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RETROSPECTIVE EVALUATION OF DIFFERENT POST-AND-CORE SYSTEMS IN TEETH RESTORED WITH SINGLE CROWNS

Tek Kuronlarla Restore Edilen Dişlerde Farklı Post ve Kor Sistemlerinin Retrospektif Bir Değerlendirmesi

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ABSTRACT

In this retrospective clinical study, the aim is to evaluate the effect of the clinical survival rates of different post-and-core systems in terms of the age and sex of the population, type of restoration, tooth position, type of post material, effect of opposing dentition, and type of cement used. A retrospective analysis was conducted via spreadsheets that showed patients who were treated with post-and-cores between August 2016 and March 2020. A total of 524 records were included in the analysis according to the inclusion criteria. Data were analysed using Kaplan–Meier and Cox proportional hazards analysis. While a statistically significant difference between the post-and-core survival among age, restoration type, cement type, opposing dentition, and service time was determined ($p<0.001$), a statistically significant difference with tooth position and sex was not detected ($p>0.05$). The analyzes showed no evidence that different post-and-core systems (prefabricated glass and carbon fiber reinforced composite resin, cast metal and prefabricated metal) were significantly associated with post-and-core survival. However, opposing dentition, type of cement, and restoration exhibited a statistically significant difference with the post-and-core survival.

Keywords: Carbon fiber, Glass fiber, Post and core, Survival rate.

ÖZ

Bu retrospektif klinik çalışmanın amacı; popülasyon yaşının ve cinsiyetin, restorasyon tipinin, diş pozisyonunun, post materyal tipinin, karşıt dişlerin etkisinin ve kullanılan siman tipinin farklı post ve kor sistemlerinin klinik hayatta kalma oranına etkisinin değerlendirilmesidir. Ağustos 2016 ile Mart 2020 arasında post ve kor uygulanan hastaları gösteren elektronik tablolar üzerinde retrospektif bir analiz yapıldı. Dahil etme kriterlerine göre analize toplam 524 kayıt dahil edildi. Veriler Kaplan-Meier ve Cox orantılı risk analizi kullanılarak analiz edildi. Post ve korların hayatta kalma oranları ile yaş, restorasyon tipi, siman tipi, karşıt diş ve hizmet süresi faktörleri ile istatistiksel olarak anlamlı bir ilişki bulunurken ($p<0.001$); diş pozisyonu ve cinsiyet faktörleri ile istatistiksel olarak anlamlı bir ilişki bulunamadı ($p>0.05$). Analizler, post ve kor sağkalımı ile farklı post ve kor sistemlerinin (prefabrike cam ve karbon fiber destekli kompozit rezin, döküm metal ve prefabrike metal) önemli ölçüde ilişkili olduğuna dair bir kanıt göstermedi. Bununla birlikte, post ve kor sağkalımı ile karşıt diş, siman ve restorasyon tipi istatistiksel olarak anlamlı bir fark gösterdi.

Anahtar kelimeler: Cam fiber, Karbon fiber, Post ve kor, Sağkalım oranı.

