GRADUATION PROJECT

Degree in Dentistry

THE USE OF THE INTRAORAL SCANNER FOR PARTIAL COVERAGE RESTORATION IMPRESSIONS AMONG THE DENTAL PROFESSORS AT THE UEM.

Madrid, academic year 2024/2025

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RESUMEN

Introducción: Las restauraciones de recubrimiento parcial son restauraciones dentales esenciales, permitiendo la máxima preservación del tejido dental sano y asegurando una excelente durabilidad. El avance de la tecnología ha llevado a la sustitución gradual de la impresión convencional por la impresión digital. El escáner intraoral se utiliza cada vez más para restauraciones de recubrimiento parcial debido a su gran exactitud, la eliminación de materiales de distorsión o la comodidad; **Objetivos:** Evaluar la eficacia y aceptación del escáner intraoral para la realización de restauraciones de recubrimiento parcial entre los profesores de Odontología de la Universidad Europea De Madrid; **Metodología:** Se diseñó una encuesta de 17 preguntas y se registraron las respuestas de 56 profesores de odontología de la Universidad Europea De Madrid sobre su nivel de satisfacción en relación con el escáner intraoral para restauraciones de recubrimiento parcial; **Resultados:** En este estudio, el 98% de los pacientes de odontólogos (42) se sienten más cómodos con el escáner intraoral que con las restauraciones convencionales. De los odontólogos que utilizan la impresión digital en su consulta (37), el 100% prefiere este método para tomar impresiones de restauraciones de recubrimiento parcial, y el 68% (25) está muy satisfecho con el uso del escáner para este tipo de prótesis; **Conclusiones:** El uso del escáner intraoral para restauraciones de recubrimiento parcial es ampliamente aceptado entre los profesores de Odontología de la Universidad Europea De Madrid. Es muy eficaz, proporciona un gran ajuste marginal y es cómodo para el paciente y el odontólogo.

PALABRAS CLAVE

Odontología, Escáner intraoral, Restauraciones de recubrimiento parcial, Ajuste marginal, Nivel de satisfacción.

ABSTRACT

Introduction: Partial coverage restorations remain essential dental restorations, allowing maximum healthy dental tissue preservation and ensuring an excellent durability. The advance of technology lead to a gradually replacing of conventional impression to digital impression. Intraoral scanner is increasingly used for partial coverage restorations due to its great accuracy, the elimination of distortion materials or the comfortability; **Objectives:** The study aims to evaluate how effective and accepted the intraoral scanner is to achieve partial coverage restorations among dental professors at the Universidad Europea De Madrid; **Methods:** A survey of 17 questions was designed and the answers of 56 dental professors at the Universidad Europea De Madrid were recorded concerning their level of satisfaction regarding the intraoral scanner for partial coverage restorations; **Results:** In this study, 98% of dentists' patients (42) are more comfortable with intraoral scanners than conventional restorations. Over the practitioners using the digital impression in their practice (37), 100% prefer this method for taking partial coverage restorations impressions, and 68% (25) are very satisfied with the use of the scanner for this type of prosthesis; **Conclusions:** The use of intraoral scanner for partial coverage restorations is widely accepted among dental professors at the Universidad Europea De Madrid. It is very effective, provides great marginal fit and is comfortable for the patient and the dentist.

KEYWORDS

Dentistry, Intraoral scanner, Partial coverage restorations, Marginal fit, Satisfaction level.

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1. INTRODUCTION

1.1. Background

Dental caries, tooth wear or trauma can significantly affect oral health, compromising the integrity and functionality of teeth but also the aesthetics. In these situations, partial coverage restorations (PCRs) have a key role in restoring dental structure while preserving maximum healthy dental tissue (1,2).

The previous defects, affecting anterior or posterior teeth, are often restored using composite resins. These restorations present several limitations as the resins used to restore the teeth are prone to suffer shrinkage and show problems in adhesion to the dentin (3). In fact, the larger the cavity and the more cusps involved in the restoration, the more susceptible it is to undergo these complications. To solve these problems, various indirect restorations have been invented for different cases (3). Among these restorations, called PCRs, we can find inlays, onlays, overlays, endocrowns and veneers (4). The restorative success of PCRs depends on several factors such as the interproximal adjustments with adjacent teeth, the correct occlusion with opposite teeth and the accuracy of the marginal fit (3,5).

For indirect restorations, impressions must be taken by the dentist and sent to the laboratory. Then, the lab technician can create the fixed restoration with the material requested by the dentist. Nowadays, two types of impressions can be used to obtain a cast to perform these restorations. We differentiate the conventional impression (CI) from the digital one (2).

There are two types of materials used to take a CI for a PCR, the addition silicone, and the polyether (6–8). The first one, also known as polyvinyl siloxane, is used with a combination of two consistencies, putty and light body silicone (6). The second one, is only available in one viscosity (8).

Digital impressions are technologies using intraoral or extraoral scanners. The extraoral device is categorized as indirect digitalization whereas the intraoral one is classified as direct digitalization (9). In fact, the extraoral scanner, more used by lab technicians, takes the impression from the cast obtained by the CI or directly from the impression, whereas the intraoral scanner (IOS), only used by dentists, takes the impressions directly into the patient's mouth (9–11).

1.2. Digital impression systems

1.2.1. History of digital impressions.

In 1973, Doctor François Duret proposed the first Computer-aided design/Computer-aided manufacturing (CAD/CAM) system during the presentation of his thesis "Empreinte

optique" in France (2,10). This new technology has revolutionized the practice of dentistry by enhancing the quality and the aesthetics of dental restorations. In fact, in 1989, the first digital impression was taken on a patient to manufacture a crown (2,12). This advancement has helped us enter in a new era of dentistry, motivating the production of new generations of CAD/CAM ever since (2,12,13).

1.2.2. Principles of direct digitalization.

In direct digitalization, an IOS is a device that analyzes the surface of an object and gathers data regarding its shape and color. Indeed, it captures the three-dimensional geometry of an object to convert it into a digital model. The IOS is composed by a camera, a software, and a computer (14). The data transfer systems for digital impression are categorized as open and closed (9,14). Open systems, more frequently used, generate Standard Tessellation Language (STL) files that are universally compatible and can be read by any CAD system, allowing easy access for manufacturers. In contrast, closed systems create encrypted STL files that are restricted to being read only by the specific CAD system associated with the commercial brand, limiting the flexibility of data usage (9).

1.2.3. Concept of CAD/CAM system.

A CAD/CAM system consists of a data acquisition unit, a software to design virtual restorations, and a computerized milling device (15). The CAD system allows the dentist to digitally scan and design a patient's restoration based on 3D images of their teeth and gums. CAM software converts the design made by CAD system into instructions that manufacturing machine can follow in the laboratory (16).

1.2.4. Concept of Standard Tessellation Language.

A STL file is created when performing a three dimensional scan (11). It is constituted by a sequence of triangulated surfaces. All of them are represented by three points and a normal surface (14). In this way, we can create designs using the CAD system because the STL file functions as a CAD mesh algorithm that conveys the three-dimensional scan with a strong accuracy. The precision of this file is influenced by the fidelity and accuracy of the scan itself (11).

