

The comparison of different coronal restorations of endodontically treated posterior teeth on the patients' quality of life and satisfaction

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Original Article

Abstract

BACKGROUND AND AIM: Everyday lives of individuals can be affected by dental treatments. The aim of this study was to evaluate the impacts of coronal restorations of endodontically treated posterior teeth (ETPT) on the patient's satisfaction and quality of life (QoL).

METHODS: This cross-sectional clinical study was conducted at School of Dentistry, Istanbul Okan University, Istanbul, Turkey, using the semantic differential scale, Oral Health Impact Profile-14 (OHIP-14), and clinical assessments. Electronic charts and files of patients who received endodontic treatment and coronal restoration from June 2018 to January 2019 were reviewed. The patients included in the study had been treated by the same endodontist and restorative dental specialist. The coronal restoration of the ETPT had to be either direct composite restoration (DCR) or indirect ceramic restoration (ICR). 123 patients were deemed fit for this study. A rendezvous was created for the patients who agreed to participate in the study ($n = 115$) and those who came to the appointment were checked for the inclusion criteria. After clinical examinations, 68 patients filled in the questionnaires. Demographic information, the semantic differential scale, and the OHIP-14 scores-provided data were analyzed by Mann-Whitney U test, independent samples t-test, and the chi-square test. Statistical significance level was considered at $P < 0.05$.

RESULTS: 68 patients ($n = 34$ in each group) participated in the study. DCR and ICR groups had similar mean OHIP-14 scores (5.03 ± 3.36 and 5.15 ± 6.17 , respectively) and general satisfaction scores (9.76 ± 0.43 and 9.88 ± 0.33 , respectively) ($P > 0.05$). There was no statistically significant difference between the satisfaction values of the two groups regarding cost, time involved, pain, aesthetics, chewing ability, pleasantness, and general satisfaction ($P > 0.05$).

CONCLUSION: According to the results of the present study, both treatment options have created similar satisfaction for patients and offered high QoL.

KEYWORDS: Composite Resins; Dental Onlays; Endodontics; Oral Health; Quality of Life

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Modern endodontic therapy consists of four steps including cleaning, shaping, obturation, and restoration of the tooth. After adequate endodontic treatment, the restoration of the tooth is the complementary process to guarantee success.¹ The selection of restorative procedures and material has always been a question for clinicians. Although having aesthetic results is important for endodontically treated teeth

(ETT), the restorative material should have the properties of biocompatibility and resistance to occlusal forces with increasing the strength of the tooth. Therefore, lots of methods and materials have been improved to restore the ETT, but it is still controversial.² The development of adhesion and mechanical properties of composite materials that are close to those of dental tissues has offered the practitioners a good option: direct composite restoration (DCR). It seems to be a

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safe option that gives good long-term results to a maximum of 8-10 years for composite fillings up to three surfaces.^{3,4} Dentists prefer DCR due to its advantages such as low cost, preservation of tooth structures, and being easy to apply. Although DCR is associated with polymerization shrinkage stress and resultant microleakage, its mechanical and physical properties have improved by the years and become more acceptable.⁵

Ceramic materials, due to their favorable mechanical properties, have the potential to function effectively as inlay/onlay.⁶ These materials are stated to be more resistant to fracture and provide more aesthetic results than DCR.^{7,8} Indirect restorations involve fabricating the restoration outside the oral cavity, using an impression of a prepared tooth. On the other hand, this technique is more expensive and time-consuming.⁹ Thus, the patient's desire in this matter affects the choice of dentists. However, some studies have shown that restoring posterior teeth with direct composite resin (DCR) and indirect ceramic (inlay/onlay) restorations (ICR) seems to give a similar acceptable treatment modality in terms of fatigue life and fracture resistance.^{10,11}

Perception of one's own life in a culture and value system according to personal goals, expectations, standards, and interests is called quality of life (QoL). Oral diseases are generally not fatal but affect the daily activities of individuals, for instance, eating, talking, socializing, and general well-being.¹² According to McGrath and Bedi, the negative effects of oral diseases on QoL prevents recognition of the positive effects of healthy daily life.¹² The health-related QoL (HRQoL) has gained popularity in recent years.^{13,14} Oral Health Impact Profile (OHIP)¹⁵ questionnaire was developed to understand the patients' perspective, and also, some scales such as semantic differential scale have been prepared to evaluate the level of patients' satisfaction.¹⁶ Generally, previous studies were conducted using the physician's observations and clinical criteria such as secondary caries, tooth

fracture, marginal chipping, and discoloration.^{9,17} However, while those criteria are of paramount importance, these data do not give us information on patient's personal feelings in terms of satisfaction, functional limitation, physical pain, and psychological and social disability. Therefore, the literature has a limited knowledge of how the restoration of ETT affects the quality of a patient's life (QoPL).

