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Tese

Restauração de dentes tratados endodonticamente: recomendações para a prática clínica e para o reporte de pesquisas

Rafael Sarkis Onofre

Pelotas, 2016

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“I've missed more than 9000 shots in my career. I've lost almost 300 games. 26 times, I've been trusted to take the game winning shot and missed. I've failed over and over and over again in my life. And that is why I succeed.

(MICHAEL JORDAN)

Notas Preliminares

A presente tese foi redigida segundo o Manual de Normas para trabalhos acadêmicos da UFPel, adotando o nível de descrição em capítulos não convencionais. Disponível no endereço eletrônico: http://sisbi.ufpel.edu.br/arquivos/PDF/Manual_Normas_UFPel_trabalhos_acad%C3%AAmicos.pdf

O projeto de pesquisa referente a esta Tese foi aprovado em agosto de 2013, pela Banca Examinadora composta pelos Professores Doutores Tatiana Pereira Cenci, Marcos Britto Corrêa, Carlos José Soares e Rafael Ratto de Moraes (suplente).

Resumo

SARKIS-ONOFRE, Rafael. **Restauração de dentes tratados endodonticamente: recomendações para a prática clínica e para o reporte de pesquisas.** 2016. 179f. Tese (Doutorado em Odontologia) – Programa de Pós Graduação em Odontologia. Universidade Federal de Pelotas, Pelotas, 2016

O objetivo desse trabalho foi avaliar fatores relacionados à restauração de dentes tratados endodonticamente utilizando guias de reporte de pesquisa e avaliar a utilização destes na literatura. Para isso, a tese foi dividida em seis capítulos, com os objetivos descritos a seguir. No capítulo 1, foi aplicado um questionário aos dentistas da cidade de Pelotas-RS, avaliando as suas preferências por materiais para restaurar dentes tratados endodonticamente. No capítulo 2, foi realizada uma revisão de literatura discutindo os conceitos atuais de restaurações de dentes tratados endodonticamente baseada em dois fatores: tratamento endodôntico e pinos intrarradiculares. No capítulo 3, uma revisão sistemática de ensaios clínicos randomizados avaliou como alguns fatores podem influenciar no comportamento clínico de dentes tratados endodonticamente quando restaurados com a combinação de pinos intrarradiculares e coroas unitárias. No capítulo 4, um ensaio clínico randomizado comparou a sobrevivência de pinos de fibra de vidro e núcleos metálicos fundidos usados para restaurar dentes tratados endodonticamente e sem paredes coronárias remanescentes com até 6 anos de acompanhamento. No capítulo 5, foi realizada uma revisão de literatura apresentando as principais iniciativas e guias para reporte de pesquisas como EQUATOR Network, CONSORT e PRISMA. No capítulo 6, foi aplicado um questionário com editores das revistas da área de odontologia listados no *Journal of Citation Report* 2013 (JCR) avaliando como os guias de reporte são utilizados. De forma geral, os dentistas relatam preferência por núcleos metálicos fundidos e pinos de fibra de vidro e uso de cimento resinoso. O nível de especialização do profissional influenciou nesta escolha. A preservação de estrutura dentária coronária é um dos principais fatores que influenciam a longevidade de dentes restaurados com o uso de pinos intrarradiculares. Em relação às técnicas e materiais, o uso de técnicas endodônticas que não causem problemas estruturais aos dentes parece ser a melhor opção para a preparação do canal radicular. Para dentes com estrutura coronária remanescente, o uso de pinos metálicos ou não-metálicos foi igualmente indicado. A revisão sistemática sugere que atualmente o uso de pinos metálicos está indicado para casos sem remanescente coronário, embora o grau de evidência gerado seja baixo. No entanto, os resultados do ensaio clínico randomizado não mostraram diferença entre sobrevivência ou sucesso de dentes tratados endodonticamente utilizando-se pinos de fibra de vidro ou metálicos fundidos. Ainda, um maior tempo de acompanhamento em ensaios clínicos é necessário. Em relação ao uso de guias de reporte, ficou claro que seu uso em odontologia é considerado

abaixo do ideal e um melhor entendimento das iniciativas disponíveis na literatura é fundamental para o desenvolvimento da pesquisa em saúde bucal.

Palavras-chave: pinos dentários; tratamento endodontico; revisão sistemática; pinos de fibra de vidro; paredes coronárias; guias de prática clínica; publicar.

Abstract

SARKIS-ONOFRE, Rafael. **Restoration of endodontically treated teeth: recommendations for clinical practice and for the research reporting.** 2016. 179f. Thesis (PhD in Dentistry). Graduate Program in Dentistry. Federal University of Pelotas, Pelotas, 2016.

The aim of this study was to evaluate factors related to the restoration of endodontically treated teeth (ETT) using research reporting guidelines and evaluating the use of the latter in the literature. Thus, this thesis was divided into six chapters with the following aims: in chapter 1, a survey with dentists of the city of Pelotas evaluating their preferences for materials to restore ETT was performed. In chapter 2, we performed a literature review discussing the current concepts on the restoration of endodontically treated teeth based on two factors: endodontic treatment and intra-radicular posts. In chapter 3, a systematic review of randomized controlled trials evaluated how selected factors influence the clinical performance of ETT restored with the combination of intra-radicular posts and single crowns. In chapter 4, a randomized controlled trial compared the survival of glass fiber posts and cast metal posts used to restore ETT without remaining coronal walls with up to 6 years of follow-up. In chapter 5, a literature review presents the main initiatives and research reporting guidelines as EQUATOR Network, CONSORT and PRISMA. In chapter 6, a survey with editors of dental journals registered on the 2013 Journal Citation Reports list (n=81) was conducted. In general, cast metal posts, glass fiber posts and resin cement were the most commonly selected materials by dentists and there was a significant association between the level of training of dentists and the type of post used. The preservation of remaining coronal walls is one of the most important factors that influence the longevity of ETT restored with intra-radicular posts. As for endodontic techniques, the use of conservative procedures that do not cause serious structural damages seems to be the best option for root canal preparation. Considering ETT with remaining coronal walls the use of metallic or non-metallic posts may be indicated. The systematic review suggests that the use of metallic and non-metallic posts is indicated in cases of absence of remaining coronal structure, although the generated the level of evidence was low. However, the results of the randomized controlled trial did not show difference between posts, while longer time of follow-up is required. Considering the use of reporting guidelines, their use is suboptimal and a better understanding of initiatives available in the literature is necessary for the development of oral health research.

Key-words: dental posts; endodontic treatment; review; glass fiber posts, systematic review, coronal walls, clinical practice guidelines; publishing.

Sumário

1 Introdução

Dentes tratados endodonticamente muitas vezes apresentam destruição da sua porção coronária por cárie, trauma e até procedimentos endodônticos agressivos (AKSORNMUANG et al., 2004, NAUMANN; BLANKENSTEIN; DIETRICH, 2005). Essas destruições, quando muito severas, fazem com que seja necessária a utilização de métodos adicionais de retenção do material restaurador coronário à parte radicular. Uma das alternativas para aumentar essa retenção e fornecer estabilidade para a restauração final é a colocação de um pino intrarradicular (FERNANDES; SHETTY; COUTINHO, 2003).

Cirurgiões-dentistas são confrontados diariamente com a disponibilidade de inúmeros materiais para se restaurar estes dentes, além de um grande número de dentes tratados endodonticamente para se restaurar (FARRELL; BURKE, 1989, SCAVO et al., 2011). Diferentes modalidades de pinos intrarradiculares e materiais para cimentação estão disponíveis no mercado e mesmo a literatura apresentando diversos estudos sobre o tema, a maneira com que as restaurações de dentes tratados endodonticamente vêm sendo realizadas muitas vezes não reflete a melhor evidência disponível, embora possa ser influenciada pela experiência clínica do cirurgião-dentista e pelo seu nível de especialização (NAUMANN et al., 2016, SCURRIA et al., 1995). No Capítulo 1 dessa tese avaliou-se, através da aplicação de um questionário, as preferências dos cirurgiões-dentistas para o uso de pinos intrarradiculares e suas respectivas modalidades de cimentação.

Dentre as variedades de pinos disponíveis destaca-se o uso de núcleo metálico fundido (NMF), indicado principalmente nos casos de destruição total da parte coronária e em casos de próteses fixas extensas que necessitem de retenção intrarradicular. Os núcleos metálicos fundidos têm demonstrado um desempenho satisfatório em estudos clínicos a longo prazo, além de adaptação à configuração e angulação das paredes do canal radicular e conexão ideal entre núcleo e pino impossibilitando, assim, a separação entre ambos. No entanto, além de requererem maior tempo de confecção e maior custo em relação aos pinos de fibra de vidro e também não apresentarem propriedades estéticas (WALTON, 2003), alguns autores

afirmam que o uso de núcleo metálico fundido pode influenciar a resistência mecânica dos dentes, aumentando o risco de dano a estrutura residual remanescente (FIGUEIREDO; MARTINS-FILHO; FARIA, 2015, ZARONE et al., 2006). Outras limitações desse tipo de dispositivo intrarradicular seriam a possibilidade de apresentar corrosão e gerar pigmentação tanto gengival como dentária, podendo representar risco para o desenvolvimento de reações alérgicas (STEWARDSON, 2001).

Por essas razões, os núcleos metálicos fundidos começaram a perder espaço para outros tipos de retentores intrarradiculares. Na década de 90, surgiram os pinos de fibra de carbono que apresentavam limitações como sua radiolucidez, dificuldade de mascarar o seu uso com restaurações cerâmicas e resina composta e possuírem rigidez semelhante aos pinos metálicos (ASMUSSEN; PEUTZFELDT; HEITMANN, 1999, VICHI; FERRARI; DAVIDSON, 2000). A partir de 2000, surgiram os pinos de fibra de vidro com o objetivo principal de oferecer melhores resultados estéticos (GIACHETTI et al., 2009). Sabe-se que estes geram uma distribuição mais homogênea da tensão na interface adesiva comparados aos núcleos metálicos fundidos, reduzindo assim o risco de fraturas radiculares (SILVA et al., 2009). Além disso, os dentes restaurados com pinos pré-fabricados reforçados com fibra de vidro quando comparados aos NMFs e cimentados de maneira semelhante apresentam um sistema mecanicamente mais homogêneo (SOARES et al., 2010).

No entanto, umas das principais causas de falhas é a sua descimentação, já que a adesão à dentina intrarradicular resulta de uma técnica de cimentação adesiva complexa e com alto grau de sensibilidade principalmente quando relacionada ao uso de cimentos resinosos convencionais (FERRARI et al., 2000, QUALTROUGH; MANNOCCI, 2003). Os cimentos resinosos autoadesivos surgiram na última década e ganharam rápida popularidade por dispensar uso de condicionamento ácido e adesivos dentinários compensando dessa maneira os problemas técnicos relacionados ao uso de cimentos resinosos convencionais (FERRACANE; STANSBURY; BURKE, 2011). Recentes revisões sistemáticas da literatura demonstraram que pinos de fibra de vidro cimentados com cimento autoadesivo apresentam maior resistência de união à dentina quando comparados a cimentos resinosos convencionais (SARKIS-ONOFRE et al., 2014, SKUPIEN et al., 2015). Assim, o uso de cimentos resinosos autoadesivos e pinos de fibra de vidro em dentes com comprometimento estrutural coronário parece estar associado a um bom

desempenho clinico das restaurações de dentes tratados endodonticamente (SARKIS-ONOFRE et al., 2014).

Quando dentes tratados endodonticamente apresentam comprometimento estrutural, alguns fatores como a estrutura coronária remanescente e a incidência de cargas oclusais parecem ser cruciais para o sucesso dessas restaurações. Adicionalmente, um desenho oclusal favorável da prótese seria mais importante para a sobrevivência dessas restaurações do que a própria modalidade de pino utilizado (TORBJÖRNER; LIC; FRANSSON, 2004a; TORBJÖRNER; LIC; FRANSSON, 2004b). Dentro desse contexto, sabe-se que uma estrutura dentária quando intacta apresenta-se como um sistema que trabalha bem. No entanto, a perda de estrutura altera dramaticamente esse cenário havendo relação direta entre a resistência do dente e a quantidade de tecido remanescente (TORBJÖRNER; LIC; FRANSSON, 2004a). Assim, a ausência de paredes residuais coronárias e de estrutura suficiente para gerar um efeito de férula seria o pior cenário para se restaurar dentes com o uso de pinos intrarradiculares como principal método de retenção do material restaurador coronário (FERNANDES; SHETTY,COUTINHO, 2003). Outrossim, dentes anteriores e posteriores apresentam comportamento mecânico e incidência de cargas oclusais diferentes, à exemplo dos incisivos com até 3x menor incidência de força quando comparados aos terceiros molares, culminando em possíveis efeitos na longevidade das restaurações. Desta forma, no Capítulo 2, os conceitos atuais para restauração de dentes tratados endodonticamente são discutidos através de uma revisão narrativa da literatura. No Capítulo 3, os fatores que podem influenciar na performance clínica da combinação entre pinos intrarradiculares e coroas unitárias são discutidos após realização de uma revisão sistemática.

Somado a isso, ainda há falta de evidência clínica baseada em estudos de longo tempo de acompanhamento sobre qual seria o melhor tipo de pino para se restaurar dentes tratados endodonticamente em situações extremas de destruição coronária (sem paredes coronárias remanescentes). No Capítulo 4 nós comparamos, através de um ensaio clínico randomizado, a longevidade de pinos de fibra de vidro e núcleos metálicos fundidos utilizados na restauração de dentes tratados endodonticamente.

Além da falta de evidência a respeito deste tema, as informações que existem na literatura são pobremente organizadas e com deficiências de descrição. Em odontologia, diversas pesquisas vem apontando as deficiências no reporte de

estudos clínicos em diferentes áreas incluindo a área de odontologia restauradora. Um estudo realizado em 2002 (JOKSTAD et al., 2002) avaliou 92 ensaios clínicos randomizados (ECRs) realizados na área de prótese e revelou que 70% dos estudos avaliados não descreviam como a randomização havia sido realizada, bem como os parâmetros utilizados para o sigilo de alocação dos tratamentos, concluindo que poucos ECRs na área de prótese são reportados de acordo com o guia atualmente disponível para reporte de estudos clínicos (CONsolidated Standards Of Reporting Trials – CONSORT). Importante destacar que o CONSORT *Statement* surgiu em 1996 (BEGG et al., 1996) e tem como "produto" a sistematização e organização em listas e recomendações acerca dos itens minimamente recomendados e que devem ser descritos quando se escreve um artigo acerca de um ECR. Poderia se supor que em 2002 não havia disseminação do CONSORT e por esta razão o artigo de 2002 reportou este alto percentual de escrita incompleta. No entanto, um estudo recente (KLOUKOS et al., 2015) avaliou a qualidade do reporte de ECRs publicados em jornais da área de prótese e implantodontia e revelou que dos 147 ECRs avaliados, 76,9% dos estudos não apresentaram *flowchart* para a descrição do número de pacientes em cada estágio do estudo. Assim, a qualidade do reporte desses estudos necessita de melhora, ressaltando que o ótimo reporte é pré-requisito essencial para a tomada de decisão clínica. Logo, fica claro que como em tantas outras áreas da saúde, os guias existentes para reportar pesquisas são subutilizados na área de odontologia e que seu uso merece um melhor entendimento. No Capítulo 5 nós apresentamos aos pesquisadores da área de odontologia os principais guias para reporte de pesquisas. Por fim, no Capítulo 6 nós avaliamos como os jornais da área de odontologia usam esses guias de reporte.

Assim, esta tese tem como enfoque principal discutir os aspectos relacionados à publicação científica em odontologia e em apresentar como isso se relaciona ao estudo de um tema específico: a reabilitação de dentes endodonticamente tratados.

Diante do exposto, os objetivos específicos da presente tese foram:

1. Avaliar as preferências dos dentistas para materiais de escolha para restauração de dentes tratados endodonticamente e a influência da experiência clínica e do nível de especialização na escolha de pinos pelos dentistas;

2. Discutir os conceitos atuais de restaurações de dentes tratados endodonticamente baseado em dois fatores: tratamento endodôntico e pinos intrarradiculares;
3. Avaliar como alguns fatores influenciam o comportamento clínico de dentes tratados endodonticamente quando restaurados com a combinação de pinos intrarradiculares e coroas unitárias;
4. Comparar a sobrevivência de pinos de fibra de vidro e núcleos metálicos fundidos usados para restaurar dentes tratados endodonticamente e sem paredes coronárias remanescentes através de um ensaio clínico controlado e randomizado.
5. Apresentar para os pesquisadores da área de saúde bucal as iniciativas chave atuais e os guias de reporte utilizados em reportes da área biomédica;
6. Avaliar o perfil dos periódicos da área de odontologia e como esses periódicos usam os guias de reporte.

2 Capítulo 1

Preferences on the posts to restore endodontically treated teeth: findings from a survey with dentists[1].

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Abstract

The aim of this study was to evaluate if clinical experience, whether in relation to length of practice time and/or level of specialization influences the dentist's preference for using posts to restore endodontically treated teeth. A cross sectional study was carried out using a questionnaire with dentists (n=276) in Pelotas, southern Brazil. Data were collected regarding clinical experience, post-graduate training, and variables related to restorations (posts/cements and use of rubber dam) for endodontically treated teeth. The data were submitted to a descriptive analysis and associations were tested. The response rate was 68%. Cast metal posts (24.53%), glass fiber posts (20.75%) and resin cement (66.67%) were the most commonly selected materials. In relation to rubber dams, 93.05% of the dentists were found not use them to lute posts. There was a significant association between the level of training of post-graduate dentists and the type of post used (p=0.027), in that dentists without post-graduate training used cast metal posts more frequently, whereas dentists with post-graduate training reported glass fiber posts as their first choice. The results of the study showed that dentists preferred cast metal posts, glass fiber posts and resin cement. Continuing education influenced the decision of the dentists on their choice of dental posts.

Key-words: "Tooth, Nonvital", Decision Making, "Dental Restoration, Permanent"

Introduction

Endodontically treated teeth (ETT) may have signs of large coronal destruction resulting from aggressive endodontic treatment, caries or trauma. In these cases, intraradicular posts may be necessary to improve retention of the restorative material to the root portion.[1] A wide range of post and cement types are available on the market for restoring ETT. Procedures vary from using a conventional cast metal post and core to adopting a one-visit technique using commercially available prefabricated post systems.[2-5] Factors related to posts, such as material, esthetics, design, luting techniques, and factors related to teeth, such as remaining coronal structure, presence of ferrule and root length, have been seen to influence post selection and survival of these restorations.[6-9]

Furthermore, the literature has shown that factors related to dentists can also influence the decision-making process, specifically in regard to clinical experience and post-graduate training.[10] The skills of a dentist can be improved over time in clinical practice. However, the introduction of new materials on the market requires training and updated knowledge by dentists, to ensure the best application of these new materials.[10-14] The dentists' preference for materials and techniques, and their level of knowledge regarding the proper use of these materials, are investigatory avenues of interest that could be adopted to guide undergraduate dental curricula and continuing education courses.

In recent years, greater interest has been seen in the Dental Practice Based Research approach, where the preferences of dentists are taken into consideration and the treatments are evaluated in a "real world" clinical practice scenario.[15,16] This way of associating knowledge with scientific interpretation has been considered the best method, and can be implemented directly and quickly in regular clinical practice.[17]

The present study was designed to evaluate the preferences of dentists for the materials chosen to restore ETT, and the influence of both clinical experience (time since graduation) and level of specialization (post-graduate training) on the dentist's choice of posts.

Materials and Methods

This cross sectional study was approved by the Local Ethics Committee (116/2009) and carried out between March and June 2009, in Pelotas, in the southern region of Brazil. All dentists registered at the local division of the Regional Council of Dentistry (n=276) were invited to participate in the study. Data were collected through a self-applied closed questionnaire. The following information was gathered: social-demographic characteristics, clinical experience (time since graduation, in years and categorized as ≤ 10 years, 11 – 20 years, and > 20 years), post-graduate training (none, specialization level, Master's or PhD degree, and dichotomized into none and specialist). Information about the use of posts to restore ETT was collected as follows: most frequently used post (cast metal, pre-fabricated metal, carbon fiber, glass fiber, more than 1 or none), the resin cement used to lute these posts (glass ionomer cement, resin cement, both or none) and the use of a rubber dam (yes or no).

First, the questionnaire was pre-tested with professionals not involved in the study, from a city with characteristics similar to those of Pelotas. The data collected did not allow any information to be included that could identify the dentist. The questionnaire was given personally at each dentist's clinic, and the information about the study and its importance were explained. The questionnaire was collected together with the signed informed consent a week later. If the dentist did not return the questionnaire after 2 visits, his/her participation was eliminated. Further information about this methodology has been published elsewhere.[10, 14]

Data were submitted to descriptive analyses, and the existing association between post-graduate training, clinical experience and dentist preferences (type of post/cement and use of rubber dam) were assessed according to Fisher's exact test. The analyses were carried out with Stata 10.0 software (StataCorp, College Station, TX, USA). A significance level of $\alpha=0.05$ was considered.

Results

Of the total 276 dentists invited to participate in the study, 187 (68%) answered the questionnaire. Those eliminated were mainly due to their not retuning the questionnaire (n=48) or not signing the informed consent (n=32), but there were

also some refusals (n=9). Since the questionnaire was self-applied, some of the dentists missed some questions; this is why the number of answers varied for each question.

Descriptive analysis showed that 52.4% of the dentists were female and 96% classified themselves as white. The average time since graduation was ≥10 years (53.2%) and 64.7% of the dentists had some degree of post-graduate training.

Table 1 shows that cast metal posts (24.5%) and glass fiber posts (20.8%) were the most commonly used type of intra-radicular post. Analyzing the group of pre-fabricated posts (metal, carbon fiber and glass fiber), there was a trend to use these instead cast metal posts. Regarding the type of cement, resin-based cement was selected by 66.7% of the dentists and non-use of a rubber dam was reported by 93.1% of the dentists.

The results in Table 2 did not show a significant association between time since graduation and type of post/cement preference and use of a rubber dam. However, there was a trend for dentists with less time since graduation to use glass fiber posts and rubber dams to lute posts more frequently than dentists with a longer time since graduation. Table 3 shows a significant association between the training of post-graduate dentists and the type of post selected (p=0.027). Dentists without post-graduate training were seen to use cast metal posts more frequently, whereas dentist with post-graduate training reported using glass fiber posts as their first choice.

