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"EFFICACY OF GLIDE PATH PREPARATION USING A ROTARY AND A RECIPROCATING FILE SYSTEM IN MODERATELY AND SEVERELY CURVED MOLAR ROOT CANALS- A COMPARATIVE IN-VITRO STUDY"

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Abstract:
Aims: This study aims to compare the efficacy of reciprocating and rotary systems in achieving full working length and assess their fracture resistance in moderately and severely curved root canals.
Settings and Design: Comparative In-Vitro Study
Methods and Material: 68 freshly extracted human molars with curved root canals were selected and divided into moderately and severely curved canals (n=34). Each group was further divided into two subgroups based on the system used- the reciprocating system (WaveOne Gold Glider) and the rotary system (ProGlider) (n=17). Instrumentation was performed according to manufacturer instructions. The length of instrumentation and fracture resistance were evaluated.
Statistical analysis used: Data were documented, organized into tables, and analyzed statistically using the Chi-square test.
Results: The reciprocating system outperformed the rotary system in achieving full working length in severely curved canals ($p < 0.05$). However, no statistically significant difference was found between the systems in moderately curved canals. The WaveOne Gold Glider exhibited greater fracture resistance than the ProGlider in both canal curvatures ($p < 0.05$).
Conclusions: The WaveOne Gold Glider demonstrated superior performance in navigating severely curved root canals compared to the ProGlider. Both systems showed comparable efficacy in moderately curved canals. The WaveOne Gold Glider also exhibited greater fracture resistance, suggesting increased durability in challenging canal anatomies. These findings highlight the importance of selecting appropriate instrumentation systems based on canal anatomy to enhance clinical outcomes and reduce instrument failure risk.

Keywords: glide path, rotary endodontics, reciprocating motion, curved canals

Introduction:

Instrumentation of the root canal aims to create a continuous funnel that tapers and follows the natural

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canal shape starting from the coronal portion to the apex.[1] This step is crucial in endodontic therapy, as it affects the efficacy of subsequent procedures[1,2]. Procedural problems in shaping curved canals often arise from the rigidity of instruments made of stainless steel.[3] While nickel-titanium (NiTi) files are more flexible and stronger than stainless steel, they are somehow susceptible to fractures within their elastic limit.

The most frequent side effect of utilizing rotary NiTi devices is fracture[4], and doctors' apprehension about fractures prevents them from being used.[5]. Both torsional shear forces (torque failure) and bending normal stresses (fatigue failure) can cause NiTi instruments to fracture. Prior to utilising NiTi rotary instruments, whether manual or mechanical, coronal enlargement[6] and glide path creation can minimize the possibility of taper lock.[7]. Inadequate establishment of a glide path may cause perforation, transportation, ledge formation, zip formation, or canal blockage.

Clinicians frequently encounter procedural challenges when performing crucial processes like Preflaring and canal scouting.[8] A crucial stage that affects the accomplishment of the biological and mechanical goals of canal preparation is establishing a glide path. In endodontics, a potentially narrow tunnel which is smooth, that runs from the canal's orifice to its radiographical apical foramen or electricaly obtained portal of escape is known as a glide route. It refines the original anatomy of the canal, facilitating passage that is safe for subsequent mechanical shaping instruments.[9]

Creating a glide path is recommended widely as an essential step to enhance the efficiency and safety of rotary NiTi instruments. It helps reduce fracture rates, prevents shaping errors, and the taper lock phenomenon, and extends the instrument's lifespan.[10,11]

Either hand files or specifically made mechanically driven NiTi devices are used for this procedure[8,10], the latter is recommended since it has been linked to less pain and flare-ups after surgery and better preservation of the natural canal anatomy.[12,13,14] The employment of tiny rotating NiTi tools, referred to as glide path instruments, has been documented to be more prone to fracture[10,15] and unexpected in terms of clinical efficacy and safety due to the canal's continued narrowness.[10] Numerous strategies, such as modifications to the NiTi alloy, instrument design, and, more recently, movement kinematics, have been put forth to address these problems.

Since reciprocating motion is less taxing on instruments in terms of torsional stress, cyclic fatigue, and working time than continuous rotation, it has opened up new possibilities for mechanically activated preparation[16,17,18]

Despite extensive research on root canal preparation, there is a lack of studies evaluating the effectiveness of various glidepath systems in achieving the full working length. (RFWL). Hence, the research aims to juxtapose the efficacy of two pathfinding systems—Rotary (Proglider) and Reciprocating (WaveOne Gold Glider)—in mechanically negotiating moderately (5°-20°) and severely curved (>20°) canals of molar in achieving full working length and also evaluate the fracture rate of the two files- Proglider and WaveOneGold Glider.

