: Herhangi bir konfor parametresinde beyazlatma tedavisi fark etmeksizin iki tarayıcı arasında istatistiksel olarak anlamlı bir fark bulunmamıştır ($P>,05$). Benzer şekilde, beyazlatma tedavisi uygulanmış ve uygulanmamış katılımcılar arasında hiçbir parametre için anlamlı bir fark tespit edilmemiştir ($P>,05$).

Sonuç: Sürekli gelişmekte olan teknolojilere sahip ağız içi tarayıcıların farklı tarayıcı tasarımları veya özelliklerine sahip olması, hastalar için konfor açısından fark yaratmamaktadır.

Anahtar Kelimeler: Ağız içi tarayıcı, CAD/CAM sistemler, hasta memnuniyeti, hasta konforu

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INTRODUCTION

The development of digital systems and technology has led to the increasing use of intraoral scanners in dental clinics.[1,2] These devices can be preferred as an option for treatments, including indirect restorations, implant procedures, removable prostheses, and surgical guides. In addition to producing restorations, these tools support various additional functions such as detecting colors, identifying caries or erosion in teeth, and three-dimensional analysis of intraoral structures.[3-5] Research has shown that intraoral scanners can eliminate the dimensional distortion of hard and soft tissue data that often occurs with conventional methods. Because intraoral scanners provide data directly from inside the mouth, their use can result in reduced laboratory costs, fewer patient session repetitions, and less time loss. Therefore, it is believed that patient comfort and preference will be enhanced, there will be a time-efficient workflow, and it will be useful for data storage.[6-8] On the other hand, their higher cost compared to conventional approaches is considered as a disadvantage of these systems. Furthermore, variations in accuracy, precision, and repeatability are dependent on the clinician's expertise, while obtaining intraoral images is time-consuming and influenced by various factors, such as the presence of saliva-like structures and restricted space within the oral cavity. It has been found that careful examination of the patient's intraoral structures and following the manufacturer's recommendations can minimize these disadvantages.[2,9-13] As digital systems become increasingly common in clinics[2] patients' demand for bleaching treatments is also on the rise. Considering the optical and micromorphological changes that bleaching treatment creates in the tooth structure, the dentist needs to follow them carefully to both satisfy the patients and apply the correct treatments.[14-17] Shade guides, spectrophotometers, colorimeters, hybrid units, phone-based systems, cameras, and intraoral scanners are the preferred methods for monitoring color.[18-20] Studies have shown that for satisfying patients during restorative procedures and bleaching treatments, the comfort of the oral tissues and the duration of keeping their mouth open are critical points. Objective evaluations of patient comfort may aid in improving the quality of dental care provided.[21,22] Three-dimensional intraoral images can be obtained with intraoral scanners during various treatments, including dental bleaching and follow-up of patients. Additionally, it is known that bleaching procedures in which the patient's mouth remains open can impact the comfort and convenience of patients on the dental chair.[22] Based on this information, the purpose of this study was to compare participant satisfaction during full arch scanning of the upper and lower jaw using commonly utilized Cerec Omnicam and Trios 3 intraoral scanners. The study also examined the impact of a recent bleaching treatment on patient satisfaction. Half of the patients included in the study had undergone bleaching treatment within the previous six months, while the other half had not undergone bleaching treatment. The study's null hypothesis was that there would be no difference in patient satisfaction between intraoral scanners.

METHODS

Identifying participants

This study was approved by the Clinical Research Ethics Committee of Marmara University Faculty of Dentistry with the date: 06.10.2023 protocol number 09.2023.1293. Thirty volunteer individuals aged between 18-45 who applied to the Marmara University Faculty of Dentistry were included in the study. The participants consisted of two groups who had received bleaching treatment by a dentist in the last 6 months (n=15) and who never had bleaching treatment before (n=15). The confirmation of whether the volunteers received bleaching treatment for this study was obtained through a review of the relevant clinical records and patient declarations. A minimum of 27 participants in the study was required for a power of %95 (1-β) a confidence interval of 95% (1-α) and a significance level of 0.05 (GPower V3.1.9.6., Germany).[19]

The inclusion and exclusion criteria for the study were as follows:

Inclusion Criteria:

- Volunteering
- Aged between 18-45 years
- Completed initial periodontal treatment.