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INTRODUCTION

Endodontically treated teeth (ETT) with excessive coronal damage, which are restored with post-and-core systems (PCSs), are regained to the stomatognathic system. Different techniques and materials are used for the restoration of ETT. Generally, PCSs can be categorized into three groups: casting or prefabricated metal PCSs, ceramic PCSs, and fiber-reinforced composite PCSs. Casting or prefabricated metal PCSs have a long clinical history. However, their disadvantages include high corrosion and elastic modulus as well as low aesthetic properties. Compared to fiber-reinforced PCSs, PCSs exhibit higher fracture strength; however, they cannot be restored (Goracci & Ferrari, 2011). In addition, catastrophic vertical root fractures are frequently observed in cast PCSs with a high elastic modulus, while fiber posts are extremely rare. In fiber PCSs, restorable errors, such as the separation of the PCS from the tooth surface as adhesives, are generally observed (Coelho et al., 2009). Metallic and non-metallic posts exhibit different stress distributions. Glass and carbon-fiber-reinforced PCSs reduce the risk of biomechanical failure in ETT due to a more homogeneous stress distribution. As they are considered to exert a positive effect, fiber-reinforced PCSs are often recommended due to their similar elastic modulus to that of dentine tissue (Coelho et al., 2009; Goracci & Ferrari, 2011). In addition, it exhibits advantages such as the application of fiber PCSs at chairside in a single appointment, its' aesthetic properties, and relatively facile removal from the root (Baba, Golden, & Goodacre, 2009; Goracci & Ferrari, 2011). The use of an appropriate adhesive cement as well as a cementation protocol are essential for long-term clinical success in fiber PCSs. Nevertheless, although sufficient adhesion is achieved by the dentin in the root, adverse effects of various factors, especially the smear layer in the canal and the polymerization of the resin cement, cannot be completely controlled (Baba et al., 2009). In rigid PCSs such as casting or prefabricated metal PCSs, there is a higher stress concentration on the root and increased risk of vertical root fracture (Dietschi, Duc, Krejci, & Sadan, 2007; Goracci & Ferrari, 2011; Wu et al., 2009)

Owing to the different force directions of the incisors, premolars, and molar teeth, they exhibit different biomechanical behaviours (Naumann, Preuss, & Frankenberger, 2007; Naumann et al.,2017). In particular, the maxillary region is considered as a high-risk area for technical failures due to larger horizontal forces (Martino et al., 2020; Sarkis-Onofre, Jacinto, Boscato, Cenci, & Pereira-Cenci, 2014). Therefore, not only the selection of materials, but also the location of the tooth, must be considered.

Several prospective clinical trials on the long-term survival of PCSs have been published, and similar results have been reported previously (Dietschi et al., 2007; Naumann et al., 2007; Naumann et al., 2017). Although retrospective clinical studies have compared PCSs and reported inconsistent results on the survival rate, there is no consensus on which PCS is more successful (Dammaschke, Nykiel, Sagheri, & Schäfer, 2013; Fredriksson, Astbäck, Pamenius, & Arvidson, 1998; Gómez-Polo, Llidó, Rivero, Del Río, & Celemín, 2010; Martino et al., 2020; Raedel, Fiedler, Jacoby, & Boening, 2015; Sarkis-Onofre et al., 2014). In systematic reviews comparing different post materials, contradictory results have been reported (Barfeie, Thomas, Watts, & Rees, 2015; Figueiredo, Martins-Filho, & Faria-E-Silva, 2015; Marchionatti, Wandscher, Rippe, Kaizer, &Valandro, 2017; Sarkis-Onofre, Fergusson, Cenci, Moher, & Pereira-Cenci, 2017; Theodosopoulou & Chochlidakis, 2009). In a meta-analysis study compiled from a systematic review examining in vitro and in vivo studies, a statistical significant difference between cast and prefabricated PCSs is not observed (Heydecke & Peters, 2002).

Several studies have reported that after the post-and-core application of ETT with excessive crown damage, restoration with fixed dental prostheses positively affects the clinical survival rate (Dammaschke et al., 2013; Jirathanyanatt, Suksaphar, Banomyong, & Ngoenwiwatkul, 2019; Skupien et al., 2016; Suksaphar, Banomyong, Jirathanyanatt, & Ngoenwiwatkul, 2018). For a more objective evaluation of whether the type of applied prosthetic material exhibits an effect, only single crown treatment is included in this study.

In this retrospective clinical study, the aim was to evaluate the effect of the clinical survival rates of prefabricated carbon and glass-fiber-reinforced composite resin, prefabricated metal, and cast metal post-and-cores in terms of the age and sex of the population, opposing dentition, tooth position, type of restoration, and post and cement. In this study, the null hypothesis that there is no difference in the survival rates of post-and-cores as a function of the material type is examined.

