

# Analysis of a glide path creation necessity at the initial stages of endodontic treatment

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## Abstract:

**Aim.** Article is to detail the positive and negative aspects associated with the creation of a glide path with various types of endodontic instruments.

**Materials and methods.** During a systematic review of the literature, Russian – and English-language publications were studied in the electronic databases PubMed, Google Scholar. Articles, the content of which concerns the methods of creating a glide path, as well as possible complications were included in analysis.

**Results.** 60 articles were reviewed during the review. After analyzing the literature according to the inclusion and exclusion criteria, the total number of publications has become 32.

**Conclusions.** according to the studied literature, it can be said that the glide path provides a predictable behavior of rotary tools and it is a recommended condition for achieving the success of endodontic treatment at the stage of canal mechanical treatment and preventing iatrogenic complications.

**Keywords:** glide path, instrumentation, pathfile, K-file.

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## INTRODUCTION

One of the main goals of dentistry is to preserve the anatomical integrity and tooth function. Unfortunately, at this point in time, pulp pathologies and periapical tissues (various forms of pulpitis and apical periodontitis) are common diseases of the dentoalveolar system, dictating the need for endodontic treatment to exclude the occurrence of extraction indications. Endodontic treatment is a complex of manipulations aimed at eliminating the microbial component and necrotic tissues from the root canal. Its main components are instrumental and medical root canal treatment.

Mechanical treatment of the canal system still remains one of the most difficult tasks in the course of endodontic treatment due to the complex anatomy of the root canals, namely, due to the variability of the cross-section of the canal, the presence of bifurcations, trifurcations, lateral canal branches, apical deltas, "dead ends" and isthmuses. Iatrogenic factors such as apical prominences, canal transportation, intracanal instrument fractures, or the formation of dentinal plugs can compromise apical patency [6].

The objective of root canal preparation is to form the optimal configuration while preserving the original anatomy as much as possible, which will ensure favorable irrigation and obturation while preserving all the positive aspects of the root filling in retrospect [4].

One of the pre-enlargement strategies for canal preparation, which has become a widely discussed issue in endodontics, is the creation of a "glide path". This condition is defined as the presence of even and smooth walls of the root canal from the orifice to physiological constriction, which ensures further predictable behavior of the instruments [1-8, 20-25]. The glide path can be created with both manual and rotary instruments. However, the use of manual files has been shown to take longer, especially in teeth with narrow, highly curved canals [10]. But is it really necessary to create a glide path at the initial stage

of endodontic treatment? What are the positive, and most importantly, negative aspects of this stage of preliminary canal expansion, since instruments that remove the excess layer of parietal dentin can by themselves change the anatomy of the canal and can negatively affect the strength characteristics of the tooth? Therefore, it is necessary to consider the currently available techniques and tools for creating a "glide path" in order to detail the answers to the above questions.

The aim of this article is to review the positive and negative aspects of glide path made with different types of endodontic instruments.

## MATERIALS AND METHODS

The presented systematic literature review was carried out in accordance with the of PRISMA [30]. The search for up-to-date information was carried out in Russian and English in the electronic databases Google Scholar, PubMed. Publications were included, the content of which related to the techniques for creating the carpet, as well as possible complications during its preparation. Search terms included "glide path in endodontics", "glide path tools", "glide path techniques", "root canal machining techniques", "glide path", "glide path preparation in endodontics", "glide path techniques", "pain during glide path development", "debris extrusion by glide path", "glide path preparation instruments".

### Study selection:

The selection of acceptable publications was carried out in several stages. At the first stage, the reviewers independently carried out a comprehensive analysis of the titles of studies and the dates of their publication in the corresponding print or electronic editions, excluding works dated earlier than 2008, and the titles of which did not correspond to the topic under discussion. At the second stage, abstracts and keywords were systematically analyzed in accordance with the criteria set by the authors. At the third stage, the full-text formats of previously

