ผลการเรียนรู้การเตรียมคลองรากฟันด้วยเครื่องมือเรซิพรอกซ์ของนักศึกษาทันตแพทย์ปริญญาตรี

Learning Effectiveness in Root Canal Shaping using Reciproc of Undergraduate Dental Students

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บทคัดย่อ

การวิจัยนี้มีจุดประสงค์เพื่อประเมินความสามารถในการเรียนรู้การใช้เครื่องมือ เรซิพรอกซ์ (VDWMunich Germany) ซึ่งเป็นเครื่องมือขยายคลองรากฟันในทิศทางหมุนไป-กลับ โดยมีกลุ่มทดลองเป็นนักศึกษาทันตแพทย์ 2 กลุ่ม กลุ่มที่ 1 เป็นนักศึกษาชั้นปีที่ 6 ที่มีประสบการณ์ในการรักษาคลองรากฟันโดยใช้เครื่องมือขยายคลองรากแบบหมุนต่อเนื่องทิศทางเดียว (Continuous rotary NiTi) และกลุ่มที่ 2 เป็นกลุ่มของนักศึกษาชั้นปีที่ 3 ซึ่งยังไม่เคยเรียนการรักษาคลองรากฟันมาก่อนทั้งในภาคทฤษฎีและภาคปฏิบัติโดยนักศึกษาทันตแพทย์ทั้งชั้นปีที่ 3 และชั้นปีที่ 6 จะถูกสุ่มเลือกตามคะแนนรายวิชากายวิภาคของฟันจาก 3 กลุ่ม ได้แก่กลุ่มคะแนนสูง (กลุ่มที่ 1) กลุ่มคะแนนปานกลาง (กลุ่มที่ 2) และกลุ่มคะแนนต่ำ (กลุ่มที่ 3) จะทำการประเมินความสามารถในการเรียนรู้ในการใช้เครื่องมือของกลุ่มตัวอย่างโดยพิจารณาจากข้อผิดพลาดที่เกิดขึ้นภายหลังการเตรียมคลองรากของฟันกรามใหญ่ซี่แรกด้านล่าง ข้อผิดพลาดนำมาใช้พิจารณา คือ การเปลี่ยนแปลงความโค้งของคลองรากฟัน ขยายคลองรากฟันผิดแนว เกิดขั้นภายในคลองราก ขยายทะลุแนวคลองราก เครื่องมือหักในคลองรากและการควบคุมความยาวของการทำงาน คัดเลือกฟันกรามใหญ่ซี่แรกที่มีรากฟันด้านใกล้กลางความโค้งปานกลางและมีความยาวรากใกล้เคียงกันจำนวน 50 ซี่และสุ่มเป็น 2 กลุ่ม กลุ่มละ 25 ซี่ให้นักศึกษาทันตแพทย์ทั้ง 2 กลุ่ม โดยจะทำการถ่ายภาพรังสีในแนวหน้า-หลังและแนวใกล้-ไกลกลางก่อนทำการทดลองเพื่อใช้ในการเปรียบเทียบผลก่อนและหลังการขยายคลองราก ผลการทดลองพบว่าการขยายคลองรากฟันของทั้ง 2 กลุ่มไม่แตกต่างอย่างมีนัยสำคัญ ความโค้งของคลองรากฟันมีการเปลี่ยนแปลงอย่างมีนัยสำคัญในฟันทุกซี่ แต่ไม่แตกต่างอย่างมีนัยสำคัญใน 2 กลุ่มตัวอย่าง การควบคุมความยาวการทำงานของทั้ง 2 กลุ่มไม่แตกต่างอย่างมีนัยสำคัญ

ไม่พบเครื่องมือหัก ขยายทะลุแนวคลองรากฟันและเกิดขั้นภายในคลองรากฟันของกลุ่มทดลอง จึงสรุปผลการทดลองได้ว่า ความสามารถในการเรียนรู้ในการใช้เครื่องมือเรซิพรอกซ์ (VDWMunich Germany) ของนักศึกษาทันตแพทย์ทั้ง 2 กลุ่มนั้นไม่แตกต่างกัน และเกิดข้อผิดพลาดภายในคลองรากเพียงเล็กน้อยในนักศึกษาทั้ง 2 กลุ่ม

