

Literature Review Article

Does cervical root canal preparation influence the quality of endodontic treatment? A systematic review

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Abstract

Objective: Cervical preparation aims to remove dentin prominences located in the cervical region of the root canal. However, there is no consensus in the literature regarding the importance of this operative maneuver in endodontic treatment. The objective of this systematic review was to answer the question: Does cervical root canal preparation influence the quality of endodontic treatment? **Material and methods:** Electronic databases (Medline/PubMed, Lilacs, Scopus, Embase, Scientific Electronic Library Online – SciELO, and Central Register of Controlled Trials – Central) were searched until July 2023, without language or year restriction. Grey literature was also searched through Google scholar and OpenGrey repository. Only in vitro studies were included that evaluated the influence of cervical preparation on endodontic treatment. Relevant results were summarized and evaluated. The risk of bias was also assessed in the studies. **Results:** Initial screening of databases resulted in 235 studies, of which 80 were excluded for being duplicates. Of 155 eligible papers, twenty-nine studies met the inclusion criteria and were selected for full-text reading. Most of studies included in this review were qualified with low risk of bias. Five studies showed moderate risk. **Conclusion:** Based on the analyzed studies, it is possible to conclude that performing the cervical preparation facilitates the execution of the steps of odontometry and mechanical chemical preparation in clinical practice.

Introduction

The cervical preparation of the root canal, prior to the mechanical chemical preparation, consists in the removal of dentinal interferences that reduce the diameter of the root canal. According to Torabinejad. [33], performing cervical preparation provides rectilinear access to the instrument along the root canal, reducing the possibility of accidents during the maneuvers of mechanical chemical preparation.

Over time, several instruments have been proposed for performing cervical preparation, such as manual and rotary nickel-titanium drills and files [4, 13, 24, 25], but there is still no consensus on which is the best instrument.

For Estrela *et al.* [8], cervical preparation is an alternative technique in order to facilitate the instrumentation of curved canals. The authors pointed out that one of the causes of iatrogenesis during endodontic preparation was the lack of control over the active part of the instrument, so that the previous preparation of the cervical third provided greater control over this instrument by the operator.

Souza and Reiss [29], in 2002, stated that the removal of cervical interference favors greater penetration of the instrument into the canal and also allows the instrument to penetrate more freely into the root canal, reducing the possibility of fracture and deformation.

To date, no systematic review has been performed evaluating such information. Therefore, the objective of this systematic review is to answer the following question: “Does cervical root canal preparation influence the quality of endodontic treatment?”.

Material and methods

This systematic review was conducted in accordance with the recommendations provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [15] and was registered in the International Prospective Register of Systematic Review (Registration number CRD42021268315).

Search strategy

The search was performed independently by two examiners (B.S.B. e B.N.P.) in the following electronic databases: Medline/PubMed, Lilacs, Scopus, Embase, Scientific Eletronic Library Online (SciELO), and Central Register of Controolled Trials (Central). The search was conducted for articles published until July 2023, without language or

year restriction. Grey literature was also searched through Google scholar and OpenGrey repository.

The electronic search strategy was developed using the most cited descriptors in previous publications on this theme combining Medical Subject Heading (MeSH) terms and text words (tw.). For each database, the following terms were combined: *((cervical preflaring) OR (cervical endodontic preparation)) AND ((endodontics) OR (endodontics treatment))*.

Additional screening on the selected studies' references was performed, and the related articles were searched in the PubMed database. All articles selected were imported into the Mendeley[®] (Mendeley Ltd, London, United Kingdom) reference manager to catalogue the references and facilitate the exclusion of duplicates.

Eligibility criteria

The eligibility criteria were based on the PICOS strategy (PRISMA-P 2015) [19, 22], as follows:

- Population (P): posterior permanente human teeth;
- Intervention (I): cervical root canal preparation;
- Comparison (C): without cervical root canal preparation;
- Outcome (O): quality of endodontic treatment;
- Study design (S): in vitro studies.

