RESEARCH

Comparison of Endodontic Treatment Qualities of Molar Teeth Performed by Endodontists and Practitioners: A Radiographic Analysis

Selen İnce Yusufoglu(0000-0002-7826-6023)[α], Esma Sarıçam(0000-0001-7701-4214)[α]

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ABSTRACT

Comparison of Endodontic Treatment Qualities of Molar Teeth Performed by Endodontists and Practitioners: A Radiographic Analysis

Background: The aim of this study was to evaluate the radiographic technical quality of root fillings and the incidence of iatrogenic errors in treatments performed by endodontists and dentists.

Methods: 1135 radiographic records of endodontic treatments performed by endodontists and dentists were qualified to be further investigated. Radiographs were assessed by two independent endodontists. The length and the density of the obturations and iatrogenic errors were investigated. Chi-square tests were used for statistics.

Results: According to iatrogenic errors; the presence of instrument fractures was significantly higher in the endodontists, and likewise, in the mesiobuccal canals of the mandibular teeth ($p<0.05$). dentists were found more likely to treat the root canal in poor radio-opacity and short filling-overfilling ($p<0.05$). no significant difference was found between the groups in other iatrogenic errors ($p>0.05$).

Conclusion: The results of this retrospective study show that the canal treatment performed by endodontists were better in terms of the quality of the root canal filling than dentists.

KEYWORDS

Endodontists, General dentists, Radiographic evaluation, Retrospective study root canal treatment

ÖZ

Endodontistler Ve Diş Hekimleri Tarafından Molar Dişlere Yapılan Endodontik Tedavilerin Kalitesinin Karşılaştırılması: Retrospektif Bir Çalışma

Amaç: Bu çalışmanın amacı, endodontistler ve diş hekimleri tarafından yapılan kanal tedavilerinde kök kanal dolgusunun radyografik teknik kalitesini ve iatrojenik hataların sıklığını değerlendirmektir.

Gereç ve Yöntemler: Endodontistler ve diş hekimleri tarafından yapılan 1135 adet kök kanal tedavisi yapılan dişlerin röntgen kaydı çalışmaya dahil edildi. Radyograflar iki uzman tarafından, kök kanal dolumlarının boyu, radyoopasitesi ve iatrojenik hataların varlığı olacak şekilde değerlendirildi. Istatistiksel olarak ki-kare testi kullanılarak analiz yapıldı.

Bulgular: İatrojenik hatalara göre; enstrüman kırıklarının varlığı endodontistlerde ve benzer şekilde mandibular dişlerin meziyobukkal kanallarında anlamlı olarak daha yüksek görüldü ($p<0.05$). Kanal dolum kalitesine bakıldığında dolumun radyoopaklığı ve dolumun boyu diş hekimi grubunda endodontistlere göre daha kötü olduğu görüldü ($p<0.05$). Diğer iatrojenik hatalarda gruplar arasında anlamlı fark bulunmadı ($p>0.05$).

Sonuç: Bu retrospektif çalışmanın sonuçlarına göre, endodontistler tarafından uygulanan kök kanal tedavisinin, kök kanal dolgusu kalitesi bakımından dişhekimlerinden daha iyi olduğunu göstermektedir.

ANAHTAR KELİMELER

Endodontist, Genel diş hekimi, Kök kanal tedavisi, Radyografik analiz, Retrospektif çalışma

Root canal treatment (RCT) is an essential part of dental health care.[1,2] As reported from many studies, the success rate of root canal treatments is >90%.[3,4] Given that the root canal treatment is performed by a general practitioner, this high success rate has been stated to decrease to 40-65%.[5] Previous studies have associated this decrease with inadequacy of the educational programs and lack of self-confidence of the practitioners during root canal procedures.[6,7] The success of root canal treatments depends on many factors, including the technical quality of RCT as one of the most important ones.[8,9]

The evaluation of the technical quality of RCT is commonly analyzed by radiographic examination.[10,11] Since the quality of the root canal filling affects the health of the periodontal tissues, the evaluation aforementioned is of crucial importance.[12,13] Radiographic evaluation of root canal obturation is dependent on the technical quality of root canal obturation.[14] The root canal obturation includes the distance between the end of the root apex, the length of RC filling-ending within 1-2 mm of the radiographic apex-[15] and density, presence of voids and taper.[11] Overfilling or inadequate filling of a root canal obturation will compromise the success rate of RCT.[16] Furthermore, the detection of other iatrogenic errors such as instrument fractures, ledge-zip formations, perforations, might cause failure of nonsurgical RCT.[2,4,12,15] Concurrently, procedural errors on the cleansing and preparation of the root canal have a negative effect on the success of the RCT by providing incomplete obturation.[17]

