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SYSTEMATIC REVIEW

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# Comparison of postoperative pain reduction using continuous rotation glide path system with other methods of glide path creation - a systematic review

Comparação de sistema de glide path rotatório contínuo com outros métodos de criação de glide path na redução de dor pósoperatória – uma revisão sistemática

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## ABSTRACT

**Objective:** Various glide path preparation techniques have been introduced, providing easiness to the practitioners. Recent literature has shown that glide path preparation influences the levels of postoperative pain occurrence in individuals receiving endodontic therapy. This systematic review aims to compare the different glide path preparation system in reduction of postoperative pain. **Material and Methods:** Electronic databases such as PubMed, Scopus, Cochrane Library, LILACS, Google Scholar, and European PMC were searched for published articles until July 2020. The studies included were randomized control trial (RCT) studies published during this time frame with comparison of continuous glide path system with various other glide path systems in reducing postoperative pain. The studies were reviewed using Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. The studies were reviewed independently by two reviewers who had assessed the included studies, extracted data and the quality using the Cochrane risk of bias assessment tool. **Results:** 544 studies were received from the initial search, 11 articles were included in full text appraisal, 4 studies were obtained for qualitative analysis. Mean VAS Scores showed an increased reduction of postoperative pain in continuous glide path treated individuals (1.90-0.20) compared to reciprocating glide path (2.00-0.50) and manual glide path (3.80-0.85). The consumptions of analgesics were seen to be as follows; Manual Glide Path > Reciprocating Glide Path > Continuous Glide Path. Three out of four studies showed an overall "high" risk of bias and another study showed an overall "unclear" bias. **Conclusion:** From the achieved results, continuous glide path with 5.25% NaOCl irrigation has shown better reduction of postoperative pain compared to other glide path systems. Individuals who had undergone manual glide path preparation showed higher incidence of postoperative pain compared to other systems. The consumption of analgesics was seen to be higher in manual glide path prepared individuals followed by reciprocating glide path and least being continuous glide path.

## KEYWORDS

Analgesics; Endodontics; Pain; Root canal preparation; Sodium hypochlorite.

## RESUMO

**Objetivo:** Várias técnicas de preparação do glide path têm sido introduzidas, permitindo maior facilidade aos profissionais. A literatura tem mostrado que a forma de preparação do glide path influencia nos níveis de dor pós-operatória em indivíduos que recebem tratamento endodôntico. Esta revisão sistemática tem como objetivo comparar os diferentes sistemas de preparação do glide path na redução de dor pós-operatória. **Material e Métodos:** Bases de dados eletrônicas como PubMed, Scopus, Cochrane Library, LILACS, Google Escolar, e European PMC foram utilizadas para pesquisar artigos publicados até Julho de 2020. Os estudos incluídos foram ensaios clínicos randomizados controlados (ECRC) publicados até este período de tempo que compararam

sistema de glide path contínuo com outros sistemas de glide path na redução de dor pós-operatória. Para revisão dos estudos, foi utilizado o 'Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines'. Dois revisores analisaram, independentemente, os estudos incluídos, os dados extraídos e a qualidade através da ferramenta de avaliação de risco de viés da Cochrane. **Resultados:** 544 estudos foram encontrados na pesquisa inicial, 11 artigos foram selecionados para avaliação de texto completo, 4 estudos foram obtidos para a análise qualitativa. A pontuação média do VAS mostrou um aumento na redução de dor pós-operatória em indivíduos nos quais foi utilizado o sistema de glide path rotatório contínuo (1.90-0.20) quando comparados àqueles nos quais foram utilizados o glide path reciprocante (2.00-0.50) e o glide path manual (3.80-0.85). A utilização de analgésicos foi vista da seguinte forma: Glide path Manual > Glide Path Reciprocante > Glide Path Contínuo. Três dos quatro estudos apresentaram um "alto" risco de viés geral e o outro estudo apresentou risco de viés geral "incerto". **Conclusão:** O glide path contínuo com irrigração de 5.25% de NaOCl mostrou a melhor redução de dor pós-operatória comparado aos demais sistemas de glide path. Indivíduos que foram submetidos à preparação de glide path pelo sistema manual apresentaram a maior incidência de dor pós-operatória. O consumo de analgésicos foi maior diante do uso do glide path manual, seguido pelo glide path reciprocante, e por último pelo glide path contínuo.

## PALAVRAS-CHAVE

Analgésicos; Endodontia; Dor; Preparo de canal radicular; Hipoclorito de sódio.

## INTRODUCTION

Root canal instrumentation is a major contributing factor in the success of the conventional endodontic therapy. Nickel-titanium (NiTi) instruments are shown to be flexible, following the canal curvature much more effectively than the previously used stainless steel instruments, while iatrogenic procedural errors are shown to be significantly reduced with the utilization of NiTi instruments compared to its stainless steel counterparts [1]. During the canal preparation process, NiTi instruments are exposed to various stresses such as tortional and cyclic fatigue with the current evidence recommending instruments to function under low operative torque for lesser incidence of instrument separation [2]. Other procedural errors which are commonly seen with the use of these instruments are ledging, zipping, transportation can be negated by securing an open pathway to the canal terminus. In order to reduce the incidence of these procedural errors the preparation of a "Glide path" is now considered pivotal step during the cleaning and shaping process which allows the rotary file to glide into the prepared procedural path thus lessen any procedural complications to occur. Another added advantage is the ability to maintain the concentricity and dentinal thickness of the canal [3].

