

## ORIGINAL ARTICLE

# Negotiating the second mesiobuccal canal: A comparison of nickel titanium files through the experience of undergraduate dental students

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## Abstract

**Objectives:** The aim of this study was to compare the ability of undergraduate students to reach working length (WL) in second mesiobuccal root canals (MB2) of maxillary first molars ( $n = 210$ ) by using Reciproc Blue without glide path preparation, and One Curve with glide path preparation.

**Methods:** The students ( $n = 105$ ) attended theoretical and practical courses. The first group ( $n = 53$ ) shaped MB2 root canals using the One Curve system and then Reciproc Blue; the second group ( $n = 52$ ) shaped MB2 root canals following the reverse sequence. Participants completed a questionnaire. The chi-square and Mann–Whitney  $U$  test were used for statistical analysis using significance of  $p < 0.05$ .

**Results:** The full WL was reached and shaping procedures were completed without complications in Reciproc Blue and One Curve groups at rates of 86.67% and 82.85%, respectively ( $p > 0.05$ ). Treatment time was shorter in Reciproc Blue ( $p < 0.05$ ). More (62.9%) students felt the One Curve system safer, while 61% felt the Reciproc Blue system faster.

**Conclusions:** Within the limitations of this study, instrument kinematics and glide path preparation did not interfere with undergraduate students' ability to achieve the WL in MB2 root canals.

## KEYWORDS

dental, education, endodontics, glide path, One Curve, Reciproc Blue, students

## 1 | INTRODUCTION

Anatomical knowledge and clinical experience are essential for endodontic treatment success. The proper detection, shaping, cleaning, and obturating of root canals are the main factors that prevent failure.<sup>1</sup> Maxillary first molars have complex anatomy regarding canal numbers, variations, and orientation in the dentition.<sup>2</sup> The main concern with this tooth is the mesiobuccal root, which

generally has two canals. A recent systematic review and meta-analysis of prevalence studies using cone-beam computed tomography (CBCT), which is shown as the best method to detect second mesiobuccal root canal (MB2), found the prevalence to be 69.9% and 39.0% in maxillary first and second molars, respectively.<sup>3</sup> These percentages can vary according to the population and geographic region, depending on ethnic and demographic factors.<sup>3,4</sup> The management of MB2 can be challenging due to the

presence of calcifications in the coronal third<sup>5</sup> and one or more abrupt curvatures; thus, reaching the working length (WL) may be difficult.<sup>6</sup> Despite technological advancements in the endodontic field, negotiating and shaping the MB2 root canal remains a challenge. It was reported that less than 80% of MB2 root canals were successfully scouted by conventional methods.<sup>7</sup>

Recent studies have shown that use of Ni-Ti instruments instead of stainless-steel files leads to better root canal treatments even in the hands of inexperienced dental students.<sup>8,9</sup> Based on this, Ni-Ti rotary files have been included in the dental curriculum of many universities.<sup>10-12</sup> Advances in Ni-Ti technologies have resulted in new instrument designs and different kinematic movements (rotation and reciprocation) leading to less iatrogenic problems.<sup>6,13</sup> The kinematics of reciprocal movement is more complex than continuous rotation. Unlike unidirectional continuous rotation, the reciprocating instrument rotation is both clockwise and counterclockwise, representing the engaging and disengaging cutting angles.<sup>13</sup>

A glide path facilitates the advancement of rotary shaping instruments into the apical third of the canal while reducing the incidence of instrument fracture.<sup>14</sup> Such paths can be created with either stainless steel or Ni-Ti files with small tip diameters.<sup>15</sup> The One Curve continuous rotation system (Micro-Mega, Besancon, France) includes a One G glide instrument for the creation of a pathway (14/0.03) and a One Curve shaping instrument (25/.06); the manufacturer recommends creating a glide path with One G before shaping the canal with One Curve.<sup>16</sup>

Single-instrument canal preparation using asymmetrical reciprocation without glide path was introduced in 2008, and Reciproc (VDW GmbH, Munich, Germany) was developed to be used in conjunction with this.<sup>17</sup> Zuolo et al. reported that the success of hand files in negotiating MB2 was 65%, the success of Reciproc files without glide path was 85%.<sup>18</sup> Recently, Reciproc Blue instruments have been introduced with improved properties. According to the manufacturer, Reciproc Blue is identical to Reciproc in design, size, variable taper (25/.08v) and reciprocation kinematic,<sup>19</sup> but is more flexible and more resistant to cyclic fatigue.<sup>19</sup> Reciproc Blue was designed to be used without a glide path<sup>20</sup> and De-Deus et al. have demonstrated its great performance in the absence of a path,<sup>21</sup> but to date there is no information available on the ability of Reciproc Blue to specifically negotiate MB2 canals without a glide path.

