GRADUATION PROJECT

Degree in Dentistry

TITLE

THE USE OF THE INTRAORAL SCANNER FOR PARTIAL COVERAGE RESTORATIONS AMONG DENTAL PROFESSIONALS

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ABSTRACT

Introduction: Digital technologies have significantly transformed restorative dentistry in recent decades. Among these innovations, intraoral scanners have emerged as an alternative to conventional impressions, particularly for partial coverage restorations, where accuracy and marginal adaptation are essential for long-term clinical success and overall treatment predictability. **Objective:** The aim of this study was to analyze the use of intraoral scanners for partial coverage restorations among dental professionals and to evaluate their effectiveness in daily clinical practice. **Material and methods:** A descriptive cross-sectional study was conducted using a questionnaire composed of 15 questions. The survey was distributed both online and in person to dental professionals. A total of 76 valid responses were included in the analysis. Data were collected using Microsoft Forms software and analyzed using descriptive statistics in Microsoft Excel. **Results:** The majority of participants reported frequent use of intraoral scanner in clinical practice, with 54% using them daily. Crowns and partial coverage restorations were among the most common indications. Most practitioners reported high satisfaction with digital impressions and improved patient comfort, accuracy and communication with dental laboratories as advantages. Marginal fit of restorations made from digital impressions was generally rated as good or very good by most respondents. However, factors such as saliva, preparation depth and operator skill were identified as influencing scanning accuracy. **Conclusions:** Intraoral scanners are widely adopted and perceived as reliable tools for partial coverage restorations, offering clinical efficiency and improved patient experience. Proper technique and clinical conditions remain essential to achieve optimal results.

KEYWORDS

Dentistry, accuracy, digital impression, intraoral scanner, partial coverage restoration.

RESUMEN

Introducción: Las tecnologías digitales han transformado significativamente la odontología restauradora en las últimas décadas. Entre estas innovaciones, los escáneres intraorales han surgido como una alternativa a las impresiones convencionales, especialmente en las restauraciones de recubrimiento parcial, donde la exactitud y la adaptación marginal son fundamentales para el éxito clínico. **Objetivo:** El objetivo de este estudio fue analizar el uso de los escáneres intraorales para las restauraciones de recubrimiento parcial entre profesionales de la odontología y evaluar su eficacia. **Material y métodos:** Se realizó un estudio observacional descriptivo de tipo transversal mediante un cuestionario de 15 preguntas. La encuesta fue distribuida online y presencial a profesionales odontológicos. Se incluyeron 76 respuestas válidas para el análisis. Los datos se recopilaron mediante Microsoft Forms software y se analizaron utilizando estadísticas descriptivas con Microsoft Excel. **Resultados:** La mayoría de los participantes informó utilizar escáneres intraorales, siendo el 54% usuarios diarios. Las coronas y las restauraciones de recubrimiento parcial fueron las indicaciones más frecuentes. La mayoría de los profesionales mostró un alto nivel de satisfacción con las impresiones digitales, destacando la comodidad del paciente, la precisión y una mejor comunicación con el laboratorio. La adaptación marginal de las restauraciones de recubrimiento parcial obtenidas mediante impresiones digitales fue evaluada mayoritariamente como buena o muy buena. Factores como la saliva, la profundidad de la preparación y la habilidad del operador influyen en la precisión del escaneo. **Conclusiones:** Los escáneres intraorales son herramientas ampliamente adoptadas y consideradas fiables para las restauraciones de recubrimiento parcial. Una buena técnica y condiciones clínicas adecuadas siguen siendo esenciales para obtener resultados óptimos.

PALABRAS CLAVE

Odontología, escáner intraoral, impresión digital, precisión, restauración de recubrimiento parcial.

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1. INTRODUCTION

1.1. Context and development in restorative dentistry

Over the past decades, modern dentistry has experienced a major transformation, guided by the need to balance between clinical efficiency, biological respect and tissue preservation (1,2). The classical operative approach, based on the extension for prevention, described by Black (1891), progressively changed to minimally invasive dentistry, based on healthy structure conservation and the achievement of more aesthetic and functional restorations. This transformation reflects the transition from a purely restorative dentistry to biomimetic dentistry, focused on restoring the teeth as closely as a natural one (3).

This evolution has been made possible thanks to significant advances in adhesive materials, resinous cements and bonding techniques, enabling clinicians to restore teeth in a durable and minimally invasive way. Improvements in bonding systems have significantly enhanced the durability of dentin-resin and enamel-resin surfaces, limiting failures related to microleakage and mechanical stress. These innovations have permitted a new approach for prosthetic preparations, focusing on minimizing tissue removal (4).

One of the fundamental principles of this philosophy is the concept of biomimetic. It aims to mimic natural properties of dental tissues. Enamel, the most external layer of the tooth highly mineralized, provide resistance, hardness and translucency to the tooth. Dentin, more elastic and richer in organic components, confers a certain flexibility and play an important role in the dissipation of occlusal forces. Understanding the complementarity of these two structures encourages professionals to favor limited preparations, conserving enamel as much as possible, who is the more favorable substrate for a good adhesion and long-term stability. In this way, biomimetic is not limited to a purely esthetic approach, but constitute a veritable biological and functional principle that guide the concept of modern restorations (5,6).

1.2. Partial coverage restorations: definition and types

In this perspective, partial coverage restorations (PCR) fit perfectly within this conservative approach (2,4,5). In contrast to full coverage restorations, these types of restorations do not require the complete reduction of the clinical crown, but only the preparation of affected or weakened areas, intended to prevent damage to healthy dental tissues. These restorations

allow the preservation of pulp vitality, help to prevent iatrogenic damage to periodontal tissues and maintain a certain proportion of healthy tooth structure, improving in this way the longevity of the restored tooth (5,7).

Partial coverage restorations exist in different design and categories depending on their extension:

- Inlays: PCR that are fully intracoronal, the aim is to replace internal structures of the tooth without covering the cusps (5,6).
- Onlays: PCR that cover one or more cusps of the weakened tooth, providing mechanical protection to the tooth, without extending over all cusps of the tooth (5,6).
- Overlays: PCR that are more extensive, covering almost all the occlusal surface of the tooth while avoiding damage to healthy tissue as in crown preparation (6).
- Veneers: thin PCR that are bonded to the vestibular surface, improving esthetics, misalignment and small tooth defects (2,5).

The choice of restoration type depends on the amount of remaining tissue, respecting functional demands and esthetic requirements (2,5,8). These restorations can be fabricated using several materials like indirect composite, feldspathic porcelain, lithium disilicate or hybrid materials, depending on clinical needs. Material choice will be conditioned by the localization and the extension of the restauration, thus affecting the bonding technique. Porcelain materials offer an excellent biocompatibility, chromatic stability and mechanical properties like a natural tooth. Hybrid materials, on the other hand, combine resin and ceramic to offer resistance and flexibility (9).

The success of a PCR also depends on strict cavity preparation principles, including the absence of undercuts, the creation of internal expulsive cavity shape that facilitate a passive fit of the restoration, a minimum material thickness of 2 millimeters at the level of functional cusps, rounded internal shape to reduce stress concentration, well defined and continuous finish lines, ideally supragingival, as well as preservation of peripheral enamel to ensure a durable and predictable adhesion (2,4,5,7).

Beyond geometry, marginal adaptation accuracy is an important factor for clinical success. An optimal marginal adaptation has been defined at 120 µm to be clinically acceptable, beyond this threshold, microleakage, debonding and mechanical strength cannot be ensured (10,11).