This cross-sectional study aimed to compare the QoPL and satisfaction levels of patients with DCR versus ICR in ETT. The null hypothesis of this study was that the coronal restoration type would not affect the QoL of patients who underwent root canal treatment.

Methods

This cross-sectional clinical study was approved by the Ethics Committee of Istanbul Okan University, Istanbul, Turkey (ethical code: 12.12.2018-23), and conducted at its Departments of Endodontics and Restorative Dentistry of School of Dentistry. The power analysis was performed with the G*power 3.1 program using data from another study by Liu et al.¹⁸ According to power analysis, the sample size was set to 68 (alpha probability of error = 0.05, power = 0.80).

Eligibility criteria: A query of the Nucleus database (a patient management software) was performed to provide dental charts of patients who received endodontic treatment from June 2018 to January 2019. Vital posterior teeth, which were shaped with ProTaper Next system (Dentsply/Maillefer, Ballaigues, Switzerland) and filled with cold lateral condensation using AH Plus sealer (Dentsply/Maillefer, Ballaigues, Switzerland), were selected from the patients' files. They were searched only for primary endodontic treatment of vital tooth codes done by one endodontist. A total of 400 patients' teeth were identified for screening. Additionally, in these teeth, final restorations performed with GC Gradia Posterior (Gc America, Inc., Alsip, IL, USA) composite resin multilayering system versus IPS

Empress (Ivoclar Vivadent, Schaan, Liechtenstein) indirect (inlay/onlay) restorations under absolute isolation (Roeko Flexi Dam, Coltène/Whaledent, Langenau, Germany) were selected for the study. Next, the patients of a specified restorative dentistry specialist were searched, and 250 patients were excluded, because the restoration had been done by other dentists in the faculty; thus, 150 patients remained. Then, data and radiographs of the patients were checked out for the eligibility criteria. Twenty-seven patients who had their anterior teeth treated were excluded from the study. 123 patients (65 DCR, 58 ICR) with these criteria who had finished 1-year occlusal function were called by phone call to check the restoration and be informed about the study. Appointments were created for those who agreed to participate in the study. They were called in the time interval of July 2019 to January 2020, in the sequence when the patient's treatment finished, from past to present.

Inclusion criteria included: 1) patients who received only one nonsurgical, single-visit primary root canal therapy to one posterior tooth (premolar/molar), which had no periapical lesion [periapical index (PAI) score I]¹⁹ and class I/II coronal restoration, 2) patient's restoration had an occlusal function at least one year, 3) patients who aged ≥ 18 years and had no history of pregnancy or breastfeeding status, 4) patients who had good oral hygiene (full mouth plaque score of $< 10\%$ and full mouth bleeding score of 15%), and (5) patients who were on the American Society of Anesthesiologists (ASA) I and II.

Patients with physical disabilities and communication difficulties, periapical abscess, sinus tract, dental caries, or periapical lesion in the other teeth were excluded from the study. Patients who had other dental treatments such as prosthetic crowns, implants, dental bleaching, or filling in the last one year after our root canal therapy and restorative treatment were not included in the study. Those with open apex teeth were also excluded from the study.

Moreover, if any teeth were extracted during this time, the patient would be excluded from the study.

Clinical assessments: In the recall visits, both restorative dentistry specialist and endodontist examined the patients. Both of them were calibrated about PAI scoring. Firstly, panoramic radiographs (PRs) of the patients and periapical radiographs of the related teeth were taken. Then, PRs were compared with the obtained pre-treatment PRs, which were taken at the end of the treatment in terms of new restoration (filling, crown, or implant) and new root canal treatment. Periapical status was checked using periapical radiographs. Besides, the intraoral examination (marginal discoloration, marginal adaptation, restoration fracture, tooth fracture) was done, percussion and palpation tests of the treated tooth were performed, and oral hygiene was evaluated using a periodontal probe by the same dentists. In the cases of observer disagreement, a third experienced examiner was consulted. Other dental procedures in our faculty or another clinic in the previous year were investigated by:

1. Comparing the first (before treatment) and the last PRs (in the follow-up session, one year later) in combination with the intraoral examination
2. Making an interview with patients
3. Checking our Nucleus database system

Data collection: All study participants provided oral and written informed consent. The questionnaire used in this study included 3 parts: (i) patients' demographic information (age, gender, education, marital status), (ii) the OHIP-14, and (iii) semantic differential scale¹⁶ to get information about individual satisfaction of patients after 1-year usage of ICR (inlay/onlay) versus DCR of ETT.

