Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

Effects of Glide Path Preparation on Apical Debris Extrusion in Root Canal Treatment: A Systematic Review

Dr. Dritali patel[1], Dr. Chintan Joshi[2], Dr. Sweety Thumar[3], Dr. Niraj Kinariwala[4], Dr. Aashray Patel[5], Dr. Juhi Dholani[6]

1.Post graduate student, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India
2.Head of department, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India
3.Associate professor, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India
4.Associate professor, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India
5.Assistant professor, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India
6.Assistant professor, Department of conservative and endodontics, Karnavati school of dentistry, Gandhinagar, India

(Received: 07 October 2023 Revised: 12 November Accepted: 06 December)

KEYWORDS

glide path, apical debris, post-operative pain, Ni-Ti rotary files, Hand files.

ABSTRACT:

Introduction: Using a glide path preparation with nickel-titanium rotary files or hand files helps prevent fracture of instruments and maintains the original anatomy of a root canal. Using glide path file systems during root canal treatment causes extrusion of intra-canal debris into peri radicular tissues, which could result in unfavorable outcomes.

Objectives: The goal of this systematic review was to look into the effects of glide path preparation on the extrusion of apical debris.

Methods: In this systematic review, we analyze various glide path preparation techniques and their impact on apical debris extrusion. We followed PRISMA guidelines, conducted a thorough literature search, and included 13 relevant studies.

Results: The original total of 169 articles was reduced to 13 after the keywords, extra filters, and inclusion, and exclusion criteria were applied. It was discovered that the majority of studies that used glide path files showed a statistically significant lesser extrusion of debris.

Conclusions: In conclusion, this review underscores the importance of glide path preparation in root canal procedures. Using a glide path file during root canal preparation diminishes debris extrusion and improves clinical prognosis.

1. Introduction

Root canal treatment is a fundamental procedure in modern dentistry, aimed at salvaging teeth suffering from infection or decay. (1) One of the pivotal factors influencing the success of this procedure is the management of debris extrusion from the apical region of the tooth. (2) The apical region, situated at the tip of the tooth's root, is particularly sensitive and must be handled with utmost care during the treatment. When debris is extruded into this area, it can lead to post-operative discomfort and compromise the long-term prognosis of the tooth. (3) Hence, the process of glide path preparation, which involves creating a smooth and unobstructed pathway to the apical region, is crucial in minimizing the risk of apical debris extrusion. (4) In this systematic review, we embark on an in-depth exploration of glide path preparation techniques and their direct impact on the prevention or exacerbation of apical debris extrusion.

Glide path preparation is a multifaceted process that requires a delicate balance between shaping the root canal space to accommodate instruments and ensuring minimal disruption to the apical region. (5 6) Dental practitioners employ various techniques, instruments,

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

and strategies to achieve this balance. (7) This systematic review aims to distill the wealth of information available in the dental literature, providing a comprehensive examination of the strengths and limitations of different glide path preparation approaches. By scrutinizing the nuances of these techniques, we hope to offer practitioners valuable insights into the most effective methods for managing apical debris extrusion, promoting precision, and ultimately improving the overall quality of root canal treatments. (8)

The ultimate goal of this systematic review is to bridge the gap between research and clinical practice. By synthesizing the current state of knowledge, we aspire to empower dental practitioners with evidence-based guidance that can enhance their decision-making in root canal treatments. Furthermore, we recognize that improved glide path preparation techniques can lead to a reduction in apical debris extrusion, resulting in enhanced post-operative comfort and a higher likelihood of successful long-term outcomes for patients. As we navigate the complexities of glide path preparation in root canal treatment, it is our hope that this review will serve as a valuable resource, fostering greater precision, efficacy, and patient satisfaction in dental practices worldwide.

