In-Vitro study to Assess Effect of a Glide Path on Canal Transportation and Centering Ratio in Double Curved canals.

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Abstract

Objective: In endodontic treatment, creating a glide path became one of the recommended essential principles to obtain a safe preparation as possible; so the aim of the research is to evaluate the efficiency of the R-Pilot system in glide path preparation within the double curved canals.

Study design: A laboratory study to assess the efficiency R-Pilot mechanical patency system on the shape marinating of the canal. Those criteria were used to evaluate the change in the original shape of the canal, Canal Transportation and Centering Ratio. The data were analyzed using SPSS V.13 program and the correlation between the variables were defined using descriptive statistics and inductive statistical tests (chi-square, T Student for independent samples, ANOVA).

Results: no significant difference between the two glide path creation systems was found in terms of the deviation amount from the canal centric. whereas, between the R-Pilot system and the manual preparation, significant difference was found in the preserving rate of the canal centric at both the coronal area and the entire canal.

Conclusion: glide path creation in the previously mentioned methods with confirmation on the importance of the mechanical patency in terms of speed, Reducing the effort and burden imposed on the practitioner compared to the use of manual files. XP Endo shaper had lower deviation values and more ability to save the shape and centric of the canal.

Keywords: endodontic treatment; canal centric; R-Pilot system; deviation amount.

Introduction

The primary goal of endodontic treatment is to eliminate or reduce bacteria in the root canal system as much as possible while preserving the original shape and path of the canal [1]. Where preparing the root canals is considered one of the most important steps of endodontic treatment, including the removal of infected and affected tissues within the root canal walls and obtaining smooth walls that facilitate irrigation and filling, by following the utmost ways to make the preparation as conservative as possible, enough to protect the tooth from the risk of refraction in the long term [2].

Root canals with anatomical curves are considered a challenge to the practicing physician, due to the risk of complications incidence such as instruments refraction and deviation occurrence [3], Stainless steel files tend to restore their original straight shape during the preparation of these curves, unlike nickel titanium files, which has a high elasticity, so it reduces the efforts and lateral forces applied on the canal walls as much as possible in intense curving canals [3].

The insertion of nickel titanium alloys in endodontic has allowed manufacturers to produce many instruments with high flexibility.
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Material and Methods

Study sample:

60 double curved canals were used in this study, each canal made of transparent resin and had two coronal and apical curvature with diameter and taper corresponding to the ISO measurement, the apex measurement was 0.15, a taper of 2%, and a working length of 16 mm for each canal.

Depending on the used patency technique The sample split into two groups A and B, manually and mechanically respectively, each of them had 30 canals (n = 30) . Each subgroup was split to three basic groups and each of them was named after the used preparation system type ((O, X, H)), each preparation system group contains 10 canals, the blocks were also numbered in each group from 1 to 10.

Study design:

A laboratory study to evaluate the effectiveness of three single-file preparation systems in preparing artificial double curved canals made of transparent resin, after performing mechanical or manual patency and studying the changes and the complications that occur when preparing such canals to determine the best patency.
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**Pattern and the best preparation system used.**

**Used Materials:**

Three different preparation systems were used, One Curve, Hyflex EDM, XP Endo shaper, R-Pilot mechanical patency system and manual Stainless-steel K-Files were used in accordance with specifications specified earlier in the sample group (Figure 1-A), a privet hand-made device was used to fix the resin blocks, a single-dimensional fixed-angle camera was used for all samples, during which time a unified fixed angle camera was used. (Figure 1-B).

**The practical steps of the research:**

These resin blocks, which contain the double curved canals, were fixed within a specially designed base for this study and solar images were taken under the same conditions in terms of dimension, angle and lighting using a digital camera, then the study was conducted on 10 levels that were determined perpendicular to the longitudinal axis of the canal where These points were determined based on the initial image, and each canal was divided into three areas (the straight coronal area, the first curvature, and the apical curvature).

By identifying these levels and areas, we can study what will happen along the length of the canal, depending on the following criteria, where the change in the natural shape of the canal is evaluated according to the following:

- Amount of deviation (expressing the centric of the canal): the maximum value of the removed resin width from two sides.
- Centering Ratio (rate of the canal centric).

