Caspian J of Dent Res

Original Article

Comparative evaluation of fracture and defect in reciproc and rotary files in severe curved root canals

Mahdis Bagherian[1], Abbas Mesgarani(DDS)[2]✉,Sina Haghanifar(DDS)[3],Ali Soleimani(DDS)[4], Sina Mirzaeerad(DDS)[4], Soraya Khafri(PhD)[5], Maryam Ehsani(DDS)[6]

1. Dental Student, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
2. Assistant Professor, Dental Materials Research Center, Department of Endodontics, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
3. Associate Professor, Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
4. Assistant Professor, Department of Endodontics, Faculty of Dentistry, Babol University of Medical Sciences, Babol- Iran.
5. Assistant Professor, Department of Social Medicine and Health, Faculty of Medicine, Babol University of Medical Sciences, Babol-Iran.
6. Associate Professor, Dental Materials Research Center, Department of Endodontics, Faculty of Dentistry ,Babol University of Medical Sciences, Babol- Iran.

✉**Corresponding Author:** Abbas Mesgarani, Faculty of Dentistry, Babol University of Medical Sciences, Babol-Iran.
Email: a_mesgarani@yahoo.com **Tel:** +981132291408-9

Received: 18 Oct 2014 **Accepted: 15 Feb 2015**

Abstract

Introduction: Root canal instrumentation is an important phase in root canal therapy. Since success in endodontic treatment depends on file defect and fracture, the aim of this study was to compare the evaluation of defect and fracture in rotary and reciproc files in severe curved root canals.

Materials &Methods: In this experimental study, 60 mesial canals of human closed apex molars with more than 30° canal curvature were randomly divided into two groups. In first group M-two rotary files number# 15, 20, and 25 and in second group R25 reciproc file were used for filing, respectively. A ×8 magnifier was applied to evaluate the defect or fracture presence in each side and if it were observed, a new file would be replaced. Therefore, the number of prepared canals with each file and fractured or defective files and the place of fracture in root canal were recorded. Kaplan Meier curve and log rank test were done by using SPSS v.22.

Results: In rotary group, seven and two files were fractured and defected, respectively and four files were fractured and no defect was observed in reciproc group. Although the mean of the number of prepared canals until fracture or defect in rotary and reciproc groups was 3.3 and 7.06, respectively, there were no significant differences between two systems. All file's fractures occurred in apical regions.

Conclusion: The results showed that there was no significant difference in defects or fractures of rotary and reciproc systems. Reciproc instruments can be more effective than rotary ones because the root canal preparation in rotary instruments is longer than in reciproc system.

Keywords: Root canal preparation, Root canal therapy, Tooth root, Root canal

Citation for article: Bagherian M, Mesgarani A, Haghanifar S, Soleimani A, Mirzaeerad S Khafri S, et al. Comparative evaluation of fracture and defect in reciproc and rotary files in severe curved root canals. Caspian J Dent Res 2015; 4: 30-6.

[Downloaded from cjdr.ir on 2026-10-06]
[DOR: 20.1001.1.22519890.2015.4.1.7.4]
[DOI: 10.22088/cjdr.4.1.30]

بررسی مقایسه ای ایجاد نقص و شکستگی در فایل های reciproc وrotary در کانال های با انحنای شدید

مهدیس باقریان، عباس مسگرانی*، سینا حقانی فر، علی سلیمانی، سینا میرزایی راد، ثریا خفری، مریم احسانی

چکیده

مقدمه: آماده سازی کانال ریشه دندان یکی از مهمترین مراحل در طی درمان کانال ریشه می باشد، با توجه به اینکه کاهش نقص و شکست در فایل ها سبب موفقیت بیشتر در درمان ریشه دندان می شود. هدف از این مطالعه بررسی مقایسه ای نقص و شکست در فایل های rotary و reciproc در کانال های ریشه دندان با انحنای شدید می باشد.