Selection of the studies

The first stage consisted of excluding the duplicated studies, considering only once, and examining the selected studies' retrieved titles and abstracts by two independent authors (B.S.B. and B.N.P.). When it was not possible to judge the studies by title and abstract, the full text was accessed and read for the final decision. The second stage consisted of reading the potentially eligible studies' full texts based on the PICOS strategy's eligibility criteria. Disagreements on study inclusion were solved by a consensus with a third author (T.A.F.M.).

Data extraction

Two authors (B.S.B. and B.N.P.) independently collected the data from the included studies. Disagreements were solved by a third author (T.A.F.M.). The following data were extracted from the included studies: publication data (authors, year, and country of origin), study characteristics (teeth evaluated, type of control, groups tested, factor analyzed in endodontic treatment, and outcome information). In cases of missing data, the authors were contacted three times by e-mail.

Quality assessment and strength of evidence

The methodological risk assessment of bias for each study was performed by two independent authors (B.S.B. and B.N.P.), and, in case of disagreement, it was resolved by a third author (T.A.F.M.).

The studies' qualitative analysis was performed from the risk of bias assessment using the Cochrane risk of bias tool for randomized clinical trials (RoB 2.0): "Bias Risk Assessment of Randomized Controlled Studies" – Cochrane Handbook 6.0 [11].

As this review only included *in vitro* studies, the criteria were adapted to allow for a critical analysis of the studies. The risk of bias between six domains (description of the sample size calculation, randomization of teeth, presence of a control group, description of cervical root canal preparation methods, description of the method for evaluating the quality of endodontic treatment, and statistical method) was evaluated. The studies were classified into: low risk, moderate risk, and high risk, as adapted from RoB 2.0.

A "yes" was assigned where the parameters were found, and a "no" in the absence of them. Articles in which none or even two of these parameters are found were classified as low risk of bias; those with three or four parameters were considered to be at moderate risk of bias; with five or six parameters, high risk of bias.

Results

Study selection

Initial screening of databases resulted in 235 studies. Of these articles, 155 were excluded as they were duplicates. From the analysis of the titles and abstracts, 50 studies were excluded and twenty-nine studies met the inclusion criteria and were selected for full-text Reading and included in this systematic review. Figure 1 presents the flow diagram of the search strategy.