Clinical success of these restorations relies on several parameters: preparation design, adhesive process quality, moisture control and most importantly, the accuracy of the impression. Marginal and internal adaptation is the key to prevent microfiltration, recurrent caries and periodontal affectations. Each step of the defined protocol, from tooth preparation to impression taking, then to fabrication to placement, directly affect the longevity of the restoration (8,12,13).

1.3. Use of intraoral scanner for partial coverage restorations: definition and characteristics

As dentistry continues to move toward more conservative and digital approach, accuracy has become an essential requirement at every stage of PCR workflow. This necessity has driven the development of innovative digital solutions, including intraoral scanners, which are redefining the standards for dental impressions in adhesive prosthodontics and achieving results comparable or better than those obtained with conventional impressions (14–16).

Technological advances have clearly transformed many techniques in dentistry, such as techniques for dental impressions. Traditionally, impression were made using conventional methods with elastomeric materials, such as silicones, polyether and hydrocolloids, which are technique-sensitive prone to numerous errors (8,17). Many factors could affect precision and trueness of the impression, such as material deformation, air entrapment, defect during plaster pouring or issues related to disinfection, storage and transport to the laboratory. These limitations, combined to patient discomfort and challenging handling for the practitioner have led to the development of more accurate and comfortable digital solutions (18).

The intraoral scanner (IOS) is a good example of the digital revolution. This device enables direct capture of the three-dimensional surface of the tooth and oral cavity, using structured light or laser technology (12). This acquisition system allows a greater accuracy, combining trueness, that is the capacity to reproduce the reality, and precision, that is the capacity to reproduce the same results each time, improving the result of the digital impression (1,10,15,16). The system analyzes the reflective points over the tooth surface and recreates in real-time a digital three-dimensional model of the dental arch (16). This information acquisition, non-invasive and instant, deletes intermediate stages related to possible errors and allow an immediate visualization of the result over a screen, thus facilitating the control and possible corrections of missing areas (19).

The advantages of the IOS are multiple. For the patient, it offers a better comfort compared to conventional impressions: no impression material, no gag reflex, reduced time at dental chair and more pleasant experience. For the practician, IOS provide accuracy, trueness and time gain. The fully digital workflow minimizes cumulative errors, improve the communication with the laboratory through instant transfer and secured stereolithography (STL) file, enabling virtual archiving of the file without time deterioration. Moreover, the three-dimensional visualization offers an easier analysis of the occlusion, treatment planification and patient education. Modern IOS offer many characteristics: ergonomic, compact shape, acquisition efficiency, automatized calibration systems and three-dimensional reconstruction algorithms that make them very pleasant to use (12–17,19). Some systems present additional technologies like caries detector, shade measurement, tooth wear monitoring or gingival changes. These innovations help to reinforce the accuracy of adhesive partial coverage restorations, where the accuracy of internal and external limits are essentials for long-term survival of the restoration (8,20,21).

However, certain limitations remain. The efficacity od the IOS can be affected by many conditions like depth of the margins, patient, movement or lightning of the area. Between full ach impression or unitary restorations, the cumulative risk of errors is not the same. Moreover, the learning curve of the operator plays also a major role: movement during scanning procedure, the acquisition sequence and the management of areas hard to reach. Over the clinical aspect, other considerations can impact IOS adoption as the initial elevated cost, maintenance and calibration needs, compatibility of files between software, disinfection needs and regulations (10,12–14,16).

Thus, the convergence of partial coverage restorations and digital impressions reflect the actual concepts of dentistry, combining minimal treatments, biological respect of structures and performance. The IOS is actually the device the most adapted to ensure these characteristics. However, the results depend on the comprehension of its limits and a rigorous management of the clinical stages, from preparation to digital design (1).

1.4. Current state of the subject

Today, the IOS appears progressively as a reliable alternative to conventional impressions and especially for partial coverage restorations. Recent studies have demonstrated their high level of accuracy, assessed through precision and trueness. This evidence show that digital impression can match or surpass the clinical accuracy of conventional methods, providing at the same time several advantages like patient comfort, clinical efficiency and improved communication with the laboratory. However, some aspects are still debated, such as scanner performance in posterior areas, capture of subgingival finish lines and the impact of moist surfaces (12,14,16,17).

1.5. Justification

Despite constant advances in digital dentistry, many articles and studies have showed heterogeneity in term of results regarding the reliability and limits of the IOS and specifically on the case of partial coverage restorations. These restorations demand a very high marginal and internal accuracy to ensure a correct bonding strength, mechanical stability and long-term success. Understanding how dental professionals use the IOS in daily practice, challenges they face up and strategies they use to optimize the scan accuracy is therefore essential.

This empirical research aims to assess current practice and challenges related to the IOS for partial coverage restorations impressions, in order to improve clinical outcomes and long-term success.

2. OBJECTIVE

Analyze the use and characteristics of the intraoral scanner for partial coverage restorations impressions, to determine its effectiveness.

3. MATERIAL AND METHODS

3.1. Design of the research protocol

3.1.1. Type and design of the study

This study is an observational and descriptive, named as cross-sectional study, designed to evaluate dental professionals practice and perceptions regarding the use of IOS for PCR at a single point of time, corresponding to the PICO question. A structured questionnaire of 15 questions was designed on Microsoft corporation with closed questions, single and multiple-choice type, to collect standardized and comparables responses collected from a group of practitioners. The questionnaire was translated to different languages and distributed to practitioners via email and in face to face.

P	Population, Patient, Problem	Dentists making partial coverage restorations
I	Intervention or exposure	Use of intraoral scanner
C	Comparison	Compared to conventional impressions
O	Outcome	Effectiveness in the dental practice

Figure 1. PICO table

Annex 1: Complete survey

3.1.2. Sample size

Sample size was determined based on the number of received answers, from dental professionals participating at the survey. To achieve a sufficient number, a minimum of 50 subjects was required to ensure valid results.

3.1.3. Inclusion and exclusion criteria

Regarding the validity of the study, some inclusions and exclusions criteria were applied to ensure the reliability. For the inclusion criteria, subjects need to be dentists that performed partial coverage restorations (PCR) and use an intraoral scanner (IOS), regardless of the brand

and models. For the exclusion criteria, dental students and dentist who were no longer working in dental clinics were not eligible to participate.

3.1.4. Intervention

No clinical intervention was performed for this study, as its purely survey based. It consists of a distribution of a standardized questionnaire, including closed ended questions that focus on demographics, clinical experience, IOS use and PCR.

3.1.5. Method of data collection

The questionnaire was distributed by email via a link or directly in person, using a QR code, at the Universidad Europea de Madrid dental clinic and campus laboratory. They were also distributed in other European countries thanks to personal and familial networks. The survey is voluntarily and anonymous. Microsoft forms software was used to automatically record and anonymize the responses, to ensure confidentiality.

The responses collected through Microsoft forms were analyzed using Microsoft Excel, in form of descriptive statistics that include percentages, frequency tables and distribution tables in order to generate a more easy interpretation of the results.

3.1.6. Ethical issues

All participants have provided the informed consent (**Annex 2**) in order to collect their answers, anonymity and confidentiality for the participants is guarantee.

Annex 2: Informed consent

3.2. Approval required

The study has received the approval of the Investigation commission of the investigation unit of the university.
Code CI: 2025-769
Code department: OD016/2526

Annex 3: Validation of investigation committee

3.3. Bibliographical research

Article research was conducted using different database as Pubmed, Medline and EBSCO. In order to find articles, the following keywords were used: “intraoral scanner”, “digital impression”, “partial coverage restorations”, “inlay”, “onlay”, “overlay”, and “veneer”.