مواد و روش ها: در این مطالعه آزمایشگاهی ۶۰کانال مزیال دندان های مولر انسانی با اپکس بسته و انحنای کانال بالای ۳۰° به دو گروه تقسیم شدند: در گروه اول از فایل های rotaryM-two شماره ۲۵،۲۰،۱۵و در گروه دوم از فایل (R25) رسیپروک برای فایلینگ کانال ها استفاده گردید. به دنبال استفاده از هر فایل جهت بررسی وجود نقص یا شکست از ذره بین ۸× در جهات مختلف بررسی صورت پذیرفت و در صورت مشاهده هر گونه نقص یا شکست، فایل جدید جایگزین می گردید. به این ترتیب شمار کانال های آماده سازی شده با هر فایل، تعداد فایل های دچار نقص یا شکست و نیز محل شکستگی فایل در کانال ریشه در هر دو گروه ثبت شد، سپس با استفاده از نرم افزار SPSS ورژن۲۲ منحنی بقای کاپلن مایر برای هر گروه رسم شده و از آزمون لوگ رانک برای مقایسه میان دو گروه استفاده گردید.

یافته ها: در مجموع ۹ فایل در سیستم روتاری دچار نقص و شکست شدند (۷ فایل دچار شکست و ۲ فایل دچار نقص شدند.) در سیستم رسیپروک ۴ فایل دچار شکست شده و موردی از نقصی مشاهده نگردید. میانگین شمار کانال های آماده سازی شده تا زمان نقص یا شکست در سیستم روتاری ۳/۳ و در گروه رسیپروک ۷/۰۶ بوده اما اختلاف بین دو گروه معنادار نبود. در هر دو سیستم rotary و reciproc تمامی فایل ها در یک سوم اپیکالی دچار شکست شدند.

نتیجه گیری: با توجه به اینکه میزان نقص و شکست فایل ها در دو سیستم rotary و reciproc اختلاف معناداری نداشته، استفاده از سیستم تک فایلی reciproc به دلیل سرعت بالاتر در آماده سازی کانال با انحنای شدید به صرفه تر می باشد.

واژگان کلیدی: آماده سازی کانال ریشه، درمان کانال ریشه، ریشه دندان، کانال ریشه

Introduction

Root canal instrumentation is an important phase during root canal therapy (RCT).[1] Canal instrumentation is necessary to clean and shape properly in RCT.[2] In recent years, the instruments have better flexibility and cutting in compare to hand files.[3] Superelastic ability of rotary files creates a tapered shape and decreases the possibility of transportation.[4-6]But the main challenge is that the flexion and torsion can lead to fracture of Ni-Ti rotary instruments.[7] Torsional fracture happens when the tip of instrument bends during file movement into the root canal and flexural fracture occurs during rotation of instrument into the curved root canal.[8,9] Inan et al's study on the evaluation of deformation and fracture of Ni-Ti rotary instruments after clinical use indicated that the fracture and deformation were detected in 25.80% of used files and fracture was found in 16.2% of files.[10] To improve the fracture resistance of Ni-Ti rotary files, manufacturers have introduced instruments with new alloys and reciprocal movement.[11,12] Reciprocal movement increases the useful life span and resistance in compare to continuous movement.[13,14] In reciproc system, instruments have been prepared by particular motor and unchangeable setting (reciproc all mode). In this system, file movement is 150° Counter - clockwise and 30°C clockwise.[7] Furthermore, Reciproc instruments require less time than M-two instruments for curved canal preparation.[15] Also, the study of Kiefner et al on the ability of reciprocal movement on cyclic fatigue resistance indicated that

[Downloaded from cjdr.ir on 2026-10-06]
[DOR: 20.1001.1.22519890.2015.4.1.7.4]
[DOI: 10.22088/cjdr.4.1.30]

using reciprocal movements increases the cyclic fatigue resistance in Ni-Ti instruments.[16] According to the fact that the decrease of defect or fracture leads to more success in RCT, the aim of this study was to compare the evaluation of defect and fracture in reciproc and rotary instruments in severe curved canals.

Methods

In this experimental study, 67 teeth with more than 30° canal curvature were selected among many extracted first and second molars of maxillary and mandibular. "The angle and radius of canal curvature (Mesial canals of mandibular molars and mesiobuccal canal of maxillary molars) were calculated with Auto CAD software and Pruett method. [17] "According to inclusion criteria, 60 canals were used.

Inclusion criteria

1. Mature root and closed apex,
2. Canal curvature>30°,
3. Root canal without accessory canals,
4. Canal without external root resorption or root caries.

In addition, the presence of clear curvature in more than one side of root canal was determined as exclusion criteria. Digital radiography (PSP, Soredex, Finland) was taken from the teeth for ruling out internal root resorption or canal curvature in more than one side and other anomalies in mesial canals of mandibular and maxillary molars.