QoL assessment (OHIP): The QoL is defined by the World Health Organization (WHO) as the perception of the individual in the cultural and value system (WHOQoL) (1995). The QoPL is associated with oral and dental health; how functional, psychological, or

social factors, and pain or discomfort affect one's well-being.²⁰ In this study, eligible patients' WHOQoL was evaluated using a short version of the OHIP (OHIP-14)²¹, as shown in table 1. Mumcu et al. proved the reliability, validity, repeatability of the Turkish version of the OHIP-14.²² Therefore, OHIP-14 questionnaire, which was translated to the Turkish language, was used in the present study. According to the structure of this index, patients were asked to provide information about their perceptions of the social impact of oral disorders on their well-being.¹⁵ The survey's questions were scored based on a 5-point Likert scale (0: Never, 1: Hardly ever, 2: Occasionally, 3: Fairly often, 4: Very often).²³

Semantic differential scale: In order to evaluate the satisfaction levels of the patients, they were asked to fill in a semantic differential scale that includes treatment cost, duration of treatment, pain, aesthetics, chewing efficacy, and general satisfaction. This scale is based on the patient's level of

satisfaction with this restoration with a score range of 1 (very dissatisfied) to 10 (very satisfied) (Figure 1). This scale is a well-accepted scale and has been using since 1957 in studies.^{16,24}

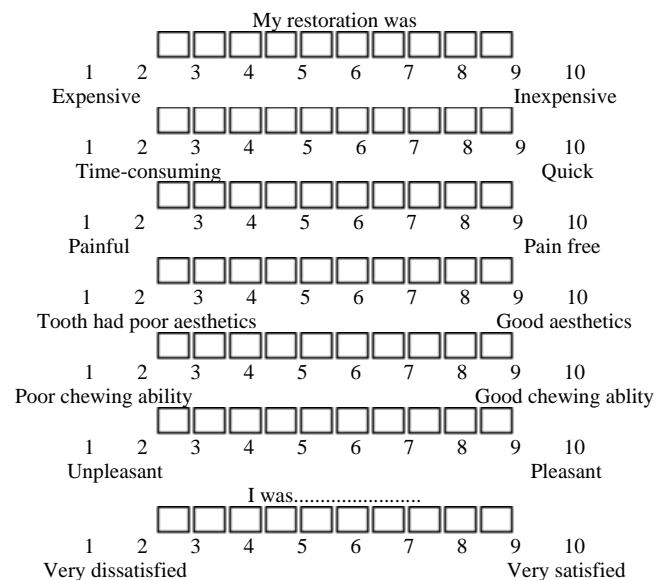


Figure 1. Semantic differential scale used to evaluate the satisfaction of patients

Table 1. Oral Health Impact Profile-14 (OHIP-14) questionnaire

During the last year, how often have the followings occurred?	
1. Functional limitation	Have you had trouble pronouncing any words because of problems with your teeth, mouth, or dentures? Have you felt that your sense of taste has worsened because of problems with your teeth, mouth, or dentures?
2. Physical pain	Have you had pain/aching in your mouth? Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth, or dentures?
3. Psychological discomfort	Have you been self-conscious because of your teeth, mouth, or dentures? Have you felt tense because of problems with your teeth, mouth, or dentures?
4. Physical disability	Has your diet been unsatisfactory because of problems with your teeth, mouth, or dentures? Have you had to interrupt meals because of problems with your teeth, mouth, or dentures?
5. Psychological disability	Have you found it difficult to relax because of problems with your teeth, mouth, or dentures? Have you been a bit embarrassed because of problems with your teeth, mouth, or dentures?
6. Social disability	Have you been a bit irritable with other people because of problems with your teeth, mouth, or dentures? Have you had difficulty doing your usual jobs because of problems with your teeth, mouth, or dentures?
7. Handicap	Have you felt that life in general was less satisfying because of problems with your teeth, mouth, or dentures? Have you been totally unable to function because of problems with your teeth, mouth, or dentures?