Only articles published in the last 10 years were included to ensure the relevance and currency of the data. Publications written in English, Spanish and French were considered eligible.

The scientific literature was used to establish the theoretical framework of the study, to support the development the survey and to compare the study finding with existing evidence already find.

4. RESULTS

4.1. Study population

A total of 77 responses were collected after sending the questionnaire. Only one person was excluded of the results due to the absence of informed consent. For this reason, 76 dental professionals were included in the final analysis of the results. Responses in Spanish and French were linguistically harmonized into English prior to data analysis.

All the participants were analyzed according to their age, years of practice, dental specialty and frequency of using an intraoral scanner (IOS). Values like age, years of practice and frequency use of IOS were categorized into different predefined group to facilitate the analysis.

Professionals who reported not using an IOS where directly redirected to the last question in order to know their potential future use of the intraoral scanner. In this way, their responses did not affect the validity of the other questions.

4.2. General analysis of the participants

Distribution of dental specialties among participants to the questionnaire (**Table 1**).

Table 1. Distribution of responses by dental specialty.

Specialty	**Response count**	**Percentage%**
General practice	46	42
Prosthodontists	13	12
Restorative/Esthetic	10	9
Endodontist	8	7
Orthodontist	4	3
Surgeon/Implantologist	15	14
Periodontist	11	10
Pediatric	3	3
Total	110	100

Frequency table showing the frequency IOS use among participants (**Table 2**).

Table 2. Distribution of the IOS use frequency.

Frequency use	**Response count**	**Percentage%**
Daily	41	54
Weekly	18	23,5
Monthly	3	4
Rarely	5	6,5
Never	9	12
Total	76	100

Percentage stacked bar showing the frequency of IOS use according to the number of years of practice (**Figure 2**).

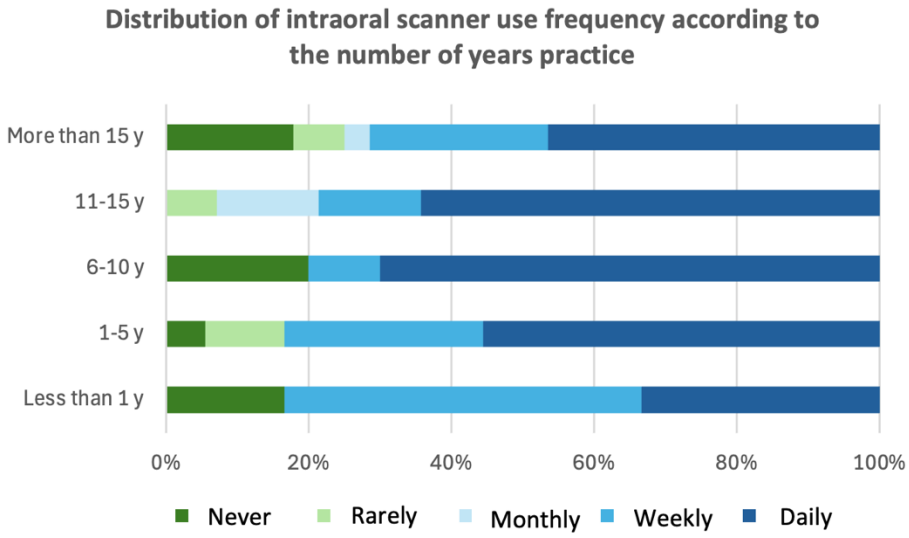


Figure 2. Distribution of IOS use frequency according to the number of years of practice.

Percentage stacked bar showing the frequency of IOS scanner use by age group (**Figure 3**).

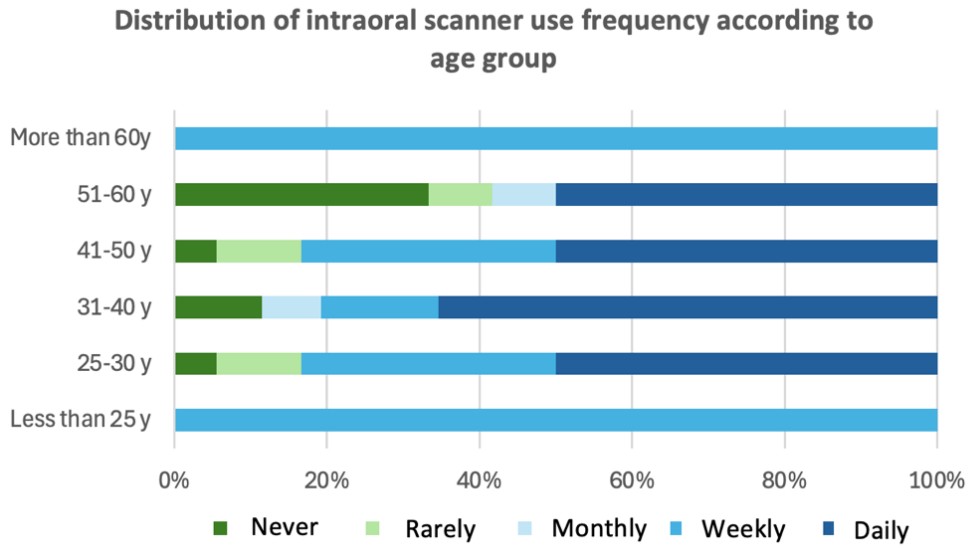


Figure 3. Distribution of IOS use frequency according to age group.

Analysis of the mean frequency score according to the specialty (**Figure 4**).

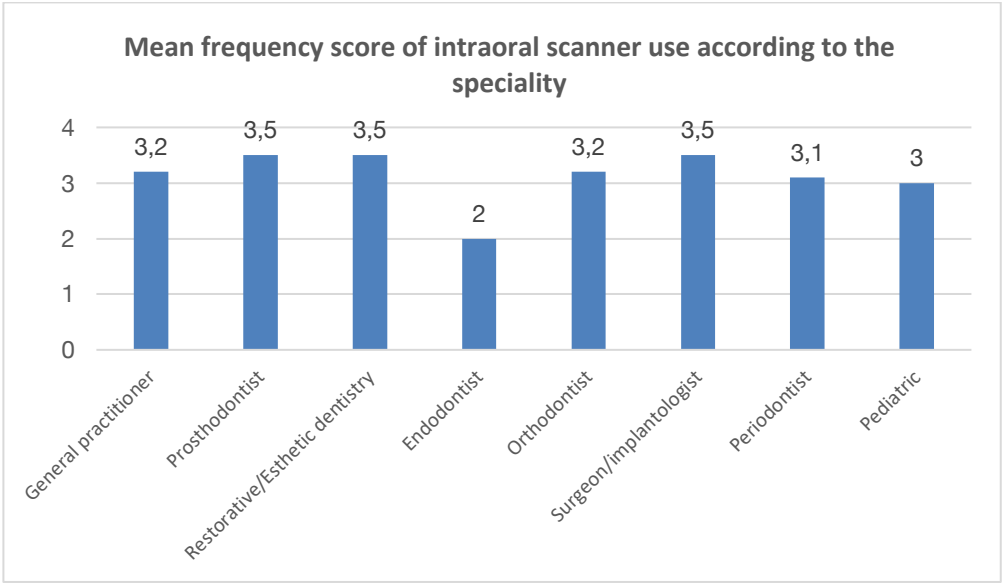


Figure 4. Mean IOS use frequency according to the specialty.