Exclusion Criteria:

- Temporomandibular disorders, mouth opening limitation,
- History of trauma
- Any treatment received by the reported teeth during two days of scanning.

Scanning and Questionnaire

Full arch scans of the upper and lower jaw were conducted for each participant using Trios 3 (3Shape, Denmark) and CEREC Omnicam (Dentsply Sirona, Germany) intraoral scanners. The technical properties of the mentioned intraoral scanners are given in Table 1. The scans were performed on two consecutive days at the same time of day under the same lighting conditions with fixed patient positioning according to the manufacturer's recommendations by a clinician with 4 years of experience (B.D.K). Following the scanning process, participants assessed the intraoral scanners based on 6 comfort parameters (palatal/lingual discomfort, labial/buccal discomfort, teeth discomfort, mouth opening discomfort, scanning time, and general satisfaction) and scored their satisfaction with the Likert scale ranging from 1-5 (1: very dissatisfied, 5: very satisfied) immediately (Table 2). During the evaluation, participants were informed about each parameter by a dentist with 4 years of experience in performing intraoral scans.

Table 1. Intraoral scanners included in the study.

Scanner	Manufacturer	Content	Light source	Record	3D Image
CEREC Omnicam	Dentsply Sirona, NY, USA	Hand-held linear scanner, CEREC Software, color calibration tool	White LED, non-polarized. Optical triangulation and confocal microscopy	Different angles	
TRIOS 3 	3Shape, Copenhagen, Denmark	T-shaped handheld scanner with wireless connection, 3Shape TRIOS Color Software, color calibration tool	LED, confocal microscopy and ultrafast optical scanning	Different angles	

Table 2. Participant evaluation parameters of intraoral scanners and Likert satisfaction scale.

	CEREC OMNICAM	TRIOS 3
PALATAL/LINGUAL DISCOMFORT		
LABIAL/BUCCAL DISCOMFORT		
TEETH DISCOMFORT		
MOUTH OPENING DISCOMFORT		
SCANNING TIME		
GENERAL SATISFACTION		

Likert Scale 5: *Very satisfied,* ***4:*** *Somewhat satisfied,* ***3:*** *Neither satisfied nor dissatisfied,* ***2:*** *Somewhat dissatisfied,* ***1:*** *Very dissatisfied.*

Statistical Analysis

Statistical analysis was performed using SPSS version 23 (IBM, SPSS Armonk, NY, USA). Wilcoxon test was used to compare satisfaction scores that did not follow a normal distribution. Mann-Whitney U test was used to compare satisfaction scores that did not conform to normal distribution according to bleaching treatment. The significance level was set at $P<.05$

RESULTS

No statistically significant difference was detected in lingual discomfort, buccal discomfort, teeth discomfort, mouth opening discomfort, scanning time, and general satisfaction scores between the Cerec Omnicam and Trios 3 scanners regardless of bleaching treatment ($P>.05$) (Table 3). Similarly, there was no statistically significant difference in any comfort parameters between both scanners for the bleached and non-bleached groups ($P>.05$) (Table 4).

Table 3. Comparison of intraoral scanners in terms of comfort.