1.3. Advantages and disadvantages of intraoral scanner.

1.3.1. Advantages of intraoral scanner.

IOS offers a lot of advantages that enhances dental practice. Firstly, it improves the accuracy by capturing detailed digital impressions, reducing the risk of human errors often associated with traditional methods. It allows an easy repeatability of the impression and a direct visualization of the model (17).

Additionally, compared to CI with irreversible material, IOS eliminates distortion of impression material and casting shrinkage (17). There is less material consumption.

Furthermore, the digital impression ameliorates patient comfort by reducing the total clinical working time (14). It is effective for patients with vomiting reflex (9,13). Overall, the IOS optimizes the clinical efficiency by facilitating the storage of digital files and improves the contact between dental professionals (2,18,19).

1.3.2. Disadvantages of intraoral scanner.

However, IOS has some notable limitations and disadvantages. The equipment represents a significant initial investment, which is an obstacle for many practitioners (12). In addition, it requires regular upgrades, both hardware and software, generating additional costs in the long term. The scanner also takes up space in the dental office (13).

One significant challenge is the necessity for some dental practitioners to learn how to use this new device, which can slowdown the initial workflow whereas they have the experience of CI (12,13). Furthermore, in some cases, it could take time to scan, so patient's comfort decreases (13).

Moreover, the digital impression has some limitations in certain situations such as the complete denture (20). Limitations may also be encountered in certain interproximal or distal areas, where the size of the tip makes access more difficult. In these areas, the relatively large size of the tip complicates the task of reaching and scanning these areas effectively (21). Finally, it is affected by some factors like the patients movements, the preparation design of the object and the scan pattern (18).

1.4. Partial coverage restorations

1.4.1. Definition

A PCR refers to a type of restorative technique that covers only a portion of a tooth, rather than the entire tooth surface (4). These restorations are typically used when a tooth is damaged, decayed, or weakened, but not to the extent that it requires a full crown (22). The

goal is to preserve as much healthy tooth structure as possible while restoring function, strength, and aesthetics (4).

1.4.2. Classification

- Inlays: These are partial indirect restorations fitted a tooth cavity without covering the cusps (23).
- Onlays: These are partial indirect restorations fitted a tooth cavity by covering at least one cusp (23).
- Overlay: These are partial indirect restorations covering all the cusps (23).
- Endocrowns: These are partial indirect restorations that cover partially or totally endodontically treated teeth (24).
- Veneers: These are partial indirect restorations that fit the front surface of the teeth (18).

1.5. Justification

On one hand, there have been great developments in the dental field with the advance of digital technologies, such as IOSs which are gradually replacing CIs. These scanners offer new advantages such as comfort, elimination of distortion of impression material or reduced working time. The development of the IOSs merits careful study, particularly for their use in PCRs. These types of prosthesis are widely used by dentists and require a high degree of precision and total adaptability.

On the other hand, as a future dentist, it is interesting to study the new technologies, which will continue to develop and improve. It is important to find out from dentists what their preferences are in terms of use and technique of impressions. The opinion of the professors at the Universidad Europea De Madrid (UEM) on the use of the IOS in their practice, especially in this study, for PCRs, can provide well-founded recommendations for new practitioners.

For these reasons, it is interesting to know, how effective do dental professors at the UEM find IOS for making PCRs and how do they perceive its acceptance in clinical practice in terms of clinical outcomes and patient satisfaction?

1.6. Hypothesis

Null hypothesis (H0): There is no difference in terms of effectiveness and acceptance of IOS to achieve PCRs among the dental professors at the UEM, compared to CI.

2. OBJECTIVE

The study aims to evaluate how effective and accepted IOS is to achieve PCRs among dental professors at the UEM.

3. MATERIAL AND METHODS

3.1. Design of the research protocol

The study aims to evaluate how effective and accepted IOS is for taking impressions for PCRs among dental professors at the UEM. A PICO question was used to help creating an objective and null hypothesis. The PICO question was the following: Is IOS (I) more effective (O) than CI (C) for achieving PCRs (P)?

To gather information about this objective, a cross sectional survey has been designed through Microsoft Form (Microsoft corporation, 2024). It consists in 17 questions in English and Spanish, distributed electronically, by e-mail or face to face, to professors at the UEM *(Annexes 1).* Results were analyzed and graphs were used to summarize them through Excel (Microsoft corporation, 2024). The survey was available from December 9th, 2024, to February 14th, 2025.

The participation to the survey was voluntary and an informed consent was provided at each participant before participating at the survey. Detailed explanations of the study's purpose and procedures were given, and the participants were assured that their answers would remain confidential and anonymous.

The survey included dental professors at the UEM. The criteria by which participants were excluded were the refusal to take part of the study, the ones who do not work in clinics, and those who do not use the IOS.

The population of dental professors at the UEM is 189. A form was sent to all of them via the email address. Of the 189 dental professors who received the email, 56 responded (30%). Of these, 1 declined to respond (2%) and 55 responded to the survey (98%).

3.2. Information sources

In addition to the survey, an investigation using several articles and journal was performed. These literatures were collected through Biblioteca CRAI, Pubmed, Medline and Google Scholar. Articles from the last 10 years were selected, from 2014 to 2024. All were published in English. The search equations used in the databases were "partial coverage restorations" AND "intraoral scanner" AND "conventional impression" AND "accuracy of intraoral scanner" AND "posterior indirect restorations" AND "veneers".

3.3. Questionnaire validation

This research had the approval of the Clinical Department under the code: OD.011/2425. On the 29th of November 2024, the Research Ethics Committee of the UEM gave its approval with the code: 2024-925.

4. RESULTS

After directly soliciting some professors of dentistry to respond to the questionnaire, 56 responses were collected. In a population of 189, a sample of 56 individuals, and with a 95% confidence level, the margin of error is 11%.

Table 1. representing the agreement to take part in this survey.

Informed consent	Number of participants	Percentage (%)
Yes	55	98%
No	1	2%
Total participants	56	100%

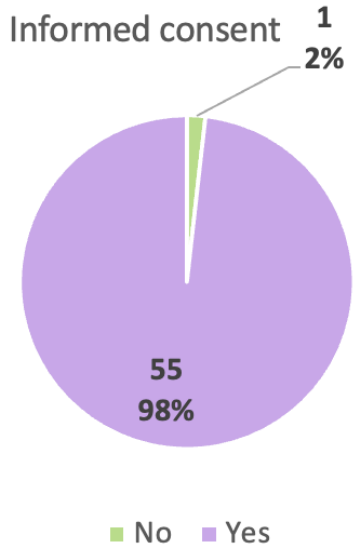

Figure 1. Pie chart representing the agreement to take part in this survey.