**Results**

The research sample consisted of 600 different sections determined in 60 simulated double curved canals. The sample was divided into two groups according to the glide path creation technique (R-Pilot, and manual files), and each group was divided into three subgroups (One Curve preparation system, XP Endo Shaper preparation system, Hyflex EDM preparation system). In addition, 10 different sections were made in each simulated canal; the sections were divided according to the studied area to the apical curvature area; the first curvature area, and the straight coronal area.

**Studying the deviation from the canal centric:**

Table No. 1 shows the various between the two means of the deviation value from the canal centric after creating the glide path using the R-Pilot system or by using manual files. A student test was performed for the independent samples and there were no significant differences in all the studied areas, as the significance level value was greater than (0.05)) for all groups.

An ANOVA test was performed to determine the differences between the used preparation systems (One Curve, XP Endo Shaper, and Hyflex EDM) in each of the studied areas in terms of...
Table 1: Studying the deviation from the canal centric

| Method               | N  | Mean | SD  | Min  | Max  | Means difference | T-value | P-value | Sig       |
|----------------------|----|------|-----|------|------|------------------|---------|---------|-----------|
| **Apical curvature** |    |      |     |      |      |                  |         |         |           |
| R-Pilot              | 120| -0.01| 0.84| -2.25| 2.77 | 0.07             | 0.59    | 0.556   |           |
| Hand files           | 120| -0.07| 0.87| -2   | 2.39 |                  |         |         |           |
| **First curvature**  |    |      |     |      |      |                  |         |         |           |
| R-Pilot              | 120| 0.46 | 0.73| -1.22| 2.39 | 0.04             | 0.395   | 0.693   |           |
| Hand files           | 120| 0.43 | 0.73| -1.71| 2.71 |                  |         |         |           |
| **Coronal curvature**|    |      |     |      |      |                  |         |         |           |
| R-Pilot              | 60 | -0.2 | 1.04| -2.78| 3.62 | 0.12             | 0.706   | 0.482   |           |
| Hand files           | 60 | -0.32| 0.75| -2.74| 1.35 |                  |         |         |           |
| **Full canal**       |    |      |     |      |      |                  |         |         |           |
| R-Pilot              | 300| 0.14 | 0.88| -2.78| 3.62 | 0.06             | 0.911   | 0.363   |           |
| Hand files           | 300| 0.08 | 0.85| -2.74| 2.71 |                  |         |         |           |

sig: significance.

the amount of deviation from the canal centric after preparation. When using the R-Pilot system to create the glide path, a statistically significant difference was found in the first curvature area (0.001), the coronal area (0.043) and the entire canal (0.007). Whereas, with the use of manual files, there was no significantly important difference except in the coronal area (0.044) (Table No. 2).

The Bonferroni test was used to compare the deviation amount variable in the canal centric after preparation between two different preparation systems separately, according to different studied areas and different glide path creation techniques. (Table No. 3) shows the results of the values of this test.

**Studying the rate of preserving the canal centric:**

Table No. 4 shows the mean and the standard deviation of the rate of preserving the canal centric after creating the glide path, the independent sample t-test was also used to study the existence of a significant difference between the R-Pilot system and the manual files, as it found a significant difference between the two preparation systems at each of the coronal area and the entire canal (0.000, 0.002), respectively, while there was no significant difference in both the apical and the first curvature area.

Figure No.2 demonstrated the canal centric preserving rate value in the research sample, the values were higher in all groups, which used the R-Pilot system.

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Table 2: studying the deviation from the canal centric ANOVA test.

