**Original Research**

### Frequency of Post-Instrumentation Symptoms Using Hand Files Versus Rotary Protapers

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**Article information**

Received: April 28th, 2018; Revised: June 8th, 2018; Accepted: June 28th, 2018; Published: June 29th, 2018

**Cite this article**

Mirza AJ, Nazir M, Javaid MA, Shafiq MK, Moosa R. Frequency of post-instrumentation symptoms using hand files versus rotary protapers. Dent Open J. 2018; 5(1): 23-29. doi: 10.17140/DOJ-5-138

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**Abstract**

**Introduction**

Controversy among dentists exists to use conventional hand files or contemporary rotary protapers for intracanal instrumentation. The controversy arose because of variable findings on post-instrumentation pain felt by the under treatment patient that acts as a deterrent to receive further endodontic treatment. This study has been planned to assess post-instrumentation pain, swelling, tenderness or redness using the hand files and rotary protapers in a confined environment where rubber dam is not used for operative field isolation from oral fluids.

**Material and Methods**

One hundred and sixty vital and non-vital teeth were root treated. The subjects were randomly divided into two groups. “Group A” was treated using hand files with step-back technique and “Group B” with rotary protapers. All the root therapies were accomplished in two or multiple visits depending on the satisfactory disinfection of the canal. Access to pulp chambers was obtained using sterile bur without rubber dam isolation and the preparation in either group was performed under normal saline irrigation. Drying of canal was obtained using paper points followed by cotton and temporary packing to ensure tight leak proof coronal seal and the subjects were recalled on subsequent day.

**Results**

Results revealed that the highest symptomatic adversity was faced by n=40 subjects with non-vital pulps after hand filing. Least frequent symptomatic complaints were made by the group with vital pulps and were treated by rotary protapers. In vital teeth, pain was reported more in hand filed teeth than in teeth that were treated with protapers. Non-vital teeth showed a similar pattern with greater number of complaints about pain in both hand filed and protaper subjects.

**Conclusion**

Rotary protapers induced less post-instrumentation symptoms than hand files in vital as well as non-vital teeth.

**Keywords**

Efficacy of hand files versus rotary files; Endodontic flare-up; Protapers versus hand file.

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INTRODUCTION

Dental clinicians in routine endodontic practices often encounter patients’ complaint of pain, swelling and tenderness on biting or redness in buccal sulcus after root canal instrumentation which may start a few hours after treatment and is always an unpleasant and disappointing incident for both the dentist and patient. The frequency of post-operative symptoms has been stated to occur in over 50% of patients undergoing root canal therapy. This frustrating happening known as “flare-up” occurs due to development of acute inflammation at the periapex in reaction to increased intensity of injury from the root canal system. Multiple studies have found link between an intracanal instrumentation technique and post-operative pain.

Intracanal instrumentation for debridement and disinfection of the canal is performed using either of the two instrumentation approaches; starting from tip of the root with fine instruments and work back up the canal with gradually larger instrument known as the “step-back” technique. Hand “K” files are commonly used for accomplishing an endodontic procedure with step-back technique. Alternative way of canal instrumentation is starting from the canal orifice situated in the pulp chamber with larger instruments and gradually progressing toward the apex with finer instruments the “crown-down” technique. The Protaper system has been developed keeping latter technique in view with progressively variable tapers of each instrument.

Regarding post-instrumentation pain following either of the two techniques, controversy exists among practicing dentists worldwide. Many clinicians prefer rotary protapers as they possess better canal cleaning efficacy than manual “K” files and create more regular root canal tapers. A recently published study shows that preparation with rotary instruments produces less anguish than preparation done with manual instruments.

Many investigators believe that protapers cause more post-instrumentation symptoms as they push more debris and bacteria towards periapical region. In contrast, many researchers found that hand filing poses more post-instrumentation problems for the patients. One of such studies reported that hand instrumentation in non-vital teeth results in apical extrusion of canal contents causing post-operative pain and swelling. In an Iranian study, researchers proved hand files superior to use for canal debridement as they found that preparation of apical and middle two-thirds was similar with the rotary and hand files but preparation of coronal third was better prepared with hand files. Researchers in another study used RaCe rotary system and hand K-Flexofile for canal preparation. Their findings revealed no significant difference in post operative flare-up between the two preparation techniques.