4.3. Intraoral scanner usage pattern

Frequency table representing which type of restoration is the most frequently performed with the IOS (**Table 3**).

Table 3. Frequency table of different types of restorations performed with an IOS.

Type of restoration	Response count	Percentage%
Inlay	49	14
Onlay	54	16
Overlay	47	14
Veneer	37	11
Crown	60	18
Bridge	48	14
Implant	44	13
Total	339	100

Practitioners' satisfaction level about IOS use for partial coverage restorations (PCR) was assessed, in comparison to conventional impressions (**Figure 5**).

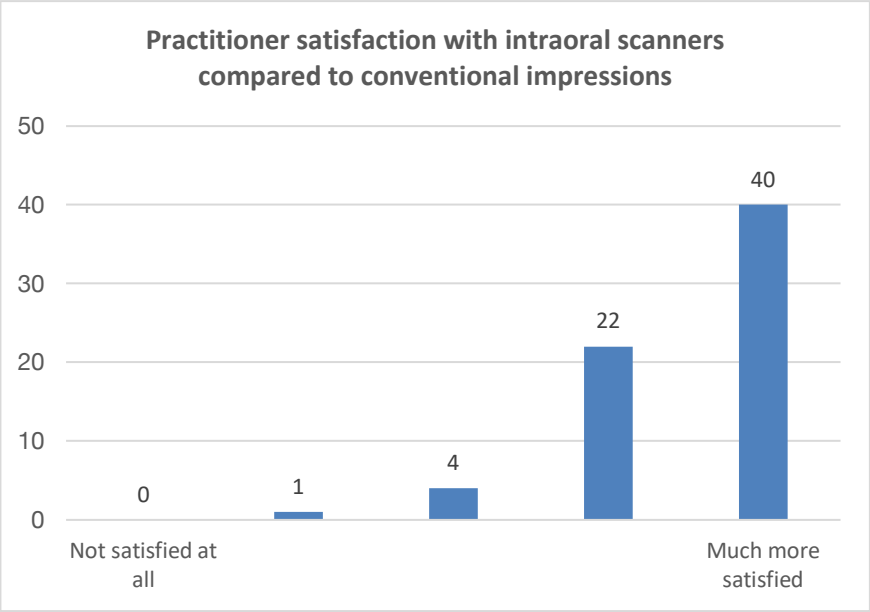


Figure 5. Practitioners' satisfaction level with the use of IOS for PCR in comparison to conventional impressions.

Patient comfort with the use of IOS compared to conventional impression (**Figure 6**).

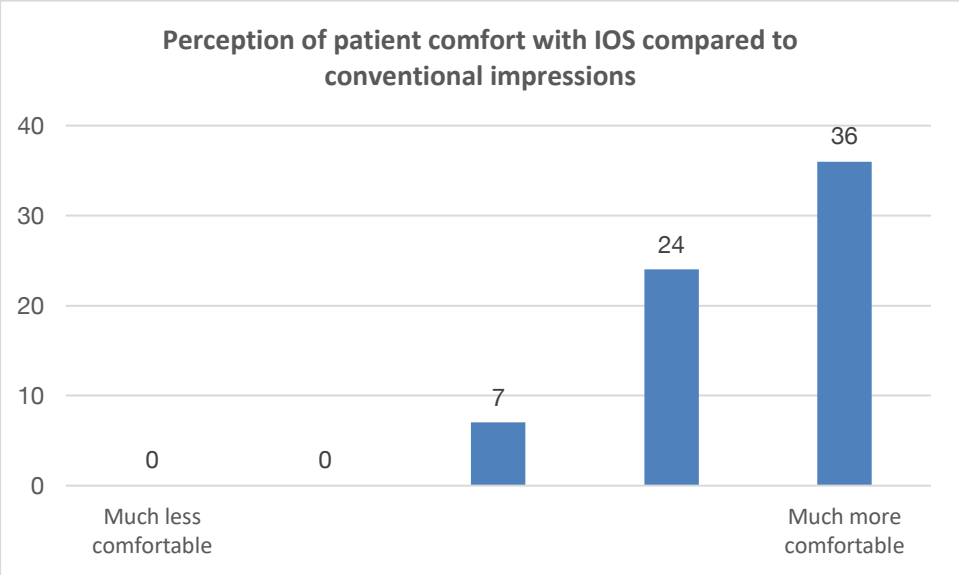


Figure 6. Perception of patient comfort using IOS compared to conventional impressions by participants

Frequency table representing the main advantages using an IOS in the dental practice (**Table 4**).

Table 4. Main advantages of the IOS

Advantages of the IOS	**Response count**	**Percentage%**
Time efficiency	42	15
Accuracy of the impression	47	17
Immediate quality control	43	16
Patient comfort	53	19,5
Better communication with dental laboratory	43	16
Complete digital workflow	45	16,5
Total	273	100

4.4. Accuracy of PCR from digital impression

Frequency table showing dentists perception of the fit of PCR fabricated using an IOS, focusing on marginal fit, interproximal adaptation and occlusal adaptation (**Table 5**).

Table 5. Fit of PCR made with IOS

	Marginal fit		**Interproximal adaptation**		**Occlusal adaptation**	
	Response count	**Percentage%**	**Response count**	**Percentage%**	**Response count**	**Percentage%**
Very bad	0	0	0	0	0	0
Bad	1	1,5	0	0	1	1,5
Neutral	4	6	10	15	11	16,5
Good	25	37,3	29	43	30	45
Very good	37	55,2	28	42	25	37
Total	67	100	67	100	67	100

Frequency table showing the number of cases failure of PCR fabricated using IOS, focusing on marginal fit, interproximal adaptation and occlusal adaptation (**Table 6**).

Table 6. Failure of PCR made with IOS.

Number of cases failure	**Marginal fit**		**Interproximal adaptation**		**Occlusal adaptation**	
	Response count	**Percentage %**	**Response count**	**Percentage %**	**Response count**	**Percentage%**
Less than 5%	39	58,2	36	54	27	40
Between 5 and 25%	16	24	18	27	19	28,5
Between 26 and 50%	8	12	9	13,4	16	24
More than 50%	4	6	4	6	5	7,5
Total	67	100	67	100	67	100

4.5. Clinical performances and limitations of IOS

Frequency table representing factors with the greatest impact on the accuracy of digital impressions of PCR (**Table 7**).

Table 7. Factors affecting the accuracy of IOS

Impacting factors	**Response count**	**Percentage%**
Type of PCR	17	7
Location in the arcade	24	10
Depth of the preparation	36	16
Geometry of the preparation	32	14
Surface reflectivity	25	11
Saliva control	44	19
Operator skill	35	15
Technology system of the scanner	18	8
Total	231	100

Frequency table representing the main disadvantages using an IOS in the dental practice (**Table 8**).

Table 8. Main disadvantages of the IOS

Disadvantages	**Response count**	**Percentage%**
High cost	44	32,5
Training needs	14	10
Lack of accuracy	2	1,5
Difficult use in moist surfaces	36	26,5
Difficult use in subgingival finish lines	34	25
Compatibility with the lab	6	4,5
Total	136	100

4.6. Perspective on IOS use

Pie chart illustrating participants intentions regarding their future use of IOS (**Figure 7**).