The main purpose of this retrospective radiographic analysis was to assess the obturation quality initial posterior RCTs performed by general dentists and

[α] Ankara Yıldırım Beyazıt University Faculty of Dentistry Departments of Endodontics, Ankara, Türkiye

endodontists in Turkey. Another purpose is to evaluate and to identify the presence of iatrogenic errors; and in the case of any iatrogenic error detection, to evaluate the frequency in which teeth the root canals were formed. The null hypothesis is that there is no difference between general dentists and endodontists in terms of the endodontic treatments.

MATERIALS AND METHODS

Case Selection

This study was approved by ethical committee for social and humanities subjects or specimens of Ankara Yıldırım Beyazıt University (reference no. 2018-245).

A random collection of dental radiographic records taken from Ankara Yıldırım Beyazıt University, Faculty of Dentistry, Tepebasi oral and Dental Health Education and Research Hospital, between the period from january 1, 2018 to july 1, 2018 were used; 535 of them treated endodontically by endodontists who had specialized training and had 10-15 years of experience after specialization, and 503 of them treated endodontically by general practitioners who had not specializated in any department and also had 10-15 years of experience after graduation of dentistry school. The examiners were blinded by randomly numbering the radiographs prior to analyses to provide de-identifying.

The inclusion criteria were the complete radiographic records of the teeth initial, trans-operatives (working length, master cone test) and the final radiograph of each endodontic treatment, with good radiographic technique or processing and the endodontic treatments of only molar tooth-type are included. The records having following criteria were exluded: incomplete radiographic records, poor or inadequate technical radiographic processing, and the overlapping of anatomic structures on the root canals. Root resorptions, calcifications, retreatments and incomplete root formation and third molars were also excluded. The endodontic treatments performed with the OneShape (MicroMega, Besançon, France) rotary file, and 2.5% sodium hypochlorite (Werax, İzmir, Turkey) solution was used for irrigation solution. Root canal obturation performed with single cone technique by using cones compatible with the root canal files. All canals filled with guttapercha cones and AH-26 (DentsplyMaillefer, Ballaigues, Switzerland) root canal sealer. Radiographs exposed using the bisecting angle technique. The radiographic procedure performed using a dental X-Ray unit (PlanmecaProX, Finland) at 50 kVp, 8 mA and 0.01 s exposure time and digital sensor (MPS, Progeny Dental, Buffalo Grove, USA). The digital software used is DigoraOptime (Soredex, USA) in which the researchers may use all options available in the software such as brightness, contrast adjustment, and magnification. No time limit was set for viewing the images.

Evaluation of the Complications of RCT

Two endodontists with >7 years of experience evaluated the records on the technical quality and procedural errors of RCT. The examiners used the following criteria for evaluation:

- Adequate root canal obturation- length of root canal obturation is ≤ 2 mm from the radiographic apex, with uniform radiodensity, free of voids and has good adaptation to root canal walls;
- Inadequate root canal obturation- any case containing a procedural error (root perforation, zipping, separated instrument); and any radiograph showing obturation with an irregular taper, large voids or termination beyond or greater than 2 mm from the radiographic apex were considered inadequat (Figure 1).

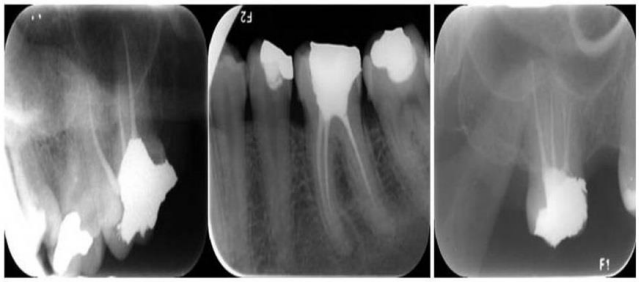

Figure 1

a) Adequate root canal treatment. b) inadequate root canal treatment (short fillings). c) Separated instruments at second mesiobuccal canal

All statistical analyses were performed by using the SPSS 21.0 software (*IBM Corp, Armonk, NY*). Statistical significance was defined at $p < 0.05$. Data were expressed in the form of frequencies and percentages. The chi-square test was used to determine statistically considerable differences in the technical quality of RCTs, and frequency of procedural errors between the two academic levels and among tooth types.