2. Methods

Protocol and Registration

This systematic review followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. (Figure 1)

Search Strategy

The literature search was done in two databases (PubMed and Ebsco host). The following keywords and combinations were used:

• ((glide path rotary file) OR (Niti files) OR (glide path files) OR (glide path) OR (patency) OR (glide path preparation) OR (rotary files)) AND ((apical debris extrusion) OR (apical extrusion of debris) OR (debris extrusion) OR (apically extruded debris))

Study Selection Process

Two independent reviewers initially screened the titles and abstracts of the available articles. For final inclusion, the articles were retrieved and assessed according to the inclusion and exclusion criteria. To find additional articles that might have been missed during the digital search, the references of every chosen article underwent a manual search. A third reviewer determined any disputes about the inclusion of final studies. The inclusion/exclusion criteria followed were:

Inclusion criteria:

• In vitro studies

• Glide path preparation used in endodontic treatment

Exclusion criteria:

• Clinical trials

• Different conventional endodontic treatments applied

Data Extraction Process

For each of the identified studies included, the following data were then extracted and tabulated using a Microsoft Excel sheet with the following information: author and title of publication, rotary glide path files assessed, sample size of teeth, degree of curvature of the teeth, methodology to evaluate the debris extrusion. (Table 1)

Quality Assessment

Two reviewers assessed the bias risk independently. The risk of bias in in-vitro experiments could not be evaluated using a standardized approach. Customized tools have been utilized in earlier investigations. A unique tool that was modified from another investigation was also used in the current study. (AlShwaimi et al., 2016) The following parameters were assessed and graded for calculating the risk of bias:

• Presence of control group

• Description of sample size calculation

• Glide path preparation by a single operator

• Standardization of weighing machine

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

• Procedures following manufacturer's instructions

• Blinding of outcome assessor.

If the authors specified it, the article received a Y (yes) for that specific parameter; if the data could not be located, the article received a N (no). Studies with 1-2 items were deemed to have a high risk of bias, those with 3–4 items a medium risk, and those with 5–6 items a low risk. (Table 2)