MATERIAL AND METHOD

The study was approved by the Adıyaman University Ethics Committee (2020/3-12). All the participants provided written informed consent for the participation in the study. All procedures performed in the study were conducted in accordance with the ethical standards given in 1964 Declaration of Helsinki, as revised in 2013. Next, a list of patients whose treatment codes were defined for four different post-and-core systems was prepared from the electronic database (Turcasoft DBYS, Turcasoft software, Samsun, Turkey) and compiled in a

table (Excel, Microsoft Corp.). Inclusion criteria included patients who have an electronic file or scanned attached documents relating to the procedure performed and adequate knowledge of radiographic and clinical outcomes after insertion, survival, or failure. Failure refers to no longer existence of the original post-and-core or the tooth in the mouth.

Patients were treated with a prefabricated glass-fiber-reinforced composite resin post (Glassix, Harald Nordin, Chailly/Montreux, Switzerland), a prefabricated carbon-fiber-reinforced composite resin post (Cytec Carbon; Hahnenkratt GmbH, Königsbach-Stein, Germany), a prefabricated metal post (Euro-Post Stainless Steel, Anthogyr SA, Sallanches, France), or a custom-cast Co-Cr metal (Wironit extra hard, Bego, Germany) post-and-core at Department of Prosthodontics (Adiyaman University Faculty of Dentistry) between August 2016 and March 2020.

After examining 620 patient files, 524 files (465 patients) were selected according to the inclusion criteria (Fig. 1). In this study, 524 post-and-cores were applied by prosthodontists to 465 patients between the ages of 12–83.

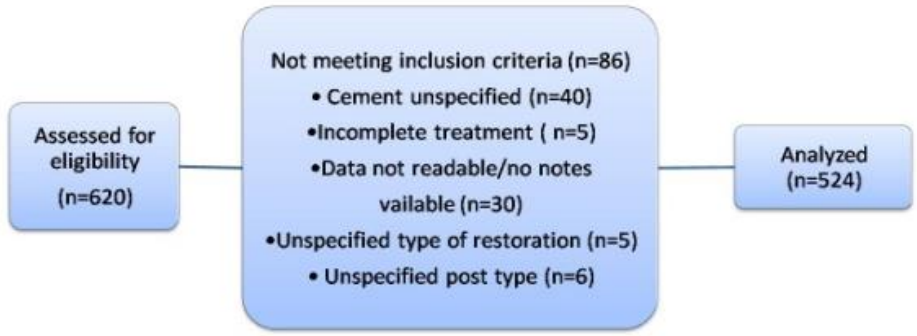

Figure 1. Inclusion Criteria of This Retrospective Study.

Data were mainly collected from the provider's treatment notes and by the examination of dental radiographs of the patients. Grading parameters were determined and applied for each parameter (Table 1): age, sex, tooth position, opposite dentition, failure, type of post, restoration, and cement.

Table 1. Recorded Parameters for each Post-and-Core Restoration.

Parameter	Grading scale
Age	Years
Sex	Male Female
Post Type	Prefabricated Metal Prefabricated Glass Fiber Prefabricated Carbon Fiber Custom Cast Metal

Restoration Type	Metal-ceramic Crown Zirconia-ceramic Crown All ceramic Crown
Cement Type	Zinc Phosphate Dual-cured Resin Glass Ionomer
Tooth Position	Anterior Posterior
Opposing Dentition	Natural Dentition Fixed Dental Prosthesis Removable Prosthesis
Failure	Yes No

Data were analysed using R statistical software (V.3.0.2; R Foundation for Statistical Computing). The Fisher post and Kruskal–Wallis test were employed to evaluate differences in patient and procedural factors between the four post-and-cores. The Kaplan–Meier analysis and log-rank test were employed to compare the survival time between the four post groups. The Cox proportional hazards model was utilized to evaluate the effect of post-and-core types by controlling the age, sex, tooth position, opposing dentition, type of post, restoration, and cement used.