RESULTS

From the 3115 root canals treated by both general practitioners and endodontists, 1282 (41.2%) were acceptable and 1833 (58.8%) were unacceptable due to the evidence of procedural errors. The 1550 of 3115 root canals performed by general practitioners; 473 (31.3%) were acceptable and 1037 (68.7%) were unacceptable; 1605 root canals performed by endodontists, 809 (50.4%) of them were acceptable and 796 (49.6%) were unacceptable. A significant difference was observed between the performance of the endodontists and the performance of general

practitioners (p<0.05) (Table 1).

With regards to the root canal quality, inadequate treatments were more likely to occur in general practitioners (p<0.05, 62.7%). Concerning the procedural errors, the presence of separated instruments in both professions was 3.6% (p>0.05), and endodontists caused more incidences of separated instruments (p<0.05, 4.6%).

When all of the RCTs were evaluated, overfilling was observed statistically more in maxillary molar teeth (p<0.05, 4.5%) whereas shorter filling was found notably more frequent in mandibular molar teeth (p<0,05, 23.6%). In the mesiobuccal canals of the mandibular molar teeth, separated instruments were detected more often to a considerable extent (p<0.05, 7.3%). All of results were shown in Table-2 in which teeth overfilling was found, in which root canal separated instrument presence and short filling and ideal root canal treatment was found. No significant difference was found between the groups in terms of other procedural errors or teeth (p>0.05) (Table 2).

Table 1.

The difference between groups and iatrogenic errors and quality of RCT

	Group							
	Dentist (n=1510)		Endodontist (n=1605)		Total (n=3115)		Chi-square Analyses	
	n	%	n	%	n	%	Chi-square	p
ADEQUATE	473	31,3*	809	50,4*	1282	41,2	116,96	p=0,0001
INADEQUATE	1037	68,7	796	49,6	1833	58,8	116,96	p=0,0001
SEPARATED INSTRUMENTS	39	2,6	74	4,6*	113	3,6	9,1	0,002
APICAL LEDGES	6	0,4	8	0,5	14	0,4	0,024	0,878
APICAL PERFORATION(OVER FILLING)	45	3	70	4,4	115	3,7	4,1	0,041
LATERAL PERFORATION	1	0,1	2	0,1	3	0,1	Fisher's Exact	1
SHORT ROOT CANAL TREATMENT	352	23,3*	284	17,7	636	20,4	15,1	0,0001
DANSITY OF ROOT CANAL TREATMENT	947	62,7*	598	37,3	1545	49,6	201,6	0,0001

Table 2.

Relationship between teeth and procedural errors. D: Distal, MB: Mesiobuccal, ML: Mesiolingual M: Mesial, P: Palatinal root canals