This comparison aims to provide valuable insights for clinicians in opting for the most suitable instrument set for root canal preparation.

Materials and Methodology:

Following institutional study ethics committee approval, First and second molars from the mandible and maxilla were freshly extracted; they were cleaned, gathered, and kept in distilled water. For each tooth, digital radiographs were acquired preopratively at different angulations to evaluate the internal anatomy and morphology. Any maxillary molars with another mesiobuccal (MB_2) root were not included in the experimental protocols; only lower molars with no other distal canal were included.

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Specimens included:
- Maxillary and mandibular first and second molars
- Moderate and severe curved root canals.

Specimens excluded:
- Tooth with carious lesion
- Mandibular teeth with double distal canals
- Straight canals

The canal curvature angles were determined using Schneider's method[19] (Fig-1-A). Canals were categorized as straight if the angle was less than 5°, moderately curved if the angle was between 5° and 20°, and severely curved if the angle was greater than 20°. Sixty-eight mandibular and maxillary molars were selected and were then divided into two groups, each consisting of 34 moderately curved and 34 severely curved teeth. They were further randomly divided into two groups consisting 17 in each- based on the type of rotary system used.
Following the access in the root canal, each tooth was placed on a specialized device that mimicked the alveolar socket and enabled the metal lip clip of an apex locator to be connected. To make this device, alginate was poured into a plastic container that was the right size, a metal pin was inserted along with the tooth, the alginate was allowed to harden, and the metal pin was then removed to make room for the metal lip clip. (Fig-1-B)

Glide Path Preparation: First, an ISO size 08 K-file was used for negotiatiating the canals. Next, a no. 10 K-file was used to take a radiograph of the working length. The file holder of the apex loactor was attached to the top of the chosen glidepath file, which was fixed to a handpiece with an electric endomotor.
Preparation of the glide path was then performed with a rotary ProGlider File (16/.02,300 rpm and 5-Ncm torque), using a gentle in-and-out motion of about 1- to 2-mm amplitude (Fig-1-C). The instrument was gently moved towards the apex using three short in-and-out pecking motions, each with an amplitude of approximately 3 mm and applying light pressure towards the apex. Subsequently, the instrument was withdrawn, wiped with gauze dampened with alcohol, and examined for any signs of fracture or deformation. Later, the canal was irrigated with 2 mL of 2.5% sodium hypochlorite. This sequence was repeated three times in an effort to reach the working length. If the instrument failed to achieve the working length after this sequence, the procedure was halted. This process was replicated in all canals. Confirmation of achieving the full working length (RFWL) was signaled by a continuous sound alert from the apex locator.
Similar steps were repeated with the rest 17 using WaveOneGoldGlider.
Total number of teeth in which full working length was attained as opposed to not, as well as the quantity of broken instruments, were among the observations made. Chi-square was used for statistical analysis once these data were collated.

Results:
This in vitro study evaluated and compared the efficacy of glide path preparation using rotary and reciprocating path-finding instruments and their fracture resistance in moderately and severely curved root canals. Sixty-eight teeth were divided into two main groups (Group A and Group B), each containing 34 teeth, and further subdivided into two subgroups (A1, A2, B1, B2) with 17 teeth each. Statistical analysis was performed using SPSS21, employing the chi-square parametric test with a significance level set at a p-value of less than 0.05.

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The results showed that for the reciprocating file system (WaveOne Gold Glider), 15 files achieved the reference working length (RFWL) in moderately curved root canals, while 13 achieved it in severely curved canals. Conversely, for the rotary file system (ProGlider), 12 files reached RFWL in moderately curved canals, and 7 files in severely curved canals. (Table-1) (Fig-2-A, B) Although the reciprocating system showed slightly better performance in severely curved canals, statistical analysis indicated no significant difference in the effectiveness of glide path preparation between the two systems for both moderately and severely curved root canals.