คำสำคัญ: *การควบคุมระยะทำงาน นักศึกษาทันตแพทย์ปริญญาตรี เรซิพรอกซ์ ประสิทธิภาพการเรียนรู้*

Abstract

The aim of this study was to evaluate the learning effectiveness in using the new reciprocating instrument, Reciproc, among the two groups of undergraduate dental students. One group was 6th year dental students who had clinical experiences in root canal treatment on both single and multiple rooted teeth with continuous rotary NiTi system. The other group was 3rd year dental students who had no knowledge in endodontics both theory and laboratory. Both 3rd and 6th year dental students were selected by dental anatomy raw score which classified into 3 levels: High score (group 1), moderate score (group 2), and low score (group 3). The effectiveness in learning how to use the Reciproc (VDWMunich, Germany) was indicated with the minimum errors in preparing a moderate curve canal in human mandibular first molar teeth. The investigated errors were canal transportation, degree of curvature changing, ledging, perforation, instrument separation, and working length control.

Fifty mesial canals of human mandibular, first molar teeth with moderate curved canal, were selected with control apical canal size and root length. Teeth were randomized into 2 groups of 25 teeth among the 3rd and 6th year dental students. Both student groups prepare canals with Reciproc. Controlled pre and post instrumentation radiographs were done in bucco-lingual and mesio-distal views. Superimposition of these radiographs was used to evaluate the canal transportation. Statistical analysis showed no difference in canal transportation among the two student groups. Degree of curvature changed from original curve was found significantly different in all teeth. But the difference of angle changed in 2 groups was not statistically different. Instrument breakage or ledging or perforation was not found. No statistically difference among the 2 groups in working length control. In conclusion, the learning effectiveness in using the new reciprocating instrument among these two groups showed no difference. Both groups were able to use this reciprocating instrument with minimum errors.

Keywords*: Learning effectiveness, Reciproc, Undergraduate dental students*

1. Introduction

Learning and teaching the technique of root canal treatment for dental students remain a major problem for many dental schools worldwide. (Hayes et al. 2001, Dummer 1991, Qualtrough & Dummer 1997, Ungerechts et al. 2014). Ledging, perforation, instrument separation and canal transportation are common procedural errors. These problems are more

common among undergraduate dental students in shaping molar root canals.

Configuration and curvatures of root canals play an important role in causing those procedural errors. The more degree of curvature the more incidence of procedural errors.

In addition, type of instrument also plays an important role in causing errors. Hand stainless steel instrumentation is taught in most dental school. The technique has several drawbacks such as an increased incidence of canal transportation, ledging, perforation and separated instrument (Pettiette et al. 1999, Kfir et al. 2004, Peru et al. 2006). Many techniques were introduced to prevent the problems. Step back technique help preventing apical deviation with small apical preparation and stepping back 1 mm incrementally in the coronal part.(Schilder, 1974) Using the clockwise and counterclockwise motion in a Balanced force technique with a non-cutting tip hand instrument e.g. FlexR file (Union Broach, New York, USA) can enlarge the apical canal width to a 30-40 sizes instrument in a moderate curved canal without canal transportation (Roane et al., 1985). Hand instrumentation require numerous number of instrument use with long learning curve. Students have difficulties in learning and are discouraged after trying at their best but still meet with the unsatisfied post instrumentation canal shape.