The study aimed to evaluate and compare the success of two different systems, Reciproc Blue without glide path and One Curve with glide path, when inexperienced undergraduate students used them to reach the full WL of

MB2 root canals. The null hypothesis is that instrument kinematics and glide path do not interfere with the ability to achieve the necessary WL.

## 2 | MATERIALS AND METHODS

This study was approved by the local ethics committee (approval number: 21.10.2020-13). Students without training or experience using rotary files for endodontic treatment were invited to the study, and informed consent was obtained.

### 2.1 | Specimen selection

The power analysis was performed with G\*Power 3.1 software (Heinrich Heine University, Dusseldorf, Germany) using data from another study by Zuolo et al.<sup>18</sup> The sample size was calculated as minimum 210 (alpha probability of error = 0.05, power = 0.95).

Three hundred fifty maxillary first molars with mature apices were selected from a pool of extracted teeth. Initial buccopalatal and mesiodistal periapical radiographs were taken and the teeth immersed in a silicon material using a custom-made box. The specimens were mounted in a custom-made holder, and CBCT scanning was used to evaluate the anatomy of two mesiobuccal root canals using Special Endo Mode (5 × 5.7 cm field of view, 96 kVp, 7.1 mA, and 15 s exposure time with 75 μm voxel size) on Promax CBCT unit (Planmeca, Helsinki, Finland). Maxillary first molars with two separate (Vertucci configuration type IV) or joining canals within 5 mm from the apex (Vertucci configuration type II) mesiobuccal root canals with 0°–40° degrees of canal curvature were included in the study.<sup>22</sup> Teeth with previous endodontic treatment or with a crown, root resorption involving the MB root, and perforation of the furcation were discarded. Then a straight-line access cavity was prepared by two experienced endodontists and ultrasonic tips were used to localize the canals. The canal orifices of MB2 were also checked under 16× magnification with an operation microscope (Leica M320, Leica microsystems, Wetzlar, Germany). The mesiobuccal cusp tip was reduced to a flat surface for use as a reference during WL determination.

DICOM data obtained from CBCT were transferred to the onDemand 3D Dental Software Program (Cybermed, Seoul, Korea), and the approximate WL of the MB2 canals was calculated from apical constriction to the reduced cusp tip with the same program (estimated WL). The teeth presenting with 16–20 mm WL in MB2 canals were selected for the study; 210 teeth were included.

## 2.2 | Grouping of the students

Undergraduate students ( $n = 105$ ) who had completed clinical endodontics internships and had never tried or been educated about rotary instruments were divided into two groups. Each student attended a 2-h theoretical lecture with slides via Zoom and a 2-h practical course on One Curve and Reciproc Blue instrumentation techniques (explained in detail below). The same endodontist gave the practical and theoretical lectures to all student groups. Due to the COVID-19 pandemic, the groups were divided into subgroups consisting of five to seven students for the practical courses. Four endodontists supervised the students during practical courses. All practical and theoretical courses were completed in 15 days.

The teeth were randomly handed out to the participants. Each student shaped MB2 canals of two maxillary molars; one with the Reciproc Blue, the other with the One Curve instrument systems. Group 1 ( $n = 53$ ) first received theoretical and practical training on One Curve, while Group 2 ( $n = 52$ ) first received theoretical and practical training on Reciproc Blue; then each group shaped the MB2 using these systems. Two days later, Group 1 received Reciproc Blue training and Group 2 received One Curve training. Thereafter, each group used those systems in the instrumentation of the MB2 root canals. The instruments were used as per the manufacturer's instructions.