Currently the most advocated method for the preparation of this glide path is manual preparation and mechanical instrumentation. It is seen that mechanical instrumentation using Nickel-titanium (NiTi) based instruments have shown lesser chances of modifications of the canal curvatures and lesser canal deviations in contrast to glide path preparation done manually [4]. Mechanical instrumentation of glide path is shown to have a better glide path preparation with shorter preparation times and lesser extrusion of debris periapically compared to manual instrumentation [5]. Literature shows that the glide path preparation has a direct correlation in pain influence in an individual [6-9].

Pain is seen to be a subjective phenomenon which is shown to be commonly associated with endodontic treatment [10]. The degree of pain experience among individuals are associated by numerous factors such as microbial factors, chemical mediator responses, immunological factors and psychological factors [11]. Apical extrusion of debris during instrumentation is seen to be a major contributing factor for inflammation of periapical tissues which has an influence on pain occurrence in individuals [12]. These extruded debris can consist of a collision of various factors such as pathogens, dentinal debris and pulpal remnants which can set off an inflammatory cascade in the periapical complex leading to postoperative pain and swelling.

Currently various mechanical glide path preparation techniques are seen such as the most commonly used continuous glide path preparation and the recently introduced reciprocating glide path preparation. The introduction of NiTi reciprocation in endodontics in recent years has shown added benefits of lesser chances of instrument separation, decreased incidence of

canal transportation, and lesser incidence of ledge formation [13]. Motor driven glide path preparation when compared to its counterpart manual glide path preparation is shown to exhibit lesser incidence of extrusion of debris periapically [14]. Though it is well known that reciprocating instruments having lesser chances of fatigue failure there is evidence suggesting that continuous glide path to be more resistant to fatigue failure than reciprocating glide path and lesser extrusion of debris periapically [12,15] while some studies have contradicted this by showing reciprocating system showing lesser incidence of apical debris extrusion [16-18].

This leads to fact that there is an influence of glide path preparation with reduction of post endodontic pain seen with different glide path preparation showing varied influence of pain in individuals. The current review emphasis on the different glide path preparation systems which has shown to reduce post endodontic pain with the review question; Is there any difference in the reduction of pain for patients undergoing root canal therapy using a continuous glide path system compared to other methods of glide path creation?

## MATERIAL AND METHODS

Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines was followed for reporting this review. The protocol was registered in PROSPERO with the Registration number: CRD42020180891. PICOS was defined as *Population:* Patients exhibiting pulp and/or periapical diseases who are receiving endodontic treatment, *Intervention:* Continuous glide path systems, *Comparison:* Other glide path systems, *Outcome:* The primary outcome was used to assess the pain reduction of continuous glide path systems when compared to other glide path systems. The analgesic prescribed for each study which could have an effect on the pain reduction and the irrigation concentration which was used to influence the outcome of the study, *Study Type:* Randomized control clinical trial studies were only selected for this review.

### Search strategy

A detailed search of various electronic databases, such as PubMed, Scopus, LILACS, European PMC, Google Scholar, Cochrane Library (CENTRAL) was conducted until the time frame July 2020 (Table I). Only English-language articles were selected. The search queries in each database were formulated with the basis of PICO question in combination with various Boolean operators. In addition, hand searching was done in the following journals; International Endodontic Journal, Journal of Endodontics, Restorative Dentistry and Endodontics and European Endodontic Journal.

### Inclusion criteria

Randomized control clinical trial studies in which endodontic therapy which participants with pulp or periapical diseases. These studies assessed postoperative pain reduction of only the glide path such as continuous glide path systems in comparison to other glide path systems. The post-operative pain reduction method of assessment was restricted to studies which had used a pain assessment scale.

### Exclusion criteria

Randomized control clinical trial studies in which participants exhibited periapical abscess, sinus tract. Experimental studies done on in vitro, ex vivo, or on animal subjects. Root canal preparation done directly without any glide path creation.

### Selection of the studies

The selected studies were analysed based on the inclusion/exclusion criteria and imported to a reference managing software. After removal of duplicates, the title and abstract of the remaining records were screened independently for eligibility by two reviewers (J.J., K.A.). In case of disagreement, a third reviewer (R.S) reviewed in order to achieve an agreement.

### Extraction of data

Extraction of data was conducted by two reviewers (J.J., K.A.) independently from the achieved full-text eligibility studies using a standardized data collection form. The extraction of data was based on the different outcome parameters such as pain reduction using different glide path systems, frequency of analgesic intake and Irrigation protocol. The risk of bias evaluation was provided by all the three authors for better valuation.

