Selcuk Dental Journal 10/2 (Nisan 2023): 468-473

Research Article / Araştırma Makalesi

Technical quality of root canal treatment performed by undergraduate students using rotary instruments versus hand instruments: A Retrospective Study

Lisans Öğrencileri Tarafından Manuel Aletlere Karşı Döner Aletler Kullanılarak Gerçekleştirilen Kök Kanal Tedavisinin Teknik Kalitesi: Bir Retrospektif Çalışma

Alperen TEKİN[α](ORCID-0000-0002-0604-0287), **Yelda ERDEM HEPŞENOĞLU**[β](ORCID-0000-0003-1844-1288), **Şeyda ERŞAHAN**[β](ORCID-0000-0002-0354-5108), **Nur Sena ARIKAN**[β](ORCID-0000-0003-0830-1038)

[α]Istanbul Medipol University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Istanbul, Türkiye
[α]İstanbul Medipol Üniversitesi, Diş Hekimliği Fakültesi, Ağız Diş ve Çene Radyolojisi AD, İstanbul, Türkiye
[β]Istanbul Medipol University, Faculty of Dentistry, Department of Endodontics, Istanbul, Türkiye
[β]İstanbul Medipol Üniversitesi, Diş Hekimliği Fakültesi, Endodonti AD, İstanbul, Türkiye

ABSTRACT

Background: The technical quality of root canal treatment (RCT) may impact on the outcome. The quality of education received during undergraduate school may be linked to the quality of treatment provided in general dental practice.

Objective: To compare the technical quality of RCT where rotary or manual step-back canal preparatory technique was employed in an undergraduate dental clinic in Turkey. Additionally, the present study aimed to compare radiographically commonly seen complications in both instrumentation systems.

Materials and Methods: Dental records of 270 patients who received RCT undertaken by dental students were investigated by retrospective chart review. 565 root canals belonging to 270 patients were randomized into two groups [(rotary, n=280, and manual hand instruments, n=285)]. Root canal obturation was evaluated on the basis of the length of obturation being >2mm from the radiographic apex, with uniform radiodensity and good adaptation to root canal walls. Inadequate root canal obturation included cases containing procedural errors such as perforation, ledge, transportation, instrument separation. Descriptive statistics were used to define categorical variables (n, %) and the level of significance was set at 0.05.

Results: The technical quality of RCT performed by undergraduate dental students was classified as 'adequate' in 75% and 53.7% of the cases, respectively for rotary and manual groups, respectively ($p < 0.05$). The highest procedural errors were seen in molars. Occurrence of procedural errors differed significantly between the groups, being 6.4% in rotary group and 12.3% in manual group ($p = 0.017$). However, occurrence of ledge formation was higher in manual group than that of rotary group ($p = 0.007$).

Conclusion: In view of our findings, RCT performed by undergraduate dental students using rotary instrumentation systems is of higher technical quality and also has fewer procedural errors than manual instrumentation.

Key words: Rotary instrumentation; manual step-back instrumentation; root canal treatment; undergraduate dental students

ÖZ

Giriş: Kök kanal tedavisinin (KKT) teknik kalitesi sonucu etkileyebilir. Lisans eğitimi sırasında alınan eğitimin kalitesi, genel dişhekimliği pratiğinde sağlanan tedavinin kalitesi ile bağlantılı olabilir.

Amaç: Türkiye'deki bir lisans eğitimi veren diş kliniğinde döner veya manuel step-back kanal preparasyon tekniğinin kullanıldığı KKT teknik kalitesini karşılaştırmaktır. İlave olarak, bu çalışma, her iki şekillendirme sisteminde radyografik olarak sık görülen komplikasyonları karşılaştırmayı amaçlamıştır.

Gereç ve yöntemler: Dişhekimliği öğrencileri tarafından KKT uygulanan 270 hastanın diş kayıtları geriye dönük çizelge ile incelendi. 270 diş 565 kök rastgele iki gruba [(Rotasyon, n=280&Manuel, n=285)] ayrıldı. Kök kanal dolumu, dolum uzunluğunun radyografik apeksten >2 mm olması, radyodensite ve kök kanal duvarlarına adaptasyon açısından değerlendirildi. Yetersiz kök kanal dolgusu, perforasyon, basamak, transportasyon, alet kırığı gibi işlemsel hataları içeriyordu. Kategorik değişkenleri (n,%) tanımlamak için tanımlayıcı istatistikler kullanıldı ve anlamlılık düzeyi 0.05 olarak belirlendi. Bulgular: Lisans diş hekimliği öğrencileri tarafından gerçekleştirilen KKT'nin teknik kalitesi, rotasyon ve manuel grupları için sırasıyla vakaların %75'inde ve %53.7'sinde 'yeterli' olarak sınıflandırıldı ($p<0.05$). En yüksek işlem hataları büyük azı dişlerinde görüldü. Genel olarak prosedürel hataların oluşumu gruplar arasında anlamlı farklılık bulundu, rotasyon grubunda %6.4 ve manuel grupta %12.3 idi ($p = 0.017$). Bununla birlikte, manuel grupta basamak oluşumunun meydana gelmesi, rotasyon grubuna göre daha yüksekti ($p = 0.007$).