### 2.2.1 | Reciproc Blue group

The Reciproc Blue R25 (25/.08v) instrument was performed with a VDW Gold endo motor (VDW, Munich, Germany) set at the "Reciproc ALL" program. The access cavity was filled with a solution of 2.5% sodium hypochlorite (NaOCl). The canals were not scouted with small stainless-steel hand files, and a glide path was not created with either rotary instruments or hand files. Reciproc Blue R25 instrument was directly inserted into the MB2 canal. A slow and gentle in-and-out pecking movement with a maximum amplitude of 3 mm was used until approximately two-thirds of the "estimated WL" was reached. After every three pecks, the file was removed, the flutes were cleaned with a sponge, and the root canal was irrigated with 2 ml 2.5% NaOCl. Then, a #10 K file was used to determine the "exact WL" via periapical radiograph. After WL verification, the Reciproc Blue R25 instrument was used until the WL was reached. The Reciproc Blue R25 instrument was placed in the root canal in the WL, and buccopalatal and mesiodistal final control periapical radiographs were taken.

### 2.2.2 | One Curve group

One Flare (25/.09) was used to instrument the teeth in this group for preflaring. A glide path was created with the One G (14/0.03) instrument and the shaping was performed with One Curve (25/.06) files in continuous rotation at 300 rpm at 3, 1.2, and 2.5 Ncm torque using a Dual Move endodontic motor (MicroMega Besançon Cedex, France) as per the manufacturer's recommendations. The access cavity was irrigated with 2 ml 2.5% NaOCl, and preflaring performed in the coronal third with One Flare (MicroMega Besançon Cedex, France). The initial canal exploration of the MB2 canal was done with a manual #10K file, and WL confirmed via periapical radiograph. A One G file (MicroMega Besançon Cedex, France) was used to create a glide path. Then the root canal was irrigated with 2 ml 2.5% NaOCl and instrumented with the One Curve file using in-and-out pecking movements until the WL was reached. The One Curve file was then placed in the root canal and buccopalatal and mesiodistal radiographs were taken for controls.

For both instrumentation systems, a total of 10–15 ml 2.5% NaOCl was used during the procedure. New instruments were used to shape each root canal.

The ability to reach WL, treatment time, and questionnaire answers were evaluated. When Reciproc Blue R25 or One Curve reached WL, the procedure was considered successful; when Reciproc Blue R25 or One Curve did not reach WL or when procedural errors occurred (ledge, canal transportation, or instrument fracture, for example), the procedure was recorded as unsuccessful.

The treatment time calculated for the Reciproc Blue system included irrigation and shaping protocols with Reciproc Blue files. The treatment time calculated for the One Curve group, a sequential system, included the total time required for instrument change, irrigation, and shaping procedures.

## 2.3 | Questionnaire

Upon completing the canal preparation with each system, the students completed a questionnaire that included questions about the effectiveness, ease, and appropriateness of the number of the files; simplicity; safety; treatment time; and general personal opinions (Table 1).

## 3 | STATISTICAL ANALYSIS

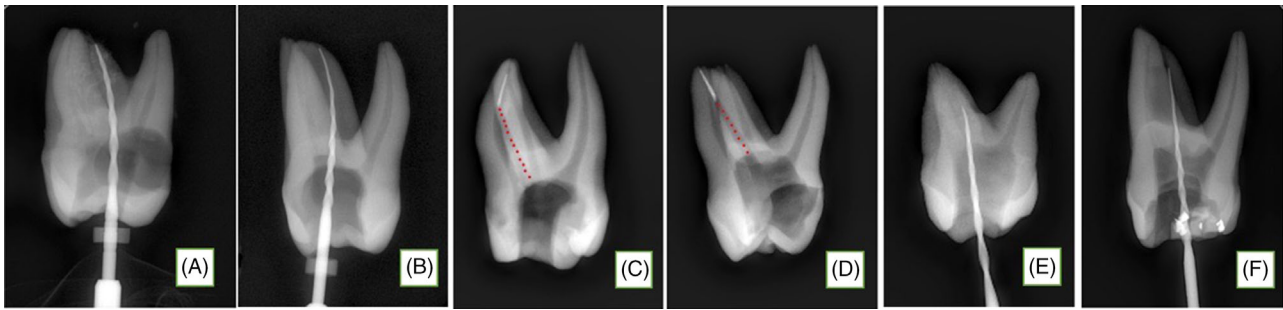
The study data were analyzed with IBM SPSS V23 (IBM Corp, Somers, NY). Compliance with normal distribution

