



GRADUATION PROJECT

Degree in Dentistry

WHAT IS THE MOST COMMONLY USED MATERIALS FOR POSTERIOR RESTORATIONS AFTER ROOT CANAL TREATMENT?

Madrid, academic year 2025/2026

Identification number:180

ABSTRACT

Introduction: Restoring of the posterior teeth after root canal treatment still constitutes a considerable clinical challenge, as these teeth frequently present with substantial structural deficit and an increased risk of fracture. Restorative material and process must therefore be selected adequately to maintain function, resistance, and to conserve the intact tooth surface;

Objectives: To identify the materials and restorative strategies most commonly used by dentists for posterior restorations after root canal treatment, and to analyze the main factors influencing these clinical decisions; **Material and methods:** A cross-sectional questionnaire survey was employed among dental professionals involved in the restoration of posterior endodontically treated teeth. The questionnaire comprised 18 items regarding demographic,

endodontic, post and core strategies, restorative techniques, final materials selections and failure mode information. Answers were collected anonymously; **Results:** A total of 103 dentists participated, and 102 responses were selected. The approach reported most frequently was indirect restorations with cuspal coverage. The most chosen final restoration was full-coverage crowns (60%), followed by onlays/overlays (34%), and direct composite restorations were applied, by far less (4%). For indirect restorative materials, monolithic zirconia was the most used followed by lithium disilicate. Main material for core build-up was composite resin (81%), and fiber posts preferred over metal posts. Fracture resistance, esthetic properties, and adhesive properties were the main parameters affecting material selection. The most prevalent failure modes were re-infection, and endodontic failure;

Conclusion: Dentists are predominantly more inclined to use indirect restorations with cuspal coverage for the posterior teeth following root canal treatment. The most common choices had included full-coverage crowns, monolithic zirconia, composite core build-ups and fiber posts. The retention of residual tooth structure, appropriate protection of the cuspal region and proper selection of material would appear to be the most important factors for sustained restorative success.

KEYWORDS

Dentistry; Posterior teeth; Root canal treatment; Endodontically treated teeth; Indirect restorations.

RESUMEN

Introducción: La restauración de los dientes posteriores después del tratamiento de conductos sigue constituyendo un reto clínico considerable, ya que estos dientes presentan con frecuencia una pérdida estructural importante y un mayor riesgo de fractura. Por ello, el material y el procedimiento restaurador deben seleccionarse adecuadamente para mantener la función, la resistencia y conservar la estructura dental sana remanente; **Objetivos:** Identificar los materiales y las estrategias restauradoras más comúnmente utilizados por los odontólogos para las restauraciones posteriores después del tratamiento de conductos, y analizar los principales factores que influyen en estas decisiones clínicas; **Material y métodos:** Se realizó un estudio transversal mediante un cuestionario dirigido a profesionales odontológicos implicados en la restauración de dientes posteriores tratados endodónticamente. El cuestionario constaba de 18 ítems relacionados con datos demográficos, estrategias endodónticas, uso de postes y reconstrucción del muñón, técnicas restauradoras, selección de materiales definitivos e información sobre los modos de fracaso. Las respuestas se recogieron de forma anónima; **Resultados:** Participaron un total de 103 odontólogos, de los cuales se seleccionaron 102 respuestas. El enfoque más frecuentemente reportado fue el de las restauraciones indirectas con recubrimiento cuspidé. La restauración final más elegida fueron las coronas de cobertura total (60%), seguidas de los onlays/overlays (34%), mientras que las restauraciones directas con resina compuesta se utilizaron en mucha menor medida (4%). En cuanto a los materiales restauradores indirectos, la zirconia monolítica fue la más utilizada, seguida del disilicato de litio. El principal material para la reconstrucción del muñón fue la resina compuesta (81%), y los postes de fibra fueron preferidos frente a los postes metálicos. La resistencia a la fractura, las propiedades estéticas y las propiedades adhesivas fueron los principales parámetros que influyeron en la selección del material. Los modos de fracaso más prevalentes fueron la reinfección y el fracaso endodóntico; **Conclusión:** Los odontólogos muestran predominantemente una mayor inclinación por utilizar restauraciones indirectas con recubrimiento cuspidé en dientes posteriores tras el tratamiento de conductos. Las opciones más comunes incluyeron coronas de cobertura total, zirconia monolítica, reconstrucciones de muñón con resina compuesta y postes de fibra. La preservación de la estructura dental remanente, la protección adecuada de la región cuspidéa y la correcta selección del material parecen ser los factores más importantes para lograr un éxito restaurador duradero.

PALABRAS CLAVES

Odontología; Dientes posteriores; Tratamiento de conductos; Dientes tratados endodónticamente; Restauraciones indirecta

TABLE OF CONTENT

1. INTRODUCTION	1
1.1- Background on root canal treatment and restorations	1
1.2- Biomechanical considerations of endodontically treated teeth	1
1.3- Direct restorative materials for posterior teeth after root canal treatment	2
1.4- Indirect restorative materials for posterior root canal treated teeth	3
1.5- Post placement and core retention systems	3
1.6- Alternative restoratives approaches: endocrowns and minimally invasive strategies	4
1.7- Restorative materials and techniques impact on periodontal and periapical health	4
1.8- Influence of the amount of remaining tooth structure on restorations choice and outcome	5
1.9- Summary and clinical significance	6
2. OBJECTIVES	7
3. MATERIAL AND METHODS	8
3.1- Study design	8
3.2- Study population and sampling	8
3.3- Survey instrument	8
3.4- Procedure	9
3.5- Ethical and legal considerations	10
3.6- Data management and statistical analysis	10
4. RESULTS	11
4.1- Participant characteristics:	11
4.2- Endodontic practice patterns:	11
4.3- Posting and Core Building Materials:	11
4.4- Restorative strategies after RCT:	13
4.5- Final restorative materials:	13

4.6-	Influencing factors contributing to the choice of materials:	14
4.7-	Modes of failure and success Factors:	14
5.	DISCUSSION	15
6.	CONCLUSIONS	18
7.	SUSTAINABILITY	19
8.	BIBLIOGRAPHY	20
9.	ANNEXES	22

1. INTRODUCTION

1.1- Background on root canal treatment and restorations

Root canal treatment (RCT) is a standard dental procedure that treats infected or damaged dental pulp tissue, preserving the natural tooth (1). After RCT, posterior teeth may exhibit significant structural deficits resulting from caries, cavity access preparation, and root canal instrumentation (1). This loss of tooth structure greatly diminishes the stiffness but also biomechanical ability of the tooth, leading to increasing fracture susceptibility (2).