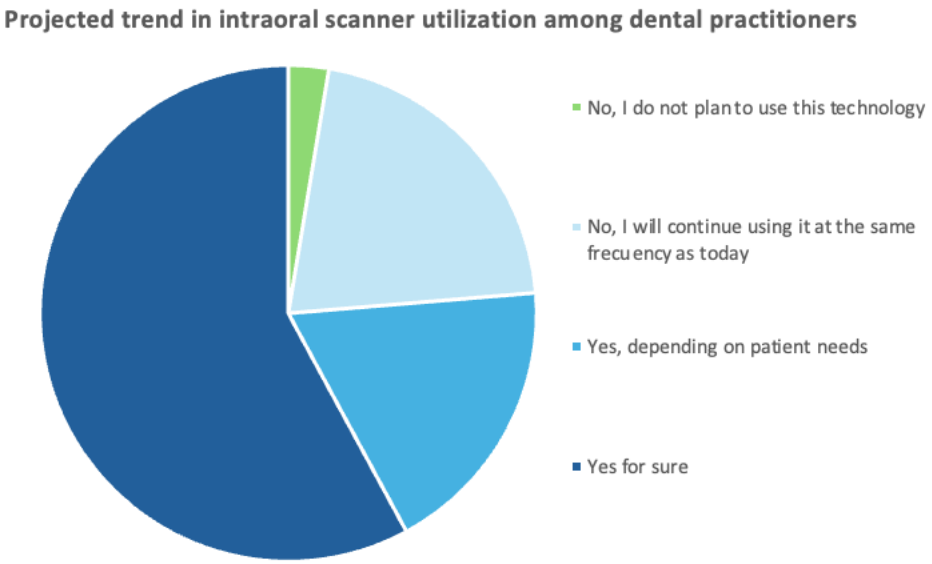


Figure 7. Projected trend in IOS utilization among dental practitioners

5. DISCUSSION

The increasing integration of digital tools into dental practice has progressively changed restorative and prosthetic treatment approaches. Among these technologies, intraoral scanner (IOS) has become a central component of modern clinical practice and workflows. Despite this general adaption, variations remain regarding the frequency of use, practicians profile and clinical indications. Evaluating theses aspects is particularly relevant in the context of partial coverage restorations (PCR), where precision and efficiency play a decisive role.

5.1. Adoption of digital tools by dentists

In the present study, 54% of the participants reported using an IOS on a daily basis in their clinical practice, indicating that digital impression systems are routinely used. Most of the remaining respondents reported weekly use (23,5%), supporting the idea that the IOS is part of regular clinical activity and not only occasional (**Table 2**). Similar trend of usage pattern are reported in the study of *Al-Hassiny et al.* (2023) (22). Together, these findings suggest that digital impression is no longer perceived as an emerging technology, but part of actual dental practice.

When analyzing scanner use according to practitioners related variables, notable differences emerged. Younger clinicians, particularly those aged 40 years and under, reported more frequent daily or weekly use compared top older groups, suggesting a greater integration of digital workflows among more recent generations of dentists. Regarding years of practice, practitioners with longer clinical experience reported high level of daily use, but those with up to five years of practice reported the highest proportion of frequent use, reflecting an early exposure to digital technologies during undergraduate or postgraduate training (**Figure 2 and 3**).

Differences were also evident across specialties. Prosthodontists, restorative - esthetic specialists and oral surgeons - implantologists demonstrated the highest mean frequency of scanner use, where general dentists reported lower usage rates, certain specialties such as endodontics showed lower integration of intraoral scanning (**Figure 4**).

These findings are comparable than those reported by *Van der Zande et al.* (2015) (23), who observed that younger, more recently graduated and those with specialization were more likely

to adopt a frequently use of digital technologies, despite an overall increase in digital adoption across the profession.

5.2. Digital restorations: satisfaction and advantages

In the table 3, we can see participants use of IOS regarding the type of restorations performed. Crowns (18%) were the most frequently reported type of restoration performed using an intraoral scanner, followed by PCR such as onlays (16%), inlays (14%) and overlays (14%). PCR thus represented a substantial proportion of IOS use in clinical practice. These patterns are consistent with the increasing adoption of digital workflows for prosthetic and restorative procedures in actual dental practice.

Regarding satisfaction, a majority of participants (60%) rated their satisfaction with IOS as the highest possible score when compared to conventional impression techniques (**Figure 5**). Higher satisfaction with digital impressions has been reported in previous studies, *Al-Hassiny et al.* (2023) (22) where clinicians and patients often perceive greater comfort with digital scanning and a preference for intraoral impressions over traditional methods.

Participants also identified a range of advantages associated with IOS use (**Table 4**). The most frequently cited benefits included improved patient comfort (19,5%) and accuracy of the impressions (17%), support the advantages of using a fully digital workflow. These perceived advantages align with the study of *Divya et al.* (2024) (24), in which respondents highlighted accuracy, increased patient comfort and communication with dental laboratories as key benefits of digital techniques.

5.3. Partial coverage restorations: intraoral scanner accuracy and failures

In another part of this study, PCR performed with IOS were evaluated for fit and adaptation (**Table 5**). Marginal fit was rated very good by 55.2 % of participants, while interproximal and occlusal adaptation were considered good by 43 % and 45 %, respectively. Although satisfaction for interproximal and occlusal contacts was not maximal, these parameters were still predominantly positive and none of the fit criteria was rated as very bad. These findings align with *Ammoun.* study (2019) (25), which identified interproximal regions and occlusal convergence as the most challenging areas for scanning, often showing reduced accuracy in partial coverage restorations due to limited access and adjacent teeth. Overall, the results

suggest that IOS provides clinically acceptable outcomes for partial restorations, with marginal fit being the most parameter, while interproximal and occlusal adaptation remain the critical points for future optimization.

Associated with these perceptions of accuracy, participants also evaluated the frequency of failures related to the same three aspects of PCR (**Table 6**). A large majority (58.2%) reported that marginal fit failures occurred in less than 5% of cases, indicating that marginal discrepancies are rare with restorations made from digital impressions. Similarly, 54% estimated interproximal adaptation failures in less than 5% of cases and 40 % indicated failure in less than 5% of cases for occlusal adaptation. However, a notable value 7.5% of respondents believed occlusal adaptation failures occurred in more than 50% of cases, making occlusal adaptation the area perceived as most recurrent to fail in PCR. These participant evaluations suggest that while digital impressions via IOS generally produce restorations with clinically acceptable fit, failure of occlusal adaptation remain the most critical and variable aspects of digital workflows.

Study (26) show that restorations made with digital workflows generally have low failure rates. Digital impressions report failure rates around 1.9%, comparable to or lower than those from conventional techniques in the study of *Xu. et al.* (2023) (26). These findings indicate that when proper scanning and fabrication protocols are applied, digital impressions reliably allow the fabrication of successful restorations with minimal technical failures.

5.4. Limitations of intraoral scanner

The questionnaire also explored the perceived limitations of IOS for PCR by asking participants to identify majors' factors affecting scan accuracy (**Table 7**). In the present study, saliva control was selected by 19% of respondents as the main challenge, followed by preparation depth (16%) and operator skill (15%), whereas the type of partial restoration was perceived as the least impactful factor (7%). These perceptions are supported by the literature, which highlights that IOS accuracy is influenced by operator-related and patient-related factors, including moisture control and preparation geometry, described in the study of *Alkali.* (2023) (1). Experimental studies have shown that increased preparation depth and complex cavity designs may reduce scan trueness and precision, confirming the multifactorial nature of digital impression accuracy as mentioned in the study of *Emre Özden et al.* (2025) (27).