Discussion

This study is the first survey among Brazilian dentists to analyze the preferences of clinicians for several aspects related to the of use intra-radicular posts. The findings of this study are important, since surveys based on questionnaires provide important information about demographics, attitudes, opinions, and the approach toward treatment.[18] The study showed that dentists preferred cast metal posts and glass fiber posts to restore endodontically treated teeth. The literature has shown that metal posts and glass fiber posts present different mechanical properties. Metal posts have a high elastic modulus, in comparison with that of dentin. This could increase the risk of root fracture and catastrophic failure[19], whereas glass fiber posts have mechanical properties similar to

those of dentin, thus reducing the risk of catastrophic failure and consequent failures related to their use, mostly involving post debonding.[1, 9]

Two systematic reviews available in the literature show that there is no evidence to support the “best way” to restore endodontically treated teeth.[20,21] A recent study comparing the use of glass fiber posts versus cast metal posts, in teeth with no remaining coronal wall, showed that no difference was found between the groups using these two types of posts, after up to 3 years of follow-up.[5] However, several factors must be borne in mind when choosing the post to be used in restoring ETT, including remaining coronal structure, presence of ferrule and post material.[1] Greater tooth survival is ensured when at least one wall is maintained, even in ETT.[22] In addition, it has been shown that the presence of ferrule (minimum 2mm) is a decisive factor for the success of cast post and core.[23] With regard to post material, metal posts have a high elastic modulus, in comparison with that of dentin, and could therefore increase the risk of root fracture and catastrophic failure,[19] whereas glass fiber posts were introduced as an alternative to metal posts, and show mechanical properties similar to those of dentin.[19]

Most dentists preferred resin-based cements to lute posts. The use of glass ionomer cements to lute posts seems to be a less sensitive technique; however, a combination of the etch-and-rinse adhesive system and regular resin cement is the most commonly used approach in restorative dentistry, specifically to lute glass fiber posts (GFPs).[24] In the past decade, self-adhesive resin cements were introduced to provide easier clinical application, compared with regular resin cements.[25] A recent systematic review of *in vitro* studies showed that the literature on these studies suggests that self-adhesive resin cement could improve the retention of GFPs into root canals.[26] However, an important limitation of the present study is related to the issue of cement choice, since no option was given for zinc phosphate cement. This must be emphasized, since zinc phosphate cements are widely used, especially to lute cast metal posts, because of their long history of success, as well as their lower price and less sensitive technique, compared with resin cements.[27] Additionally, it may be said that the use of glass fiber posts may also be related to the experience of clinicians with resin cements, while when no experience is considered, dentists tend to avoid the use of resin based cements and use zinc phosphate.

Considering post-graduate training, the literature seems to suggest that dental specialists are more familiar with the literature and participate in meetings with greater frequency, directly influencing their clinical choices and, consequently, their practices. These dentists are also more prepared to introduce new technologies in their clinical practice.[10-14] Our results show that dentists with post-graduate training tend to prefer glass fiber posts as their first choice to restore ETT, whereas non-specialists tend to prefer cast metal posts. In a survey with 909 American dentists, the different philosophies and techniques for restoring ETT varied significantly depending on the dentist's geographic region, age, faculty status, and specialty status.[28] Furthermore, pre-fabricated posts are more popular among dentists than cast metal posts. A survey with 6029 dentists from Germany showed the same trend in preferring pre-fabricated posts.[29] One of the most important advantages of these posts is that there is no need for a laboratorial step, unlike cast metal posts, and that they can be applied using a one-visit technique. In the current scientific literature, several clinical trials have shown good clinical performance for pre-fabricated posts.[2-5]

Another important issue is the use of rubber dam isolation. A recent study[30] evaluated the influence of using a rubber dam during post placement for the success of root-canal-treated teeth. A retrospective chart review of 185 patients showed that the success rate of the underlying endodontic treatment was significantly enhanced when a rubber dam was used. This result is important, since most dentists in the present study reported not using rubber dams to lute posts, even though they were taught to use rubber dams to lute glass fiber posts in dental school. However, this does not seem to be a common practice in clinical situations.

This study has some limitations, since it was based on a self-applied closed questionnaire. Some disadvantages include the fact that self-application requires another visit by the research staff, and the interviewee does not always answer all the questions of the questionnaire. The response rate was 68%, which can be considered high in comparison with another German survey in the same field.[29]

Conclusion

In conclusion, the results of the study showed that dentists preferred cast metal and glass fiber posts cemented with resin-based cement to restore ETT. Continuing education was a factor influencing the decisions on the choice of dental posts.

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Tables

Table 1: Number of observations and frequencies of the variables studied, among dentists.

Variable	n*	%(CI 95%)
Type of Post	159	
Cast Metal Post	39	24.53 (18.0 - 32.0)
Pre-fabricated Metal Post	28	17.61 (12.0 - 24.4)
Carbon Fiber Post	7	4.40 (1.8 - 8.9)
Glass Fiber Post	33	20.75 (14.7 - 27.9)
More than 1	17	10.69 (6.4 - 16.6)
None	35	22.01 (15.8 - 29.3)
Type of Cement	111	
Glass Ionomer Cement	31	27.93 (19.8 - 37.2)
Resin Cement	74	66.67 (57.1 - 75.3)
Both	6	5.41 (2.0 - 11.4)
Rubber Dam Use	187	
No	174	93.05 (88.4 - 96.2)
Yes	13	6.95 (3.7 - 11.6)

Table 2: Association between length of clinical practice time (time since graduation) and variables related to post use.

	Time since graduation in years [n (%)]				
Variable	0 -9 years	10 - 11 years	> 20 years	Total	P value
Type of Post					0.644
Cast Metal Post	20(52.3)	9(23.68)	9(23.68)	38(100)	
Pre-fabricated Metal Post	15(53.57)	4(14.29)	9(32.14)	28(100)	
Carbon Fiber Post	1(14.29)	3(42.86)	3(42.86)	7(100)	
Glass Fiber Post	18(54.55)	4(12.12)	11(33.33)	33(100)	
More than 1	4(23.53)	6(35.29)	7(41.18)	17(100)	
None	20(57.14)	8(22.86)	7(20.00)	35(100)	
Type of Cement					0.108
Glass Ionomer Cement	15(50)	7(23.33)	8(26.67)	30(100)	
Resin Cement	37(50)	14(18.92)	23(31.08)	74(100)	
Both	0(0)	3(50)	3(50)	6(100)	
Rubber Dam Use					0.466
No	78(45.09)	39(22.54)	56(32.37)	173(100)	
Yes	7(53.85)	4(30.77)	2(15.38)	13(100)	

Table 3: Association between post-graduate training of dentists and variables related to post use.

	Post-graduate training [n (%)]			
Variable	No	Yes	Total	P value
Type of Post				0.027
Cast Metal Post	20(52.63)	18(47.37)	38(100)	
Pre-fabricated Metal Post	12(42.86)	16(57.14)	28(100)	
Carbon Fiber Post	1(16.67)	5(83.33)	6(100)	
Glass Fiber Post	14(42.2)	19(57.8)	33(100)	
More than 1	8(47.06)	9(52.94)	17(100)	
None	6(17.14)	29(82.6)	35(100)	
Type of Cement				1
Glass Ionomer Cement	13(41.94)	18(58.06)	31(100)	
Resin Cement	31(43.06)	69(56.94)	72(100)	
Both	3(50.0)	3(50.0)	6(100)	
Rubber Dam Use				0.548
No	62(36.05)	110(63.95)	172(100)	
Yes	3(23.08)	10(76.92)	13(100)	

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3 Capítulo 2

Current concepts on the restoration of endodontically treated teeth[2].

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Abstract

The aim of this review was to discuss the current concepts of restorations placed in endodontically treated teeth (ETT) based on two factors: endodontic treatment and intra-canal posts. In relation to endodontic treatment the current literature suggests that the use of simplified techniques for root canal preparation can result in structural problems. There is a relationship between the quality of coronal restoration/use of rubber dam in all steps and success of endodontic treatment**.** For intra-canal posts the literature shows a strict relationship between mechanical properties of posts and the placed restoration performance. Glass fiber posts seem to perform better while the preservation of coronal walls increases the longevity of ETT. We can conclude that the use of conservative techniques in all steps of treatment associated with strict protocols can reduce the chances of failure for ETT.

Keywords: Dental posts; “Dental Restoration, Permanent”; Endodontic treatment; Review; “Tooth, Nonvital”.

1. Introduction

The new concepts of restorative dentistry have shown that the preservation of tooth structure is a fundamental point to avoid tooth loss. Sometimes the teeth may have a partial coronal destruction due to endodontic treatment, caries or trauma [1] and it is well established that in these situations the use of composite resin as restorative material seems to be the best option [2,3].

In other situations the teeth may have an aggressive coronal destruction due the same reasons cited above or as the result of an aggressive restorative cycle, practiced in the past. Under those circumstances and after endodontic treatment, the use of intraradicular posts may be necessary to improve the retention of the restorative material to the root portion [1]. However, there is no consensus in the available literature about the best way to restore endodontically treated teeth (ETT). Whereas aspects related to the posts and to the cementation are extensively studied [1], other factors related to the root canal treatment, to the post placement procedures also play a role on the longevity of ETT.

Better understanding of the factors that could affect the longevity of ETT and their possible relationship is essential since restorations placed in endodontically treated teeth have a reduced survival rate compared to those restorations placed in vital teeth [2]. Thus, the aim of this review is to discuss the current concepts of restorations placed in endodontically treated teeth based on two factors: endodontic treatment and intra-canal posts

2. Endodontic treatment:

2.1 Endodontic preparation x Structural problems (root cracks).

The mechanical instrumentation of the root canal is considered an important step of canal preparation. The major goals of this preparation are the prevention of periradicular disease and/or promotion of healing in cases where disease already exists. The preservation of dentin structure through avoidance of iatrogenic damage to the root canal system and root structure seems to be essential to preserve the teeth in long-term [4].

In the past, the root canal preparation was carried out through manual techniques and these techniques and instruments were improved over time. Recently, the introduction of handpieces improved the root canal preparation mainly

reducing de working-time through a simplified technique with a large number of handpieces on the market including rotatory, oscillatory and ultra-sonic instruments [5,6]. However, even with advantages compared with other techniques, with the introduction of mechanized techniques it might be assumed that the incidence of dentinal defects might be increased compared with traditional preparations and one common complication associated with these mechanical techniques is vertical root fracture (VRF), which usually leads to tooth loss [7-10].

The literature shows that the use of simplified techniques can result in dentinal defects like incomplete cracks or even VRF. The dentinal defects can occur due to higher generation of stress and friction inside of root canal and sometimes due to the shape of instruments used resulting in different rates of defects in the different root thirds [11-13]. It is important to note that there is no consensus in the available literature if minor dentinal defects may lead to root fractures over time. However, there is a consensus that such defects should be prevented. In the context of restoration of ETT, the use of intra-canal posts with mechanical properties similar to that of dentin (i.e. glass fiber posts) seems to be a good option to prevent the propagation of dentinal defects, which will be discussed in further sections.

It is important to note that the studies that evaluated the relationship between endodontic preparation and structural problems present limitations regarding the simulation of clinical conditions in *in vitro* models and the forces from extraction and sawing of the specimens may contribute to defects and mask some results [14,15]. Furthermore, other steps of endodontic treatment and materials used could influence the incidence of dentinal defects. The literature also indicates that the incidence of these defects may increase during endodontic retreatment, ultrasonic irrigation and use of high concentrations of NaOCl (2.5 or 5.25%), with decrease of elastic modulus and flexural strength of dentin when NaOCl is used as an irrigant and a possible correlation with co-factors as post space preparation and occlusal forces[16,17].

Thus, the use of conservative techniques that do not cause serious structural damages seems to be the best option for root canal preparation especially in teeth that will receive intra-canal posts.

2.2 Impact of the Quality of Coronal Restoration x Success in endodontic treatment.

Under optimal clinical conditions, the endodontic treatment has a good outcome for primary root canal treatment ranging between 90-95% with no preoperative apical periodontitis [18,19]. Yet, in the presence of preoperative apical periodontitis success rates range between 75-80% [19-23]. This is important since Torabinejad and colleagues stated that without coronal restorations, bacterial products were found at the apex after only 3 weeks confirming the importance in preventing the contamination of apices and clearly showing the importance of a coronal restoration [24].

In this way, the Cochrane collaboration presented, in a review published in 2008, that there is no difference between single- and multiple-visit root canal treatment in the effectiveness of root canal treatment on radiological success, with the former presenting a shorter timespan of a temporary coronal restoration and consequent contamination [25]. Yet, these findings should be interpreted with caution because patients undergoing a single visit may experience a slightly higher frequency of swelling and are more likely to take painkillers.

A recent systematic review showed a strong effect between adequate root canal treatment and adequate restorative treatment on healing of apical periodontitis. Furthermore, in nonstatistical terms, the review showed that trying to salvage a poorly performed root canal treatment by placing a well-sealed coronal restoration is as futile as placing an inadequate restoration over well-filled root canals in anticipating the resolution of apical periodontitis for every patient in the long run [26].

Table 1 presents the main characteristics and findings of each study included in that review with the relationship between endodontic success and quality of endodontic/restorative procedures. The majority of the included studies were cross sectional and the impossibility of determining whether a periapical pathosis is healing or not because a radiograph provides only static description of the dynamic inflammatory process has to be considered together with the lack of information about the time elapsed between treatment and observation period [27-35].

Naturally, endodontists and restorative dentistry professionals think that their own fields are the most important. We believe that the most important is to alert the professionals to the potential impact of an aspect, sometimes neglected, on the

maintenance of periapical health. Still, the results available in the current literature confirm that all steps of endodontic treatment and restorative procedures should not be neglected and the use of strict protocols in all steps reduces the chance of failures over time and this can be illustrated by the study of Özkurt et al. (2011) [36] that showed that the simple gap between the post and the remaining root canal filling is a decisive factor in the access of microorganisms and consequent endodontic success.

2.3 Rubber dam use x success of ETT restoration

As previously described, Torabinejad et al. (1990) confirmed the importance of coronal final restoration [24]. Other study evaluated the reduction of sealing ability of root canal filling during post space preparation, showing a significant difference between the sealing ability of intact fillings and that of partially removed ones [37]. One of the main findings is that the reduction of the fillings to 3 mm can result in an unpredictable seal. Preserving 4-5 mm of gutta-percha will ensure an adequate seal [38].

These findings confirm the importance of well hermetic seal of coronal and root portion of teeth leading to an uncontaminated environment within the root canal system. This maintenance is strongly related to the use of rubber dam during all steps of endodontic treatment and post space preparation, which is corroborated by The American Association of Endodontists: *"Tooth isolation using the dental dam is the standard of care; it is integral and essential for any nonsurgical endodontic treatment. One of the primary objectives of endodontic treatment is disinfection of the root canal system. Only dental dam isolation minimizes the risk of contamination of the root canal system by indigenous oral bacteria. The dental dam also offers other benefits, such as aiding in visualization by providing a clean operating field and preventing ingestion or aspiration of dental materials, irrigants and instruments*" [39].

A recent study evaluated the influence of rubber dam's use during post placement on the success of root canal–treated teeth. A review of 185 patients showed that the success rate of the underlying endodontic treatment was significantly enhanced when a rubber dam was used [40]. To our knowledge this study is the only available with that primary outcome and these results should base the clinical decisions of dentists since the current literature is showing that 40% of dentists in USA usually/sometimes/never use rubber dam during endodontic treatment [41] and in a recent survey with general dental practitioners in Brazil, only

7% reported the used of rubber dam to lute intra-canal posts [42]. As the results of Goldfein et al. (2013) were based on a cross sectional study, the same disadvantages stated above have to be considered and other clinical studies should be developed [40].

3. Intra-canal posts:

3.1 Current posts used

After a good endodontic treatment is performed, the coronal restoration needs to be planned. There is a wide range of types of posts and cements on the market when planning to restore ETT, varying from a conventional cast metal post and core to one-visit techniques, using commercially available prefabricated post systems. These posts can be divided into two groups: metallic posts (cast metal posts – CMP, pre-fabricated), and fiber posts. This section is based on the observations about these two groups [1, 43-46].

Cast metal posts were the modality of intra-canal retention most used in the past. The great advantage is the perfect shape between post and root canal, due to the prior impression of the canal, favoring the frictional retention and resulting in a good retention capacity. For this reasons, the CMP are still used as gold standard in cases of extreme loss of coronal portion (with no remaining walls) and in cases of large fixed prostheses. As these techniques need a laboratorial step, the use CMP is more expensive than other pre-fabricated posts. The pre-fabricated metal posts were introduced in the market to provide a one-visit technique associated to fracture resistance of CMP and with different degrees of taper and surface design to improve the retention. When the pre-fabricated posts are used the core is made with direct materials as composite resin and the posts can be luted through an adhesive technique. Still, no metallic posts present good esthetics losing ground to more esthetic solutions [1].

The main aim of the introduction of pre-fabricated fiber posts on the market was to provide an esthetic solution in cases of rehabilitation of ETT. Initially, a wide range of posts were available on the market depending on their format, taper, translucency and the material they were made of. Different designs were thought to be important to improve retention since intra-radicular dentin adhesion was not believed to be adequately achieved [47]. Nowadays, with the advance of materials and techniques, the use of glass fiber posts seems to be a good option since they

have good aesthetic properties with good adhesion to root dentin. A recent systematic review of in vitro studies showed that the *in vitro* literature seems to suggest that the use of self-adhesive resin cement could improve the retention of glass fiber posts into root canals [48].

3.2 Influence of post's materials on mechanical behavior of endodontically treated teeth

Several studies have shown a strict relationship between mechanical properties of posts and the behavior ETT [49-51]. The two main properties discussed in the literature are the fracture resistance and elastic modulus with two parameters influencing the mechanical behavior of ETT restored with posts: the characteristics of the interfaces and the rigidity of the materials.

It has been suggested that ETT are more brittle and may fracture more easily than vital teeth and the use of intra-radicular posts could improve the fracture resistance. A recent systematic review of *in vitro* studies compared the fracture resistance between cast and fiber posts suggesting a low effect size favoring the cast posts [52]. We believe that this property has a secondary role on the longevity of ETT once this test present limited information about internal behavior of the structures and will not be largely discussed in this review.

The elastic modulus seems to be an important property to be studied and considered in the restoration of ETT since represents own stiffness of a material within the elastic range and describes the association between stress and strain. The influence of allowing to simulate the stress distribution and predicts stress concentration i.e. probable points of failure initiation on the structure or material [53].

Metallic posts (Ni-Cr alloy: 205000 MPa) are classified as having a high elastic modulus when compared with the dentin (18000 MPa) and studies show that due to the high elastic modulus a concentration of stress on the interface post/cement may occur leading to a root fracture. Even when simulated, this condition using less rigid cement (i.e. resin cement) was not possible to improve the stress in the system teeth/post/cement because the high rigidity of the metal post [54,55].

The use of glass fiber posts (E= 37000 Mpa) to restore ETT present the most favorable stress condition due to the elastic modulus similar to that of dentin, with more favorable stress distribution and concentration of stress on the interface post/cement [56]. Notwithstanding, glass fiber posts debonding does not cause damage to structure. A recent study evaluated the influence of crown, post, and

remaining coronal dentin on the biomechanical behavior of ETT and reported that in the absence of remaining coronal dentin, the association between metal free restoration and glass fiber posts showed better biomechanical behavior than the association of cast metal posts and metal free/metal coronal restorations and glass fiber posts/composite resin cores showed homogenous stress distribution within the post space, irrespective of the crown material [51]. These findings are important as a more favorable stress distribution and concentration of stress on the interface post/cement could prevent that minor dentinal defects may lead to root fractures. Still, further studies are necessary.

3.3 Clinical evidence available in the literature.

Two Cochrane Systematic Reviews tried to answer how to best (procedures/materials) restore ETT and both showed that there is no evidence available in the current literature, while studies based on well designed and well conducted RCT should be conducted [57,58]. Yet, the current literature presents some important data allowing the dentists to base their clinical decisions.

Studies have shown that the preservation of coronal walls is the one of main factors that can influence the survival of ETT. Fokkinga et al. (2007) performed a controlled clinical study on post-and-cores and covering crowns with up to 17 years of follow-up and showed higher restoration survival probabilities to “substantial dentin height” group compared to “minimal dentin height” group when both were restored with prefabricated metal posts/composite core restoration with covering crowns [43]. Ferrari et al. (2012), over a six-year observation time, showed that regardless of the restorative procedure, preservation of at least one coronal wall significantly reduced the failure risk [59].

However, there is no consensus in the literature regarding the limit of remaining walls between the use or not of posts to improve the retention of coronal material to radicular portion. Stockton et al. (1998) already commented on *“The need to reappraise the application of posts for the restoration of endodontically treated teeth and define criteria for their precise placement cannot be overstated”* [60]. Fokkinga et al. (2007) showed no difference in the survival probability between restorations with and without posts in teeth with ‘‘substantial dentin height’’ left [43]. The findings of Ferrari et al. (2012) showed a direct relationship between the number of remaining walls and survival rates of teeth restored with metal-ceramic crowns/no posts [59]. It is interesting that comparing these findings with the groups that used

posts the results of survival rates are similar in the groups with 4/3/2 remaining walls and presents a decrease of survival rate compared to the group with 1 remaining wall. Bitter et al. (2009) compared the use or not of posts in ETT with 2 or more walls, 1 wall and no remaining wall and the results showed that in the no-wall group, post placement had a significant effect on the survival rate. Teeth without post retention revealed a significantly higher failure rate (31%) compared with teeth restored with post retention (7%), in 1-wall group no effects of post placement on the failure rate could be demonstrated and in the 2 or more walls no failure occurred [61].

These data are important because they show an important threshold between the uses of posts. However, longer follow-up periods are needed to effectively determine this limit since *in vitro* literature showed that even presenting more reparable fractures the use of crowns/no posts exhibited additional dentinal cracks to the root surface, which can impact their longevity [62]. It is important to point out that when the literature use the expression “coronal remaining walls”, this is related to remaining wall(s) with sound dentin and enamel.

Other factor that seems to be important is the “ferrule effect”. Parallel walls of dentin extending coronally from the crown margin provide a ferrule that enclosed by a crown provides a protective effect by reducing stresses within a tooth called the ‘‘ferrule effect’’. Recent literature review pointed out the benefits of “ferrule effect” mainly in single root teeth; however, this effect should be investigated over time [63]. Ferrari et al. (2012) evaluated these factors in a randomized controlled trial and after 6 years showed lower survival rates in all “absent ferrule” groups when compared to “present ferrule” groups [59].

The absence of coronal remaining walls and consequently “ferrule effect” is the worst scenario to restore ETT and traditionally, in this situation the use of cast metal posts was largely recommended. Fokkinga et al. (2007), did not find differences in restoration-survival between prefabricated metal and cast post-and-cores and affirm that dentists and researchers should be careful to conclude that in the situation of a tooth with ‘‘minimal dentin height’’ (worst scenario) always a cast post-and-core is preferred [43]. Sarkis-Onofre et al. (2014) carried out a randomized controlled trial comparing the survival ETT restored with glass fiber or cast metal dental posts used with no remaining coronal wall (ferrule height, 0–0.5 mm) and after up to 3 years of follow up the results showed similar clinical performance for both

posts [46]. This result suggests that glass fiber posts may also be a good option to restore ETT in this scenario, but longer follow-up periods are needed.

Table 2 presents the available clinical trials that evaluated any intra-canal post to restore ETT. Clinical studies that evaluated the performance of intra-canal posts (Table 2) present different designs, aims and some present limitations as well and therefore, results should be compared and evaluated with caution. Well-designed and well-conducted RCT are still needed, especially evaluating patient risk factors' influence. Still, some findings are important to be highlighted: 1) It is clear that endodontic treatment, amount of coronal residual structure, and use of strict protocols can influence the success/survival rates of these restorations; 2) In general posts are a viable solution to restore ETT if recommended procedures are strictly followed; 3) All studies that evaluated glass fiber posts showed better or similar success/survival rates than other posts evaluated. Thus, glass fiber posts good success/survival rates together with their biomechanical and esthetic characteristics certainly indicates this type of post as a feasible option to restore ETT [43-46, 59, 61, 64-88].