The restoration process, following RCT, must be successful to restore the function, form, aesthetics to the tooth and to prevent continuous microbial colonization or mechanical damage (2). Posterior restoration should ideally protect tooth structure, restore occlusal stability and periodontal health (2). A dominant factor in the restoration strategy is the amount and quality of the residual coronal tooth structure, for which a ferrule effect (a band of natural tooth structure wrapping around the crown) and the number of remaining walls largely influence fracture-resistance and survival of the tooth (3). There is some evidence to support that the root-filled posterior teeth with sufficient remaining tooth structure and ferrule are more likely to bear the predicted prognosis than root-filled posterior teeth with insufficient remaining tooth structure (2,3).

The challenge of restorative treatment in endodontically treated teeth (ETT) is especially prominent in the posterior dentition because of elevated occlusal forces and functional requirements (3). Further, the complex choice regarding restoration type is affected by factors including tooth position, amount of remaining tooth tissue and the timing of definitive restoration placement post-RCT (2,3). Delays after four months in placing a cuspal cavity coverage restoration have been shown to facilitate more easily to tooth fracture, and extraction (3).

1.2- Biomechanical considerations of endodontically treated teeth

Mechanical characteristics of ETT differ slightly but significantly from vital teeth (3,4). Changes in dentin collagen and moisture content were initially hypothesized to increase brittleness, but more recent studies suggest that these physical properties remain unchanged post-treatment (4). As opposed to this, volumetric loss of hard tissue (due to caries, access cavity preparation, and root canal treatments) is the most important factor influencing tooth strength (4). For

example conservative endodontic access cavities, reduce tooth stiffness by about 5%, while wider preparation, like MOD cavities, can reduce stiffness by about 63% (5).

From a clinical perspective, vertical root fractures, cusp fractures, and periodontal issues are frequently the cause of failure, highlighting the essential role that balance should play in restoring the mechanical integrity of the body (4,5).

The so-called ferrule effect: an area of natural tooth material surrounding the crown margin, is well thought of as critical for fracture prevention and long run success (5). For complete reinforcement, a minimum 1-2 mm of sound dentin is generally determined to be necessary (6). The addition of a ferrule is effective in spreading this type of stress evenly and reducing the concentration that can lead in catastrophic failure (6). A complete ferrule effect, however, is not always achievable due to extensive structural loss, requiring clinicians to balance restorative goals with biological and esthetic considerations (7).

The amount and quality of remaining tooth structure, including the number and thickness of remaining dentin walls, significantly affect the survival of ETT (7). The position of the teeth and proximal contacts also affect the prognosis; the molars have higher failure rates; meanwhile the existence of nearest teeth may also help in providing better stress distribution (8).

1.3- Direct restorative materials for posterior teeth after root canal treatment

Direct restorations in one place on a single visit, are conservatively applied as a restorative option for the posterior root canal-treated teeth (8). Composite resin have developed into the leading direct restorative material due to the combination of excellent adhesive bonding ability, esthetic characteristics as well as retention of tissue, compared to amalgam (9).

Modern advancements such as bulk-fill and short-fiber-reinforced composites (SFRC) offer better mechanical properties and lower polymerization shrinkage stress than traditional composite preparation (6,9). SFRC materials serve as crack-arresting agents by the orientation of fibers, providing an improved fracture protection and durability when the teeth is structurally compromised (9).

As well as providing acceptable short to medium term survival outcomes, clinical evidence in direct composite restorations have supported the approach (9). The main complications are polymerization shrinkage related increase in stress and marginal degradation resulting in secondary caries (9). In an alternative, prospective randomized controlled trial, comparing direct composite restorations to full coverage metal-ceramic crowns, found similar 3-year survival rates among premolars with Class 2 cavities, indicating potential acceptability of direct restorations for teeth with adequate coronal structure (9). In contrast, literature suggest

increased failure rates for direct restorations in teeth with extensive structural loss, including those lacking coronal walls or undermined (9).

1.4- Indirect restorative materials for posterior root canal treated teeth

Indirect restorations produced outside the mouth are therefore the leading alternative technique for posterior teeth with great coronal structure loss (10,9). Among the indirect materials are lithium disilicate ceramics, zirconia, porcelain-fused-to-metal (PFM) crowns, and CAD/CAM composite or ceramic onlays and endocrowns (10). Lithium disilicate and zirconia have excellent mechanical properties, including high fracture resistance, excellent wear characteristics, and esthetic advantages ; while zirconia can present challenges in marginal adaptation and adhesive cementation (10). Metal-ceramic crowns are known to have an 11-year survival rate of around 95%, but dental caries is still the major contributor to the failure of a crown (9,10).

Reviews comparing indirect and direct restorations always showed better long-term survival for posterior teeth restored with indirect cuspal coverage restorations, especially when placed within four months following RCT (10). All-ceramic crowns constructed from reinforced glass ceramic display similar 5-year survival compared to metal-ceramic crowns, with similar failure mechanisms, dental caries and most often from a ceramic core fracture (10).

1.5- Post placement and core retention systems

In structurally compromised teeth the use of intraradicular posts to anchor core build-ups and for the final restorations is still clinically debated (11). Posts do not reinforce the tooth structure; rather, they provide mechanical retention for restorations when the coronal walls are insufficient (11). Post insertion requires removal of more dentin to prepare the post space, potentially eroding radicular structure even more (11). Flexible fiber-reinforced posts are preferable to rigid metal or ceramic posts because of their elastic modulus similarity to dentin, leading to a more equidimensional stress distribution with a reduction in the chance of catastrophic root fractures (11).

Clinical data show that posts are selectively indicated when there is little or no ferrule effect; when sufficient coronal structure remains, placing a post does not improve the survival of the restoration and may be contraindicated (11). Notable recent prospective clinical trials and long-term studies have not provided a conclusive advantage of flexible versus rigid post materials regarding tooth survival and restoration success (11,12). Adhesive luting protocols are critical for post retention; self-adhesive resin cements have gained in popularity for their

easier application. Although certain combinations of adhesive-cement with total-etch protocols usually result in enhanced bonding strength to radicular dentin (12). Advanced multi-fiber reinforced composite posts and custom CAD/CAM posts give adhesive retention with lower additional dentin preparation (12).

1.6- Alternative restorative approaches: endocrowns and minimally invasive strategies

Endocrowns are a conservative and effective alternative to traditional post-and-core restorations for posterior teeth that have undergone root canal treatment (12). An endocrown is a monolithic, adhesive restoration that anchors within the pulp chamber without the need for an intraradicular post, preserving more tooth structure compared to conventional crowns with post (13). Lithium disilicate ceramics are the most widely used for endocrowns due to their favorable adhesive properties, fracture resistance, and esthetics. Studies indicate that endocrowns provide comparable survival rates to traditional indirect crowns in molars, while premolars and anterior teeth have shown less favorable outcomes likely due to biomechanical loading differences and smaller bonding surfaces (13).