Sonuç: Bulgularımıza göre, lisans dişhekimliği öğrencileri tarafından döner enstrümantasyon sistemleri kullanılarak gerçekleştirilen KKT, daha yüksek teknik kaliteye sahiptir ve ayrıca manuel enstrümantasyondan daha az prosedür hatasına sahiptir.

Anahtar sözcükler: Döner enstrümantasyon; manuel step-back yöntemi ile şekillendirme; kök kanal tedavisi; lisans diş hekimliği öğrencileri

Introduction

Cleaning and shaping are the most significant step for a successful root canal treatment (RCT) because this determines the extent of the sterility of the root canal system and the possibility of achieving a satisfactory three-dimensional root filling.[1] Cleaning includes removal of the necrotic pulp chamber, microorganisms, debris, and infected dentin, while shaping contains widening of the canal to allow irrigation activation and to create space for canal filling.[2] Since it is difficult to remove all microorganisms from the canal walls in root canals with complex anatomy, various shaping techniques and instruments have been developed.[2] Conventional canal cleaning-shaping methods include hand instruments and irrigation solutions. Apical enlargement is performed by ISO normed 0.02 tapered stainless steel hand instruments with filing motion. The conical, flared form of the canal can be given by the step-back technique.[3] However, incorrect use of hand instruments in curved canals causes the canal to lose its natural form[3] and causes complications such as ledge formation, transportation, broken endodontic instruments, perforation, underfilling, or overfilling.[4] The success of the process with hand instruments largely depends on the clinician's skills.[5]

Due to its capability to keep the canal's natural curvature, rotary instruments are preferred instead of stainless-steel hand instruments.[6]

Gönderilme Tarihi/Received: 3 Ekim, 2022
Kabul Tarihi/Accepted: 4 Ocak, 2023
Yayınlanma Tarihi/Published: 21 Ağustos, 2023
Atıf Bilgisi/Cite this article as: Tekin A, Erdem Hepşenoğlu Y, Erşahan Ş, Arıklan NS. Technical quality of root canal treatment performed by undergraduate students using rotary instruments versus hand instruments: A Retrospective Study. Selcuk Dent J 2023;10(2): 468-473 Doi: 10.15311/ selcukdentj.1183747

Sorumlu yazar/Corresponding Author: Alperen TEKİN
E-mail: alperentekin@medipol.edu.tr
Doi: 10.15311/ selcukdentj.1183747

With the development of high torque NiTi (nickel-titanium) rotary instruments, canal shaping steps have been reduced and the total root canal treatment time has been shortened. Rotary instruments with various taper angles provide the appropriate conicity to the anatomy of the existing canal better than hand instruments.[5] Rotary NiTi file systems prepare canals in less time with fewer complications such as canal transportation, straightening, or perforations.[7] In root canal shaped using NiTi rotary instruments, procedural errors like working length loss, broken instrument, apical transportation, zip formation, strip perforation, and unnecessary root weakening are less common.[8]

Procedural errors in treatment adversely affect the shaping and cleaning cause insufficient root canal obturation that risks the treatment outcome.[9] The root canal therapy outcome may be affected by its technical quality. Factors affecting the technical quality of root canal fillings are obturation length, distance from the apex, homogeneity of the filling (no voids), canal conicity, and presence of procedural errors. To evaluate the technical quality of the RCT, most researchers use radiographic evaluation.[10] The quality of RCT is improved by teaching modern techniques and employing new materials in dental education. The performance of NiTi rotary systems in undergraduate dentistry education has been the focus of countless research.[11] The effectiveness of NiTi rotary instruments for the management of curved root canals, obtained from studies, has contributed to their use in the education of undergraduate dentistry students.[11] However, several factors such as the risk of broken instruments, perforation or deviation of the root canal, and cost limit the application of such techniques in undergraduate education.[11] Furthermore, those who are new to NiTi rotary file systems are worried about the rotation speed, fractured instrument, and screwing effect in the canal when using it for the first time.[12]

The objective of this study was to evaluate the technical quality of RCTs performed in an undergraduate dentistry clinic at Istanbul Medipol University, Turkey, using either a NiTi rotary or manual stainless steel hand instruments RCT preparation technique.