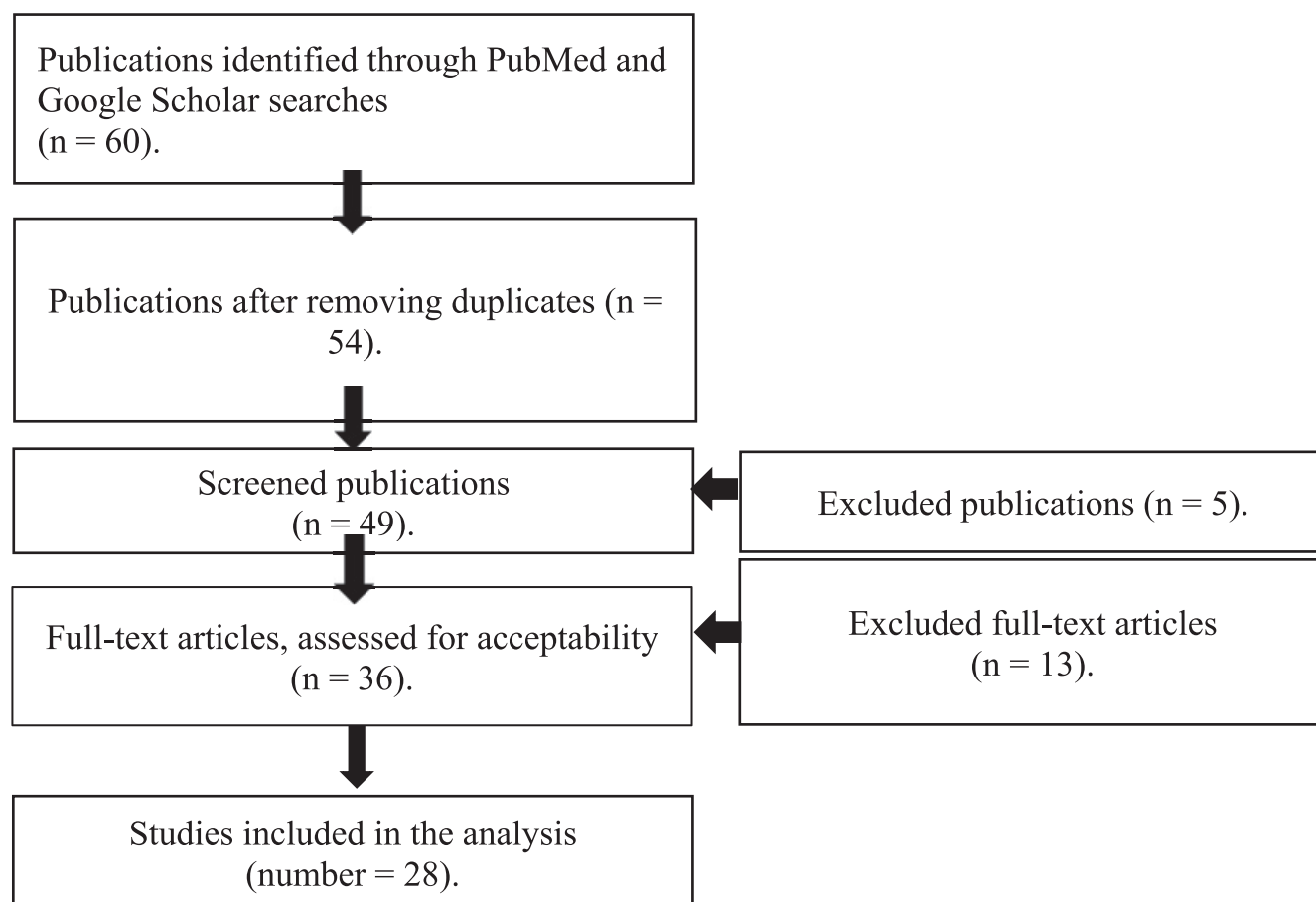


Table 1. Article selection process [30]

selected acceptable studies were analyzed in order to confirm their relevance to the topic of this review work.

During the analysis of all the information selected, the possibility of bias was considered. The Cochrane Collaboration system was used to determine the risk of potential bias (low, medium, high and unclear risk) in the course of examining selected information [31, 32].

## RESULTS

Sixty articles were reviewed, ten were on the PubMed base, 50 on Google Scholar. After making a selection according to the exclusion criteria, the total number of publications was 32. In the selected articles, the stages of creating a glide path were analyzed.

## DISCUSSION

The optimal outcome of endodontic dental treatment depends on a large number of factors, including the state of the instruments used, the order in which they are used and the doctor's manual skills. Adequate instrumentation of the equine canals is sometimes very difficult from the point of view of the anatomical structure of the canals, namely, the presence of narrowings, laterals and deltas, which increases the possibility of poor-quality processing. It is necessary to develop a certain tactics of mechanical processing, preventing the occurrence of iatrogenic complications during the procedure. The correctness of the initial stages of instrumentations, including the "glide path", determines the effectiveness of further manipulations. The authors emphasize the importance of a glide path in the formation of the optimal configuration of the root canal at the early stages of preparation for the safe use of subsequent large rotary or manual files [23-25].