**Table I -** Search strategy in various electronic databases

| Electronic database | Search Strategy |
|---|---|
| PubMed | ((((pulpitides[MeSH Terms]) OR (endodontics[MeSH Terms]) OR (root canal therapy[MeSH Terms])) OR (Symptomatic reversible pulpitis)) OR (Assymptomatic irreversible pulpitis)) OR (Asymptomatic irreversible pulpitis)) OR (Asymptomatic reversible pulpitis)) OR (root canal preparation[MeSH Terms]) AND (Continuous glide path)) AND (Manual Glide Path)) OR (Reciprocating Glide Path) AND (postendodontic pain) OR (postoperative pain)) OR (Pain[MeSH Terms])) OR (pain measurement[MeSH Terms])) OR (intractable pain[MeSH Terms]) |
| Scopus | TITLE-ABS-KEY(Rootcanaltherapy) OR TITLE-ABS-KEY(Rootcanaltherapies) OR TITLE-ABS-KEY(Endodonticinflammation) OR TITLE-ABS-KEY(Pulpitis) OR TITLE-ABS-KEY(Apicalperiodontitis) AND ALL(Continuousglidepath) OR ALL(NiTi) OR ALL(Nickel-Titanium) AND TITLE-ABS-KEY(Glidepath) OR ALL(Reciprocating) OR ALL(Manual) OR ALL(stainlesssteel) AND ALL(Pain) OR ALL(Swelling) OR TITLE-ABS-KEY(Postoperativepain) OR TITLE-ABS-KEY(Postendodonticpain) OR ALL(Painthreshold) OR ALL(Painmeasurement) OR ALL(Intractablepain)) |
| Cochrane Library | #1 Root canal therapy |
| | #2 Root canal therapies |
| | #3 Endodontic Inflammation |
| | #4 Pulpitis |
| | #5 Apical Periodontitis |
| | #6 #1 OR #2 OR #3 OR #4 OR #5 |
| | #7 (Continuous glide path) |
| | #8 (Nickel-titanium) |
| | #9 (Glide Path) |
| | #10 #7 OR #8 OR #9 |
| | #11 Stainless steel |
| | #12 (Manual) |
| | #13 (Reciprocating) |
| | #14 (Reciprocating glide path) |
| | #15 (Manual glide path) |
| | #16 #12 OR #13 OR #14 OR #15 |
| | #17 Pain assessment |
| | #18 Pain |
| | #19 Flareup Symptom |
| | #20 Pain measurement |
| | #21 Intractable Pain |
| | #22 #17 OR #18 OR #19 OR #20 OR #21 |
| | #23 #6 AND #10 AND #16 AND #22 |
| LILACS | "Glide Path" OR "PathFile" OR "Postoperative Pain" |
| Google Scholar | "Endodontics" AND "Continuous Glide Path" AND "Reciprocating Glide Path" OR "Manual Glide Path" AND "Pain Reduction" |
| European PMC | "Endodontics" AND "Continuous Glide Path" AND "Reciprocating Glide Path" OR "Manual Glide Path" AND "Pain Reduction" |

## Quality assessment of the included studies

The quality assessment of all the included studies was done using the Cochrane Risk of Bias Tool. The key domains which were assessed were 1) randomization process, 2) allocation concealment, 3) Outcome assessment blinding, 4) data outcome assessment, 5) bias in reporting, 6) other bias. Judgment was done by two reviewers (J.J., K.A.) and in a situation of disagreement, a third reviewer (R.S) was consulted to achieve an agreement. The judgment of the study based on key domains were categorized as "low" risk of bias when more than four of the key domains were low and a study were considered "high" risk of bias when two or more domains were considered as "high". If the study didn't follow any of the outcome it was considered "unclear"

## RESULTS

### 1) Selection criteria for the studies

The initial electronic media search yielded 556 articles and additional hand search searching yielded 108 articles. The search flow chart is shown in Figure 1 which followed the PRISMA guidelines. After the removal of duplicates, the remaining 544 articles were screened based on the title and abstracts. 533 articles were found irrelevant and excluded. A final of 11 articles were achieved which was subjected to full-text reviewing. From the achieved articles, 8 articles were excluded [14,19-23] since two studies were systematic review [19,21]. One study was an in vitro study which didn't follow the selection parameter and was excluded [14] and the remaining though being in vivo studies [20,22,23] were still not selected since the studies did not follow the strict selection parameters set for this review. Finally, four studies were selected to be included for this review [6-9].

### 2) Characteristics of the included studies

The characteristics of the selected studies were shown in Table II and Table III. Three of the selected studies [7-9] had taken age groups between 18-69 years with one of the selected studies giving no data [6]. From the selected studies, Keskin et al. [7] had taken a total of 240 patients (137 female and 103 male), Adıgüzel et al. [9] had taken a total of 93 patients (50 female and 43 male) and Tüfenkçi et al. [8] had taken a total of 88 patients (50 female and 38 male) and Pasqualini et al. [6] had taken a total of 280 patients (140 female and 140 male). For the diagnostic characteristics of the tooth, variations were seen among the studies. Adıgüzel et al. [9] had selected on single rooted lower first or second premolar diagnosed with asymptomatic nonvital teeth. Two studies [6,7] had a similar inclusion criteria of maxillary and mandibular teeth diagnosed with asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, symptomatic apical periodontitis or asymptomatic apical periodontitis.