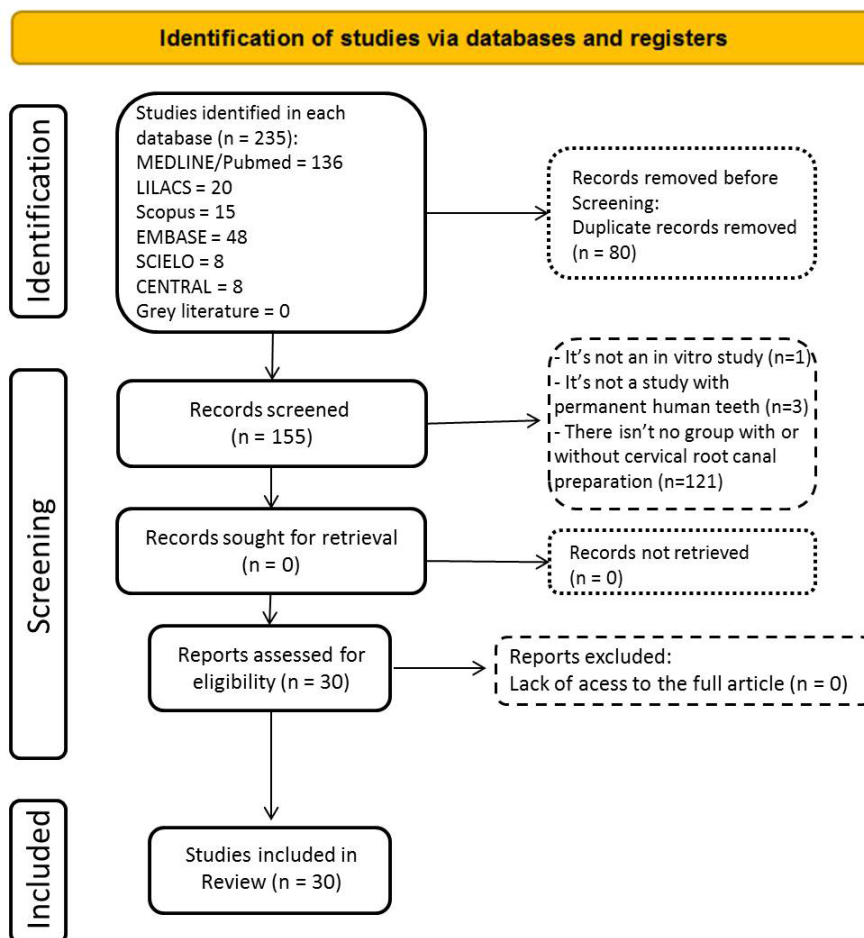


Figure 1 - PRISMA flow diagram representing the systematic review process

Data extraction

Table I presents the characteristics and main findings of the included studies. Authors of studies with insufficient data were contacted by e-mail, but no additional information was received.

Table I - Data extracted from the included studies

Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Amaral <i>et al.</i> [1]	Brazil	Lower molar	Three groups: - PathFile + WaveOne group - ProTaper SX + WaneOne group - WaveOne group	Apical transport and preparation centering	Cervical or apical enlargement resulted in reduced transportation and improved centralization of the middle thirds compared with the exclusive use of the WaveOne system.
Ashwini and Bhandari [2]	India	Upper premolar	Five groups: - Control group - Gates Glidden group - ProTaper group - Race group - Galaxy Diamond group	Determination of the initial apical instrument	Cervical preparation increases the accuracy of apical size determination.
Barbieri <i>et al.</i> [3]	Brazil	Upper molar	Four groups: - Reciproc group - Preflaring + Reciproc group - WaveOne group - Preflaring + WaveOne group	Apical transport	Cervical preparation did not influence apical transportation in curved root canals instrumented using Reciproc R25 and WaveOne Primary files.
Barroso <i>et al.</i> [4]	Brazil	Upper premolar	Five groups: - Control group - Gates Glidden group - K3 group - ProTaper group - LA Axxess group	Determination of the initial apical instrument	Cervical preparation improved the determination of the anatomical diameter at the WL.

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Borges <i>et al.</i> [5]	Brazil	Upper incisor	Thirteen groups: – Control group – Reciproc – WaveOne – ProTaper – ProTaper Next – Profile – K-flies – Cervical preflaring + Reciproc – Cervical preflaring + WaveOne – Cervical preflaring + ProTaper – Cervical preflaring + ProTaper Next – Cervical preflaring + Profile – Cervical preflaring + K-flies	Apical extrusion of debris	Cervical preflaring was associated with the extrusion of smaller quantities of apical debris.
Borges <i>et al.</i> [6]	Brazil	Upper incisor	Thirteen groups: – Control group – Reciproc – WaveOne – ProTaper – ProTaper Next – Profile – K-flies – Cervical preflaring + Reciproc – Cervical preflaring + WaveOne – Cervical preflaring + ProTaper – Cervical preflaring + ProTaper Next – Cervical preflaring + Profile – Cervical preflaring + K-flies	Incidence of root dentin defects after root canal preparation	All instruments caused root dentin defects, regardless of the enlargement or not of the cervical portion. Cervical preflaring was associated with a lower incidence of defects, mainly in root canals prepared with WO and PTN.

To be continued...

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Cecchin <i>et al.</i> [7]	Brazil	Upper molar	Five groups: - Control group - Gates Glidden group - Anatomic Endodontics Technology group - GT Rotary files group - LA Axxess group	Determination of the initial apical instrument	The cervical preflaring used interferes in the determination of initial apical file.
Guimarães <i>et al.</i> [9]	Brazil	Lower incisor	Two groups: - LA Axxess group - ProTaper group	Measurement working length	The preflaring procedure increased the number of accurate measurements for both electronic apex locators.
Gunes and Yeter [10]	Turkey	Lower incisor	Six groups: - ProTaper Next group - EndoFlare + Protaper Next group - 2Shape group - EndoFlare + 2Shape group - OneCurve group - EndoFlare + OneCurve group	Apical extrusion of debris	Cervical preflaring of root canals did not affect the amount of apically extruded debris.
Ibarrola <i>et al.</i> [12]	U.S.	Lower molar	Two groups: - Control group - Profile group	Measurement working length	Cervical preparation of canals will allow working length files to more consistently reach the apical foramen, which in turn increases the efficacy of the electronic Apex Locator.
Ibelli <i>et al.</i> [13]	Brazil	Upper incisor	Four groups: - Control group - Orifice Opener group - Gates Glidden group - LA Axxess group	Determination of the initial apical instrument	Cervical preparation improved anatomical diameter determination.