Nickel-titanium (NiTi) instrument was introduced in 1988.(Walia et al., 1988) The deviation of apical canal curvature was decreased with the hand NiTi instrumentation(Pettiette et al., 1999) and the success of endodontic treatment increased compare to stainless steel instrument (Pettiette et al., 2001). Further development to continuous rotary NiTi instrumentations increased the shaping ability (Schafer & Schlingemann, 2003), (Sonntag et al., 2007) and the uses are widely accepted. (Parashos & Messer, 2004) It offered many advantages over the hand stainless steel instrumentation due to the flexibility, the cutting efficiency, the design of greater tapering and the cross sectional pattern. 3rd year dental student group were able to prepare curved root canals by rotary instruments with greater preservation of tooth structure, lower risk of procedural errors and much quicker than hand instruments. (Baumann & Roth 1999, Gluskin et al. 2001). The technique had made an impact in endodontic teaching and were widely taught in dental school both undergraduate and graduated level (Arbab-Chirani & Vulcain, 2004).

However, rotary instrumentation was associated with significantly more fractures (Sonntag et al., 2003). Numerous numbers of instruments along with time consuming are required to complete shaping a canal to an optimal size and taper. Students are discouraged and frustrating especially in teeth with complex canal anatomy. Long learning curves are encountered due to the use of numerous numbers of instruments and various techniques to overcome the problems.

Moreover, studies showed that standard sterilization of the used instrument is inadequate (Van Eldik et al., 2004). Further instrument development is aimed to improve cyclic fatigue resistance and prevent cross contamination by single use instrument.

In 2010, Reciproc was introduced as a single use file (Yared, 2008)'to prevent cross contamination and decrease the chance of flexural fatigue(Gavini et al., 2012). The resistance to cyclic fatigue is enhanced with reciprocating motion (Pedulla et al. 2013, Varela-Patino et al. 2010). and the use of M-wire nickel-titanium (Pereira et al., 2013). The angles of rotation are unequal and lower than the angle at which the elastic limit of the instrument. Consequently, torsional stress would be reduced and safety would be enhanced. Previous studies (You et al. 2010, De-Deus et al. 2010). have shown that reciprocation extends the flexural cyclic fatigue life of the tested instrument in comparison with continuous rotation. Reciproc is a single file system that is able to complete a canal preparation with only one file. This decrease an economical burden to the user in using the single use file.

Hand files are not used as a glide path with Reciproc instrumentation in most of the canal shape even a narrow and curved canal (De-Deus et al. , 2013). Therefore, it was expected that the incidence of procedural errors resulting from the use of small hand file in narrow canals will be reduced. Only when the Reciproc instrument meets resistance in a canal that hand file is needed as a glide path. This goes against the current teaching standard of continuous rotary instrumentation which requires a glide path and gradual enlargement of a canal with different sizes and tapered instruments. The benefits are shorter working time, shorter learning curve and simplicity.

The Reciproc instrument is expected to be beneficial for undergraduate students who lack of experiences. With the single file technique, the learning curve will be shortened. The M-wire alloy and reciprocating movement help reducing instrument fracture. Moreover, the flexibility of M-wire and the reciprocating movement will add the ability in maintaining the original canal shape. Ledging and perforation are avoided. Studies to confirm that Reciproc will be beneficial for undergraduate dental students are lacking. And with no evidence based that in which level of undergraduate students that the Reciproc should be introduced. Thus, the purpose of this study was to determine the shaping ability and preparation time among the undergraduate dental students. Learning and teaching root canal preparation for undergraduate dental students are facing problems with the use of hand stainless steel instrumentation and continuous NiTi rotary instrumentation. Main problems are degree of canals curvature, canal transportation, ledging, perforation, loosening working length and instrument separation. In addition, long learning curve are required due to the use of numerous numbers of instrument. Cross contamination is involved with the inadequate clean of the used instrument.

2. Objective

To compare the learning effectiveness of the 3rd and 6th year undergraduate dental students in preparing moderate curved canals with the single file system. The learning effectiveness is indicated by the errors after complete preparation which are canal transportation**,** ledging, perforation, loosening working length and separated instruments.