4. Discussion

The rehabilitation of ETT still remains a challenge for the clinicians even with the advance of materials and techniques since various factors are involved on their chance of survival. The main goal of this review was to alert the dentists that the results available in the current literature confirm that all steps of endodontic treatment and restorative procedures should not be neglected and the use of strict protocols in all steps reduces the chance of failures over time.

The factors discussed in this review show that the preservation of tooth structure through the use of conservative techniques in all steps of treatment might be one of the most important factors for the longevity of ETT. The association of conservative root preparation with use of techniques that do not cause serious structural damages and use of intra-canal posts with elastic modulus similar to that of dentin seems to be the most conservative approach to restore ETT. Furthermore, properties of glass fiber posts might be important to prevent the propagation of dentinal defects and can be a good solution for teeth with structural problems.

Other factors as the choice of restorative coronal material might influence the longevity of ETT and are beyond of the scope of the present review. A recent published review discussed the clinical dilemma of how to restore ETT and showed that the clinical success of coronal restoration of ETT depends on the degree of destruction of teeth [89]. These findings confirm all factors discussed and presented in this review and confirm the importance of minimally invasive dentistry as well.

5. Conclusion

We can conclude that the use of conservative techniques in all steps of treatment associated with strict protocols can reduce the chance of failures the rehabilitation of ETT.

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Tables Captions:

Table 1**:** Characteristic of nine studies employed for meta-analysis (adapted from Gillen and colleagues, 2011) [26].

Table 2: Clinical posts studies (adapted and updated from Soares, 2013) [64].

Study*	Study Design	Sample Size (teeth)	Type of evaluation(1)	Calibration(2)	5-point Periapical Index(3)	Seal and Length	Conclusion
Ray & Trope (1995) [27]	Cross-sectional	1010	R	N	N	N	The combination of good restoration and good root-filling had the highest absence of periradicular inflammation rate, significantly higher than poor restoration and poor root-filling.
Tronstad et al. (2000) [28]	Cross-sectional	1001	R	Y	N	N	The technical quality of the endodontic treatment , as judged radiographically was significantly more important than the technical quality of the coronal restoration when the perapical status of endodontically treated teeth was evaluated.
Kirkevang et al. (2000) [29]	Cross-sectional	614	R	Y	Y	Y	Inadequate root canal and coronal restorations were associated with an increased incidence of apical periodontitis
Hommez et al. (2002) [30]	Cross-sectional	745	R/C	Y	N	N	The importance of a good coronal restoration, as well as of a good root filling should be emphasized as the technical quality of both infuencing the periapical status.
Dugas et al. (2003) [31]	Cross-sectional	610	R/C	Y	Y	N	The quality of root filling and the restoration were found to impact on the periapical health of root-filled teeth,with the impact of the restoration beingmost critical when the quality of the root filling was adequate.
Segura-Egea et al. (2004) [32]	Cross-sectional	93	R	Y	Y	Y	Adequate root fillings and coronal restorations were associated with a lower incidence of apical periodontitis; an adequate root filling had a more substantial impact on the outcome of treatment than the quality of the coronal restoration.
Siqueira et al. (2005) [33]	Cross-sectional	2051	R	Y	N	N	Even though the coronal restoration had a significant impact on the periradicular health, the quality of the root canal filling was found to be the most critical factor in this regard.
Georgopoulou et al. (2008) [34]	Cross-sectional	7378	R	Y	N	N	Quality of root canal treatment, as well as quality of coronal restoration, are strongly associated with the incidence of apical periodontitis.
Tavares et al. (2009) [35]	Cross-sectional	1035	R	Y	Y	N	The quality of the endodontic treatment was the most important factor for success, although the quality of the coronal restoration also influenced the treatment outcome.

1 - R: qualities of root canal treatment and coronal restorations were evaluated radiographically; R/C: qualities of root canal treatment and coronal restorations were evaluated both radiographically and clinically.

2 - Y: evaluators were calibrated; N: evaluators were not calibrated.

3 - Y: 5-point Periapical Index [50] was used to evaluate the severity of apical periodontits; N: 5-point Periapical Index was not used.

4 - Y: both seal and length of root fillings were evaluated, N: only length was evaluated.

Author/Year	Time of follow-up	N	Post System*	Conclusion
Hatzikyriakos et al., 1992 [65]	3 years	154	Screw post or gold post with resin core and cast post-and-core	The statistical analysis revealed that only the factor "type of abutment" (posts and cores for fixed partial denture and removable partial denture) had some effect on the failure of the restorations.
Ferrari et al., 2000 [66]	4 years	200	Fiber post and cast post-and-core	The results of this retrospective study indicated that the fiber post system was superior to the conventional cast post and core system after 4 yrs of clinical service
Glazer et al., 2000 [67]	4 years	52	Carbon fiber post	Carbon fiber post (CFRR) are among the most predictable systems available today. CFRR posts in the upper anterior teeth are associated with a higher success rate and longer life than those placed in premolars, especially lower premolars. This study contributes to the growing body of evidence that supports the use of CFRR posts in the restoration of endodontically treated teeth.
Monticelli et al., 2003 [68]	2 - 3 years	225	Fiber glass and carbon post	The statistical analysis did not reveal any significant difference in the survival rate of the tested posts, suggesting that all are equally and sufficiently reliable for clinical use.
Ellner et al., 2003 [69]	10 years	50	Cast post-and-core and prefabricated post	If recommended procedures are strictly followed, posts and cores can serve as abutments for fixed single crowns with satisfactory long-term results.

Malferrari et al., 2003 [70]	30 months	205	Quartz fiber post	Over a 30-month period, the rehabilitation of endodontically treated teeth using quartz-fiber posts showed good clinical results. No crown or prosthesis decementation was observed, and no post, core, or root fractures were recorded.
Grandini et al., 2005 [71]	30 months	100	Fiber post	Restoration of endodontically treated teeth with fiber posts and direct resin composites is a treatment option, that in the short term conserves remaining tooth structure and results in good patient compliance.
Naumann et al., 2005 [72]	2 years	105	Fiber post	Parallel-sided and tapered glass fibre posts result after 2 years of clinical service in an equal rate of survival.
Mannocci et al., 2005 [73]	5 years	219	Fiber post	It can be concluded that restorations with fiberposts and composite were found to be more effective than amalgam in preventing root fractures but less effective in preventing secondary caries.
Creugers et al., 2005 [74]	5 years	319	Metallic post	The type of post and core was not relevant with respect to survival. The amount of remaining dentin height after preparation influenced the longevity of a post-and-core restoration.
Balkenhol et al., 2007 [75]	10 years	802	Cast post-and-core	Post and cores custom-fabricated using a standardised fabrication technique have a good long-term prognosis. The most common cause of failure is loss of retention.
Fokkinga et al., 2007 [43]	17 years	307	Cast post-and-core, prefabricated metal post and resin composite core, Post-free all-composite core	The results of this study showed no difference in survival probabilities among different core restorations under a covering crown of endodontically treated teeth. The preservation of substantial remaining coronal tooth structure seems to be critical to the long-term survival of endodontically treated crowned teeth
Jung et al., 2007 [76]	05 - 10 years	72	Cast post-and-core and composite post	It can be concluded that over an average observation period of 8.56 years the indirect cast post-and-core buildup and the direct composite post buildup can be considered of similar value.
Ferrari et al., 2007 [77]	7 - 11 years	985	Fiber post	The results indicated that fiber posts in combination with bonding/luting materials may be used routinely for restoring endodontically treated teeth.

Naumann et al., 2007 [78]	3 years	91	Titanium and fiber post	Titanium and glass fiber reinforced composite posts result in successful treatment outcomes after 2 years. The material combination used seems to be appropriate in the short term for cementing endodontic posts, irrespective of the post material.
Cagidiaco et al., 2007 [79]	2 years	162	Fiber post	Restorations placed with the use of a fiber post and core resulted in 4.3% post debondings and 3.0% endodontic failures after 2 years of clinical service.
Schmitter et al., 2007 [80]	2 years	100	Titanium and fiber post	Fiber posts are superior to titanium posts with respect to short-term clinical performance. Especially for titanium posts, clinical survival depends on several variables.
Salvi et al., 2007 [81]	4 years	325	Cast post-and-core and titanium post	Provided that high-quality root canal treatment and restorative protocols are implemented, high survival and low complication rates of single - and multirooted root-filled teeth used as abutments for fixed restorations can be expected after a mean observation period of >or=4 years.
Piovesan et al., 2007 [44]	97m	69	Polyethylene fiber reinforced	Polyethylene fiber–reinforced posts with composite cores may be recommended for clinical use. Restorations evaluated in this study presented high survival rates after the 97-month follow-up period.
Naumann et al., 2008 [82]	5-79 months	149	Fiber post	Significantly higher failure rates were found for restorations of anterior teeth compared to posterior teeth. Restorations in teeth with no proximal contacts compared to at least one proximal contact, single crowns compared to fixed partial dentures and less than two remaining cavity walls had a higher Hazard Ratio. However, these correlations were not statistically significant.
Bitter et al., 2009 [61]	32 months	120	Quartz fiber post	Fiber post placement was efficacious to reduce failures of postendodonticrestorations only with teeth that exhibited no coronal walls. Post insertion for teeth showing a minor substance loss should be critically reconsidered.
Gomes-Polo et al., 2010 [83]	10 years	112	Cast post-and-core and titanium prefabricated post	The results showed no significant difference between Cast post-and-core and titanium prefabricated post after a 10-year average follow-up.
Zicari et al., 2011 [84]	Up to 37 months	205	Prefabricated glass fiber posts, custom-made glass fiber posts, gold alloy-based post and cast cores	After being followed for up to 3 years, both cast gold and composite post and core systems performed well clinically.
Ferrari et al., 2012 [59]	72 months	360	Prefabricated or customized fiber posts	Regardless of the restorative procedure, the preservation of at least one coronal wall significantly reduced failure risk.

Naumann et al., 2012 [45]	Up to 120 months	149	3 different Glass-fiber–reinforced endodontic posts (GFRPs)	The relatively high annual failure rate of GFRPs highlights that the treatment decision should take into account the most relevant factors as tooth type and the number of remaining cavity walls.
Sterzenbach et al., 2012 [85]	Up to 84 months	91	Glass fiber–reinforced epoxy resin posts and titanium posts	When using self-adhesive luted prefabricated posts in severely destroyed abutment teeth with 2 or less cavity walls and a 2-mm ferrule, postendodontic restorations achieved high long-term survival rates irrespective of the post material used (ie, glass fiber vs titanium).
Spielman et al., 2012 [86]	Mean 3.9 years	1298	Metal, fiber and not placed	These results suggest that molars (as opposed to other types of teeth), full-coverage restorations, preoperative proximal contacts, good periodontal health, non-Hispanic/Latino ethnicity, endodontic therapy performed by a specialist and older patient age are associated with restorative success for endodontically treated teeth in general practice.
Gbadebo et al., 2014 [87]	6 months	40	Glass fiber-reinforced post and stainless steel parapost	Glass fiber-reinforced post performed better than the metallic post based on short term clinical performance.
Juloski et al., 2014 [88]	4 years	60	Fiber post	Analysis revealed that neither the amount of coronal residual structure nor the luting material significantly influenced the failure risk.
Sarkis-Onofre et al., 2014 [46]	Up tp 3 years	72	Cast metal posts and glass fiber posts	Glass fibre and cast metal posts showed similar clinical performance in teeth with no remaining coronal wall after 3 years.
* Posts related by the authors				

4 Capítulo 3

Performance of post-retained single crowns: systematic review of related risk factors[3]

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Abstract:

Introduction: Narrative reviews have shown that several factors could influence the clinical performance of endodontically treated, restored with post retained single crowns. The aims of this review were to assess the influence of the number of remaining coronal walls, use or not of posts and their type on the clinical performance of these restorations.

Methods: Randomized controlled trials and controlled clinical trials on ETT restored with the combination of post/crown or no post and crown were searched in Medline, Embase, and the Cochrane Library. Two authors independently reviewed all identified titles and abstracts for eligibility. Tables and graphs were generated to summarize the included studies and reports of randomized trials were assessed for bias using the Cochrane risk of bias tool.

Results: Nine articles were identified as meeting the inclusion criteria. Teeth without ferrule presented the highest values of variation of success/survival (0 to 97%) whereas teeth with remaining coronal walls (1, 2, 3 to 4 walls, with ferrule) presented lower variation. The use of posts with high elastic modulus success/survival ranged between 71.8 and 100% whereas posts with low elastic modulus ranged between 28.5 and 100%. Survival of crowns without posts varied between 0 to 100%. The worst performance of posts with low elastic modulus and without posts were associated to the absence of ferrule and preservation of only one coronal wall.

Conclusion: Restoration of ETT should focus on the maintenance of coronal structure. Until more studies with long-follow up are not available, posts with high elastic modulus present better performance when restoring ETT with no ferrule.

Keywords: Glass fiber posts, Systematic review, coronal walls, post and core technique.

Introduction

Narrative reviews have shown that several factors could influence the clinical performance of endodontically treated teeth (ETT) restored with the combination of intra-canal posts and single crowns. These factors might be related to the teeth as the number of remaining coronal walls or tooth location, or to materials of post/crown and to used cements (1-3). Considering the materials used to manufacture posts/crowns and the following cementation procedures, elastic modulus vary and could influence the biomechanical behavior of ETT (1, 3). Hence, the mode of failure of the restoration i.e. root fracture, post debonding/fracture or crown debonding/fracture, presents a direct effect in tooth survival.

Recent reports of clinical trials have shown that the preservation of coronal walls is a critical factor on the clinical performance of ETT while there seems to be a direct relationship between number of remaining walls and survival/success rates of ETT (4-6). Furthermore, anterior and posterior teeth receive different load directions and the influence of the survival/success of the restorations remains to be tested. Still, no systematic reviews have studied the influence of those parameters taken together and how they would affect tooth success and survival. Restoration success and survival of restoration present different definitions. Based on a recent article (7) restoration success is defined *as the ability of a restoration to perform as expected and survival of restorations was defined by percentage of restorations that remained in situ with or without modifications.*

The general objective of this review was to assess how pre-specified factors influence the clinical performance of ETT restored with the combination of intra-canal posts and single crowns. The specific objectives were to assess the influence of (i) number of remaining coronal walls and (ii) type of post (categorized by elastic modulus) on the survival/success of ETT restored with the combination of intra-canal post and single crown. The secondary objectives were to assess the influence of tooth location (anterior vs. posterior), post cementation strategy (type of luting cement) and the use or not of posts on the survival/success of endodontically treated post-retained single crowns.

Methods/Design

The current review is based on the guidelines of Cochrane Handbook for Systematic Reviews of Interventions (8) and followed the four-phase flow diagram based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (9). The reporting of review was based on the PRISMA Checklist (9).

Protocol

The protocol of this review was registered with PROSPERO database (CRD42014013343). Due to the heterogeneity of reporting of studies some slight modifications were performed. We included studies that reported the success of restorations instead of only including studies that reported survival of restorations and only included studies where both groups presented crowns as final restoration. Also, the classification of remaining coronal walls was changed.

Criteria for selecting studies for this review

Types of studies: We included randomized controlled trials (RCTs) and controlled clinical trial (CCTs). We excluded case series and case reports.

Types of participants: Adults over 18 years of age with endodontically treated teeth restored with the combination of post/crown or no post/crown. Only studies that evaluated patients with good oral health (caries/periodontal disease free) were included.

Intervention: RCTs or CCTs that evaluated the combination of posts and single crowns or the comparison of posts/crowns vs no posts/crowns. The randomized studies could present the randomization according to the strategy of post cementation, type of posts and/or crown and the use or not of posts. The controlled trials could present posts and crowns tested according to the number of remaining coronal walls.

Information sources and literature search

Electronic searches

Searches were performed without language restrictions and restricted to the period between 1985 and 2015 in electronic databases (Medline, Embase, and the Cochrane Collaboration's Library). Additionally, abstracts of the last ten editions of the International Association of Dental Research meeting (2004-2013) and ClinicaTrials.gov were examined. References were searched for all papers included in the review in order to identify any further relevant studies and two authors undertook the electronic database searches independently. An experienced librarian drafted the search strategies, which were peer reviewed by another expert librarian using the Peer Review of Electronic Search Strategies (PRESS) checklist (10). The literature search is available in the additional file 1.

Study selection procedure

Literature searches were de-duplicated in EndNote program before uploading to Distiller Systematic Review Software® (Distiller SR), an online program that facilitates screening and data extraction. A team of researchers (RSO and TPC) with content expertise identified articles by first analyzing titles and abstracts for relevance and presence of the selection criteria listed above. Retrieved records were classified as i) include, ii) exclude or iii) uncertain. The full text articles of included and uncertain records were obtained for further eligibility screening by the same two reviewers. Discrepancies in eligibility were resolved through discussion between the two reviewers. In the event of disagreement, the opinion of a third specialist (MSC) was obtained. In case of identification of the same study in distinguished papers, the paper with higher follow-up was considered. In case of missing information or data, authors were contacted by e-mail.

Data collection process

A standardized outline was used to extract the following data:

- Publication details: author, year of publication, language, status of publication
- Characteristics of study: duration of follow-up, clinical setting, country, study design, sample size, comparison tested (i.e. glass fiber posts in teeth with 2 to 3 remaining walls vs. 1 remaining wall; glass fiber posts vs. cast metal posts)
- Characteristics of teeth evaluated: number of anterior or/and posterior teeth, number of remaining coronal walls in the teeth included in each group
- Details about the groups tested: post used (material and classification according to elastic modulus. See below), crown used (metal/metal-ceramic/ all ceramic), number of remaining coronal walls, strategy of post cementation (adhesive or non-adhesive)
- Outcome information: time of baseline (post or crown cementation) type of failure(s) (endodontic failure, crown/post fracture, crown dislodgements, post debonding), evaluation methods (clinical/radiographic exam)

Data collection process was completed by one person and checked out by a specialist in that field.

Assessment of effectiveness

The primary outcomes were the survival/success of the restoration and all modes of failure (endodontic failure, crown/post fracture, crown dislodgements, post debonding and root fracture) were considered as absolute failures. The assessment of the restoration/tooth was made through clinical evaluation, radiographic exam or both. All three were considered because the assessment depends on the tooth situation and degree of failure.

The following situations were characterized as failures:

- Endodontic failure: radiographic signs of apical periodontitis, clinical signals and/or symptoms of tenderness to percussion or presence of periapical abscess draining through a fistula.

- Crown fracture: material chip fractures that damage marginal quality or proximal contacts and bulk fractures with partial loss (less than half of the restoration).
- Post fracture: all levels of fracture of post were considered irrespective of its position on the arch or extension.
- Crown dislodgment: characterized as total loss of crown or partial loss that allows dislodgment using a manual instrument.
- Post debonding: characterized as total loss of post /post and crown or partial loss that allows dislodgment using a manual instrument.
- Root fracture: root fractures leading to tooth extraction and partial root fractures that could be treated with all types of surgical crown lengthening.

Risk of Bias assessment

Reports of randomized trials were assessed for bias using the Cochrane risk of bias tool considering the judgment of the random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other sources of bias (8). Rating was completed by one person and checked out by another researcher. The publication bias was not statically assessed but searches for unpublished studies were performed to minimize the publication bias.

Data synthesis

Tables and graphs were generated to summarize the included studies and the results. The posts used were categorized according to the elastic modulus: low, high or with no post. The number of remaining coronal walls was categorized in 1 wall, 2 walls or 3 to 4 walls, according to the reported by authors. Teeth classified as having absence of ferrule, as with no coronal remaining walls and classified by authors as insufficient tooth tissue left were categorized in the same category (absence of ferrule) and teeth classified by authors as presence of ferrule and sufficient tissue left were categorized in the same category (presence of ferrule).

Post cementation strategy was classified in adhesive cementation (regular or self-adhesive) or non-adhesive. The data was categorized also according to tooth

location, anterior or posterior. As there is no consensus about the use of the terms success and survival in the included studies, we decided as a *post hoc* decision to consider success and survival together in the analysis. Also, data regarding the success or survival of restorations was collected according to the reported by authors.

A meta-analysis was not possible due to heterogeneity of designs. As such, the studies were synthetized descriptively. Graphs comparing the survival/success were created considering the number of remaining coronal walls and according to the classification of posts above mentioned. Also, a summary of findings was created.

Quality of body of evidence

The evidence was interpreted according to the GRADE framework (11). The GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach defines the quality of a body of evidence as the extent to which one can be confident that an estimate of effect or association is close to the quantity of specific interest. The evaluation involves consideration of within-study risk of bias (methodological quality), directness of evidence, heterogeneity, precision of effect estimates and risk of publication bias**.**

Results

Literature search

The literature search yielded 445 titles and abstracts (Figure 1). Nine randomized controlled trials (4-6, 12-17) fulfilled the eligibility criteria and were possible to extract the data. Thirteen studies were excluded because they did not match the inclusion criteria or it was impossible to access the raw data or the final manuscript (18-30).

Study characteristics

Table 1 presents the characteristics of studies and table 2 presents characteristics of materials used in each study and survival/success reported. All included studies were published in English language and were classified as randomized controlled trials. The duration of follow-up ranged between 6 months (13) to up to 17 years (6). Most studies were performed in Europe (77.7%, n=7) and

(55.5%, n=5) were conducted in university centers including the study of Fokkinga et al. 2007 (6) that presents also a sample from a private dental office. The average sample size was 170 teeth ranging from 27 (14) to 360. Four studies included both anterior and posterior teeth (6, 13, 16, 17) whereas three studies (4, 5, 15) included only posterior teeth (pre-molar) and one-study (14) only anterior teeth. Three studies (13, 16, 17) compared the posts of different elastic modulus and three studies (4-6) tested the use of posts vs. use of crowns without posts. All studies evaluated the restorations through clinical and radiographic examination. As for cementation materials used, only three studies used non-adhesive materials to lute the posts (6, 12, 14) and only two studies used all-ceramic crowns as final restoration (15, 17).

Success/Survival of restorations

Table 3 and figures 2 and 3 summarize the percentage of success/survival considering number of remaining coronal walls and the type of posts. Teeth with absence of ferrule presented the highest values of variation of success/survival (0%-97%) whereas teeth with remaining coronal walls presented lower variation of values (3 – 4 walls: 66.7%-100%) demonstrating the influence of number of remaining coronal walls on rehabilitation of ETT.

The use of posts with high elastic modulus presented percentage of success/survival ranging between 71.8 and 100% whereas posts with low elastic modulus presented percentage ranging between 28.5 and 100%. The use of crowns without posts presented percentage ranging between 0 and 100%. The worst performance of posts with low elastic modulus and without posts were associated to absence of ferrule and preservation of only one coronal wall.

Risk of bias and Quality of evidence

The majority of included studies had unclear risk of bias on the following items: random sequence generation (55.6%), allocation concealment (77.8%) and blinding of participants and personnel (88.9%). Most studies had low risk of bias on the following items: incomplete outcome data (88.9%), selective reporting (100%) and other bias including bias due to different baseline characteristics of groups (Figure 4). Based on The GRADE approach the evidence was classified as low due to the

limitation in the design and implementation and imprecision of results due to small sample size of the studies (Table 3).

Discussion

Narrative reviews have shown that several factors could influence the clinical performance of endodontically treated teeth and in the choice of “the best” restoration for these teeth (1-3). This systematic review suggests that the number of remaining coronal walls and the use of posts are key factors for the success/survival of these restorations. Although a meta-analysis was not possible, the descriptive analysis clearly shows that teeth that had preserved coronal walls and the combination of post and single crown is present yields in higher values of success/survival.