	Bleaching Treatment	Cerec Omnicam	Trios 3	Test St.	p*
Palatal/ Lingual Discomfort	(-)	3.6 ± 0.91	3.87 ± 0.35	-0.973	.331
	(+)	3.8 ± 0.86	3.87 ± 0.92	-0.277	.782
Labial/ Buccal Discomfort	(-)	3.33 ± 0.72	3.4 ± 0.99	-0.188	.851
	(+)	3.8 ± 0.86	3.73 ± 1.03	-0.264	.792
Teeth Discomfort	(-)	4.27 ± 0.8	4.47 ± 0.83	-0.78	.435
	(+)	3.73 ± 0.88	3.8 ± 1.15	-0.333	.739
Mouth Opening Discomfort	(-)	3.8 ± 0.68	3.6 ± 0.91	-0.535	.593
	(+)	3.67 ± 0.82	3.67 ± 0.62	0	1.000
Scanning Time	(-)	3.47 ± 1.25	3.8 ± 1.08	-1.029	.304
	(+)	3.53 ± 1.25	3.8 ± 1.01	-0.954	.340
General Satisfaction	(-)	4.2 ± 0.86	4.07 ± 0.46	-0.535	.593
	(+)	3.87 ± 0.74	3.73 ± 0.7	-0.535	.593

**Wilcoxon Test, Test St.: Test statistics, mean ± standard deviation.*

Table 4. Evaluation of comfort parameters according to bleaching treatment.

	Intraoral Scanner	Bleaching (-)	Bleaching (+)	Test St.	P*
Palatal/ Lingual Discomfort	Cerec Omnicam	3 (2 - 5)	4 (3 - 5)	99.50	.563
	Trios 3	4 (3 - 4)	4 (2 - 5)	102.50	.594
Labial/ Buccal Discomfort	Cerec Omnicam	3 (3 - 5)	4 (2 - 5)	71.50	.061
	Trios 3	4 (1 - 4)	4 (1 - 5)	88.50	.235
Teeth Discomfort	Cerec Omnicam	4 (3 - 5)	4 (2 - 5)	75.00	.100
	Trios 3	5 (2 - 5)	4 (2 - 5)	76.00	.102
Mouth Opening Discomfort	Cerec Omnicam	4 (2 - 5)	4 (2 - 5)	99.00	.524
	Trios 3	3 (2 - 5)	4 (3 - 5)	104.50	.719
Scanning Time	Cerec Omnicam	3 (1 - 5)	3 (2 - 5)	111.00	.949
	Trios 3	4 (1 - 5)	4 (2 - 5)	111.00	.948
General Satisfaction	Cerec Omnicam	4 (3 - 5)	4 (3 - 5)	86.50	.252
	Trios 3	4 (3 - 5)	4 (3 - 5)	80.00	.115

**Mann-Whitney U Test, Test St.: Test statistics, median (minimum–maximum).*

DISCUSSION

CAD/CAM systems enable the utilization of materials that are otherwise impossible to use conventionally. Additionally, these systems facilitate the development of more precise, compatible, and acceptable restorations by relying on detailed analysis.[23,24] When referring to intraoral scanners, the literature more frequently highlights the benefits of digital systems over traditional methods discussing the comfort of the patient and clinician, rather than solely comparing intraoral scanners with one another.[21,22,25,26] Digital systems offer patients several advantages over conventional systems, including less gag reflex, reduced nausea, increased comfort for respiratory disorders, and less trauma to teeth and periodontal tissues resulting in decreased sensitivity. Additionally, clinicians benefit from digital systems by accelerating the workflow and reducing physical strain, particularly after acquiring experience.[3,21,27]

In this study, various satisfaction parameters such as lingual discomfort, buccal discomfort, teeth discomfort, mouth opening discomfort, scanning time, and general satisfaction were evaluated using the Likert satisfaction scale with a sample of 30 participants. As a result of the analysis, there was no statistically significant difference between the scanners in any of the parameters. Yang et al. utilized identical comfort parameters and a Likert satisfaction scale in their clinical study of patient comfort and satisfaction with the fabrication of lithium disilicate crowns and they found no significant difference in any of the parameters between the scanners similar to the present study.[22] Digital systems are commonly preferred for various procedures, including the design of customized orthodontic appliances, the production of indirect restorations and removable prostheses, implant planning, and surgical guides. Studies show that patients generally find digital systems to be a preferred option for various treatments. They report feeling comfortable and satisfied with these systems and find them acceptable in terms of different parameters.[8,22,25,26,28] While some studies focused on intraoral scanning for preparation and production of restorations, others evaluated full arch scanning of either the lower or upper jaw, as in this study. The reason for including full arch scans of both the lower and upper jaw in this study was aimed to comprehensively evaluate the patient's comfort with soft/hard tissues and mouth opening. Cerec Omnicam and Trios 3 intraoral scanners, which are frequently used in dental clinics as CAD/CAM systems[2] were compared in the present study.