Teeth were disinfected and put in hypochlorite 5.25% (Golrang, Iran) to remove superficial soft tissues and were placed in room temperature until the experiment time. After preparation of the access cavity with diamond fissure bur, the canal orifice was cleared with an endodontic explorer and patency was determined with No#10 hand K- file (MANI, Utsunomiya, Tochigi, Japan) in each canal. The crowns of selected teeth were amputated with a fissure bur and the hand piece and water spray were used in a way that working length of all specimens was 16mm from the apical foramen. Determination of working length was done with No#10 hand file visually and if the tooth had two orifices and one foramen, one of the canals would be evaluated. According to angle and radius of canal curvature, specimens were divided into two groups (n=30), the mean of angle and radius of canal curvature in reciproc group was 37.2±7.5 and 3.08±0.9 and in rotary group was 37.6±7.75 and 3.29±0.6, respectively so that there were no significant differences between two groups (table1).

Table1. The mean of curvature angle and radius in root canals between rotary and reciproc groups in studied teeth of 2groups(Rotary and Reciproc).

	Reciproc (n=30) Mean±SD	Rotary (n=30) Mean±SD	pvalue
Degree	37.2±7.5	37.6±7.75	0.9
Radius	3.08±0.90	3.29±0.60	0.1

The whole files were evaluated using a ×8 magnifier for lack of any initial defect. All canals were filed with No#8, 10, 15 hand files and No#3, 2, 1 Gates-Glidden drills (MANI, Utsunomiya, Tochigi, Japan) were used respectively for preparation of coronal and middle parts. Canals were rinsed by 1ml Hypochlorite 5.25%.In Rotary group, the patency was confirmed by No#10 hand file. All the filing steps were done by using VDW silver reciproc end omotor (VDW Co., Munich, Germany) with 280 rpm speed and 120 gcm torque and 1:16 gear. This end omotor had the ability of filing in reciprocal and continuous method. For preparation of 30 mesial canals of molars in rotary group, the M-two files (VD WCo. Munich, Germany) were used as follow respectively: 5%-15, 6%-20, 6%-25. R25 (VDW Co., Munich, Germany) file was used to prepare the 30 mesial canals in reciproc group.

RC-Prep (premier-USA) was used in all canals in two groups. Teeth were embedded in miniature clamp and all procedures were done by one operator. The time of file rotation in each canal was between 5-10 sec and the applied pressure to file was lighted with the range of 2-3 mm in all the steps.

Method evaluation

In both groups, thirty canals were prepared. After filing of every canal, files were cleaned with an alcohol prep swab and assessed with×8 magnifier. If any small defect was observed, another file of the same number would be replaced to continue filing. The length of each file after preparation termination was assessed to evaluate any fracture. Control and evaluation of files were performed in 4 directions and also each file was observed during the rotation. The used file in the

[Downloaded from cjdr.ir on 2026-10-06]
[DOR: 20.1001.1.22519890.2015.4.1.7.4]
[DOI: 10.22088/cjdr.4.1.30]

absence of defect or fracture was applied in the next canal and after finishing canal preparation, the previous steps were repeated. Assessment and control in next canals were continued until any defect or fracture was observed. If canal obstruction due to fractured instrument was observed, first, the preparation of canal would be finished second, the numbers of prepared canals until fracture was calculated and then the fractured file was replaced with new one and preparation was continued in subsequent canals. This procedure was continued until the preparation termination of 30 canals in each group. In all fractured or defected files, the below points were considered:

1. The place of fracture (coronal, middle and apical) in canals,
2. Number of prepared canals until defect or fracture of instrument,
3. Type of instrument damage (defect or fracture).

SPSS software V.22 was used for figuring Kaplan Meier chart which evaluated the number of canals preparation until defect or fracture in both groups and log rank test compared reciproc and rotary groups with each other. T test was applied to compare the mean of angle and radius of curvature of canals in two groups.