4.1. Question 1: Please, indicate your gender.

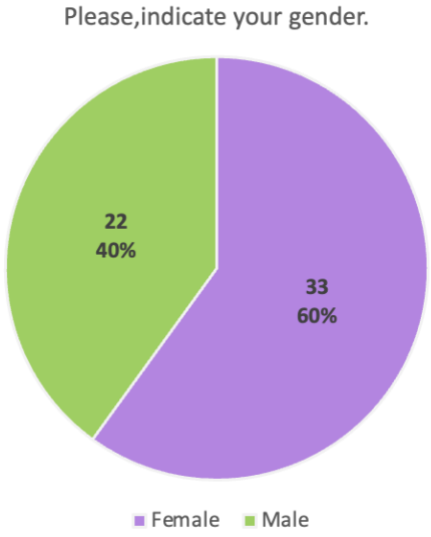

Figure 2. Pie chart showing the gender of participants.

4.2. Question 2: Please, indicate your age.

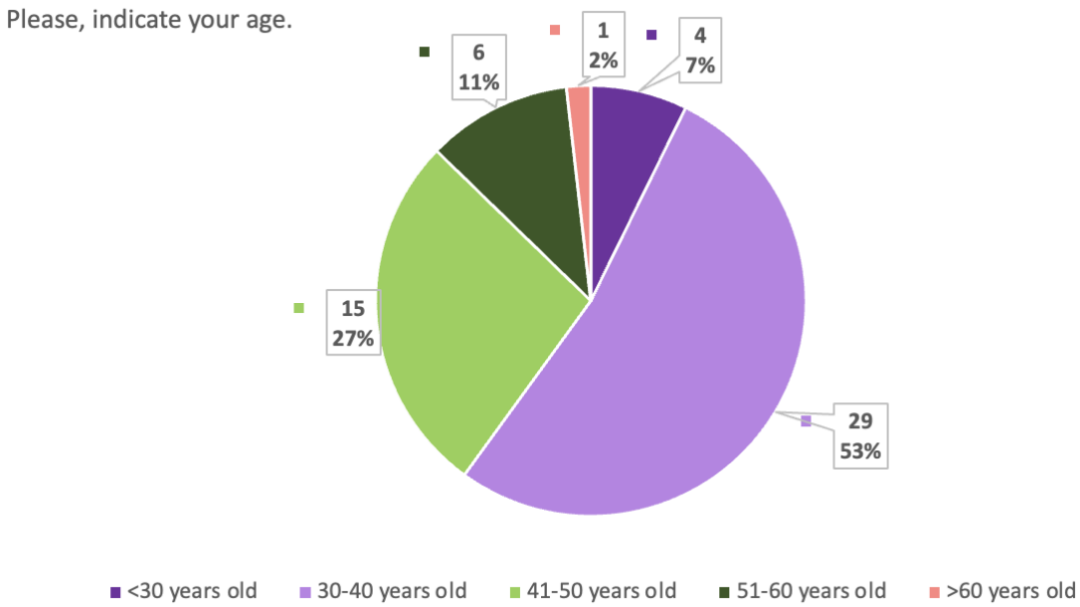

Figure 3. Pie chart indicating the age of participants.

4.3. Question 3: Do you have a specialty?

Table 2. indicating if participants have specialty or not.

	Number of participants	Percentage (%)
Total	55	100%
With specialty	49	89%
Without specialty	6	11%

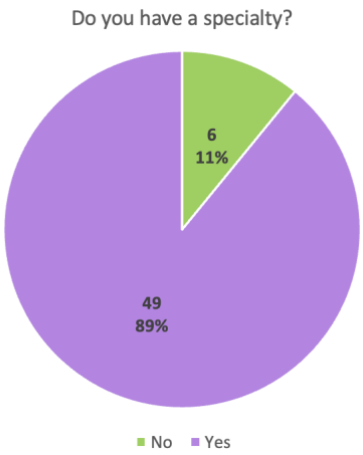

Figure 4. Pie chart indicating if participants have specialty or not.

4.4. Question 4: Which one?

Table 3. identifying which specialties the participants have.

	Specialty (Master 'degree)	Number of participants	Percentage (%)
Without specialties		6	11%
With specialties		49	89%
	Surgery	4	7%
	Periodontics	1	2%
	Pediatric Dentistry	4	7%
	Implantology	3	5%
	Dental Prosthetics	19	35%
	Dental Aesthetics	3	5%
	Advanced Orthodontics	2	4%
	Advanced Endodontics	13	24%
Total participants		55	100%

4.5. Question 5: What is the frequency of using an intraoral scanner in your clinical practice?

Table 4. categorizing the frequency of use of IS.

Frequency	Number of participants	Percentage (%)
Daily	28	51%
Weekly	12	22%
Monthly	1	2%
Rarely	2	4%
Never	12	22%
Total participants	55	100%

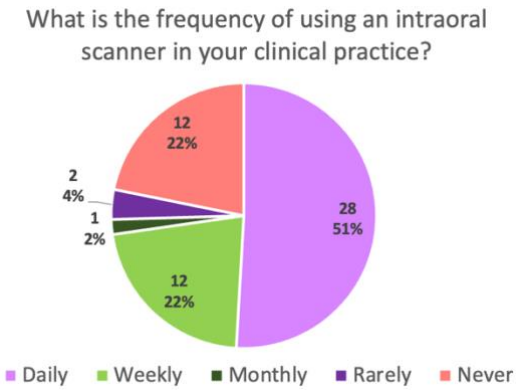

Figure 5. Pie chart categorizing the frequency of use of IOS.

4.6. Question 6: Are your patients more comfortable with intraoral scanners or conventional impressions?

Of the 55 participants who answered question 5, 12 participants did not use the IOS and are excluded from the following questions concerning its use.

Table 5. defining the patient's preferred impression.

Patient's preferred impression in term of comfort:	Number of participants	Percentage (%)
Intraoral scanners	42	98%
Conventional impressions	0	0%
Both	0	0%
Neither	1	2%
Total participants	43	100%

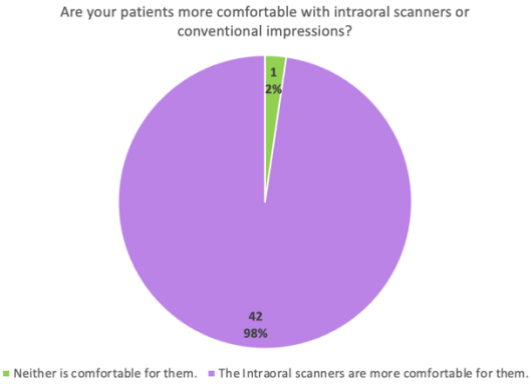

Figure 6. Pie chart defining the patient's preferred impression.

4.7. Question 7: Have you already used the intraoral scanner for partial coverage restorations?

Table 6. distinguishing if participants use of IOS for PCRs or not.

Use of intraoral scanner for partial coverage restoration:	Number of participants	Percentage (%)
Yes	37	86%
No	6	14%
Total participants	43	100%

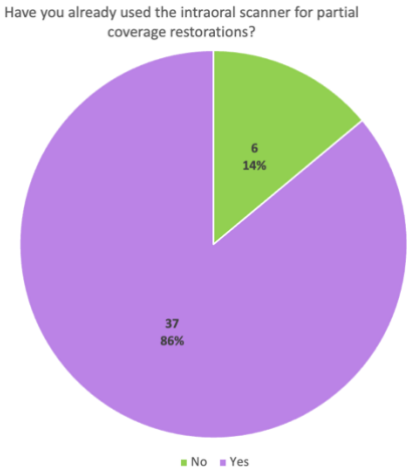

Figure 7. Pie chart distinguishing if participants use IOS for PCRs or not.

