JO JOURNAL OF OSSEOINTEGRATION periodontics and prosthodontics

Role of occlusion on fiber post restored teeth rehabilitation: a systematic review

M. PECCIARINI, A. BIAGIONI, N. DISCEPOLI, M. FERRARI

Department of Medical Biotechnologies, Division of Fixed Prosthodontics, University of Siena, Siena, Italy

TO CITE THIS ARTICLE
Pecciarini M, Biagioni A, Discepoli N, Ferrari M. Role of occlusion on fiber post restored teeth rehabilitation: a systematic review. J Osseointegr 2020.

DOI 10.23805 /JO.2020.12.01.02

KEYWORDS Endodontically treated teeth; Fiber post; Occlusion.

ABSTRACT

Aim The restoration of root filled teeth is a challenge in dentistry. Many studies have assessed the role of the number of remaining walls, the influence of tooth location, post type, post cementation strategy and the type of final restoration. The aim of this review was to evaluate how many Randomized Clinical Trials (RCTs) take into account the role of occlusion in endodontically treated teeth (ETT) rehabilitation.
Materials and methods RCTs for ETT restored with fiber post were searched for in Medline/PubMed and Cochrane Library. No time limitation was applied. Only papers written in English were considered.
Results Of 43 full-text papers no one evaluated the topic of interest.
Conclusions In the existing literature nothing could be found related to RCTs evaluating the role of occlusion on ETT with fiber posts rehabilitation.

INTRODUCTION

The restoration of endodontically treated teeth (ETT) has long been a challenge in dentistry. The rate of complications of fixed prosthetic restorations on root filled abutment teeth has been reported with a higher incidence (1). Caries, trauma, previously existing restorations or access methods for the root canals treatment may produce great coronal and radicular tissue loss, thus making it often difficult to achieve a sufficient anchorage of restoration in the remaining dentinal tissue (2); in such situation intra-radicular posts are recommended to retain the definitive crown restoration (3).
Cast post and cores have been widely used in the past, but some disadvantages such as loss of retention, necessity of removal of large amount of tooth structure, and root fracture (due to the high modulus of elasticity of metal post) (4-6) led to their replacement by fiber post. The use of fiber-reinforced composite posts for restoring ETT became popular in the late 90's and nowadays, thanks to their good physical properties and biocompatibility, they are probably the most clinically used type (7-9). Nevertheless, root-filled teeth undergo biomechanical changes following loss of pulp vitality and endodontic therapy (10). Several factors may affect the clinical performance of fiber post-restored teeth, and those factors should be taken into account in decision-making; there seems to be a strong correlation between the preservation of tooth tissue (the number of the remaining walls or the amount of coronal residual structure), the presence of the ferrule effect and long-term success rate of ETT (7,10-12). Furthermore, prognosis is influenced by the type of post, tooth position in the dental arches, number of interproximal contacts and type of the final prosthesis (13). When a post is required, the use of dowels with an elastic modulus closer to that of dentine (18 GPa), such as fiber posts (25-57 GPa), results in a better stress distribution that protect sthe tooth against catastrophic root fracture (7, 9, 14, 15-17). The survival rate seems to be higher for teeth with interproximal contacts thanks to a better stress relief and support by neighboring teeth (13, 18, 19).
Regarding the type of tooth, the need for a post varies greatly between the anterior and posterior teeth (20). Anterior teeth and premolars are more prone to non-