The high variability in the findings of existing studies creates confusion in the minds of general dental practitioners who carry out regular endodontic procedures in their practices. The dentists who graduated at the time when hand instruments and step-back technique were the lone option available to them for root canal preparation remain bewildered between choosing hand files or protapers rotary system for the purpose and widely continue using hand files. They probably consider hand files safer than rotary protapers and brood over many times to use latter with the fear of post-instrumentation pain and other symptoms. Keeping these senior dentists’ mental perplexity in view, this study was therefore, planned to be conducted in local environment where rubber dam is uncommon with an objective to assess frequency of post-instrumentation flare-up using manual files and rotary protapers.

MATERIAL AND METHODS

After approval from ethical committee of the institution, one hundred and sixty teeth with vital and non-vital pulp were endodontically treated. Patients fulfilling the inclusion criteria were selected. The inclusion criteria included the patients of either sex of 20-50 years of age needing root canal treatment (RCT) having no radiographic periapical lesion. The list of exclusion criteria was a bit strict including; patients who refused to give written consent to participate in the study, patients taking antibiotics, patients who missed appointment on the subsequent day after chamber opening and canal instrumentation, patients with periodontally involved teeth, patients with teeth having fine curves, open apices, calcific metamorphosis or requiring endodontic retreatment and medically compromised patients.

All the participants were clinically examined and detailed medical history including history of taking any antibiotics within six weeks of the RCT procedure performed was recorded. Thermal tests were performed to categorize the vital and non-vital pulp status. Intraoral radiographs of the under treatment teeth were obtained to exclude the teeth with extra root curvatures, open apices, canal calcifications, apical radiolucencies or periodontal involvement.

The subjects of the study were randomly divided into two groups. The subjects in “Group A” were treated using NiTi “K” files (Mailoey-Union Broach Co. York, PA 17402, USA) with conventional step-back technique following the method mentioned by Mullaney and “Group B” subjects were treated using rotary protapers (Maillefer, Dentsply, Switzerland).

All the root canal treatments were accomplished in at least two or multiple visits depending on the satisfactory disinfection of the canal. Intracanal instrumentation was performed by single operator to eliminate any procedural discrepancy. Access to pulp chambers was obtained using sterile tungsten carbide bur without rubber dam isolation. Local anesthesia was injected wherever required. Root canal preparation in either group was performed under copious irrigation with normal saline. Drying of canal was obtained using appropriate sized absorbent paper points (Maillefer, Dentsply, Switzerland) followed by cotton pack and “Cavit G” (3M ESPE,AG, Germany) packing to ensure tight leak proof coronal seal.

Each subject was recalled on the subsequent day after his/her canal preparation and was clinically examined for any pain,
swelling, tenderness or redness in the treated tooth. Need of taking any analgesic at home after the last visit was reported as “Post- Instrumentation pain”.

RESULTS

A total of 160 participants took part in this study out of which six subjects were unable to partake in the follow-up assessment. Results revealed that the highest symptomatic adversity was faced by the n=40 subjects with non-vital pulps after hand filing was performed on them. Contrarily, least frequent symptomatic complaints were made by the group that possessed vital pulps and were treated by machine driven protapers. Table 1 shows a descriptive overview of the results that were obtained in regards to the treatment performed and the vitality of the pulp in the tooth treated.

| Table 1. Results in Vital and Non-Vital Teeth After Hand Filing and After Treating with Protapers |
|---------------------------------------------------------------|
| **Vital Pulp** | Preparation with hand files n=39 | Preparation with protapers n=37 |
| Positive Response | Negative Response | Positive Response | Negative Response |
| Pain | 10 | 29 | 2 | 35 |
| Swelling | 3 | 36 | 1 | 36 |
| Tenderness to palpation | 9 | 30 | 1 | 36 |
| Tenderness to percussion | 12 | 27 | 4 | 33 |
| Redness in sulcus | 4 | 35 | 1 | 36 |
| **Non-Vital Pulp** | Preparation with hand files n=40 | Preparation with protapers n=38 |
| Positive Response | Negative Response | Positive Response | Negative Response |
| Pain | 14 | 26 | 6 | 32 |
| Swelling | 18 | 22 | 8 | 30 |
| Tenderness to palpation | 18 | 22 | 12 | 26 |
| Tenderness to percussion | 21 | 19 | 14 | 24 |
| Redness in sulcus | 16 | 24 | 10 | 28 |

In vital teeth, pain was reported more in hand filed teeth than in teeth that were treated with protapers. Non-vital teeth showed a similar pattern with greater number of patient complaints about pain in both hand filed and protapers subjects. The latter however, showed a significant number of participants with complaints compared to all other patients involved in the study. Furthermore, pain in non-vital teeth after protapers in comparison to pain in non-vital teeth after hand filing showed a significant difference p=0.003. Also, significant results were achieved (p=0.025) when pain in non-vital teeth was compared with pain in vital teeth after hand filing. Treatment with protapers usually yielded a lower level of pain experienced in both vital and non-vital pulps.