Materials and methods

Digital periapical radiographs of 270 patients who had RCT by dentistry students between 2018-2020 were obtained from Istanbul Medipol University, Department of Endodontics, and evaluated retrospectively. RCTs of patients were performed by 5th or 4th year undergraduate students within two academic years in the Faculty of Dentistry of Istanbul Medipol University.

The study was approved by Istanbul Medipol University Local Ethics Committee on 10/06/2021 and numbered E-10840098-772.02-2736. The research was done in complete compliance with the Helsinki Declaration. Written informed consent was received from all participants.

Periapical radiographs were taken with the Carestream RVG 5200 (Carestream Health, Inc.) device and analyzed with Kodak Dental Imaging Software. Radiographic evaluation of the RCT was performed twice by two researchers at different times. The results were then compared, and researchers have reached a consensus.

Five hundred sixty-five root canals belonging to 270 patients were randomized into two [(NiTi rotary, n=280, and manual stainless steel hand instruments, n=285)] groups. The treatment protocol of the manual group included working length determination with radiographs, instrumentation with 0.02 tapered K and H files (Kerr Endodontics, Orange, CA) using manual step-back technique, and irrigation with 2.5% sodium hypochlorite (NaOCl). Treatment protocol of the rotary group included working length determination with radiographs, instrumentation with VDW rotary files (VDW, München, Germany), and irrigation with 2.5% NaOCl. In all groups, root canal fillings have been carried out with gutta-percha and resin-based canal sealer AH Plus (Dentsply DeTrey GmbH, Konstanz, Germany) using lateral condensation.

The quality of RCT and iatrogenic errors were evaluated on periapical radiographs taken immediately after treatment. The evaluated data comprises the type of tooth treated, root filling length, ledge formation, perforation, and presence of broken instruments or voids. On periapical radiographs, the length of obturation was assessed by the distance from the radiographic apex. Obturation homogeneity was evaluated according to the adaptation of sealer and gutta percha to root canal walls. Completed RCT was classified as inadequate when it included any of the following in the final radiograph (Figure 1).

Figure 1. Some examples of iatrogenic errors in root canal treatment complications, **1a**. Ledge; **1b**. Broken instrument in the apical third of MB2 of an upper maxillary first molar; **1c**. Overfilling; **1d**. Transportation and apical perforation; **1e**. Coronal perforation; **1f**. Underfilling.

1. Ledge formation: If the root filling diverged from the canal's initial route and was shorter than the working length.[13]
2. Apical transportation: When the natural anatomic foramen of the apical canal is relocated on the external root surface.[14]
3. Apical perforation: When the filled canal's apical differed from the radiologic apex or the filling protruded through the apical foramen.[14]
4. Furcation perforation: Extrusion of filling material from the furcation.[13]
5. Strip perforation: When the interior wall of curved roots has filling material.[13]
6. Instrument Fracture: When an instrument piece was seen inside a canal.[13]
7. Zip formation: When the apical end of filling forms a teardrop shape on the outer wall.[14]
8. Overfilling: Extruded root filling from the apex.[15]
9. Underfilling: Canal filling was 2mm or shorter than the radiologic apex.[15]
10. Voids: Presence of the voids in obturation.

Descriptive statistics were used to define categorical variables (n,%) and the statistical level of significance was set at 0.05.

Results

Radiographic evaluation of the RCT was performed twice by two researchers at different times. The results were then compared, and researchers have reached a consensus.

In 210 (75%) teeth in the rotary group, RCT was successful and with no procedural errors. On the other hand, in 70 (25%) teeth in the rotary group, RCT was unsuccessful and detected procedural errors. The frequency of procedural errors in the rotary group was as follows: underfilling (more than 2 mm from the radiographic apex), 15 (5.4%); overfilling, 20, (7.1%); voids-nonhomogenous, 40 (14.3%); broken instruments, 5 (1.8%); apical perforation 4 (1,4); apical transportation, 10 (3.6%); and ledge formation, 4 (1.4%) (**Table 1**).