4.8. Question 8: Which of the following is your preferred method for taking partial coverage restoration impressions?

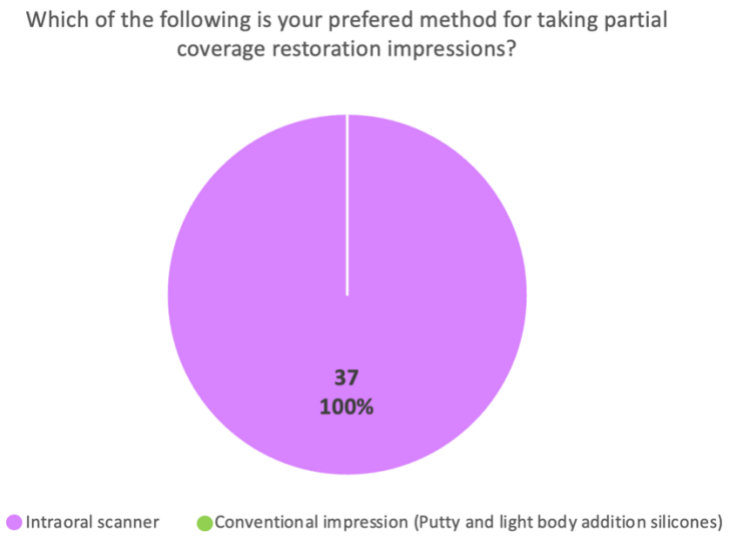

Figure 8. Pie chart showing which impression method is the preferred for taking PCR.

4.9. Question 9: In your opinion, what are the main advantages in using intraoral scanners for partial coverage restorations? (Select all that apply)

Table 7. characterizing the main advantages of using IOSs for PCRs.

	Advantages	Number of participants	Percentage (%)
Suggested answers	Better storage	20	13%
	Less material consumption	24	16%
	Better communication with dental labs	25	16%
	Increased accuracy	26	17%
	Improved patient comfort	28	18%
	Time efficiency	30	19%
Individual answers	Checking for errors at the time of the design	1	1%

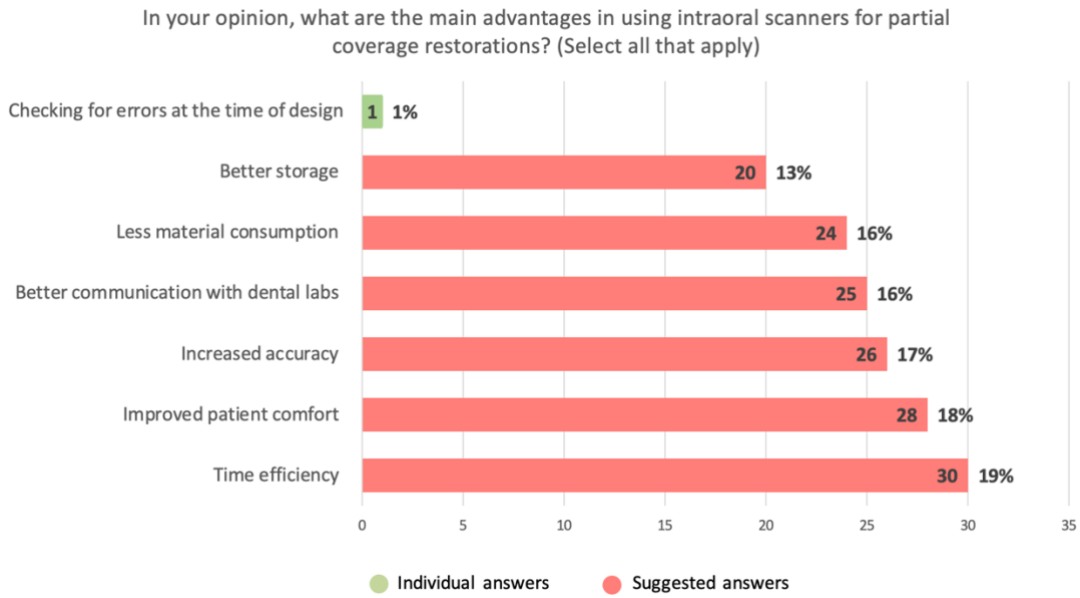

Figure 9. Bar chart characterizing the main advantages of using IOSs for PCRs.

4.10. Question 10: How would you rate your overall satisfaction with the intraoral scanner for partial coverage restoration?

Table 8. classifying the level of satisfaction of IOS for PCR.

Overall satisfaction level	Number of participants	Percentage (%)
Very satisfied	25	68%
Satisfied	12	32%
Neutral	0	0%
Dissatisfied	0	0%
Very dissatisfied	0	0%
Total participants	37	100%

4.11. Question 11: How satisfied are you with the accuracy of marginal fit-interproximal adjustment-occlusion for partial coverage restoration with the intraoral scanner?

Table 9. classifying the level of satisfaction regarding the accuracy of marginal fit-interproximal adjustment-occlusion of PCR with IOS.

Evaluated item	Marginal fit		Interproximal adjustment		Occlusion	
Participants	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
Very satisfied	18	49%	13	35%	8	22%
Satisfied	19	51%	22	59%	23	62%
Neutral	0	0%	2	5%	6	16%
Dissatisfied	0	0%	0	0%	0	0%
Very dissatisfied	0	0%	0	0%	0	0%
Total participants	37	100%	37	100%	37	100%

4.12. Question 12: How would you rate your satisfaction with the accuracy of veneers scanning?

Table 10. classifying the level of satisfaction of IOS for veneers.

Overall satisfaction level	Number of participants	Percentage (%)
Very satisfied	6	16%
Satisfied	20	54%
Neutral	10	27%
Dissatisfied	1	3%
Very dissatisfied	0	0%
Total participants	37	100%

4.13. Question 13: Have you encountered any limitations or failure while using intraoral scanners for partial coverage restorations?

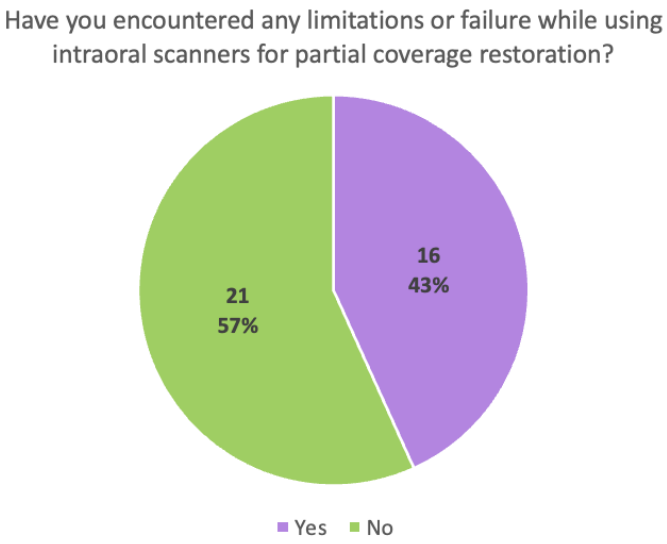

Figure 10. Pie chart categorizing if participants have encountered limitations while using IOSs for PCRs or not.