RESULTS

A total of 524 patients, 239 (45.61%) male and 285 (54.39%) female, between the ages of 12–83 participated in the study. Table 2 lists the analysed variables related to the patients, restorations, and their breakdown. There was a statistically significant difference between post-and-core survival among age, restoration type, cement type opposing dentition, and service time ($p<0.001$). However, there was no statistically significant difference between post-and-core survival with tooth position ($p=.703$) and sex ($p=.516$).

Table 2. Parameters Examined and the Grading Criteria Involved in Chart Analysis.

Factor	**All Posts (N=524) N (%) or mean (SD); median [IQR] (range)**	**Prefabric Metal (N=279)**	**Glass Fiber-reinforced Composite Resin Post (N=63)**	**Carbon Fiber-reinforced Composite Resin Post (N=36)**	**Cast Metal Post-and-Core (N=146)**	**P Value (Fisher Exact or Kruskal Wallis)**
Sex						
Male	239(45.6)	134(48)	24(38.1)	15(41.7)	66(45.2)	.516
Female	285(54.4)	145(52)	39(61.9)	21(58.3)	80(54.8)	
Age(year)	258[12-41]	67	20	4	11	<.001
	266[42-83]	212	43	32	135	
Cement						
Zinc Phosphate	185(35.3)	113(41)	1(1,5)	1(2,7)	70(48)	<.001
Dual-cured Resin	84 (16)	0	61(97)	23(63)	0	

Glass-Ionomer	255(48.67)	166(59)	1(1.5)	12(33.3)	76(52)	
Type of Restoration						
Metal-ceramic	395(75.4)	226(81)	23(36.5)	17(47)	129(88)	<.001
Zirconia-supported	106(20.2)	53(19)	23(36.5)	13(36)	17(12)	
All Ceramic	23(4,4)	0	17(27)	6(16,67)	0	
Opposing Dentition						
Natural	246(47)	112(40.14)	31(49.2)	25(69.4)	78(53.4)	.001
Fixed Dental Prosthesis	206(39.3)	115(41.22)	27(42.9)	11(30.6)	53(36.3)	
Removable Prosthesis	72(13.7)	52(18.64)	5(7.9)	0	15(10.3)	
Tooth Position						
Anterior	237(45.2)	122(51.5)	32(13.5)	18(24.7)	65(27.4)	.703
Posterior	287(54.8)	157(54.7)	31(10.8)	18(6.3)	81(28.2)	
Duration (Day)	524[500,1000]	279	63	36	146	.000

The Kaplan–Meier analysis revealed that a statistically significant difference in the survival rates among post types for each group is not observed ($p > 0.05$). By the evaluation of the survival rates at 500 days in terms of the post type, a statistical significant difference was observed for the prefabricated metal (54%), glass-fiber-reinforced (57%), carbon-fiber-reinforced (75%), and cast metal (96%) posts. By the evalution of the survival rates at 1000 days in terms of post type, a statistical significant difference was observed for the prefabricated metal (16%), glass-fiber-reinforced (27%), carbon-fiber-reinforced (31%), and cast metal (68%) posts (Fig.2.). A statistically significant difference between different restoration types in terms of survival rate was not observed (log-rank test $p>0.05$). A statistically significant difference between different cement types in terms of survival rate was not observed (log-rank test $p>0.05$). A statistical significant difference between different tooth positions in terms of survival rate was not observed (log-rank test $p>0.05$). A statistically significant difference was observed between different age groups in terms of survival rate (log-rank test $p<0.05$). A statistically significant difference between sex in terms of survival rate was not observed (log-rank test $p>0.05$). A statistically significant difference between opposing dentition in terms of survival rate was observed (log-rank test $p<0.05$).