3. Material and Methods

Teeth selection and preparation: Approval for the study protocol was obtained from the research committee of Rangsit University (ทพ. 1800/826). 50 mandibular molar teeth were selected from a pool of more than 200 teeth. The inclusion criteria were fully formed apices, no apical resorption, no evidence of cracks and no history of endodontic treatment. Teeth were cleaned, disinfected and stored in 10% formalin solution at room temperature. Distal root was cut off to the level of cemento enamel junction to prevent radiographic superimposition on mesial canals (Figure 1).

Figure 1: Distal root was cut off to the level of cemento-enamel junction

Only teeth with moderately curvature 10-20 degree of curvature were included in the experiment. Classification according to Schneider[35]: straight = less than 5 degree, moderate = 10–20 degree, severe = 25-70 degree.

Angle of curvatures were determined according to Luiten (Luiten et al., 1995). The midpoint of line drawn across the canal orifice and 2 mm apical to the orifice intersected a line drawn parallel to the apical 1 mm of the canal. The resulting angle defined the curvature of the canal. (Figure 2).

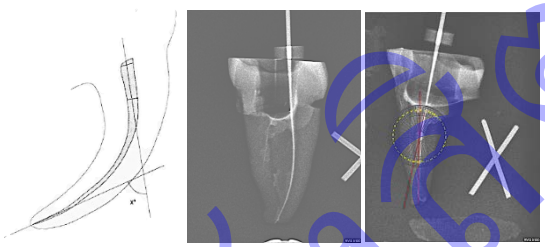

Figure 2: Determination of canal curvature according to Luiten (Luiten et al., 1995) (left). Measuring the curvature in the radiograph bucco-lingual (middle) and mesio-distal view (right) with the metal cross as guideline for accuracy in superimposition.

Endodontic access was prepared. Mesiobuccal (MB) and mesiolingual (ML) canals were negotiated using a size 10/02 K-File (VDWMunich Germany) passively with 5.25% sodium hypochlorite (NaOCl) as a lubricant and pulp tissue dissolvent. Each canal only allows the 10/02 hand file negotiating to the foramen passively but not loosely. The canals that were not able to insert 10/02 K-file or fit loosely were not selected. This will allow the samples to be comparable in apical canal width.

Under the dental operating microscope (Carl Zeiss, Göttingen, Germany) at 20x magnification, the 10/02 negotiating file was inserted until the tip was just visible and tangent to the apical foramen. The rubber stop was moved to the reference point, the file was withdrawn and the canal length was measured under the DOM at 5x magnification. Working length was determined by subtracting 1 mm. from the apical foramen. The selected canals were in the range of working length from 15-21 mm. Contrast media (Telebrix,Guerbet, France) were injected in selected

canals. Pre-instrumentation digital radiograph were taken in 2 views: mesio-distal and bucco-lingual with 10/02 instrument in the canals to enhance the contrast of canal configuration. In bucco-lingual view the x-ray tube was 50 degree shifted until the apical 1/3 were able to evaluate the curvature and canals transportation after preparation. (Figure 3)

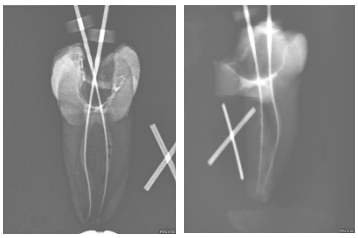

Figure 3: Pre-instrumentation digital radiograph of the mesio-buccal and mesio-lingual canal after injected contrast media and with instrument size 10/02 to enhance the contrast of canal configuration for better evaluation transportation and canal curvature. Bucco-lingual view on left and mesio-distal view on right.

Selected canals were those with mesio-buccal and mesio lingual canals that were separated from the orifice to the apical foramen. In case of canals joined at the foramen, only one canal was selected. (Figure 4)

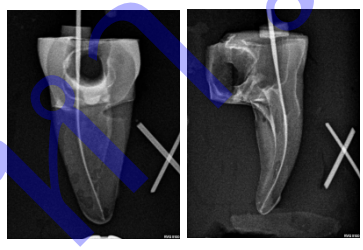

Figure 4: Only one canal was selected In case of mesio-buccal and mesiolingual canals joined at the foramen.