Results

Defect and fracture were occurred in 9 files of rotary group. Two files were defected (No#15, increase of flute diameter) and seven files were fractured (1file No#15, 4 files No#20 and 2 files No#25) and in reciproc group, four files were fractured and no defect was observed in file shape. There was not any canal obstruction persue fracture of No#15 M-two instrument. However, the fractures of No#20 M-two instruments led to obstruction, therefore canal preparation with No#25 instruments was impossible in this condition. (table 2)

According to Kaplan Meier survival curve and Logrank test (table 3, figure1), reciproc group prepared more canals than rotary group. On average, each reciproc file prepared 7 canals and each rotary file prepared 3.3 canals but this difference was not statistically significant (p=0.08).

All files in rotary and reciproc groups were fractured in apical regions. The fractured fragment of reciproc instruments was longer than M-two instruments.

Table2. Comparsion of fracture and defect in used instruments of rotary and reciproc groups

Reciproc	Rotary			Type of system
	15	20	25	Number of teeth
✓	✓	✓	✓	Num 1
F	✓	✓	✓	Num 2
✓	✓	✓	✓	Num 3
✓	✓	✓	✓	Num 4
✓	✓	✓	✓	Num 5
✓	✓	✓	✓	Num 6
✓	✓	✓	✓	Num 7
✓	✓	✓	✓	Num 8
F	✓	F		Num 9
✓	✓	✓	F	Num 10
✓	✓	✓	✓	Num 11
✓	✓	✓	✓	Num 12
✓	D	✓	✓	Num 13
✓	✓	F		Num 14
✓	✓	✓	✓	Num 15
✓	✓	✓	✓	Num 16
✓	✓	✓	✓	Num 17
F	✓	F		Num 18
✓	✓	✓	✓	Num 19
✓	F	✓	✓	Num 20
✓	✓	✓	✓	Num 21
✓	✓	✓	✓	Num 22
✓	✓	✓	✓	Num 23
✓	✓	F		Num 24
✓	✓	✓	✓	Num 25
✓	✓	✓	F	Num 26
F	✓	✓	✓	Num 27
✓	D	✓	✓	Num 28
✓	✓	✓	✓	Num 29
✓	✓	✓	✓	Num 30

D: Defected file F: Fractured file ✓ : Sound file

Table3. Mean estimate and median estimate of number of prepared canal in groups (Rotary and Reciproc)

	Mean			Median	
	Estimate	SE	CI 95%	Estimate	SE
Reciproc	7.067	1.402	(4.320-9.814)	9.000	.000
Rotary	3.300	.852	(1.631-4.969)	2.000	.744
Overall	4.567	.863	(2.874-6.259)	4.000	1.069

LogrankX^2:3.075 P=0.08

[Downloaded from cjdr.ir on 2026-10-06]
[DOR: 20.1001.1.22519890.2015.4.1.7.4]
[DOI: 10.22088/cjdr.4.1.30]

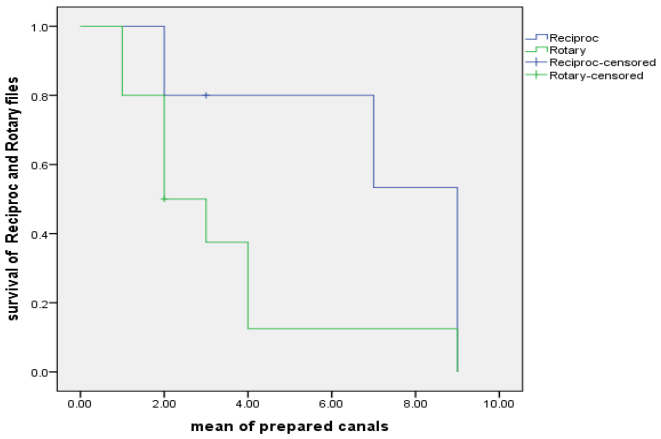

Figure1. Survival of reciproc and rotary files peruse canal preparation

Discussion

This study indicated that the number of fractured or defective Ni-Ti rotary files was more than reciproc files in mesial severe curved canals of maxillary and mandibular first and second molars although there was no significant difference between 2 groups. Flexibility and high resistance to cyclic fatigue of M-two files in compare to other rotary instruments and similarity of cross sectional area to reciproc instruments [18- 20] were the reasons of using them in current study.