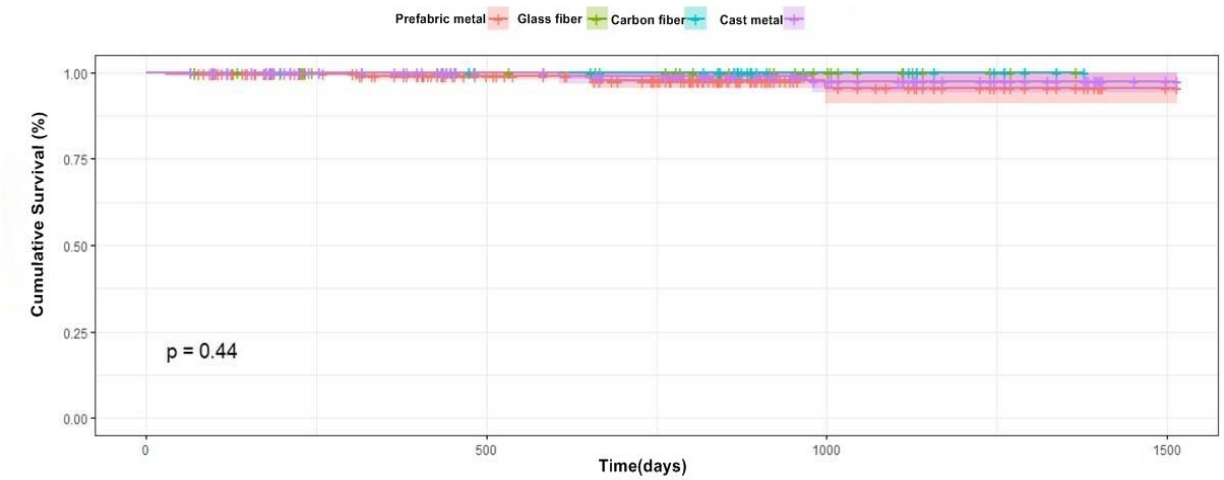

Figure 2. Kaplan–Meyer Survival Curves for the Post-and-Cores, Subdivided According to the Post Type.

In addition to the Kaplan–Meier analysis, the Cox proportional hazards model was utilized to evaluate the effect of post type while controlling other factors, and a statistically significant difference was not observed in terms of post type ($p>0.05$). In the Cox proportional hazards model, a statistically significant difference was found only in terms of the opposing dentition for the model ($p=.046$). When the model was established with the opposing dentition variable, a significant (HR=0.107, 95% CI=0.020, 0.565, $p=.008$, Fig.3.) difference for the removable prosthesis model was observed. In the presence of removable dentures in the opposing dentition, the chances of extraction in post-and-cores were 9.337 (1/exp (–2.234)) times greater than that of a natural tooth.