Endocrowns are well supported by minimally invasive restorative techniques that focus on the conservation of residual tooth structure (13). Methods like deep margin elevation (DME) involve repositioning subgingival restoration margins coronally using adhesive composite resin. This method facilitates better isolation during restorative treatments, improves marginal adaptation, and reduces the risk of gingival inflammation and periodontal complications related to subgingival margins (13). DME also simplifies impression taking and fabrication of indirect restorations without the need for surgical crown lengthening, which may affect periodontal health (13).

Advances in adhesive technology and biomaterials are pivotal for both endocrowns and minimally invasive adhesive strategies. The predictability of these approaches has been facilitated with improved bonding agents, resin cements, and fiber-reinforced composite materials that closely mimic dentin's mechanical behavior, resulting in durable and fracture-resistant restorations while minimizing invasive tissue removal (13).

1.7- Restorative materials and techniques impact on periodontal and periapical health

Coronal restoration quality directly affects periodontal and periapical health in endodontically treated teeth. The restoration is the most significant barrier to microbial infiltrations into the root canal system: poor restorations with open margins, recurrent decay, or fractures enable bacterial contamination and compromise periapical healing (14).

In retrospective study, 40.5% of teeth restored with composite restorations presented with apical periodontitis. On the other hand, 28.4% of patients with amalgam restorations developed apical periodontitis, indicating material-related differences in marginal seal quality and longevity (14).

Clinical evidence demonstrates that elevated periodontal index: specifically plaque index, gingival index, clinical attachment loss and probing depth, increases the risk of apical periodontitis in restored root canal treated teeth. (14). These periodontal factors greatly contribute to increase the risk of apical periodontitis by 1,5 to 2 (14). The close anatomical relationship between the endodontic and periodontal structures enables the transmission of bacterial pathogens through lateral canals, accessory canals and the apical foramen (14).

The choice of restoration material affects marginal adaptation and the tissue response. Adhesive materials such as resin composites and ceramic restorations provide a superior marginal seal compared to traditional non-adhesive materials (14). Subgingival margins, particularly those associated with inadequate restorations, promote biofilm accumulation and gingival inflammation (15).

Timing of restorations placement is important, late restorations exceeding 60 days after RCT results in unprotected root canals susceptible to contamination while early implantation (<14 days) offers protective cuspal coverage and remains very good for the periodontal health (15).

1.8- Influence of the amount of remaining tooth structure on restorations choice and outcome

The rest of the tooth structure determines the choice of material for long-term maintenance (15). Less than 30% of original coronal structure teeth are 3 times more likely to have extraction and require protective indirect restorations, while those with more than 30% can be treated with conservative direct composites resin or fiber posts with elastic moduli similar to dentin (16). Tissue preservation is the most critical determinant of restoration longevity (16). Conservative access cavities reduce stiffness by 5% and extensive preparation by 63%, therefore reducing biomechanical strength in case of extensive preparations (16).

A satisfactory ferrule of 2 mm decreased the failure rates to 6.67% compared with 26.2% without ferrule, independent of the material used (17,16). In teeth with more than 50% remaining structure and an adequate ferrule, direct composite restorations with fiber posts achieve 5-year survival rates consistent with crowns (78%) when performed within 14 days following RCT (17). Teeth with 30-60% structural loss should be evaluated specifically according to the configuration of the wall, presence of ferrule effect and occlusal risk (17).

Those with coronal wall deficiency (<30% or absent coronal wall) will need to have immediate indirect cuspal coverage restorations (17).

1.9- Summary and clinical significance

Restoring posterior teeth from root canal treatment is a complex clinical decision that demands consideration of biomechanics, material science evidence, and individual patient factors. At present, indirect cuspal coverage restorations appear to have superior long-lasting performance for teeth with significant structural loss, while direct composite restorations may be effective enough for teeth only with minimal compromise but adequate coronal structure remaining. Posts should be applied selectively, such as flexible fiber-reinforced systems, when the ferrule is inadequate. Other techniques like endocrowns and deep margin elevation are conservative alternatives that broaden the range of treatment possibilities. Rapid restoration after root canal work is still recommended for good tooth survival and prevention of fracture.

2. OBJECTIVES

Primary objective:

The primary objective will be to evaluate and compare the clinical effectiveness of direct restorations materials versus indirect restorations materials (Lithium disilicate, zirconia, PFM...) in posterior teeth that have undergone root canal treatment, focusing on technique used by dentist and long-term survival.

Secondary objectives:

- To compare the failure rates of direct restorations vs indirect restorations in posterior teeth after root canal treatment.
- To assess the impact of the amount of remaining tooth structure on the choice and survival of direct versus indirect restorations in root canal-treated posterior teeth.

3. MATERIAL AND METHODS

Survey items and introduction were developed with the aid of focused review of clinical and material-science literature on posterior restoration and root-filled posterior teeth, obtained from PubMed and Medline Complete, including relevant articles on post-endodontic restorative strategies and selection of materials.

3.1- Study design

Analysis of restorative techniques and most frequently used materials for posterior restorations after root canal treatment using a cross-sectional, questionnaire-based survey design among dental professionals.

3.2-Study population and sampling

The focus group was dentists involved in posterior root canal-treated teeth, including general practitioners and some specialists (endodontics, prosthodontics, oral surgery and others). The survey was sent as an electronic questionnaire to the clinicians through professional networks, personal contacts and email. Convenience sampling strategy was applied in the survey and all clinicians who received the link were asked to participate voluntarily.

Inclusion criteria were.

- Licensed dentists who were in clinical practice at the time of the study.
- To be involved in decision-making and/or provision of restorative treatment for posterior teeth following root canal therapy.

Analysis excluded incomplete questionnaires with no responses to key questions about final restoration and material selection.

3.3-Survey instrument

The information was gathered through the questionnaire: "Survey: Posterior Restoration After Root Canal Treatment" specifically design for this project.

The survey consisted of 18 items:

- Demographics and professional profile: country of practice, years of clinical experience, principal practice type, type of practice.
- Endodontic practice profile: performance of root canal treatments, average number of posterior RCT cases restored per month.
- Post and core strategies: the frequency of post placement, the preferred post type (fiber, metal, ceramic, other) and preferred core build-up material (composite, resin-modified glass ionomer, glass ionomer, amalgam...).
- Restorative approach: frequency of cuspal coverage, use of direct composite restorations, most frequently used final restoration (full-coverage crown, onlay/overlay, direct composite, temporary long-term restoration...) and preferred material (monolithic zirconia, lithium disilicate, metal-ceramic, full metal, composite resin...)
- Clinical reasoning and outcomes: main reasons for selecting the material (fracture resistance, esthetics, cost, familiarity, adhesive performance, laboratory/CAD-CAM factors), perceived main failure mode (tooth fracture, restoration fracture, loss of retention, re-infection...), necessity for immediate cusp coverage as well as the most important factors to success (residual tooth structure, adhesive selection, occlusal maintenance, choice of material, skill of the operator, or equivalent).
- Comments: free-text area to encourage additional comments or suggestions about posterior restorations after RCT

The questionnaire consisted of multiple-choice questions with either single or multiple answers, ordinal Likert-type question and a single open-ended question.