Caballero et al reported that the number of defect or fracture in rotary instruments was more than reciproc instruments and their results were similar to the present study. This could be attributed to the fact that three files and only one file were used for canal preparation in rotary and reciproc groups, respectively. [21] Furthermore, Gavini et al. represented that the number of cycles until fracture in reciproc instruments was about two times more than rotary instruments with continuous rotations. [3]

Due to more resistance of reciproc instruments in compare to Rotary instruments, some studies have been done on the type of their alloys. The reciproc instrument alloy (M-wire Ni-Ti) has higher resistance than rotary instrument alloy (traditional Ni-Ti grinding process). [19,22] while, some studies indicated that reciprocating motion besides type of instrument (reciproc) would increase the resistance against fracture in compare to rotary instrument and continuous motion. [9, 16, 19, 23] This could be a reason of less fracture in reciproc instruments than M-two ones in our study. In this study, the amount of vertical movement range was 2-3 mm. According to the studies of Li et al. and Zarrabi et al. the mentioned range would decrease the probability of rotary instruments fracture. [24, 25] In rotary group the fractured files were more than defective files (7 files were fractured and 2 files were defected) and it was similar to Inan et al's. study that indicated the number of fracture in rotary used files was more than defective files.[10] Furthermore, 2 defective files in current study were related to No#15 rotary instruments such as Inan et al study.

The most occurrence of defects was in No#15 instruments.[10] In the present study, 4 files were fractured in reciproc group but there was no defective instrument in reciproc files.

The study of Plotino et al. conducted on the deformation and fracture of reciproc instruments in clinical use showed that the number of fractured files was more than defective instruments.[26] All the fracture occurrences (rotary and reciproc instruments) were in apical regions in the current study, which was similar to the studies of Zarrabi et al. and Ruddle et al. [25, 27] It could be attributed to severe canal curvature and tapering of canal in the apical region. The length of fracture fragment in reciproc instruments was longer than M-two instruments in this study, which was resemble to that of F da Frota et al.[28] Finally, it can be more useful to evaluate the defects in future studies because of better accuracy of electronic microscope than magnifier.

Conclusion

The results showed that there was no significant difference in defects or fractures of rotary and reciproc systems. Reciproc instruments can be more effective than rotary ones because the root canal preparation in rotary instruments is longer than in reciproc system.

Acknowledgments

Authors are grateful for the support of staff and personnel of the Endodontic, Oral and Maxillofacial Radiology Departments of Babol Dental Faculty.

Funding: This study was a part of thesis and research project (Grant No: 9236217) supported and funded by Babol University of Medical Sciences.

Conflict of interest: We declare that there is no conflict of interest.

[Downloaded from cjdr.ir on 2026-10-06]

[DOR: 20.1001.1.22519890.2015.4.1.7.4]
[DOI: 10.22088/cjdr.4.1.30]