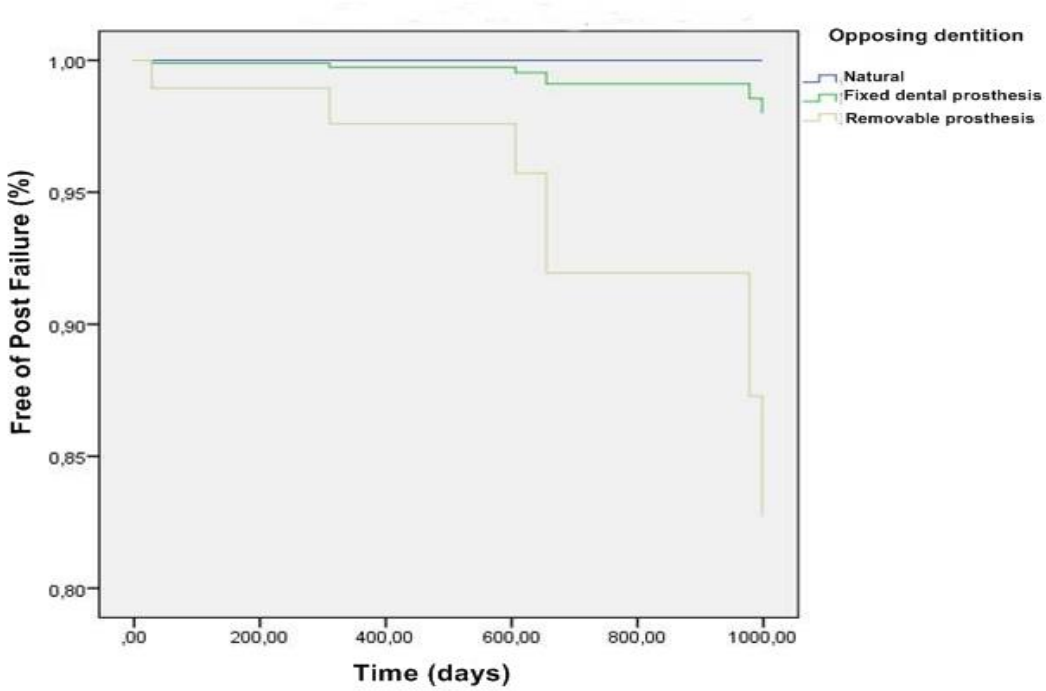

Figure 3. Cox Proportional Hazards Analysis for Post Survival with Respect to the Opposing Dentition.

DISCUSSION

Data suggested that the null hypothesis stating that there is no difference in the post-and-core survival rate should be partially accepted. In the results of this study, a statistically significant difference between the post-and-core survival among age, restoration type, cement type, opposing dentition, and service time was observed ($p<0.001$), however a statistically significant difference with tooth position and sex was not observed ($p>0.05$).

Sarkis-Onofre et al. evaluated glass-fiber-reinforced and cast metal posts in 72 teeth of 54 participants during a three-year follow-up and reported a good survival rate for glass-fiber-reinforced and cast metal posts as well as similar clinical performance regardless of the tooth position (Sarkis-Onofre et al., 2014). Similarly, in this study, a statistically significant difference in terms of the effect of tooth position on survival rate was not observed ($p=.143$).

This study revealed that metal posts are placed as defining restorations with a higher percentage of metal-ceramic crowns in teeth compared with that of glass-fiber-reinforced composite resin posts. The restoration frequency of zirconia-supported or all-ceramic crowns was 63.5% for glass-fiber-reinforced composite resin posts, 19% for prefabricated metal posts, and 12% for cast metal post-and-cores. A greyish colour was observed throughout the ceramic crowns as well as the reduction in the depth of translucency due to the metal posts; hence, metal posts must be extensively masked with a metal substructure to maintain aesthetics. Since glass fiber-reinforced composite resin posts are more aesthetic than metal posts, there may be a tendency to place them in the anterior region where all-ceramic crowns are more acceptable. As a result, in parallel with our study, the aesthetic expectation of prosthodontists may have affected their treatment preferences (Martino et al., 2020).

In dentistry today, conventional casting and prefabricated metal posts, which are frequently preferred with a long clinical history, cause stress on teeth due to the higher elastic modulus of metals than that of teeth; hence, root fracture complications are observed (Al-Omiri, Mahmoud, Rayyan, & Abu-Hammad, 2010; Santos et al., 2010). In this study, post failure due to tooth extraction was observed only in prefabricated and cast metal posts. In addition, although 98.2% and 98.6% success rates were observed for prefabricated and cast metal posts, respectively, a statistically significant difference was not observed in comparison with that observed with fiber-reinforced composite posts ($p>0.05$).

The type of the cement material significantly affected the survival probability ($p<0.001$). Posts bonded with resin or zinc phosphate cements were significantly more likely to survive than those bonded with glass-ionomer cement. Similar results were observed in

several studies (Balkenhol, Wöstmann, Rein, & Ferger, 2007; Martino et al., 2020). Finally, the placement of a full coverage crown, compared to composite resin or temporary restorations, in ETT with excessive crown destruction leads to an improved survival rate (Marchionatti et al., 2017). In this study, high survival rates were observed for all-ceramic (100%), zirconia-supported (99.1%), and metal-ceramic (98.5%) restorations due to the placement of a full coverage crown on teeth with post-and-core, and the higher survival rates indicate that the type of restoration affects survival ($p<0.001$).