Teeth were embedded in silicone jig (Panasil, German) to serve as a guideline in positioning the post instrumentation teeth in the same position as the pre instrumentation and thus be able to evaluate the canal transportation by superimpositioning. (Figure 5)

The tube angulation was controlled by the custom made platform with a definite angulation from a protractor. (Figure 6)

Figure 5: Teeth embedded in silicon jig and aligned with the definite angle to the X-ray tube. All position were fixed to obtain the correct superimpositioning of the pre and post instrumentation.

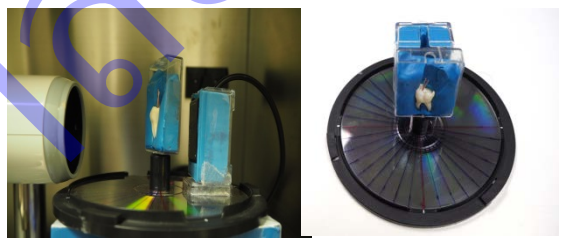

Figure 6: The tube angulation was controlled by the custom made platform with a definite angulation from a protractor.

Students Preparation: The inclusion criteria for the 3rd year dental students were those who had no experience in endodontic. Dental anatomy scores were used to randomize the 3rd year dental student subjects since there were no other score that related to skill performance for this group.

On the others hand, the inclusion criteria for the 6th year dental students were those who at least achieved minimum requirement as assigned by the endodontic department of Rangsit University. Dental anatomy scores were also used to randomize the 6th

year dental student subjects to be comparable with the 3rd year dental student.

Students from each year were divided into 3 levels according to their dental anatomy raw scores: High score (group 1), moderate score (group 2), low score in (group3).

Random samplings were taken from the divided group. Students were randomly selected from each score levels from each year. The total amounts of students from each year were 26.

Student instructions: All students were instructed how to perform Reciproc instrumentation according to the manufacturer instruction. The instruction was done by the only one instructor and all students. The Reciproc instrumentation will be followed immediately. Students were allowed to practice in any two molar teeth before instrumentation in the experiment teeth. The 3rd and 6th year dental student instrumented the same tooth. MB and ML were divided to let the students having chances to prepare in MB and ML at the same number.

Reciproc instrumentation: Each sample groups were operated with Reciproc file R25 in a reciprocating motion powered by a torque-limited electric motor (Silver Reciproc; VDW) at 10 reciprocating cycles per second. The root canal was flushed with normal saline solution using a 30-gauge needle that was inserted 2-3 mm above the working length. The instruments were used in a slow in-and-out pecking motion with amplitude of about 3 mm The flutes of the instruments were cleaned after three in-and-out movements (pecks) with damped gauze. Apical patency was maintained using a size 10/02 K-file to ensure the canals were free of debris. The mechanical instrumentation was continued until reaching the working length.

Learning effectiveness indicated by the following procedural errors

A. Instrument separation
B. Ledging or perforation
C. Canal transportation

Superimposition the pre and post instrumentation radiographs. The root canal margins were highlighted with a computed program (Adobe photoshop CC). No transportation was indicated when the post instrumentation radiograph cover the pre instrumentation completely. (Figure 7)

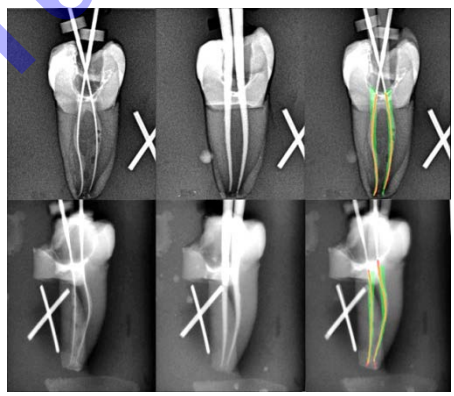

Figure 7: Left column showed the pre-instrumentation. Middle column showed the post-instrumentation. Right column showed the superimposition: green was the post instrumentation canal while red is the pre instrumentation canal. No transportation was indicated when the green area covered all red area and vice versa.