	MANDIBULAR FIRST MOLAR								MANDIBULAR SECOND MOLAR							
	D (n=332)		MB (n=343)		ML (n=343)		Chi-Square		D (n=207)		MB (n=207)		ML (n=207)		Chi-Square	
	n	%	n	%	n	%	Chi-Square	p	n	%	n	%	n	%	Chi-Square	p
SEPARATED INSTRUMENTS	6	1,8	21	6,1	11	3,2	9,14	0,01*	2	1	19	9,2	10	4,8	14,736	0,001*
APICAL LEDGES	1	0,3	4	1,2	1	0,3	*	0.582	1	0,5	1	0,5	1	0,5	*	0.632
OVER FILLING	17	5,1	10	2,9	3	0,9	10,635	0,005*	11	5,3	6	2,9	2	1	7,089	0,029*
LATERAL PERFORATION	0	0	0	0	0	0	-	-	0	0	1	0,5	1	0,5	-	0,334
SHORT FILLING	60	18,1	94	27,4	106	30,9	15,552	0,0001*	21	10,1	49	23,7	57	27,5	21,222	0,0001*
DENSITY OF FILLING	177	53,3	170	49,6	176	51,3	0,951	0,622	92	44,4	104	50,2	100	48,3	1,446	0,485
	MAXILLARY FIRST MOLAR								MAXILLARY SECOND MOLAR							
	D (n=307)		M (n=307)		P (n=307)		Chi-Square		D (n=185)		M (n=185)		P (n=185)		Chi-Square	
	n	%	n	%	n	%	Chi-Square	p	n	%	n	%	n	%	Chi-Square	p
SEPARATED INSTRUMENTS	10	3,3	10	3,3	4	1,3	3,461	0,177	6	3,2	10	5,4	4	2,2	2,863	0,239
APICAL LEDGES	1	0,3	4	1,3	0	0	*	0.395	0	0	0	0	0	0	-	-
OVER FILLING	9	2,9	6	2	11	3,6	1504	0,471	9	4,9	13	7	18	9,7	3,287	0,193
LATERAL PERFORATION	0	0	1	0,3	0	0	*	0,67	0	0	0	0	0	0	-	-
SHORT FILLING	70	22,8	74	24,1	36	11,7	18,064	0,0001*	37	20	27	14,6	5	2,7	26,613	0,0001*
DENSITY OF FILLING	135	44	156	50,8	154	50,2	3,505	0,173	100	54,1	95	51,4	86	46,5	2,177	0,377

DISCUSSION

The technical quality and procedural errors of root canal fillings performed by endodontists and general dentists are subjected to radiographic evaluation. Routine procedural periapical radiographs (initial, intraoperative and postoperative) were used for the present study.

It is challenging to precisely evaluate the quality of root canal obturation by using only radiographic evaluation. Periapical radiographs, although the most commonly used determinant, do not reflect the 3-dimensional form of the root canal system. It is possible that obturation voids and missed canals, along with other evaluation criteria, were undetected, resulting in an overestimation of RCT obturation quality. Radiographic criteria for quality of RCT were evaluated in accordance with European guidelines and previous studies on the outcome of RCT.[12,15] On the radiographs, it is not possible to monitor all procedural errors. Over-instrumentation, for instance, which may push pulp remnants and microorganisms beyond the apex, causing acute apical periodontitis, can be detected by the use of radiographs only when it is followed by the extrusion of filling material but not during previous stages of RCT.[17]

In 41.2% of the cases in the present study, RCT was without procedural errors and exhibited technically adequate root canal obturation. This result differs somewhat from those of other studies, where the proportion of technically adequate root canal obturation varied from 23% to 96%.[18,19] These differences may be the result of differences in evaluation criteria, materials, educational system, methodology, and sample size between the present and previous studies. 58.8% of the treated teeth in this study exhibited procedural errors. The quality of root canal obturation or frequency of procedural errors differ vastly between endodontists and general dentists in the present study, indicating the effect of the academic level on the outcome is existent. The number of treatments of endodontists and of general practitioners producing acceptable root fillings differed immensely, with the former being larger. A previous study that obtained similar results also found that accredited postgraduate training resulted in improved treatment outcomes.[19] Postgraduate education, and the higher number of cases performed by endodontists compared to general dentists can be the reason for the endodontists' superior success at treatment quality.

Although the score was individually calculated for each root, since the tooth was considered as a unit, the failure of one root would lead to the failure of the tooth as a whole when determining the highest score possible of all roots.

1550 root canals were performed by general practitioners from which 1037 (68.7%) were unacceptable due to exhibition of procedural errors. There is a probable correlation between the reason of high percentage and inadequate chemomechanical preparation and/or obturation the root canals. The technique used for chemomechanical preparation was crown-down technique with OneShape Niti files, and for the filling of root canals was single cone technique. The endodontists and the general practitioners both used the same methods; however, the former complied with the methods and used lateral condensation of cold guttapercha for obturation where single cone was inadequate for the tight hermetic obturation. Furthermore, the single cone method may create voids assuming that the cone does not fit the root canal preparation. Different surveys have shown that general dentists do not follow guidelines instructed during their basic education.[7,20,21] It is known that the occurence of apical periodontitis is often associated with inadequate root canal obturation.[22]