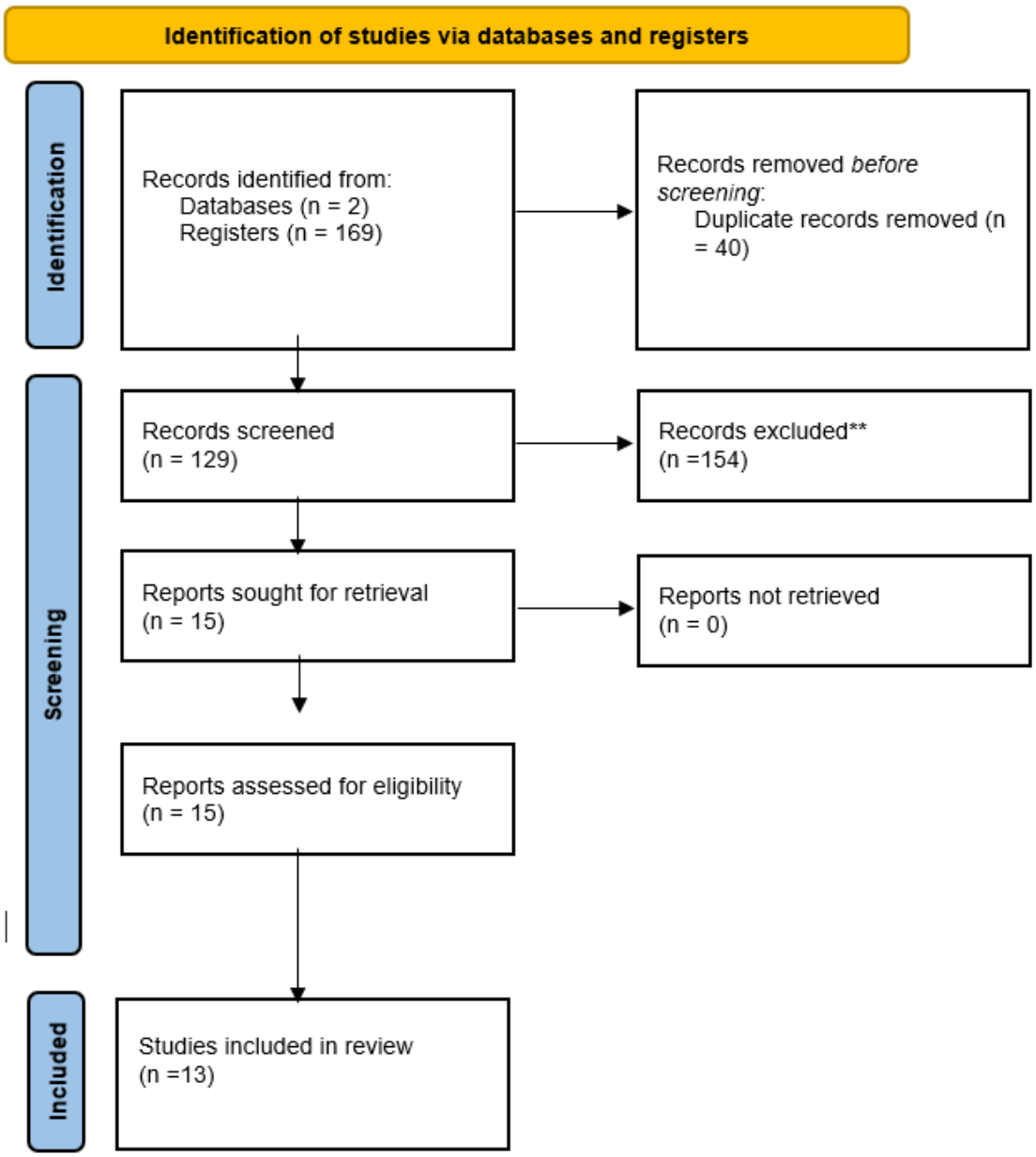

Figure 1: Prisma flowchart

Sr. No.	Title	Author Name	Sample size and type	Canal curvature	Files assessed	Methodology	Results
1	Effects of Different Glide Path Files on Apical Debris Extrusion in Curved Root Canals	Betul Gunes et al.	Sixty human mandibular molar teeth	Between 25° and 65°	Group G-File: G1 (#0.12) and G2 (#0.17) and a WaveOne Gold Primary Group One G: One G (#0.14) and WaveOne Gold Primary reciprocation file Group ProGlider: a ProGlider (#0.16) rotary file and a WaveOne Gold Primary reciprocation file Group PathFile: PF1 (#0.13) and PF2 (#0.16) rotary files and and WaveOne Gold Primary reciprocation file Group K-files: ISO #10 and #15 manual K-files and a WaveOne Gold Primary reciprocation file Group without a glide path: only WaveOne Gold Primary reciprocation files.	Separate Eppendorf tubes and Electronic scales	One G group showed less debris extrusion than the K-file group, No difference between between the One G and G-Files, ProGlider, PathFile, and WaveOne Gold without glide path groups, No difference between K-file group and the G-Files, ProGlider, PathFile, and WaveOne Gold without glide path groups.
2	Effect of glide path preparation on apical extrusion of debris in root canals instrumented with three single-file systems: An ex vivo comparative study	Ajinkya M. Pawar et al.	Sixty human mandibular molar teeth	20° to 40°	Group 1: 20/0.02 + OneShape® Group 2: 20/0.02 + WaveOne Group 3: 20/0.04 + Self-adjusting File	Polyethylene tube and weighing machine	Self adjusting file showed less debris extrusion, No difference between oneshape and waveone
3	Influence of a glide path on apical extrusion of debris during canal preparation using single-file systems in curved canals	H. S. Topcuoglu et al.	Ninety extracted mandibular molar	25° to 35°	group 1 Rec: Reciproc file group 2 OS: OneShape file group 3 WO: WaveOne file group 4 GP + Rec: PathFile instruments 1 (size 13, 0.02 taper) and 2 (size 16, 0.02 taper) + Reciproc file group 5 GP + OS: PathFile instruments 1 (size 13, 0.02 taper) and 2 (size 16, 0.02 taper) +OneShape file group 6 GP + WO: PathFile instruments 1 (size 13, 0.02 taper) and 2 (size 16, 0.02 taper) + WaveOne file	Eppendorf tubes and Electronic scales	One shape showed less debris extrusion than Reciproc and WaveOne groups when no glide path was created, No difference amongst the OneShape, Reciproc and WaveOne groups when creating a glide path.

