

Clinical success of endodontic posts: a systematic review

Sucesso clínico de pinos endodônticos: uma revisão sistemática

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ABSTRACT

The aim of this study is to conduct an updated systematic review on the clinical success of endodontic posts covering all systematic reviews and meta-analyses that have been published since 2012. A protocol for systematic review studies with meta-analysis (PRISMA) was used. Based on the PICO formulated question, a detailed search strategy involving electronic searching and hand-searching was developed in order to identify the most relevant studies. The abstracts of identified systematic reviews and meta-analyses were reviewed by 2 authors independently. Electronic searches retrieved 273 references of relevant systematic reviews. The results of the five studies included in this systematic review did not show significant differences in the incidence of failures between fiber posts and metal posts, they only indicate the superiority of the use of posts in teeth with remaining dentin. This systematic review should be interpreted with caution, as there is a need for more randomized clinical trials with better methodological quality to provide high-quality evidence on the subject.

Keywords: Systematic review, Nonvital Tooth, Post Techniques, Survival rate

RESUMO

O objetivo deste estudo é realizar uma revisão sistemática atualizada sobre o sucesso clínico dos pinos endodônticos, abrangendo todas as revisões sistemáticas e meta-análises publicadas desde 2012. Foi utilizado um protocolo para estudos de revisão sistemática com meta-análise (PRISMA). Com base na pergunta formulada pelo PICO, foi desenvolvida uma estratégia de pesquisa detalhada envolvendo busca eletrônica e busca manual para identificar os estudos mais relevantes. Os resumos das revisões sistemáticas e meta-análises identificadas foram revisados por dois autores de forma independente. As buscas eletrônicas recuperaram 273 referências de revisões sistemáticas relevantes. Os resultados dos cinco estudos incluídos nessa revisão sistemática não mostraram diferenças significativas na incidência de falhas entre pinos de fibra e pinos metálicos, apenas indicam a superioridade do uso de pinos em dentes com dentina remanescente. Essa revisão sistemática deve ser interpretada com cautela, pois há necessidade de mais ensaios clínicos randomizados com melhor qualidade metodológica para fornecer evidências de alta qualidade sobre o assunto.

Palavras-chave: Revisão sistemática, Dente não vital, Técnicas de pino, Taxa de sobrevivência

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1. INTRODUCTION

Root canal treatment is the recommended therapeutic approach for pathologic dental pulps. It involves the non-surgical removal of necrotic and infected tissues, mechano-chemical treatment of the root canals which is then followed by root canal obturation and placement of permanent restoration.¹ However, root canal treated teeth are non-vital brittle teeth that are often associated with extensive loss of coronal tissues due to initial damage by caries, fracture and by root canal treatment procedures.² It is, thus, recommended to place endodontic posts inside the treated root canals to reinforce the permanent restorations and to minimize the occlusal load stress subjected upon the weakened tooth structures.³⁻⁶

Endodontic posts are rigid dental devices that are cemented or bonded into the radicular portions of endodontically treated canals.^{7,8} There are currently a wide range of post types and systems used in dental practice. They are generally classified into smooth or threaded (according to surface type), pre-fabricated or custom-made (according to fabrication mode), cylindrical or tapered (according to shape) and metallic or non-metallic (according to material type).^{9,10} Metallic posts can be manufactured from precious, semi-precious and base metals while non-metallic posts can be made of ceramics, composites, zirconium oxide or fibers containing glass, carbon and other materials.^{8,11,12} This wide range of post types and systems does not simplify the process of post selection and clinical evidence-based decision making, particularly with the reported advantages and disadvantages of each post type that have been published in a plethora of low quality studies.^{5,13} To further elaborate, in a study by Schmitter and co-authors¹⁴ which investigated the methodological quality of published systematic reviews and meta-analyses into the clinical success of endodontic posts, it was concluded that there was a lack of good quality published systematic reviews and that there was no decisive clinical conclusion to be drawn.¹⁴

Evidence-based practice is the recommended decision-making approach in clinical dentistry. It involves the use of reliable and validated methods to systematically review all published evidence in a specific clinical situation with the aim of producing evidence-based clinical recommendations.¹⁵ However, it can only function effectively in the abundance of high quality clinical studies. Although the study by Schmitter and co-authors¹⁴ highlighted the inability to formulate evidence-based clinical recommendations in relation to

endodontic posts, the study included systematic reviews and meta-analyses that had been published before April 2012.¹⁴ Thus, the methodological quality of recently published systematic reviews and meta-analyses on endodontic posts have not been systematically assessed, taken into consideration that numerous post materials and systems have been developed in that period. Therefore, the aim of this study is to conduct an updated systematic review on the clinical success of endodontic posts covering all systematic reviews and meta-analyses that have been published in the period since 2012.