### 1. General information.

Understanding the configuration of the pulp space and its variations allows the clinician to successfully prepare all root canals for three-dimensional, airtight obturation. It is necessary to collect as much data as possible about the anatomy of a particular canal (size, width, presence of narrowing or calcifications) and its geometry (orientation in space and curvature) to standardize the instrumentation plan. The designation of these parts is of paramount importance, since some anatomical features can compromise the safety and effectiveness of the subsequent use of large instruments [9].

The previously created "glide path", which is a tunnel from the orifice to a point in the apical zone, creates a pathway free of pulp and dentin tissues with smooth walls, along which the passive passage of rotary and manual instruments is possible without the risk of significant bending and breakage [1-9, 20-27]. Moreover, the glide path, according to Ruddle et al. is considered one of the foundational links in "winning the game of Endodontics" [24]. The end point of the glide path is the ability to insert the file from the orifice of the canal to the apical narrowing along the walls without jamming and excessive pressure, which makes it easier to manipulate the instrument.

Before creating a "glide path", it is necessary to carry out a number of manipulations: isolate the working field, penetrate and open the pulp cavity, create a straight-line access to the orifices and expand them, scouting, including passage, determination of the working length with K-files of sizes 08-10 according to ISO [12, 26].

The instruments used to create the "glide path" must be flexible enough to accommodate the curvature of the channel and strong enough to withstand fatigue stress.

The physical properties of a file depend on its geometric design and manufacturing processes such as surface treatment and / or thermal exposure. Different cross-sectional designs can affect tool stiffness and stress distribution during use [16].

To prepare the glide path, several methods have been proposed based on manual actions (K-files from stainless steel, Antaeos Stiff C, C-file, C + file, D-finder, Stiff K file, Flexofile, SenseusProFinder, Pathfinder CS), machine (PathFile, G-File, EndoWave Mechanical Glide Path Kit, Scout-RaCe File, Race ISO 10 and X-Plorer Canal Navigation NITI File, Proglider) files [10-12, 15] or their combinations using a combination of a reciprocating tip and K-files made of stainless steel [6, 8]. Irrigation is recommended after each instrument used to evacuate dentin chips and other blocking particles from the canal [18].

## 2. A glide path using manual instruments.

Talking about K-files, it is necessary to detail the working method with them and indicate the pros and cons of their isolated use during the creation of the glide path. The operation of this type of tools was proposed a long time ago and is still widespread. According to West et al. [25], the glide path is considered to be formed if a file of ISO size 10 fits freely in the canal, while Van der Vyver et al. [27] believe that an ISO size 15 instrument easily glides in the canal up to working length without the need for rotation, determines the formation of the glide path.

It is necessary to strictly follow certain steps to prevent intraoperative complications at the stage of creating a "glide path":

- Determining the exact location of the root canal orifice. Magnification and optimal illumination are useful elements for locating the orifices;
- Visualization of the course of the canal to the radiographic apex in the images;
- Ability to perform correctly and determine the phasing of movements by manual files, namely:

*"Follow"* – determination of the place of entry into the canal and removal of all overhanging edges of dentin and enamel that prevent rectilinear access. Ensure thorough irrigation with sodium hypochlorite before inserting the instrument into the canal. It is necessary to use the smallest file that will easily pass through the canal and slightly wedge in the apical part of the canal. As soon as the first file can stand vertically in the channel on its own, *"Follow"*, moving the file down the canal.

*"Smooth"* – once the physiological apex is reached, make short amplitude vertical movements until the file is free. If initially the file is jammed in the canal, which does not allow for amplitude movements, then the instrument is apparently blocked by two or more canal walls. It is necessary to turn the instrument handle to the left and right by several tens of degrees (*"watch-wind"* from 30 to 60 degrees) without moving up or down, which will facilitate the evacuation of a small amount of parietal dentin and free the file for further movements.

*"Envelope"* – if the tooth undergoing endodontics has narrow and curved root canals and the initial reaching of the physiological apex by the K-file # 10 is not possible, stop until the maximum resistance. The next step is to fade out the file using movement envelopes until the instrument is completely free. That is, there is no special need for the use of tools of smaller sizes according to ISO (06 and / or 08) [24].