Table 1: Characteristics of studies

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

4	Debris extrusion by glide-path establishing endodontic instruments with different geometries	Jung-Hong Ha et al.	Forty extracted incisor teeth	<105°	group SS: SS hand K-file group (#15/0.02 taper) group OG: One G (#14/0.03 taper) group PG: ProGlider (#16/progressive taper) group SR: ScoutRace (#15/0.02 taper)	Polyethylene tube and weighing machine	Group PG showed least debris extrusion. Groups OG and SR showed no significant differences, Group SS showed maximum debris extrusion
5	Apically extruded debris produced during glide path preparation using R-Pilot, WaveOne Gold Glider and ProGlider in curved root canals	Cangul Keskin et al.	Eighty mandibulat molar	25° to 35°	group PG + RB25: ProGlider + Reciproc Blue R25 group R-Pilot + RB25: R-Pilot with 'Reciproc All' setting + Reciproc Blue R25 group WGG + RB25: R-Pilot with 'WaveOne All' setting + group Manual glide path + RB25:	Eppendorf tubes and Electronic scales	No difference among RG, RP and WGG groups
6	Comparison of apical extrusion of intracanal bacteria by various glide-path establishing systems: an in vitro study	Alberto Dagna et al.	Sixty mandibular first molar	10° to 20°	group K-file: K-files size 10, 15, and 20 group PathFile: 3 instruments with 0.02 taper and tip size 13 (PathFile #1), 16 (PathFile #2), and 19 (PathFile #3) group G-File: 2 instruments with 0.03 taper and size 12 (G1) and 17 (G2) group ProGlider: ProGlider single-file rotary glide path file group One G: One G with 0.03 taper and tip size 14	BHI agar	group K file extruded the highest number of bacteria compared to the 4 other groups, no difference between other groups
7	Effects of different glide path techniques on the amount of extruded debris and preparation times during root canal preparation	Damla Kirichi et al.	Thirty six mandibular molar	25° to 35°	group WOG+WGG: WaveOne gold glider + WaveOne gold primary file group WOG+PG: ProGlider file + WaveOne gold primary file group WOG: WaveOne gold primary file	Eppendorf tubes and Electronic scales	WGG/WOG extruded less debris than WO group, no difeerence between WO and PG/WOG
8	Influence of traverse and waveone gold glider glide path files on the amount of apically extruded debris.	Afra Rashid Saeed Ali Almheiri et al.	Sixty mandibular premolar	< 5°	group Traverse: Traverse file 0.18/06 group WGG: WGG size 0.15 mm and 0.2 tapers using "WAVE ONE ALL" group K file: K-file # 15 and 20. K-file # 20	Eppendorf tubes and Electronic scales	WGG have a significantly lower value than K-file, no difference between Traverse and K-file.