The presence of swelling was another clinical variable used in this study. Patients with non-vital pulps reported greatest degrees of swelling. Hand filed teeth that were non-vital showed the greatest number of complainants. Swelling in vital teeth after protapers compared to swelling after hand filing showed a significance of p=0.157. Also, swelling in non-vital pulps after treatment with protapers in comparison to swelling in non-vital teeth after hand filing (p=0.002) was significantly pronounced.

When tenderness to palpation and percussion were analyzed, the results showed a similar trend with non-vital teeth producing the most tenderness to both the mentioned entities. Tenderness to palpation was lower in all four groups under scrutiny as compared to tenderness to percussion. Hand filed cases produced the most adverse results when non-vital pulps were involved in the treatment. So much so that when tenderness to percussion in non-vital teeth after hand filing was compared to tenderness to percussion in vital teeth after the same procedure, statistical analysis proved a high level of significance p=0.003. Figure 1 shows a percentage stacked chart for the results obtained in the tenderness to percussion field after hand filing was performed on them.

Redness in the sulcus was the final parameter assessed and showed a 4 times greater value between vital and non-vital teeth respectively. The greatest number of participants that experienced this symptom were the ones with non-vital pulps. A significance of p=0.014 was produced statistically when redness in non-vital teeth after protapers usage was compared with redness in non-vital teeth after hand filing. Figure 2 shows a descriptive graphical analy-
The findings of this study reveal that patients either had swelling, redness in buccal sulcus, tenderness on percussion and palpation are the impediments associated with a RCT procedure. Eruption of post-instrumentation symptoms including pain, swelling, tenderness or redness. This finding matches with a study which reported that hand filing using step-back technique results in pushing of canal content in teeth with non-vital pulps into periapex and causes post-operative symptoms. Matching results were found in two other studies which reported that vital teeth develop less post-instrumentation symptoms than non-vital teeth. A Turkish study contradicts this finding with the conclusion that pulp status doesn’t affect the post-instrumentation level of pain.

The reason for this contradiction may be the use of Ca(OH)$_2$ as an interappointment medicament used by the investigator in that study. Many logical reasons however, may be given for superior functionality of rotary protapors over manual files. The protapors are developed to clean a canal with crown-down technique which involves early coronal flaring. The early flaring of a canal improves instrument control during apical instrumentation of the canal and thus crown-down technique is found to extrude less debris apically compared to the step-back filing. One more reason for superiority of protapors may be linked with less apical transportation and less dentin cutting than with the manual files. Contrarily, one report shows that change in cross-section area at 2 and 3 mm from the apex was significantly greater with manual NiTi K-file as compared to rotary Protaper.

Inability of the hand files to perfectly debride apical 1/3 of the under-preparation canal may be one reason for inferior manual file function. A study was done to assess of the apical root canal cleaning efficacy of various hand instrument techniques showed that the apical portion of the canal was less clean than the middle and coronal portions regardless of the technique employed. Result of another such study in which five canal instrumentation techniques were employed indicated that although all of them effectively removed major chunk of debris from the canals but none could clean the entire root canal system.

Apical extrusion of debris and bacteria through the foramen is also linked to post-instrumentation symptoms. It generates periodontal inflammation with higher neuropeptide concentration which consequently promotes peripheral sensitization characterized as hyperalgesia and occurrence of impulsive pain in the tooth. Reports of two relevant studies showed that manual “K” files apically pushed significantly greater amount of irrigating solution, bacteria and debris as compared to rotary protapors. The reason for more apical extrusion with hand files may be associated to their filing action which acts as a piston and tends to push the debris through the foramen as less space is available to escape coronally. Moreover, findings of two other studies on the same issue have proved that the healing diminishes when infected dentin is pushed down to the periapical area while using hand files that
might be a cause of post-instrumentation pain and swelling.

