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Endodontic glide path – importance and performance techniques

Ендодонтски инструмантациони пут – значај и технике извођења

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Endodontic glide path – importance and performance techniques

Ендодонтски инструмантациони пут – значај и технике извођења

SUMMARY
Glide path is a procedure that precedes mechanical instrumentation of the root canals. It is defined as a procedure used to expand or create a smooth tunnel from the coronal part of the root canal to its physiological terminus. It is performed using small sized hand files or specially designed mechanical NiTi instruments. An adequately created glide path extends the life of rotary NiTi instruments, enables better mechanical and chemical debridement and easier preservation of original morphology of endodontic space during further mechanical instrumentation.
Frequent use of mechanical instrumentation in daily practice requires better understanding of glide path, its significance, and instruments and techniques used for its creation.
Keywords: glide path; hand K-files; rotary NiTi instruments

САЖЕТАК
Увод Формирање инструментационе путање је процедура која претходи машинској препарацији канала корена. Подразумева успостављање/проширивање јасног и глатког каналског тунела од његовог коронарног дела до апексне констрикције. Може се формирати ручним турпијама малог промера, од нерђајућег челика као и специјално дизајнираним машинским никл титанијумским инструментима. Инструментациона путања продужава трајање машинских инструмената, омогућава ефикасније чишћење и дезинфекцију канала као и очување оригиналне морфологије ендодонтског простора током даље машинске инструментације. Све чешћа примена машинске инструментације у свакодневној пракси, намеће потребу за бољим разумевањем ове процедуре, њеним значајем као и начинима формирања.
Кључне речи: инструментациона путања; ручни инструменти; машински НиТи инструменти

INTRODUCTION

Modern endodontic therapy involves mechanical instrumentation of root canals with instruments made of nickel-titanium (NiTi) alloy, in accordance with modernized and adapted procedures based on Schilder's principles [1]. Due to superelasticity and unique design, NiTi rotary files enable more efficient and predictable cleaning and shaping of the root canals with less possibility of procedural errors when compared to manual instruments [2, 3, 4].

Nevertheless, flexural, and torsional stresses, especially in curved canals, may result in unexpected fractures of NiTi instruments during clinical use [1, 2, 3]. New techniques and instruments have been introduced to overcome this problem [5]. A special attention has been paid to the creation of glide path, a procedure that precedes mechanical instrumentation, with the aim of reducing cyclic fatigue or torsional stress and safer use of NiTi rotary files during further shaping and cleaning canals [6, 7, 8].

However, the concept of glide path preparation in many endodontic schools is not clearly defined. Most world schools of dentistry do not include glide path preparation training in its courses.

Glide path – definition

The first definition of the term glide path was given by West in 2010, explaining that "the glide path is a smooth radicular tunnel from the coronal orifice of a root canal to the physiologic terminus (apical constriction)" [9]. Ruddle et al. redefined this term as "a clinical procedures to expand or create a smooth tunnel from the coronal part of the root canal to its physiological terminus before its final enlargement, aiming to control torsional stress and reduce the odds of NiTi instruments fracture" [10]. Berruti and Patino used term "micro glide path" for initial scouting/exploring and apical patency of the canal with small precurved stainless steel files using gentle watch-winding movements. In case of curved and obliterated canals, further enlarging is necessary, with manual or specially designed NiTi instruments, in order to create "macro glide path" [11, 12].

Significance of glide path

With introduction of mechanical NiTi instruments into endodontic practice, glide path gains special importance. Blum et al. 2003 first proposed the formation of a smooth glide path using small flexible stainless steel hand files to facilitate the application of rotary NiTi endodontic instruments [13].

Berutti et al. and Patino et al. observed that creating the glide path with hand files, leads to a reduction in torsional stress and cyclic fatigue of rotary instruments [11, 12]. The formation of glide path contributed to an increase in average life of mechanical files almost six times and a drastic reduction in the risk of files breakage [11–14].

Glide path improves mechanical and chemical debridement, creating space for instruments and irrigants to process and disinfect endodontic space more easily and efficiently [7]. Glide path enables conical instrumentation while preserving the original position of apical foramen, so 3D obturation is more certain [8, 15, 16].

Numerous studies have indicated reduced extrusion of apical debris if glide path creation preceded mechanical instrumentation [16, 17, 18]. Detritus extrusion into periapical tissue negatively affects the success of endodontic therapy. Consequently, leading to postoperative pain and persistent inflammation [19].

Glide path significantly contributes to easier preservation of original morphology of endodontic space in all aspects (curvature, volume dimension and centering) during mechanical instrumentation [15–19].