2. MATERIAL AND METHODS

2.1 Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) protocol was adopted in this study to ensure the use of the most valid and reliable methodology for identification, analysis and outcome reporting. As recommended by the PRISMA protocol, a PICO (Population or Participants, Interventions, Comparisons, Outcomes) formulated question was designed to facilitate a comprehensive literature search strategy. The PICO question comprised of the following elements:

Participants: Patients requiring placement of endodontic posts following root canal treatment. Interventions and Comparisons: Any endodontic post type or system either against each other or against a control or a placebo. Outcomes: Primary outcomes: all treatment outcomes were considered in this study. While secondary outcomes included success rates, survival rates and failure rates.

2.2 Search methods for identification of studies

Based on the PICO formulated question, a detailed search strategy involving electronic searching and hand-searching was developed to identify the most relevant systematic reviews and meta-analyses. The following keywords were used: “human”, “teeth”, “post” and “review”. However, the search was limited to reviews or systematic reviews and it was also adjusted to only include studies published from 2012 onwards. The following search methods were used:

Electronic search: Medline (from 2012 to October 2017), Web of Science (from 2012 to October 2017) and the Cochrane Oral Health Library (from 2012 to October 2017) databases were searched.

Hand-searching: Journal of Endodontics (from 2012 to October 2017), the International Endodontic Journal (from 2012 to October 2017) and Oral Surgery, Oral Pathology, Oral Radiology, and Endodontics (from 2012 to October 2017) journals were hand-searched. Furthermore, the textbook of Cohen's Pathways of the pulp was also included to augment the findings of the search strategy. The reference lists of the included systematic reviews were also examined for any possible relevant systematic reviews.

2.3 Selection of studies

The abstracts of the identified systematic reviews and meta-analyses were reviewed by the 2 authors independently. The full-text copies of all relevant and potentially relevant systematic reviews were obtained for further assessment. Any disagreements on the eligibility of potentially included studies were resolved through discussion and in accordance with the inclusion and exclusion criteria. For the inclusion of studies, it was observed that they should necessarily be systematic reviews with or without meta-analysis; the design of included studies should be random clinical trials, cohort studies, prospective and retrospective studies. They should necessarily consider outcomes such as catastrophic, non-catastrophic or restoration failures. Otherwise, the studies found should be excluded from this review.

2.4 Data extraction

The study details and outcomes data were collected by the 2 authors independently by a custom-made data extraction sheet. The following characteristics were extracted: (1) participants; (2) interventions/comparisons; (3) outcomes; (4) types of included studies, (5) sample size, (6) duration of follow-up periods, and (7) study results and conclusions. Any disagreements were discussed, and data were only included if consensus was reached. In addition to that, the statistical findings of the included systematic reviews and meta-analyses were also extracted by using an extraction form designed particularly for this purpose. It included the number of studies analyzed, statistical methods used in data pooling and analyses (e.g. fixed effects model, random effects model and Der Simonian-Laird method), p-values, effect size, heterogeneity levels (I^2) and results.

2.5 Quality assessment of the included systematic reviews and meta-analyses

The methodological quality of the included systematic reviews and meta-analyses were assessed by the use of the Revised Assessment of Multiple Systematic Reviews (RAMSTAR). The sum of the scores for each paper was calculated and then added to records of study. The greater the sum of the scores, the higher the methodological quality of the systematic review and meta-analysis.

The quality assessment of the included systematic reviews and meta-analyses was conducted by the 2 authors independently. Disagreements were discussed, and data were only included if consensus was reached. The inter-examiner variability was also calculated by using kappa index, linear weighted kappa index, Dahlberg's d statistics and coefficient of variation as the RAMSTAR checklist consists of both continuous and ordinal scales.

3. RESULTS

3.1 Results of literature search

The electronic searches retrieved 273 references of relevant systematic reviews; 155 references from MEDLINE; 117 references from Web of Science and 1 reference from the Cochrane Oral Health Library. In addition to that, handsearching retrieved 1 more reference. After examination of the titles and abstracts of these references, all those which did not match our inclusion criteria were excluded. Full-text copies of the remaining studies (n= 11) were subjected to further assessment, and 5 references were excluded as a result. Thus, 6 systematic reviews were included in this study and were then subjected to full-text qualitative and quantitative assessment by RAMSTAR protocol. The sample consisted of 5 studies.