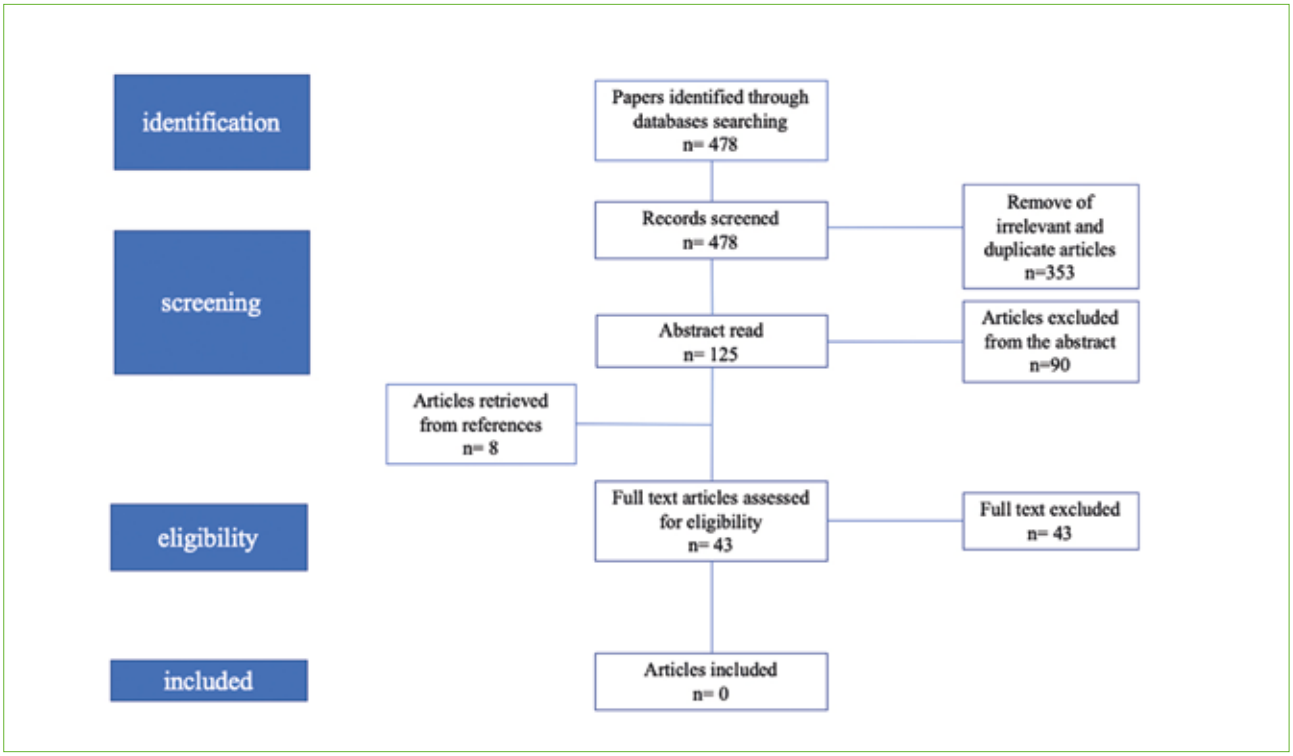

FIG 1 Flow diagram of paper selection.

axial loading compared with molars during function or parafunction so they more often require a post-retained restoration. The survival rate of different tooth types remains still controversial; in a clinical study conducted by Piovesan, no difference was identified between anterior and posterior teeth (21). Conversely, two studies reported that anterior teeth have a higher risk of failure (13, 22), while a prospective study by Glazer, stated that premolars reported failures more frequently than anterior teeth (that study is in agreement with other studies) (23-25).

As for the type of final restoration, Naumann's clinical study showed that the type of final restoration is an important determinant of failure in fiber post-retained restorations (13); however, a recent review reported that a univocal correlation between failure rates of fiber post-restored teeth and the type of prosthetic restoration (single crown or fixed dental prosthesis) can not be found (26). Another prospective clinical study reported a direct correlation between the degree of hard tissue loss and survival of single crowns and fixed dental prosthesis, and it pointed out that less predictable clinical outcomes could be expected when teeth with an insufficient coronal structure are restored with either FDPs or SCs (27).

A very important aspect is the functional role of restored endodontic treated teeth in the occlusion. In the case of compromised root filled tooth and parafunctions, not only can post placement be planned, but a suitable design of the occlusal surface should also be performed (28).

In recent years, some retrospective in vivo studies were performed analysing the survival of different post systems (29-31). These studies evaluated the effect of various clinical aspects, such as occlusal contacts, on the prognosis (32). However, analysis of retrospective data implies a systematic bias, as there are no standardized baseline conditions.

The aim of this review is to highlight prospective RCTs on fiber post-restored teeth that take into account the role of occlusion on the success and survival rates under clinical service.

MATERIALS AND METHODS

An electronic search was conducted through Medline/PubMed and Cochrane Library databases to collect all prospective RCTs on the use of fiber posts for the restoration of ETT till 2019 (no limit regarding the year of publication). Only articles written in English were considered.

The strategy of the search included the use of different key terms: "fiber post" OR "fiber posts" OR "fiber-reinforced post" OR "fiber-reinforced posts" AND "root filled teeth" OR "root-filled tooth" OR "endodontically treated teeth" OR "endodontically treated tooth" OR "fiber post restored teeth" AND "occlusion" AND "restoration".