The questionnaire also addressed the perceived disadvantages of the IOS (**Table 8**). The most frequently reported one was high cost (32.5%), followed by difficulties when scanning moist surfaces (26.5%) and challenges related to subgingival finish lines (25%). These findings suggest that the main barriers to intraoral scanner application remain economic and clinically related rather than technological. Similar limitations have been described in the study of *Dhull. et al.* (2024) (12), where financial investment, moisture control and the management of subgingival margins are consistently reported as primary challenges in digital impression workflows. Only 1.5% of participants identified lack of accuracy as a disadvantage, indicating that scanner precision is no longer perceived as a major concern among clinicians. This perception aligns with contemporary studies demonstrating high levels of trueness and precision of IOS systems for single-unit and partial restorations as previously cited.

5.5. Perspectives on the future use of intraoral scanners

The future of IOS use in the field of partial coverage restorations appears promising. In the present study, 58% of participants indicated that they intend to increase their use of IOS in the coming years, while most of the remaining respondents reported that they would continue using them at the same frequency (**Figure 7**). These findings suggest a sustained and potentially expanding role of digital impression systems in restorative practice. As described by *Al-Hassiny et al.* (2023) (22), clinicians are increasing their practice with digital workflows and plan to expand the use of IOS in daily practice. This trend reflects the growing role of IOS as a standard tool for indirect and PCR, enabling more efficient, predictable, and patient-friendly restorative procedures.

6. CONCLUSIONS

The results of this study show that intraoral scanners are widely integrated into modern dental practice for partial coverage restorations. Most practitioners report high satisfaction, good marginal adaptation and improved comfort compared to conventional impressions. However, factors such as saliva, preparation depth and operator experience can influence scanning accuracy. Overall, intraoral scanners represent a reliable and promising tool for restorative dentistry.

7. SUSTAINABILITY

Today, sustainability appears as an important aspect for actual dental practice. The conversion from conventional techniques to digital workflow helps to reduce the impact of dentistry over the environment. Digital impressions reduce the use of consumables as impressions materials and plaster, while it minimizes wastes and permit to eliminate the need of model transport, making it more ecological.

From an economical point of view, the initial investment to buy the IOS is considerable but over the time, this technology provide efficiency, reduced chairside time and few cases of re-impression, all of these points permit to enhance the cost-effectiveness and productivity of the practician.

Finally, from a social dimension, patient conditions, comfort and professional working conditions are much better with the IOS. Intraoral scanning offers more comfort to the patient and to the practician and offer a modern treatment approach.

Together, these elements demonstrate that digital dentistry and particularly the use IOS for partial coverage restorations impressions offer a more sustainable, efficient and ethically responsible dental practice.

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9. ANNEXES

9.1. Complete questionnaire

Graduation project survey

The use of intraoral scanner for partial coverage restorations among dental professionals

* Obligatoire

1. Which language would you like to use to answer this questionnaire? *

- ◯ English
- ◯ Español
- ◯ Français

2. **INFORMED CONSENT**

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 restorations among dental professionals"* and directed by

The purpose of this work is to analyse the use and the caracteristics of intraoral scanner for partial coverage preparations impressions and the information will be collected through a brief survey.

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.

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 intraoral scanner for partial coverage restorations among dental professionals"?

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 aforementioned 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

*

- ◯ Yes
- ◯ No

3. What is your specialty? *

- [ ] General practitioner
- [ ] Prosthodontist
- [ ] Restorative/esthetic
- [ ] Endodontist
- [ ] Orthodontist
- [ ] Surgeon/Implantogist
- [ ] Periodontist
- [ ] Pediatric dentist
- [ ]

4. How long have you been practicing dentistry? *

- ◯ Less than 1 year
- ◯ 1 to 5 years
- ◯ 6 to 10 years
- ◯ 11 to 15 years
- ◯ More than 15 years

5. What is your age ? *

- ◯ Under 25 years old
- ◯ 25-30 years old
- ◯ 31-40 years old
- ◯ 41-50 years old
- ◯ 51-60 years old
- ◯ More than 60 years old

6. How often do you use the intraoral scanner in your practice ? *

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Rarely
- ◯ Never

7. For which type of fixed prosthetic restorations do you use the intraoral scanner? Select one or multiple possibilities *

- ☐ Inlays
- ☐ Onlays
- ☐ Overlays
- ☐ Veneers
- ☐ Crowns
- ☐ Bridges
- ☐ Implants
- ☐

8. Compared to conventional impressions, how would you rate your level of satisfaction when using an intraoral scanner for partial coverage impressions? *

1	2	3	4	5

Not satisfied at all Much more satisfied

9. What do you consider to be the main advantages of using an intraoral scanner? Select one or more options *

- [ ] Time efficient
- [ ] Accuracy of the impression
- [ ] Immediate quality control
- [ ] Patient comfort
- [ ] Better communication with dental laboratory
- [ ] Complete digital workflow
- [ ] Other

10. Regarding the fit of partial coverage restorations prepared using an intraoral scanner, how do you perceive the following aspects ? *

	Very bad	Bad	Neutral	Good	Very good
Marginal fit	◯	◯	◯	◯	◯
Interproximal adaptation	◯	◯	◯	◯	◯
Occlusion	◯	◯	◯	◯	◯

11. Regarding the fit of partial coverage restorations prepared using an intraoral scanner, how is the frequency of failure of the following aspects ? *

	Less than 5% of cases	Between 5% and 25% of cases	Between 26% and 50% of cases	More than 50% of cases
Marginal fit	◯	◯	◯	◯
Interproximal adaptation	◯	◯	◯	◯
Occlusion	◯	◯	◯	◯

12. In your opinion, which factors have the greatest impact on the accuracy of a digital impression for partial coverage restorations? Select one or more options *

- [ ] Type of partial coverage restoration (inlay, onlay, ...)
- [ ] Location in the arcade
- [ ] Depth of the preparation
- [ ] Geometry of the preparation

- [ ] Surface reflectivity
- [ ] Saliva control
- [ ] Operator skill
- [ ] Technology system of the scanner (confocal, triangulation, microscopy, ...)
- [ ] Other

13. How do you perceive patient comfort when using digital impressions compared to conventional one? *

1	2	3	4	5
Much less comfortable				Much more comfortable

14. What do you consider to be the main disadvantages of using an intraoral scanner? Select one or more options *

- [ ] High cost
- [ ] Training needs
- [ ] Lack of accuracy
- [ ] Difficult use in moist surfaces
- [ ] Difficult use with sub gingival finish lines
- [ ] Compatibilty with the lab
- [ ] Other

15. Do you plan to increase your use of intraoral scanners in the coming years? *

- ◯ Yes for sure
- ◯ Yes, depending on patient needs
- ◯ No, I will continue using it at the same frecuency as today
- ◯ No, I do not plan to use this technology

16. **CONSENTIMIENTO INFORMADO**

El presente cuestionario forma parte del Trabajo de Fin de Grado en Odontología de la Universidad Europea de Madrid titulado "*uso del escanner intraoral para las restauraciones de recubrimiento partial entre profesionales dentales"* y dirigido por

El propósito del presente trabajo es analizar el uso y las características del escanner intraoral sobre las impresiones para restauraciones de recubrimiento parcial y la información será recogida a través de una breve encuesta.