3.4- Procedure

The survey was designed in an internet survey site (Microsoft Forms), distributed through email and messaging apps with a shareable URL and QR code. Participation was anonymous, voluntary, and no identifying personal data were collected. The survey was open to responses for 1 month. Only one response per professional was considered, and duplicate post-answers were excluded.

3.5-Ethical and legal considerations

The Ethics Committee received and approved the study protocol, including the survey instrument and recruitment plan.

CI code: 2026-219

CD code: OD.050/2526

There was no patient information gathered, and the study did not interfere with existing therapeutic treatment.

3.6- Data management and statistical analysis

The responses were exported from the survey to an excel table for easy cleaning and analysis.

Data were checked for completeness and consistency. The main result of interest was the most used final restoration and material of posterior root canal-treated teeth as a function of total responses.

4. RESULTS

A total of 103 dentists participated in the survey, and 102 respondents provided consent for their responses to be included in the analysis. The survey collected information regarding clinicians' restorative strategies for posterior teeth following root canal treatment (RCT).

4.1- Participant characteristics:

Many had considerable clinical experience. 51% of the respondents had over 20 years, 31% had 10–20 years, 11% 3–10 years, and 7% < 3 years of clinical experience.

Most dentists reported working in private practice (89%), with minority members working in public clinics or hospitals (4%), mixed practice (5%), or other settings (2%).

When asked about specialization, the majority of respondents were general dentists (94), with fewer practicing prosthodontics, oral surgery, endodontics, orthodontics, or other specialists.

4.2-Endodontic practice patterns:

While most of the respondents said they were doing the root canal treatments themselves. 66%, said they perform RCT routinely, 21% perform the RCT occasionally, and 14% refer to other practitioners for these treatments.

In clinical workload, 43% of respondents reported 5–10 posterior RCT cases per month and 35% fewer than 5 cases per month, with 17% reporting 10–20 cases and 6% reporting over 20 cases per month.

4.3-Posting and Core Building Materials:

In restoration after RCT, when questioned regarding placement of posts within posterior teeth, the majority of dentists indicated that posts are used frequently (34%), occasionally (31%), or always (17%). A lesser proportion, 18% rarely placed one, and a minority (1%) never did (Table 1).

When considering clinicians putting posts together, the majority of users favored fiber posts (57%) and metal posts (40%) more often, with ceramic posts being less used (Table 2).

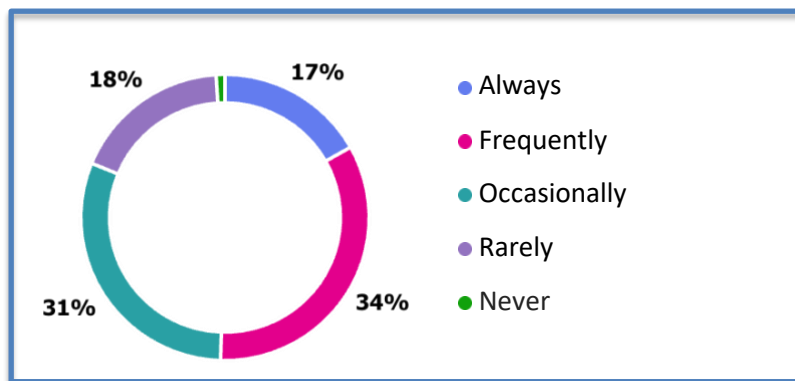


Table 1: Frequency of posts placement in endodontically treated posterior teeth

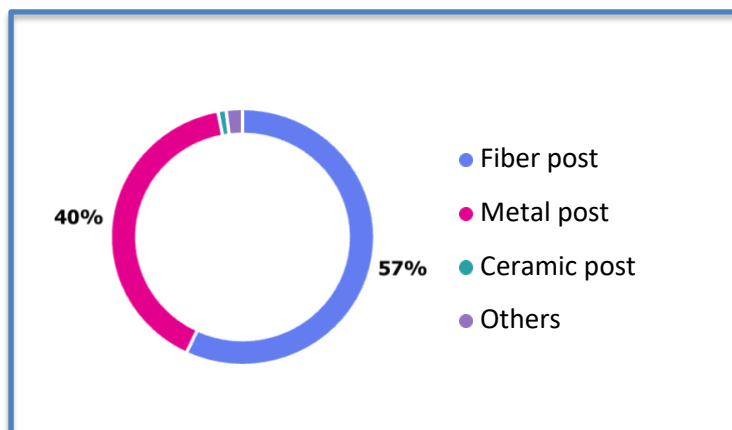


Table 2: Type of posts used for posterior endodontically treated teeth

Among the core build-up materials, resin composite was the most prevalent (81%), followed by resin-modified glass ionomer (9%) and glass ionomer (2%), which were used far less frequently (Table 3).

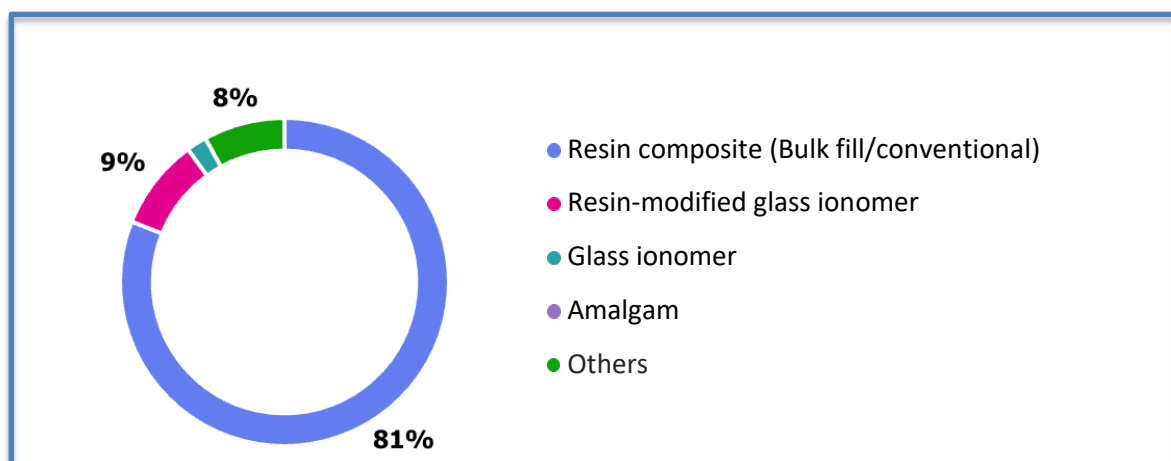


Table 3: Core build-up materials

4.4-Restorative strategies after RCT:

Almost all dentists reported performing cuspal coverage regularly on posterior endodontically treated teeth. More specifically, 50% reported that they would frequently perform cuspal coverage and 32% were always using the procedure, suggesting that it is one of the most prevalent strategies in the clinic.