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Leonardi <i>et al.</i> [14]	Brazil	Lower incisor	Six groups: - F2 ProTaper - SX and F2 ProTaper - MTwo - SX and MTwo - BR3 BioRace - SX and BR3 BioRace	Apical root canal preparation and cleaning	Cleaning ability improves when root canal preparation with F2 ProTaper is complemented by prior cervical enlargement.
Lima <i>et al.</i> [16]	Brazil	Lower molar	Three groups: - Control group - Gates Glidden group - ProTaper group	Determination of the initial apical instrument	The Gates-Glidden drills and Hand ProTaper system used in the preparation of the cervical and middle thirds of root canals showed similar results in the adaptation of initial apical file in the mesiobuccal canals of mandibular molars.
Lins <i>et al.</i> [17]	Brazil	Lower molar	Two groups: - Control group - Gates Glidden group	Determination of the initial apical instrument	When the preflaring was not performed, the difference between the diameters of the files and the anatomic diameters was greater. Preflaring was shown to be essential for the determination of patency and initial apical files.
Lopez <i>et al.</i> [18]	Brazil	Upper molar	Two groups: - Control group - ProTaper group	Measurement working length	The cervical third is flared with nickel- titanium files, the resulting change in WL becomes irrelevant for the clinical practice.
Maniglia-Ferreira <i>et al.</i> [20]	Brazil	Upper molar	Four groups: - cervical preflaring + Reciproc - Reciproc - cervical preflaring + WaveOne - WaveOne	Fracture strength and plastic deformation and/or urfasse cracking in emdodontic instruments	Cervical preflaring allowed a significant increase in the number of times Reciprov and WaveOne files could be reused safely.

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Melo <i>et al.</i> [21]	Brazil	Lower molar	Three groups: - Without cervical preflaring - #25/.06 instruments group - #25/.12 instruments group	Measurement working length	The cervical preparation protocols influenced the accuracy of electronic foramen locators, where the less conservative one produced the best results.
Morgental <i>et al.</i> [23]	Brazil	Lower incisor	Two groups: - Control group - LA Axxess group	Measurement working length	Preflaring procedure was advantageous for all electronic Apex locators.
Pécora <i>et al.</i> [24]	Brazil	Upper incisor	Four groups: - Without flaring - Gates Glidden - Quantec - LA Axxess	Determination of the initial apical instrument	Cervical preparation improved anatomical diameter determination.
Sharma <i>et al.</i> [27]	Índia	Upper molar	Eight groups: - Control group - LA Axxess group - HyFlex group - Gates Glidden group - ProTaper group - Race group - FlexMaster group - K3 group	Determination of the initial apical instrument	Cervical preparation reduced the discrepancy between initial apical file diameter and apical canal diameter.
Schmitz <i>et al.</i> [26]	Brazil	Lower molar	Five groups: - Control group - Gates Glidden group - ProTaper group - EndoFlare group - LA Axxess group	Determination of the initial apical instrument	Cervical preparation improved initial apical file fitting to the canals at the WL in mesiobuccal roots of maxillary first molars.

To be continued...