Thus, the importance of glide path is primarily in increasing safety and efficiency during the use of rotary NiTi instruments in the following stages of endodontic therapy [6, 7, 8, 12, 20].

The size and shape of glide path

Properly created glide path faithfully reflects the appearance of original morphology of the root canal, and can be short or long, narrow, or wide, straight, or curved [10].

For efficient and safe preparation of root canals, it is very important to establish adequate glide path dimensions. The minimum size of glide path according to West, is ISO 0.10 [9]. More precisely, after the formation of glide path, the dimensions of canal should correspond or be one size bigger than the size of the tip of first NiTi rotary instrument used for canal instrumentation [11]. This facilitates application and activation of rotary, extremely flexible NiTi instruments that usually have a non-cutting tip [21].

Glide path preparation techniques

The creation of a glide path can be realized with manual or mechanical instruments.

The use of hand files with smaller diameter is a standard, long-standing procedure that maintains better tactile sensation, less possibility of instrument fracture and easier overcoming of canal obstructions. Due to the retention of shape after removal from the canal, the hand files provide information to the operator about the curvature and complexity of canal [22].

Apart from K-files, which are the instruments most commonly used for initial patency and creation of micro glide path, other hand instruments can also be used (Table 1).

Disadvantages of manual techniques are hand fatigue, fatigue of the operator, longer duration of procedure, risk of procedural errors, greater chances for changing original canal anatomy and increased apical extrusion [14].

In order to avoid errors of manually created glide path, special and innovative mechanical NiTi instruments are being introduced. Those instruments were launched for macro glide path and the first system appeared in 2009. (PathFiles, Dentsply Sirona) [7].

Mechanical glide path instruments with their basic characteristics and methods of application are presented in Table 2 [8].

The first mechanical glide path systems were made from a conventional, austenitic, superelastic alloy with full rotation activation, and were suitable for preparation of straight or slightly curved canals. Instruments with different dimensions and conicity were also launched [14].

Glide path systems were further developed with the aim of reducing the number of instruments, which decreases the possibility of errors and significantly speeds up the procedure [7, 8]. Also, the emergence of new technological solutions, design modifications and transformation of conventional NiTi alloy and different thermal treatments led to the optimization of glide path instruments microstructure and resistance to cyclic fatigue [20, 21].

The improvement of cutting efficiency, passability and flexibility of glide path systems (especially in curved canals) was achieved by manufacturing instruments from martensitic alloy [23, 24].

Different activation techniques of glide path instruments (full rotation or reciprocating motion) were introduced with the aim of improving blade efficiency and resistance to cyclic fatigue. Studies have shown that increase in resistance to cyclic fatigue is influenced by advanced metallurgical solutions as well as the kinematics of movement [17–20, 23, 24, 25]. The researchers point out that instruments activated by reciprocating motion have a higher resistance to cyclic fatigue since they are exposed to lower stress compared to instruments with full rotation. De Deus at al. 2021. have noticed a small percent of fractures and deformation rates of glide path instrument with reciprocating motion (R-Pilot) after previously established micro glide path with size 08 hand file [20].

Instruments activated by reciprocating motion show higher cutting efficiency, reduced extrusion of dentin filings and better centricity compared to instruments with full rotation [20]. According to Keskin et al. [17], Waveone Gold showed greater resistance to cyclic fatigue than R-Pilot, although both are reciprocating instruments, but made of different type of alloy. WaveOne is made of Gold NiTi alloy while R-Pilot is made of M-Wire. In the same study, R-Pilot showed greater resistance to cyclic fatigue than Pro Glider (both from M-Wire), demonstrating less exposure to instrument stress in reciprocating motion.

Generally, the advantages of Glide path NiTi files are shorter preparation time, reduced possibility of procedural errors, better maintenance of the original anatomy, less operator and hand fatigue, reduced apical extrusion and postoperative pain [26, 27]. Possibility of instrument fracture reduced tactile sensation and instruments cost are disadvantages of using mechanical glide path systems [22].

CONCLUSION

Although glide path preparation requires time and adherence to technical protocols, it is one of the crucial stages during the processing of complex endodontic systems. Proper creation of glide path can extend the life of mechanical NiTi instruments and impact necessary quality control of mechanical and chemical debridement and predictable, hermetic obturation. Although the development of new methods and mechanical glide path systems is intensive, the role of manual instruments should not be neglected, and it is up to the therapist to decide on a specific method and system, depending on the diagnosis, canal morphology, and primarily on knowledge, experience, and technical capabilities.