D. Degree of curvature changed

Measuring pre and post instrumentation curvature according to Luiten (Luiten et al., 1995). Differences of angle were evaluated.

E. Working length control

Evaluation the working length control with gutta percha cone 25/08 which is the same size as Reciproc R25 that were used in preparing the experiment teeth.

a) Good control = at working length (1 mm from apical foramen)

b) Accepted control = extended apically not more than 0.5 mm over the working length (0.5 mm from apical foramen) Or shorter than the working length not more than 1 mm (maximum of 2 mm. from apical foramen)

c) Poor control = Tangent to the foramen or protruding over the foramen or shorter than the working length more than 1 mm

Data analysis: Data analyzed with SPSS 23.0 (SPSS, Inc., Chicago, IL, USA) the differences in the degree of curvature among the 2 groups were analyzed with Kolmogorov-Smirnov to ensure normal distribution. Secondly, the collected data were then analyzed with independent T test. The number of post instrumentation canals with different level of working length were analyzed with Chi square test. A P-value < 0.05 was considered statistically significant.

4. Result

A. Instrumentation separation: not found

B. Ledging or perforation: not found

C: Canal transportation: not found

D: Degree of curvature changing

The mean degree of curvature changing was 1.148 in the 3rd year student group and 1.327 in the 6th year students group. The degree of curvature changing in 2 groups were normally distribute. Data analysis with independent T-test. The degree of curvature changed was statistically significantly within the group in both group (P > 0.05). But no statistically significant difference between the 2 group (P > 0.05) (Figure 8)

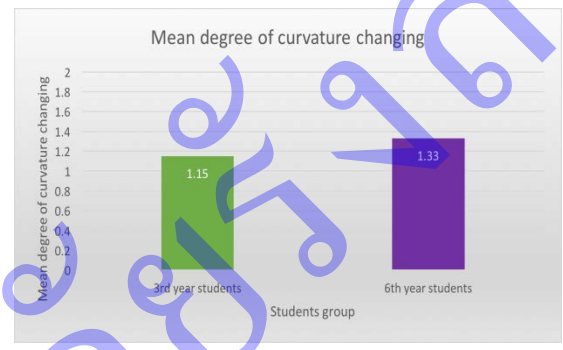

Figure 8: Differences of mean degree of curvature changed among the 3rd and 6th year dental students groups.

E: Working Length Control: The number of root canal with good, accepted and poor control were 7, 9, 9 in the 3rd year dental students group and 6, 11, 8 in the 6th year dental students group. Data analysis with chi square found no statistically significant differences within the group (P > 0.05) and between the 2 groups. (Figure 9)

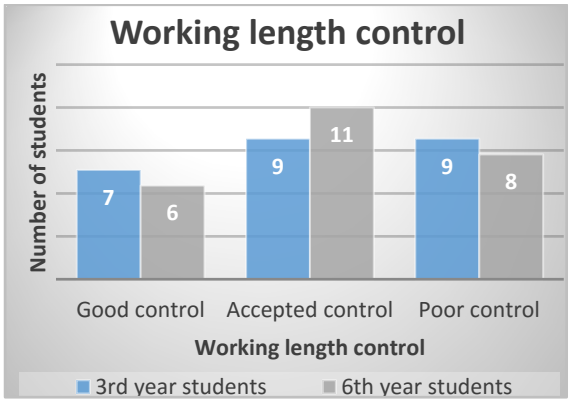

Figure 9: Number of canals with different level of post instrumentation working length among the 3rd and 6th year dental soudent group.

The 3rd and 6th year dental students are classified by grade level were able to control working length with no statistically significant difference (P > 0.05).(Figure 10, 11)

Figure 10: Working length control of 3rd year dental student with different grade level.