Table – 1

Curvature of the canal	PG n=17	WOG n=17	p- Value (< 0.05)
Moderately curved	12	15	0.810
Severely curved	07	13	0.084

Table 1- shows the comparison between the efficacy of glide path preparation using a ROTARY (PG) and a RECIPROCATING FILE SYSTEM (WOG) in moderately and severely curved molar root canals to reach the full working length (RFWL).
In terms of fracture resistance, the WaveOne Gold Glider demonstrated superior performance compared to the ProGlider system. The ProGlider files had a higher incidence of fractures, particularly in severely curved root canals. No fractures were observed with the WaveOne Gold Glider in moderately curved canals, and only one fracture occurred in severely curved canals. The statistical analysis revealed a significant difference in fracture resistance between the two systems, indicating that the WaveOne Gold Glider is more durable and reliable, especially in challenging canal anatomies (p=0.013) (Table-2) (Fig-2-C)

Table – 2

Fracture in the canal	PG n=17	WOG n=17	p- Value (< 0.05)
Moderately curved	02	00	0.013
Severely curved	06	01	

Table 2 compares the fracture resistance of wave one gold glider and proglider in moderately and severely curved root canals.

Discussion:
In this study, the experimented glide-path instruments had a noticeable impact on the frequency of fracture of the two pathfinfing instruments i.e Proglider and WaveOneGoldGlider in moderately and severely curved root canals. However, our findings did not indicate a significant difference in the effectiveness of these two systems for preparation of the glide path in moderate to severe curvature, it is noteworthy that WaveOne Gold glider files achieved RFWL in severely curved canals at a higher rate than ProGlider files. Specifically, out of 17 severely curved canals, 13 were successfully negotiated to full working length using the reciprocating system, compared to 7 canals with ProGlider files. This observation aligns with a study conducted by Gustavo et al[10]. in 2008, which similarly demonstrated the superior performance of WaveOne Gold glider over ProGlider.
The study showed a significant difference in fracture resistance, with WaveOne Gold glider demonstrating lower fracture frequencies compared to the rotary instrument (ProGlider), Additionally,

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it is suggested that the use of a gold alloy in WaveOne Gold glider may have contributed to its superior performance over ProGlider, as suggested by a recent systematic review conducted by Ferreira F et al.[20] However, it's worth noting that none of these previous investigations directly compared the fracture resistance of the two files or assessed the efficiency of rotary and reciprocating file systems in root canals with moderate and severe curvatures.

The current results are intriguing, especially when compared to the 38.30%–68.30% success rate of rotary pathfinding instruments in reaching the apical foramen.[18] Three primary factors can explain these findings:

1. The asymmetric reciprocating kinematics, which lessens torsional stress and enables the instrument's apical advancement. [16]
2. The instrument's design reduces contact with the dentinal walls by having a tiny tip diameter (0.125 mm) and a consistent taper (0.04 mm).[20]
3. The cross-sectional shape (S), which improves cutting effectiveness.

During significant preparation of the glide path, the glide path file is subjected to mechanical stress and may fracture due to cyclic or torsional fatigue. Given their smaller dimensions, pathfinding instruments are more flexible, making cyclic fatigue less relevant as a cause of instrument fracture compared to torsional stress.[10]

In a previous study conducted by Gustavo et al[10], The highest fracture rate was observed with ProGlider (11.6%), when compared with other reciprocating glide path files. These high fracture rates can be attributed to a larger instrument taper leading to a stronger phenomenon of taper lock and an increased chance of torsional fatigue. A Proglider with variable taper produces a flute diameter of 0.99 mm, which increases the area in contact with the canal walls and raises the possibility of taper lock. Arias and associates[15]. revealed that using ProGlider during glide path preparation resulted in higher peak torque and force as compared to using a constant 2% taper file which may indicate a higher chance of torsional fracture.[16] The rate of fracture observed with ProGlider in this study supports this assumption. Although M-Wire technology of proglider and its better ability to hold out against in vitro cycles to fracture in previous studies,[17] these advantages did not prevent ProGlider from having the higher fracture rate in this study.

Multitudinous studies have demonstrated the efficacy of electronic apex locators, establishing the electronic method as the most accurate for determining working length (WL).[18,19] The Root ZX, often regarded as the gold standard among EALs,[20] was used in this study to evaluate the performance of the pathfinding instruments. The 0.0 reading mark served as the reference point in this study to assess the effectiveness of both file systems.

Canals with severe and moderate curvature were opted for due to their higher incidence in lower molars and the clinical challenge they present for glide path procedures. All canals appeared negotiable, as scouting was achieved with an 8-K hand file, indicating that there was no notable anatomical obstacles. Thus, the failure of some Proglider and Wave-One GoldGlider instruments to reach the working length was likely not due to anatomical challenges. It may be possible that dentinal debris or shavings generated during preparation became packed in the apical third of the canal, obstructing the pathfinding file from reaching the apical terminus. This underscores the importance of thorough irrigation of the root canal, although further studies are needed to confirm this hypothesis.