In the present study, short filling in mesiolingual canals of mandibular molars was the most frequent procedural error (23.6%). Molars and especially mandibular molars are the subjects of procedural errors more frequently, generally having the lowest ratio of adequate to inadequate RCTs.[11,12,23] The reason might be the anatomical complexity of molars or insufficient chemomechanical preparation. In addition to this error resulted from inaccuracies in working length determination, where some of the dentists determined the working length based only on X-ray findings without using an electronic apex locator, some studies have determined that the accuracy of electronic apex locator has reached 97%.[24] Instrumentation mishaps such as ledges, blocking, and root canal transportation which reduces the efficiency of cleaning and shaping increase the possibility of short filling the root canal obturation[11] and cause adverse effects on healing process of apical periodontitis and prognosis of teeth[12]; yet in this study, ledge formation and blocking were not spotted because of using NiTi rotary systems.

In the present study, a recurrent procedural error was the existence of separated instruments (3.6%) located in mesiobuccal canals of mandibular molars. Supporting obtained results, other studies have stated that encountering procedural errors in mandibular molars is more probable.[11,12,23]; possibly as a result of the mentioned above. Among previous studies researching separated instruments, Khabaz et al. found separated instruments in 0.9% of the canals they examined[12] while Balto et al. reported the separated instrument as 0.5%[18] and Vukadinov et al. as 2.8%[25], which are again considerably lower compared to the present study. The high rate of separated instruments of this study might be attributed to Ni-Ti files. In this study, One Shape cyclic fatigue by ProTaper Next and Hyflex CM instruments than by the One Shape and Protaper Universal files[26], instead of OneShape files, Protaper Next and Hyflex CM might be adopted.

In the sample of the present study, maxillary molars especially palatinal canals were overfilled more commonly than other teeth. The root canal obturation of maxillary teeth was stated by other studies to be of better quality than that of mandibular teeth.[1] Nevertheless, supporting this study, AlRahabi[11] claimed the result of overfilling to be the missing of apical stop during cleaning and shaping because of the inadequacy of length control on root canal files.

The most common procedural errors encountered in this study were short filling (23.6%), overfilling (4.5%), and separated instruments (3.6%). Teeth formerly treated by endodontists suffered from more incidences of overfilling and separated instruments as found in this study, while the incidence of short filling was found be more likely to occur in teeth that had been treated by general dentists. From this study one can recognize that endodontists' treatments contain more separated instruments and overfilling; probable reasons being the endodontists' efforts to reach the root canal apex and better preparations. The patients that have cooperative problems or teeth with anatomical difficulties may be more applying to endodontists and these may be the reasons for more iatrogenic errors in endodontists group. Also due to the lack of adaptation in the palatinal root of the single cones, overfilling can be observed as a result of more pressure applications with the spreader during the lateral condensation technique especially in endodontists.The zygomatic arc and maxillary sinus superpositions around maxillary molar teeth could be deceptive for the decision of gutta-percha cone placement in the palatinal root canal of these teeth. The apex locaters may be giving false results in these root canals more than others. These errors can also be related to endodontists' overpreparing to achieve the ideal preparation. The short fillings in the treatments of general dentists may be associated with their concern of creating a separated instrument. General dentists make insufficient preparations due to the possibility of fracture of instruments where they encounter resistance during the root canal preparation, so it can result in short filling.

Other iatrogenic errors, apical ledges and lateral perforation rates were dependent on using rotary instruments and detection of the length of root canal well; making the difference between the statistics irrelevant.

This study evaluated the teeth obturated with single-cone technique. This is the limitation of this study. Further studies comparing the quality of endodontic treatments with other filling techniques in terms of endodontists and general dentists could be performed for this respect.

CONCLUSION

Within the limitations of the present study, it can be concluded that 68.7% of root canal fillings performed by dentists were radiographically inadequate, which is a satisfactory result, given the dentists' lack of experience and permission. Fractured instrument was the most common procedural error after short filling and mostly occurred at mesiobuccal canals of mandibular molars teeth. Endodontists caused more incidences of separated instruments and general dentists caused more incidences of short filling. The difference on other procedural errors was of no account.

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Corresponding Author:

Selen İNCE YUSUFOGLU
Ankara Yıldırım Beyazıt University
Faculty of Dentistry
Department of Endodontics,
Ankara, Turkey
Phone : +90 537 683 30 95
E-mail : dtselenince@hotmail.com