In 153 (53.7%) teeth in the manual group, RCT was successful and with no procedural errors. On the other hand, in 132 (46.3%) teeth in the manual group, RCT was unsuccessful and contained procedural errors. The frequency of procedural errors in the manual group was as follows: underfilling (more than 2 mm from the radiographic apex), 24 (8.4%); overfilling, 22 (7.7%); voids-nonhomogenous, 95 (33.3%); broken instruments, 9 (3.2%); apical perforation, 3 (1.1%); apical transportation, 17 (6%) and ledge formation 16 (5.6%) (**Table 1**).

Table 1. The frequency of demographic information and complications in both manual and rotary groups

		Manual		Rotary		p	
		n	%	n	%		
Grade of student	IV	69	48.6%	52	40.6%	0,189	X²
	V	73	51.4%	76	59.4%		
Tooth type	Anterior	14.Şub	15.8%	06.Şub	13.2%		X²
	Premolar	07.Şub	13.3%	24.Oca	8.6%		
	Molar	28.Şub	20.7%	07.Mar	23.9%		
Apical Transportation	(-)	268	94.0%	270	96.4%	0,182	X²
	(+)	17	6.0%	10	3.6%		
Ledge formation	(-)	25.Eyl	94.4%	02.Eki	98.6%	00.Oca	X²
	(+)	16.Oca	5.6%	04.Oca	1.4%		
Coronal	(-)	285	100.0%	280	100.0%	1	X²
	(+)	0	0.0%	0	0.0%		
Middle	(-)	11.Eki	100.0%	06.Eki	100.0%	01.Oca	X²
	(+)	00.Oca	0.0%	00.Oca	0.0%		
Apical	(-)	282	98.9%	276	98.6%	0,686	X²
	(+)	3	1.1%	4	1.4%		
Broken instrument	(-)	02.Eki	96.8%	01.Eki	98.2%	00.Oca	X²
	(+)	09.Oca	3.2%	05.Oca	1.8%		
Procedural errors	(-)	250	87.7%	262	93.6%	0,017	X²
	(+)	35	12.3%	18	6.4%		
Root canal filling quality	Adequate (no procedural error, 0-2mm length)	23.Tem	71.9%	14.Ağu	81.1%	00.Oca	X²
	Acceptable, (with procedural error, 0-2 mm length)	03.Şub	11.9%	18.Oca	6.4%		
	Underfilling,> 2 mm	24.Oca	8.4%	15.Oca	5.4%		
	Overfilling	22.Oca	7.7%	20.Oca	7.1%		
Homogenity of root canal filling	Nonomogeneous	95	33.3%	40	14.3%	0	X²
	Homogeneous	190	66.7%	240	85.7%		
Outcome of RCT*	Unsuccessful	11.May	46.3%	10.Mar	25.0%	00.Oca	X²
	Successful	01.Haz	53.7%	28.Tem	75.0%		

X² Chi-square test
**RCT: Root canal treatment*

There were significant differences in the frequency and type of procedural errors between the manual and rotary preparation types ($p < 0.05$). The prevalence of complications was significantly higher in the manual group than that in the rotary group ($p < 0.05$). The technical quality of RCT done by 5th or 4th year undergraduate students were classified as successful in 75% and 53.7% of the cases, respectively for rotary and manual groups (**Figure 2**). There was a significant difference between the two groups concerning the technical quality ($p = 0.017$). The occurrence of ledge formation was statistically significantly higher in the manual group than that of rotary group ($p = 0.007$). There was no significant difference between manual and rotary groups regarding instrument breakage ($p = 0.294$). The homogeneity of root canal fillings (without voids) in the rotary group was significantly higher than that of the manual group ($p = 0.000$). The success rate of RCT in the rotary group was significantly higher than that of the manual group ($p = 0.000$).

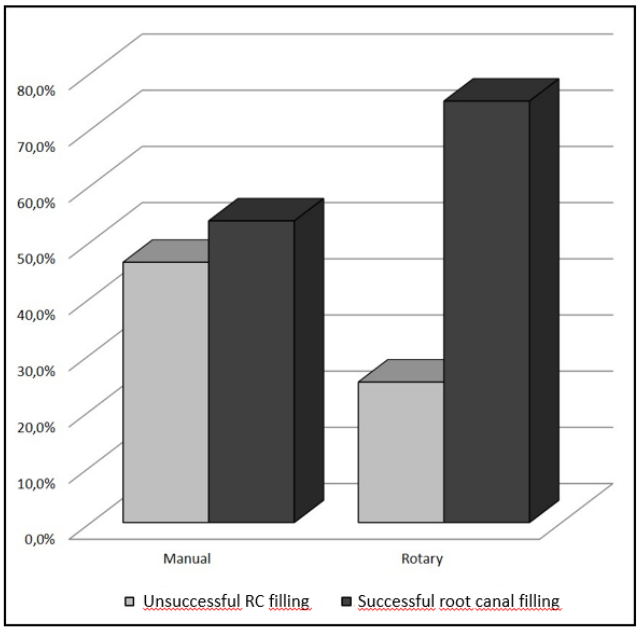

Figure 2. Technical quality of RCT in both manual and rotary groups.