Assessing the frequency percentage at which glide path instruments reach the working length (WL) without breaking or distorting is an effective method for ranking their performance and safety. The methodology used in this study aligns well with this objective.

To the best of our knowledge, there hasn't been any clinical or peer-reviewed in vitro research that has specifically looked at how the variables examined in this study affect the performance of pathfinding equipment. While there have been numerous studies focusing on glide path instruments, many of them

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have concentrated on different factors like apical transportation and canal irregularities. [10,12]
Within the confines of this study, the WaveOne Gold Glider (reciprocating) demonstrated superior efficiency and reduced instrument breakage compared to the ProGlider (rotary) when mechanically scouting both moderately and severely curved canals of molar teeth.

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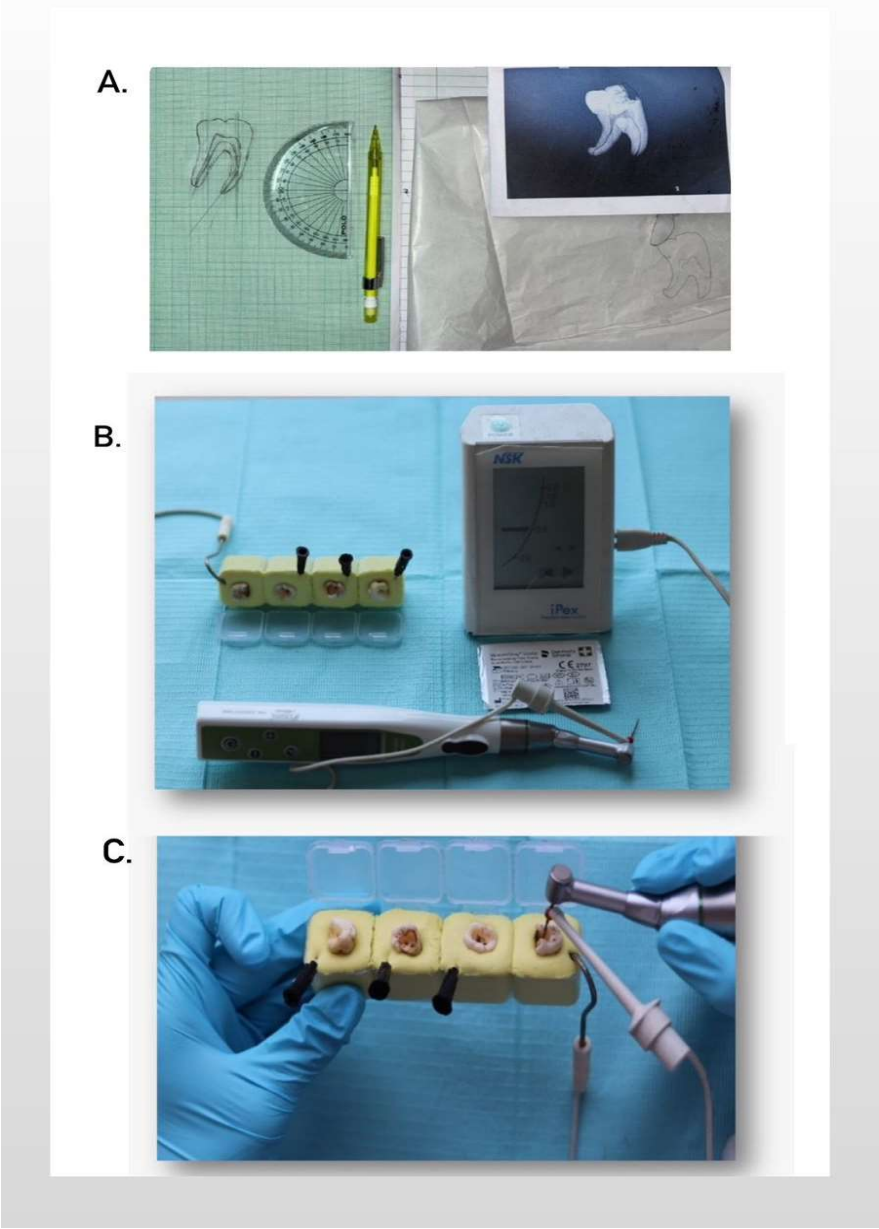

Fig1- A) Scheneider technique to determine the curvature of the root; B) File holder of the apex locator attached to the upper portion of the WaveOne gold glider file, secured onto a handpiece of an endo-motor; C) Preparation of glide path using rotary Proglider file