4.5-Final restorative materials:

Regarding the commonly used final restoration for posterior teeth in RCT, full-coverage crowns (60%) were chosen by most respondents, followed closely by onlays or overlays (34%). A direct composite restoration was chosen by 4% of respondents followed by long-term temporary restorations by 2% (Table 4).

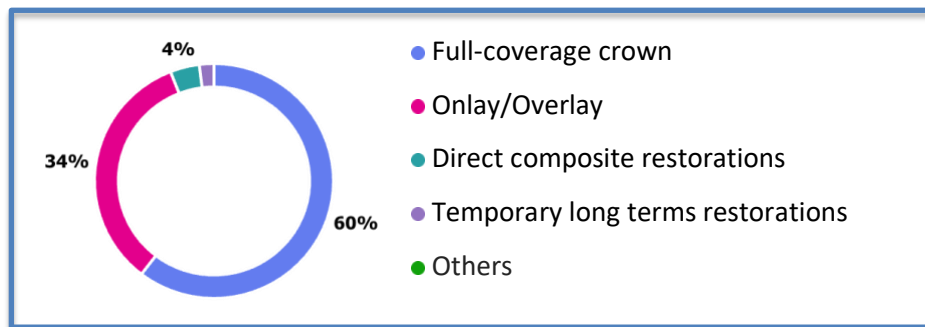


Table 4: Restoration types for posterior endodontically treated teeth

Of indirect restorative materials, monolithic zirconia exhibited the highest frequency of selection followed by lithium disilicate (e.g., IPS e.max). Metal-ceramic crowns, composite CAD-CAM restorations, as well as full metal crowns were also less common (Table5).

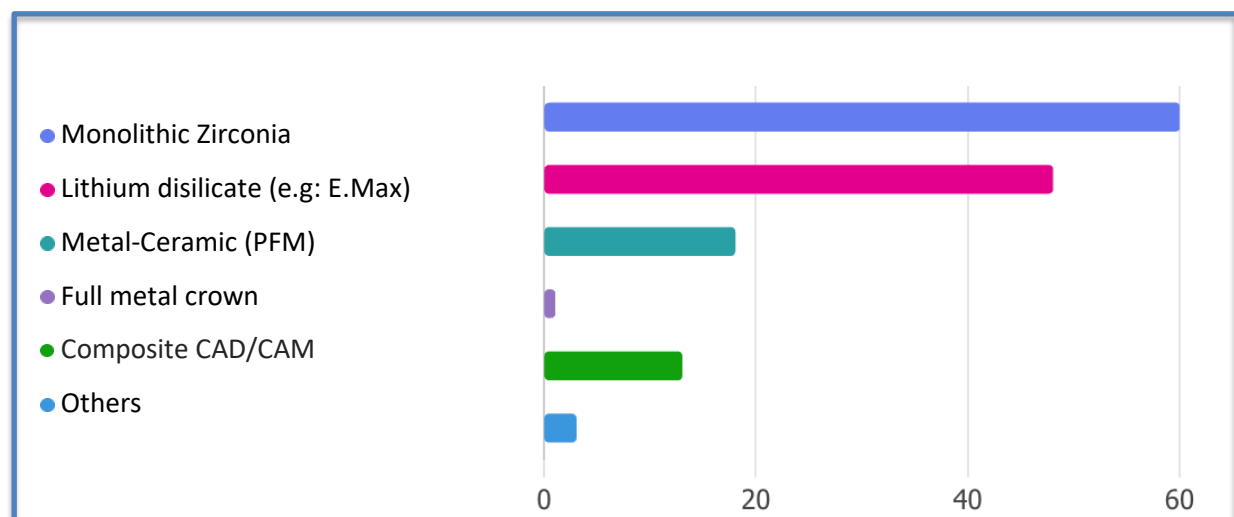


Table 5: Restoratives materials used for posterior endodontically treated teeth

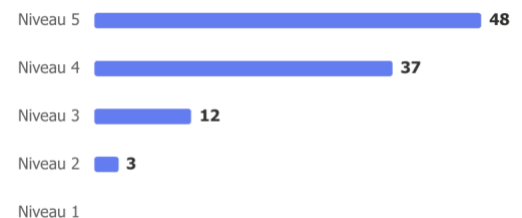
4.6-Influencing factors contributing to the choice of materials:

Fracture resistance was the most frequently reported factor of choice when selecting a material (75 responses), followed by esthetic considerations (65 responses) and adhesive behaviour (48 responses). Other elements were; cost, knowledge of the material and access to CAD-CAM workflows.

4.7-Modes of failure and success Factors:

The most frequent failure mode of restored posterior RCT teeth reported by respondents was the re-infection or endodontic failure (53%), followed by tooth fracture (26%), fracture of the restoration (9%), and loss of retention (8%).

We asked clinicians if timely cuspal protection prevents fractures and they rated it a high average score of 4.30 out of 5, corresponding to the consideration of this factor as clinically relevant.



Finally, when participants were asked regarding the single most significant characteristic of a successful long-term restoration in posterior endodontically treated teeth, the majority chose remaining tooth structure, occlusal management, adhesive protocol, and operator skills (Table 6).