Su participación en este estudio es de carácter libre y voluntario, pudiendo solicitar ser excluido del mismo, sin justificación previa ni perjuicio para usted. La información recogida será confidencial y no se usará para ningún otro propósito fuera de esta investigación y derivados de la divulgación investigativa. Los datos recogidos serán completamente anónimos. No se solicitarán datos personales identificativos. Los datos que se recojan en la encuesta se tratarán de acuerdo con lo establecido en la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales.

¿Da su consentimiento de participación en la encuesta como voluntario/a para que los resultados en la encuesta se utilicen en el Trabajo Fin de Grado "*uso del escanner intraoral para las restauraciones de recubrimiento partial entre profesionales dentales"*?

A los efectos de lo dispuesto en el reglamento de la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales, queda informado y es expresamente consiente de la utilización de los datos proporcionados en la encuesta, con los fines anteriormente indicados. El presente consentimiento se otorga sin perjuicio de todos los derechos que le asisten en relación con normativa anteriormente citada, existiendo la posibilidad de acceder a la información proporcionada, rectificación, cancelación y oposición en cualquier momento que lo desee. Para ello debe dirigirse por escrito al tutor *

- ◯ Si
- ◯ No

17. ¿Cual es su especialidad? *

- ☐ Odontólogo/a general
- ☐ Prostodoncista
- ☐ Restauradora/estética
- ☐ Endodoncista
- ☐ Ortodoncista
- ☐ Cirujano/Implantologó
- ☐ Periodoncista
- ☐ Odontopediatra
- ☐

18. ¿Desde cuánto tiempo ejerce la odontología? *

- ◯ Menos de 1 año
- ◯ 1 a 5 años
- ◯ 6 a 10 años
- ◯ 11 a 15 años
- ◯ Más de 15 años

19. ¿Cuál es su edad? *

- ◯ Menos de 25 años
- ◯ 25-30 años
- ◯ 31-40 años
- ◯ 41-50 años
- ◯ 51-60 años
- ◯ Más de 60 años

20. ¿Con qué frecuencia utiliza el escáner intraoral en su práctica? *

- ◯ Diario
- ◯ Semanalmente
- ◯ Mensual
- ◯ Rara vez
- ◯ Nunca

21. ¿Para qué tipo de restauraciones protésicas fijas utiliza el escáner intraoral? Seleccione una o varias opciones. *

- [ ] Inlays
- [ ] Onlays
- [ ] Overlays
- [ ] Carillas
- [ ] Coronas
- [ ] Puentes
- [ ] Implantes
- [ ] Otros

22. En comparación con las impresiones convencionales, ¿cómo calificaría su nivel de satisfacción al usar un escáner intraoral para impresiones de recubrimiento parcial? *

1	2	3	4	5

Muy insatisfecho Muy satisfecho

23. ¿Cuáles considera que son las principales ventajas de usar un escáner intraoral? Seleccione una o varias opciones. *

- [ ] Mayor eficiencia
- [ ] Mayor precisión
- [ ] Control de calidad inmediato
- [ ] Mejor confort del paciente
- [ ] Mejor comunicación con el laboratorio dental
- [ ] Flujo de trabajo digital completo
- [ ] Otros

24. En relación con el ajuste de las restauraciones de recubrimiento parcial realizadas usando un escáner intraoral, ¿cómo percibe los siguientes aspectos? *

	Muy pobre	Pobre	Neutral	Buena	Muy buena
Ajuste marginal	◯	◯	◯	◯	◯
Ajuste interproximal	◯	◯	◯	◯	◯
Oclusión	◯	◯	◯	◯	◯

25. En relación con el ajuste de las restauraciones de recubrimiento parcial preparadas con un escáner intraoral, ¿con qué frecuencia ocurren fallos en los siguientes aspectos? *

	Menos del 5% de los casos	Entre 5% y 25% de los casos	Entre 26% y 50% de los casos	Más del 50% de los casos
Ajuste marginal	◯	◯	◯	◯
Ajuste interproximal	◯	◯	◯	◯
Oclusión	◯	◯	◯	◯

26. En su opinión, ¿qué factores tienen el mayor impacto en la precisión de una impresión digital para restauraciones de recubrimiento parcial? Seleccione una o varias opciones. *

- ☐ Tipo restoración parcial (inlay, onlay, ...)
- ☐ Localización en la arcada
- ☐ Profundidad de la preparación
- ☐ Geometría de la preparación
- ☐ Reflectancia de la superficie
- ☐ Control de saliva

- [ ] Habilidad del operator
- [ ] Sistema de escaneo (confocal, triangulación, microscopía, ...)
- [ ] Otros

27. ¿Cómo percibe la comodidad del paciente al usar impresiones digitales en comparación con las convencionales? *

1	2	3	4	5

Muy incómodo Muy cómodo

28. ¿Cuáles considera que son las principales desventajas de usar un escáner intraoral? Seleccione una o varias opciones. *

- [ ] Coste
- [ ] Necesidad de formación
- [ ] falta de precisión
- [ ] Dificultad para escanear superficies húmedas
- [ ] Uso difícil con lineas de terminación subgingivales
- [ ] Compatibildad con el laboratorio
- [ ] Otros

29. ¿Planea aumentar el uso de escáneres intraorales en los próximos años? *

- ◯ Sí, seguro
- ◯ Sí, dependiendo de las necesidades del paciente
- ◯ No, seguiré usándolo con la misma frecuencia que hoy
- ◯ No, no planeo usar esta tecnología

30. **CONSENTEMENT ÉCLAIRÉ**

Cette enquête fait partie du projet de fin d'études en chirurgie dentaire de l'Université européenne de Madrid intitulé "L'utilisation du scanner intra-oral pour les restaurations de recouvrement partielle chez les professionnels dentaires" et

L'objectif de ce travail est d'analyser l'utilisation et les caractéristiques du scanner intra-oral pour les empreintes de restaurations à recouvrement partielle. Les informations seront recueillies au moyen d'une brève enquête.

Votre participation à cette étude est volontaire. Vous pouvez demander à être retiré de l'étude sans justification préalable et sans préjudice pour vous. Les informations recueillies resteront confidentielles et ne seront utilisées à aucune autre fin que celle de la recherche et de la diffusion des résultats de la recherche. Les données recueillies seront totalement anonymes. Aucune information permettant de vous identifier personnellement ne vous sera demandée. Les informations recueillies dans le cadre de l'enquête seront traitées conformément aux dispositions de la loi organique 3/2018 du 5 décembre relative à la protection des données à caractère personnel et à la garantie des droits numériques.

Donnez-vous votre consentement pour participer à l'enquête en tant que volontaire afin que les résultats soient utilisés dans le projet de fin d'études intitulé "L'utilisation du scanner intra-oral pour les restaurations de recouvrement partielle chez les professionnels dentaires" ?