	Mean observational period	No. of teeth	Post brand name and manufacturer	Type of post	Tooth type	Information
Sterzenbach et al. 1	84 mo	91	-Fiberpoints Root Pins Titanium (Schütz Dental Group) -Fiberpoints Root Pins Glass (Schütz Dental Group)	Prefabricated titanium post vs Glass fiber–reinforced epoxy resin post	All teeth	Tooth guidance
Cloet et al. 3	60 mo	205	- Parapost FibreLux (Coltène) - Ever Stick (StickTech) vs No post	- Prefabricated glass fiber post - castumized glass fiber post	All teeth	Antagonist contact
Ferrari et al. 11	24 mo	120	DT Light Post (RTD) vs no post	Quartz fiber post	Premolars	Antagonist contact (natural teeth)
Naumann et al. 13	39 mo	149	-DentinPost -FibreKor (Jeneric Pentron) -Luscent Anchor (Dentatus)	Glass fiber post	All teeth	- Antagonist contact (periodontal supported or other) - Functional status
Mancebo et al. 20	36 mo	87	Snowpost	Zircon-rich glass fiber–reinforced epoxy resin post	All teeth	Antagonist contact (natural teeth)
Piovesan et al. 21	97 mo	109	Ribbond (Ribbond)	Polyethylene Fiber Post	All teeth	Normal occlusion
Gbadebo et al. 35	6 mo	40	-NS -ParaPost system SS (Coltene)	-glass fiber-reinforced post - metallic stainless steel post	All teeth	Antagonist contact (natural teeth)
Naumann et al. 36	24 mo	105	-FibreKor -Luscent Anchors	Glass fiber post	All teeth	-Antagonist contact (periodontal supported or other) - Functional status
Naumann et al. 37	120 mo	149	-DentinPost -FibreKor -Luscent Anchors	Glass fiber post	All teeth	-Antagonist contact (periodontal supported or other) - Functional status
Cagidiaco et al. 38	36 mo	120	DT Light Post vs Ever Stick vs no post	-Quartz fiber post -customized fiber post	Premolars	Antagonist contact (natural teeth)
Juloski et al. 39	48 mo	120	GC Fiber Post (GC Corp.)	Fiber post	Premolars	Antagonist contact (natural teeth)
Mannocci et al. 40	36 mo	117	Composipost (RTD)	Carbon fiber post	Premolars	Antagonist contact
Mannocci et al. 41	60 mo	219	Composipost vs amalgam rest.	Carbon fiber post	Premolars	- Antagonist contact - Orthodontic Class 1 occlusal scheme
Malferrari et al. 42	30 mo	180	Aestheti-Plus (RTD)	Quartz fiber post	All teeth	Antagonist contact (natural teeth, crown, denture, no antagonist)
Skupien e t al. 43	60 mo	57	White Post DC, FGM	Glass fiber post	All teeth	Bilateral occlusal posterior contacts
Ferrari et al. 44	36 mo	120	GC Fiber Post (GC Corp.)	Fiber post	Premolars Molars	-Antagonist contact (natural teeth) - interproximal contact with 2 adjacent natural teeth

TABLE 1 Sixteen of the excluded articles

This systematic review is structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), and the PICO method as applicable in relation to the topic of the review (33). The research question was formulated with reference to patient (adults), intervention (Randomized Clinical Trials on fiber post-restored teeth), outcome (role of occlusion).
Inclusion criteria were the following.
- *In vivo* study.
- Conducted in human adults.
- Direct assessment of the role of occlusion.
- Prospective design (Randomized Clinical Trials).
- Study on endodontically treated teeth restored with fiber post system.
- Well described clinical work steps.
- Clinical studies evaluating quantitative outcome measurements such as success, survival, failure and/or complications.

Exclusion criteria were the following.
- *In vitro* studies.
- Descriptive studies, retrospective studies, cross-sectional studies, case reports, case series, case-control studies, expert opinions, reviews.
- Articles not written in English.

The retrieved papers were analyzed based on a three-steps selection process that considered titles, abstracts and full texts. Firstly, a list of titles was obtained from database and titles that clearly did not refer to the inclusion criteria were excluded; the same was done about the abstracts. When it was not possible to make a decision based on title/abstract, the full article was obtained. At step 3 full-text papers were carefully read and all the study not fulfilling the inclusion criteria were not included in the review. The references of relevant papers were also checked to identify other potentially relevant articles.