0 = Never, 1 = Hardly ever, 2 = Occasionally, 3 = Fairly often, and 4 = Very often

The data corresponding to each response provided by the patients for the demographic information questionnaire, semantic differential scale, and the OHIP-14 were analyzed using SPSS software (version 23, IBM Corporation, Armonk, NY, USA). The normality of the variation of the data was examined using the Kolmogorov-Smirnov test. Mann-Whitney U test was used to compare the data that were not distributed normally. Independent samples t-test was used to examine age between the groups. The chi-square test was used to examine the differences between categorical data. Statistical significance level was considered at $P < 0.05$.

Results

Out of the 123 patients, 8 patients declined to participate in the study on the phone. Totally, 115 patients (55 ICR, 60 DCR) referred for clinical examinations. After clinical and radiological assessments, 47 people were not eligible and the study was completed with 68 patients ($n = 34$ in each group) whose tooth had a negative response to percussion and palpation tests, no sense of pain, as well as no periapical lesion at the end of the first year of function (Figure 2). The distribution of marital status, gender, and educational status

of the patients between the two groups was similar, as seen in table 2 ($P > 0.05$). The DCR group included 16 men and 18 women with a mean age of 32.94 ± 12.37 years. The ICR group included 13 men and 21 women with a mean age of 32.35 ± 9.08 years. None of the patients had tooth extraction or implant during this period.

Table 3 presents the OHIP-14 scores of individuals. In the present study, participants who were treated with DCR and ICR had similar summary OHIP-14 scores (5.03 ± 3.36 and 5.15 ± 6.17 , respectively) and similar domain scores across all domains ($P > 0.05$). None of the patients had any difficulty in pronouncing words regardless of the restoration type, and almost all participants had no change in the sense of taste. The eating activity was not affected by none of the restoration types.

The most commonly experienced impacts 'very often' and 'fairly often' in the patients were psychological discomfort (20 participants in DCR and 13 participants in ICR) and physical disability (13 participants in DCR and 12 participants in ICR). None of the patients had been totally unable to function because of the oral health-related problems.

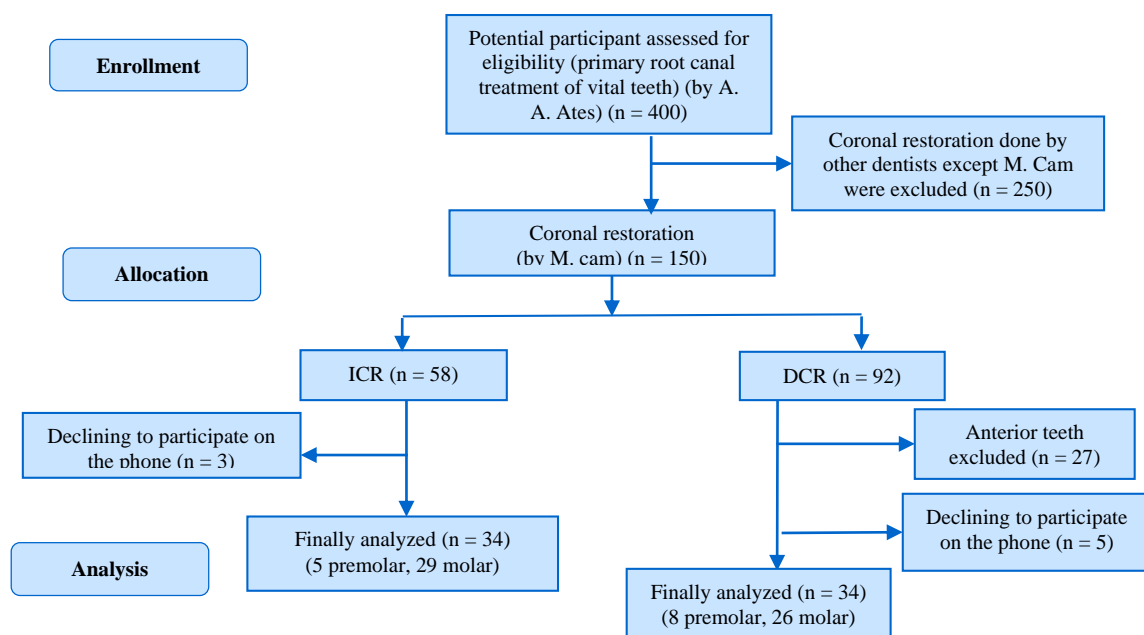


Figure 2. Flow-chart of the respondents' participation in the study (DCR: Direct composite restoration; ICR: Indirect ceramic restoration)