Conformément aux dispositions du règlement de la Loi organique 3/2018 du 5 décembre relative à la protection des données personnelles et à la garantie des droits numériques, vous êtes informé(e) et donnez expressément votre consentement pour que les données fournies dans le cadre de cette enquête puissent être utilisées aux fins susmentionnées. Ce consentement est accordé sans préjudice de tous les droits dont vous disposez en vertu de la réglementation précitée, notamment le droit d'accès, de rectification, de suppression et d'opposition, que vous pouvez exercer à tout moment. Pour ce faire, vous devez écrire

- ◯ Oui
- ◯ Non

31. Quelle est votre spécialité ? *

- ☐ Omnipraticien
- ☐ Prothodontiste
- ☐ Dentisterie restauratrice/esthétique
- ☐ Endodonctiste
- ☐ Orthodontiste
- ☐ Chirurgien/Implantologiste
- ☐ Parodontiste
- ☐ Dentisterie pédiatrique
- ☐

32. Depuis combien de temps pratiquez-vous en tant que chirurgien-dentiste ? *

- ◯ Moins d'un an
- ◯ 1 à 5 ans
- ◯ 6 à 10 ans
- ◯ 11 à 15 ans
- ◯ Plus de 15 ans

33. Quel âge avez vous ? *

- ◯ Moins de 25 ans
- ◯ 25-30 ans
- ◯ 31-40 ans
- ◯ 41-50 ans
- ◯ 51-60 ans
- ◯ Plus de 60 ans

34. A quelle fréquence utilisez-vous le scanner intra-oral dans votre pratique ? *

- ◯ Quotidienement
- ◯ Hebdomadaire
- ◯ Mensuel
- ◯ Rarement
- ◯ Jamais

35. Pour quel type de restaurations prothétiques fixes utilisez-vous le scanner intra-oral ? Sélectionnez une ou plusieurs options. *

- [ ] Inlays
- [ ] Onlays
- [ ] Overlays
- [ ] Facettes
- [ ] Couronnes
- [ ] Bridges
- [ ] Implants
- [ ] Autre

36. En comparaison aux empreintes conventionnelles, comment évalueriez-vous votre niveau de satisfaction lors de l'utilisation d'un scanner intra-oral pour les empreintes à recouvrement partiel ? *

1	2	3	4	5

Très insatisfait Très satisfait

37. Quels sont, selon vous, les principaux avantages de l'utilisation d'un scanner intra-oral ? Sélectionnez une ou plusieurs options. *

- [ ] Gain de temps
- [ ] Précision de l'impression
- [ ] Control qualité immédiat
- [ ] Confort du patient
- [ ] Meilleure communication avec le laboratoire dentaire
- [ ] Flux de travail entièrement numérique
- [ ] Autre

38. Concernant l'adaptation des restaurations à recouvrement partiel réalisées avec un scanner intra-oral, comment percevez-vous les aspects suivants ? *

	Très mauvaise	Mauvaise	Neutre	Bonne	Très bonne
Adaptation marginale	◯	◯	◯	◯	◯
Adaptation Interproximale	◯	◯	◯	◯	◯
Occlusion	◯	◯	◯	◯	◯

39. Concernant l'adaptation des restaurations à recouvrement partiel préparées avec un scanner intra-oral, à quelle fréquence observez-vous des échecs pour les aspects suivants ? *

	Moins de 5% des cas	Entre 5% et 25% des cas	Entre 26% et 50% des cas	Plus de 50% des cas
Adaptation marginale	◯	◯	◯	◯
Adaptation interproximale	◯	◯	◯	◯
Occlusion	◯	◯	◯	◯

40. Selon vous, quels facteurs ont le plus d'impact sur la précision d'une empreinte numérique pour les restaurations de recouvrement partiel ? Sélectionnez une ou plusieurs options. *

- ☐ Type de restoration partielle (inlay, onlay, ...)
- ☐ Localisation dans l'arcade
- ☐ Profondeur de la préparation
- ☐ Geometrie de la préparation
- ☐ Brillance de la surface
- ☐ Contrôle de la salive
- ☐ Habilité de l'opérateur
- ☐ Technologie du scanner (confocal, triangulation, microscopie, ...)
- ☐

41. Comment percevez-vous le confort du patient lors de l'utilisation d'empreintes numériques par rapport aux empreintes conventionnelles ? *

1	2	3	4	5

Très inconfortable Très confortable

42. Quels sont, selon vous, les principaux inconvénients de l'utilisation d'un scanner intra-oral ? Sélectionnez une ou plusieurs options. *

- [ ] Coût élevé
- [ ] besoin de formation
- [ ] Manque de précision
- [ ] Usage difficile sur les surfaces humides
- [ ] Usage difficiles avec les marges subgingivales
- [ ] Compatibilité avec le laboratoire
- [ ] Autre

43. Prévoyez-vous d'augmenter votre utilisation du scanner intra-oral dans les prochaines années ? *

- ◯ Oui certainement
- ◯ Oui, en fonction des besoins des patients
- ◯ Non, je continuerai à l'utiliser à la même fréquence qu'aujourd'hui
- ◯ Non, je ne prévois pas d'utiliser cette technologie

Ce contenu n'a pas été créé ni n'est approuvé par Microsoft. Les données que vous soumettez sont envoyées au propriétaire du formulaire.

Microsoft Forms

9.2. Informed consent

MODELO DE CONSENTIMIENTO INFORMADO PARA ENCUESTAS DE TRABAJO FIN DE GRADO

Este documento es un modelo de Consentimiento Informado para encuestas **anónimas** desarrolladas en Trabajos de Fin de Grado de Odontología. El tutor responsable deberá eliminar este encabezado y sustituir el texto en rojo por la información que corresponda. En algunos casos será necesario adaptar el Consentimiento Informado al estudio e incluir información adicional.

CONSENTIMIENTO INFORMADO

El presente cuestionario forma parte del Trabajo de Fin de Grado en Odontología de la Universidad Europea de Madrid titulado "*uso del escanner intraoral para las restauraciones de recubrimiento partial entre profesionales dentales"* y dirigido por el Profesor/a El propósito del presente trabajo es analizar el uso y las características del escanner intraoral sobre las impresiones para restauraciones de recubrimiento parcial y la información será recogida a través de una breve encuesta.

Su participación en este estudio es de carácter libre y voluntario, pudiendo solicitar ser excluido del mismo, sin justificación previa ni perjuicio para usted. La información recogida será confidencial y no se usará para ningún otro propósito fuera de esta investigación y derivados de la divulgación investigativa. Los datos recogidos serán completamente anónimos. No se solicitarán datos personales identificativos. Los datos que se recojan en la encuesta se tratarán de acuerdo con lo establecido en la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales.

¿Da su consentimiento de participación en la encuesta como voluntario/a para que los resultados en la encuesta se utilicen en el Trabajo Fin de Grado "*uso del escanner intraoral para las restauraciones de recubrimiento partial entre profesionales dentales"*?

Si ☐ **No** ☐

A los efectos de lo dispuesto en el reglamento de la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales, queda informado y es expresamente consiente de la utilización de los datos proporcionados en la encuesta, con los fines anteriormente indicados. El presente consentimiento se otorga sin perjuicio de todos los derechos que le asisten en relación con normativa anteriormente citada, existiendo la posibilidad de acceder a la información proporcionada, rectificación, cancelación y oposición en cualquier momento que lo desee. Para ello debe dirigirse por escrito al tutor Prof.

9.3. Validation of investigation committee

Universidad Europea

Comisión de Investigación

Villaviciosa de Odón, 4 de noviembre de 2025

Estimado/a investigador/a,

La Comisión de Investigación de la Unidad de Investigación, una vez revisada la documentación e información, remitida por el investigador responsable con fecha 03/11/2025 11:54:06, relativa al proyecto abajo indicado, autoriza su desarrollo en la Universidad Europea.

Título del proyecto:	The use of intraoral scanner for partial coverage restorations among dental professionals
Tipo de proyecto:	TFG
Investigador/a responsable:	
Código CI:	2025-769
Código OTRI:	Sin especificar
Código Departamento:	OD016/2526
Dictamen:	APROBADO

Atentamente,

Ruth M. Risueño

Universidad Europea
ESCUELA DE DOCTORADO E INVESTIGACIÓN

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