*"Balance"* – Uses Roane's Balanced Force method when file size is needed larger than ISO # 10. This protocol

involves turning the file handle clockwise and then counterclockwise with slight apical pressure so that the instrument does not "twist" or change its position in the canal. During a clockwise movement, the file blades cut the dentin, during an apical counterclockwise movement, it advances. Free dentin accumulates between the edges of the instrument. This movement can be repeated several times as the file moves apically [6, 11, 17, 18].

Also, the authors recommended to pre-bend the instruments slightly for use in channels with high curvature. This allows the watch-winder technique to create space for the larger curved files to advance only to the point of maximum resistance without the risk of excessive transportation.

Further establishment of the glide path is necessary to create a round and smooth shape of the canal walls, usually a small taper (02). Sizes "# 15 or 20 can be recommended if there is a high risk of clogging the edges of the file with dentin chips, which creates a risk of blocking the file [12].

The minimum size of the "sliding" file for the subsequent safe use of rotary instruments is K-file No. 10. Moreover, it is important to adhere to the rule that during subsequent work with rotary instruments, the root canal should be expanded during glide path to the same size or by at least 1 size over ISO is larger than the first machine file to be used for root canal preparation [15-18]. If the doctor prefers to work with large file sizes and does not take into account the above fact, then it is possible that this will lead to an increase in the space for rotation, thereby creating the risk of the formation of steps on the walls of the radicular dentin.

As with every method, preparing a glide path using K-files alone has advantages and disadvantages. The former includes the presence of good tactile sensitivity, the ability to visualize the curvature of the canal to obtain additional information about its anatomy, the rigidity of stainless-steel hand instruments, which helps to overcome the zones of dentinal blockages and calcifications, lower cost and no need for a tip [3, 6, 17].

It is worth noting the sensitivity of this technique to the doctor's manual skills, which determines the success of the manipulation performed in the framework of the further use of larger rotary or hand instruments [17]. Also, there is great fatigue of the dentist's hands, a significant possibility that the 15 / 0.02 taper K-file will not easily pass in the canal after the ISO # 10 K-file, which can lead to the formation of steps and apical transport of the canal. Based on the study data, the use of stainless-steel K-files resulted in more channel aberrations compared to positioning the K-file in the reciprocating part of the M4 handpiece. The protrusions created using the stainless-steel K-files during manual preparation of the glide path were located between the apical curvature and the physiological apex, while the aberrations created using the manual K-files in M4 were located between the coronal and apical thirds of the root channel [11]. Indisputable is the presence of changes in the initial anatomy of the root canal, the possibility of its transportation, increased apical extrusion of the intra-root contents, possibly leading to post-endodontic pain, which will be discussed further [6, 8, 12, 15, 17].

Other manual glide path tools that can be safely used in an endodontic appointment: Antaeos Stiff C file (Schwed), C-file (Dentsply), C-file (Roydent), C + file (Dentsply), D-finder (Mani), Stiff K file (Brasseler), Flexofile (Dentsply / Maillefer) and SenseusProFinder (Dentsply / Maillefer), Hi-5 file (Miltex), Pathfinder CS (SybronEndo) and others [3].



### 3. Glide path in reciprocal handpiece instruments + K-file combination.

The use of a reciprocal handpiece mode in combination with stainless steel K-files is also possible to create a glide path. The doctor's course of action is as follows: first, the patency of the canal is established using a size 8 or 10 K-file and the working length is determined. The doctor performs further work using a handpiece with reciprocating movements: the active instrument moves in one direction, "cutting" into the dentin of the canal walls, and then in the opposite direction to separate the instrument. The K-file is in the canal for 5-10 seconds until the clinician feels the instrument is free of parietal dentin. Next, it is necessary to remove the file 0.5-1 mm from the canal and again reach the working length. If the file in the handpiece does not reach the apical constriction, it is necessary to remove the blocking area manually [3, 6, 8, 10, 17]. Also, the authors recommend subtracting 1 mm from the working length in order to avoid transport of the apical part of the canal [17].

The M4 handpiece has a 4: 1 gearbox, moves 30 ° both clockwise and counterclockwise, thus replicating the "winding" technique, which can help stabilize the instrument inside the canal, reduce torque stress and metal fatigue, and also allow it is safe to carry out the initial stage of glide path preparation while the physician accurately controls the apical pressure [17].

The advantages of this technique are less stress and fatigue of the doctor, less time for performing a glide path, especially in cases of narrow root canal systems. There is an observation that stainless steel K-files used with the M4 showed significantly greater resistance to cyclic fatigue compared to rotary NiTi files [10] and fewer aberrations, which were predominantly located between the upper and middle thirds of the canal [11].