Preservation of coronal tissue is related to the so-called “ferrule effect“, a circumferential dentin collar of at least 2 mm in height. Recent review based on *in vitro* and *in vivo* studies (31) suggests that the presence of ferrule has a positive effect on fracture resistance of ETT. Also, concluded that when adequate ferrule is provided some factors as type of post, final restoration and luting agents might present lower impact on the performance of ETT. Presence of ferrule could be related to enhanced stress distribution since finite element analyses have shown higher values of stress including the cervical region associated to absence of ferrule (32, 33).

The use of posts with different elastic modulus or whether the use of post is necessary has been discussed in literature (4-6). The use of posts with higher values of elastic modulus than that of dentin is associated with a higher concentration of stress in the adhesive interface and could be related to catastrophic failures whereas the use of posts with elastic modulus similar to that of dentin is associated to better stress distribution (34). In general, this review suggests a better performance of posts with high values of elastic modulus. Some factors should be pointed out to understand these results. The studies with longer time of follow-up, up to 17 and 10 years (6, 12) evaluated different modalities of posts with high values of elastic modulus demonstrating good performance after a large time of follow-up. Conversely, the study evaluating posts with low values of elastic modulus presenting longer follow-up was Ferrari et al. 2012 (5) with 6 years of follow-up. Thus, it seems obvious that posts with high elastic modulus have been followed up longer,

explaining why those posts seem to perform better. Still, longer follow-up is necessary to better compare both posts.

Ferrari et al. 2012 (5) included teeth with presence and absence of ferule and both groups did not present remaining coronal walls. Based on the included studies, these groups had the worst rates of success of posts (28.5%, 31.6% and 39.9%). However, even both groups presenting a huge number of failures, the authors reported high rates of survival. Also, teeth with at least 1 wall showed almost twice the success rate compared to teeth with absence of ferule demonstrating that the presence of remaining walls might be essential for the success of posts with low elastic modulus. Comparing all studies included, groups with at least 1 remaining coronal wall had good performance regardless of the post used. Thus, it may be said that in this scenario, both types of posts may be indicated.

When considering teeth with insufficient tissue left, the use of posts with high values of elastic modulus is indicated based on two reasons: 1) there are studies evaluating these posts with long time of follow-up; 2) only two studies compared posts with low/high values of elastic modulus in teeth with insufficient tissue left (16, 17) and even presenting high rates of success/survival, both studies need more time of follow-up because of the (considered) short follow-up of both studies (3 years). Thus, unless more studies with long follow-up are provided, high moduli posts should be preferred when no ferrule is present.

Baba et al. 2009 (1) suggested the use of posts in ETT only when the coronal portion cannot be retained by another means. The success on restoring ETT without posts seems to be associated to the number of remaining coronal walls since the studies of Ferrari et al. 2007 and Ferrari et al. 2012 (4, 5) presented an association between the success of use of crowns without posts and the number of remaining coronal walls. Also, the study of Fokkinga et al. 2007 (6) presented 88% survival rates with use of crowns without posts in teeth with substantial dentin height while the groups with posts (and crowns) presented rates ranging between 71 to 85%(6).

Overall, the included studies presented unclear risk of bias to important aspects of a randomized controlled trial as random sequence generation, allocation concealment and blinding. Comparing the studies with more time of follow-up of both types of posts the study of Ferrari et al. 2012 (5) presented unclear risk of bias for

three important aspects of randomized controlled trials: random sequence generation, allocation concealment, blinding of participants and personnel and high risk of bias considering blinding of outcome assessment. The study of Fokkinga et al. 2007 (6) presented unclear risk of bias for these four aspects. However, it is impossible to determine if the studies were performed incorrectly or if the reporting was poor.

The evidence generated with this review was classified as low and this is an important limitation of the study. Another limitation is associated with the short time of follow-up of included studies since only two studies presented more than 6 years of follow-up. Limitations of the systematic review process include the identification of heterogeneous studies for inclusion and as consequence a meta-analysis was not possible.

Conclusion

This review suggests that the number of coronal walls and the use of posts associated with crowns are essential factors to be considered to restore endodontically treated teeth with a main focus on the maintenance of coronal structure. Due to the use of different groups of teeth and the predominance of use of adhesive cementation in the included trials, it was impossible to identify the influence of these factors on posts survival.

In general, posts with high values of elastic modulus present better performance. Considering teeth with remaining coronal walls both posts may be indicated. When ferrule is absent posts with high values of elastic modulus are indicated since longer follow-up studies are necessary to analyze the performance of posts with low values of elastic modulus.

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Figure 1: PRISMA 2009 Flow Diagram

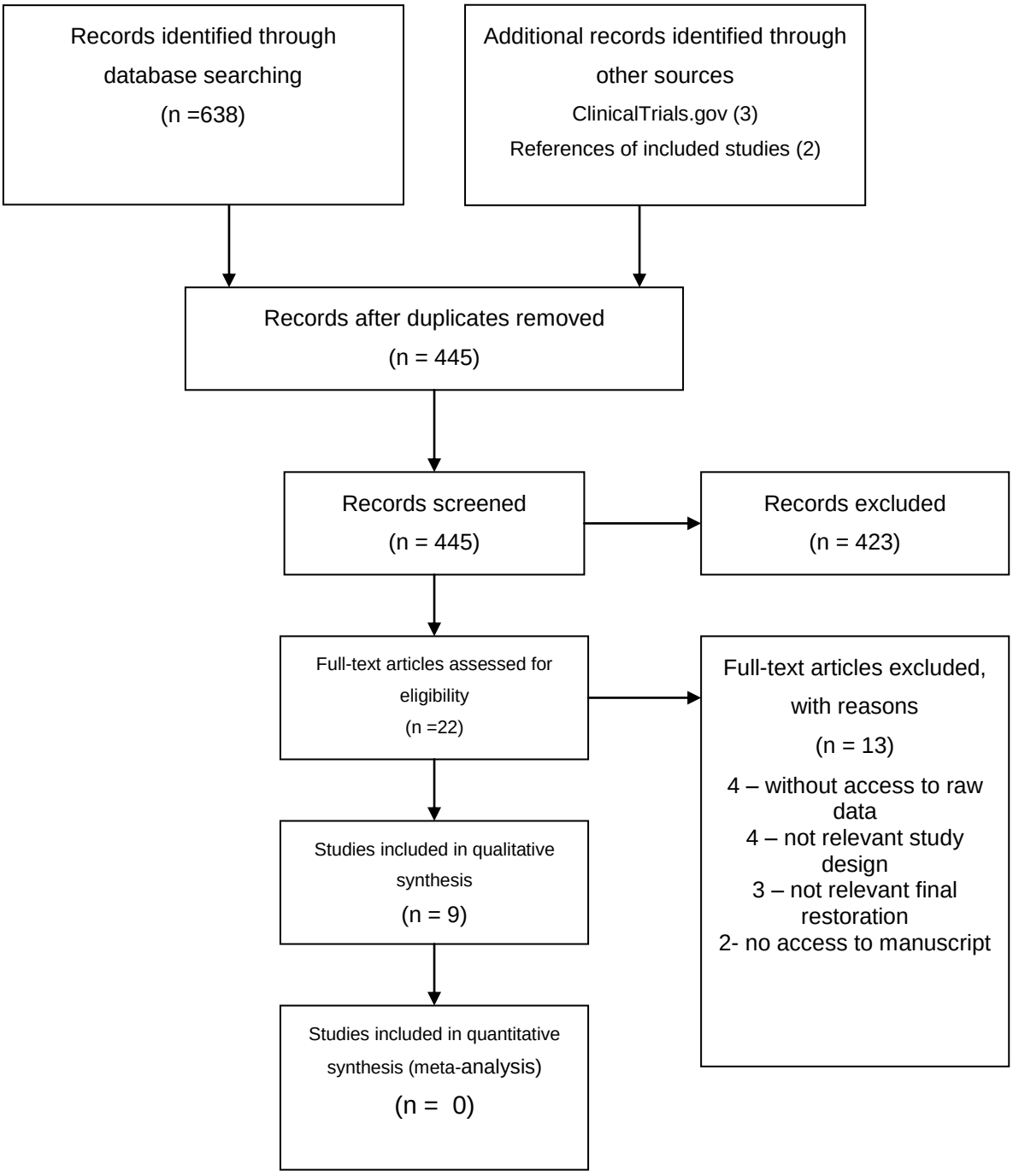
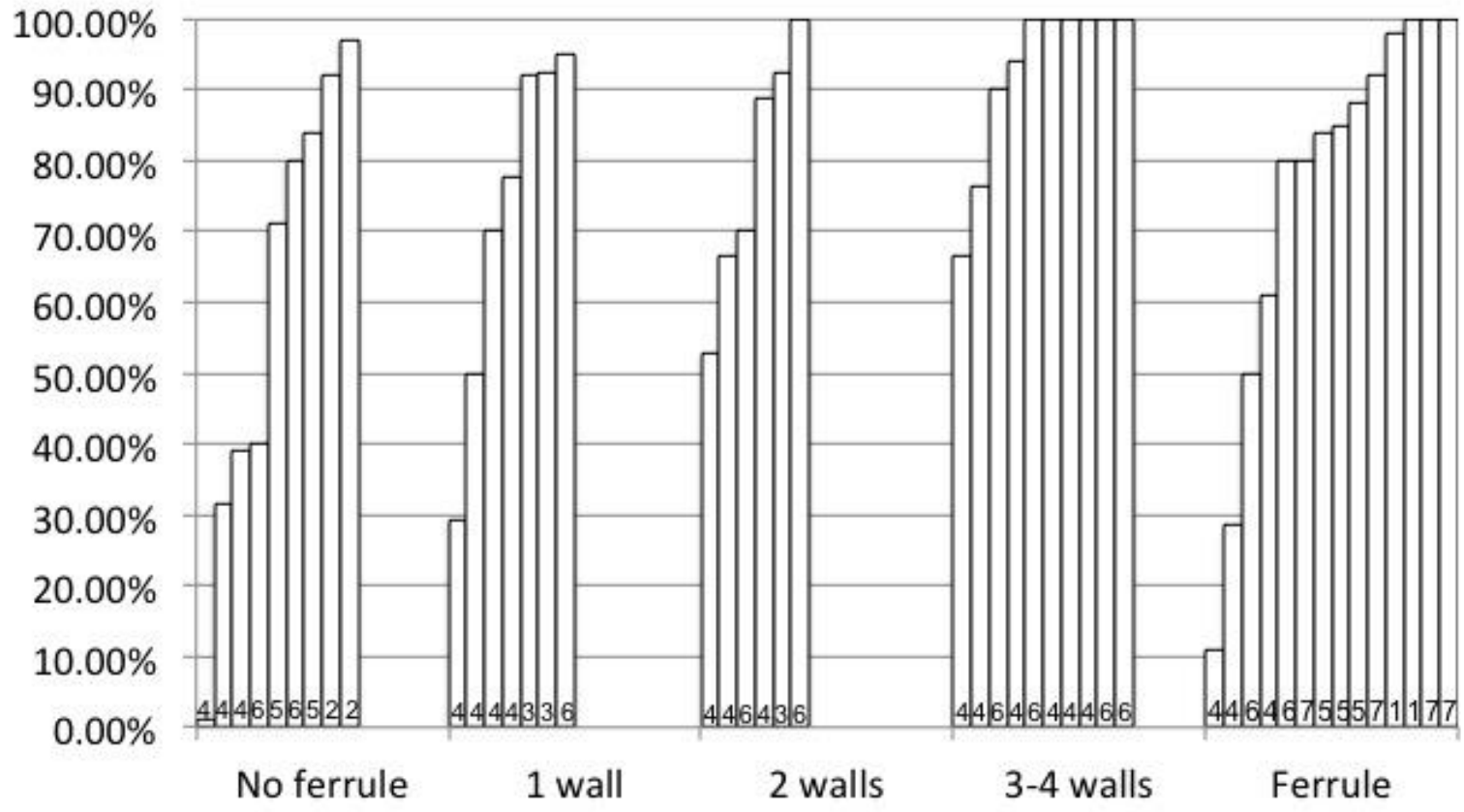


Figure 2: Success/Survival of ETT considering number of remaining walls.



1 - Gbadebo et al. 2014

2 - Sarkis-Onofre et al. 2014 - All failures calculated together (survival probabilities).

3 - Zicari et al. 2011 - Success: Absence of absolute and relative failures and data for all groups together.

4 - Ferrari et al. 2012

5 - Fokking et al. 2007 - Survival probabilities of restorations.

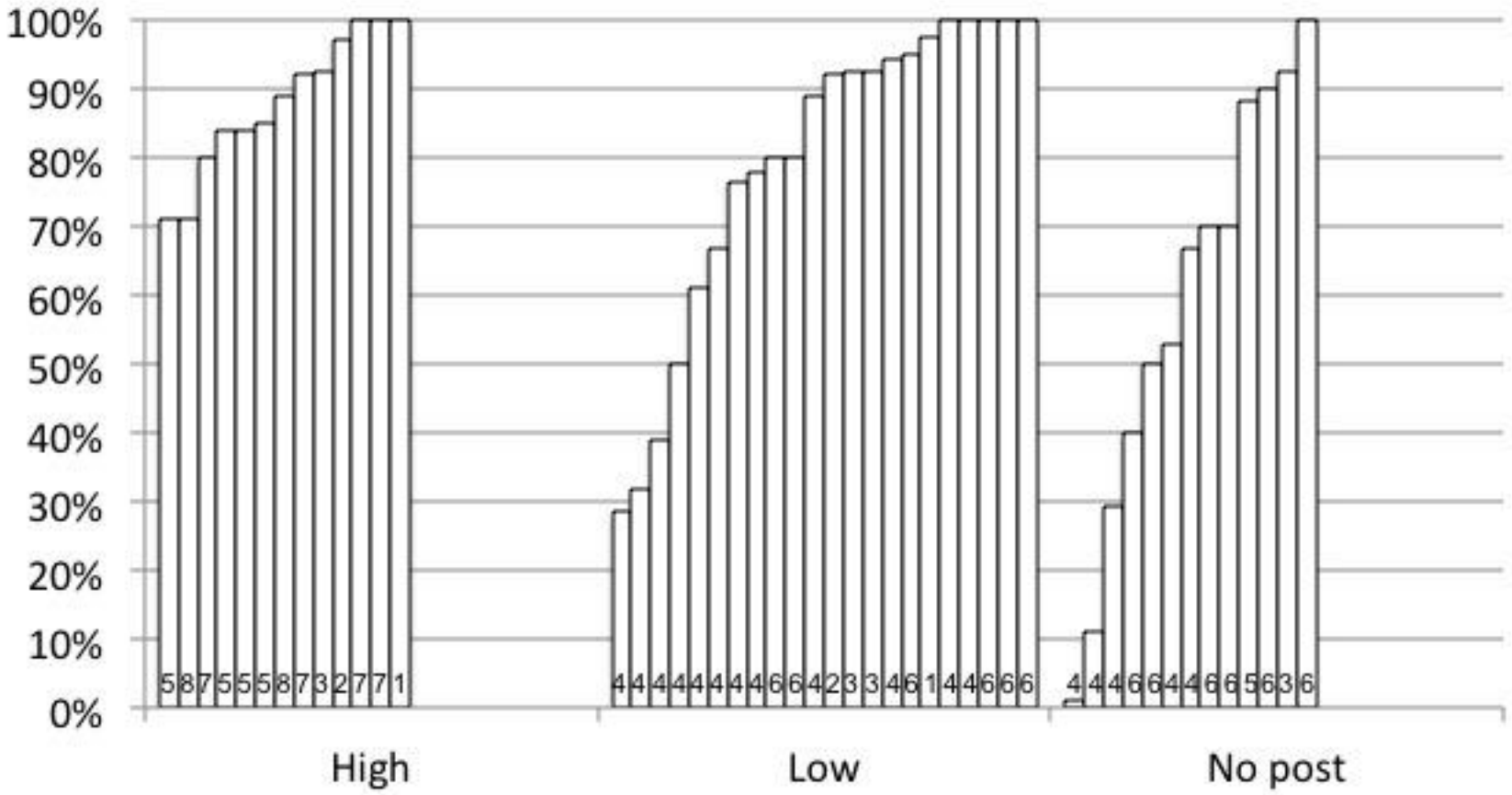
6 - Ferrari et al. 2007

7 - Ellner et al. 2003

8 - King et al. 2003

*Monticell et al. 2003 – not included, did not report success/survival

Figure 3: Success/Survival of ETT considering the type of post used or no use of post.



1 - Gbadebo et al. 2014

2 - Sarkis-Onofre et al. 2014 - All failures calculated together (survival probabilities).

3 - Zicari et al. 2011 - Success: Absence of absolute and relative failures (data for all groups together).

4 - Ferrari et al. 2012

5 - Fokking et al. 2007 - Survival probabilities of restoration.

6 - Ferrari et al. 2007

7 - Ellner et al. 2003

8 - King et al. 2003

*Monticell et al. 2003 – not included, did not report success/survival.

Figure 4: Risk of bias graph - review authors' judgments about each risk of bias item presented as percentages across all included studies and about each risk of bias item for each included study.

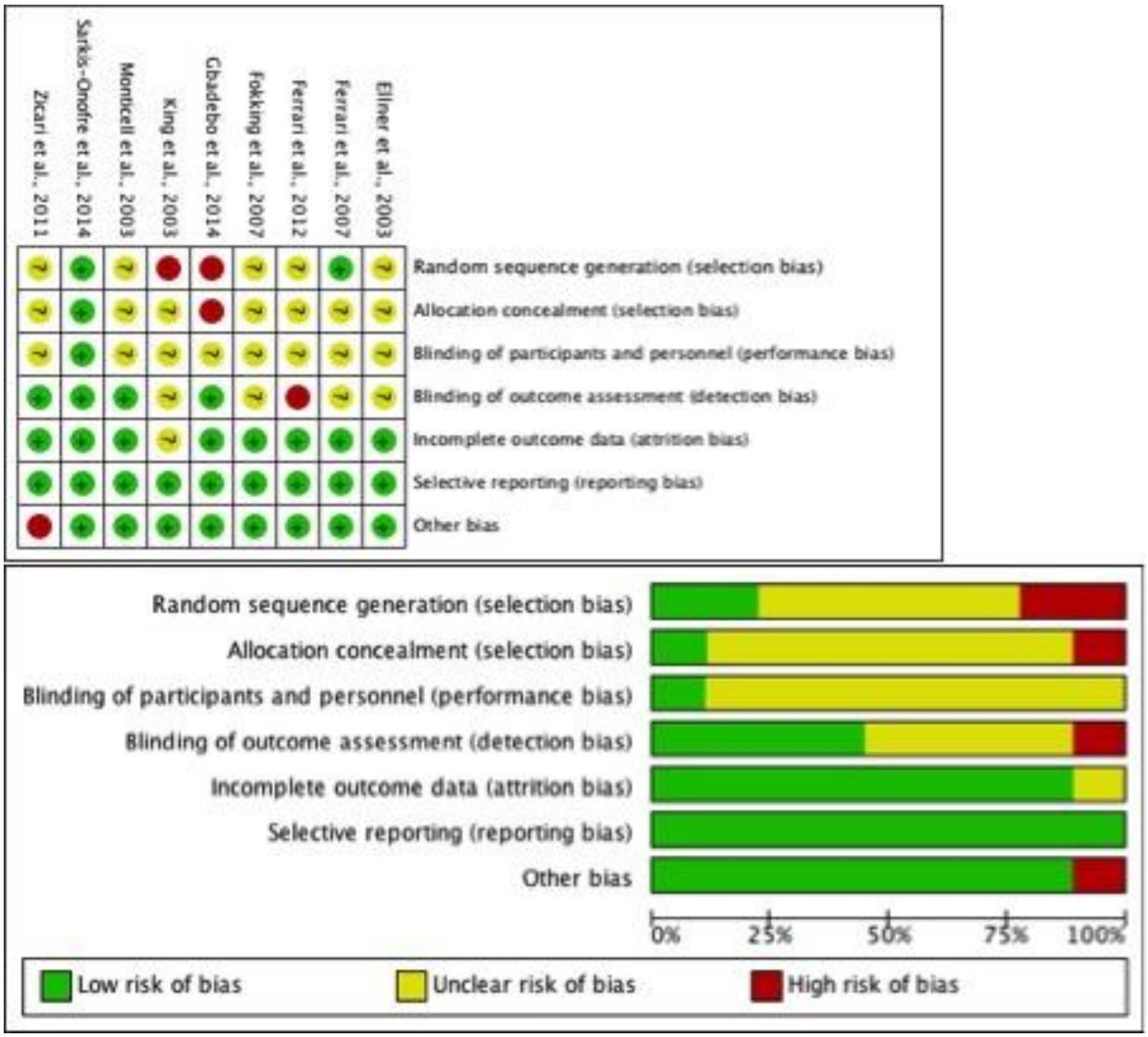


Table 1: Characteristics of included studies.

Author/Year	Duration of follow-up	Clinical setting	Country	Sample size (teeth)	Comparison tested	Number of remaining coronal walls (by group)	Evaluation methods
Gbadebo et al. 2014	6 months	University/Hospital	Nigeria	40	Metallic stainless steel vs. Glass fiber posts	Minimum of 2 mm coronal tooth structure cervically for ferrule effect.	Clinical and radiographic
Sarkis-Onofre et al. 2014	up to 3 years	University	Brazil	72	Cast metal vs. Glass fiber posts	No walls or the enamel portion of one wall with no dentinal support.	Clinical and radiographic
Zicari et al. 2011	up to 3 years	University	Belgium	205	Prefabricated gold alloy-based posts and core vs. prefabricated glass fiber posts vs. custom made glass fiber posts (insufficient tooth tissue) and prefabricated gold alloy-based post vs direct composite core without post (sufficient tooth tissue)	Insufficient tooth tissue left and sufficient tissue left.	Clinical and radiographic
Ferrari et al. 2012	6 years	Private dental office	Italy	360	No post vs. prefabricated fiber posts vs. glass fiber customized post	All coronal/three retained/two preserved/one left walls, presence/ausence of a ferrule.	Clinical and radiographic
Fokkinga et al. 2007	up to 17 years	Private dental office and University	Netherlands	307	Cast post-and-core restoration vs. prefabricated metal post vs. post-free	Substantial dentin height (ferrule of 1–2mm could be achieved) and minimal dentin height (no ferrule of 1–2mm could be achieved).	Files of the current dentists and 18% was clinically examined and cross-checked with the patient records.
Ferrari et al. 2007	2 years	Private dental office	Italy	240	No post vs. prefabricated fiber posts	All coronal/three retained/two preserved/one left walls, presence/ausence of a ferrule.	Clinical and radiographic

Ellner et al. 2003	up to 10 years	Not reported	Sweden	50	Conventional tapered posts and cores cast in a type III gold alloy vs. prefabricated posts in nonoxidizing gold alloy and cast cores vs. cast posts and cores in a type III gold alloy vs. threaded titanium posts with resin composite	2 mm of remaining vertical marginal tooth substance available for ferrule preparation.	Clinical and radiographic
King et al. 2003	Mean of 87 months	Not reported	England	27	Carbon fiber post vs. prefabricated metal post (precious alloy)	Not reported	Clinical and radiographic
Monticell et al. 2003	2 years	University	Italy	225	2-stage quartz fiber post vs. double taper quartz fiber post vs. glass fiber post	Two coronal walls left.	Clinical and radiographic

Table 2: Characteristics of materials used in each study and survival/success reported.