Discussion

This study was designed to evaluate the technical quality of RCTs completed by undergraduate students in Istanbul Medipol University. It was attempted to determine which had the higher success rate by comparing hand files versus rotary files. For this study, digital periapical radiographs were taken after the RCTs were collected. The technical quality of RCT has been shown to affect the outcome of RCT and the health of the peri radicular tissues.[11] In addition, procedural errors encountered by students in this study are listed. Procedural errors are a significant determinant in endodontically treated teeth' long-term survival.[16]

According to the evaluated periapical radiographs, 76.73% of the canals performed by the students were classified as adequate (71.9% of them with manual technique and 81.1% of them with rotary instrumentation). In a detailed analysis, 75% of the rotary group and 53.7% of the manual group were found to be successful. Procedural errors occurred in 12.3% of the canals in the manual group and 6.4% of the canals in the rotary group. In this study, the most common iatrogenic error was underfilling (8.4%) in the manual group and overfilling (7.1%) in the rotary group. In previous studies, different evaluations were used to classify RCTs as adequate or inadequate. Some studies have only examined the obturation length for adequate filling assessment,[17] but most studies have also examined lateral condensation along with root filling length.[9,18] In this study, we accepted criteria of the obturation length being 0-2 mm proximity to the radiographic apex, homogeneous density, satisfactory adaptation to root canal walls, and without procedural errors as successful.

Homogeneous filling was reported in 77.3% and acceptable filling length was reported in 85.3% of the root canals, amongst the 565 RCTs examined. The relationship between filling uniformity and prognosis is not evident like the filling length to the radiologic apex.[14] Some of the studies have shown uniform and nonuniform root fillings had the same prognosis.[19] Besides other studies have shown nonuniform and less compact fillings negatively affect the success of the treatment.[20]

In the manual group, the percentages of canal filling lengths that were adequate (no procedural error), 0-2mm short with procedural error, >2mm short, and overfilling were 71.9%, 11.9%, 8.4%, 7.7%, respectively. In the rotary group, the percentages of canal filling lengths that were adequate (no procedural error), 0-2mm short, >2mm short, and overfilling were 81.1%, 6.4%, 5.4%, 7.1%, respectively. The canal filling length greatly affects the healing rates. According to Sjogren et al.[19] and Smith et al.[21], the healing

rates of RCTs ending 0-2 mm to the radiographic apex were found to be successful with 87-94%. The healing rates of underfillings and overfillings were 68-77.6% and 75-76%, respectively. Non-void and homogeneous canal fillings were associated with lower levels of disease recurrence.[20]

Many researchers have stated the benefits of rotary preparation with NiTi canal instruments over manual hand preparation, both for experts and novice operators.[22] Although many studies are demonstrating the superiority of NiTi rotary files in RCTs, most countries still train students using the step-back technique with stainless steel hand instruments.

In this study ledge formation incidence was 5.6% for manual step-back technique and 1.4% for rotary technique. According to the research of Eleftheriadis & Lambrianidis,[16] ledge formation was observed in 154 of the 620 root canals (24.8%) shaped with step-back technique in the student clinic. In the same study, anterior and premolars had less ledge formation than molars. According to Kapalas et al.[4], ledge formation occurred in 51.5% of the canals treated by undergraduates, even working under guidance. Also, in the same study, specialized endodontists demonstrated a significant incidence rate of the ledge of 33.2% of treated teeth even though they had higher clinical skills. The researchers found that the most important cause of step formation is the canal curvature.[16] Like our research, Sonntag et al.[23] found out that 11.3% of the manual NiTi group and 5.3% of the rotary NiTi group had ledges. Additionally, zip formation was seen in 47.3% of the manual NiTi group and 17.3% of the rotary NiTi group in the same study. It has been proven by various studies that ledge and zip formation in hand files is higher.[24] Supporting the results of our study, Kum et al.[25] compared rotary NiTi files and manual stainless steel hand files in extremely curved canals. As a result, less canal transportation, less canal deflection, less instrumentation time, and better preservation of working length were observed with the use of rotary Nİ-Ti instruments .[25] Less transportation in canals shaped with NiTi rotary files could be due to the crown-down technique, which has various advantages over the step-back technique. The great flexibility of NiTi instruments, lowers the possibility of canal transportation for curved canal shaping.[25]