Table 1: Characteristics of studies

9	Effect of glide path files with different metallurgy on intracanal bacterial extrusion by HyFlex electrical discharge machining file: An in vitro study.	Priyanka Soni et al.	Forty human mandibular bicuspids	0°-10°	group (PROGLIDER): Proglider group (EDGEGLIDEPATH): EdgeGlidePath - progressive taper from 2% to 7% and tip diameter 0.17 group (NEONITI GPS): Neoniti GPS - taper 0.3 and tip diameter 0.15 group (HYFLEX EDM): No glide path, HyFlex EDM (25/.08)	brain heart infusion broth	Hyflex EDM showed highest exrusion, EdgeGlidePath showed less extrusion than Proglider, Neoniti GPS showed higher extrusion compared to Proglider and EdgeGlidePath,
10	Comparison of Apical Extrusion of Bacteria After Glide Path Preparation Between Manual K File, One G Rotary, and WaveOne Gold Glider Reciprocation Preparations.	Nicole low pui yii et al.	Forty mandibular first molars	10° to 30°	group K-file: sizes 10, 15 and 20 K file group One G: One G rotary glide path group WaveOne Gold Glider: WaveOne Gold Glider reciprocating glide path group Control (Negative): Canals were not infected, glide path for 2 specimens was created with One G, another 2 specimens with WaveOne Gold Glider and 1 specimen with the K-files. group Control (Positive): Canals were infected but no glide path was created	brain heart infusion agar	Manual glide path with K-files had the largest number of extruded bacteria, No significant difference between rotary and reiprocating glide path techniques
11	Effect of a Glide Path with Rotary Files on Apical Extrusion of Intra-Canal Debris during Root Canal Preparation Using a Reciproc System: an in vitro Study.	Alaa Shaker et al.	Sixty mandibular premolar	<5°	group Glide Path + Reciproc: PathFile instruments 1 (size 13, 0.02 taper), 2 (size 16, 0.02 taper), and 3 (size 19, 0.02 taper) + Reciproc group Reciproc: no glide path + Reciproc	Eppendorf tubes and Electronic scales	Reciproc group showed more extrusion comapred to group with glide path preparation
12	Effect of taper of glide path preparation on debris extrusion during root canal instrumentation of mesial canals in mandibular molars.	Ajinkya M. Pawar et al.	Eighty mandibular molars	20° to 40°	group 1: 20/0.02 + Universal ProTaper group 2: 20/0.02 + WaveOne group 3: 20/0.04 + Universal ProTaper group 4: 20/0.04 + WaveOne	Eppendorf tubes and Electronic scales	Universal ProTaper showed less extrusion, debris extrusion was greater with glide path by 20/0.02 hand K-files compared with 20/0.04 rotary files

Table 1: Characteristics of studies

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

13	Effect of glide path preparation on apical debris extrusion of rotary and reciprocating single-file systems: OneShape versus WaveOne	Sevinç Aktemur Türker et al.	Forty-eight extracted human mandibular incisors	0 to 10°	group 1: WaveOne with glide path group 2: WaveOne without glide path group 3: OneShape with glide path group 4: OneShape without glide path	Eppendorf tubes and Electronic scales	No statistically significant difference between the groups

Table 1: Characteristics of studies

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

Table 2: Risk of bias assessment

Study	Presence of control group	Description of sample size calculation	Glide path preparation done by single operator	Standardization of universal testing machine	Procedures following manufacturer's instructions	Blinding of outcome assessor	Overall risk of bias
Betul Gunes et al.	✗	✗	✓	✗	✓	✗	high risk bias
Ajinkya M. Pawar et al.	✗	✓	✓	✓	✓	✓	low risk bias
H. S. Topcuoglu et al.	✗	✓	✓	✓	✗	✓	medium risk bias
Jung-Hong Ha et al.	✗	✓	✓	✓	✓	✓	low risk bias
Cangul Keskin et al.	✗	✓	✗	✗	✓	✓	medium risk bias
Alberto Dagna et al.	✗	✓	✓	✓	✓	✗	medium risk bias
Damla Kirichi et al.	✓	✗	✓	✓	✓	✓	low risk bias
Afra Rashid Saeed Ali Almheiri et al.	✓	✓	✓	✓	✗	✗	medium risk bias
Priyanka Soni et al.	✓	✓	✓	✓	✓	✓	low risk bias
Nicole low pui yii et al.	✗	✓	✓	✓	✓	✗	medium risk bias
Alaa Shaker et al.	✓	✗	✓	✓	✓	✓	low risk bias
Ajinkya M. Pawar et al.	✓	✓	✓	✓	✗	✗	medium risk bias
Sevinç Aktemur Türker et al.	✗	✓	✓	✓	✓	✓	low risk bias