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Silva <i>et al.</i> [28]	Brazil	Lower incisor	Four groups: - Control group - Gates Glidden group - Navigator group - ProDesign S group	Fracture resistance of endodontically treated teeth after cervical preflaring and root canal preparation and to assess the volume of the root canal and the amount of remaining root dentin	All instruments reduced the dentin thickness and increased the canal volume in the cervical at 3 mm and 5 mm. Gates Glidden reduced fracture resistance of mandibular incisors submitted to cervical preflaring, whereas NiTi instruments did not.
Tan and Messer [30]	Australian	Upper and lower molar and premolar	Two groups: - K-file group - Lightspeed Rotary group	Determination of the initial apical instrument	Cervical preparation resulted in an increase in the instrument size that bound at WL.
Teixeira <i>et al.</i> [31]	Brazil	Lower molar	Two groups: - Control group - Gates Glidden group	Measurement working length	Cervical preparation not able to influence the accuracy of apex locator in determining the exact working length.
Tennert <i>et al.</i> [32]	Germany	Lower molar	Four groups: - Control group - FlexMaster group - ProTaper group - Race group	Determination of the initial apical instrument	Cervical preparation increases the accuracy of apical size determination.
Vanni <i>et al.</i> [34]	Brazil	Upper molar	Five groups: - Control group - Gates Glidden group - K3 group - ProTaper group - LA Axxess group	Determination of the initial apical instrument	Cervical preparation improved the determination of the initial apical instrument.
Villalobos <i>et al.</i> [35]	Chile	Lower molar	Two groups: - Gates Glidden group - Protaper group	Quantify the dentin removed	A greater cervical root dentine removal in canals treated with ProTaper files was observed.

To be continued...

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Author (s) (year of publication)	Country of origin of the study	Dental group	Experimental groups	Factor analyzed in endodontic treatment	Main findings
Vivan <i>et al.</i> [36]	Brazil	Lower molar	Four groups: - Control group - Largo group - CP Drill group - LA Axxess group	Determination of the initial apical instrument	Cervical preparation does not influence the determination of the anatomical diameter.
Zamin <i>et al.</i> [37]	Brazil	Lower incisor	Four groups: - Control group - #30/08 file group - #30/10 file group - #70/12 file group	Tooth root fracture resistance	A high level of dentin wear promoted during the cervical preparation increased the fracture susceptibility of roots. Over-preparation of the cervical area overcomes any potential strengthening a resin sealer can provide.

Quality assessment

Table II summarizes the risk of bias of the selected in vitro studies. According to the evaluated parameters, most of studies included in this review were qualified with low risk of bias. Studies that showed moderate risk were Guimarães *et al.* [9], Ibarrola *et al.* [12], Melo *et al.* [21], Tan and Messer [30], and Villalobos *et al.* [35].

Table II - Quality assessment of the in vitro studies

Study	Description of the sample size calculation	Randomization process	Presence of control group	Description of cervical root canal preparation methods	Description of the method for evaluating the quality of endodontic treatment	Statistical method	Risk of bias
Amaral <i>et al.</i> [1]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Ashwini and Bhandari [2]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Barbieri <i>et al.</i> [3]	No	No	Yes	Yes	Yes	Yes	Low risk
Barroso <i>et al.</i> [4]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Borges <i>et al.</i> [5]	No	Yes	No	Yes	Yes	Yes	Low risk
Borges <i>et al.</i> [6]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Cecchin <i>et al.</i> [7]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Guimarães <i>et al.</i> [9]	No	No	No	Yes	Yes	Yes	Moderate risk
Gunes and Yeter [10]	No	Yes	No	Yes	Yes	Yes	Low risk
Ibarrola <i>et al.</i> [12]	No	No	Yes	Yes	Yes	No	Moderate risk
Ibelli <i>et al.</i> [13]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Leonardi <i>et al.</i> [14]	No	Yes	Yes	Yes	Yes	Yes	Low risk

To be continued...