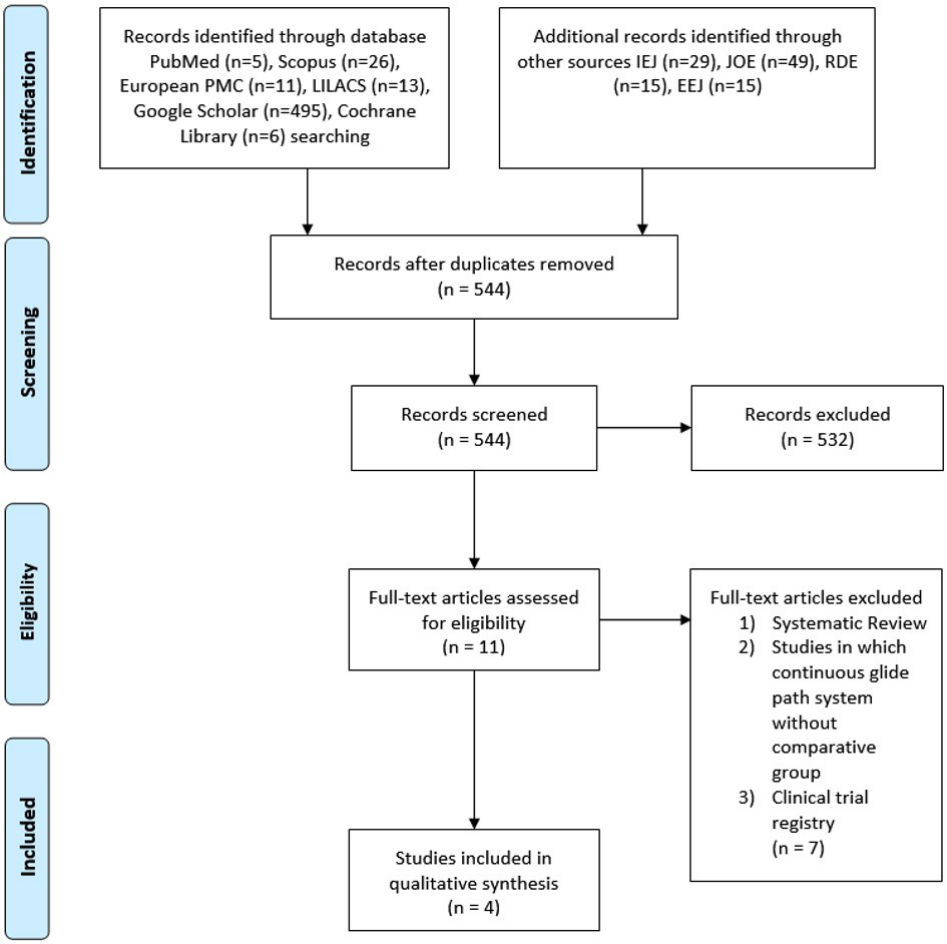


**Figure 1 -** Flow Chart of all the included studies according to the PRISMA guideline.

**Table II -** Characteristics of the included studies

| Author and Year | Sample Characteristics | Sample Size | Anaesthetic Solution used | Type of Root Canal Treatment | Groups | Irrigation Protocol | Method of Pain Evaluation | Analgesic Taken | Conclusion |
|---|---|---|---|---|---|---|---|---|---|
| Adıgüzel et al., 2019 [9] | Mandibular first or second premolars diagnosed with asymptomatic non-vital pulp | 93 patients (Age group from 20 to 65 years) | 4% articaine with 1:100,000 epinephrine | Single visit root canal treatment | 3 groups; Group 1: Manual Glide Path (Preparation done up to 15 K-File), Group 2: One G Glide Path System (Continuous Glide Path), Group 3: R-Pilot Glide Path System (Reciprocating Glide Path | 5 ml of 2.5% Sodium Hypochlorite and 5ml of 17% ethylenediaminetetraacetic acid (EDTA). | 10-point VAS Scale | Yes, Ibuprofen 400mg given. | The continuous glide path system (One G) yielded similar results when compared to Reciprocating glide path system (R-Pilot) in terms of postoperative pain but the consumption of analgesics was seen to higher with Reciprocating glide path system compared to the continuous rotary counterpart. The manual glide path preparation (K-File) showed significant higher postoperative pain compared to other rotary glide path preparation. |
| Tüfenkçi et al., 2019 [8] | Lower first of second molar diagnosed with asymptomatic irreversible pulpitis (instrumentation in only mesiolingual (ML) and mesiobuccal (MB) canals) | 88 patients (50 female and 38 male) | 1.8% Articaine with 1:100,000 epinephrine | Multi visit root canal treatment (Only Glide Path Preparation was done) | 4 groups; Group 1: R-Pilot Glide Path (Reciprocating Glide Path), Group 2: WaveOne Gold Glider Group (Reciprocating Glide Path), Group 3: One G Glide Path Group (Continuous Glide Path), Group 4: Proglider Glide Path Group (Continuous Glide Path) | Not mentioned | 10-point VAS Scale | Not mentioned | Continuous glide path system (One G) showed significant less intraoperative pain compared to other Reciprocating glide path systems (R-Pilot and WaveOne Gold Glider) |
| Keskin et al., 2019 [7] | Maxillary and mandibular teeth diagnosed with asymptomatic irreversible pulpitis, symptomatic irreversible pulpitis, symptomatic apical periodontitis, asymptomatic apical periodontitis | 240 patients (137 women and 103 men aged between 18-60 years) | 2ml of 4% articaine with 1:100,000 adrenaline | Single visit root canal treatment | 3 groups; Group 1: Manual Glide Path (Preparation done up to 15 K-File), Group 2: Proglider System Group (Continuous Glide Path), Group 3: R-Pilot Glide Path System (Reciprocating Glide Path) | 10ml of 5.25% Sodium Hypochlorite, 2.5% distilled water, 2.5% of 17% ethylenediaminetetraacetic acid (EDTA). Final irrigation with 2.5% distilled water and 2.5ml of 5.25% Sodium hypochlorite with a 30-G needle. | 10 cm VAS Scale | Ibuprofen – 600mg | The postoperative pain reduction intensity was seen to be similar with reciprocating and continuous rotary glide path system, it was seen to be lower than manual glide path preparation group at all measurement points. |
| Pasqualini et al., 2012 [6] | Maxillary and mandibular teeth diagnosed with asymptomatic/ symptomatic irreversible pulpitis, pulp necrosis, pulp necrosis with or without apical periodontitis | 280 patients (140 per group) | 2% mepivacaine with adrenaline 1:100,000 | Multi visit root canal treatment | 2 groups; Group 1: PathFile Glide System (Continuous Glide Path), Group 2: Manual Glide Path (Preparation done up to 20 K-File) | 5% Sodium Hypochlorite using 30 G Needle for a total of 10 ml | 5 -level Pain Scale | Analgesics Prescribed (No data of specifics of analgesic given) | Continuous rotary glide path system (PathFile) showed significantly higher postoperative pain reduction compared to manual glide path (K-File) instrumentation. |