**TABLE 1** The satisfaction questionnaire given to the undergraduate students ( $n = 105$ ) and the percentage of answers

	Number of respondents ( $n$ )	Percentage (%)
Which part of the canal was difficult to prepare with Reciproc Blue?		
Coronal third	8	7.6
Apical third	70	66.7
None	23	21.9
Both	4	3.8
Which part of the canal was difficult to prepare with One Curve?		
Coronal third	18	17.1
Apical third	38	36.2
None	46	43.8
Both	3	2.9
The number of files of the Reciproc Blue system?		
Highly acceptable	70	66.7
Acceptable	28	26.7
Missing	7	6.7
The number of files of the One Curve system?		
Highly acceptable	18	17.1
Acceptable	75	71.4
Missing	12	11.4
Which one of the files made you feel safe regarding file breakage while you are shaping?		
Reciproc Blue	39	37.1
One Curve	66	62.9
Are you generally satisfied with the use of the Reciproc Blue system?		
Yes	83	79
No	22	21
Are you generally satisfied with the use of the One Curve system?		
Yes	98	93.3
No	7	6.7
Which system do you prefer to use in the future?		
One Curve	62	59
Reciproc Blue	29	27.7
Both of them	14	13.3
Which system do you think is easier to shape root canals?		
One Curve	52	49.5
Reciproc Blue	49	46.7
None of them	4	3.8
Which system do you think is faster?		
One Curve	41	39
Reciproc Blue	64	61

was determined with the Kolmogorov–Smirnov test. The chi-square test was used to compare the success rates of the groups and the Mann–Whitney  $U$  test was used to compare the treatment times of the groups. Results

were presented as mean  $\pm$  standard deviation (SD) and median (minimum–maximum) for quantitative data; and frequency and percentage for categorical data. The significance level was taken as  $p < 0.05$ .



**FIGURE 1** Some examples of cases where reaching working length (WL) (A and B), instrument separation (C and D), and inability to move toward the apex (E and F) occurred in Reciproc Blue (RB) and One Curve (OC) groups, respectively

## 4 | RESULTS

The distribution of Vertucci configurations was balanced between the two systems: Reciproc Blue and One Curve included 70.48% and 67.62% type II configurations, and 29.52% and 32.38% type IV configurations, respectively. There was no significant difference between type II and type IV configurations in Reciproc Blue and One Curve groups regarding the success rate ( $p > 0.05$ ).

### 4.1 | Success rate of reaching working length

In the Reciproc Blue group, in 86.67% ( $n = 91$ ) of the MB2 canals, the full WL was reached and shaping procedures were completed without complications (Figure 1A). Negotiation of the MB2 canals up to the WL was unsuccessful in 14 canals due to instrument separation (six canals) (Figure 1C) and inability to move toward the apex (eight canals) (Figure 1E). In the One Curve group, the full WL was reached and shaping procedures were completed without any complications in 82.85% ( $n = 87$ ) of the MB2 canals (Figure 1B). Negotiation of the MB2 canals up to the WL was unsuccessful in 18 canals due to instrument separation (six canals; 5 = One Curve and 1 = One Flare files) (Figure 1D) and inability to move toward the apex (Figure 1F) (12 canals). Perforation occurred in two roots where instruments were fractured. There was no statistically significant difference in the groups regarding the rate of reaching WL ( $p > 0.05$ ).

### 4.2 | Instrument separation

The incidence of file separation was similar in both groups (5.71%) (Figure 2). In Reciproc Blue group 6 Reciproc Blue R25 (5.71%) and in One Curve Group, 5 One Curve instruments (4.76%) and 1 One Flare (0.95%) files were fractured inside the MB2 canal.

### 4.3 | Treatment time

Table 2 summarizes the treatment time for shaping the MB2 root canals with Reciproc Blue and One Curve. The treatment time for the One Curve group was statistically longer than the Reciproc Blue group ( $p < 0.05$ ).

### 4.4 | Questionnaire results

All students completed the questionnaire. Table 1 presents the results. Both instrument groups created high satisfaction percentages in the students (One Curve 93.3%, Reciproc Blue 79%).