4.14. Question 14: If yes, which ones?

Table 11. specifying which limitations they encountered.

	Limitations	Number of participants	Percentage (%)
Suggested answers	Data management	0	0%
	Limited use	7	33%
	Equipment size	1	5%
	Difficult learning	2	10%
	Cost	7	33%
Individual answers	Sometimes the scanner does not detect the bottom of the pulp chamber and gaps remain	1	5%
	Capturer size	1	5%
	Full arch implants	1	5%
	Restoration margin scanning	1	5%

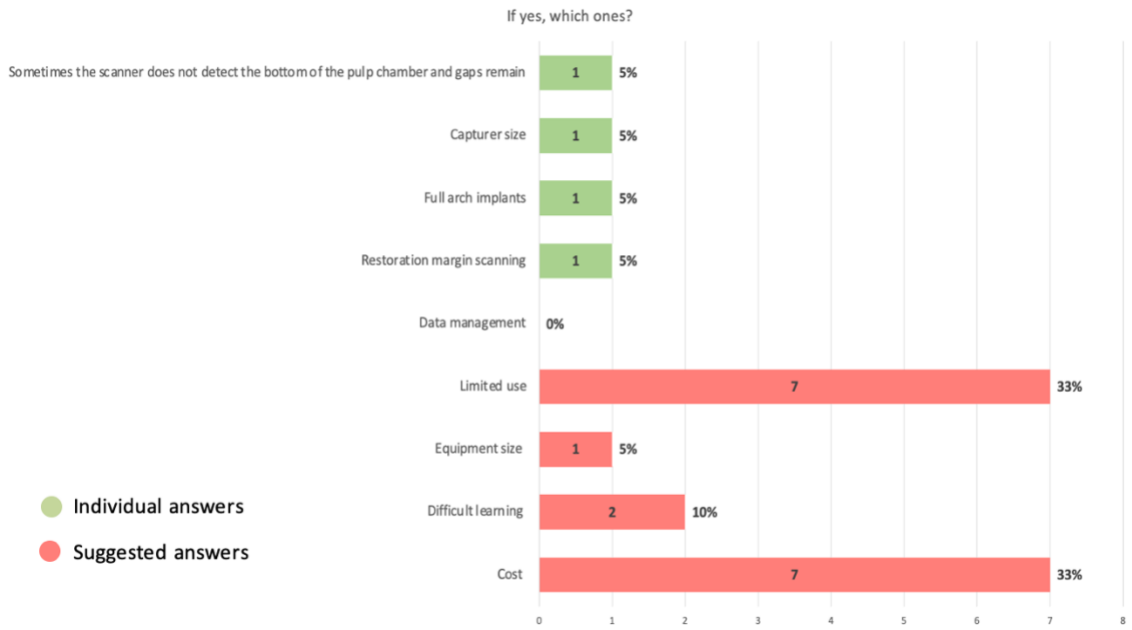

Figure 11. Bar chart specifying which limitations they encountered.

5. DISCUSION

These results support the rejection of the null hypothesis assuming that there is no difference in terms of effectiveness and acceptance of IOS to achieve PCRs among the dental professors at the UEM, compared to CI.

5.1. Adoption of intraoral scanner.

The sample predominantly consisted of females (60%) and participants aged 30–40 years (53%), with most respondents (89%) having a specialty. Prosthodontics (39%) was the most common, followed by Advanced Endodontics (27%). Women, 30–40 years old participants, and those specialized in Prosthodontics, reported the highest daily scanner usage, emphasizing the increasing adoption of digital dentistry. These results align with previous findings in a study done by Muhetaer et al. (2024), which highlight a strong presence of younger dental practitioners, with the 26–35 age group being the most represented (34.1%), and Prosthodontics showing the highest adoption of digital technology (60% CAD/CAM users) (25).

5.2. Intraoral scanner vs conventional impression.

As demonstrated in the table 5, participants' patients are more comfortable with IOS than CI. In fact, over 43 participants using the scanner in their clinical practice, 42 said that patients feel more at ease with IOS (98%). Only one respondent thought that neither the IOS nor CI are comfortable for its patients (2%). These results suggest a better acceptance for the use of IOS and null acceptance for CI among patients. Patient satisfaction is a crucial factor for a dentist. A network meta-analysis, directed by Sivaramakrishnan et al. (2019), analyzed the patient preference and operating duration for digital versus CI. The study analyzed data from 471 patients, 236 of whom received digital impression and 235 a CI. It showed, with a statistically significant result, that patients were 31.23 times more likely to prefer digital impression over CI, with a confidence of interval of 5.95 to 163.87. This means that a higher number of patients best-liked the digital impression method to the conventional method (13).

Moreover, the figure 8 demonstrates that all the participants prefer to perform impressions for PCRs with IOS (100%) rather than with CI (0%). This suggest that IOS is more accepted for PCRs than CI. Sharma et al. (2020) compared and evaluated the different results obtained for the marginal fit of inlays fabricated by conventional impression and pressing technique (group A) or realized with digital impressions and milling technique (group B1) (5). The study supports the preference of IOS because it suggests that the use of digital impression for indirect restorations improves accuracy. Results demonstrated that group A had the highest marginal discrepancies, with cervical gaps (92.61±9.75µm) and occlusal gaps (28.63±0.91µm) superior to

the cervical gaps (38.50±2.78µm) and occlusal gaps (21.64±1.06µm) of group B1 with intraoral scanning (5).

5.3. Advantages of intraoral scanner for partial coverage restorations.

In the figure 9, we can see participants' opinion concerning the advantages of using IOS for PCRs. Results indicate that IOS has better storage (13%), less material consumption (16%) and better communication with dental labs (16%). The IOS also increases accuracy (17%) as shown in the previous study (5). One participant added the fact that with IOS, we can check for errors at the time of design (1%). This could decrease the total time of treatment to prevent the need of performing new impressions at different appointments. In fact, the time efficiency was also reported with the most answers as regards as the advantages (19%).

Meanwhile, the network meta-analysis directed by Sivaramakrishnan et al. (2019) estimated an increase in time needed to do digital impression (2.72 minutes longer in average) with 95% confidence interval [0.08; 5.32] compared to CI. This analysis used eleven studies involving 589 patients evaluating the impression time to perform different types of prosthesis with conventional method versus digital impressions (13).

As mentioned above, the IOS improves patient comfort (18%). In the previous review, patients highlighted advantages of IOS over CI such as the reduce of gag reflex and queasiness, the easier breathing and better comfort feeling. With the use of conventional method, patients perceived anxiety, increased in time, bad test and smell. The size of trays is also source of discomfort (13).