In this study, the extraction of all teeth for patients in the age range of 42-83 was conducted. Survival rates for the age range of 12-41 were 100%, while they were 97.4% for the age range of 42-83, and a statistically significant correlation between age and post-and-core survival was observed ($p<0.001$). Martino et al. reported that factors such as age, restoration and cement type, and opposing dentition affect survival rates in their retrospective study, where they evaluated survival rates of prefabricated fiber-reinforced composite resin, prefabricated metal, and custom-cast metal post-and-cores (Martino et al., 2020). In this study, when the opposing dentition factor model was established in the Cox proportional risk model, a statistically significant difference between the success variable and the removable prosthesis model was observed (Fig.3.). This result may be related to excessive occlusal forces on these teeth due to biomechanical factors between post-and-core-treated teeth restored with full coverage dental prostheses and acrylic teeth in removable prostheses.

This study exhibited several limitations. As it was a retrospective study, post-preparation as well as the used cementation protocol and materials were not standardized, and the same clinician was not employed. The treatment protocol likely varied between providers, possibly affecting the survival rate. Hence, studies with better controlled parameters should be conducted. A prospective or randomized controlled trial can provide more useful data, which can be directly correlated with dental practice. In addition, it would be beneficial to conduct new studies, which include the mesio-distal and occluso-gingival distances, crown-root ratios, and the number of remaining dentin walls of teeth restored with post-and-cores. Finally, longer observation times with an appropriate follow-up examination can improve the results of future studies.

CONCLUSIONS

Within the limitations of this in vitro study, the following conclusions were drawn: The restoration and cement type affect the survival rate of post- and-cores in ETT. In addition, the presence of removable prostheses in opposing dentition also affects the survival rate in ETT.

Conflict of interest: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports.

Ethical approval: The Ethics Committee of Adıyaman University, Faculty of Medicine (Protocol Number: 2020/3-12).

REFERENCES

Al-Omiri, M. K., Mahmoud, A. A., Rayyan, M. R., Abu-Hammad, O. (2010). Fracture resistance of teeth restored with post-retained restorations: an overview. Journal of Endodontics, 36(9),1439-1449.

Baba, N. Z., Golden, G., Goodacre, C.J. (2009). Nonmetallic prefabricated dowels: a review of compositions, properties, laboratory, and clinical test results. Journal of Prosthodontics, 18, 527-536.

Balkenhol, M., Wöstmann, B., Rein, C., Ferger, P. (2007). Survival time of cast post and cores: a 10-year retrospective study. Journal of Dentistry, 35(1), 50-58.

Barfeie, A., Thomas, M. B., Watts, A., Rees, J. (2015). Failure mechanisms of fibre posts: A literature review. The European Journal of Prosthodontics and Restorative Dentistry, 23(3), P115-27.

Coelho, C. S., Biffi, J. C., Silva, G. R., Abrahão, A., Campos, R.E., Soares, C.J. (2009). Finite element analysis of weakened roots restored with composite resin and posts. Dental Materials Journal, 28, 671-678.

Dammaschke, T., Nykiel, K., Sagheri, D., Schäfer, E. (2013). Influence of coronal restorations on the fracture resistance of root canal-treated premolar and molar teeth: a retrospective study. Australian Endodontic Journal, 39(2), 48-56.

Dietschi, D., Duc, O., Krejci, I., Sadan, A. (2007). Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature--Part 1. Composition and micro- and macrostructure alterations. Quintessence International, 38, 733-743.

Figueiredo, F. E., Martins-Filho, P. R., Faria-E-Silva, A. L. (2015). Do metal post-retained restorations result in more root fractures than fiber post-retained restorations? a systematic review and meta-analysis. Jounal of Endodontics, 41, 309-316.

Fredriksson, M., Astbäck, J., Pamenius, M., Arvidson, K. (1998). A retrospective study of 236 patients with teeth restored by carbon fiber-reinforced epoxy resin posts. Journal of Prosthetic Dentistry, 80(2), 151-157.