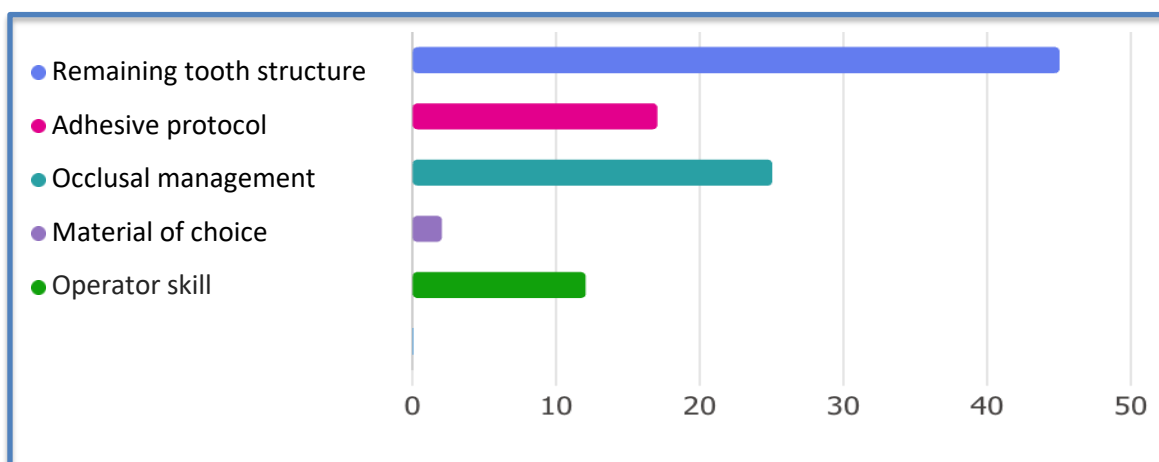


Table 6: Characteristics for a successful long-term restoration in posterior endodontically treated teeth

5. DISCUSSION

The aim of this study was to investigate the restorative materials and clinical strategies most used by dentists for posterior teeth following root canal treatment (RCT). Restorative teeth that underwent endodontic treatment generally had considerable loss of structural integrity due to caries, previous restorations and the endodontic access cavity itself. Consequently, it is difficult to achieve a good restoration of these teeth, and the materials selection plays a crucial role in ensuring long term success (18).

The findings provided in the present survey suggest that the indirect restorations with cuspal coverage are considered the most widely employed restorative procedure for posterior endodontic teeth.

Most dentists reported using full-coverage crowns, and onlays or overlays, while direct composite restorations were used less frequently.

This result indicates that clinicians recognize increased fracture risk in posterior teeth after root canal treatment and so prefer indirect restorations to give mechanical protection to the remaining tooth structure (7).

The posterior teeth are usually more susceptible to fracture after endodontic treatment, primarily due to the loss of structure rather than the endodontic procedure itself (17).

When large amounts of dentin and cuspal support are lost, occlusal forces can more easily lead to structural failure (18).

Cuspal coverage restorations like crowns, onlays, or overlays are often used for redistribution of occlusal stresses and protection of weakened cusps, which is the reason why they are frequently used by clinicians (19).

Moreover, another of the major findings of the surveys was the high use cases of monolithic zirconia and lithium disilicate as restorative materials for indirect restorations. Their applications in such materials have expanded drastically in the late past decades due to the developed ceramic processes and digital dentistry techniques (2).

Monolithic zirconia is very well used for its great mechanical characteristics, high fracture resistance, which makes it suitable especially in posterior load-bearing areas.

Concurrently, lithium disilicate ceramics are well appreciated for esthetic properties and adhesiveness to tooth structure which has a good retention and marginal adaptation (5).

The results indicated that composite resin was the most used material to conduct core build-up procedures. Over 80% of the respondents stated they used composite materials for this purpose.

Among the advantages of composite resin include adhesive bonding to dentin, excellent mechanical strength, and easy handling (16).

Such properties enable a conservative reconstruction of lost tooth structure that serves as support for indirect restorations. Moreover, modern composite materials can be easily inserted into the tooth, using bulk-fill methods, which could simplify clinical procedure (9).

With respect to post systems, we could see that most clinicians preferred fiber posts to metal posts. This trend reflects a shift in restorative dentistry toward more biomimetic approaches. Fiber post has an elastic modulus closer to that of dentin, so it may have a more favorable distribution of stress within the root (20). Thus, they are typically linked to a lower risk of catastrophic root fracture than rigid metallic posts. Moreover, fiber posts are adhesive compliant, resulting in better retention and a good integration to composite core materials (20).

Notably, the survey results indicate that posts are not systematically placed in posterior endodontically treated teeth, where for many clinicians placing a post can compromise the teeth. This is consistent with the current clinical guidelines that posts should not be used routinely but reserved as additional retention for the core building.

Posts do not support tooth structure but serve to capture the core restoration when there is a lack of coronal tooth structure (5).

Another key aspect highlighted by the survey was the importance of cuspal coverage in preventing fractures. Clinicians rated the importance of immediate cuspal coverage highly, with an average of 4.30 out of 5. This finding supports the clinical perception that protecting weakened cusps is fundamental for the long-term survival of endodontically treated posterior teeth.

When considering relevant factors to material selection, fracture resistance was deemed the most important criterion, followed by esthetic considerations and adhesive performance. This prioritization embodies the clinical phenomenon that posterior teeth suffer high occlusal forces and therefore that restorations must be able to support high mechanical stress (19). Yet, esthetics still are an important factor also, especially for those posterior teeth that are visible while smiling.

Another finding from the survey related to the failure mode which was re-infection or endodontic failure rather than fracture of the restoration. This means that the long-term prognosis of endodontically treated teeth relies not only on the materials selections but also on the quality of endodontic treatment and on the well-maintained quality of coronal seal and its coronal arrangement. Thus, adequate sealing of the access cavity and appropriate restorative design are necessary to avoid bacterial leakage and to guarantee the success of the treatment (21).

The remaining tooth structure was the main determinant of recovery success, as demonstrated in another study findings. This finding is in accordance with modern restorative dentistry principles, which underline the importance of retaining tooth structure when predicting long-term prognosis of endodontically treated teeth. The amount of residual dentin, the presence of a ferrule, and the extent of cuspal loss all influence the biomechanical behavior of the restored tooth (21).

On balance, this survey demonstrated that restorative measures are necessary to preserve the remaining tooth structure and reestablish the biomechanical integrity of posterior teeth following root canal treatment. Contemporary adhesive materials, fiber posts and high-strength ceramics are among those that have supported the creation of modern tools to supply long-lasting and esthetic treatments to both functional and biological needs (15).

Nonetheless, several limitations should be kept in mind in interpreting the outcome of the present study. First, the survey was obtained from self-reported questionnaires, which may not perfectly mimic the clinical practice.

Moreover, most of the sample was comprised of general dentists who worked in a private practice, which might hamper the generalizability of the findings to a wider range of clinical disciplines and specialist practices. In addition, this survey more closely illustrates what clinicians desire than what they find useful in a clinical outcome.

Longitudinal studies using different restorative materials in posterior endodontically treated teeth should be pursued to assess the survival and failure rates of these restorative materials. Studies of this nature would offer important information about which restorative approaches are most successful at preserving the structural integrity and functional life of these teeth.

6. CONCLUSIONS

This questionnaire-based study concludes that indirect restorations with cuspal coverage are the predominant restorative method in posterior endodontically treated teeth, within the limitations of current data.