5.4. Limitations of intraoral scanner for partial coverage restorations.

The use of IOS for PCRs has its limitations. In the figure 11, most participants indicated a high cost (33%) and limited use (33%). Some of them added the difficult learning (10%) and equipment size (5%). More especially, concerning the limited use of IOS for PCRs, 3 participants mentioned the difficulty of restoration margin scanning (5%), the capturer size (5%) and sometimes the scanner does not detect the bottom of the pulp chamber and gaps remain (5%).

The study directed by Muhetaer et al. (2024), compared the subjective opinion of users and non-users of CAD/CAM system. 46% of non-users explained that the initial cost of the equipment is high and 47.8% did not have knowledge to use this device and felt that technology upgrades occurred too frequently (25). Despite these shortcomings, most of them are ready to try this system (91.6%). If they listen the users, 94.4% of whom recommended its use because the

CAD/CAM system decreases the total cost and operative time by increasing the quality and the efficiency (25).

The use of IOS is also limited by external factors. You et al. (2022) aim to evaluate the impact of salivary contamination for fine structure reconstruction and occlusal records of inlay and onlay preparations (26). The study scanned 40 groups of inlay/onlay with IOS and tested the effect of salivary contamination level. It proved that salivary contamination impacted the fine structure accuracy ($P<0.001$) and the interocclusal space ($P<0.001$). The interocclusal space was larger with severe salivary contamination (22µm) than with moderate (15µm) and mild (6µm) (26). As for the fine accuracy, a contamination increased from mild to severe the internal angle deviations of inlays (from 1.1 to 8.2 degrees or 1.1 to 6.7 degrees) and onlays (from 3.8 to 7.5 degrees or 3.1 to 8.0 degrees) (26).

This illustrates that IOS has a few drawbacks, which can be eliminated as the technology evolves. These do not limit the predisposition to use this technique rather than the conventional one.

5.5. Satisfaction level of the use intraoral scanner to perform partial coverage restorations.

In the tables 8 and 10, we can see the level of satisfaction of participants regarding using the IOS for PCRs or veneers. In both tables, participants are mostly satisfied or very satisfied. In fact, in table 8, 68% of participants are very satisfied and 32% are satisfied. In table 10, 54% are satisfied with the use of IOS for veneers. These results show that IOS use is generally accepted and effective to perform PCRs and veneers.

More specifically, in table 9, we can see the level of satisfaction concerning the accuracy of marginal fit, interproximal adjustment and occlusion of PCRs with IOS. Globally, participants are initially more “very satisfied” with marginal fit (49%), then interproximal adjustment (35%), and then occlusion (22%). None of them is dissatisfied with all adjustments mentioned before (0%). The study directed by Muhetaer et al. (2024) evaluated also these three adjustments for different types of prosthesis including some PCRs. The same preferences were found, starting with the marginal fit, 75.2% of respondents affirmed it was very good, then the contact point (74.1%) and the occlusion (73.7%) (25).

Some studies are interested with marginal fit and so potential marginal gaps. The following plays a critical role in the long-term success of a PCR. Indeed, excessive gaps can lead to plaque accumulation, cement shrinkage or secondary caries. As demonstrated in the study direct by Sharma et al. (2020), the use of IOS for inlays increases accuracy (5). The study conducted by Vergas-Corral et al. (2024) compared the marginal fit of IOS and CI with silicone and proved that IOS produced smaller marginal gaps (2). In fact, this study showed that the mean marginal gap

for digital impression was 164±84 µm whereas it was 209±104 µm for CI, with a statistical difference of (P=0.041) (2). These results explain why IOS should be largely accepted for PCRs. It is very difficult to obtain a 100% adjustment, but this device leads a very good precision for a durable result.

5.6. Limitations and recommendations

The limitations of this study are that the sample should be bigger to achieve 5% margin of errors with 95% confidence interval.

Moreover, there are not many articles concerning the use of IOS for PCRs yet. It could be interesting to develop more the level of satisfaction concerning the use of IOS for these types of prosthesis regarding the duration of treatment, patients' comfort, the accuracy of scanning or the difference of efficacy of impression between IOS and CI. The total time required for PCR captured with IOS should be developed, as well as the study of occlusion with the antagonist and the interproximal relationship with adjacent teeth.

It could be interesting and more precise to compare and study specific brands of IOS, to limit biases linked to differences in performance between devices.

6. CONCLUSIONS

The use of IOS for PCRs is widely accepted among dental professors at the UEM. The study proved that this technique is very effective for these types of restorations. The many advantages and accuracy of IOS make it the ideal tool for PCR impressions.

7. SUSTAINABILITY

The use of IOS for PCRs contributes to sustainability from economic, environmental, and social points of view.

Economically, IOS reduces material wastes and improves efficiency, lowering costs for both dental practitioners and patients. By eliminating CI materials, clinics save on recurring expenses and can store information digitally for several years. The use of IOS reduces total treatment time, which in turn increases the number of patients and thus profitability.

Environmentally, IOS significantly reduces the use of disposable impression materials; silicone, alginate, and plaster models, which contribute to clinical wastes. It reduces the number of non-degradable materials. Digital impression eliminates the need for physical storage and transportation of models to dental laboratories, reducing carbon emissions associated with shipping.

Socially, IOS enhances patient experience because it eliminates discomfort from CI by reducing chair time or gag reflex. It also improves accuracy, leading to better-fitting restorations. Moreover, it improves the communication between the dental laboratory and the dentist. It also makes it easier for patients to visualize future treatment results.

8. REFERENCES

1. Vianna ALSDV, Prado CJD, Bicalho AA, Pereira RADS, Neves FDD, Soares CJ. Effect of cavity preparation design and ceramic type on the stress distribution, strain and fracture resistance of CAD/CAM onlays in molars. J Appl Oral Sci [Internet]. 2018 Aug 20 [cited 2024 Oct 22];26(0). Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1678-77572018000100491&lng=en&tlng=en

2. Vargas-Corral FG, Vargas-Corral AE, Rodríguez-Valverde MA, Bravo M, Rosales-Leal JI. Clinical comparison of marginal fit of ceramic inlays between digital and conventional impressions. J Adv Prosthodont. 2024;16(1):57.

3. Veneziani M. Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique. Int J Esthet Dent. 2017;12(2):204–30.

4. Ghodsi S, Shekarian M, Aghamohseni MM, Rasaeipour S, Arzani S. Resin cement selection for different types of fixed partial coverage restorations: A narrative systematic review. Clin Exp Dent Res. 2023 Dec;9(6):1096–111.

5. Sharma A, Abraham D, Gupita A, Singh A, Sharma N. Comparative evaluation of the marginal fit of inlays fabricated by conventional and digital impression techniques: A stereomicroscopic study. Contemp Clin Dent. 2020;11(3):237.