Table 2. Comparative evaluation of sociodemographic status between the study groups

Variables	DCR (n = 34)	ICR (n = 34)	P
Gender			
Women	18 (52.9)	21 (61.8)	0.624*
Men	16 (47.1)	13 (38.2)	
Marital status			
Single	15 (44.1)	15 (44.1)	> 0.999*
Married	19 (55.9)	19 (55.9)	
Education			
Illiterate	0 (0)	1 (2.9)	0.702*
Up to primary school	2 (5.9)	1 (2.9)	
Secondary school	9 (26.5)	8 (23.5)	
Post-secondary school	23 (67.6)	24 (70.6)	
Age (year)	32.94 ± 12.37	32.35 ± 9.08	0.824**

The values are presented as number (%) or mean ± standard deviation (SD)

*Chi-square test; **Independent samples t-test; statistically significant (P < 0.05)

DCR: Direct composite restoration; ICR: Indirect ceramic restoration

There was no statistical difference between the satisfaction values of the two groups regarding treatment cost, time involved, pain, aesthetics, chewing ability, pleasantness, and general satisfaction (P > 0.05) (Table 4). The general satisfaction rate in the two groups was very high (DCR score = 9.76, ICR score = 9.88). In terms of the cost, the patients' satisfaction score decreased in both groups similarly (DCR score = 5.12, ICR score = 5.21). Patients were generally satisfied in terms of the time required for restoration of tooth (DCR score = 7.29, ICR score = 7.21), pain (DCR score = 9.09, ICR score = 8.44), aesthetics (DCR score = 9.38, ICR score = 9.27), chewing ability (DCR score = 9.53, ICR score = 9.59), and pleasantness (DCR score = 9.76, ICR score = 9.85).

Clinically, none of the restorations required replacement after 1 year of function.

No marginal discoloration, fracture of teeth, or restorations were observed. Only one tooth with class II composite restoration showed minor marginal chipping. This margin was adjusted using discs, and then, judged as clinically acceptable.

Discussion

The present study compared the impact of coronal restoration of premolars and molars using DCR and ICR on the patients' QoL and satisfaction. Both treatment methods supported high QoPL and satisfaction levels. Therefore, the null hypothesis was accepted.

Coronal restoration of ETT needs to take into consideration that reduced tooth structure results from caries, trauma, and cavity preparations. Especially, extensive access cavities may cause fracture of cusps, incisal margins, and vertical tooth fractures.^{9,17,25}

Table 3. The Oral Health Impact Profile-14 (OHIP-14) scores of direct composite restoration (DCR) vs. indirect ceramic restoration (ICR) groups as mean ± standard deviation (SD) and median (Q1-Q3) (Q1: The median of the lower half of the data, Q3: The median of the upper half of the data)

	DCR (n = 34)		ICR (n = 34)		P*
	Mean ± SD	Median (Q1-Q3)	Mean ± SD	Median (Q1-Q3)	
Functional limitation	0.06 ± 0.24	0 (0-0)	0.03 ± 0.17	0 (0-0)	0.558
Physical pain	0.32 ± 0.64	0 (0-0.3)	0.65 ± 1.61	0 (0-0)	0.926
Psychological discomfort	2.68 ± 2.01	3 (0-4.0)	1.97 ± 2.48	0.5 (0-4.0)	0.168
Physical disability	1.47 ± 1.78	0 (0-3.3)	1.47 ± 2.03	0 (0-4.0)	0.863
Psychological disability	0.24 ± 0.55	0 (0-0)	0.47 ± 1.02	0 (0-0.3)	0.476
Social disability	0.12 ± 0.41	0 (0-0)	0.35 ± 0.85	0 (0-0)	0.166
Handicap	0.15 ± 0.44	0 (0-0)	0.21 ± 0.77	0 (0-0)	0.745
Summary OHIP-14	5.03 ± 3.36	5 (2.8-7.0)	5.15 ± 6.17	3.5 (0-8.0)	0.408

*Mann-Whitney U test; statistically significant (P < 0.05).