Author/Year	Post used	Elastic Modulus of post	Strategy of post cementation	Crown used	Success/Survival reported
Gbadebo et al. 2014	Glass Fiber Posts	Low	Adhesive	Metal-ceramic	97.50%
	Metallic stainless steel	High	Adhesive	Metal-ceramic	100%
Sarkis-Onofre et al. 2014	Glass Fiber Posts	Low	Adhesive	Metal-ceramic	91.90%
	Cast Metal Posts	High	Adhesive	Metal-ceramic	97.10%
Zicari et al. 2011	Prefabricated gold alloy-based posts	High	Adhesive	All-ceramic	92.30%
	Prefabricated glass fiber posts	Low	Adhesive	All-ceramic	92.30%
	Custom made glass fiber posts	Low	Adhesive	All-ceramic	92.30%
	Direct composite core without post	NA	NA	All-ceramic	92.30%
Ferrari et al. 2012	No post **(4 coronal walls)**	NA	NA	Metal-ceramic	100.00%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	100.00%
	Glass fiber customized post	Low	Adhesive	Metal-ceramic	100.00%
	No post **(3 coronal walls)**	NA	NA	Metal-ceramic	66.70%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	94.10%
	Glass fiber customized post	Low	Adhesive	Metal-ceramic	76.50%
	No post **(2 coronal walls)**	NA	NA	Metal-ceramic	52.90%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	88.90%
	Glass fiber customized post	Low	Adhesive	Metal-ceramic	66.70%
	No post **(1 coronal wall)**	NA	NA	Metal-ceramic	29.40%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	77.80%
	Glass fiber customized post	Low	Adhesive	Metal-ceramic	50%
	No post **(Ferrule present)**	NA	NA	Metal-ceramic	11.10%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	61.10%

	Glass fiber customized post	Low	Adhesive	Metal-ceramic	28.50%
	No post **(Ferrule absent)**	NA	NA	Metal-ceramic	0%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	38.90%
	Glass fiber customized post	Low	Adhesive	Metal-ceramic	31.60%
Fokkinga et al. 2007	Prefabricated cast-on post **(Substantial dentin height)**	High	Non-adhesive	Metal or Metal-ceramic	85%
	Prefabricated metal post	High	Non-adhesive	Metal or Metal-ceramic	84%
	No post	NA	NA	Metal or Metal-ceramic	88%
	Prefabricated cast-on post **(Minimal dentin height)**	High	Non-adhesive	Metal or Metal-ceramic	84%
	Prefabricated metal post	High	Non-adhesive	Metal or Metal-ceramic	71%
Ferrari et al. 2007	No post **(4 coronal walls)**	NA	NA	Metal-ceramic	100%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	100%
	No post **(3 coronal walls)**	NA	NA	Metal-ceramic	90%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	100%
	No post **(2 coronal walls)**	NA	NA	Metal-ceramic	70%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	100%
	No post **(1 coronal wall)**	NA	NA	Metal-ceramic	70%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	95%
	No post **(Ferrule present)**	NA	NA	Metal-ceramic	50%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	80%
	No post **(Ferrule absent)**	NA	NA	Metal-ceramic	40%
	Prefabricated quatz fiber posts	Low	Adhesive	Metal-ceramic	80%

Ellner et al. 2003	Cast metal post (gold alloy)	High	Non-adhesive	Metal ceramic or gold alloy with acrylic resin facing	100%
	ParaPost system with prefabricated metal posts (nonoxidizing gold alloy)	High	Non-adhesive	Metal ceramic or gold alloy with acrylic resin facing	92%
	ParaPost system with with cast posts and cores (gold alloy)	High	Non-adhesive	Metal ceramic or gold alloy with acrylic resin facing	100%
	Threaded titanium posts with cores in resin composite	High	Non-adhesive	Metal ceramic or gold alloy with acrylic resin facing	80%
King et al. 2003	Carbon fiber post	High	Adhesive	Metal ceramic	71%
	Prefabricated metal post (precious alloy)	High	Non-adhesive	Metal ceramic	89%
Monticell et al. 2003	2-stage quartz fiber post	Low	Adhesive	All-ceramic	Not reported
	Double taper quartz fiber post	Low	Adhesive	All-ceramic	Not reported
	Glass fiber post	Low	Adhesive	All-ceramic	Not reported

*NA = not applied

Table 3: Summary findings.

Factors affecting the survival of the combination of posts and single crowns

Clinical situation: Restoration of endodontically treated teeth.

Population: Endodontically treated teeth restored with the combination of post/crown or no post/crown.

Comparison/Intervention: combination of any posts and single crowns or no posts and single crowns.

Outcomes	Success/Survival by remaining walls (Range %)	Success/Survival by type of posts[#] (Range)	Number of participants	Quality of evidence (GRADE)
Success/Survival	No ferrule: 0-97% 1 wall: 29.4-95% 2 walls: 52.9-100% 3 – 4 walls: 66.7-100% Ferrule: 11-100%	High: 71-100% Low: 28.5-100% No post: 0-100%	1526 teeth (9 studies)	□□OO Low

[#] **Type of post classified according to elastic modulus (high or low) or no use of posts.**

Supplementary Material

Search Strategies

Database: Embase Classic+Embase <1947 to 2016 January 12>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) <1946 to Present> Search Strategy:

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1 Tooth, Nonvital/
2 ((teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*) adj3 (devital* or de-vital* or endodontically-treated or endo-dontically-treated or nonvital* or non-vital* or pulpless*)).tw.
3 ((dental* or dentist* or endodonti* or endo-donti* or teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*) and ETT).tw.
4 or/1-3
5 exp Crowns/
6 (crown$1 or post$1 or dowel$1 or full cast$1 or indirect restor*).tw.
7 (dental* or dentist* or endodonti* or endo-donti* or teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*).mp.
8 6 and 7
9 (post$1 adj2 core$1).tw.
10 (parapost* or para-post*).tw.
11 or/5,8-10
12 4 and 11
13 (controlled clinical trial or randomized controlled trial).pt.
14 clinical trials as topic.sh.
15 (randomi#ed or randomly or RCT$1 or placebo*).tw.
16 ((singl* or doubl* or trebl* or tripl*) adj (mask* or blind* or dumm*)).tw.
17 trial.ti.
18 or/13-17
19 12 and 18
20 Controlled Clinical Trials as Topic/
21 (control* adj2 trial*).tw.
22 (nonrandom* or non-random* or quasi-random* or quasi-experiment*).tw.
23 (nRCT or nRCTs or non-RCT$1).tw
24 (control* adj3 ("before and after" or "before after")).tw.
25 time series.tw.
26 (pre- adj3 post-).tw.
27 (pretest adj3 posttest).tw.
28 (control* adj2 stud$3).tw.
29 Control Groups/
30 (control$ adj2 group$1).tw.
31 or/20-30
32 12 and 31
33 19 or 32
34 exp Animals/ not (exp Animals/ and Humans/)
35 33 not 34
36 (comment or editorial or interview or letter or news).pt.
37 35 not 36 (
38 37 use prmz
39 tooth pulp disease/

40 ((teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*) adj3 (devital* or de-vital* or endodontically-treated or endo-dontically-treated or nonvital* or non-vital* or pulpless*)).tw.
41 ((dental* or dentist* or endodonti* or endo-donti* or teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*) and ETT).tw.
42 or/39-41
43 exp tooth crown/
44 (crown$1 or post$1 or dowel$1 or full cast$1 or indirect restor*).tw.
45 (dental* or dentist* or endodonti* or endo-donti* or teeth* or tooth* or molar or molars or premolar* or pre molar* or incisor* or cuspid* or bicuspid* or bi-cuspid*).mp.
46 44 and 45
47 (post$1 adj2 core$1).tw.
48 (parapost* or para-post*).tw.
49 or/43,46-48
50 42 and 49
51 randomized controlled trial/ or controlled clinical trial/
52 exp "clinical trial (topic)"/
53 (randomi#ed or randomly or RCT$1 or placebo*).tw.
54 ((singl* or doubl* or trebl* or tripl*) adj (mask* or blind* or dumm*)).tw.
55 trial.ti.
56 or/51-55
57 50 and 56
58 "controlled clinical trial (topic)"/
59 (control* adj2 trial*).tw.
60 (nonrandom* or non-random* or quasi-random* or quasi-experiment*).tw.
61 (nRCT or nRCTs or non-RCT$1).tw.
62 (control* adj3 ("before and after" or "before after")).tw.
63 time series analysis/
64 time series.tw.
65 pretest posttest control group design/
66 (pre- adj3 post-).tw.
67 (pretest adj3 posttest).tw.
68 controlled study/
69 (control* adj2 stud$3).tw.
70 control group/
71 (control$ adj2 group$1).tw. (
72 or/58-71
73 50 and 72
74 57 or 73
75 exp animal experimentation/ or exp models animal/ or exp animal experiment/ or nonhuman/ or exp vertebrate/
76 exp humans/ or exp human experimentation/ or exp human experiment/
77 75 not 76
78 74 not 77
79 (editorial or letter).pt.
80 78 not 79
81 80 use emczd
82 38 or 81
83 remove duplicates from 82 (494) [TOTAL UNIQUE HITS]

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Cochrane Library

Date Run: 01/12/16

ID	Search	Hits
#1	[mh "Tooth, Nonvital"]	155
#2	((teeth* or tooth* or molar or molars or premolar* or (pre next molar*) or incisor* or cuspid* or bicuspid* or (bi next cuspid*)) near/3 (devital* or (de next vital*) or "endodontically-treated" or "endo-dontically-treated" or nonvital* or (non next vital*) or pulpless*)):ti,ab,kw	227
#3	((dental* or dentist* or endodonti* or (endo next donti*) or teeth* or tooth* or molar or molars or premolar* or (pre next molar*) or incisor* or cuspid* or bicuspid* or (bi next cuspid*)) and ETT):ti,ab,kw	8
#4	{or #1-#3}	231
#5	[mh Crowns]	575
#6	(crown or crowns or post or posts or dowel or dowels or "full cast" or "full casts" or (indirect next restor*)):ti,ab,kw	49913
#7	(dental* or dentist* or endodonti* or endo-donti* or teeth* or tooth* or molar or molars or premolar* or (pre next molar*) or incisor* or cuspid* or bicuspid* or (bi next cuspid*))	30407
#8	#6 and #7	3035
#9	((post or posts) near/2 (core or cores)):ti,ab,kw	239
#10	(parapost* or (para next post*)):ti,ab,kw	20
#11	{or #5, #8-#10}	3044
#12	#4 and #11	144

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5/6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7

Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7/8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	NA

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Figure1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 1 and 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Figure 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Table 1 and 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10/11/12
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	10/11/12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	10/11/12

FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	NA

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

5 Capítulo 4

An up to 6 years RCT comparing cast metal and glass fiber posts[4].

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Email: Tatiana.dds@gmail.com

Abstract word count:
Total word count: 3147
Total number of tables/figure: 2 tables and 1 figure
Number of references: 24
Keywords: Fiber-reinforced Post, Dowel and Core, Dental Restoration, Follow-up Studies, Cementation, Clinical Trial

[4]Artigo formatado segundo as nornas do periódico Journal of Dental Research. O texto é aqui apresentado de acordo com as normas do periódico.

Abstract

The restoration of endodontically treated teeth with no ferrule is a continuous challenge in Dentistry, and few clinical studies with reasonable follow-up time are available. The aim of this randomized controlled trial was to test if glass fiber posts would present similar survival compared with cast metal posts in teeth without remaining coronal walls after up to 6 years of follow-up. Eighty-seven patients and 119 teeth were evaluated, with a mean follow-up time of 37.6 months. Teeth were randomly allocated into the glass fiber or cast-metal post groups. All teeth were restored with single metal-ceramic crowns. Survival probabilities were analyzed using Kaplan–Meier statistics ($p<0.05$) and annual failure rates were calculated. Both posts presented similar performance for success ($P=0.29$) and survival ($P=0.2$). Cast metal posts presented AFR of 1.88% after 3 years and 18.35% after 5.9 years while glass fiber posts presented an AFR of 3.23% after 3 years and 3.69% after 6.33 years. Fourteen failures were observed, with nine failures in the glass fiber post group (15.7%) and five in cast metal post group (8.2%). After up to 6 years of follow up, glass fiber and cast metal posts showed good and similar clinical performance. Also, in general both posts presented low values of AFRs with 3.2% and 7.1% after 3 and 6 years, respectively. (NCT 01461239)

Introduction

The absence of residual coronal walls is the worst-case scenario to restore endodontically treated teeth (ETT). The use of a post-retained restoration is necessary as the main method of retaining the coronal restorative material in these situations (Fernandes et al. 2003; Goracci and Ferrari 2011; Ferrari et al. 2012). Traditionally, metal posts have been used to restore endodontically treated teeth because of their long reported survival (Ellner et al. 2003; Fokkinga et al. 2007). Metal posts are classified based on their elastic modulus values (pre-fabricated or cast metal posts) presenting high values, while non-metallic posts as glass fiber posts present low values. Based on literature, it is expected that ETT restored with these different types of posts would present distinct mechanical behaviors (Pierrisnard et al. 2002; Eraslan et al. 2009).

Although it seems to be a consensus that cast metal posts will properly perform, glass fiber posts are widely used in clinical practice, and few randomized controlled trials compared posts with different elastic modulus to restore teeth with no ferrule (Zicari et al. 2011). Also, available studies have short follow-up. Studies with longer follow-ups are important especially to have restorative treatments with more predictability since some materials might present late failures especially after 5 years of follow-up in Prosthodontics and Operative Dentistry. As such, a 10-year retrospective study showed a good survival rate of cast metal posts (Gomez-Polo et al. 2010), but there is still lack of studies comparing both posts with longer follow-ups. Thus, the aim of this study was to evaluate the survival of teeth restored with glass fiber or cast metal posts in teeth with no ferrule after up to 6 years of follow-up. It was hypothesized that glass fiber post retained restorations would perform similarly to cast metal post-retained ones.

Materials and Methods

Experimental Design

This study was an equivalency, prospective, double blind (patient and evaluator), randomized controlled trial (RCT) with parallel groups designed to compare the survival of cast metal posts and glass fiber posts. The study was registered at ClinicaTrials.gov (NCT01461239) and approved by the Local Research and Ethics Committee (Protocol 122/2009). The reporting of the study is based on the CONSORT Statement (Piaggio et al. 2012). The study took place at the Department of Restorative Dentistry, School of Dentistry, Federal University of Pelotas (Brazil). First, the oral health of the participants was assessed and all participants signed written informed consent before being accepted into the study. Patients who met the following inclusion criteria were included: participants with good oral health (no caries lesion, no periodontal disease) that had anterior or posterior endodontically treated teeth without coronal walls or 1 wall in enamel without dentin support (with a ferrule height of 0 to 0.5 mm) that needed use of intra-radicular post (glass fiber or cast metal post, according to the randomization) and a single crown. The participants should have bilateral occlusal posterior contacts. Exclusion criteria were: endodontically treated teeth with periodontal or occlusal problems and large prostheses (Kennedy Class I or II) opposing the tooth to be restored. The participants were recalled after 6 months and annually until 6 years for clinical and radiographic examination. The main outcome was post debonding.

Sample Size Calculation

Sample size calculation was performed as described elsewhere (Sarkis-Onofre et al. 2014). Briefly, considering that studies have shown no difference in survival between post types (Naumann et al. 2005; Naumann et al. 2007; Sterzenbach et al. 2012; Zicari et al. 2011), sample size calculation was performed based on the equivalence of treatments, with a two-sided 90% confidence interval and a difference of more than 18% between the standard (cast metal) and experimental treatment groups. Seventy-two teeth were included at first, but after the first publication, patients' intake was kept with a now reported sample size of 114 teeth.

Randomization Procedures

All teeth were randomized and assigned to each group using a computer-generated list of random numbers. Each number was written on a white paper and placed into plain brown envelopes by a researcher not involved in the study according to the treatment previously randomized. Allocation only occurred after filling removal and root canal preparation. The first randomization was to post selection (glass fiber or cast metal post); when glass fiber post was selected a second randomization was made to which resin cement to be used (regular or self-adhesive resin cement). The randomization was stratified by tooth type, anterior, premolar or molar with a 1:1 allocation using random blocks sizes of 6 and 8.

Clinical Procedures

Materials and procedures used for root canal treatment and for all restorative procedures were reported in detail elsewhere (Sarkis-Onofre et al. 2014). Briefly, all teeth included received endodontic treatment using the crown down technique, irrigated with 2.5% NaOCl solution and filled by lateral condensation technique using Grossman Cement (Endo-fill, Dentsply/Maillefer, Petrópolis, Brazil) and gutta-percha cones (Dentsply/Maillefer, Petrópolis, Brazil).

Glass fiber posts were luted with regular resin cement (RelyX ARC, 3M, ESPE, St Paul, USA) with previous application of 37% phosphoric acid and adhesive (Single Bond or ScotchBond Multi Purpose) or self-adhesive resin cement (RelyX U100 or U200, 3M, ESPE). For both techniques, the resin cement was applied into the root canal using a Centrix syringe (DFL Indústria e Comércio S.A., Rio de Janeiro, Brazil) and the core build up with composite resin (ScotchBond Multi Purpose and Z250, 3M, ESPE). Cast metal posts were luted with self-adhesive resin cement (RelyX U100 or U200, 3M, ESPE). After post cementation, radiographs were taken to check the success of the procedure. All teeth received a single metal-ceramic crown as the final restoration. Undergraduate (last year) and graduate students that attended 12h of lectures/hands-on training carried out all procedures.

Evaluation Parameters

Post cementation date was considered as baseline. All participants were recalled after 6 months and annually up to 6 years for clinical and periapical radiographic examination. As patients' intake occurred during a broad timespan,

follow-up time varied. Calibration of the main outcome was not necessary since it was debonding or not. Two examiners were calibrated to perform the FDI criteria (Hickel et al. 2010) evaluation for the crown. Initially, a blind examiner performed the crown evaluation and another person without involvement in the study performed the radiographic exam. Only after the initial evaluation of the crown, the radiographic exam was evaluated. This sequence of evaluation was chosen to ensure blindness. Periodontal status (probing depth and clinical attachment level), pain occurrence, antagonist status and occlusion pattern were evaluated. The occurrence of the following events was recorded:

- Secondary caries: presence of caries adjacent to crowns.
- Endodontic failure: radiographic signs of apical periodontitis, clinical signals and/or symptoms of tenderness to percussion or presence of periapical abscess draining through a fistula.
- Crown fracture: material chip fractures that damaged marginal quality or proximal contacts and bulk fractures with partial loss (less than half of the crowns).
- Post fracture: all levels of fracture of post were considered irrespective of its position on the arch or extension.
- Crown dislodgment: characterized as total loss of crown or partial loss that allows dislodgment using a manual instrument.
- Post debonding: characterized as total loss of post /post and crown or partial loss that allows dislodgment using a manual instrument.
- Root fracture: root fractures leading to tooth extraction and partial root fractures that could be treated with all types of surgical crown lengthening.

The occurrence of failures where categorized in absolute or relative failure. Root fractures resulting in tooth extraction were considered absolute failure and post debonding with possibility of recementation was considered relative failure. If the patient returned to the exam with a tooth without the post, the time of failure was based on patient self-report of when the post debonded. Success was defined as the absence of absolute and relative failures and survival was defined as the absence of absolute failures.

Statistical Analysis

Statistical analysis was performed using Stata 13.0 software (StataCorp, College Station, USA**)**. Descriptive analyses were used to describe the participants (teeth) included in the study and the reasons for failure. Kaplan-Meier analysis with log-rank test was used to test the success and survival between glass fiber posts and cast metal posts considering a cut-off value of P=0.05. In cases of patients who failed to attend the latest study visit the last observed value forward was used for any parameter including time in service. The annual failure rates of the restorations were calculated according to the formula: $(1-y)^z = (1-x)$, in which 'y' expresses the mean AFR and 'x' the total failure rate at 'z' years considering all restorations and separated by type of post after 3 and 6 years and using data from success of restorations. The principle of per protocol analysis was used in all analyses and 95% of confidence interval (95% CI) was considered. Data regarding the evaluation of the crown with FDI criteria were not analyzed neither included in this report because all crowns presented score 1 and 2 for all aspects.

Results

All procedures were performed between July 2009 and July 2015. Figure 1 presents the participants flow diagram. One hundred and thirty-five teeth (96 patients) were randomized. A total of 65 glass fiber posts and 69 cast metal posts were luted and after up to 6 years, 58 glass fiber posts and 61 cast metal posts were followed and analyzed.

Table 1 presents the characteristics of patients and teeth included in the analysis. Eighty-seven patients and 119 teeth were included in the analysis. Seventeen (19.5%) were male and 70 (80.5%) were female. The mean age was 42.7 (SD 12.2) years old. Sixty-seven (56.3%) posts were luted in anterior teeth, 36 (30.3%) in premolars and 16 (13.4%) in molars. The mean follow-up was 37.6 (SD 19.3) months.

Table 2 presents the characteristics of each failure. Fourteen failures were observed, including nine glass fiber post failures (15.7%) and five cast metal post failures (8.2%). Characteristics of failed teeth included: eight (57.1%) failures observed in premolars, including five root fractures. Most post debondings (66.7%)

were associated with the use of self-adhesive resin cement. The median time of failure was 25 months.

Kaplan-Meier graphs considering success (A) and survival (B) of restorations are presented in Figure 2. Both analyses did not present statistically significant differences (P=0.29 for success and P=0.2 for survival). The survival probability of cast metal posts after 5.9 years was 0.3 (95% CI 0.0003 - 0.8732) and for glass fiber posts was 0.8 (95% CI 0.5984 - 0.8784). The AFR of both posts after 3 and 6.3 years were 3.2 and 7.1%, respectively. Taking posts into consideration separately, cast metal posts presented AFR of 1.9% and 18.3% after 3 and 5.9 years respectively, while glass fiber posts presented AFR of 4.6% and 4% after 3 and 6.3 years, respectively. To explore the influence of that failure, we calculated the AFRs considering the time before the failure (between 67 and 68 months) for both groups. Cast metal posts presented AFR of 1.6% and glass fiber posts of 4.6%

Discussion

Cast metal posts are still widely used due to its history of success. However, glass fiber posts gained widespread use in the two last decades together with the enhancement of resin-based cements, which led to more predictable clinical results. Still, systematic reviews found no evidence to support a “best technique” to restore ETT (Bolla et al. 2007; Sequeira-Byron et al. 2015). The issue on restoration of endodontically treated teeth appears to be threefold: short follow-up RCTs; a lack of transparent reporting; and in vitro based research guiding clinical procedures. This randomized controlled trial presents a comparison between glass fiber and cast metal posts in teeth without remaining coronal walls after up to 6 years of follow-up. Although it is expected that ETT restored with different types of posts will present distinct mechanical behaviors, both posts presented similar and adequate clinical performance. The results of this randomized controlled trial are aligned with conclusions of recent systematic reviews.