| Method          | Preparation system | N  | SD  | SE  | Min  | Max  | F-value | P-value | Sig |
|-----------------|--------------------|----|-----|-----|------|------|---------|---------|-----|
| **R-Pilot**     |                    |    |     |     |      |      |         |         |     |
| Apical curvature| One Curve          | 40 | 0.2 | 1.35| -3.22| 3.39 | 0.314   | 0.731   |     |
|                 | XP Endo Shaper     | 40 | -0.1| 1.55| -3.41| 2.84 |         |         |     |
|                 | Hyflex EDM         | 37 | 0.05| 2.11| -3.73| 3.36 |         |         |     |
| **First curvature** | One Curve        | 40 | 1.27| 1.12| -0.77| 3.64 | 7.391   | 0.001   | *   |
|                 | XP Endo Shaper     | 40 | 0.48| 1.28| -2.31| 2.65 |         |         |     |
|                 | Hyflex EDM         | 40 | 1.45| 1.2  | -1.53| 3.87 |         |         |     |
| **Coronal curvature** | One Curve       | 20 | -0.37| 0.92| -1.79| 1.92 | 3.323   | 0.043   | *   |
|                 | XP Endo Shaper     | 20 | -0.83| 1.02| -3.05| 1.18 |         |         |     |
|                 | Hyflex EDM         | 20 | 0.07| 1.34| -1.53| 4.44 |         |         |     |
| **Full canal**  | One Curve          | 100| 0.52| 1.34| -3.22| 3.64 | 5.103   | 0.007   | *   |
|                 | XP Endo Shaper     | 100| -0.01| 1.43| -3.41| 2.84 |         |         |     |
|                 | Hyflex EDM         | 97 | 0.63| 1.75| -3.73| 4.44 |         |         |     |
| **Hand files**  |                    |    |     |     |      |      |         |         |     |
| Apical curvature| One Curve          | 40 | 0.45| 1.75| -2.86| 5.28 | 0.435   | 0.648   |     |
|                 | XP Endo Shaper     | 40 | 0.03| 2.2  | -3.95| 4.57 |         |         |     |
|                 | Hyflex EDM         | 40 | 0.42| 2.64| -4.44| 9.54 |         |         |     |
| First curvature | One Curve          | 40 | 1.65| 0.92| -0.61| 3.19 | 2.723   | 0.07    |     |
|                 | XP Endo Shaper     | 40 | 1.06| 1.21| -1.76| 3.16 |         |         |     |
|                 | Hyflex EDM         | 40 | 1.51| 1.41| -2.49| 3.85 |         |         |     |
| Coronal curvature | One Curve       | 20 | 0.28| 0.78| -1.28| 1.27 | 3.297   | 0.044   | *   |
|                 | XP Endo Shaper     | 20 | -0.23| 1.08| -2.16| 1.45 |         |         |     |
|                 | Hyflex EDM         | 20 | -0.4| 0.72| -2.11| 0.59 |         |         |     |
| Full canal      | One Curve          | 100| 0.9 | 1.43| -2.86| 5.28 | 2.123   | 0.121   |     |
|                 | XP Endo Shaper     | 100| 0.39| 1.74| -3.95| 4.57 |         |         |     |
|                 | Hyflex EDM         | 100| 0.69| 2.04| -4.44| 9.54 |         |         |     |
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Table 2: sig: significance.
*: statistically significant.

Table 3: Studying the deviation from the canal centric after preparation, Bonferroni test

| variables      | Preparation method | I-J | SE  | P-value | Significance |
|----------------|--------------------|-----|-----|---------|--------------|
| R-Pilot        | First curvature    | XP Endo Shaper | 0.79 | 0.27 | 0.011 *      |
|                |                    | Hyflex EDM    | -0.18| 0.27 | 1            |
|                | XP Endo Shaper     | Hyflex EDM    | -0.97| 0.27 | 0.001 *      |
|                | Coronal area       | XP Endo Shaper | 0.46 | 0.35 | 0.577        |
|                |                    | Hyflex EDM    | -0.44| 0.35 | 0.64         |
|                | XP Endo Shaper     | Hyflex EDM    | -0.9 | 0.35 | 0.038 *      |
|                | Full canal         | XP Endo Shaper | 0.53 | 0.21 | 0.042 *      |
|                |                    | Hyflex EDM    | -0.12| 0.22 | 1            |
|                | XP Endo Shaper     | Hyflex EDM    | -0.64| 0.22 | 0.009 *      |
| Manual         | Coronal area       | XP Endo Shaper | 0.51 | 0.28 | 0.203        |
|                |                    | Hyflex EDM    | 0.68 | 0.28 | 0.051        |
|                | XP Endo Shaper     | Hyflex EDM    | 0.17 | 0.28 | 1            |

*: statistically significant
Discussion

The importance of mechanical preparation of root canals comes not only in terms of removing all live and dead tissues inside the root canal, but also from the importance of creating a sufficient place to allow the entry of both irrigating fluids, intra-canalicual dressing, and filling materials in order to complete their role in disinfection the root canal system and seal it tightly [15] while preserving the original shape of the canal [16].