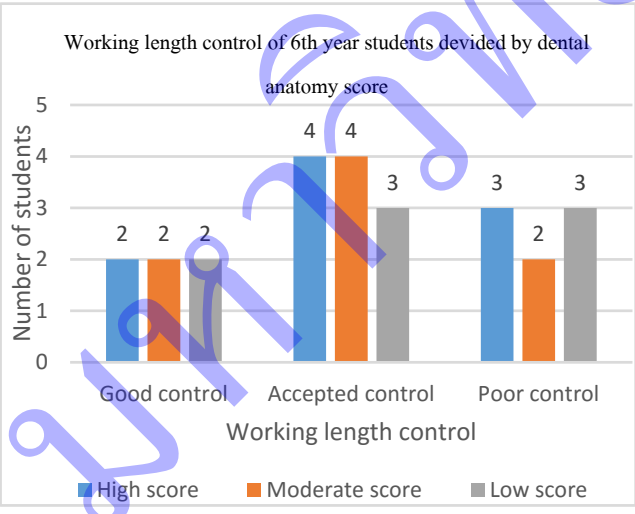

Figure 11: Working length control of 6th year dental student with different grade level.

5. Discussion

In the present study, the null hypothesis was accepted. There was no differences in learning effectiveness in using the reciprocating instrument. The 2 groups complete the preparation with no canal transportation. This is in accordance with balanced forced technique which is able to maintain the original canal shape when preparing moderate curved canals. With the M-wire nickel titanium that gave more flexibility to the instruments, the chance of maintaining the canal shape is increased. The use of the single file system keeps the learning curve to minimum and leads to an easy and simple technique. The 3rd year dental student who has never use any handpiece were also able to prepare canals with no errors. This technique does not need glide path so the errors due to hand instrumentation was avoided.

It is important to highlight that there was no evidence of instrument fracture among the 2 groups. The counterclockwise movement of the reciprocation play an important role in preventing fracture even without a glide path. In addition, the motor was set to the cycle that will never over the elastic limit of the instrument. And all preparation was done with new instrument that chance of flexural fatigue was less. During the experiment the only one instructor supervised at all times one by one, the process was controlled to be correct.

Canal transportation can be evaluated by many methods such as root sectioning, CBCT (Nazarimoghadam et al., 2014). Pre and post-operative radiographs superimposition (Pettiette et al., 2001),(Saber et al., 2015) was used in this study. Since

this research was done by undergraduate dental students with limitations of resources. Evaluation method gained accuracy from control radiograph technique. With the use of contrast media, it remarkably help visualize root canal

Luiten technique (Luiten et al., 1995) was used to measure the degree of root canal curvature due to the more definite position at the canal orifices and at the apex than Pruett and Schneider which use the beginning of canal curvature as a reference point.

The limitations of this study included the randomized selection of inexperienced groups based on their dental anatomy. There was a problem in the relationship between handskills in dental anatomy and endodontics because dental anatomy hand skill could not represent their skill in endodontics but dental anatomy is the only subject that 3rd year dental student have learned to represent their hand skill.

The result of the present study (Thongsuphan & Mochadaporn, 2013) was in accordance with the result of the previous study on the use of continuous NiTi rotary instrument (M-Two) among the 3rd year and 6th year dental students, in which there were no significant differences in canal transportation. This may confirm that using rotary instrumentation in the undergraduate level is safe. With single instrument system, the learning curve is decreased with an acceptable outcome of instrumentation, students may be more encouraged in learning.

6. Conclusion

As a result of this study, instrumentation with single reciprocating instrument and with no glide path in a moderately curved canal by undergraduate students can avoid canal transportation, instrument separation, ledging, perforation and losing working length. However, further study should include more pattern of canal configuration that are commonly found such as apical irregularities that may need more skill in hand instrumentation. A more evaluation technique such as 3D CT scan is also needed. However, this study is useful as baseline information in considering the possible of using this instrument among undergraduate student.

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8. Reference

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