Time taken for canal preparation with instruments is another key factor which may cause more discomfort after hand filing as manual preparation of canal takes longer time than rotary protapers.42-44

In this study, all the root canal procedures were performed under cotton roll isolation as the majority of general dental practitioners in this part of the world, carry out most of the restorative and endodontic procedures without rubber dam.45,46 This is not very unusual in other countries despite its known benefits. A study done on the issue of usage of rubber dam during root treatment cited many studies which found that rubber dam use by general practitioners is either not very encouragingly or disappointingly low.47 A UK based study also found that 63% of its respondents never used a rubber dam during endodontic treatment.48 Another survey done in Czechoslovakia, reveals that merely 8% of the general practicing dentists use rubber dam while performing RCT.49

NaOCl in concentration of 2.6%-5.25% is considered as most effective and potent irrigant for under preparation root canals50 but in higher concentrations above 0.5%, due to its toxicity and bad taste, its use become impracticable in situations where rubber dam isolation is not performed. As an alternate, abundant amount of normal saline was used as an irrigation solution during all the canal preparation.

CONCLUSION

The findings of this study within its limitations are indicative of better performance of rotary protapers than hand files even in situations where rubber dam is not used. For general dental practitioners, using protapers is better option as fear of inadvertent slipping of a hand file from the fingers doesn’t arise and time consumed is far less.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Alonso-Ezpeleta LO, Gasco-Garcia C, Castellanos-Cosano L, Martín-González J, López-Frías FJ, Segura-Egea JJ. Postoperative pain after one-visit root-canal treatment on teeth with vital pulps: Comparison of three different obturation techniques. Med Oral Patol Oral Cir Bucal. 2012; 17(4): c721-c727.

2. Levin I, Amit A, Ashkenazi M. Post-operative pain and use of analgesic agents following various dental procedures. Am J Dent. 2006; 19(4): 245-247.

3. Oginni A, Udoye CI. Endodontic flare-ups: comparison of incidence between single and multiple visits procedures in patients attending a Nigerian teaching hospital. Osun Journal Trop. 2004; 27(108): 23-27.

4. Sipavičiūtė E, Manelienė R. Pain and flare-up after endodontic treatment procedures. Stomatologija. 2014; 16(1): 25-30.

5. Goreva LA, Petrikas AZh. Postobturation pain associated with endodontic treatment. Stomatologija (Mask). 2004; 83: 14-16.

6. Makeeva IM, Turkina Alu. Effects of the method of mechanical root canal treatment on emergence of pain after endodontic management. Stomatologija (Mask). 2005; 84: 21-23.

7. Jayakodi H, Kailasam S, Kumaravadivel K, Thangavelu B, Mathew S. Clinical and pharmacological management of endodontic flare-up. J Pharm Bioallied Sci. 2012; 4(2): 294-298. doi: 10.4103/0975-7406.100277

8. Kumar S, Sengupta J. Endodontic treatment for mandibular molars using ProTaper. Med J Armed Forces India. 2011; 67(4): 377-379. doi: 10.1016/S0377-1237(11)60091-9

9. Prasad M, Mujawar SAV. Evaluation of the efficacy of rotary vs. hand files in root canal preparation of primary teeth in vitro using CBC. Eur Arch Paediatr Dent. 2014; 15(2): 113-120. doi: 10.1007/s40368-013-0072-1

10. Guelzow A, Stamm O, Marcus P, Kielbassa AM. Comparative study of six rotary nickel-titanium systems and hand instrumentation for root canal preparation. Int Endod J. 2005; 38(10): 743-752.

11. Shokrané A, Ajami M, Farhadi N, Hosseini M, Rohani B. Postoperative endodontic pain of three different instrumentation techniques in asymptomatic necrotic mandibular molars with periapical lesion: A prospective, randomized, double-blind clinical trial. Clin Oral Investig. 2017; 21(1): 413-418. doi: 10.1007/s00784-016-1807-2

12. Bürklein S, Schäfer E. Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. J Endod. 2012; 38: 850-852. doi: 10.1016/j.joen.2012.02.017

13. Ferraz CC, Gomes NV, Gomes BP, Zaia AA, Teixeira FB, Souza-Filho FJ. Apical extrusion of debris and irrigants using two hand and three engine-driven instrumentation techniques. Int Endod J. 2001; 34(5): 354-358.