In addition to varying camera features, scanning sensitivities, and software technologies[8,29-32], the designs of the scanner parts also differ. Despite the differences in features and designs of the scanners, this clinical study found no statistically significant difference in satisfaction for any comfort parameter between the scanners. Digital systems, like intraoral scanners, are regularly enhanced in clinician ergonomics and patient comfort[26,33], indicating that patients are satisfied with these scanner designs and technologies. Therefore, the null hypothesis of the study was accepted. Although the period between the visits and session duration are known to impact patient satisfaction[21,22], receiving bleaching treatment within the last 6 months did not significantly affect satisfaction in full arch scans of the upper and lower jaw. Despite the necessity for multiple visits and brief intervals between them, the bleaching treatment and subsequent follow-up process did not result in any discomfort for the patient during intraoral scanning. At present, to the authors knowledge there are no studies in comparison that assess the comfort of these two scanners and evaluate the impact of previous treatment sessions like dental bleaching.

In a clinical study that evaluated the Carestream CS 3600, Trios 3, CEREC Omnicam, and traditional silicone impressions, the Carestream CS 3600 and Trios 3 were found to have shorter scan times than the others.[11] In a study examining the accuracy of intraoral scanners with different scanning paths, they found that scans performed with the "one-way" method differed in the upper and lower jaws and there were differences in accuracy with different tip movements of the scanner. The experience of the clinician and preferred scanning methods are known to impact the accuracy, precision, and scanning times of intraoral scanners.[27,29,30] Since the patient scans in this study were performed by a clinician with 4 years of experience using both scanners by following the manufacturer's recommendations, no significant difference was found in scanning time as expected. No statistically significant difference was found in the "general satisfaction" parameter, which is similar to the finding that there was no statistically significant difference between the intraoral scanners in other parameters. This finding supports that although some studies also provide a "total" score by including the sum of the Likert scale scores[22], there is no need for a separate total score in the evaluation part since the "general satisfaction" parameter is also included in this study's comfort parameters. The study included 16 male and 14 female participants. Numerous studies assess anterior esthetic restorations and dental treatments, including the impacts of these treatments on individuals' dental appearance and satisfaction levels. In a study where participants assessed their dental appearance, no significant difference was found between the genders.[34-36] Similarly, tooth bleaching treatments were evaluated for satisfaction and sensitivity, and no significant differences were observed between the genders in terms of bleaching treatment satisfaction and sensitivity.[37] Although there are no differences between genders, the number of male and female participants in the present study was comparable.

The frequent introduction of new intraoral scanner models and technologies can be considered as a limitation. The advancements in digital technology are also improving software, scanning times, validity, ergonomics, and designs.[12,21,38] Additionally, it should be noted that the participants' mouths, hard and soft tissues, joint structures, tooth sizes, and anatomical structures vary depending on gender and are distinct to each participant.[39-41] These variations are also within the limitations of this study.

CONCLUSION

Cerec Omnicam and Trios 3 intraoral scanners are similar in comfort parameters according to patient satisfaction scores regardless of bleaching treatment.

Ethics Committee Approval: This study was approved by the Clinical Research Ethics Committee of Marmara University Faculty of Dentistry with the date: 06.10.2023 protocol number 09.2023.1293.

Informed Consent: Each participant gave consent before answering the questionnaire.

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