**Table III -** Characteristics of the outcome measures of the included studies

| Author and Year | Outcome Measures (Results) | Secondary Outcome Measures | Final Outcome |
|---|---|---|---|
| Adıgüzel et al., 2019 [9] | **1) Pain at 24 hours** (*p* value: 0.027) | **Frequency of analgesic intake** | Manual glide path showed higher pain levels compared to R-Pilot and One-G groups. |
| | *Manual Glide Path* | *p* value: 0.327 | At 24 hours highest pain reduction was seen with One-G group compared to R-Pilot Group. |
| | n=31, Mean & SD: 3.71±2.03, Median 4.00, Minimum: 0.00, Maximum: 7.00, | *Manual Glide Path* | **Analgesic intake:** |
| | *R- Pilot Glide Path* | None – 12 individuals, 1 tablet – 9 individuals, 2 tablets – 6 individuals, 3 tablets – 4 individuals | Manual Glide Path > R-Pilot Group > One-G Group at different time intervals |
| | n=31, Mean & SD: 2.00±1.87, Median: 1.00, Minimum: 0.00, Maximum: 6.00 | *One G* | |
| | *One G Glide Path* | None – 20 individuals, 1 tablet – 5 individuals, 2 tablets – 4 individuals, 3 tablets – 2 individuals | |
| | n=31, Mean & SD: 1.05±1.07, Median: 1.00, Minimum: 0.00, Maximum: 3.00 | *R-Pilot* | |
| | **2) Pain at 48 hours** (*p* value: 0.621) | None – 17 individuals, 1 tablet – 7 individuals, 2 tablets – 5 individuals, 3 tablets – 2 individuals | |
| | *Manual Glide Path* | | |
| | n=31, Mean & SD: 2.95±1.36, Median: 3.00, Minimum: 0.00, Maximum 6.00 | | |
| | *R- Pilot Glide Path* | | |
| | n=31, Mean & SD: 1.38±0.80, Median: 1.00, Minimum: 0.00, Maximum: 3.00 | | |
| | *One G Glide Path* | | |
| | n=31, Mean & SD: 0.62±0.67, Median: 1.00, Minimum: 0.00, Maximum: 2.00 | | |
| | **3) Pain at 72 hours** (*p* value: 0.309) | | |
| | *Manual Glide Path* | | |
| | n=31, Mean & SD: 2.19± 1.33, Median: 2.00, Minimum: 0.00, Maximum: 4.00 | | |
| | *R- Pilot Glide Path* | | |
| | n=31, Mean & SD: 1.29±1.06, Median: 1.00, Minimum: 0.00, Maximum: 3.00 | | |
| | *One G Glide Path* | | |
| | n=31, Mean & SD: 0.57±0.68, Median: 0.00, Minimum: 0.00, Maximum: 2.00 | | |
| Tüfenkçi et al., 2019 [8] | *R- Pilot Glide Path* | None | **Levels of Pain Decrease** |
| | n=22, Median: 2.0000, Minimum: 1.00, Maximum: 5.00, Standard Deviation: .95346 | | R-Pilot Group >WaveOne Gold Glider Group >One G Group>ProGlider Group |
| | *WaveOne Glider Glide Path* | | |
| | n=22, Median: 3.0000, Minimum: 0.00, Maximum: 4.00, Standard Deviation: 1.01183 | | |
| | *One G Glide Path* | | |
| | n=22, Median: 2.0000, Minimum: 1.00, Maximum: 3.00, Standard Deviation: .63960 | | |
| | *ProGlider Glide Path* | | |
| | n=22, Median: 1.5000, Minimum: 0.00, Maximum: 3.00, Standard Deviation: .80178 | | |