DCR: Direct composite restoration; ICR: Indirect ceramic restoration; OHIP-14: Oral Health Impact Profile-14; SD: Standard deviation

Table 4. The semantic differential scale scores presenting patients satisfaction with direct composite restoration (DCR) vs. indirect ceramic restoration (ICR) as the mean \pm standard deviation (SD) and median (Q1-Q3) (Q1: The median of the lower half of the data, Q3: The median of the upper half of the data)

	DCR (n = 34)		ICR (n = 34)		P*
	Mean \pm SD	Median (Q1-Q3)	Mean \pm SD	Median (Q1-Q3)	
Cost	5.12 \pm 2.10	5 (3.8-6.0)	5.21 \pm 2.28	5 (3.8-7.0)	0.852
Time involved	7.29 \pm 2.65	8 (5.0-10.0)	7.21 \pm 2.84	8 (5.0-10.0)	0.980
Intraoperative pain	9.09 \pm 1.88	10 (9.0-10.0)	8.44 \pm 2.35	10 (8.0-10.0)	0.177
Postoperative aesthetics	9.38 \pm 1.13	10 (9.0-10.0)	9.27 \pm 1.31	10 (9.0-10.0)	0.654
Chewing ability	9.53 \pm 0.96	10 (9.0-10.0)	9.59 \pm 0.61	10 (9.0-10.0)	0.607
Pleasantness	9.76 \pm 0.55	10 (10.0-10.0)	9.85 \pm 0.44	10 (10.0-10.0)	0.485
General satisfaction	9.76 \pm 0.43	10 (9.8-10.0)	9.88 \pm 0.33	10 (10.0-10.0)	0.207

*Mann-Whitney U test; statistically significant ($P < 0.05$)

DCR: Direct composite restoration; ICR: Indirect ceramic restoration; SD: Standard deviation

Therefore, it is difficult for the dentist to decide which coronal restoration type to use after root canal treatment. Maximum preservation of healthy tooth structure and the use of restorative materials with mechanical properties similar to dental structure favor greater longevity of the tooth-restoration complex.²⁶ Several studies have compared existing methods in terms of clinical performance and longevity,^{3,4} but there is no study evaluating endodontically treated posterior teeth (ETPT) from the patient's point of view. Thus, the aim of this study was to compare the impact of coronal restoration of premolars and molars using DCR and ICR on the patients' QoL and satisfaction. At the end of the 1-year clinical function, patients reported similar mean scores of OHIP-14 (DCR = 5.03, ICR = 5.15) and general satisfaction (DCR = 9.76, ICR = 9.88). Additionally, restorations were clinically successful in the vast majority of the cases.

Cimilli et al. demonstrated that the QoL of endodontically treated patients was affected by pain;²⁷ therefore, in the present study, the patients who had a successful endodontic treatment with a negative response to percussion and palpation tests, no sense of pain, as well as no periapical lesion at the end of the first year, were selected for the study. Hamasha and Hatiwsh¹⁶ and Dugas et al.²⁸ reported that different treatment providers affected the QoL, and endodontists generated higher satisfaction among the patients. High satisfaction and QoL scores of this study can

be associated with the high qualified endodontic treatment results similar to those mentioned in previous studies.^{16,27,28}

Personal and social factors such as periodontal disease, education, gender, age, and nationality were associated with oral HRQoL (OHRQoL).²⁹ These factors were similar between the groups. Additionally, the patients who received other dental treatments were excluded from the study to prevent confusion while completing the OHIP-14 questionnaire. The exclusion of these aforementioned patients from the study benefited, as it was aimed to get results that reflected the truth about ICR and DCR.