Regarding the treatment of ETTs, a few remarks have to be placed. First, it seems that a post should be used, decreasing risk of tooth failure i.e. fracture (Zhu et al. 2015). Second, single crowns seem to be the best treatment modality for these teeth (Ploumaki et al. 2013). However, there is still doubt whether the performance of post-restored ETTs is truly depending on the remaining coronal tissue and absence/presence of ferrule. Another problem in the current evidence available is

that the systematic reviews on this subject usually include a low number of primary studies and most of the included studies present completely different designs and poor reporting, resulting in low quality of evidence. Therefore, these reviews are bringing recommendations still-to-be-proven. A recent meta-analysis (Skupien et al. 2016) showed a positive effect of presence of ferrule in the survival of ETT, especially in premolars demonstrating that the absence of ferrule and coronal walls is the worst-case scenario to restore ETT. This is the reason why studies with worst-case scenarios should be conducted: they represent challenge to the clinician that sometimes has to rely on his/her own experience to decide on treatment options for the patients.

In general and as supported by the literature, restoration of ETT presents higher AFR than vital teeth. AFRs after 3 and 6 years were 3.2% and 7.1% respectively in the studied sample. Recent review (Demarco et al. 2012) demonstrated that AFRs of posterior composite restorations placed in vital teeth can vary between 1 and 3% while for ETT, the AFRs vary from 2 to 12.4%. When AFRs are observed by type of post, cast metal posts presented higher AFR (18.3%) than glass fiber posts (4%) after 6 years of follow-up. However, one should consider the last period of observation in figure 2A, between 60 and 80 months where few posts were under observation in both groups. At this time, one cast metal post failed, causing decrease of survival probability (0.3) and consequently increasing the AFR of this group after 6 years. To explore the influence of that failure, we calculated the AFRs considering the time before the failure (between 67 and 68 months) for both groups. Cast metal posts presented AFR of 1.6% and glass fiber posts of 4.6% demonstrating AFRs comparable with vital teeth; however, more time of follow-up is necessary to confirm these rates in the studied sample.

Fourteen failures were observed in the trial, with the majority associated to post debonding with the use of self-adhesive resin cement. The failure patterns of glass fiber and cast metal posts have been widely discussed. However, in this trial post debonding was the main cause of failure in both groups. Also, no difference between groups was identified concerning the incidence of root fracture. This result is in accordance with recent systematic review (Figueiredo et al. 2015) that demonstrated no difference for root fracture incidence between metal and fiber posts. It is likely that other factors rather than posts' elastic moduli alone will result in root fracture. Eight failures were observed in premolars including five of six root fractures

observed in the trial. This result could be explained by the association of two details: 1) only teeth with absence of ferrule were included in this trial 2) a recent systematic review (Skupien, 2016) demonstrated a negative effect of absence of ferrule in the survival of endodontically treated premolars not observed in anterior teeth or molars.

As the use of resin cement to lute posts has shown a good clinical performance (Zicari et al. 2011; Gbadebo et al. 2014) some aspects regarding post debonding failures should be highlighted: 1) although most post debondings were associated with the use of self-adhesive cement, cast metal posts were luted only with that cement and 2) two failures were observed after 1 month of post cementation and very likely they were both associated with technical problems of the operator.

This RCT was conducted based on the assumed equivalence of the interventions. Its aim was to demonstrate that the new intervention (glass fiber posts) is not worse, in terms of the primary response variable, than the standard (cast metal posts) using a predefined margin (Friedman et al. 2010). This approach was used because the majority of clinical studies have not produced results favoring any particular post available in the market. Two important limitations are observed in this study. One is the fewer number of restorations under observation after 40 months of follow-up in both groups, meaning that more time of follow-up is necessary. Another is to statistical methods used, because due to the small number of events (failures), a Cox-regression could not be performed. Yet, the results of this trial can help dentists to respond how to rehabilitate ETT with absence of coronal walls. Therefore, based on this trial dentists may consider the use of any of the tested posts luted with resin cement and associated with a single crown as a good restorative option.

Conclusion

Although more evidence should be generated to indicate one type of post instead of the other in ETT without ferrule, glass fiber and cast metal posts showed adequate and similar clinical performance after up to 6 years of follow-up. Also, in general both posts presented low values of AFRs with 3.2% and 7.1% after 3 and 6 years respectively.

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Figures

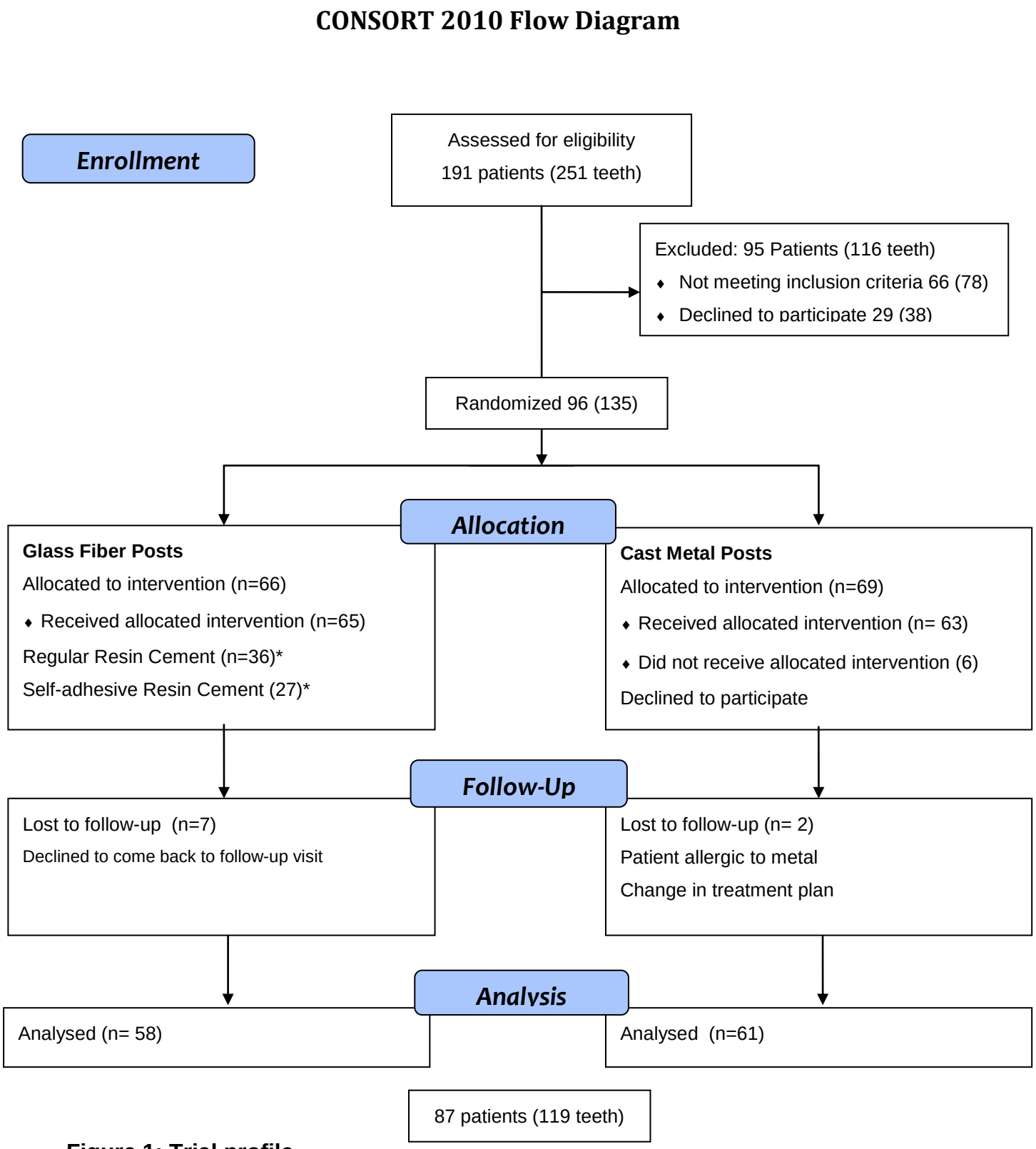

Figure 1: Trial profile

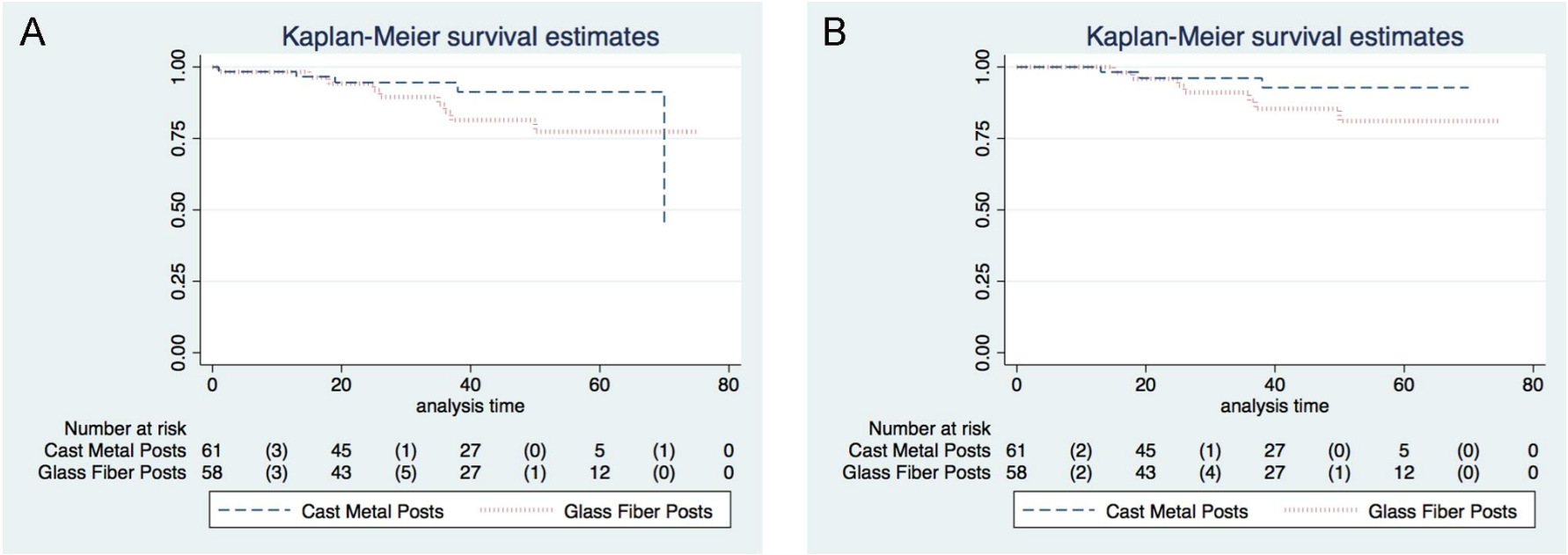

Figure 2: Kaplan-Meier graphs considering success (A) and survival (B) of restorations. Success was considered as the absence of absolute and relative failures and survival was considered as the absence of absolute failures. Axis x represents the time in months. Numbers below the graphs represent number of observations (number of failures) per period.

Tables

Table 1: Characteristics of included patients (teeth).

Characteristics/Post	Cast Metal Posts	Glass Fiber Posts	All data
Number of patients (teeth)	52 (61)	45 (58)	87 (119)
Gender n(%)			
Male	11 (21.2)	7 (9.5)	17 (19.5)
Female	41 (78.8)	38 (90.5)	70 (80.5)
Age (dp)	41.5 (13.7)	44.7 (10.1)	42.7 (12.2)
Tooth type n(%)			
Anterior	36 (59)	31 (53.4)	67 (56.3)
Premolar	16 (26.2)	20 (34.5)	36 (30.3)
Molar	9 (14.8)	7 (12.1)	16 (13.4)
Cement n(%)			
Regular	NA	29 (52.7)*	NA
Self-adhesive	61(100)	26 (47.3)*	87 (73.1)
Mean of follow-up (SD)$	36.2 (17.8)	39 (20.8)	37.6 (19.3)

***** Missing data

Table 2: Characteristics of each failure observed in the trial

Tooth number	Type of Post	Resin Cement	Time of failure in months	Reason of failure
44	Glass Fiber	Regular	37	Root fracture
45	Glass Fiber	Regular	36	Debonding
11	Glass Fiber	Regular	35	Debonding
24	Glass Fiber	Self-adhesive	15	Debonding and root fracture
15	Glass Fiber	Regular	50	Debonding
25	Glass Fiber	Self-adhesive	25	Root fracture
11	Glass Fiber	Self-adhesive	1	Debonding
44	Glass Fiber	Regular	18	Root fracture
24	Glass Fiber	Regular	26	Root fracture
26	Cast Metal*	Self-adhesive	19	Root fracture
24	Cast Metal	Self-adhesive	13	Debonding
31	Cast Metal	Self-adhesive	38	Debonding
11	Cast Metal	Self-adhesive	1	Debonding
22	Cast Metal	Self-adhesive	70	Debonding

* Cast Metal Post were only luted with self-adhesive resin cement

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	2
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	3
	2b	Specific objectives or hypotheses	3
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	4
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	NA
Participants	4a	Eligibility criteria for participants	3
	4b	Settings and locations where the data were collected	4
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	5/6
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	4/6/7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	NA
Sample size	7a	How sample size was determined	3
	7b	When applicable, explanation of any interim analyses and stopping guidelines	NA
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	5
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	5

Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	5
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	5
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	6
	11b	If relevant, description of the similarity of interventions	NA
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	7
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	7
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Figure 1
	13b	For each group, losses and exclusions after randomisation, together with reasons	Figure1
Recruitment	14a	Dates defining the periods of recruitment and follow-up	7
	14b	Why the trial ended or was stopped	7
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Table1
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	8
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	8
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	8
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	8
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Table2
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	9/10
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	10
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	9/10/11

Other information			
Registration	23	Registration number and name of trial registry	4
Protocol	24	Where the full trial protocol can be accessed, if available	NA
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	NA

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6 Capítulo 5

Use of guidelines to improve the quality and transparency of reporting Oral Health Research[5]

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Key words: Guideline Adherence, Review, Dentistry, Oral Health

[5] Artigo publicado: Journal of Dentistry 2015 Apr;43(4):397-404.O texto é aqui apresentado de acordo com as normas do periódico.

Abstract

Objective: The use of reporting guideline is directed at enhancing the completeness and transparency of biomedical publications. The aims of this paper are to present some of the key initiatives and guidelines providing indications and directions on the use of specific tools in oral health research.

Methods: The EQUATOR Network and five established guidelines (CONSORT, STROBE, PRISMA, CARE and SPIRIT) are introduced.

Results: Five guidelines are presented covering reporting of case reports, non-randomized studies, randomized controlled trials and systematic reviews. The importance of adherence to these guidelines by oral health researchers is emphasised.

Conclusions: Endorsement and robust implementation of reporting guidelines will translate into improved and more complete reporting in health research. Moreover, by ingraining the use of guidelines, it may be possible to indirectly improve the methodological quality of clinical studies. Active implementation strategies to encourage adherence to these guidelines among researchers, reviewers, editors and publishers may be an important facet in the advancement of knowledge in dentistry.

Clinical significance: Inadequate reporting of research can lead to wasted research resources and risks publication of inaccurate or misleading findings with implications on healthcare decisions. Familiarity and diligent compliance with methodological and reporting guidelines is therefore essential to maximize the yield from dental research.

Introduction

There is overwhelming evidence that the quality of reporting of biomedical research is suboptimal.[1] Inadequate reporting has important downstream consequences for patient care and is common both to medical and dental research with several studies alluding to deficiencies in the reporting of trials published in a variety of dental journals and specialty areas.[2-5] Poor reporting has implications for different spheres of knowledge and understanding and risks having negative societal impacts by impacting on clinical decisions, allied research questions, and ultimately public health policy. The use of guidelines and associated tools aims to improve the completeness, pertinence and clarity of reporting in health research and consequently research transparency. Guidelines are typically presented as a checklist with completion of key items required to adequately inform end users including clinicians, researchers, and guideline and policy developers.[6]

All stakeholders, including researchers, journals editors, funding agencies, ethics committees and governments have a role in ensuring that guidelines are imbedded in research reporting. Various initiatives have been promoted in recent years directed at improving the completeness, quality and transparency of research with specific guidelines developed to help researchers improve the reporting of their research; ultimately, the latter are also likely to translate into improved design and conduct of research. There are now a large number of guidelines for specific study designs ranging from the reporting of case reports, to randomised controlled trials, and systematic reviews. Guideline development is an evolving area; recent developments can be followed on the EQUATOR network (www.equator-network.org).[7-14]

The aim of this paper is to raise awareness to key current initiatives and reporting guidelines used in biomedical reports among oral health researchers.

Reporting guidelines

This paper is based on six initiatives (Table 1): Enhancing the QUAlity and Transparency Of health Research (EQUATOR) Network and five specific guidelines: CAse REports (CARE), Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT), Consolidated Standards of Reporting Trials (CONSORT), Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Enhancing the QUAlity and Transparency Of health Research (EQUATOR Network)

Prior to conducting a biomedical study, familiarity with the EQUATOR Network (http://www.equator-network.org/) is recommended.[7,8,14] The EQUATOR Network is an initiative led by an international team of health researchers, statisticians and research methodologists. The initiative is designed to encourage improvement in published health research literature through more complete and transparent reporting based on specific reporting guidelines and better research practices. The EQUATOR Network supports the development of initiatives aiming to improve the reporting quality of health-related research publications and the methodological quality of research studies. Prospective researchers are encouraged to consult this resource prior to commencing a research study to ensure that key areas have been considered in the research design.

When the EQUATOR Network project began in 2006, three main goals were proposed: to identify initiatives related to the preparation and dissemination of guidelines reporting in health research studies, to identify specific key initiatives, and to establish collaboration with stakeholders in this field. After a series of meetings and a detailed literature review[15] the EQUATOR Network initiative was formally launched in 2008. The EQUATOR initiative now aspires to seven major goals[14]:

- *"To develop and maintain a comprehensive collection of online resources providing up-to-date information, tools and other materials related to health research reporting (Library for health research reporting)."*
- *"To assist in the development, dissemination and implementation of robust reporting guidelines."*
- *"To actively promote the use of reporting guidelines and good research reporting practices through an education and training program."*

- *"To support journals in implementing reporting guidelines and conduct regular assessments of how journals use these guidelines."*
- *"To conduct regular audits of reporting quality across the health research literature."*
- *"To set up a global network of local EQUATOR centers to facilitate the improvement of health research reporting on a worldwide scale."*
- *"To develop a general strategy for translating the principles of responsible research reporting into practice."*

The initiative has been instrumental in developing a series of education projects including workshops, seminars and conferences globally. Furthermore, it hosts a website with an up-to-date, access free resources relating to health research reporting and methodology containing a library of guidelines, policy documents, toolkits for various stakeholders, such as authors and editors, and a specific section of translated reporting guidelines. Guidelines which are under development are also listed on the site. Key guidelines translated into 15 different languages are currently available on the site. The initiative also presents its Spanish version – the EQUATOR's Spanish website in partnership with Pan American Health Organization (www.espanol.equator-network.org)[16].

EQUATOR has been endorsed by a series of influential organizations including Cochrane Groups, editorial groups and specific journals including *The Lancet* and *British Medical Journal*. It receives funding from a range of sources including the National Institute for Health Research (UK), Medical Research Council (UK), Pan-American Health Organization and Chief Scientist Office (Scotland). Sustained funding should ensure that this resource remains a dynamic, contemporaneous and complete with dedicated to 'improving the quality of research publications and of research itself'.

CAse REports (CARE)

While case reports are accepted as having a low level of evidence, they may occasionally have an influential role in health research since by introducing potentially beneficial interventions, which may later be subjected to more rigorous analyses. A case report can lead to hypotheses for clinical studies, aid clinicians in the treatment and management of specific and rare health conditions and may

support healthcare education. The CARE initiative defines case reports as *"professional narratives that outline the diagnosis, treatment, and outcomes of the medical problems of one or more patients"*.

The CARE guidelines provide a structure to improve the completeness, quality and transparency of the reporting of case reports. These guidelines were introduced in some medical journals in 2013[9]. The CARE checklist and case report template may be downloaded free-of-charge in multiple languages from the CARE group website (care-statement.org)[17].

The CARE guideline is based on 13 key components to provide sufficient clinical information of the case. The checklist begins with components of the title, keywords and abstract and aspects of the main text including a timeline of the case with delineation of important dates. The use of figures or tables showing the key events of the case and the follow-up are recommended within the CARE guidelines. The final two items include reference to patient-reported outcomes and experiences, and ethical aspects including informed consent. The Case Report writing template includes a brief explanation of each of the 13 items to facilitate clear and detailed description of the case. The CARE initiative is increasingly being endorsed by influential journals including BMJ Case Reports.

Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT)

The SPIRIT guidelines are recommended for use in developing a protocol for a proposed randomized trial. SPIRIT should not be confused with CONSORT, a reporting guideline for reporting the completed trial (see below). While CONSORT may be useful both in improving reporting characteristics and in informing the experimental design in dental research, SPIRIT guidelines are recommended for design and reporting of trial protocols. The SPIRIT initiative defines a protocol as "*a document that provides sufficient detail to enable understanding of the background, rationale, objectives, study population, interventions, methods, statistical analyses, ethical considerations, dissemination plans, and administration of the trial; replication of key aspects of trial methods and conduct; and appraisal of the trial's scientific and ethical rigor from ethics approval to dissemination of results"*.

The protocol for clinical trials is instrumental in informing the research methodology, data analyses and interpretation, ethical aspects and dissemination of the results. The importance of protocols and their impact on research design is accepted.[18-20] In 2007, a team of international researchers introduced the Standard

Protocol Items: Recommendations for Interventional Trials (SPIRT) initiative aiming to improve the completeness of trial protocols. In 2013, the SPIRIT group published papers introducing the SPIRIT 2013 statement[12] and an explanatory paper.[21] The SPIRIT website (www.spirit-statement.org)[22] also offers downloads in various languages including Chinese.

The SPIRIT 2013 Statement is based on a 33-item checklist and a diagram considered the basic set of items to be included in protocols. The checklist presents items ranging from administrative information including trial registration and funding (types of funding and other source of support) to methodological aspects and items related to ethics and dissemination of results. The diagram should be included in the protocol detailing timelines for enrollment, interventions, and assessments. To date, a large number of groups have endorsed the SPIRIT 2013 Statement including more than 50 journals, academic institutions, industry, trial groups and patient groups.

Consolidated Standards of Reporting Trials (CONSORT)

The CONSORT Statement is recommended for use when reporting a randomised controlled trial (www.consort-statement.org/)[23]. The CONSORT group is an initiative leaded by an international team of trialists, methodologists and medical journal editors that began in 1993 and 1994 after a meeting of two groups with the same objective: develop a checklist with essential key components that authors should provide in the reporting of randomized controlled trials. The result of this meeting was the Consolidated Standards of Reporting Trials (CONSORT) Statement originally published in 1996.[24] This original version has since been revised on two occasions in 2001[25] and again in 2010.[11,26]

The CONSORT 2010 Statement includes a 25-item checklist and a flow diagram to be used in the main text; these aspects are considered to be the minimum number of items in the reporting of two-group parallel-group randomized controlled trials (RCTs). The checklist includes items related to the title, introduction, several items concerning the methodology including detail of sample size, randomization, blinding among others. In the results section the use of the participant flow diagram is recommended to outline the number of patients allocated to specific groups, details of those withdrawing in each part of the study and numbers completing the study and included in the final analyses (Figure 1). Items related to the discussion section including limitations of the study should also be reported on. Additionally, a separate

CONSORT for reporting RCTs in journals and conference abstracts is also available[27].