In this study, fracture incidence was 3.2% for the manual step-back technique and 1.8% for the rotary technique. Contrary to our study, Alrahabi[24] found that instrument fracture incidence was 5.56% and 1.1% for NiTi rotary instruments and stainless steel files, respectively. According to Iqbal et al.[26], the frequency of instrument fracture is seven times higher for rotary NiTi instrumentation than hand instruments. But in this study, there was no significant difference in the rate of broken instruments in the manual or rotary groups. According to Sonntag et al.[23], even though the novice operators created more fractures, they accomplished better RCTs with rotary NiTi instruments compared to hand files. The percentage of broken NiTi rotary instruments ranges from 3.7 % to 13.3 % in undergraduate researches.[22,23] Instrument fracture can be caused by improper file use and a lack of experience.[27] Experience is the most essential element determining error rates in rotary files.[27]

In other studies, evaluating RCT done by undergraduate students, the most common iatrogenic error detected was the ledge formation.[15] Indeed, we found a high incidence of apical transportation for both manual (6.0%) and rotary (3.6%) techniques. It has also been shown that canal transportation is associated with root canal leaking.[28]

In this study, we found out that 27.6% of the canals had nonhomogeneous density. 33.3% of non-homogeneous fillings were found in the manual group and 14.3% in the rotary group. Kirkevang et al.[19] stated that insufficient compactness of the filling causes microleakage along with the root filling, resulting in failed treatment. Likewise, Eriksen & Bjertness[29] found that the recurrence of apical periodontitis was higher in poor filling densities.

In this study, the most common iatrogenic error was underfilling (8.4%) in the manual group and overfilling (7.1%) in the rotary group. Alamoudi et al.[13] reported that iatrogenic errors such as underfilling, ledge formation, overfilling, fractured instruments were found 8.4%, 4.2%, 4%, and 3%, respectively. Underfilling may occur due to ledge formation or insufficient shaping. Insufficient shaping results from inaccurate working length or debris blockage in the apical.[30]

Some researchers stated that stainless steel files cause more apical transportation than nickel-titanium files.[31] The active tips of the rigid stainless steel files cut dentine on the inner side of the curve, forcing the canal to straighten and formation of ledges.[31] Khabbaz et al.[15] reported root perforation in 11.8% of the cases and apical foramen perforation in 32.6% of the cases treated by undergraduate students. Perforation may damage the periodontal ligament and the alveolar bone, as a result, recovery is adversely affected.[15]

In a study evaluating the canals treated by Turkish undergraduate students with hand files in 2006, the successful root canal filling rate was found to be 33%.32 But, in this study, 53.7% of the cases in the manual group and 75% of the cases in the rotary group were classified as successful root fillings. The differences in results may be due to the differences between educational systems, materials used for instrumentation and obturation.

One of the limitations of our study was that we made our evaluation only with periapical radiographs, which are two-dimensional imaging methods.[33] It is impossible to separate anatomical structures that are superimposed, such as the root canals. Furthermore, the length of the root canal fills may not be correctly represented. To avoid misunderstanding, radiographs with superimposed canals or anatomical structures were discarded. If the CBCT images of the patients were evaluated for three-dimensional imaging, different results could have been obtained. Nevertheless, Alves et al.[34] found no significant difference in the detection of iatrogenic errors in different imaging methods in his study. Due to its high radiation and cost, CBCT imaging is not always preferred. Other studies showed that the periapical radiograph is the gold standard when evaluating the quality of RCT.[16,32,33] Even though the radiological evaluation of the RCT is critical for treatment's result, the main factor is the antiseptic environment in which the treatment is performed, and the materials used.[35] Another limitation of our study is that there is no standardization in apical diameter, canal taper, working time, etc., so it is not possible to make a complete comparison in the research. It will be useful to standardize and re-examine all variables in future randomized controlled studies.