14. Nair PN, Henry S, Cano V, Vera J. Microbial status of apical root canal system of human mandibular first molars with primary apical periodontitis after “one-visit” endodontic treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005; 99(2): 231-252. doi: 10.1016/j.tripleo.2004.10.005

15. Fairbourn DR, McWalter GM, Montgomery S. The effect of four preparation techniques on the amount of apically extruded debris. J Endod. 1987; 13: 102-108. doi: 10.1016/S0099-2399(87)80174-7

16. Moghaddam KN, Mehran M, Zadeh HF. Root canal cleaning efficacy of rotary and hand files instrumentation in primary molars. Iran Endod J. 2009; 4(2): 53-57.
17. Talebzadeh B, Nezafati S, Rahimi S, et al. Comparison of manual and rotary instrumentation on postoperative pain in teeth with asymptomatic irreversible pulpitis: A randomized clinical trial. Iran Endod J. 2016; 11(4): 273-279. doi: 10.22037/iej.2016.4

18. Leonardo Rde T, Puente CG, Jaime A, Jent C. Mechanized instrumentation of root canals oscillating systems. J Contemp Dent Pract. 2013; 14(1): 149-152.

19. Ingle J. Endodontics. 5th ed. Hamilton, Canada: BC Decker Inc; 2008: 525-530.

20. Kalhoro FA, Mirza AJ. A study of flare-ups following single-visit root canal treatment in endodontic patients. J College of Physicians and Surgeons Pakistan. 2009, 19 (7): 410-412. doi: 07.2009/JCPSP.410412

21. AF de Baja. Incidence and severity of post-operative pain following root canal treatment of teeth with non-vital pulps using hand and rotary instrumentation techniques. Website. www.endoexperience.com/documents/post-op-pain-inst-tech.pdf. Accessed on March 6, 2018.

22. Wang C, Xu P, Ren L, Dong G, Ye L. Comparison of post-obturation pain experience following one-visit and two-visit root canal treatment on teeth with vital pulps: A randomized controlled trial. Int Endod J. 2010; 43(8): 692-697. doi: 10.1111/j.1365-2591.2010.01748.x

23. Ida DNDA, Rahul W, Marina F. The Quality of Canal Preparation Using Stainless Steel Hand Files and Nickel-Titanium Rotary Instruments. Website. www.google.com.pk/search?q=The+Quality+of+Canal+Preparation+Using+Stainless+Steel+Hand+Files+and+Nickel-Titanium+Rotary+Instruments. Accessed on March 8, 2018.

24. Wei X, Lin Z, Peng S. The effect of root canal preparation with nickel-titanium rotary instruments in reducing post-operative pain. J Endod. 2008; 34(7): 855-858. doi: 10.1016/j.jendod.2007.11.041

25. Arias A, Macorra JC de la, Azabal M, Hidalgo JJ, Peters OA. West China J Stomatol. 2003; 21: 202-204.

26. Portenier I, Lutz F, Barbakow F. Preparation of the apical part of the root canal by the Lightspeed and step-back technique. Int Endod J. 1998; 31: 103-111.

27. Farzana F, Hossain SMI, Islam SMN, Rahman MA. Postoperative pain following multi-visit root canal treatment in endodontic patients. J Endod. 2008; 34(7): 855-858. doi: 10.1016/j.jendod.2007.11.041

28. Saumya-Rajesh P, Krithikadatta J, Velmurugan N, Sooriarakas C. Postinstrumentation pain after the use of either Mtwo or the SAF system: A randomized controlled clinical trial. Int Endod J. 2017; 50(8): 750-760. doi: 10.1111/iej.12702

29. Keskin C, Demiryurek EO, Ozyurek T. Postoperative pain after single-versus-multiple visit root canal treatment in teeth with vital or non-vital pulps in a turkish population. Asian Journal of Scientific Research. 2015; 8: 413-420. doi: 10.3923/ajsr.2015.413.420

30. Goëric AC, Michielch RJ, Schultz HH. Instrumentation of root canals in molars using the step-down technique. J Endod. 1982; 8: 550-554. doi: 10.1016/S0099-2399(82)80015-0

31. Ruiz-Hubbard EE, Gutmann JL, Wagner MJ. A quantitative assessment of canal debris forced periapically during root canal instrumentation using two different techniques. J Endod. 1987; 13: 554-558. doi: 10.1016/S0099-2399(87)80004-3

32. Ingle J. Endodontics. 5th ed. Hamilton, Canada: BC Decker Inc; 2008: 525-530.

33. Kakar S, Dhingra A, Sharma H. Shaping potential of manual NiTi K-File and rotary ProTaper and analyzing the final outcome of shaped canals using CT. J Contemp Dent Pract. 2013; 14(3): 451-455.