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

3. Results

The search identified a total of 169 preliminary results: where 107 were found in PubMed, and 62 in Ebsco host. Mendeley reference management software (Elsevier, AMS, Netherlands) was used to manually delete duplicates. From there, 154 records were removed upon reading the title and abstract.13 articles were included for data extraction.

4. Discussion

A wide variety of glide path preparation instruments can be found in various motions and techniques. When NiTi rotary instruments are used for glide-path preparation rather than manual stainless steel (SS) hand files, the process is quicker and better preserves the original anatomy of the canal, requiring fewer adjustments to the canal's curvatures. (9) Debris is extruded in the process of all instrumentation techniques. Thus, the purpose of this study was to provide a comprehensive analysis of the literature that has been written about the extrusion of debris in the presence of glide path preparation.

The study done by Betul Gunes et. al focused on the importance of creating a glide path before root canal procedures and compared different methods of creating these glide paths in curved root canals. The researchers found that the One G glide path method resulted in significantly less apical debris extrusion compared to the use of K-files. However, there was no significant difference between other glide path methods, and all methods resulted in some apical debris extrusion. In conclusion, various glide path methods had similar outcomes when used with the WaveOne Gold file, with K-files causing more debris extrusion than the One G method. (10) Ajinkya M. Pawar et. al evaluated the effect of a new glide path preparation protocol using a 20-0.04 file on the extrusion of debris in mesial canals of molars, comparing it with glide paths prepared using a 20-0.02 K-file and subsequent instrumentation with OneShape and WaveOne files. The results showed that the group using the 20-0.04 rotary file and Self-Adjusting File for glide path preparation and instrumentation resulted in significantly less apical debris extrusion compared to the groups that used 20-0.02 K-files and OS or WO files. This suggests that the 20-0.04 rotary file and SAF combination is more effective in minimizing debris extrusion in curved mesial canals during mandibular molar root canal treatments. (11)

The study by H. S. Topcuoglu et. al investigated the impact of creating a glide path on debris extrusion using single-file systems. They found that when no glide path was created, the OneShape file resulted in less debris extrusion compared to Reciproc and WaveOne. However, there was no significant difference between Reciproc and WaveOne. When a glide path was established before canal preparation, all systems produced significantly less debris extrusion. (12) Another study assessed the amount of debris extrusion produced during glide-path preparation with instruments having different geometric designs in endodontic procedures. The researchers used four different instruments, including One G, ProGlider, a size 15 ScoutRace, and a size 15 stainless-steel K-file, on 40 extracted teeth. They found that the ProGlider group resulted in less debris extrusion compared to the other files. The ScoutRace and One G groups showed no significant difference but had less debris extrusion than the stainless-steel group. (13) Another study compared apical debris production during glide path preparation in curved root canals using manual methods (K-file) and engine-driven instruments (R-Pilot, WaveOne Gold Glider, and ProGlider), followed by preparation with Reciproc Blue. Manual preparation produced the most debris, while all methods caused some debris extrusion. There were no significant differences between the engine-driven instruments (RP, PG, WGG) regarding debris production. (14).