## 5 | DISCUSSION

The study found that both instrument kinematics (rotation and reciprocation) used by the undergraduate students were successful in negotiating MB2 root canals regardless of a glide path. Therefore, the null hypothesis was accepted. The treatment time was shorter in the single-file Reciproc Blue group working with reciprocation kinematics than the One Curve Group ( $p < 0.05$ ). According to the questionnaire, more students felt the One Curve system safer than Reciproc Blue system ( $p < 0.05$ ).

Previous studies have reported the presence of MB2 root canals in maxillary first molars at rates of 18%–96%.<sup>3,4,23–26</sup> Missing these MB2 canals leads to endodontic failure and may require repeating treatment of the case.<sup>25–27</sup> Missed MB2 root canal is a main cause of unsuccessful treatments, and undeniably clinicians fail to detect, discover, and shape these canals. The authors were interested in investigating the preparation of MB2 canals by inexperienced users. Because the study's purpose was to compare the two systems' ability to reach WL, the endodontists created the access cavities and located the MB2 canal orifices using an operation microscope.

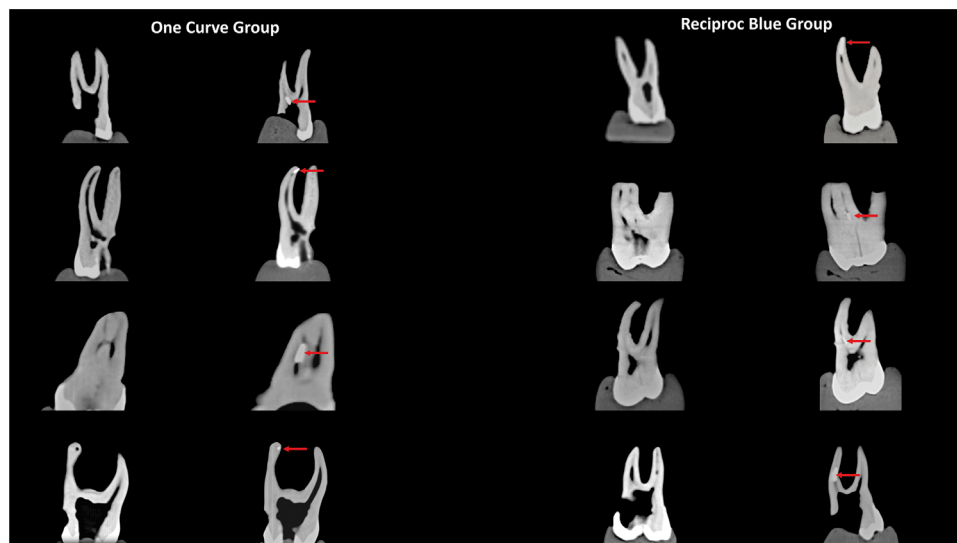


FIGURE 2 Broken instrument examples of Reciproc Blue and One Curve groups

TABLE 2 The time required for shaping MB2 canals with Reciproc Blue and One Curve instruments (in seconds)

	Mean $\pm$ standard deviation	Median (minimum–maximum)	Test statistics	p-Value
Reciproc Blue	499.9 $\pm$ 215.4	450.5 (190.0–1200.0)	U = 5381.5	<0.001
One Curve	596.9 $\pm$ 187.1	544.0 (350.0–1093.0)		

Abbreviations: MB2, second mesiobuccal root canal; U, Mann–Whitney U test.

The creation of a glide path minimizes the risk of instrument fracture, which can occur with the binding of the tip of the instrument in the canal.<sup>28</sup> Although One Curve is marketed as a “single file” system, the manufacturer recommends its use with the One Flare orifice opener and One G glide path file<sup>29</sup>; One G decreases the torque effect thanks to the variable flute on its cutting edges.<sup>30</sup> Yared, the inventor of Reciproc Blue, claims the majority of the canals can be shaped using a single Reciproc Blue R25 alone without prior instrumentation or a glide path regardless of the degree of canal calcification and root curvature.<sup>31</sup> The results of this and other studies support Yared’s claim.<sup>18,21,31–33</sup> In this study, WL was achieved in 86.67% of the cases in the Reciproc Blue group at the hands of inexperienced users. Given these results, it appears that Reciproc Blue is highly effective for reaching WL even when used by inexperienced users and without scouting or glide path.