3.2 Characteristics of included studies

The details and outcomes of the included studies were extracted by a data extraction sheet designed for this study (Table 1). The included studies encompassed various endodontic types and systems. Also, it was distinctive that the included studies varied significantly according the number and type of studies evaluated, which two of them observed only randomized clinical trials (RCT)(Zhu et al., 2015; Marchionatti et al., 2017)^{16,17}, two evaluated RCT and cohort (Figueiredo et al., 2015 and Yang et al., 2015)^{18,19} and one evaluated cohort and retrospective study (Ploumaki et al., 2013).²⁰ Other

point observed is that while one study evaluated 11 RCT (Figueiredo et al., 2015)¹⁸, another evaluated only 2 RCT (Yang et al., 2015)¹⁹, which reduces the quality of evaluation and comparison of the studies. We also observed that only 2 studies the follow up were more than 5 years (Ploumaki et al., 2013; Figueiredo et al., 2015)^{18,20}, which don't allows a good comparison of the Clinical performance and failure modes of the posts (Table 2).

Table 1: Studies included in the meta-systematic review

STUDY	YEAR	TYPE
Ploumaki et al.	2013	Systematic review and meta-analysis
Figueiredo et al.	2015	Systematic review and meta-analysis
Zhu et al.	2015	Systematic review and meta-analysis
Yang et al.	2015	Systematic review and meta-analysis
Marchionatti et al.	2017	Systematic review

Table 2: Number, design, follow-up and sample size of papers analyzed by study

STUDY	Number and type of papers	Total number of patients (m) and restorations (n)	Follow-up (years)
Ploumaki et al.	2 PRS / 2 RET	n=1254	>6 y
Figueiredo et al.	7 RCT / 7 CS	m=3202; n=4752	>5 y; median (IQR):8.2 (6.6-10.0)
Zhu et al.	3 RCT	m=648; n=648	2-6 y
Yang et al.	2 RCT / 3 CS	n=573	2.7 – 8.7 y
Marchionatti et al.	11 RCT	n=1394	1.25 – 9.1 y

RCT: random clinical trial; CS: cohort study; PRS: prospective; RET: retrospective

There was also great heterogeneity in the results, where 3 studies had different outcomes in the evaluation of failures and types of posts studied, in addition to indications for use. Such a difference does not allow us to compare the studies and results of Figueiredo et al., 2015¹⁸ and Zhu et al., 2015¹⁶. It should also be noted that Marchionatti et al., 2017¹⁷ only performed a literature review report (RS) and did not perform meta analysis. The evaluation of the studies shows us that we have 4 articles of systematic review with meta-analysis, but due to the differences found, we can only verify the conclusions of the studies as a systematic review of the literature.

4. DISCUSSION

This work consisted of a careful search that resulted in 273 papers on the clinical success of endodontic posts, of which, after applying inclusion and exclusion criteria established a priori, resulted in only 5 papers, being 5 systematic reviews, 4 of which presenting meta-analysis. The heterogeneity of articles such as types of studies and posts, the divergence in the measurement of results and the differences in follow-up times ended up by limiting inferences and allowed only the comparative presentation of studies by the systematic review of literature, without statistical results of meta-analyses.¹⁶⁻²⁰

Literature review studies with meta-analysis have enabled coherent decisions of clinical therapeutic approaches, supported by practice based on scientific evidence.¹⁵ The last paper addressing the performance of endodontic posts was carried out almost a decade ago and observed a methodological failure in published works¹⁴, due to protocols with little scientific basis.^{3,5,15} Even with such methodological limitations, this work pointed out the superiority of fiber posts. Fiber posts have modulus of elasticity similar to that of dentin, which contributes to evenly distributing tensions, resulting in lower interfacial tension and failure.^{21,22}

In this study, and considering this subject, clinical follow-up and evaluation of failures are essential, and, this was another discordant factor in the five works found. The reasons for failures of post-endodontic post restorations are mainly root fracture, microleakage, metal corrosion, decementation and concentration of forces.^{10,23} The heterogeneity of studies was even clearer when results of failures presented by studies were evaluated. The articles showed three different outcomes, evaluating “catastrophic”

failures considering the indication of root fractures that indicate the need for extraction of the tooth element, “non-catastrophic” failures^{16,18} and another criterion for evaluating the survival of restorations.^{17,18}