The composite resin has been widely used as the restoration material for both anterior and posterior teeth.³⁰ However, when it comes to the restoration of the non-vital teeth, new materials and techniques have been developed for filling, and several studies have proved that the fracture resistance decreases in endodontic treatment related to the loss of tooth structure. Ceramic inlay/onlay has been shown as an alternative restoration option to composite resin material, because of many advantages such as aesthetics, resistance to compression and tensile, and biocompatibility.^{31,32} Abduo and Sambrook reported that ceramic inlay/onlay had a survival rate of 71.0%-98.5% after 5 years of clinical function. On the other hand, they also showed that the incidence of failure increased in the restoration of the non-vital teeth.³³ An in vitro study by Batalha-Silva et al. showed that both indirect and direct

restorations provided excellent fatigue resistance, while indirect restoration [computer-aided design (CAD)/computer-aided manufacturing (CAM)] showed a higher resistance.³⁴ Gokturk et al. compared various restorations of ETT, and reported that there was no difference between DCR and ICR in terms of fracture resistance.¹¹ Consistent with the results of the mentioned studies, after one-year occlusal function, almost all restorations were successful clinically. Chipping was observed in only one tooth of the composite restoration group.

The greatest dissatisfaction was related to the treatment cost item in this study. In our faculty, composite restorations costed two times less than inlay/onlay restorations. Despite this difference in treatment cost, both treatment options were neither cheap nor expensive from the patient's perspective (satisfaction scores: DCR = 5.12, ICR = 5.21). It can be explained that treatment cost is not a primary factor that affects the satisfaction of patients.

However, this study had also some limitations that need to be addressed. One of the limitations is that the baseline scores, which help to understand the improvement of the QoL, were not calculated. As the aim of this study was to assess only two treatment methods, if baseline scoring was done before endodontic treatment, the effect of

endodontic treatment would have been evaluated. If it was done after endodontic treatment, the qualification of temporary filling would be confusing in comparison of the groups.

Conclusion

According to the results of this study, there was no difference in the QoPL on the clinical performance of ETT with DCR or ICR. Further long-term prospective studies regarding both clinical performance and QoL assessment of ETT with direct/indirect restorative materials will provide additional data to support the validity of the restorative treatment decision.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

This cross-sectional clinical study was approved by the Ethics Committee of Istanbul Okan University (ethical code: 12122018/100). All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

References

1. Siqueira JF, Rocas IN, Alves FR, Campos LC. Periradicular status related to the quality of coronal restorations and root canal fillings in a Brazilian population. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2005; 100(3): 369-74.
2. Baba NZ, Goodacre CJ. Restoration of endodontically treated teeth: contemporary concepts and future perspectives. *Endod Topics* 2014; 31(1): 68-83.
3. Dammaschke T, Nykiel K, Sagheri D, Schafer E. Influence of coronal restorations on the fracture resistance of root canal-treated premolar and molar teeth: a retrospective study. *Aust Endod J* 2013; 39(2): 48-56.
4. Kopperud SE, Tveit AB, Gaarden T, Sandvik L, Espelid I. Longevity of posterior dental restorations and reasons for failure. *Eur J Oral Sci* 2012; 120(6): 539-48.
5. Han SH, Sadr A, Tagami J, Park SH. Internal adaptation of resin composites at two configurations: Influence of polymerization shrinkage and stress. *Dent Mater* 2016; 32(9): 1085-94.
6. Vohra F, Baloch H, Ab Ghani SM. Modern adhesive ceramic onlay, a predictable replacement of full veneer crowns: A report of three cases. *J Dow Univ Health Sci* 2014; 8(1): 35-40.
7. Desai PD, Das UK. Comparison of fracture resistance of teeth restored with ceramic inlay and resin composite: An in vitro study. *Indian J Dent Res* 2011; 22(6): 877.
8. Collares K, Correa MB, Laske M, Kramer E, Reiss B, Moraes RR, et al. A practice-based research network on the survival of ceramic inlay/onlay restorations. *Dent Mater* 2016; 32(5): 687-94.