RESULTS

The electronic databases searches identified 478 articles. After removal of irrelevant articles, 353 studies were left. From the remaining articles identified as relevant, the examination of titles and abstracts revealed that 78 were *in vitro* studies, 2 were finite element analyses, 3 were case reports, 5 were review papers, 1 was conducted on children, and 1 was not in English language. Eight studies were retrieved from the references of the selected articles. Finally, 43 clinical studies were carefully read, but no study fulfilled the inclusion criteria. Twenty-seven of the full-text papers read were excluded (retrospective study n. 8; review n. 2; not in English n. 1; did not evaluate the topic of interest n. 17). The remaining excluded articles (n=16) only mentioned the type of antagonist contact (such as natural tooth, porcelain crown etc.), or that the selected teeth had to be in occlusal function with the antagonist teeth, with no interest in the role of occlusion (1, 11, 13, 20, 21, 34-44) (Table 1, Fig. 1).
No *in vivo* RCT was found that directly assessed the role of occlusion for the rehabilitation of endodontically treated teeth.

DISCUSSION

The restoration of endodontically-treated teeth is usually a challenge, and posts are often needed to retain the coronal restoration when there is substantial tissue loss. From these findings, there are no data directly assessing the role of occlusion for the restoration of ETT. A recent study by Ferrari assessed the influence of the use of posts and the type of posterior tooth (premolars vs molars) for the treatment of partial crowns in lithium disilicate. They showed, in a 3-year observational period, that the clinical performance of ETT restored with lithium disilicate partial crowns was not significantly affected by the use of a fiber post and by the type of tooth (premolars or molars). They pointed out that premolars had a greater failure risk even though there were not statistically significant differences among the two groups; only two failures, in a total of 120 teeth, were observed on premolars with group lateral guidance. That is why it might be suggested the use of a fiber post on premolars in particular when these teeth are part of lateral group guidance of lateral movements. However, further RCTs are needed to understand how different anterior guides and other occlusal determinants could influence the prognosis and the therapeutic choice of ETT (44).
Restorative dentistry is concerned with the rehabilitation of the teeth. It is easy to consider a tooth as a single entity, but it must always be remembered that that tooth is only one component of a functioning unit (masticatory system) composed of the teeth and their supporting tissues, the temporomandibular joints (TMJs), and the neuromuscular system. The term "occlusion" defines the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues. However, this definition refers to a static relationship (static occlusion); during function the teeth move across one another and this relationship is called dynamic occlusion (45).
In most prosthetic therapies (relatively small amounts of restorative treatment, for example up to two or three units of crown or bridge work) the static position of the occlusion between the arches and the dynamic occlusal relationship should not be altered during treatment (46-48). Centric occlusion is the occlusion of opposing teeth when the mandible is in centric relation; this may or may not coincide with the maximal intercuspal position and often represent the position used (45). However, specific clinical conditions may require changes in

the static and dynamic occlusal relationships to achieve the aim of the therapy (46-48). Occlusal reorganisation may be considered when the patient's existing intercuspal position is considered unsatisfactory for any of the following reasons: repeated fracture/failure of teeth or restorations, bruxism, lack of interocclusal space for restorations, trauma from the occlusion, unacceptable function and the presence of temporo-mandibular diseases (46). Centric relation is the common reference position for a reconstructed occlusion, and it has been defined as "a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position" (45).

It is important that restorations are in functional harmony with the masticatory system to ensure a comfortable functioning system when a rehabilitation of endodontically treated teeth has to be planned. This interrelationship between the jaws is unique to each individual and involves the application of forces of varying magnitude and duration. Posselt reported that in only 10% of the population, is there a complete harmony between the teeth and the TMJ, whilst the majority of individuals exhibit some degree of occlusal interference to which they adapt satisfactorily with no significant problem (49). However, individual's ability to adapt to the presence of occlusal interferences is strongly influenced by their emotional and psychological state (50). This may lead to a lowering of the threshold to adapt, promoting the onset of parafunctional activity.