6. Madanshetty P, Guttal SS, Meshramkar R, Newaskar PS, Anehosur GV. Addition Silicone Impressions in Fixed Prosthodontics: Clinical Standpoints. Cureus [Internet]. 2023 Aug 23 [cited 2024 Nov 10]; Available from: https://www.cureus.com/articles/174338-addition-silicone-impressions-in-fixed-prosthodontics-clinical-standpoints

7. Nagi N, Fouda AM, Bourauel C. Comparative evaluation of internal fit and marginal gap of endocrowns using lithium disilicate and polyether ether ketone materials - an in vitro study. BMC Oral Health. 2023 Apr 7;23(1):207.

8. Barakat MM, Khan NS, Araby YA, Zakaria WM. Comparative Evaluation of Dimensional Accuracy and Tear Strength of Vinyl Siloxanether and Polyether Impression Materials: An In Vitro Study. World J Dent. 2021 Apr 3;11(6):457–61.

9. Takeuchi Y, Koizumi H, Furuchi M, Sato Y, Ohkubo C, Matsumura H. Use of digital impression systems with intraoral scanners for fabricating restorations and fixed dental prostheses. J Oral Sci. 2018;60(1):1–7.

10. Sason G, Mistry G, Tabassum R, Shetty O. A comparative evaluation of intraoral and extraoral digital impressions: An in vivo study. J Indian Prosthodont Soc. 2018;18(2):108.

11. Shely A, Lugassy D, Rosner O, Zanziper E, Nissan J, Rachmiel S, et al. The Influence of Laboratory Scanner versus Intra-Oral Scanner on Determining Axes and Distances between Three Implants in a Straight Line by Using Two Different Intraoral Scan Bodies: A Pilot In Vitro Study. J Clin Med. 2023 Oct 20;12(20):6644.

12. Róth I, Czigola A, Fehér D, Vitai V, Joós-Kovács GL, Hermann P, et al. Digital intraoral scanner devices: a validation study based on common evaluation criteria. BMC Oral Health. 2022 Dec;22(1):140.

13. Sivaramakrishnan G, Alsobaiei M, Sridharan K. Patient preference and operating time for digital versus conventional impressions: a network meta-analysis. Aust Dent J. 2020 Mar;65(1):58–69.

14. Richert R, Goujat A, Venet L, Viguie G, Viennot S, Robinson P, et al. Intraoral Scanner Technologies: A Review to Make a Successful Impression. J Healthc Eng. 2017;2017:1–9.

15. Singh K, Kalsi S. MANUSCRIPT TITLE - DIGITAL IMPRESSIONS IN PROSTHODONTICS - A REVIEW ARTICLE. Indian J Compr Dent Care IJCDC. 2018 Jul 1;8(2):1184-1184–7.

16. Dickens N, Haider H, Lien W, Simecek J, Stahl J. Longitudinal Analysis of CAD/CAM Restoration Incorporation Rates into Navy Dentistry. Mil Med. 2019 May 1;184(5–6):e365–72.

17. Chiu A, Chen YW, Hayashi J, Sadr A. Accuracy of CAD/CAM Digital Impressions with Different Intraoral Scanner Parameters. Sensors. 2020 Feb 20;20(4):1157.

18. Şen N, Eroglu H. Effect of preparation design and scan pattern on the accuracy of intraoral scans for complete arch laminate veneers under simulated intraoral variables. J Esthet Restor Dent. 2024 Oct;36(10):1437–43.

19. Ender A, Zimmermann M, Mehl A. Accuracy of complete- and partial-arch impressions of actual intraoral scanning systems in vitro. Int J Comput Dent. 2019;22(1):11–9.

20. Afrashtehfar KI, Alnakeb NA, Assery MKM. ACCURACY OF INTRAORAL SCANNERS VERSUS TRADITIONAL IMPRESSIONS: A RAPID UMBRELLA REVIEW. J Evid-Based Dent Pract. 2022 Sep;22(3):101719.

21. Alkadi L. A Comprehensive Review of Factors That Influence the Accuracy of Intraoral Scanners. Diagnostics. 2023 Oct 24;13(21):3291.

22. Wayakanon K. Partially Coverage Restoration: An Esthetically Conservative Treatment for a Complex Cavity Restoration. Open J Stomatol. 2017;07(04):234–41.

23. Naik V, Jain A, Rao R, Naik B. Comparative evaluation of clinical performance of ceramic and resin inlays, onlays, and overlays: A systematic review and meta analysis. J Conserv Dent. 2022;25(4):347.

24. AlDabeeb DS, Alakeel NS, Al Jfshar RM, Alkhalid TK. Endocrowns: Indications, Preparation Techniques, and Material Selection. Cureus. 2023 Dec;15(12):e49947.

25. Muhetaer A, Yang HY, Huang C. Application of Chairside CAD/CAM and Its Influencing Factors among Chinese Dental Practitioners: a Crosssectional Study. Chin J Dent Res. 2024 Sep 2;27(3):253–62.

26. You R, Han F, Sun Z, Xie H, Chen C. Evaluation of intraoral optical scanning accuracy for fine structure reconstruction and occlusal records of inlay/onlay preparations. Int J Comput Dent. 2022 Sep 20;25(3):257–65.

9. ANNEXES

9.1. Survey

Informed consent / Consentimiento informado:

1) This survey is part of the Graduation Project in Dentistry at Universidad Europea of Madrid titled "The use of the intraoral scanner for partial coverage restoration impressions among the dental professors at the UEM", directed by [redacted]
Your participation in this study is voluntary. You may request to be withdrawn from the study without prior justification or prejudice to you. The information collected will be kept confidential and will not be used for any other purpose outside this research and research dissemination purposes. The data collected will be completely anonymous. No personal identifying information will be requested. Information collected in the survey will be treated in accordance with the provisions of Organic Law 3/2018, of December 5, Protection of Personal Data and Guarantee of Digital Rights. For the purposes of the provisions of the regulation of the Organic Law 3/2018, of 5 December, on the Protection of Personal Data and Guarantee of Digital Rights, you are informed and expressly consent that the data provided in the survey may be used for the pre-mentioned purposes. This consent is granted without prejudice to all the rights that you have in relation to the aforementioned regulations, with the possibility of accessing the information provided, rectification, cancellation and opposition at any time you wish. For such purposes, you must write to the tutor [redacted]
Do you give your consent to participate in the survey as a volunteer for the results to be used in the Final Degree Project "The use of the intraoral scanner for partial coverage restoration impressions among the dental professors at the UEM"?

Esta encuesta forma parte del Proyecto de Graduación en Odontología de la Universidad Europea de Madrid, titulado " El uso del escáner intraoral para la restauración de impresiones de recubrimiento parcial entre los profesores de odontología de la UEM", dirigida por [redacted].
Su participación en este estudio es voluntaria. Puede solicitar que se le retire del estudio sin justificación previa o perjuicio para usted. La información recogida se mantendrá confidencial y no se utilizará para ningún otro fin que no sea el de esta investigación y la difusión de la investigación. Los datos recogidos serán completamente anónimos. No se solicitará ninguna información de identificación personal. La información recogida en la encuesta será tratada de acuerdo con lo dispuesto en la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos de Carácter Personal y Garantía de los Derechos Digitales. En cumplimiento de lo dispuesto en el Reglamento de la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos de Carácter Personal y Garantía de los Derechos de Digite, se le informa y autoriza expresamente que los datos facilitados en la encuesta puedan ser

utilizados para los fines antes mencionados. Este consentimiento se otorga sin perjuicio de todos los derechos que usted tenga en relación con la normativa antes mencionada, con posibilidad de acceder a la información facilitada, rectificación, cancelación y oposición en cualquier momento que lo desee. Para ello, deberá dirigirse por escrito al profesor titular, [redacted]

¿Da su consentimiento para participar en la encuesta como voluntario para que los resultados se utilicen en el proyecto de graduación « Uso del escáner intraoral para la restauración de impresiones de recubrimiento parcial entre los profesores dentales de la UEM»?