Continuation of the table II

Study	Description of the sample size calculation	Randomization process	Presence of control group	Description of cervical root canal preparation methods	Description of the method for evaluating the quality of endodontic treatment	Statistical method	Risk of bias
Lima <i>et al.</i> [16]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Lins <i>et al.</i> [17]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Lopez <i>et al.</i> [18]	No	No	Yes	Yes	Yes	Yes	Low risk
Maniglia-Ferreira <i>et al.</i> [20]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Melo <i>et al.</i> [21]	Yes	No	Yes	Yes	Yes	Yes	Moderate risk
Morgental <i>et al.</i> [23]	No	No	Yes	Yes	Yes	Yes	Low risk
Pécora <i>et al.</i> [24]	No	No	Yes	Yes	Yes	Yes	Low risk
Sharma <i>et al.</i> [27]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Schmitz <i>et al.</i> [26]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Silva <i>et al.</i> [28]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Tan and Messer [30]	No	No	No	Yes	Yes	Yes	Moderate risk
Teixeira <i>et al.</i> [31]	No	No	Yes	Yes	Yes	Yes	Low risk
Tennert <i>et al.</i> [32]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Vanni <i>et al.</i> [34]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Villalobos <i>et al.</i> [35]	No	No	No	Yes	Yes	Yes	Moderate risk
Vivan <i>et al.</i> [36]	No	Yes	Yes	Yes	Yes	Yes	Low risk
Zamin <i>et al.</i> [37]	No	Yes	Yes	Yes	Yes	Yes	Low risk

Discussion

Cervical preparation consists of removing interferences in the cervical third of the root canal, allowing instrumentation without resistance in this region and adequate root canal preparation in all subsequent steps [36]. Thus, the objective of this systematic review was to gather the available literature reporting in vitro studies that evaluated the influence of cervical preparation on the quality of endodontic treatment in permanent teeth.

The studies included in this systematic review evaluated different outcomes, such as accuracy in the determination of the initial apical instrument, improvement in the determination of the anatomical diameter in the WL, extrusion of debris and apical transport, used to measure the quality of endodontic treatment. Despite the heterogeneity of the studies in terms of methodology and evaluated outcomes, they had a low risk of bias, except for Guimarães *et al.* [9], Ibarrola *et al.* [12], Melo *et al.* [21], Tan and Messer [30], and Villalobos *et al.* [35] who showed moderate risk.

According to Amaral *et al.* [1], the use of cervical preparation resulted in decreased apical transport, as well as better centering of the middle thirds compared to the exclusive use of WaveOne, without cervical preparation in lower molars. However, the study by Barbieri *et al.* [3], using maxillary molars and the reciproc and WaveOne system with and without cervical preparation, concluded that cervical preparation did not influence apical transport in curved canals instrumented with these systems.

The analysis of the determination of the initial apical instrument in endodontic treatment was the outcome with the highest number of articles included. Ashwini and Bhandari [2], Tennert *et al.* [32], and Cecchin *et al.* [7] concluded that cervical preparation increased the accuracy of determining the size of the initial apical instrument and improved the determination of the anatomical diameter of the canal. In contrast, Vivan *et al.* [36] published that there is no influence of cervical preparation in determining the anatomical diameter.

The analysis regarding the extrusion of apical debris presented controversies. Borges *et al.* [5] described that cervical prewidening was associated with lower amount of apical debris extrusion, while Gunes and Yeter [10] concluded that the amount of apically extruded debris is not affected by cervical prewidening.

Regarding the influence of cervical preparation on the effectiveness of electronic apex locators in measuring working length, Ibarrola *et al.* [12], Morgental *et al.* [23], Guimarães *et al.* [9], and Melo *et al.* [21] concluded that cervical preparation had a positive influence. However, for Lopez *et al.* [18], when NiTi files were used, the result was irrelevant for clinical practice, as well as for Teixeira *et al.* [31], who concluded that the determination of working length is not influenced by cervical preparation when measured with an electronic apex locator.

Silva *et al.* [28] studied the effect of different instruments for cervical preparation on dentin thickness and fracture resistance of endodontically treated teeth. All experimental groups by Silva *et al.* [28] reduced dentin thickness and increased volume in the cervical canal by 3 mm to 5 mm when compared to the control group. The group using Gates Gildden reduced fracture resistance, however the group using NiTi showed no reduction in fracture resistance after cervical preparation. Zamin *et al.* [37] corroborate that the high level of wear promoted during cervical preparation increases the susceptibility to fracture of the roots, and that excess wear outweighs any strengthening with resin sealant.

Conclusion

Based on the analyzed studies, it is possible to conclude that the performance of cervical endodontic preparation increases the accuracy of apical size determination, improved the determination of the anatomical diameter at the WL, not affect the amount of apically extruded debris, and reduced transportation and centralization the instrument.

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