The negative aspects include increased risks of apical transportation with files larger than ISO 15, postoperative pain sensitivity and the possibility of periapical inflammatory reactions due to extrusion of the microbial contents of the canal, contaminated dentinal sawdust into the peri-apical tissues, the formation of dentinal "plugs" in the apical part of the canal, and also a decrease in process control due to the loss of the proper level of tactile sensations. Nevertheless, the combination of the K-file and the reciprocal mode of the handpiece is less sensitive to the level of manual skills of the doctor than the single use of K-files [3, 6, 8, 10, 11, 17].

### 4. Carpet using NiTi rotary files.

Special rotary NiTi files for carpet preparation have been developed, mainly available in 3 ISO sizes (013, 016 and 019) and 3 lengths (21, 25 and 31 mm), the taper of which is from 2%. They have some positive properties, of which resistance to cyclic fatigue and flexibility are worth mentioning. Representatives are: G-File (Micro-Mega), ScoutRace (FKG Dentaire SA), PathFile (Dentsply Maillefer), One G (Micro-Mega) and ProGlider (Dentsply Maillefer), RaCe ISO 10 (FKG Dentaire), X-Plorer Canal Navigation NiTi Files (Clinician's Choice Dental Products Inc.) [3, 6, 7, 11, 24]. One G has an ISO 14 diameter at the D0 tip and a constant taper of 3%, a working end with three cutting edges located at three different radii relative to the canal axis, which possibly enhances the cutting action and allows you to save space for the evacuation of intracanal contents. ProGlider, in turn, has a diameter of ISO 16 at the tip D0, an increasing taper, and, in the experiment, it demonstrated a significantly shorter time spent by a doctor to prepare a CD with an average time of 11.3 seconds [28].

In the study, PathFile # 1 and PathFile # 2 showed a higher level of fatigue resistance than G-files. G-1 had similar fatigue resistance to PathFile # 3, G-2 had the lowest resistance while PathFile # 1 had the highest. G-files have a taper of 3% and PathFiles have a taper of 2%, which may be the reason for the difference in fatigue resistance [18].

When using tools with a taper of 0.02, changing the file of size 10 to No. 15 is difficult, since the diameter of the working part of the next tool increases by 50%. However, the Xplorer 15 / 0.01 has ½ the ISO taper of a # 15 manual file and a triangular cross-section that provides a margin of flexibility, so it will slide through a canal even with strong curvature with relative ease if the # 10 file reaches working length without jamming or resistance. If it is not possible to pass to the working length minus 1 mm, the restoration of patency is provided by file No. 10 [6].

Compared to manual preparation of CDs using stainless steel K-files, the use of NiTi rotary instruments is accompanied by faster results, relative preservation of the original canal anatomy, which leads to fewer modifications of its curvature and, ultimately, to fewer aberrations, not producing pronounced apical transportation, even when the files repeatedly reach the working length up to 10 times [4]. As with the M4 + K-file, nickel-titanium files reduce the doctor burden and are easier to use and are less sensitive to manual skills.

The disadvantages are the risk of instrument breakage in the canal due to jamming and the presence of fatigue stresses, a decrease in tactile sensations, as well as the high cost of this type of instrument in comparison with manual instruments, which can negatively affect the operating time of each file by a doctor, an increase in the number of sterilization cycles performed for them [11, 17].

Summarizing, when choosing between manual and rotary files, one should not give unconditional preference to only one of the types of tools, it is more rational to use them in combination, alternately. Initially, you need to achieve the formation of a "glide path" manually, using a small K-file (for example, # 10) and, then, instead of a larger manual tool 15 / 0.02, you can use rotary tools such as PathFiles and Xplorer files, ProGlider and others [6]. The authors put forward the position that the use of Mtwo and PathFile without preliminary manual preparation of the sliding path to the working length was associated with the occurrence of pronounced friction and resistance in the canal, which could lead to a greater likelihood of instrument breakage, which is an iatrogenic complication and compromises the relatively predictable outcome of endodontic treatment. [8]. That is, we can say that at present, most rotary systems need, or for them, to one degree or another, it is recommended to establish a glide path to the apical foramen before direct use of automatic instrumentation in order to eliminate blocking elements of the individual anatomy of the canals and preserve their macroanatomical characteristics, the occurrence of iatrogenic complications such as canal transportation, aberrations, perforations, fractures of nickel-titanium instruments and the formation of "dentin plugs" [1, 3, 7].