Three studies compared the apical extrusion of bacteria during glide-path preparation (15 16 17), Alberto Dagna et. al tested manual stainless-steel files and different NiTi rotary files (PathFiles, G-Files, ProGlider, and One G) on infected mandibular first molar teeth. The results showed that the manual technique produced the highest bacterial extrusion, while the four rotary file groups had similar bacterial extrusion levels. (15) The study by Nicole LOW PUI-YII et. al compared manual stainless-steel files (K-files), rotary files (One G), and reciprocating files (WaveOne Gold Glider). It concluded that manual K-files resulted in significantly more extrusion of bacteria compared to the other groups. (17)

Another study compared Proglider, EdgeGlidePath Files, and Neoniti GPS. EdgeGlidePath files resulted in less

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

apical extrusion compared to Proglider and Neoniti GPS. (16) Kırıcı D et. al compared WaveOne Gold and ProGlider preparation with no glide path preparation and concluded that WaveOne Gold and ProGlider preparation had significantly less apically extruded debris compared to the group with WaveOne Gold without glide path preparation. (18) A similar study comparing Traverse file, WaveOne Gold Glider and stain less steel K file concluded that WaveOne Gold Glider produced the least amount of apical extruded debris followed by the Traverse group then the K-file group. (19) Alaa Shaker et al. compared Reciproc rotary files with glide path preparation and without glide path preparation. They concluded that reciproc file extruded less debris when glide path was prepared. (20) Ajinkya M. Pawar et al. noted that when WaveOne and Universal ProTaper was used with both 20/0.02 and 20/0.04 taper rotary file as glide path, 20/0.04 resulted in less debris extrusion. (21) Sevinc Aktemur Turker et. al found no difference when comparing WaveOne and OneShape with and without glide path preparation. (23)

The choice of instruments and techniques can significantly impact the amount of debris and bacteria extruded. While manual methods may result in more extrusion, various nickel-titanium rotary systems, such as WaveOne Gold, ProGlider, and others, have shown promise in reducing extrusion. The use of glide path preparation, regardless of the specific instruments or motion used, generally leads to less debris extrusion and may contribute to safer and more efficient endodontic procedures. However, it is essential to consider the specific clinical context and the unique characteristics of each case when selecting the most appropriate instruments and techniques to minimize extrusion and enhance the success of root canal treatments. Further research and clinical studies will continue to refine these techniques, ultimately benefiting both dental practitioners and their patients.

Conclusion

This literature evaluation leads to the conclusion that, when it comes to maintaining the original root canal morphology, engine-driven glide route preparation performs on par with or better than manual glide path preparation. The consistent finding across these studies is that implementing glide path preparation, regardless of the specific instruments or motion used, tends to minimize extrusion and contribute to a better clinical outcome.

References

1. 1. AlRahabi MK. Root canal treatment in elderly patients: A review and clinical considerations. Saudi Med J. 2019 Mar;40(3):217-223.
2. 2. Predin Djuric N, van der Vyver PJ, Vorster M, Vally ZI. Factors influencing apical debris extrusion during endodontic treatment - A review of the literature. S. Afr. dent. J. 2021 Feb; 76(1): 28-36.
3. 3. Santoro V, Lozito P, Donno AD, Grassi FR, Introna F. Extrusion of Endodontic Filling Materials: Medico-Legal Aspects. Two Cases. Open Dent J. 2009 Apr 16;3:68-73.
4. 4. Kumar A, Sarthaj S. Glide Path in Endodontics. Cons Dent Endod J. 2017;2(2):48-51.
5. 5. Keskin C, Sivas Yilmaz Ö, Inan U, Özdemir Ö. Postoperative pain after glide path preparation using manual, reciprocating and continuous rotary instruments: a randomized clinical trial. Int Endod J 2019; 52(5):579–87.
6. 6. Tzanetakis GN, Koletsi D. A priori power considerations in Endodontic Research. Do we miss the timeline? Int Endod J 2021; 54(9):1516–26.
7. 7. 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):210–6.
8. 8. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Part I. Methodology, application and relevance. Int Endod J 1993; 26(1):37–43.
9. 9. Pasqualini D, Mollo L, Scotti N, et al. Postoperative pain after manual and mechanical glide path: a randomized clinical trial. J Endod 2012;38:32e6.
10. 10. Gunes B, Yesildal Yeter K. Effects of Different Glide Path Files on Apical Debris Extrusion in Curved Root Canals. J Endod. 2018 Jul;44(7):1191-1194.
11. 11. Pawar AM, Pawar M, Kfir A, Thakur B, Mutha P, Banga KS. Effect of glide path preparation on apical extrusion of debris in root canals instrumented with three single-file systems: An *ex*