Other important resources developed by the group include CONSORT extensions focusing on designs other than two-group parallel-group RCTs and focusing on specific outcomes. The extensions for cluster trials[28], non-inferiority /equivalence trials[29] and pragmatic trials[30] are design-related while extensions for acupuncture trials (STRICTA),[31] harms,[32] herbal medicinal interventions,[33] non-pharmacologic treatment,[34] reporting of patient-reported outcomes[35] are outcomes related. These extensions are available outlining specific nuances of each trial design or outcome. Other extensions are in development, including CONSORT for crossover trials and CONSORT for multiple-groups, and CONSORT within person trials, which maybe particularly useful for those reporting oral health RCTs.

CONSORT has been endorsed by more than 800 biomedical journals including the *British Medical Journal, The Lancet* and *New England Journal of Medicine*. Similarly, CONSORT compliance is encouraged among leading dental journals including the *Journal of Dentistry, Journal of Dental Research, American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO)* and *Journal of Endodontics*. Meta-epidemiological research has demonstrated the positive impact of CONSORT endorsement in a review of 50 studies that evaluated 16,604 RCTs.[36]

It is important to point out that the CONSORT Statement and its extensions aim to improve the completeness of reporting of RCTs and not directly to improve methodological quality. However, relevant literature is referred to within the CONSORT website to enhance methodological quality of trial design; educational papers have also been published to promote improved clinical trial methodology within dentistry.[37]

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

The STROBE guidelines were developed to guide the reporting of observational studies including cohort, case-control, and cross-sectional studies. Like the CONSORT statement, STROBE is directed at improving the completeness of reporting rather than being aimed at improving methodological issues. In September 2004 a meeting involving 23 methodologists and statisticians was held in Bristol (UK) as a preliminary step in the development of the guideline; after a series of discussions the STROBE Statement was published in 2007. In keeping with allied

guidelines the STROBE initiative included one paper introducing the STROBE statement[13] allied to an explanatory document.[38]

The statement was adapted specifically for cohort, case-control, and cross-sectional studies based on a 22-item checklist regarded as the basic set of items to be included in the reporting of observational studies. The checklist includes items relating to title, introduction, several items to be reported in the methods as study design, setting, quantitative variables, statistical methods among others. Use of a participant flow diagram is also recommended. Distinction is drawn between study designs with 18 items common to cohort, case-control, and cross-sectional studies. However, individual items related to participants, statistical methods, descriptive and outcome data are specific for each design. Moreover, data sources/measurement, participants, and descriptive and outcome data should be reported separately for cases and controls in case-control designs and for both exposed and non-exposed participants in cohort designs, if applicable.

The STROBE website (www.strobe-statement.org)[39] provides open access to all publications and translations of the STROBE papers. There is also a discussion forum and access to existing related commentaries, editorials and associated publications available in the medical literature.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

The PRISMA guidelines have been developed for the reporting of systematic reviews and (where possible) meta-analyses. After a series of studies and a meeting held in 2005 with 29 stakeholders, the PRISMA Statement was launched in 2009 as a revised updated version of the QUOROM Statement (QUality Of Reporting Of Meta-analyses). The aim is to provide a checklist with essential key components for the reporting of systematic reviews and meta-analyses. The guideline was developed specifically to use in systematic reviews of randomized trials, although it may be also helpful in the reporting of reviews relating to other designs.[40] The first and current version of PRISMA Statement was published in 2009 incorporating both the PRISMA Statement[41] and an explanatory paper.[10] Both were published simultaneously and re-published in leading, high-impact medical journals for increase visibility and awareness.

The PRISMA Statement is based on a checklist involving 27 items. Items to be reported in the methods include eligibility criteria, details of searches, including a complete electronic search, data analyses, outcome measures and approaches to gauging risk of bias both within and between studies. Translated versions of the guidelines are also available (www.prisma-statement.org)[42]. Prior registration of systematic review protocols is also encouraged within The PRISMA statement. The International Prospective Register of Systematic Reviews (PROSPERO) is an on-line registry (www.crd.york.ac.uk/PROSPERO/).[43,44] Recently, the PRISMA group published the Preferred Reporting Items for Systematic reviews and Meta-analyses Protocols (PRISMA-P)[45,46] aiming to help the researchers improve the methods used in developing protocols of systematic reviews and meta-analyses. This initiative is similar to the SPIRIT statement with respect of randomized trials.

Discussion

The use of guidelines to improve the completeness of reporting in heath research has been widely discussed and encouraged in the literature.[7, 8, 36] This review aimed to present the current guidelines used in health research to raise awareness of the existence of these resources among oral health researchers, peer reviewers and editors. Furthermore, an educational framework to guide researchers prior to writing a research paper or protocol to aid in the selection of the appropriate guideline is presented (Table 1 and Figure 2). The need for increased awareness of guidelines has variously been illustrated by inadequate reporting in leading general dental and specialty dental journals historically.[2-5] More recent research related both to clinical trials and systematic reviews has alluded to an improved situation but has exposed similar deficiencies.[47,48] In addition, official endorsement of accepted guidelines (including CONSORT) has thus far been lacking among a large proportion of high impact dental journals.

The positive impact of endorsement of reporting guidelines in the completeness of reporting of studies has been established.[36] However, it is apparent that the endorsement of guidelines for journals and institutions is a relatively passive process with journals merely recommending adherence to key guidelines (i.e. CONSORT, PRISMA) by submitting a completed checklist. Typically, the adherence is not assessed systematically by peer reviewers or the editorial team. More recent active implementation initiatives have shown promise with Pandis et al.[49] presented results of a CONSORT implementation strategy used in the *AJO-DO*. This approach

involves the assessment of the initial RCT submission by the editorial team with detailed evaluation of the reporting of CONSORT checklist by the associated editors prior to peer review. Suggestions are made in relation to CONSORT aspects requiring adjustment before initiating the peer review process. The paper compared the completeness of reporting of RCTs published before and after this active initiative demonstrating a significant improvement in reporting of RCTs after the evaluation of editorial team. This approach may be extended to other journals, although it does entail a significant increase in the burden on editorial teams and does result in alteration of the traditional phasing of peer review.

Dental researchers are also encouraged not only to use guidelines in the reporting of their studies, but also to use appropriate guidelines to design and to write and register protocols for proposed studies. Detailed design and protocol development helps to alleviate methodological and weaknesses. Pre-publication of registered protocols for clinical trials and systematic reviews can prevent unnecessary duplication (to be distinguished from important replication) of research and help in the advance of the dental science. Furthermore, pre-publication of protocols may help to reduce publication bias and selective reporting.[50] Selective reporting involves preferential publication of either interesting or positive research findings, while less interesting, often negative, results are left unpublished. The consequence may be misleading conclusions from research, which may in turn result in inappropriate healthcare practices. Within the CONSORT guidelines it has been recommended that primary and secondary outcomes should be defined clearly with presentation of both estimated effect size and associated precision. *Post hoc* adjustments should be described clearly to allow potentially biased alterations to be identified. However, discrepancies between conduct and reporting are possible and compliance with reporting guidelines is suboptimal; *post hoc* changes to outcomes are, therefore, not always transparent. There is also empirical evidence both of inconsistencies and selective outcome reporting in medical journals with issues exposed both in relation to primary and secondary outcome reporting.[51,52,53] Nevertheless, the importance of use of protocol registration within dentistry is clear.

The use of guidelines is not recent having been prompted in 1935 by a US army airplane crash in a flight piloted by Major Ployer P. Hill. Modern guidelines were developed as an *aide memoir* for pilots before, during and after the flight and to help them with adoption of novel technologies.[54] Since then guidelines have permeated

throughout healthcare and biomedical research. Active promotion and adherence to these guidelines for all stakeholders is integral in the advancement of knowledge. As alluded to by Drummond Rennie[55]: *"The whole of medicine depends on the transparent reporting of clinical trials"*. Dental research is equally reliant on clear and detailed research reporting; it is therefore incumbent on researchers to be cognizant with contemporary and accepted guidelines.

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Figure Legends

Figure 1: CONSORT flow diagram

Figure 2: Interrelation among studies and the role of reporting guidelines

Figures

Figure 1: CONSORT flow diagram

CONSORT
TRANSPARENT REPORTING of TRIALS

CONSORT 2010 Flow Diagram

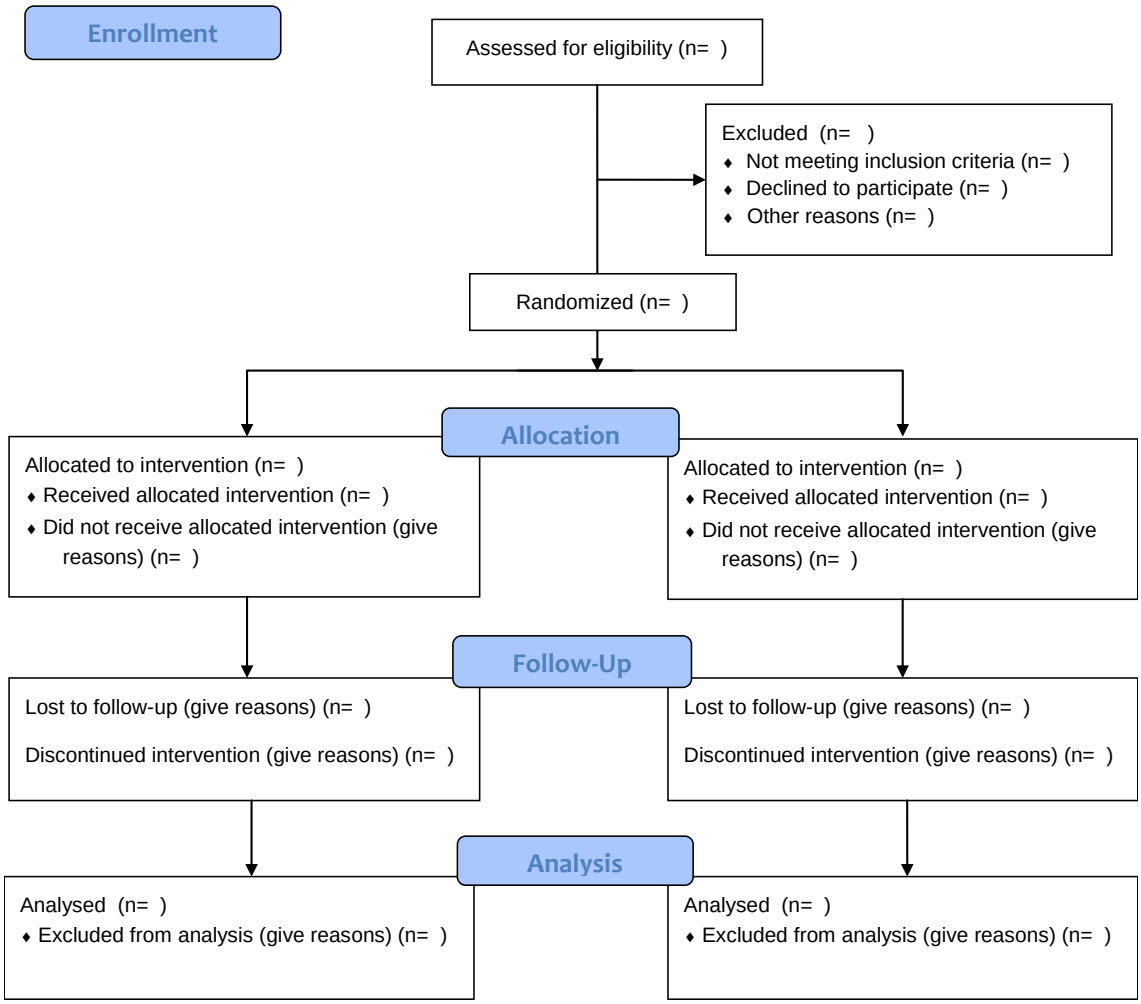

Figure 2: Interrelation among studies and the role of reporting guidelinesl

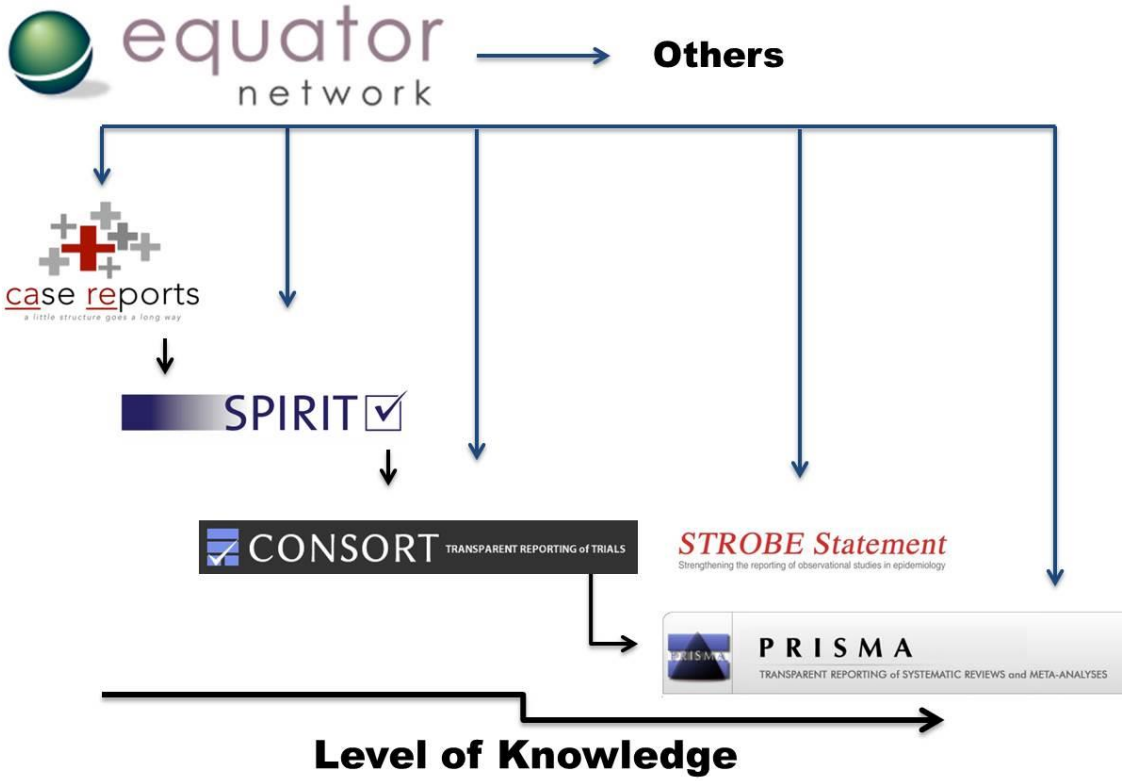

Table 1: Summary of the guidelines

Guideline	CARE	SPIRIT	CONSORT	STROBE	PRISMA
Used for	Case reports	Protocols of intervention trials	Randomized controlled trials	Observational studies	Systematic review of clinical trials and meta-analysis
Number of items	13 items	33 items	25 items and an especific for abstracts	22 items	27 items
Main topics	Title Keywords Abstract Main text aspects including a timeline of the case (figure or table) Patient-reported outcomes Ethical aspects	Administrative informations Methodological aspects (diagram with all schedules of the study) Items related to ethics and dissemination of results.	Title and abstract Introduction Several items of methods Results (flow diagram is strongly recommended) and discussion Other information (registration, protocol e funding)	Title and abstract Introduction Several items of methods Results (consider use of a flow diagram) and discussion Other information (registration, protocol e funding)	Title and abstract Introduction Several items of methods (including full eletronic search) Results (study selection through the four-phase flow diagram) Discussion and Funding
Extensions (yes/no)	No	No	Yes	No	Yes
Translations (yes/no)	Yes	Yes	Yes	Yes	Yes

7 Capítulo 6

Research reporting guidelines in dentistry: a survey of editors[6]

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Abstract

Background: The use of reporting guidelines has an important role in the development of health research, improving the quality and precision of the publications. This study evaluated how dental journals use reporting guidelines.

Methods: All editors of dental journals registered on the 2013 Journal Citation Reports list (n=81) were invited to participate. Data were collected through a self-reported web-based questionnaire. Information about the profile of journal/editor and on the use of reporting guidelines by journals was gathered. Information/recommendations about the use of reporting guidelines was also collected from the websites of all journals. Data were descriptively analyzed and frequencies were summarized.

Results: Thirty-four (42%) editors completed the questionnaire. Most journals are members of Committee on Publication Ethics (64.7%) and/or following International Committee of Medical Journal Editors recommendations (20.6%), while 26.5% it is not member of any editorial group. Most editors are not familiar with the EQUATOR Network (55.9%), do not work full time (85.3%) and 88.2% receive any income/payment. Most of them received educational training for this position (55.9%). The CONSORT Statement was endorsed by 61.8% of journals. Information from websites showed that 44.4% of journals do not recommend any reporting guideline, 51.9% mention CONSORT Statement in the website and 28.4% only recommend the use of CONSORT Statement.

Conclusion: There is a clear room for improving the use of reporting guidelines in dental journals. Broadening the understand and the edorsement/adherence/implementation of reporting guidelines by journals may promote quality and transparence of published dental research.

Introduction

The problems with reporting of health research and possible consequences have been pointed out in the literature (Glasziou et al. 2014; Simera and Altman 2009). Chalmers and Glasziou (2009) suggested that at least half of researches published present low quality or insufficient information with waste of ten billions of pounds. The completeness and transparency of reporting is necessary to allow reviewers and readers on making a correct judgment about quality and risk of bias of these studies (Glasziou et al. 2014). A recent study revealed significant growth of dental literature with the total number of publications more than doubled in the last years including all types of articles (Jayaratne and Zwahlen 2015). However, several papers were published discussing problems of reporting in various areas in dental research (Cairo et al. 2012; Jokstad et al. 2002; Kloukos et al. 2015; Montenegro et al. 2002; Savithra and Nagesh 2013) and the use of reporting guidelines could improve the quality and transparency of reporting oral health research (Sarkis-Onofre et al. 2015).

A series published by The Lancet discuss 17 recommendations to reduce waste in health research including waste from incomplete or unusable reports. One suggestion of the authors is that a better understanding of initiatives as the EQUATOR network and the active use of reporting guidelines supported by that initiative (i.e. CONSORT, PRISMA, STROBE) could improve this situation (Al-Shahi Salman et al. 2014; Chalmers and Glasziou 2009; Chan et al. 2014; Glasziou et al. 2014; Ioannidis et al. 2014). Also, the literature has been suggesting that authors and reviewers should improve the quality of research reporting with training in topics such as reporting guidelines, publication ethics, and research integrity (Glasziou et al. 2014; Moher and Altman 2015).

The present study evaluated the profile of dental journals and how dental journals use reporting guidelines through the actions taken by journals related to the use of the following guidelines: Consolidated Standards of Reporting Trials (CONSORT) (Schulz et al. 2010), Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al. 2009) and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (von Elm et al. 2007) statements. Also, verified the information/recommendations about the use of

reporting guidelines by journals from the journals' websites and compared with the answers of editors.

Materials and Methods

In this cross sectional study all editors-in-chief of dental journals i.e. journals on Dentistry, Oral Surgery & Medicine registered on the 2013 Journal Citation Reports (JCR) list (n=81) were invited to participate. E-mail addresses of the editors-in-chief were obtained from the journals' websites or from recent publications of editors. Data were collected through a self-reported web-based questionnaire developed using Google forms (Google Inc.) between June and September 2015. The following information were obtained from the questionnaire: impact factor and content area of the journal, membership of Committee on Publication Ethics (COPE) or any editorial group, familiarity with the EQUATOR Network, employment as a full-time editor of the journal, time spent as editor, editor income/payment for the position, education training for the position, information about the endorsement and implementation of CONSORT (Schulz et al. 2010), PRISMA (Moher et al. 2009) and STROBE (von Elm et al. 2007) and adherence of other reporting guidelines.

First, the questionnaire was piloted with 3 editors of dental journals that were not included in JCR 2013. The data collected did not allow any information to be included that could identify the editor or the journal. The questionnaire was sent individually by e-mail for each editor. If the editor did not return the questionnaire after 3 weeks, a reminder was sent. After four attempts, if the editor did not return, his/her participation was eliminated. All respondents have read the terms of study and agreed to participate (Local research and ethics committee approval #44345815.0.0000.5317).

Information/recommendations about the use of reporting guidelines by journals and impact factor of journal were also collected directly from the journals' websites by one member of the research team. Data were descriptively analyzed and frequencies were summarized using Excel program (Microsoft Office).

Results

Of the 81 editors invited to participate in the study, 34 (42%) completed the questionnaire. Results about profile of dental journals are presented in Table 1. The median of impact factor of respondent journals was 1.4 (IQR=1.076-2.025). The most prevalent content subarea papers published in the journals was orthodontics (n=11; 32.4%). Most journals are members of Committee on Publication Ethics (n=22;

64.7%) but not familiar with EQUATOR Network (n=19; 55.9%). Considering the editorial teams, 26.5% are not members of any editorial team whereas 20.6% following the International Committee of Medical Journal Editors (ICMJE) recommendations. Most editors do not work full time (85.3%) and the majority of editors (n=30; 88.2%) receive any income/payment to carry out their functions as an editor-in-chief. Furthermore, more than a half received some sort of educational training for this position (n=19; 55.9%).

Results about the use of reporting guidelines by journals are summarized in Table 2. The majority of journals (n=25; 73.5%) recommend peer reviewers to use reporting guidelines as part of their review assessment. The CONSORT Statement was endorsed by 61.8% (n=21) of journals. Of these 21 journals, 66.7% (n=14) answered that authors are required to follow the CONSORT recommendations and checklist in the instructions to authors, and 57.1% (n=12) require authors to submit completed checklist, which is reviewed by the editorial team. More than half of the journals (n=18; 52.9%) endorsed PRISMA Statement. Of these 18 journals, 66.7% (n=12) answered that authors are required to follow the PRISMA recommendations and checklist in the instructions to authors, and 61.1% (n=11) requiring the submission of the completed checklist with editorial team review. Most journals (70.6%) do not endorse the STROBE Statement.

Figure 1 summarizes the results of information/recommendations about the use of reporting guidelines by the journals collected from their websites. Thirty-six journals (44.4%) did not recommend use of any reporting guideline; these journals were classified with the lowest impact factors in Dentistry (n=21; 58.3%). Forty-two journals (51.9%) mention the CONSORT Statement in their website and 23 (28.4%) journals only recommended the use of CONSORT Statement. Five journals mentioned the EQUATOR Network library of reporting guidelines including the Journal of Dental Research that currently has the highest impact factor in dentistry (IF= 4.139).

The results indicate that the majority of journals are not familiar with EQUATOR Network (55.9%), this information corroborates the information collected from journal websites; only 5 journals mentioning this initiative. In both the survey and the websites, the CONSORT Statement was the most endorsed initiative.

Discussion

Reporting guidelines aims to improve the completeness, quality and transparency of research with specific guidance for a broad range of study designs and types of data. Use of reporting guidelines has been associated with improvements in the completeness of reporting. As such, reporting guidelines might be an effective tool to help reduce waste and increase the value of research (Glasziou et al. 2014; Turner et al. 2012a; Turner et al. 2012b). This is the first survey and evaluation of instructions to authors developed in dental research to evaluate the profile of dental journals and actions taken by these journals related to reporting guidelines.