**Table III -** Continued...

| Author and Year | Outcome Measures (Results) | Secondary Outcome Measures | Final Outcome |
|---|---|---|---|
| Keskin et al., 2019 [7] | *ProGlider Glide Path* | **Number of patients reported with pain in different time intervals** | **Pain level reduction** |
| | n=80, Mean VAS Score: 1.97-0.28 | *6TH hours:* | R-Pilot Group = ProGlider Group > Manual Glide Path Group |
| | *R-Pilot Glide Path* | Manual Instrumentation: 60 patients | **Lesser number patients reported with pain** |
| | n=80, Mean VAS Score: 1.57-0.21 | ProGlider Glide Path: 43 patients | R-Pilot Group > ProGlider Group > Manual Glide Path Group |
| | *Manual Glide Path* | R-Pilot Glide Path: 39 patients | |
| | n=80, Mean VAS Score: 2.82-1.32 | *12TH hours:* | |
| | Postoperative pain reduction with manual and engine driven glide path preparation ($P < 0.05$) | Manual Instrumentation: 56 patients | |
| | Postoperative pain reduction was seen to show not much significant difference between R-Pilot and ProGlider Groups ($P > 0.05$) | ProGlider Glide Path: 42 patients | |
| | | R-Pilot Glide Path: 36 patients | |
| | | *18TH hours:* | |
| | | Manual Instrumentation: 47 patients | |
| | | ProGlider Glide Path: 25 patients | |
| | | R-Pilot Glide Path: 25 patients | |
| | | *24 hours:* | |
| | | Manual Instrumentation: 40 patients | |
| | | ProGlider Glide Path: 24 patients | |
| | | R-Pilot Glide Path: 14 patients | |
| | | *48TH hours:* | |
| | | Manual Instrumentation: 34 patients | |
| | | ProGlider Glide Path: 17 patients | |
| | | R-Pilot Glide Path: 9 patients | |
| | | *72ND hours:* | |
| | | Manual Instrumentation: 33 patients | |
| | | ProGlider Glide Path: 14 patients | |
| | | R-Pilot Glide Path: 7 patients | |
| Pasqualini et al., 2012 [6] | Mean & Standard Deviation at baseline for PathFile Glide Path Group: 2.5 ± 1.53, Manual Instrumentation: 2.31± 1.35. | **Mean analgesic intake** | **Reduction of Pain** |
| | At 24 hours: Mean and Standard Deviation | K-File: 3.7 ± 2.2 and PathFile Group: 2 ± 1.7 (*p*-value: 0.001) | PathFile Group > Manual Glide Path Group |
| | K-File Group: 1.33, PathFile: 0.94 | | |
| | At 48 hours: Mean and Standard Deviation | | **Analgesic Intake** |
| | K-File Group: 1.15, PathFile: 0.67 | | Higher in Manual Glide Path compared to PathFile Group |
| | At 72 hours: Mean and Standard Deviation | | |
| | K-File Group: 0.87, PathFile: 0.44 | | |
| | *p*-value on postoperative pain reduction scores between PathFile and K-File Groups: 0.004 | | |

Tüfenkçi et al. [8] had an inclusion criteria of only asymptomatic irreversible pulpitis in 1st and 2nd mandibular molars. Most of the studies focused on single visit RCT except for Tüfenkçi et al. [8] and Pasqualini et al. [6] whom focused on intraoperative pain during glide path creation. Inspite of their assessment of intraoperative pain, the study was included in our study based on previous literature suggesting there is no compelling difference for the incidence of postoperative pain

occurrence during multi visit and single visit endodontic treatment [24,25]. The post-operative pain assessment for all the included studies had been done using the Visual Analogue Scale (VAS) Scale except for Pasqualini et al. [6] had done post-operative pain assessment using a 5 level pain scale. For continuous glide path system, One-G (Micro-Mega, Besançon Cedex – France) was the most commonly used system among the selected studies [8,9] being WaveOne Glider (Dentsply Sirona, USA), ProGlider (Dentsply Tulsa, USA) and PathFile (Dentsply Sirona, USA) systems [6,8]. R-Pilot (VDW - Munich, Germany) was the most commonly used reciprocating glide path system and for manual glide path, K-Files was the most commonly used.

### 3) Risk of bias

The summary of the risk of bias of the included is given in Figure 2 and Figure 3. Three included studies were considered as overall "high" risk of bias [6,8,9] with Pasqualini et al. [6] was seen to show "high" risk of bias for randomization and allocation concealment domain. Two studies [8,9] had shown "high" risk of bias in performance bias and detection bias domain. Keskin et al. [7] was considered as overall "unclear" due to the various domains considered as unclear. Table IV explains the risk of bias assessment of individual studies.

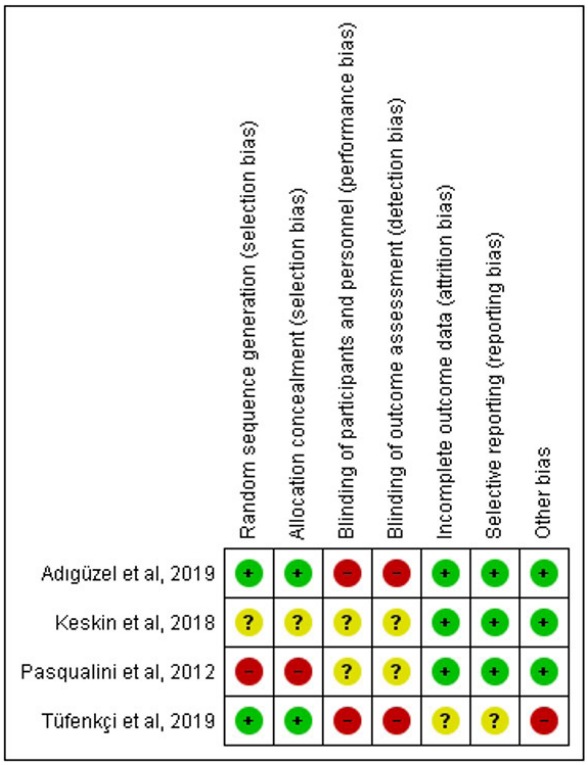


**Figure 2 -** Risk of bias summary of all individual studies.

## DISCUSSION

Glide Path is the initial preparation of the root canal system in a shape of a radicular funnel from the root canal orifice to the apical terminus allowing subsequent instrumentation to take place [26]. During glide path preparation, there is an initial apical enlargement taking place, which has an influential role in reducing preparation times and other failures [27]. As well as this, the centricity of the canal is also maintained to allow further instrumentation to take place with the possibility of complications to reduce significantly [28]. The current review evaluates the reduction of postoperative pain of continuous glide path system with other glide path preparation methods. The included studies show simultaneous comparison using continuous glide path system and various other glide path systems in reduction of pain post treatment in a single visit [7,9] or multi visit root canal procedure [6,8].