Before beginning clinical practice, it is critical to master theoretical knowledge of endodontic principles as well as preclinical practice. In Istanbul Medipol University, students take the preclinical course for 200 hours. In preclinical course, students work on extracted teeth with both hand and rotary files. Student training should be improved in both instrumentation techniques for better treatment outcomes. Self-assessment of the quality of RCT should be included in the curriculum to improve preclinical and clinical endodontic instruction, as students should be able to determine the quality of their work and maintain or improve it after graduation.[33]

Current undergraduate students will be future clinicians, so regular evaluation of undergraduate students' work will determine the quality of future RCTs.[21] To increase the success rates of RCT performed in student clinics, modern treatment methods should be taught to students as well as traditional treatment methods, and the opportunities provided by modern technology should be utilized. The use of rotary files, endo motors, apex locators, and modern materials in the student clinic should be expanded in all universities. After graduation, students should know the materials and methods that suit the needs of both the patients and their own.

Conclusion

In view of our findings, RCT performed by undergraduate dental students using rotary instrumentation systems is of higher technical quality and also has fewer procedural errors than manual instrumentation. It has been shown that the shaping capabilities of rotary NiTi files are superior to the hand files, even when used by students, but still there is a need for improvement in the training of students at the preclinical and clinical levels for both instrumentation techniques.

Değerlendirme / Peer-Review

İki Dış Hakem / Çift Taraflı Körleme

Etik Beyan / Ethical statement

Teşekkür Bu çalışma 1. Uluslararası Türk Japonya Diş Hekimleri Birliği Kongresi'nde sözlü bildiri olarak sunulmuştur (25 Haziran 2021, Türkiye).

Acknowledgements This study was presented in the 1th International Turkish Japan Dental Association Congreess as an oral presentation (25 June 2021, Turkey).

Benzerlik Taraması / Similarity scan

Yapıldı – ithenticate

Etik Bildirim / Ethical statement

ethic.selcukdentaljournal@hotmail.com

Finansman / Grant Support

Yazarlar bu çalışma için finansal destek almadığını beyan etmiştir. | The authors declared that this study has received no financial support.

Çıkar Çatışması / Conflict of Interest

Yazarlar çıkar çatışması bildirmemiştir. | The authors have no conflict of interest to declare.

Yazar Katkıları / Author Contributions

Çalışmanın Tasarlanması | Design of Study: AT(%60), YEH (%40)
Veri Toplanması | Data Acquisition: AT (%50), YEH (%50)
Veri Analizi | Data Analysis: AT (%75), ŞE (%25)
Makalenin Yazımı | Writing up: AT (%70), NSA (%15), ŞE (%15)
Makale Gönderimi ve Revizyonu | Submission and Revision: NSA (%40), ŞE (%30), YEH (%30)