The study found that regardless of glide path preparation, the rate of reaching WL was higher and the complication risk numerically lower in the Reciproc Blue group than the One Curve group. Because Reciproc Blue is just one file system, it may be easier for a learner to use and to manipulate. Moreover, though Reciproc Blue was used without prior instrumentation in the root canal,

the number of broken instruments was statistically similar for both groups; the cross-section, tip design, and clockwise/counter-clockwise motion of the Reciproc Blue may achieve a comparable scouting ability with only one file.<sup>21,33</sup> In the present study, the instrument fracture rate exceeded 5% in each group, which exceeds the clinically accepted fracture rate of 2.5%.<sup>8</sup> As ESE guidelines<sup>34</sup> recommend that students prepare 20 teeth throughout their entire dental education, inexperienced users shaping only one tooth may have adversely affected the fracture rate in this study. On the other hand, this rate was higher than other studies<sup>8,35</sup> conducted with rotary instruments by undergraduate students. The difference in study design may have caused that difference. Caballero-Flores et al.<sup>35</sup> assessed the rotary file fracture incidence of 24 undergraduate students in 2056 root canals; Sonntag et al.<sup>8</sup> assessed 450 simulated root canals shaped with rotary instruments by 30 students. In our study, students in each group only shaped one MB2 canal and they were using rotary instruments for the first time. From this point of view, the undergraduate students in the previous studies were more experienced than the students in our study.

Our study recorded the students’ opinions of the instruments they were using. Surprisingly, the majority felt the One Curve was safer to avoid file fracture during

shaping procedures (62.9%), despite the fact that numerically more complications occurred with it. In their endodontic education within the regular undergraduate curriculum, students learn to start with small hand files to scout the canal, which is also a requirement when using One Curve. Thus study participants might have felt safer and more comfortable with OC compared with Reciproc Blue.

On the other hand, 61% of the students stated that Reciproc Blue was faster. The recorded shaping procedure times (Table 2) confirm this, and it may be related to the fact that only one Reciproc Blue file was used to prepare the MB2 canals without a glide path.

A limitation of this study is that the teeth in the student groups were not equal in curvature radius, curvature location, and initial root canal dimensions.<sup>36</sup> In addition, the teeth used ranged widely in WL values. In studies conducted on extracted teeth, standardization of groups is very difficult, especially in canals as difficult to localize and negotiate as the MB2. A large sample size (105 per group) may have compensated for this limitation, but the results should nonetheless be interpreted carefully.

Identifying and preparing the MB2 root canal is vital to preventing unsuccessful endodontic treatments.<sup>37</sup> To the best of our knowledge, this study is the first to compare the success of Reciproc Blue and One Curve files when used by inexperienced undergraduate students to negotiate and prepare MB2 root canals in maxillary first molars. The Reciproc Blue group experienced fewer complications than the One Curve group, albeit with a slight margin. The students stated that One Curve provided them with more confidence, adding that generally they would prefer this system in the future.

The majority of the students was satisfied with both systems and found the number of files acceptable. However, students felt safer using the One Curve system than shaping the root canal directly with the Reciproc Blue instrument. Both groups in the study showed high rates of reaching the WL, so incorporating both techniques into the undergraduate education shows promise for shaping difficult canals like the MB2 in future root canal treatments.

In conclusion, instrument kinematics and glide path preparation did not affect the success of undergraduate students in negotiating MB2 canals. The results of this study must be carefully adapted to the clinical setting, as clinical scenarios and tooth anatomy are widely varied. Further in vitro and in vivo studies with different clinical scenarios and magnification systems are needed.

#### AUTHOR CONTRIBUTIONS

Ayfer Atav Ateş: contributed to study conception and design, data acquisition, analysis, and interpretation,

drafted and critically revised the manuscript. Burçin Arıcan: contributed to study conception and design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript. Elif Çifçiöğlü: contributed to study conception and design, critically revised the manuscript. Enver Sedat Küçükay: contributed to conception, design, drafted and critically revised the manuscript. All authors gave final approval and agreed to be accountable for all aspects of the work.

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#### CONFLICT OF INTEREST

The authors declare they have no conflicts of interest related to this study.

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