During normal functional activity (eating, speaking and at rest) the teeth only make contact for short periods, applying a relatively moderate force. The prolonged forceful nature of parafunctional activity leads to a significant increase in the load applied to the occluding teeth (parafunctional loads can be six times the normal chewing force) (51). Such increased loading may predispose root filled teeth to fracture or other types of failure such as post fractures, debonding or composite core fractures jeopardizing long-term ETT restoration survival rates (28). Given the increase in individuals and professional categories subject to intense psychophysical stress, it is likely that an increase in the prevalence of bruxism and temporomandibular disorders will be observed.

A recent paper indicates that bruxism is related to mechanical complications and that restorative treatment planning should consider the many risk factors, such as teeth with root canal treatments, that may be exaggerated by bruxism (52).

The lack of information about the occlusal pattern of the patients (i.e. parafunctions, canine guidance, group function) might adversely affect the lifespan of restored ETT.

Considering that many clinical trials showed a decrease of tooth fracture when fiber posts were used for restoration of ETT (53-55), it is likely that, when a fracture occurs, occlusion might be a key determinant. A correct management of the occlusion and how restoration may affect it should be considered in any treatment plan, but unfortunately this topic is very often underestimated in daily clinical practice (56). Any treatment plan to ETT should start with the analysis of existing occlusion to understand the functional role of the teeth in the occlusion.

CONCLUSIONS

Instead of finding out the reasons for the failure of our procedures, it would be better to take into account patient occlusion to avoid such failures.

In the existing literature nothing could be found related to RCTs evaluating the role of occlusion on ETT with fiber posts rehabilitation. Nothing could be found related to the type of occlusion and failure of root filled teeth.

Further RCTs are needed to clarify the role of some essential baseline factors regarding occlusion determinants (type of occlusion, canine or group guidance, horizontal and vertical overlap, absent/present teeth, and absent/present parafunction) in the therapeutic choice for ETT reconstruction in order to provide relevant clinical indications.

REFERENCES

1. Sterzenbach G, Franke A, Naumann M. Rigid versus flexible dentine-like endodontic posts. Clinical testing of a biomechanical concept, Seven years results of a randomized controlled clinical pilot trial on endodontically treated abutment teeth with severe hard tissue loss. J Endodontics 2012; 38(12): 1557–1563.
2. Heydecke G, Peters MC. The restoration of endodontically treated single-rooted teeth with cast or direct posts and cores: A systematic review. J Prosthet Dent 2002;87:380–386.
3. Kimmel SS. Restoration of endodontically treated tooth containing wide or flared canal. N Y State Dent J 2000;66(10):36-40
4. Borelli B, Sorrentino R, Zarone F, Ferrari M (2012) Effect of the length of glass fiber posts on the fracture resistance of restored maxillary central incisors. Am J Dent 25:79–83.
5. Ferrari M, Breschi L, Grandini S. Fiber Posts and Endodontically treated teeth: a compendium of scientific and clinical perspective. 1st ed. Modern Dental Media, Wendywood (South Africa); 2008. p. 149-161.
6. Salameh Z, Sorrentino R, Papacchini F, Ounsi HF, Tashkandi E, Goracci C, Ferrari M. Fracture resistance and failure patterns of endodontically treated mandibular molars restored using resin composite with or without translucent glass fiber posts. J Endodont 2006; 32:752–755.
7. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: A systematic review of the literature, part II (evaluation of fatigue behavior, interfaces, and in vivo studies). Quintessence Int 2008; 39(2):117-129.
8. Tay FR, Pashley DH. 2007. Monoblocks in root canals: A hypothetical or a tangible goal. J Endod. 33(4):391-398.
9. Goracci C, Ferrari M. Current perspectives on post systems: A literature review.