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Table 1. Manual glide path instruments

Name (company)	Alloy	Design (cross section)	Sizes (ISO)	Motion (movement)
K- file (Kerr)	Stainless steel	Square	6, 8, 10, 15, 20	0.6–15 Clockwise 20–Combined clockwise and balanced force
C file (Dentsply/Tulsa)	Special thermal hardening steel	Twisted file	6, 8, 10	Clockwise
C+ file (Dentsply/Maillefer)	Special thermal hardening Steel	Square	6, 8, 10, 15	Clockwise
D finder (Mani)	Stainless steel	D-shaped	8, 10, 12, 15	Clockwise
Hi-5 file (Miltex)	Stainless steel	Pentagon	6, 8, 10, 15	Clockwise
Pathfinder CS (SybronEndo)	Stainless steel	Square	7 (K1) 9 (K2)	Clockwise
S finder (JS Dental)	Stainless steel	Incomplete circle with two parallel straight edges	8	Clockwise
C- Pilot files (VDW)	special thermal hardening steel	Square inactive Pilot tip	6, 8, 10, 12.5, 15	Clockwise
FlexoFiles (Dentsply/Maillefer)	Stainless steel	06–10 Square 15–20 Triangulare	6, 8, 10, 12, 15, 17, 20	Clockwise
Senseus FlexoFiles (Dentsply/Maillefer)	Stainless steel	06–10 Square 15–20 Triangulare	6, 8, 10, 15, 20	Clockwise

ISO – International Organization for Standardization

Table 2. Mechanical glide path instruments.

Name (company)	**Alloy**	**Sizes (ISO) Taper**	**M Speed and torq**	**Method of use**
PathFiles (Dentsply Sirona)	NiTi	1–13, 2% 2–16, 2% 3–19, 2%	CR 300 rpm 5 N/cm	Used in sequence after hand file ISO 10
RaCe ISO 10 (FKG Dentaire)	NiTi Electrochemical plolishing	1–10, 2% 2–16, 4% 3–10, 6%	CR 600–800 rpm 1.5 N/cm	Used in sequence after hand ISO 06 and 08
ScoutRaCe (FKG Dentaire)	NiTi Electrochemical plolishing	1–10, 2% 2–15, 2% 3–20, 2%	CR 600–800 rpm 1.5 N/cm	Used after estimated working length with hand ISO 06 - 08
G-Files (Micro-Mega, Besançon, France)	NiTi	G1–12, 3% G2–17, 3%	CR 250–400 rpm 1.2 N/cm	Used in sequence after hand file ISO 10
ProGlider (Dentsply Sirona)	NiTi M-Wire	1–16, Progressive tapers 2–8%	CR 300 rpm 2–5 N/cm	Used after estimated working length with hand file ISO 10
Instrument One G (Micro-Mega)	NiTi	1–14, 3%	CR 250–400 rpm 1.2 N/cm	Used after estimated working length with hand file ISO 10
X-Plorer Canal Navigation NiTi Files (Clinician's Choice Dental Products Inc.)	NiTi	1–15, 1% 2–20, 1% 3–20, 2% 4–25, 2%	CR 400 rpm 2 N/cm	Used after estimated working length with hand file ISO 8 or 10
Hyflex Glide Path File Sequence (Coltene)	1-NITi 2&3 NiTi CM-Wire	1–15, 1% 2–15, 2% 3–20, 2%	CR 300 rpm 1.8 N/cm	Used after estimated working length with hand file ISO 10
Hyflex EDM Glide Path (Coltene)	NiTi CM-Wire EDM process	10, 5%	CR 300 rpm 1.8 N/cm	Used after estimated working length with hand file ISO 10
PathGlider AK03(Komet, GmbH)	NiTi	15, 3% 20, 3%	CR 300 rpm 0.5 N/cm	Used after estimated working length with hand file ISO 10
R-Pilot (VDW)	NiTi M-Wire	12.5, 4%	Reciprocating motions at Reciprocating settings	Used after estimated working length with hand ISO 06 and 08
WaveOne Gold Glider (Dentspli Sirona)	NiTi Gold heat treated	15, Variable tapers from 2%	Reciprocating motions at WaveOne settings	Used after estimated working length with hand file ISO 10

*Modified table of Ajina et al. [8], Eur Endod J. 2022;
ISO – International Organization for Standardization; NiTi – nickel titanium conventional alloy; M – memory NiTi alloy; CM – controlled memory NiTi alloy; EDM – electrical discharge machining NiTi alloy; CR – continuous rotation