The final restoration selected was mainly full-coverage crowns, followed by onlays and overlays, while direct composite restorations were much less common.

Monolithic zirconia was the type of material most commonly used among indirect restorative materials, followed by lithium disilicate.

Composite resin was undoubtedly the best for core build-up treatments and fiber posts were the dominant post system when more retention was needed.

Fracture resistance was the main factor influencing material selection, and clinicians considered cuspal coverage important for preventing fracture.

Re-infection or endodontic failure was considered the most common cause of failure, ahead of tooth fracture, restoration fracture, or retention loss. This means that the long-term prognosis of these teeth is influenced not only by the choice of the restorative material, but also by quality of the endodontic treatment and coronal seal.

The remaining tooth structure was reported to be among the strongest predictors for success for the restorations.

Thus, treatment planning of posterior teeth treated with root canals should be influenced by sound dental tissue preservation, cuspal protection need and material choice to promote long-term clinical outcomes.

7. SUSTAINABILITY

Sustainability in restorative dentistry focuses on the maintenance of natural tooth structure, extending the life of a restoration, and reducing the biological, material, and economic costs of retreatment. In posterior teeth subjected to root canal treatment, a choice of an ideal restorative strategy is a clinical and sustainable decision.

These results show clinicians generally prefer restorations with cuspal protection and long-standing resistance, especially full-coverage crowns, onlays, and overlays.

Correctly indicated, these restorations can lower the fracture incidence, reinfection and contribute to long-term survivability.

Sustainability also depends on small, non-invasive interventions. Conservative adhesive restorations when there is enough dental structure may help in preserving healthy dental tissues and in reducing unnecessary loss of sound structure.

From an environmental point of view, prolonged restorations may decrease the use of clinical materials, laboratory resources, and chairside time required for retreatment.

Also, digital workflows and modern adhesive materials may improve precision and efficiency, helping clinicians deliver treatments that are both effective and more resource-conscious.

Therefore, sustainability in the restoration of posterior endodontically treated teeth should be understood as the combination of durability, tissue preservation, prevention of failure, and rational use of materials.

8. BIBLIOGRAPHY

1. Bhuva B, Giovarruscio M, Rahim N, Bitter K, Mannocci F. The restoration of root filled teeth: a review of the clinical literature. *Int Endod J*. 2021 Apr 1;54(4):509-509–35. Located at: MEDLINE Complete; 33128279. doi:10.1111/iej.13438
2. Patel SR, Youngson C, Jarad F. Principles guiding the restoration of the root-filled tooth. *Br Dent J*. 2025 Apr 1;238(7):508-508–16. Located at: MEDLINE Complete; 40217033. doi:10.1038/s41415-025-8401-4
3. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature--Part 1. Composition and micro- and macrostructure alterations. *Quintessence Int Berl Ger* 1985. 2007 Oct 1;38(9):733-733–43. Located at: MEDLINE Complete; 17873980
4. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). *Quintessence Int Berl Ger* 1985. 2008 Feb 1;39(2):117-117–29. Located at: MEDLINE Complete; 18560650
5. Caussin E, Izart M, Ceinos R, Attal JP, Beres F, François P. Advanced Material Strategy for Restoring Damaged Endodontically Treated Teeth: A Comprehensive Review. *Mater Basel Switz*. 2024 Jul 28;17(15). Located at: MEDLINE Complete; 39124400. doi:10.3390/ma17153736
6. Slutzky-Goldberg I, Slutzky H, Gorfil C, Smidt A. Restoration of endodontically treated teeth review and treatment recommendations. *Int J Dent*. 2009 Jan 1;2009:150251–150251. Located at: MEDLINE Complete; 20309408. doi:10.1155/2009/150251
7. Sadaf D. Survival Rates of Endodontically Treated Teeth After Placement of Definitive Coronal Restoration: 8-Year Retrospective Study. *Ther Clin Risk Manag*. 2020 Feb 21;16:125-125–31. Located at: MEDLINE Complete; 32110030. doi:10.2147/TCRM.S223233
8. AlSwayyed T, Bin Nafesah R, Alqutub M, Alfarhan A, Almashhaf A, Alshaikh H, et al. Restorative Treatment Patterns After Root Canal Obturation in Public Hospitals in Riyadh. *Clin Cosmet Investig Dent*. 2021 Sep 11;13:389-389–94. Located at: MEDLINE Complete; 34539189. doi:10.2147/CCIDE.S326681
9. Alhamdan MM, Aljamaan RF, Abuthnain MM, Alsumikhi SA, Alqahtani GS, Alkharaiyef RA. Direct Versus Indirect Treatment Options of Endodontically Treated Posterior Teeth: A Narrative Review. *Cureus*. 2024 Aug 24;16(8):e67698–e67698. Located at: MEDLINE Complete; 39318905. doi:10.7759/cureus.67698
10. Chrepa V, Konstantinidis I, Kotsakis GA, Mitsias ME. The survival of indirect composite resin onlays for the restoration of root filled teeth: a retrospective medium-term study. *Int Endod J*. 2014 Oct 1;47(10):967-967–73. Located at: MEDLINE Complete; 24386996. doi:10.1111/iej.12242
11. Chawla S, Kumar T, Mittal S, Keshav V, Gilhotra V, Kaur P. A Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth Using Different Post-Obturation Restorative Materials: An In Vitro Study. *J Pharm Bioallied Sci*. 2024 Feb 1;16(Suppl