In the present review, from the included studies three out of four studies showed an overall "high" risk of bias and the latter showing an overall "unclear" bias. Though all studies in the included studies [6-9], had done randomization the mode of randomization was not described adequately by some studies [6,7] giving a "high" risk of bias and "unclear" bias. Only one study [6] showed a "high" risk of bias for random sequence generation and allocation concealment. Two studies of the included studies [8,9] showed a "high" risk of bias with inadequate information mentioned of the blinding of participants and personals and outcome assessment. All this difference in risk values not being adequately followed by the authors in different domains could have a possible influence in the results of their study.

During the root canal therapy, pain occurrence is influenced by various operator dependent factors such as chemical, mechanical or bacterial causes. This occurs mainly by introducing dentinal debris, necrotic pulpal tissue and bacteria causing periodontal inflammation occur [29]. During the instrumentation procedure, it is inevitable to avoid debris extrusion to occur. The introduction of various glide path systems show reduction of debris extrusion to be substantial in reducing postoperative pain [30].

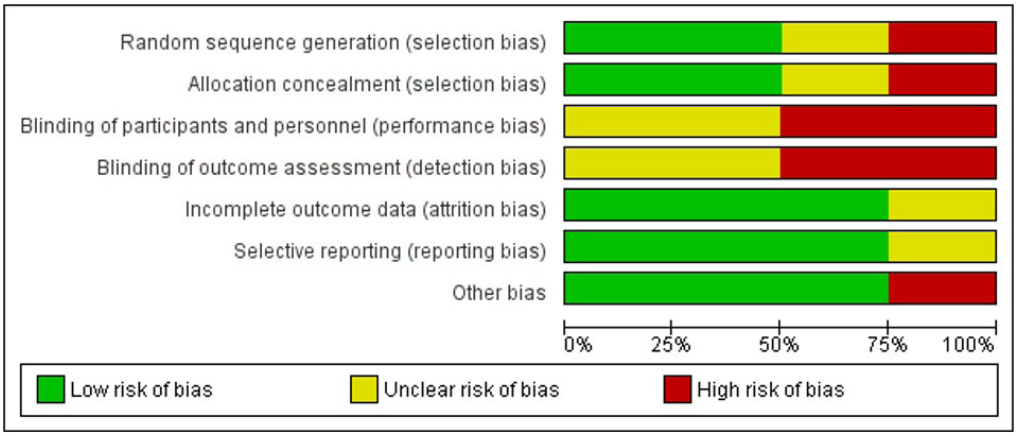


**Figure 3 -** Risk of bias summary of all individual studies.

**Table IV -** Risk of bias of the Included studies according to Cochrane risk of bias for randomized controlled trials

| Studies | Random Sequence Generation | Allocation Concealment | Blinding of Participants and Personnel | Blinding of outcome assessment | Incomplete outcome data | Selective reporting | Other bias |
|---|---|---|---|---|---|---|---|
| Adıgüzel et al., 2019 [9] | Low | Low | High | High | Low | Low | Low |
| Tüfenkçi et al., 2019 [8] | Low | Low | High | High | Unclear | Unclear | High |
| Keskin et al., 2018 [7] | Unclear | Unclear | Unclear | Unclear | Low | Low | Low |
| Pasqualini et al., 2012 [6] | High | High | Unclear | Unclear | Low | Low | Low |

Various experimental research have shown that the mechanical glide path has significantly lesser debris extrusion compared to its manual counterpart [31-33]. Currently, two mechanical glide path systems are being used such as continuous glide path system and reciprocating glide path system [34]. With the advent of various metallurgical advancements, the use of reciprocating motion in endodontics has shown a significant advantage such as shorter preparation times [35] but with frequent controversies being more apical extrusion [36] and other more debris accumulation [37] than that of continuous rotary counterpart.

The included studies used various glide path systems such as continuous, reciprocating or manual glide path for glide path preparation. Preparation of the glide path usually goes in combination with the canal's pre-flaring, decreasing the fracture risk of instruments in the canal [38]. Manual glide path preparation is usually done with the use of stainless-steel hand K-Files which is done post scouting the canal. which is shown to have increased extrusion of debris; therefore, more postoperative pain incidence [39]. Zheng et al. [40] had shown that iatrogenic errors such as canal transportation in curved canals are seen to be more evident with hand glide path preparation that its rotary counterpart. The included studies [6,7] used glide path preparation using hand K-Files had reported an increase in postoperative pain compared to other glide path preparation methods possibly due to the fact that hand K-Files tend to use the conventional step-back technique compared to conventional rotary instrumentation which uses the conventional crown-down technique [41].

Nickel-Titanium instruments are shown to have greater flexibility, superelasticity, superior cutting ability and more centric root canal preparation than stainless steel instruments and shown to have changed the way of endodontic instrumentation [42]. The most common being continuous rotary instrumentation and the latter being reciprocating rotary instrumentation. Continuous rotary glide path systems follow the same principle as conventional rotary instruments which prepares the canal space in a crown down

technique, thus reducing postoperative pain [43]. The current included studies [6-9] have all done a comparison with continuous rotary glide path system with other glide path systems in reduction of postoperative pain. All studies showed had evaluated a final outcome of pain reduction with continuous glide path preparation showing a lesser postoperative pain occurrence than glide path prepared using manual method. Numerous continuous glide path systems were used with included studies mainly reporting the usage of PathFile, ProGlider and One-G files. The One-G files is shown to have an evolving cross section with 3 cutting edges [44]. PathFile is shown to have a square cross section with a rounded edge [4] and ProGlider is made with M-Wire NiTi alloy with variable taper [45]. Though in future studies have been inconsistent [18,36,46], the present studies by Tüfenkçi et al. [8] and Adıgüzel et al. [9] concluded that continuous glide path system had lesser postoperative pain incidence than reciprocating glide path systems. In contrast, Keskin et al. [7] had shown a similar postoperative pain reduction at various time intervals for both glide path systems.