Where canals curvature and canal anatomical anomalies are one of the most important challenges faced by the practitioner during endodontic treatment, due to the many potential complications during treatment such as zipping occurrence, deviation of the canal, opening or changing in the shape or location of the apex, which causes subsequent failure of the endodontic treatment [17].

Despite the advantages and the massive flexibility of nickel-titanium mechanical files, securing an initial glide path on the canal before using the mechanical preparation instruments is considered among the recommended matters, whether manually or by using glide path creation mechanical files [18].

In this study, double curved resin blocks were used instead of using natural teeth, due to the ineffectiveness of those last for comparison between preparation systems, as differences, even minor ones, between those teeth may make clear variances in results more than these made by different preparation systems [19], thus giving the resin blocks the possibility of unification the required standards in the study sample in terms of length, hardness, manufacturer's material, curvature radius and angle [20,21], and, although it may not significantly reflect the clinical aspect due to the difference between the hardness of the dentin and the resin [22], though, it is a good and valid measure for studying different preparation systems [23,24].

The results of our study showed that when comparing the two methods of creating a glide path
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With an R-Pilot mechanical file and using manual K-Files up to the size of # 20’ in studying the amount of deviation of the canal centric, by subtracting the output of the removed resin in the right side, -in each level of the study levels- from the removed resin in the left side, in two stages after creating the glide path and after preparation, our study did not show a significant difference in the deviation amount from the canal centric after creating the glide path, regardless the followed method.

Whereas the study of the rate of preserving the canal centric after the glide path creating step, there were no clear differences between the two methods. Thus, the two methods were equal in preserving the canal centric in the apical curvature area. However, in the first curvature area, the coronal area and in the entire canal, our study had proved that the glide path creation using R-Pilot mechanical file is better than creating it using manual files.

Our study showed that the deviation amount values in the centric of the canal after preparing the apical area did not differ according to the different preparation systems applied and the used method to create the glide path.

As for in the first curvature area, coronal area and the entire canal, the XP Endo Shaper preparation group outperformed which made her the smallest among the Preparation groups compared to the One Curve preparation system group and the Hyflex EDM preparation system group. This can be explained by the difference in tapering between the single-files used in the preparation as the XP Endo Shaper has the smallest taper between them.

Our study agreed with the results of a previous study [25], which compared different types of glide path creation using single-file mechanical files (R-Pilot - Wave One Gold Glider - ProGlide) in terms of the ability of R-Pilot file to maintain the shape and centric of the canal. Compared to other glide path creation systems.

We also agreed with another study [26], which compared five different types of mechanical preparation systems on a 120 S-shaped manufactured canal sample with or without glide path creation and showed that the files with smaller taper were more preserver on the shape and the centric of the canal, where (Schilder H 1974) [27] showed that the elasticity and hardness of the file varies according to the size, diameter and taper of the used instrument. Therefore, instruments with smaller tapering led to better results in terms of maintaining centric.

Also, when comparing this study with that of (Alfadley et al, 2020) we show the superiority of the XP-Endo Shaper over Wave One Gold in terms of maintaining the centrality and the shape of the
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The same thing with the R-Pilot mechanical file, which is considered very recent, and despite the presence of many studies that discussed its ability to resist efforts in various forms and degrees of curvature of the root canals, until now there was only one study dealt with the ability of maintaining the shape and the centric of the canal. It is important to mention that in this research, we studied the ability to maintain the shape and the centric of the canal only. The absence of differences between the glide path creation systems does not mean neglecting the importance of mechanical patency, including speed, reducing the effort imposed on the practitioner, especially in curved canal and safety in preparation.

Conclusion

Creating a glide path in one of the described methods, emphasizing the importance of mechanical patency in terms of speed and reducing the effort and burden imposed on the practitioner compared to the use of manual files.

Emphasis on the one-time use of mechanical preparation systems whenever possible, especially in canals with anatomical anomalies, to avoid complications resulting from preparation.

Consider depending on high flexibility and smaller tapering preparation systems for preparing curved root canals with complex anatomical anomalies. XP Endo shaper had lower deviation values and more ability to save the canal’s shape and centric.

Conflicts of interest

The authors declare no competing interest.

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