Journal of Chemical Health Risks

www.jchr.org

JCHR (2023) 13(6), 1442-1452 | ISSN:2251-6727

vivo comparative study. J Conserv Dent. 2017 Mar-Apr;20(2):110-114.

12. 12. Topçuoğlu HS, Düzgün S, Akpek F, Topçuoğlu G, Aktı A. Influence of a glide path on apical extrusion of debris during canal preparation using single-file systems in curved canals. Int Endod J. 2016 Jun;49(6):599-603.
13. 13. Ha JH, Kim SK, Kwak SW, El Abed R, Bae YC, Kim HC. Debris extrusion by glide-path establishing endodontic instruments with different geometries. J Dent Sci. 2016 Jun;11(2):136-140.
14. 14. Keskin C, Sivas Yilmaz Ö, Inan U. Apically extruded debris produced during glide path preparation using R-Pilot, WaveOne Gold Glider and ProGlider in curved root canals. Aust Endod J. 2020 Dec;46(3):439-444.
15. 15. Dagna A, El Abed R, Hussain S, Abu-Tahun IH, Visai L, Bertoglio F, Bosco F, Beltrami R, Poggio C, Kim HC. Comparison of apical extrusion of intracanal bacteria by various glide-path establishing systems: an *in vitro* study. Restor Dent Endod. 2017 Nov;42(4):316-323
16. 16. Soni P, Kumar P, Taneja S, Jain A. Effect of glide path files with different metallurgy on intracanal bacterial extrusion by HyFlex electrical discharge machining file: An: in vitro: study. Endodontology. 2022 Jul 1;34(3):168-72.
17. 17. Low N, Zhen Jie S, Bhatia S, Davamani F, Nagendrababu V. Comparison of Apical Extrusion of Bacteria After Glide Path Preparation Between Manual K File, One G Rotary, and WaveOne Gold Glider Reciprocation Preparations. Eur Endod J. 2021 Aug;6(2):221-225.
18. 18. Kirici D, Koç S, Kuştarcı A. Effects of different glide path techniques on the amount of extruded debris and preparation times during root canal preparation. J Dent Res Dent Clin Dent Prospects. 2020 Summer;14(3):187-190.
19. 19. Almheiri AR, Elsewify T, Eid B. Influence of traverse and waveone gold glider glide path files on the amount of apically extruded debris. Brazilian Dental Science. 2023 Jun 13;26(2).
20. 20. Shaker A, Rikab MS, Alharissy M. Effect of a glide path with rotary files on apical extrusion of intra-canal debris during root canal preparation using a reciproc system: An in vitro study. Journal of International Dental and Medical Research. 2019 Dec 1;12(4):1263-7.
21. 21. Pawar AM, Pawar M, Kfir A, Thakur B, Mutha P, Banga KS. Effect of glide path preparation on apical extrusion of debris in root canals instrumented with three single-file systems: An *ex vivo* comparative study. J Conserv Dent. 2017 Mar-Apr;20(2):110-114.
22. 22. Türker SA, Koçak S, Kocak M, Saglam B. Effect of glide path preparation on apical debris extrusion of rotary and reciprocating single-file systems: OneShape versus WaveOne. Cumhuriyet Dental Journal. 2015 Feb 11;18(1):1-8.
23. 23. Türker SA, Koçak S, Kocak M, Saglam B. Effect of glide path preparation on apical debris extrusion of rotary and reciprocating single-file systems: OneShape versus WaveOne. Cumhuriyet Dental Journal. 2015 Feb 11;18(1):1-8.