- 1):S343-S343–5. Located at: MEDLINE Complete; 38595597.
doi:10.4103/jpbs.jpbs_554_23
12. Selvaraj H, Krithikadatta J, Shrivastava D, Onazi MAA, Algarni HA, Munaga S, et al. Systematic review fracture resistance of endodontically treated posterior teeth restored with fiber reinforced composites- a systematic review. *BMC Oral Health*. 2023 Aug 13;23(1):566–566. Located at: MEDLINE Complete; 37574536. doi:10.1186/s12903-023-03217-2
 13. Kaya Büyükbayram I, Güven ME, Ayman D, Şener Yamaner ID, Cakan EF. Fracture resistance of resin endocrowns with and without fiber reinforced composite base material: A preliminary study. *J Appl Biomater Funct Mater*. 2023 Jan 1;21:22808000231151832–22808000231151832. Located at: MEDLINE Complete; 36708253. doi:10.1177/22808000231151832
 14. Durmazpınar PM, Kamalı SG, Ağralı ÖB, Türkaydın D, Öveçoğlu HS. The effect of periodontal status and coronal restoration quality on early and late term failures in root canal-treated teeth. *BMC Oral Health*. 2025 Sep 26;25(1):1459–1459. Located at: MEDLINE Complete; 41013403. doi:10.1186/s12903-025-06752-2
 15. de Kuijper MCFM, Cune MS, Özcan M, Gresnigt MMM. Clinical performance of direct composite resin versus indirect restorations on endodontically treated posterior teeth: A systematic review and meta-analysis. *J Prosthet Dent*. 2023 Sep 1;130(3):295–295–306. Located at: MEDLINE Complete; 34980474. doi:10.1016/j.prosdent.2021.11.009
 16. Stenhagen S, Skeie H, Bårdsen A, Laegreid T. Influence of the coronal restoration on the outcome of endodontically treated teeth. *Acta Odontol Scand*. 2020 Mar 1;78(2):81–81–6. Located at: MEDLINE Complete; 31322454. doi:10.1080/00016357.2019.1640390
 17. Singh P, Sandhu R, Karthik S, Bharti S, Bhargava M. Comparative Evaluation of Survival Against Fracture in Premolars Treated Endodontically for Cervical Lesions and Restored with Resin and Crowns. *J Pharm Bioallied Sci*. 2024 Dec 1;16(Suppl 4):S3959–S3959–61. Located at: MEDLINE Complete; 39926791. doi:10.4103/jpbs.jpbs_1017_24
 18. Melfsen L, Maklennan A, Magnucki G, Neumann M, Zitzmann N, Neuhaus K. Why, when and how are endodontically treated teeth restored: A questionnaire-based study comparing the decision-making of dentists in Germany and Switzerland. *SWISS Dent J SSO – Sci Clin Top*. 2025 Dec 5;135(04):1–15. doi:10.61872/sdj-2025-04-01
 19. Sricharat P, Nalamliang N, Jearanaiphaisarn T. Occlusal and behavioral factors associated with vertical root fractures in endodontically treated teeth: A retrospective matched case-control study. *J Dent*. 2026 Apr;167:106553. doi:10.1016/j.jdent.2026.106553
 20. Aly YM, Bakry SI, Tuma Halabi MA. Fracture resistance and bond strength of endodontically treated teeth, restored with three fiber post and core system: an in vitro study. *Sci Rep*. 2025 Nov 7;15(1):39007. doi:10.1038/s41598-025-23778-2
 21. Chisini LA, Cenci MS, Skupien JA, Marchiori FT, Galdino-Santos L, Fokkinga W, et al. Restoration's Longevity in Endodontically Treated Teeth: A Machine Learning Survival Analysis From Randomised Clinical Trials. *Int Endod J*. 2026 Feb;59(2):251–61. doi:10.1111/iej.70048

9. ANNEXES

14/04/2026 20:05

Dental survey

Dental survey

CONSENTIMIENTO INFORMADO: El presente cuestionario forma parte del Trabajo de Fin de Grado en Odontología de la Universidad Europea de Madrid titulado: « What is the most commonly used material for posterior restorations after a root canal treatment » y dirigido por el Profesora Susana Gil Krokun. El propósito del presente trabajo es to evaluate and compare the clinical effectiveness of direct restorations materials (resin composite, glass ionomers, amalgam...) versus indirect restorations materials (Lithium disilicate, zirconia, PFM...) in posterior teeth that have undergone root canal treatment, focusing on technique used by dentist and long-term survival. 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. 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. Susana Gil Krokun.

 [Ver encuesta](#)

1. Do you give your consent to participate in the survey as a volunteer for the results to be used in the Final Degree Project: « What is the most commonly used material for posterior restorations after a root canal treatment » *

☐ Si

☐ No

2. Country of practice

3. Years of clinical experience

☐ 0-3 years

☐ 3-10 years

☐ 10-20 years

☐ more than 20 years

<https://forms.cloud.microsoft/Pages/DesignPageV2.aspx?previousorigin=Marketing&origin=NeoPortalPage&subpage=design&id=DQStkWsW0yxEjaJBLZtrQAA...> 1/5

4. Main practice type

- ☐ General dentistry
- ☐ Endodontics
- ☐ Prosthodontics
- ☐ Oral surgery
- ☐ Orthodontics
- ☐ Others

5. Type of practice

- ☐ Private
- ☐ Public clinic/hospital
- ☐ University/academic settings
- ☐ Mixed
- ☐ Others

6. Do you perform root canal treatment yourself ?

- ☐ Yes, routinely
- ☐ yes, occasionally
- ☐ No, I refer them
- ☐ other

7. On average, how many posterior RCT (root canal treatments) cases do you perform per month ?

- ☐ <5
- ☐ 5-10
- ☐ 10-20
- ☐ >20

8. Do you routinely place a post in posterior teeth after RCT

- ☐ Always
- ☐ Frequently
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

9. If a post is used, which type do you prefer and why ?

- ☐ Fiber post
- ☐ Metal post (cast or prefabricated)
- ☐ Ceramic post
- ☐ Others

10. What materials do you most commonly used for the core build up ?

- ☐ Resin composite (bulk fill / conventional)
- ☐ Resin-modified glass ionomer
- ☐ Glass ionomer
- ☐ Amalgam
- ☐ Others

11. Do you perform cuspal coverage for posterior RCT teeth ?

- ☐ Always
- ☐ Frequently
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

12. Do you perform direct restorations with composite resin for posterior RCT teeth ?

- ☐ Always
- ☐ Frequently
- ☐ Occasionally
- ☐ Rarely
- ☐ Never

13. What is your most commonly used final restoration for posterior RCT teeth ?

- ☐ Full-coverage crown
- ☐ Onlay/overlay
- ☐ Direct composite restoration
- ☐ Temporary long term restoration
- ☐ others

14. If a crown/onlay is used, which materials do you prefer ?

- ☐ Monolithic zirconia
- ☐ Lithium disilicate (e.g. E.max)
- ☐ Metal-ceramic (PFM)
- ☐ Full metal crown
- ☐ Composite CAD/CAM
- ☐ Others

15. Reason(s) for choosing this material (multiple answers allowed) ?

- ☐ Fracture resistance
- ☐ esthetics
- ☐ Cost-effectiveness
- ☐ Familiarity/habit
- ☐ Adhesive performance
- ☐ Lab/CAD-CAM workflow availability
- ☐ others

16. In your experience, what is the main failure mode for restored posterior RCT teeth ?

- ☐ Fracture of the tooth
- ☐ Fracture of the restorations
- ☐ Loss of retention/debonding
- ☐ Re-infection/endodontic failure
- ☐ others

17. How important do you consider immediate cuspal coverage in preventing fractures ?



18. What would you say is the single most important factor in success of these restorations ?

- ☐ Remaining tooth structure
- ☐ Adhesive protocol
- ☐ Occlusal management
- ☐ Material of choice
- ☐ Operator skill
- ☐ others

19. Do you have any comments or recommendations regarding posterior restoration after RCT ?

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