Gómez-Polo, M., Llidó, B., Rivero, A., Del Río, J., Celemín, A. (2010). A 10-year retrospective study of the survival rate of teeth restored with metal prefabricated posts versus cast metal posts and cores. Journal of Dentistry, 38(11), 916-920.

Goracci, C., Ferrari, M. (2011). Current perspectives on post systems: a literature review. Australian Dental Journal, 56(1), 77-83.

Heydecke, G., Peters, M. C. (2002). The restoration of endodontically treated, single rooted teeth with cast or direct posts and cores: a systematic review. Journal of Prosthetic Dentistry, 87, 380-386.

Jirathanyanatt, T., Suksaphar, W., Banomyong, D., Ngoenwiwatkul, Y. (2019). Endodontically treated posterior teeth restored with or without crown restorations: a 5-year retrospective study of survival rates from fracture. Journal of Investigative and Clinical Dentistry, 10(4), e12426.

Marchionatti, A. M. E, Wandscher, V. F., Rippe, M. P., Kaizer, O. B., Valandro, L. F. (2017). Clinical performance and failure modes of pulpless teeth restored with posts: a systematic review. Brazilian Oral Research, 31, 1-14.

Martino, N., Truong, C., Clark, A. E., O'Neill, E., Hsu, S. M., Neal, D., Esquivel-Upshaw, J. F. (2020). Retrospective analysis of survival rates of post-and-cores in a dental school setting. Journal of Prosthetic Dentistry, 123(3), 434-441.

Naumann, M., Preuss, A., Frankenberger, R. (2007). Reinforcement effect of adhesively luted fiber reinforced composite versus titanium posts. Dental Materials, 23, 138-144.

Naumann, M., Sterzenbach, G., Dietrich, T., Bitter, K., Frankenberger, R., von Stein-Lausnitz, M. (2017). Dentin-like versus rigid endodontic post: 11-year randomized controlled pilot trial on no-wall to 2-wall defects. Jornal of Endodontics, 43, 1770-1775.

Raedel, M., Fiedler, C., Jacoby, S., Boening, K. W. (2015). Survival of teeth treated with cast post and cores: a retrospective analysis over an observation period of up to 19.5 years. Journal of Prosthetic Dentistry, 114(1), 40-45.

Santos, A. F., Meira, J. B., Tanaka, C. B., Xavier, T. A., Ballester, R. Y., Lima, R. G.,…Versluis A. (2010). Can fiber posts increase root stresses and reduce fracture? Journal of Dental Research, 89(6), 587-591.

Sarkis-Onofre, R., Fergusson, D., Cenci, M.S., Moher, D., Pereira-Cenci, T. (2017). Performance of post-retained single crowns: a systematic review of related risk factors. Journal of Endodontics, 43, 175-183.

Sarkis-Onofre, R., Jacinto, R.C., Boscato, N., Cenci, M.S., Pereira-Cenci, T. (2014). Cast metal vs. glass fibre posts: a randomized controlled trial with up to 3 years of follow up. Journal of Dentistry, 42, 582-7.

Skupien, J. A., Cenci, M. S., Opdam, N. J., Kreulen, C. M., Huysmans, M. C., Pereira-Cenci, T. (2016) Crown vs. composite for post-retained restorations: a randomized clinical trial. Journal of Dentistry, 48, 34-39.

Suksaphar, W., Banomyong, D., Jirathanyanatt, T., Ngoenwiwatkul, Y. (2018). Survival rates from fracture of endodontically treated premolars restored with full-coverage crowns or direct resin composite restorations: A retrospective study. Journal of Endodontics, 44(2), 233-238.

Theodosopoulou, J. N., Chochlidakis, K.M. (2009). A systematic review of dowel (post) and core materials and systems. Journal of Prosthodontics, 18, 464-472.

Wu, H., Hayashi, M., Okamura, K., Koytchev, E. V., Imazato, S., Tanaka, S.,… Ebisu, S. (2009). Effects of light penetration and smear layer removal on adhesion of post-cores to root canal dentin by self-etching adhesives. Dental Materials, 25(12), 1484-1492.