References

1. Baugh D, Wallace J. The role of apical instrumentation in root canal treatment: a review of the literature. J Endod 2005; 31:333-40.
2. Yared G. Canal preparation using only one Ni-Ti Rotary instrument: preliminary observations. Int Endod J 2008; 41:339-44.
3. Gavini G, Caldeira CL, Akisue E, Candeiro GT, Kawakami DA. Resistance to flexural fatigue of Reciproc R25 files under continuous rotation and reciprocating movement. J Endod 2012; 38:684-7.
4. Peters OA. Current challenges and concepts in the preparation of root canal systems: a review. J Endod 2004; 30:559-67.
5. Schafer E, Schulz-Bongert U, Tulus G. Comparison of hand stainless steel and nickel titanium Rotary instrumentation: a clinical study. J Endod 2004; 30:432-5.
6. Chen JL, Messer HH. A comparison of stainless steel hand and Rotary nickel-titanium instrumentation using a silicone impression technique. Aust Dent J 2002; 47:12-20.
7. Pedulla E, Grande NM, Plotino G, Gambarini G, Rapisarda E. Influence of continuous or reciprocating motion on cyclic fatigue resistance of 4 different nickel-titanium Rotary instruments. J Endod 2013; 39:258-61.
8. Pedulla E, Plotino G, Grande NM, Scibilia M, Pappalardo A, Malagnino VA, et al. Influence of rotational speed on the cyclic fatigue of Mtwo instruments. Int Endod J 2014; 47:514-9.
9. Kim HC, Kwak SW, Cheung GS, Ko DH, Chung SM, Lee W. Cyclic fatigue and torsional resistance of two new nickel-titanium instruments used in reciprocation motion: Reciproc versus WaveOne. J Endod 2012; 38:541-4.
10. Inan U, Gonulol N. Deformation and fracture of Mtwo Rotary nickel-titanium instruments after clinical use. J Endod 2009; 35:1396-9.
11. Gao Y, Shotton V, Wilkinson K, Phillips G, Johnson WB. Effects of raw material and rotational speed on the cyclic fatigue of ProFile Vortex Rotary instruments. J Endod 2010; 36:1205-9.
12. Bhagabati N, Yadav S, Talwar S. An in vitro cyclic fatigue analysis of different endodontic nickel-titanium Rotary instruments. J Endod 2012; 38:515-8.
13. You SY, Bae KS, Baek SH, Kum KY, Shon WJ, Lee W. Lifespan of one nickel-titanium Rotary file with reciprocating motion in curved root canals. J Endod 2010; 36:1991-4.
14. De-Deus G, Moreira EJ, Lopes HP, Elias CN. Extended cyclic fatigue life of F2 ProTaper instruments used in reciprocating movement. Int Endod J 2010; 43:1063-8.
15. Burklein S, Benten S, Schafer E.Shaping ability of different single-file systems in severely curved root canals of extracted teeth. Int Endod J 2013; 46:590-7.
16. Kiefner P, Ban M, De-Deus G. Is the reciprocating movement per se able to improve the cyclic fatigue resistance of instruments? Int Endod J 2014; 47:430-6.
17. Pruett JP, Clement DJ, Carnes DL JR. Cyclic fatigue testing of nickel - titanium endodontic instruments. J Endod 1997; 23: 77-85.
18. Grande NM, Plotino G, Pecci R, Bedini R, Malagnino VA, Somma F. Cyclic fatigue resistance and three- dimensional analysis of instruments from two nickel-titanium rotary systems. Int Endod J 2006; 39:755-63.
19. Dagna A, Poggio C, Beltrami R, Colombo M, Chiesa M, Bianchi S. Cyclic fatigue resistance of OneShape, Reciproc, and WaveOne: An in vitro comparative study. J Conserv Dent 2014; 17:250-4.
20. Uroz-Torres D, Gonzalez-Rodriguez MP, Ferrer-Luque CM**.** Shaping ability of Mtwo and Twisted File rotary systems in curved root canals. J Clin Exp Dent 2012; 4:e275-80.
21. Caballero H, Rivera F, Salas H. Scanning electron microscopy of superficial defects in Twisted files and Reciproc nickel-titanium files after use in extracted molars. Int Endod J 2015; 48: 229-35.
22. Arora A, Taneja S, Kumar M. Comparative evaluation of shaping ability of different rotary NiTi instruments in curved canals using CBCT. J Conserv Dent 2014; 17:35-9.
23. Vadhana S, SaravanaKarthikeyan B, Nandini S, Velmurugan N. Cyclic fatigue resistance of RaCe and Mtwo rotary files in continuous rotation and reciprocating motion. J Endod 2014; 40:995-9.
24. Li UM, Lee BS, Shih CT, Lan WH, Lin CP. Cyclic fatigue of endodontic nickel-titanium Rotary

[Downloaded from cjdr.ir on 2026-10-06]

[DOR: 20.1001.1.22519890.2015.4.1.7.4]

[DOI: 10.22088/cjdr.4.1.30]

instruments: static and dynamic tests. J Endod 2002; 28: 448-51.

25.Zarrabi MH, Javidi M, Mesgarani A, Poursattar Bejeh Mir A. Number of severely curved root canals preparation leading to either defect or fracture using three Rotary systems. J Dent Shiraz Univ Med Sci 2011; 12:252-260. [In Persian]

26. Plotino G, Grande NM, Porciani PF. Deformation and fracture incidence of Reciproc instruments: a clinical evaluation. Int Endod J 2014; 48:199-205.

27. Ruddle CJ. Nonsurgical retreatment. J Endod 2004; 30:827-45.

28. F da Frota M, G Espir C, LCV Berbert F, A F Marques A, C Sponchiado-Junior E, Tanomaru-Filho M, et al. Comparison of cyclic fatigue and torsional resistance in reciprocating single-file systems and continuous rotary instrumentation systems. J Oral Sci 2014; 56:269-75.

[Downloaded from cjdr.ir on 2026-10-06]

[DOR: 20.1001.1.22519890.2015.4.1.7.4]

[DOI: 10.22088/cjdr.4.1.30]