The introduction of reciprocating instrumentation by Yared [47] had paved the way for single use reciprocating instrumentation in endodontics. Reciprocating instrumentation is seen to be an advancement of the balanced force technique, which is shown to be superior since it is shown to exhibit better fatigue levels for the instrument hence preventing instrument separation from occurring [48,49]. Currently, this concept has been advocated for glide path preparation and included studies [7-9] showing the use of reciprocating glide path systems being used. The currently advocated reciprocating glide path system used is WaveOne Gold Glider, made up of thermo-mechanically treated alloy showing a lesser incidence of cyclic fatigue than R-Pilot files produced using M-wire technology [50]. Despite this difference, Tüfenkçi et al. showed no difference in pain levels between R-Pilot and WaveOne Gold Glider [8].

The administered use of analgesics could have a varied effect on pain score levels. NSAID's are the most commonly prescribed analgesics for pain reduction in endodontics by reducing inflammatory mediators such as PGE2 [51]. The included studies [7,9] prescribed ibuprofen as an analgesic for administration in case of moderate/severe pain. It was seen that lesser administration of analgesics dosage was seen in continuous glide path prepared groups compared to other glide path prepared groups with manual glide path preparation showing the highest analgesic consumption.

Visual Analogue Scale (VAS) Scale is a reliable pain predictor tool used to assess an individual's pain levels. This is due to its relative simplicity and easiness of completion for the individual [52] as well as high inter-rater reliability and test-retest reliability requiring the individual to evaluate pain in a mathematical model, thus negating potential change of responses [53]. The included studies [7-9] used VAS Scale to assess preoperative pain and postoperative pain reduction. Pasqualini et al. [6] had done the pain evaluation using a 5 point verbal pain scale, which is shown to exhibit certain disadvantage compared to VAS Scale is that the reference values could not necessarily emulate the same meaning for each person and could potentially change the outcome of the pain response [54]. A recent review evaluated the outcome of single and multi-visit endodontic treatment procedures and showed a higher incidence of flareups in single visit endodontic treatment procedures though the present included studies showed postoperative pain was seen to be similar for both the scenarios [24].

The use of endodontic irrigants such as Sodium Hypochlorite (NaOCl) have shown to have an influential role in the success of endodontic therapy since they lubricate the canal during instrumentation simultaneously reducing the canal preparation time by reducing the operative torque levels of the instruments [55]. Its primary mechanism of action is to act on by chlorination action on microbes leading to their degradation [56]. Though the irrigants have shown a considerable role in reducing microbes, its role as an influential factor in reducing post-operative pain is less explored. Recently, various clinical studies have been introduced in dental literature assessing the influence of different sodium hypochlorite concentrations in reducing postoperative pain [57-59]. Mostafa et al. [58] concluded that 1.3% NaOCl showed lesser post-endodontic pain than 5.25% NaOCl in the nonvital tooth with a lesser intake of analgesics seen by the participants who were irrigated with 1.3% NaOCl. Another study by Farzaneh et al. [57] in their clinical study showed that participants with symptomatic irreversible pulpitis when irrigated

with 5.25% NaOCl showed lesser postoperative pain when compared to irrigation with 2.5% sodium hypochlorite stating that 5.25% NaOCl has higher dissolution capacity and inhibiting the release of signaling molecules to enable the inflammation cascade to begin. The included studies [6,7,9] in the current review have used various concentration for irrigation and have an influence in the overall results of the study. It was seen that a higher amount of analgesic consumption was seen among individuals irrigated with 2.5% NaOCl when compared to a higher concentration. With the evidence of current literature, it can be stated a higher concentration of NaOCl is recommended for reduction of postoperative pain.

The possibility of meta-analysis for the current review was negated due to the following reason; The included studies had evaluated the pain measurements using various pain measurement scales at different time intervals leading to increased heterogeneity, use of different comparison groups in the included studies which could have a possible influence on the postoperative pain scores.

## CONCLUSION

In regard to the present review with three out of four studies showing an overall "high" risk of bias it can be concluded to an extend that mechanical instrumentation with continuous rotary glide path systems are shown to simulate better postoperative pain reduction levels compared to its reciprocating counterpart. Reciprocating glide path system, though in dental literature are shown to be advantage in preparation times it is not the case with postoperative pain reduction, with pain incidence seen to be much higher than continuous glide path preparation. Manual glide path preparation had shown a higher incidence of postoperative pain compared to other glide path systems. The consumption of analgesics was seen to be much higher in manual glide path preparation followed by reciprocating glide path preparation and continuous glide path preparation. The use of higher concentration of NaOCl is recommended in conjugation with continuous glide path preparation in order to provide an effective reduction with postoperative pain. Considering the relative lack of similar studies, further studies are necessary for a definitive conclusion regarding this aspect.

## Authors' Contributions

JJ: conceptualization, data collection, data analysis, manuscript preparation. AK: data collection, data analysis, manuscript editing, supervision. RS: data analysis, manuscript editing.

## Conflict of Interest

The authors have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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