34. Wu MK, Wesselink PR. Efficacy of three techniques in cleaning the apical portion of curved root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1995; 79 (4): 492-496.

35. Siqueira JF, Araújo MCP, Garcia PF, Fragal RC, Saboia Dantas CJ. Histological evaluation of the effectiveness of five instrumentation techniques for cleaning the apical third of root canals. J Endod. 1997; 23(8): 499-502. doi: 10.1016/S0099-2399(97)80309-3

36. Nakamura-Craig M, Smith TW. Substance P and peripheral inflammatory hyperalgesia. Pain. 1989; 38: 91-98.

37. Kalra P, Rao A, Suman E, Shenoy R, Baranya-Shrikrishna S. Evaluation of conventional, protaper hand and protaper rotary instrumentation system for apical extrusion of debris, irrigants and bacteria- An in vitro randomized trial. J Clin Exp Dent. 2017; 9(2): e254-e258. doi: 10.4317/jced.53340

38. Kazuo K, Akpinar KE, Sumer Z, Er K, Bek B. Apical extrusion of intracanal bacteria following use of various instrumentation techniques. Int Endod J. 2008; 41(12): 1066-1071. doi: 10.1111/j.1365-2591.2008.01470.x

39. Madhusudhana K, Mathew VB, Reddy NM. Apical extrusion of debris and irrigants using hand and three rotary instrumentation systems - an in vitro study. Contemp Clin Dent. 2010; 1: 234-236. doi: 10.4103/0976-237X.76390

40. Walton R, Fouad A. Endodontic interappointment flare-ups: A prospective study of incidence and related factors. J Endod. 1992; 18: 172-177. doi: 10.1016/S0099-2399(06)81413-5

41. Houck V, Reader A, Beck M, Nist R, Weaver J. Effect of tre-
phination on postoperative pain and swelling in symptomatic necrotic teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 90: 507-513.

42. Silva LA, Leonardo MR, Nelson-Filho P, Tanomaru JM. Comparison of rotary and manual instrumentation techniques on cleaning capacity and instrumentation time in deciduous molars. J Dent Child (Chic). 2004; 71(1): 45-47.

43. Azar MR, Mokhtare M. Rotary Mtwo system versus manual K-file instruments: Efficacy in preparing primary and permanent molar root canals. Indian J Dent Res. 2011; 22(2): 363. doi: 10.4103/0970-9290.84283

44. Reddy N, Admala SR, Dinapadu S, Pasari S, Reddy MP, Rao MS. Comparative analysis of efficacy and cleaning ability of hand and rotary devices for gutta-percha removal in root canal retreatment: an in vitro study. J Contemp Dent Pract. 2013; 14(4): 635-643.

45. Mirza AJ, Javaid MA, Asghar S, Siddiqui AA, Berkathullah M. Rubber Dam: Is it a popular method of field isolation among dentists in karachi?. Annals ASH KMe&D. 2017; 22: 81-86.

46. Mirza AJ, Aljanakh M, Javaid MA, Siddiqui AA, Asghar S. Rubber dam placement: why majority of senior dentists practicing in Ha’il, Saudi Arabia ignore it?. Baqai J Health Sci. 2017; 20(1): 1-6.

47. Anabtawi MF, Gilbert GH, Bauer MR, et al. Rubber dam use during root canal treatment: findings from The Dental Practice-Based Research Network. J Am Dent Assoc. 2013; 144(2): 179-186.

48. Palmer NO, Ahmed M, Grieveson B. An investigation of current endodontic practice and training needs in primary care in the north west of England. Brit Dent J. 2009; 206(11): 584-585. doi: 10.1038/sj.bdj.2009.473

49. Kapitán M, Sustová Z. The use of rubber dam among Czech dental practitioners. Acta Medica (Hradec Kralove). 2011; 54(4): 144-148.

50. Kandil HE, Labib AH, Alhadainy HA. Effect of different irrigant solutions on microhardness and smear layer removal of root canal dentin. Tanta Dental J. 2014; 11(1): 1-11. doi: 10.1016/j.tdj.2014.03.001