It is encouraging that from the present results, most of dental journals endorsed or mention in their instructions to authors the CONSORT Statement (Schulz et al. 2010) since in a recent survey evaluating the high impact factor medical journals, 63% of journals refer to CONSORT Statement in the instructions to authors (Shamseer et al. 2016). Some dental journals (44.4%), however, do not refer/endorsed any reporting guideline confirming that reporting guidelines remain much less used/endorsed to than they should be.

A better understanding of profile of editors and journals is important since they have a key role to ensure that articles published are as transparent as possible and with completeness of details (World Medical 2013). Editorial teams, ethics committee and initiatives as EQUATOR Network are also critical to help editors and journals to guarantee the transparency of article journals. However, in dentistry, there are a huge number of journals that are not members of any editorial team or member of the Committee on Publication Ethics, and are still not familiar with the EQUATOR Network. These initiatives can provide resources with important information about ethics, publications and journalology for editors since many dental and medical editors are untrained and uncertified.

A recent article discusses proposals helping to improve reporting the medical research literature (Moher and Altman 2015) and one highlighted topic is the importance to develop core competences especially through training for editors and peer reviewers. Our results suggest that in dentistry many editors (44.1%) have not received any educational training for the position of editor and still 26.5% of dental journals do not recommend peer reviewers to use reporting guidelines as part of their review.

Hirst and Altman (2012) evaluated the use of reporting guidelines for peer-reviewers of submitted manuscripts of 116 health research journals and their findings demonstrated low percentage of journals mentioning reporting guidelines in instructions to peer-reviewers whereas our results demonstrated the majority of dental journals (73.5%) recommend peer reviewers to use reporting guidelines as part of their review assessment. One possible reason of this increase could be a series of papers published after 2012 recommending and encouraging journals to use reporting guidelines during peer review process (Glasziou et al. 2014). Also, most of respondents are members of some editorial team that could recommend this use of reporting guidelines. However, there are few studies evaluating this topic as the randomized trial by (Cobo et al. 2011) in which the authors found that manuscripts reviewed using reporting guidelines presented better quality than articles reviewed without reporting guidelines. Examples as BMC Oral Health journal that peer reviewers are asked to refer to checklists when evaluating such studies should be encouraged in oral health research community. Also, a more active training of peer reviewers on how to use guidelines and checklists would improve the oral health science directly and indirectly.

One important topic evaluated in the present study is the endorsement and implementation of reporting guidelines by journals. The results of our study show that by far the CONSORT Statement is the initiative most endorsed and most extensively evaluated, which was also pointed out for medical journals (Turner et al. 2012a; Turner et al. 2012b). Results of this survey showed that the PRISMA Statement is endorsed by 52.9% journals. However, with the increased number of systematic reviews published in the last few years more journals should endorse PRISMA statement (Moher et al. 2009) for the same reasons as cited above considering the CONSORT Statement. In contrast, two important findings are worrying: 1) other initiatives are far less endorsed than CONSORT, and only 22.2% of dental journals referred 2 or more initiatives in their instructions to authors and 2) 44.4% of journals do not refer any initiative in the instructions to authors at all.

Findings of a recent systematic review (Turner et al. 2012a; Turner et al. 2012b) are clearly showing the positive impact of the endorsement of reporting guidelines in the completeness of reporting of studies. Yet, it seems to be apparent that this process of endorsement is a passive process with journals merely recommending adherence to key guidelines by submitting a completed checklist.

Recent article proposed actions and potential benefits for supporting adherence to PRISMA-P (Preferred Reporting Items For Systematic Review and Meta-Analysis Protocols) by stakeholders including journal editors and one of the actions is *encourage compliance to PRISMA-P for authors submitting protocols for publication* and *offer PRISMA-P as a template to assist in protocol writing for publication* (Moher et al. 2015).

Results of our survey showed that in the great majority of journals that endorse the CONSORT and PRISMA Statements, authors are required to follow recommendations and checklist in the manuscript guidelines of the journal and submit the completed checklist, which will be reviewed by the editorial team. In contrast, in many journals authors are asked to use the checklist, but no action is taken if it is not used. The American Journal of Orthodontics and Dentofacial Orthopedics, to help authors understand and apply the standards, has prepared a separate document about the CONSORT and PRISMA Statements. Also, (Pandis et al. 2014) showed the benefits of a recent active implementation of reporting guidelines in this journal, where the submission process and the editorial team are actively using the CONSORT statement to guide the RCT manuscript authors from initial submission thought the whole process (preview to peer review process). The results demonstrated a significant improvement in reporting of RCTs after the assessment. This approach should be encouraged and extended to other journals.

One limitation of our survey is that, despite of the four attempts in having the editor's reaction to, we had a relatively low response rate (42%). Still, this response rate is in accordance with a previous survey that evaluated the CONSORT endorsement by high impact factor medical journals with a 39% response rate (Hopewell et al. 2008). Another limitation is that only 7 journals with impact factor higher than 2.0 answered the survey.

Final remarks

Results of this study provide evidence that reporting guidelines are used less than ideal in dentistry and as consequence the quality of reporting oral health research remains suboptimal. Some suggestions are presented to improve these problems:

- Editors should be trained for the position;

- Authors should be trained to making research articles fit for purpose and to use reporting guidelines;
- A active implementation of reporting guidelines by journals is encouraged;
- Journals should recommend peer reviewers to use reporting guidelines as part of their review as well as peer reviewers should be trained for their use;
- Journalology should be integrated into training curriculum of universities.

Conclusions

In conclusion, the use of reporting guidelines has an important role in the development of oral health research but their use are suboptimal. Thus, without a broad understandment of the edorsement/adherence/implementation of reporting guidelines it is difficult to achieve the benefits for which that guidelines were developed.

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Table 1: Profile of dental journals (n = 34)

1 - What is the impact factor (IF 2013) of your journal?	
Median (IQR[#])= 1.4 (1.076-2.025)	
2 - In what content area(s) does the journal publish?*	**n (%)**
Orthodontics	11 (32.4)
Oral Biology	4 (11.8)
Endodontics	3 (8.8)
Oral Surgery	3 (8.8)
Cariology	5 (14.7)
Oral Implantology	5 (14.7)
Public Health	7 (20.6)
Dental Materials	5 (14.7)
Education	2 (5.9)
Pediatric Dentistry	4 (11.8)
Oral Pathology	4 (11.8)
Periodontology	2 (5.9)
Restorative Dentistry	3 (8.8)
All areas of Dentistry	5 (14.7)
Others	8 (23.5)
3 - Is the journal a member of the Committee on Publication Ethics?	
Yes	22 (64.7)
No	12 (35.3)
4 - Are you familiar with the EQUATOR Network?	
Yes	15 (44.1)
No	19 (55.9)
5 - Is the journal a member of any editorial group?	
WAME - World Association of Medical Editors	1 (3)
ICMJE - International Committee of Medical Journal Editors[$]	7 (20.6)
CSE - Council of Science Editors	3 (8.8)
EASE - European Association of Science Editors	1 (2.9)
Others editorials teams	6 (17.6)
British Dental Editors Forum	1
Dental Editors	1
ABEC (Associação Brasileira de Editores Científicos)	1
Korean association of medical journal editors	1
Other	2
None	9 (26.5)
Other responses	7(20.6)

6 - Are you employed as a full-time editor by this journal?	
Yes	5 (14.7)
No	29 (85.3)
7 - How long have you been an editor in any capacity, full or part time?	
Mean = 100.6 months	
8 - Do you receive any income/payment as editor?	
Yes	30 (88.2)
No	4 (11.8)
9 - Have you received any educational training for the position of editor?	
Yes	19 (55.9)
No	15 (44.1)
10 - What type of training have you received?	
Short course (one < week) offered by commercial group	8 (42.1)
Online resources, such as PKP - Public Knowledge Project (https://pkp.sfu.ca/)	2 (10.5)
Others	9 (47.4)

[#] IQR: Interquartile Range
[$] Journals following the ICMJE Recommendations
*Authors could check all responses that apply

Table 2: Use and actions taken by journals related to the use reporting guidelines

11 - Does the journal recommend peer reviewers to use reporting guidelines as part of their review?	**n (%)**
Yes	25 (73.5)
No	9 (26.5)
12 - Has your journal endorsed the Consolidated Standards of Reporting Trials (CONSORT) Statement?	
Yes	21 (61.8)
No	13 (38.2)
13 - In what year was the CONSORT Statement endorsed by your journal?	
2001	1 (4.8)
2003	1 (4.8)
2005	2 (9.5)
2008	2 (9.5)
2009	1 (4.8)
2010	1 (4.8)
2011	1 (4.8)
2012	2 (9.5)
Don't know	10 (47.6)
Consolidated Standards of Reporting Trials (CONSORT) Statement	
14 - What actions are taken by the journal related to the CONSORT checklist?*	
Authors are required to follow the CONSORT recommendations and checklist in the manuscript guidelines of the journal.	14 (66.7)
Authors must submit the completed checklist and the editorial team reviews it.	12 (57.1)
Authors must submit the completed checklist, but the editorial team does not review it.	0(0)
Authors are asked to use the checklist, but no action is taken if it is not used.	7(33.3)
Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement	
15 - Has your journal endorsed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement?	
Yes	18 (52.9)
No	16 (47.1)

16 - In what year was the PRISMA Statement endorsed by your journal?

2009	3 (16.7)
2010	3 (16.7)
2012	1 (5.6)
2013	3 (16.7)
2014	2 (11.1)
Don't know	6 (33.3)

17 - What actions are taken by the journal related to the PRISMA checklist (you may select as many as you want)?*

Authors are required to follow the PRISMA recommendations and checklist in the manuscript guidelines of the journal.	12 (66.7)
Authors must submit the completed checklist and the editorial team reviews it.	11 (61.1)
Authors must submit the completed checklist, but the editorial team does not review it.	0 (0)
Authors are asked to use the checklist, but no action is taken if it's not used.	5 (27.8)

Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement

18 - Has your journal endorsed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement?*

Yes	10 (29.6)
No	24 (70.6)

19 - In what year was the STROBE Statement endorsed by your journal?

2010	2 (20)
2012	1 (10)
2013	2 (20)
2014	1 (10)
Don't know	4 (40)

20 - What actions are taken by the journal related to the STROBE checklist (you may select as many as you want)?*

Authors are required to follow the STROBE recommendations and checklist in the manuscript guidelines of the journal.	4 (40)
Authors should submit the completed checklist but the editorial team does not review it.	0 (0)
Authors must submit the completed checklist, but the editorial team does not review it.	3 (30)
Authors are asked to use the checklist, but no action is taken if it's not used.	6 (60)

Guidelines and initiatives		
21 - Has your journal endorsed the use of others guidelines or initiatives? Which ones (you may select as many as you want)?*		
CaRe (Case Report)		3 (8.82)
SAMPL (Statistical Analyses and Methods in the Published Literature)		3 (8.82)
STARD (Standards for Reporting of Diagnostic Accuracy)		3 (8.82)
COREQ (Consolidated Criteria for Reporting Qualitative Research)		4 (11.76)
Others	ARRIVE (Animal Research: Reporting In Vivo Experiments)	1 (2.94)
	sedentexCT.eu	2 (5.88)
None		13 (38.23)
Other responses		7 (20.58)

*Authors could check all responses that apply

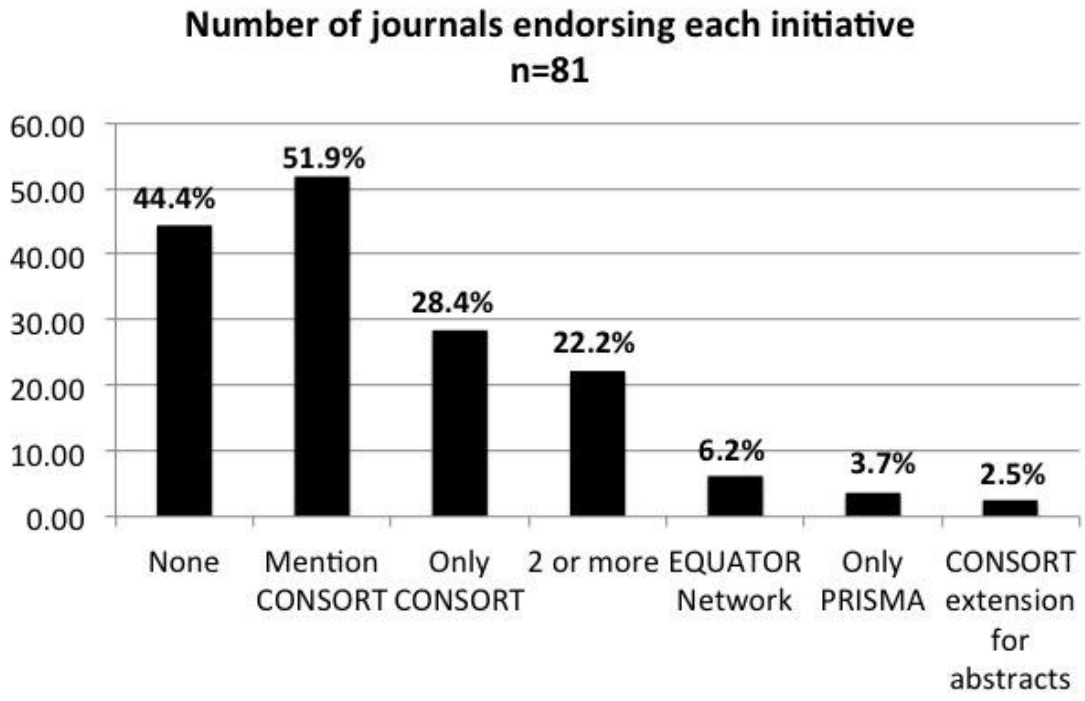

Figure 1: Number of journals endorsing each initiative

8. Discussão Geral e Recomendações

Vários fatores relacionados à reabilitação de dentes tratados endodonticamente (DTE) vem sendo discutidos na literatura através de estudos de revisão, estudos clínicos e principalmente, laboratoriais. Além disso, maneiras de como melhor organizar e reportar essas informações também são alvo de discussões. Alguns fatores relacionados à restauração de DTE foram abordados nessa tese como os fatores estruturais, os endodônticos, os relacionados ao uso de pinos intrarradiculares e coroas unitárias e aqueles que influenciam as escolhas de técnicas e materiais pelos profissionais para reabilitação desses dentes. Neste contexto, foi discutido o uso de guias de reporte como forma de melhorar a plenitude e a organização das informações publicadas na área de odontologia. Assim, devido à amplitude do tema alguns aspectos foram discutidos nesse capítulo para melhor reportar a evidência gerada.

Atualmente, encontra-se no mercado um grande número de pinos intrarradiculares, materiais para cimentação e materiais para a reconstrução coronária para a reabilitação de DTE. No **capítulo 1** dessa tese, nós avaliamos se fatores pré-determinados poderiam influenciar as escolhas de materiais por cirurgiões-dentistas para reabilitação destes dentes. Nesse estudo, houve predileção por núcleos metálicos fundidos e pinos de fibra de vidro associados ao uso de cimento resinoso. O nível de especialização do profissional influenciou nesta escolha. Esses achados estão de acordo com estudos prévios (MORGANO et al., 1994, NAUMANN et al., 2016) que demonstraram a influência de diversos fatores como idade e local de trabalho na escolha de materiais e técnicas para restaurar DTE, além da preferência por pinos pré-fabricados. Esse tipo de estudo é importante, pois associado à interpretação científica é considerado o método mais direto e rápido para implementação dos resultados na prática clínica dos cirurgiões-dentistas (GILBERT et al., 2011).

Nos **capítulos 2 e 3** dessa tese, foram discutidos através de uma revisão narrativa e de uma revisão sistemática alguns fatores que podem influenciar a longevidade de restaurações de DTE com o uso de pinos intrarradiculares e coroas unitárias. A partir de ambos os trabalhos pode-se constatatr que a preservação de estrutura dentária coronária é um dos principais fatores que influenciam a longevidade de dentes restaurados com o uso de pinos intrarradiculares. Em relação

às técnicas e materiais, o uso de técnicas endodônticas que não causem problemas estruturais aos dentes parece ser a melhor opção para preparação do canal especialmente em dentes que vão receber pinos intrarradiculares. Em relação a pinos intrarradiculares, os achados mostram que em dentes com remanescente coronário (1 a 4 paredes) ou dentes com férula, tanto pinos metálicos como não metálicos parecem estar indicados em associação à coroas unitárias. Já em dentes sem remanescente coronário e sem férula, os pinos metálicos parecem estar mais indicados. No entanto, os estudos que compararam o uso desses pinos em dentes sem férula necessitam mais tempo de acompanhamento e essa questão de pesquisa foi abordada no **capítulo 4**. Vale ressaltar que embora o **capítulo 2** seja uma revisão narrativa de literatura, os artigos incluídos são em sua maioria ensaios clínicos randomizados e revisões sistemáticas da literatura que atualmente são consideradas os estudos com maior nível de evidência.

No **capítulo 4**, nós avaliamos através de um ensaio clínico randomizado e controlado a longevidade de DTE sem férula restaurados com núcleo metálico fundido ou pino de fibra de vidro associados ao uso de coroas metalo-cerâmicas. Alguns aspectos desse estudo merecem destaque: 1) é o ensaio clínico com essa temática com maior tempo de acompanhamento na literatura, 2) ambos os pinos apresentaram bom desempenho clínico e no geral baixa taxa anual de falha e 3) ensaio clínico randomizado é considerados o desenho de estudo ideal para se comparar intervenções e apresenta alto grau de evidência. No entanto, ainda é necessário maior tempo de acompanhamento clínico dessas restaurações para que se possa afirmar que não há diferenças entre os retentores.

Importante salientar que as evidências científicas e conclusões acima discutidas se tornam inutilizáveis se não forem reportadas de maneira correta e com plenitude de informações (GLASZIOU et al., 2014). No **capítulo 3** dessa tese foi desenvolvida uma revisão sistemática da literatura e seu reporte foi baseado nas recomendações do *Preferred Reporting Items for Systematic Reviews* (PRISMA). Já no **capítulo 4**, foi desenvolvido um ensaio clínico randomizado e seu reporte foi baseado nas recomendações do *Consolidated Standards of Reporting Trial* (CONSORT). Ambas as iniciativas são consideradas guias para reporte de pesquisas e assim como outras iniciativas similares, o seu uso vem sendo amplamente discutido na literatura biomédica. Os **capítulos 5 e 6** trazem importantes informações sobre o uso desses guias na área de odontologia e trazem

informações que se completam. O **capítulo 5** visou apresentar os principais guias utilizados para reporte de pesquisa como forma de incentivar o uso na área de odontologia. Esse capítulo se torna fundamental visto que o **capítulo 6** mostrou que a maioria dos editores de revistas da área de odontologia não conhece a iniciativa EQUATOR Network e 44,4% dos jornais avaliados ainda não recomendam o uso de nenhum guia nas suas instruções aos autores. No entanto, é encorajador que a maiorias das revistas citem o CONSORT nas suas instruções. Assim, o uso de guias de reporte de pesquisas deve ser encorajado por editores, revisores, pesquisadores e todas as partes envolvidas na pesquisa odontológica.

9 Conclusões Gerais

Núcleos metálicos fundidos, pinos de fibra de vidro e cimento resinoso são materiais de escolha para a reabilitação de dentes tratados endodonticamente. A manutenção do remanescente coronário é um dos fatores mais importantes para a longevidade destas restaurações sendo pinos metálicos e não metálicos indicados quando há estrutura coronária remanescente. Quando não há remanescente, embora o uso de pinos metálicos esteja indicado, ainda são necessários ensaios controlados e randomizados com maior tempo de acompanhamento para gerar alto grau de evidência. Em relação ao uso dos guias de reporte, seu uso em odontologia deve ser mais incentivado para o desenvolvimento da odontologia baseada em alto grau de evidência.

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Apêndices

Apêndice A – Nota da Tese

Nota da Tese

Dentes tratados endodonticamente e o uso de guias de reporte.

Endodontically treated teed and the use of reporting guidelines.

Alguns dentes após a realização do tratamento endodôntico apresentam uma destruição da sua porção coronária necessitando a colocação de um pino intra-canal para aumentar a retenção do material restaurador coronário. Esse tema é amplamente discutido na literatura científica odontológica, embora a forma como os pesquisadores descrevem esses estudos ainda apresente uma qualidade abaixo do ideal. Essa tese discutiu a influência de alguns fatores na reabilitação de dentes que apresentam destruição da porção coronária além de discutir o uso de guias que podem melhorar a forma como as pesquisas vêm sendo descritas. Foi demonstrado que o nível de especialização dos dentistas pode influenciar na escolha de materiais para a reabilitação desses dentes. Além disso, a preservação da estrutura dentária coronária é um dos fatores mais importantes para obter-se uma boa longevidade clínica dessas restaurações. Quando os dentes ainda apresentam estrutura remanescente tanto pinos metálicos quando não metálicos estão indicados; já em situações de destruição extrema os pinos metálicos parecem estar mais indicados. Quanto ao uso de guias para melhorar a forma como as pesquisas vêm sendo descritas, constatou-se que eles ainda são poucos usados e que merecem uma maior atenção por todas as partes envolvidas na pesquisa odontológica.

Campo da pesquisa: Clínica Odontológica

Candidato: Rafael Sarkis Onofre, Cirurgião-dentista (2010) e Mestre em Odontologia (Dentística) (2012) pela Universidade Federal de Pelotas (2012).

Data da defesa e horário: 19/04/2016 às 8h30min

Local: Auditório do Programa de Pós-graduação em Odontologia da Universidade Federal de Pelotas. 5º andar da Faculdade de Odontologia de Pelotas. Rua Gonçalves Chaves, 457.

Membros da banca: Prof. Dr. Álvaro Della Bona, Prof. Dr. Luiz Felipe Valandro, Prof. Dr. Rafael Ratto de Moraes, Prof. Dr. Marcos Britto Correa, Prof. Dr. Fábio Garcia Lima (Suplente) e Prof. Dr. Mateus Bertolini Fernandes dos Santos (Suplente).

Orientadora: Profa. Dra. Tatiana Pereira Cenci

Co-orientador: Prof. Dr. Maximiliano Sérgio Cenci

Informação de contato: Rafael Sarkis Onofre, rafaelonofre@gmail.com, Rua Gonçalves Chaves, 457- Programa de Pós Graduação em Odontologia.

Apêndice B – Súmula do currículo do candidato

Súmula do currículo

Rafael Sarkis Onofre nasceu em 16 de dezembro de 1986, em Pelotas, Rio Grande do Sul. Completou o ensino fundamental e médio em Escola privada na mesma cidade. Possui graduação em Odontologia pela Universidade Federal de Pelotas (2010). Realizou mestrado (2012) em Odontologia (Dentística) no Programa de Pós-graduação em Odontologia da Universidade Federal de Pelotas onde atualmente realiza doutorado com orientação da Profa. Dra. Tatiana Pereira Cenci. Realizou estágio de doutorado sanduíche (PDSE - Capes) no *Centre for Practice-Changing Research*, Ottawa Hospital Research Institute (Canadá) com orientação do Professor Dr. David Moher (2014). Desenvolve pesquisas relacionadas à longevidade de restaurações de dentes tratados endodonticamente e fatores associados. Apresenta experiência em odontologia baseada em evidência, tendo foco em ensaios clínicos, revisões sistemáticas e jornalogia (tradução livre do termo em inglês, *journalology*). Realizou pesquisas durante o período de graduação na área de biologia molecular.

Publicações:

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