### 5. Apical extrusion of intracanal content. Post-endodontic pain.

Pain that occurs in patients after endodontic treatment is a feeling of discomfort or aching pain after the completion of root canal treatment and is not uncommon. It occurs, according to the authors, in 25-40% of patients, regardless of the level of tissue involvement in the pathological process (pulpitis, periodontitis) and decreases in intensity to 40%

in the first 48 hours and to 11% 7 days after treatment. Numerous factors contribute to potentiation / elimination of postoperative pain, in particular, it depends on the patient's reactivity, the group of the tooth being restored, the number of patient visits for treatment, the type of chemical used for irrigation or relief of inflammation, as well as the method of obturation, which makes the clinical study of postoperative pain quite difficult [1, 8].

3% NaOCl is most commonly used as the primary irrigant in endodontic practice. Unfortunately, in addition to the targeted antimicrobial and proteolytic effects, there is a risk of a so-called hypochlorite accident or, at least, irritation of periapical tissues. The clinical symptoms and severity of post-endodontic pain is in direct proportion to the concentration and amount of sodium hypochlorite excreted from the root apex. Standardization of irrigation protocols, such as control of needle penetration depth, can eliminate the effect of intraoperative variables on pain scores [1, 29].

Mechanical, chemical and microbial factors are considered as one of the main damaging agents for periapical tissues. Instrumental techniques used in the treatment and preparation of root canals for three-dimensional homogeneous obturation may play a role in the development of postoperative pain, as necrotic pulp particles, contaminated dentinal sawdust and bacteria can invade the periapical region, causing an inflammatory response. All instrumentation methods are associated with the extrusion of in-canal content, and its amount varies depending on the kinematics and design of the tool used [7, 8, 13, 22]. According to the authors, the use of the "glide path" method (mainly rotary instruments) at the initial stages of root canal preparation can reduce the amount of substances extruded behind the apex, which, in turn, reduces the response from the periapical tissues, reducing postoperative sensitivity and pain, since there is no massive release of chemical mediators of inflammation, such as neuropeptides, metabolites of arachidonic acid, cytokines, lysosomal enzymes, platelet activating factor, fibrinolytic peptides, vasoactive amines, kinins and others [1].

According to the majority of studies, preparation of the glide path using manual files is associated with a large number of residues carried into the periapical tissues, and, therefore, with a greater likelihood of postoperative sensitivity and pain. This may be due to the fact that stainless steel K-files tend to straighten the canals due to their rigidity and create aberrations and transportations,

predominantly between the median and apical or apical part of the root canal. Computer studies have shown that the use of only K-files for glide path causes asymmetric enlargement of the apical region in all directions, while the use of rotating instruments preserves the original canal geometry [1-3, 7, 8, 22].

Based on the results of some studies, ProGlider produced the smallest proportion of extrusion of substances outside the root canal, which may be due to the design features of this file, including its variable taper from 0.020 to 0.085. Residues captured in the apical portion of the NiTi file are effectively lifted coronal during rotation and subsequent irrigation.

The design features and taper of the One G file also help remove debris more efficiently than K-files, as do the ScoutRace, R-pilot and WaveOne Gold Glide [3, 13].

In an experiment evaluating the apical extrusion of intracanal material contaminated with *Enterococcus faecalis* on a specially designed apparatus, it was found that rotary instruments PathFiles, G-Files, ProGlider, One G remove less material beyond the apex during preparation of the glide path than K-files, which was determined after counting *Enterococcus faecalis* [7].

There are no precise considerations as to whether it is possible to extrapolate the differences between the systems for preparing the sliding path to clinical practice, since the amount of "debris" excreted into the periapical tissues can be a subthreshold, threshold, or inadequate irritant for the periodontium. Further in vitro and in vivo studies are needed to detail the results.

## CONCLUSIONS

The "glide path", determined after the initial instrumentation in the presence of even and smooth walls of the root canal from the orifice to physiological constriction, ensuring the predictable behavior of rotary instruments, is not only recommended, but also a necessary condition for the success of endodontic treatment at the stage of mechanical treatment of the canal and prevention iatrogenic complications, such as pronounced canal transportation, aberrations, and breakage of the instrument.

It is recommended to use a combined method of preparing a glide path which consists in the initial use of a small K-file (for example, No. 10) and, then, instead of a larger manual instrument, use rotary instruments, which provide the doctor with greater confidence in the preparation of complex endodontic cases.

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