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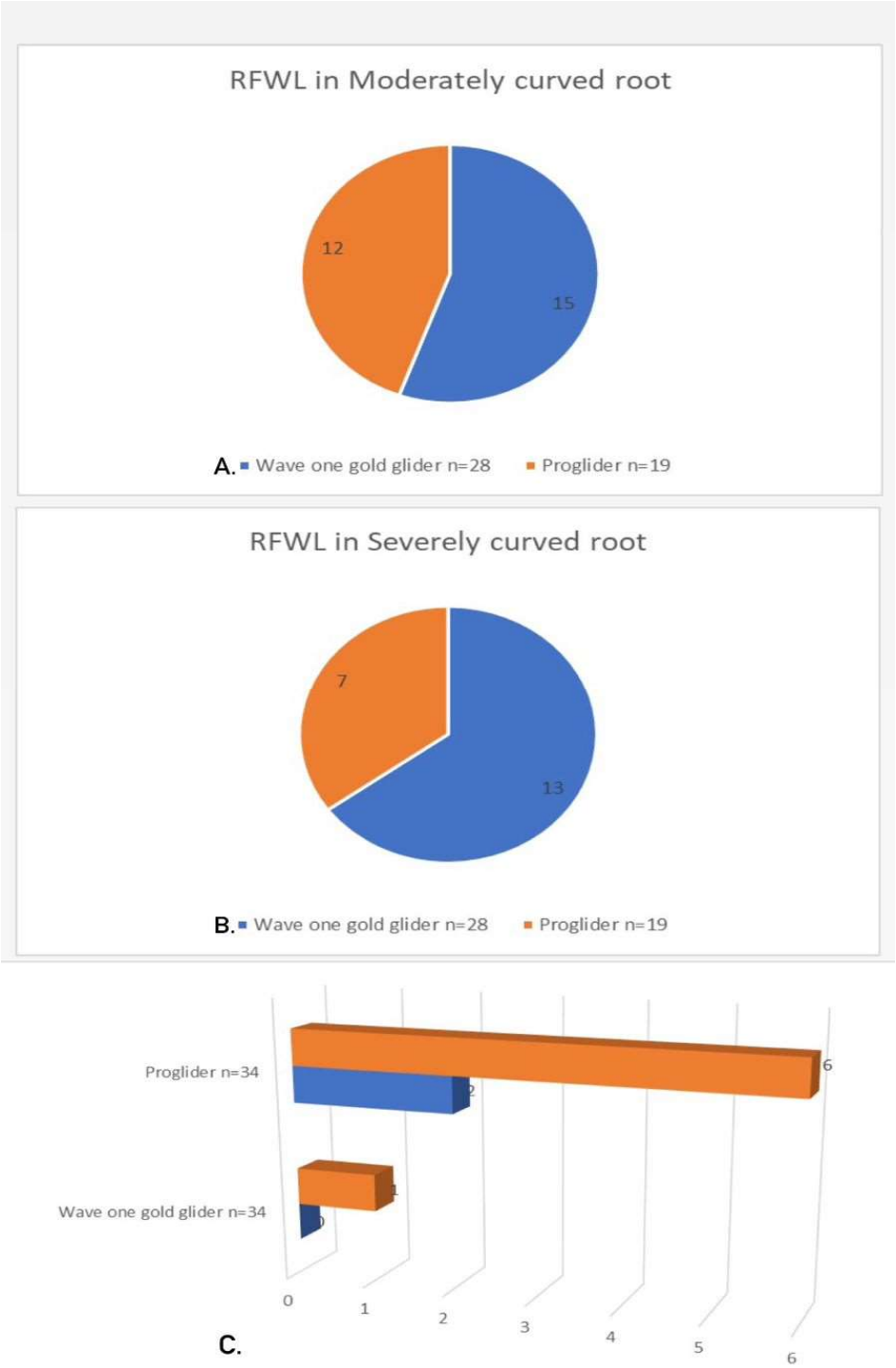

Fig2- A) Comparison of ROTARY (PG) and a RECIPROCATING FILE SYSTEM (WOG) in moderately curved molar root canals to reach the full working length (RFWL), B) Comparison of ROTARY (PG) and a RECIPROCATING FILE SYSTEM (WOG) in severely curved molar root canals to reach the full working length (RFWL), C) comparison of fracture resistance of Wave one gold glider and Proglider in moderately and severely curved root canals