- Yes / Si
- No / No

2) Please, indicate your gender. / Por favor, indique su género.
   - Male / Masculino
   - Female / Mujer
   - Other: ____ / Otro: ____

3) Please, indicate your age. / Por favor, indique su edad.
   - < 30 years old / años
   - 30-40 years old / años
   - 41-50 years old / años
   - 51-60 years old / años
   - > 60 years old / años

4) Do you have a specialty? /¿Tiene una especialidad?
   - Yes / Si
   - No / No

5) Which one? /¿Cuál?
   - Master's degree in dental Aesthetics / Máster Universitario en Estética Dental
   - Master's degree in Periodontics / Máster Universitario en Periodoncia
   - Master's degree in Advanced Endodontics / Máster Universitario en Endodoncia Avanzada
   - Master's degree in Surgery / Máster Universitario en Cirugía
   - Master's degree in Implantology / Máster Universitario en Implantología
   - Master's degree in Advanced Orthodontics / Máster en Ortodoncia Avanzada
   - Master's degree in Dental Prosthetics / Máster Prótesis Dental
   - Master's degree in Pediatric Dentistry / Máster en Odontologia Pediatrica

6) What is the frequency of using an intraoral scanner in your clinical practice? / ¿Cuál es la frecuencia de uso de un escáner intraoral en su práctica clínica?
   - *Daily / Diario*
   - *Weekly / Semanal*
   - *Monthly / Mensual*

- *Rarely / Raramente*
- *Never / Nunca*

7) Are your patients more comfortable with intraoral scanners or conventional impressions? /¿Sus pacientes están más cómodos con escáneres intraorales o impresiones convencionales?
   - The Intraoral scanners are more comfortable for them. / Los escáneres intraorales son más cómodos para ellos.
   - The Conventional impressions are more comfortable for them. /Las impresiones convencionales son más cómodas para ellos.
   - Both are comfortable for them. / Ambos son cómodos para ellos.
   - Neither is comfortable for them. / Ninguno de los dos se siente cómodo.

The use of intraoral scanner for partial coverage restorations. / El uso del escáner intraoral para restauraciones de recubrimiento parcial.

8) Have you already used the intraoral scanner for partial coverage restorations? / ¿Ya ha utilizado el escáner intraoral para restauraciones de recubrimiento parcial?
   - *Yes / Si*
   - *No / No*

9) Which of the following is your prefered method for taking partial coverage restoration impressions? / ¿Cuál de los siguientes es su método preferido para tomar impresiones de restauración de recubrimiento parcial?
   - Intraoral scanner / Escáneres intraorales
   - Conventional impression (Putty and light body addition silicones) / Impresión convencional (Siliconas de adición pesada y fluida)

*10)*In your opinion, what are the main advantages in using intraoral scanners for partial coverage restorations? *(Select all that apply) /* En su opinión, ¿cuáles son las principales ventajas de utilizar escáneres intraorales para restauraciones de recubrimiento parcial? *(Seleccionar todo lo que se aplique)*
   - *Increased accuracy / Mayor precisión*
   - *Improved patient comfort / Mejora del confort del paciente*
   - *Time efficiency / Eficiencia del tiempo*
   - *Better communication with dental labs / Mejor comunicación con los laboratorios dentales*
   - *Better storage / Mejor almacenamiento*
   - *Reproducible / Reproducible*
   - *Less material consumption / Menos consumo de material*
   - Other: ____ / Otro: ____

*11)*How would you rate your **overall satisfaction** with the intraoral scanner for partial coverage restoration? / ¿Cómo calificaría su **satisfacción general** con el escáner intraoral para la restauración de recubrimiento parcial?
   - *Very Satisfied / Muy satisfecho*
   - *Satisfied / Satisfecho*

- *Neutral / Neutral*
- *Dissatisfied / Insatisfecho*
- *Very Dissatisfied / Muy insatisfecho*

12) How satisfied are you with the accuracy of **marginal fit** for partial coverage restoration with the intraoral scanner? / ¿Qué tan satisfecho está usted con la precisión del **ajuste marginal** para la restauración de recubrimiento parcial con el escáner intraoral?
    - *Very Satisfied / Muy satisfecho*
    - *Satisfied / Satisfecho*
    - *Neutral / Neutral*
    - *Dissatisfied / Insatisfecho*
    - *Very Dissatisfied / Muy insatisfecho*

13) How satisfied are you with the accuracy of the **interproximal adjustment** for partial coverage restoration with the intraoral scanner? / ¿Qué tan satisfecho está usted con la precisión del **ajuste interproximal** para la restauración de recubrimiento parcial con el escáner intraoral?
    - *Very Satisfied / Muy satisfecho*
    - *Satisfied / Satisfecho*
    - *Neutral / Neutral*
    - *Dissatisfied / Insatisfecho*
    - *Very Dissatisfied / Muy insatisfecho*

14) How satisfied are you with the accuracy of the **occlusion** for partial coverage restoration with the intraoral scanner? / ¿Qué tan satisfecho está usted con la precisión de la **oclusión** para la restauración de recubrimiento parcial con el escáner intraoral?
    - *Very Satisfied / Muy satisfecho*
    - *Satisfied / Satisfecho*
    - *Neutral / Neutral*
    - *Dissatisfied / Insatisfecho*
    - *Very Dissatisfied / Muy insatisfecho*

15) How would you rate your satisfaction with the accuracy of **veneers** scanning? / ¿Cómo calificaría su satisfacción con la precisión del escaneo de las **carillas**?
    - *Very Satisfied / Muy satisfecho*
    - *Satisfied / Satisfecho*
    - *Neutral / Neutral*
    - *Dissatisfied / Insatisfecho*
    - *Very Dissatisfied / Muy insatisfecho*

16) Have you encountered any limitations or failure while using intraoral scanners for partial coverage restoration? / ¿Ha encontrado alguna limitación o fracaso mientras utiliza escáneres intraorales para la restauración de recubrimiento parcial?
    - *Yes / Si*
    - *No / No*

17) If yes, which ones? / Si sí, ¿cuáles?
- Cost / Coste
- Equipment size / Tamaño del equipo
- Difficult learning / Aprendizaje difícil
- Difficulty in reading *(example: subgingival lines, very fine lines)* / Dificultad de lectura *(ejemplo: líneas subgingivales, líneas muy finas)*
- Limited use / Uso limitado
- Data management / Gestión de datos
- Other: ____ / Otro: ____