This research observed the clinical success through three outcomes, according to included papers. The first of them was the incidence of “catastrophic” failures, which was used in most studies, where there was no significant difference in the root fracture rate¹⁸ between fiber and metal posts, similar result was found in the study by Sarkis-Onofre et al., 2014¹¹, however, the presence of posts in restorations decreases the incidence of fractures on teeth with less coronary remnants (less than 3 walls).^{6,16} However, in the *in vitro* study conducted by Alharbi et al., 2014⁹ vertical tooth fracture was the most common fracture mode for teeth restored with pins and metal cores. Root and vertical fractures, depending on the level that they occur, doom the tooth to extraction. The risk of root fracture may be related to the modulus of elasticity of posts due to the influence of different physical properties of the material.^{9,11,24,25} Another important point is the post length, as it directly affects the distribution of stresses along the root and can affect the incidence of vertical root fracture.²⁶

The second outcomes was “non-catastrophic” failures, associated to the retention of posts in the root canal and according to one of the studies^{18,27}, the incidence of these failures is higher in fiber posts than in metal posts. In teeth restored with adhesively cemented posts, such as fiber posts, adhesive failure is the most common failure mode and is related to problems in the adhesive technique.^{11,23,28}

The third outcome evaluated was survival of “restorations”. One of the studies observed that metal and non-metal posts presented the same survival rate (more than 90%)²⁰ but single crowns were superior compared to other rehabilitation techniques. Another study has observed greater survival of metallic posts¹⁸ however, this superiority may have been caused by the heterogeneity of comparative groups that used fiber pins (carbon and glass). Two other studies^{16,19} reported that survival was greater when any type of post was used, but that there is a need to observe the amount of coronary walls, because the smaller the amount of walls, the greater the need for posts.

The use of the structured research question (PICO) is to give reliability and scientific bases in systematic reviews¹⁵; in this sense, both Intervention and outcome with such heterogeneity reinforce the need for further studies and higher methodological quality in study designs. Some of the systematic reviews did not achieve the R-AMSTAR quality

score, which is necessary to provide reliable consensus based on the best available evidence. In most of included studies, there was high heterogeneity in relation to comparisons made, which may reduce the external validity of the effect of intervention. Another limitation of this review is the limited follow-up time of some studies included in the systematic reviews conducted by Zhu et al., 2015, Yang et al., 2015 and Marchionatti et al., 2017.^{16,17,19} Clinical trials with longer follow-up time are necessary as they provide more accurate information about the clinical performance and failure modes of teeth restored with different types of root canal posts.

The results of studies included in the reviews of Ploumaki et al., 2013²⁰, Figueiredo et al., 2015¹⁸ and Marchionatti et al., 2017¹⁷ did not demonstrate significant differences in the survival rate of fiber posts and metal posts, however, in the systematic review conducted by Schmitter et al. 2013¹⁴, the highest survival rate was obtained with fiberglass posts. In the systematic review conducted by Zhu et al., 2015¹⁶, the results showed that the use of posts appears to have significant influence in reducing the catastrophic failure rate of endodontically treated teeth, but when three or four coronal walls remain, post placement appears to have no influence. Yang et al., 2015¹⁹ reported higher success rates when there is presence of coronal wall, with significant differences. The need for new randomized clinical trials with better methodological quality and longer follow-up times in order to define the proposed research question becomes evident through this systematic review.

The main advantage of this work was to identify the evaluative disparity that still remains, almost a decade after the last review, indicating the need for further in-depth studies and it is worth emphasizing the importance of the use of well-adapted and well-indicated intra-root retainers for the longevity of the dental remnant in the oral cavity. Thus, even considering the above limitations, the indication of well-adapted posts is favorable for the reestablishment of the dental remnant.

5. CONCLUSIONS

This systematic review consisted of five articles, which showed different results, different subgroups according to materials used and high level of heterogeneity in the meta-analysis performed by the authors, leading to the conclusion that the results of this study should be analyzed only as a pure systematic review.

Therefore, the results of studies included in this systematic review did not show significant differences in the incidence of failures between fiber posts and metal posts, they only indicate the superiority in the use of posts in teeth with remaining dentin. The results of this systematic review should be interpreted with caution, as there is a need for further randomized clinical trials with better methodological quality to provide high-quality evidence on the subject.

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