KAYNAKLAR

1. Ahmed MA, Dall AQ, Khoso NA, Jouhar R. Comparison of post-operative pain by using ProTaper rotary and manual step-back root canal preparation techniques in single visit endodontics. J Pak Dent Assoc. 2012;21:103–107.
2. Viana, F. L. P., Souza, T. A., Sampieri, M. B. S., & Vasconcelos, B. C. Endodontic treatment of hypertaurodontic teeth with anatomical variations. General dentistry. 2021.
3. Saunders EM. Hand instrumentation in root canal preparation. Endodontic Topics 2005;10:163-7.
4. Kapalas A, Lambrianidis T. Factors associated with root canal ledging during instrumentation. Endod Dent Traumatol 2000; 16: 229–231.
5. Krishna PP, Beena RG, Bharani DP. A comparison of root canal preparations using stainless steel, NiTi hand and NiTi engine-driven endodontic instruments – An in vitro study. Bangladesh J Med Sci. 2010;9:223–230.
6. Schäfer E, Lohmann D. Efficiency of rotary nickel-titanium FlexMaster instruments compared with stainless steel hand K-Flexofile--Part 1. Shaping ability in simulated curved canals. Int Endod J. 2002;35(6):505-513.
7. Song YL, Bian Z, Fan B, Fan MW, Gutmann JL, Peng B. A comparison of instrument centering ability within the root canal for three contemporary instrumentation techniques. Int Endod J. 2004;37:265–71.
8. Esposito PT, Cunningham CJ. A comparison of canal preparation with nickel titanium and stainlesssteel instruments. J Endod. 1995;21:173-76.
9. Hülsmann M, Herbst U, Schäfers F. Comparative study of root canal preparation using Lightspeed and Quantec SC rotary NiTi instruments. Int Endod J 2003;36:748-56.
10. Lambrianidis T. Risk Management in Root Canal Treatment. Thessaloniki, Greece: University Studio Press.;2001
11. Saunders WP, Saunders EM, Sadiq J, Cruickshank E. Technical standard of root canal treatment in an adult Scottish sub-population. Br Dent J. 1997;182(10):382-386.
12. De Alencar AH, Dummer PM, Oliveira HC, Pécora JD, Estrela C. Procedural errors during root canal preparation using rotary NiTi instruments detected by periapical radiography and cone beam computed tomography. Braz Dent J. 2010;21(6):543-9.
13. Bjorndal L, Reit C. The adoption of new endodontic technology amongst Danish general dental practitioners. Int Endod J 2005;38:52–8.
14. Alamoudi RA, Alharbi AH, Farie GA, Fahim O. The value of assessing case difficulty and its effect on endodontic iatrogenic errors: a retrospective cross-sectional study. Libyan J Med. 2020;15(1):1688916.
15. Khabbaz MG, Protogerou E, Douka E. Radiographic quality of root fillings performed by undergraduate students. Int Endod J. 2010;43(6):499-508.
16. Eleftheriadis GI, Lambrianidis TP. Technical quality of root canal treatment and detection of iatrogenic errors in an undergraduate dental clinic. Int Endod J. 2005;38(10):725–734.
17. De Cleen MJ, Schuurs AH, Wesselink PR, Wu MK. Periapical status and prevalence of endodontic treatment in an adult Dutch population. Int Endod J. 1993;26(2):112-119.
18. Kirkevang LL, Hörsted-Bindslev P, Orstavik D, Wenzel A. A comparison of the quality of root canal treatment in two Danish subpopulations examined 1974-75 and 1997-98. Int Endod J. 2001;34(8):607-612.
19. Sjogren U, Hagglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990;16(10):498-504
20. Chugal NM, Clive JM, Spångberg LS. Endodontic infection: some biologic and treatment factors associated with outcome. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;96(1):81-90.
21. Smith CS, Setchell DJ, Harty FJ. Factors influencing the success of conventional root canal therapy--a five-year retrospective study. Int Endod J. 1993;26(6):321-333.
22. Baumann, M.A. and A. Roth, Effect of experience on quality of canal preparation with rotary nickel-titanium files. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 1999.88(6): p. 714–718.
23. Sonntag D, Delschen S, Stachniss V. Root-canal shaping with manual and rotary Ni-Ti files performed by students. Int Endod J. 2003;36(11):715-723.
24. Alrahabi M. Comparative study of root-canal shaping with stainless steel and rotary NiTi files performed by preclinical dental students. Technol Health Care. 2015;23(3):257-265.
25. Kum KY, Spängberg L, Cha BY, et al. Shaping ability of three ProFile rotary instrumentation techniques in simulated resin root canals. J Endod. 2000;26(12):719-723.
26. Iqbal MK, Kohli MR, Kim JS. A retrospective clinical study of incidence of root canal instrument separation in an endodontics graduate program: a PennEndo database study. J Endod. 2006;32(11):1048-1052.
27. Yared GM, Bou Dagher FE, Machtou P. Failure of ProFile instruments used with high and low torque motors. Int Endod J. 2001;34(6):471-475.
28. Wu MK, Fan B, Wesselink PR. Leakage along apical root fillings in curved root canals. Part I: effects of apical transportation on seal of root fillings. J Endod. 2000;26(4):210-216.
29. Eriksen HM, Bjertness E. Prevalence of apical periodontitis and results of endodontic treatment in middle-aged adults in Norway. Endod Dent Traumatol. 1991;7(1):1-4.
30. Lin LM, Rosenberg PA, Lin J. Do procedural errors cause endodontic treatment failure?. J Am Dent Assoc. 2005;136(2):187-231.
31. Miserendino LJ, Moser JB, Heuer MA, Osetek EM. Cutting efficiency of endodontic instruments. Part 1: a quantitative comparison of the tip and fluted regions. J Endod. 1985;11(10):435-441.
32. Er O, Sagsen B, Maden M, et al. Radiographic technical quality of root fillings performed by dental students in Turkey. Int Endod J. 2006;39(11):867–872.
33. Vukadinov T, Blažić L, Kantardžić I, Lainović T. Technical quality of root fillings performed by undergraduate students: a radiographic study. ScientificWorldJournal. 2014;2014:751274.
34. Alves RAA, Souza JB, Alencar AHG, et al. Detection of procedural errors with stainless steel and NiTi instruments by undergraduate students using conventional radiograph and cone beam computed tomography. Iran Endod J. 2013;8(4):160.
35. Eriksen HM, Kirkevang L-L, Petersson K. Endodontic epidemiology and treatment outcome: general considerations. Endodontic Topics 2002;2: 1–9.