Aust Dent J 2011; 56 (Suppl 1):77-83.
10. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontical- ly treated teeth: A systematic review of the literature-Part I. Composition, micro and macro-structure alterations. Quintessence Int 2007; 38:733–743.
11. Ferrari M, Cagidiaco MC, Grandini S, et al. Post placement affects survival of endodontically treated premolars. J Dent Res 2007;86:729–34.
12. Ferrari M, Vichi A, Fadda GM, et al. A randomized controlled trial of endodontically treated and restored premolars. J Dent Res 2012;91:72S–8.
13. Naumann M, Blankenstein F, Kiessling S, Dietrich T. Risk factors for failure of glass fiber-reinforced composite post restorations: a prospective observational clinical study. Eur J Oral Sci 2005;113:519-524.
14. Cagidiaco MC, Goracci C, Garcia-Godoy F, Ferrari M. Clinical studies of fiber posts: a literature review. Int J Prosthodont 2008;21:328–336..
15. Figueiredo FE, Martins-Filho PR, Faria-E-Silva AL. Do met- al post-retained restorations result in more root fractures than fiber post-retained restorations? A systematic review and meta-analysis. J Endodont 2015; 41:309–316. doi:10.1016/j.joen.2014.10.006
16. Zicari F, Coutinho E, Scotti R, Van Meerbeek B, Naert I (2013) Mechanical properties and micro-morphology of fiber posts. Dent Mater 29:e45–e52
17. Ferrari M, Vichi A, Garcia-Godoy F. Clinical evaluation of fiber-reinforced epoxy resin posts and cast post and cores. Am J Dent 2000; 13:15B–18B.
18. Bru E, Forner L, Llena C, Almenar A. Fibre post behaviour prediction factors. A review of the literature. J Clin Exp Dent 2013; 5: e150–e153. doi:10.4317/jced.50619 .
19. Caplan DJ, Kolker J, Rivera EM, Walton RE. Relationship between number of proximal contacts and survival of root canal treated teeth. Int Endod J 2002; 35: 193--199.
20. Mancebo JC, Jimenez-Castellanos E, Canadas D. Effect of tooth type and ferrule on the survival of pulpless teeth restored with fiber posts: a 3-year clinical study. Am J Dent 2010;23:351–6.
21. Piovesan EM, Demarco FF, Cenci MS, Pereira-Cenci T. Survival rates of endodontically treated teeth restored with fiber-reinforced custom posts and cores: A 97-month study. 1mJ Prosthodont 2007;20:633-639.
22. Schmitter M, Rammelsberg P, Gabbert 0, Ohlmann B. Influence of clinical baseline findings on the survival of 2 post systems: A randomized clinical trial. Int J Prosthodont 2007;20: 173-178.
23. Glazer B. Restoration of endodontically treated teeth with carbon fibre posts. A prospective study. J Call Denr Assoc 2000;66:613-618.
24. Sorrentino R, Salameh Z, Zarone F, Tay FR, Ferrari M. Effect of post-retained composite restoration of MOD preparations on the fracture resistance of endodontically treated teeth. Jf Adhesive Dentistry 2007; 9, 49–56.
25. Heydecke G, Butz F, Strub JR. Fracture strength and survival rate of endodontically treated maxillary incisors with approximal cavities after restoration with different post and core systems: an in-vitro study. J Dentistry 2001; 29, 427-33.
26. Sorrentino R, Di Mauro MI, Ferrari M, Leone R, Zarone F. Complications of endodontically treated teeth restored with fiber posts and single crowns or fixed dental prostheses-a systematic review. Clin Oral Investig 2016; 20(7):1449-1457.
27. Ferrari M, Sorrentino R, Juloski J, Grandini S, Carrabba M, Discepoli N et al. Post-retained single crowns versus fixed dental prostheses: a 7-year prospective clinical study. J Dent Res 2017 Dec;96(13):1490-7.
28. Zarow M, Ramirez A, Paolone G et al. A new classification system for the restoration of root filled teeth. International Endodontic J 2018 March; 51(3): p. 318-334.
29. Ferrari M, Vichi A, Mannocci F, Mason PN. Retrospective study of the clinical performance of fiber posts. Am J Dent 2000;13:9B–13B.
30. Torbjorner A, Karlsson S, Odman PA. Survival rate and failure characteristics for two post designs. J Prosthet Dent 1995;73:439–444. 31. Weine FS, Wax AH, Wenckus CS. Retrospective study of tapered, smooth post systems in place for 10 years or more. J Endod 1991;17:293–297.
32. Iqbal MK, Johansson AA, Akeel RF, Bergenholtz A, Omar R. A retrospective analysis of factors associated with the periapical status of restored, endodontically treated teeth. Int J Prosthodont 2003;16:31–38.
33. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, Clarke M, Devereaux PJ, Kleijnen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clinical Epidemiol 2009; 62, e1–e34.
34. Cloet E, Debels E, Naert I. Controlled clinical trial on the outcome of glass fiber composite cores versus wrought posts and cast cores for the restoration of endodontically treated teeth: a 5-year follow-up study. Int J Prosthodont 2017;30(1):71-9.
35. Gbadebo OS, Ajayi DM, Oyekunle OO, Shaba PO. Randomized clinical study comparing metallic and glass fiber post in restoration of endodontically treated teeth. Indian J Dent Res 2014;25(1):58-63.
36. Naumann M, Blankenstein F, Dietrich T. Survival of glass fibre reinforced composite post restorations after 2 years—an observational clinical study. J Dentistry. 2005;33(4):305–312.
37. Naumann M, Koelpin M, Beuer F, Meyer-Lueckel H. 10-year survival evaluation for glass-fiber-supported postendodontic restoration: a prospective observational clinical study. J Endodontics. 2012;38(4):432–435.
38. Cagidiaco MC, García-Godoy F, Vichi A, Grandini S, Goracci C, Ferrari M. Placement of fiber prefabricated or custom made posts affects the 3-year survival of endodontically treated premolars. Am J Dent 2008;21(3):179-84.
39. Juloski J, Fadda GM, Monticelli F, Fajó-Pascual M, Goracci C, Ferrari M. Four-year survival of endodontically treated premolars. Restored with fiber posts. J Dent Res 2014; 93:52S–58S.
40. Mannocci F, Bertelli E, Sherriff M, Watson TF, Ford TRP. Three-year clinical comparison of survival of endodontically treated teeth restored with either full cast coverage or with direct composite restoration. Journal of Prosthetic Dentistry. 2002;88(3):297–301.
41. Mannocci F, Qualtrough AJ, Worthington HV, Watson TF, Pitt Ford TR. Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fiber posts and resin composite: Five-year results. Oper Dent 2005;30:9-15.
42. Malferrari S, Monaco C, Scotti R. Clinical evaluation of teeth restored with quartz fiber-reinforced epoxy resin posts. International Journal of Prosthodontics 2003;16(1):39–44.
43. Skupien JA, Cenci MS, Opdam N, Kreulen C, Huysmans MC, Pereira-Cenci T. Crown vs. Composite for post-retained restorations: an up to 5 years RCT. J Dentistry http://dx.doi.org/10.1016/j.jdent.2016.03.007
44. Ferrari M. et al. Posterior partial crowns out of lithium disilicate (LS2) with or without posts: A randomized controlled prospective clinical trial with a 3-year follow up. J Dentistry, https://doi.org/10.1016/j.jdent.2019.01.004.
45. The glossary of prosthodontic terms. 9th edition. J Prosthetic Dentistry 2017; 117:5S
46. Wassell RW, Steele JG, Welsh G. Considerations when planning occlusal rehabilitation: a review of the literature. International Dental Journal 1998; 48, 571–81.
47. Celenza FV. The theory and clinical management of centric positions: II. Centric relation and centric relation occlusion. Int J Perio Rest Dent 1984; 4, 62-66.
48. Celenza FV. The theory and management of centric positions: I .Centric occlusion. Int J Periodontics Restorative Dent 1984; 1:9-15.
49. Posselt U. Studies in the mobility of human mandible. Acta Odontol Scand 1952;10 (Suppl10):1-109.
50. Ramfjord SO, Ash MM. Occlusion. 2nd ed. Philadelphia: WB Saunders Co; 1971. p. 104.
51. Eliyas S, Jalili J, Martin N. Restoration of the root canal treated tooth. British Dental J 2015; 218, 53–62.
52. Manfredini D, Serra-Negra J, Carboncini F, Lobbezoo F. Current Concepts of Bruxism. Int J Prosthodontics 2017; 30(5): 437–438.
53. Creugers NH, Mentink AG, Fokkinga WA, Kreulen CM. 5-year follow-up of a prospective clinical study on various types of core restorations. Int J Prosthodont 2005;18:34-39.
54. Monticelli F, Grandini S, Goracci C, Ferrari M. Clinical behavior of translucent-fiber posts: a 2-year prospective study. Int J Prosthodont 2003;16:593-596.
55. Grandini S, Goracci C, Tay FR, Grandini R, Ferrari M. Clinical evaluation of the use of fiber posts and direct resin restorations for endodontically treated teeth. Int J Prosthodont 2005;18:399-404.
56. Ricketts D, Bartlett DW. Advanced Operative Dentistry 2011; 69-85. doi:10.1016/b978-0-7020-3126-7.00006-5.