9. Torres CRG, Mailart MC, Crastechini E, Feitosa FA, Esteves SRM, Di Nicolo R, et al. A randomized clinical trial of class II composite restorations using direct and semidirect techniques. *Clin Oral Investig* 2020; 24(2): 1053-63.
10. Shor A, Nicholls JI, Phillips KM, Libman WJ. Fatigue load of teeth restored with bonded direct composite and indirect ceramic inlays in MOD class II cavity preparations. *Int J Prosthodont* 2003; 16(1): 64-9.
11. Gokturk H, Karaarslan ES, Tekin E, Hologlu B, Sarikaya I. The effect of the different restorations on fracture resistance of root-filled premolars. *BMC Oral Health* 2018; 18(1): 196.
12. McGrath C, Bedi R. Population based norming of the UK oral health related quality of life measure (OHQoL-UK). *Br Dent J* 2002; 193(9): 521-4.
13. Pesaressi E, Villena RS, Frencken JE. Dental caries and oral health-related quality of life of 3-year-olds living in Lima, Peru. *Int J Paediatr Dent* 2020; 30(1): 57-65.
14. Sterenborg BMM, Bronkhorst EM, Wetselaar P, Lobbezoo F, Loomans BAC, Huysmans MDNJ. The influence of management of tooth wear on oral health-related quality of life. *Clin Oral Investig* 2018; 22(7): 2567-73.
15. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. *Community Dent Health* 1994; 11(1): 3-11.
16. Hamasha AA, Hatiwsh A. Quality of life and satisfaction of patients after nonsurgical primary root canal treatment provided by undergraduate students, graduate students and endodontic specialists. *Int Endod J* 2013; 46(12): 1131-9.
17. Kassis C, Houry P, Mehanna CZ, Baba NZ, Bou Chebel F, Daou M, et al. Effect of inlays, onlays and endocrown cavity design preparation on fracture resistance and fracture mode of endodontically treated teeth: An in vitro study. *J Prosthodont* 2021; 30(7): 625-31.
18. Liu P, McGrath C, Cheung GS. Improvement in oral health-related quality of life after endodontic treatment: A prospective longitudinal study. *J Endod* 2014; 40(6): 805-10.
19. Orstavik D, Kerekcs K, Eriksen HM. The periapical index: A scoring system for radiographic assessment of apical periodontitis. *Endod Dent Traumatol* 1986; 2(1): 20-34.
20. Su N, van Wijk A, Visscher CM. Psychosocial oral health-related quality of life impact: A systematic review. *J Oral Rehabil* 2021; 48(3): 282-92.
21. Slade GD. Derivation and validation of a short-form oral health impact profile. *Community Dent Oral Epidemiol* 1997; 25(4): 284-90.
22. Mumcu G, Inanc N, Ergun T, Ikiz K, Gunes M, Islek U, et al. Oral health related quality of life is affected by disease activity in Behcet's disease. *Oral Dis* 2006; 12(2): 145-51.
23. Allen PF. Assessment of oral health related quality of life. *Health Qual Life Outcomes* 2003; 1: 40.
24. Osgood CE, Suci GJ, Tannenbaum PH. *The Measurement of Meaning*. Champaign, IL: University of Illinois Press; 1957.
25. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature--Part 1. Composition and micro- and macrostructure alterations. *Quintessence Int* 2007; 38(9): 733-43.
26. Varlan C, Dimitriu B, Varlan V, Bodnar D, Suci I. Current opinions concerning the restoration of endodontically treated teeth: Basic principles. *J Med Life* 2009; 2(2): 165-72.
27. Cimilli H, Karacayli U, Pişman N, Kartal N, Mumcu G. Comparison of the oral health-related quality of life and dental pain in symptomatic irreversible pulpitis and pericoronitis. *J Dent Sci* 2012; 7(3): 250-60.
28. Dugas NN, Lawrence HP, Teplitsky P, Friedman S. Quality of life and satisfaction outcomes of endodontic treatment. *J Endod* 2002; 28(12): 819-27.
29. Sischo L, Broder HL. Oral health-related quality of life: What, why, how, and future implications. *J Dent Res* 2011; 90(11): 1264-70.
30. Rocca GT, Krejci I. Bonded indirect restorations for posterior teeth: from cavity preparation to provisionalization. *Quintessence Int* 2007; 38(5): 371-9.
31. Yamanel K, Caglar A, Gulsahi K, Ozden UA. Effects of different ceramic and composite materials on stress distribution in inlay and onlay cavities: 3-D finite element analysis. *Dent Mater J* 2009; 28(6): 661-70.
32. Murgueitio R, Bernal G. Three-year clinical follow-up of posterior teeth restored with leucite-reinforced ips empress onlays and partial veneer crowns. *J Prosthodont* 2012; 21(5): 340-5.
33. Abduo J, Sambrook RJ. Longevity of ceramic onlays: A systematic review. *J Esthet Restor Dent* 2018; 30(3): 193-215.
34. Batalha-Silva S, de Andrada MA, Maia HP, Magne P. Fatigue resistance and crack propensity of large MOD composite resin restorations: Direct versus CAD/CAM inlays. *Dent Mater* 2013; 29(3): 324-31.