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Review Article

Efficacy of different files in removing filling material from the root canals: A comprehensive review

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ABSTRACT:
The goal of endodontic treatment is the eradication of harmful microorganisms from the root canal. Thus, cleaning and shaping are key for the success of endodontic treatment. However, the anatomical complexities of the root canal system and limitations in current preparation and irrigation techniques lower the success rates for endodontic treatment. Studies concerning the morphology of the root canal system have shown wide variances in the canal shape and the presence of two or more canals in a single root. Furthermore, complete disinfection in the presence of several curvatures and narrow canals is difficult to achieve by all known techniques, whether chemical or mechanical. Consequently, the reported success rate for root canal treatment (RCT) is approximately 75%. Although RCT is a reliable and highly successful treatment, some cases do exhibit post-treatment disease.
Key words: Files, Removing, Root canal

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INTRODUCTION

Success is the expected outcome after root canal treatment (RCT), regardless of the clinical conditions. However, predicting success usually requires adopting a referential or criteria, and presupposes that the patient is healthy. It is estimated that RCT should be considered completed when the tooth is permanently restored and in function. RCT clinical success can be analyzed based on different points of view, with specific values that involve the dentist, the patient or the tooth itself. References for the dentist are the value of symptom (clinical silence - absence of pain), the value of image (root canal space completely filled with no evidence of periapical inflammation), and the value of clinical condition (a well-restored and functioning tooth).[1-3]

The dentist's skills are crucial to interpret correctly the radiographic features and establish a diagnostic hypothesis. For the patient, the value of symptom (no pain) is essential. Apart from this, RCT success is associated with predictive aspects that eliminate the need of interventions and establishes treatment conclusion. The success for the tooth itself is associated with absence of disease (root canal infection or periapical inflammation).[4- 6]

The life of an endodontically treated tooth implies understanding that biological and mechanical events have a multifactorial nature and cannot be viewed separately. Ideally, it is expected to preserve the largest possible number of teeth until the end of life. Successful RCT prevents pain, apical periodontitis (AP) and tooth loss, but it is a real challenge because several clinical conditions can contribute, alone or in combination, for a poor prognosis, namely root canal perforation, overfilling, endodontic and periodontal lesion, root fracture, periapical biofilm, traumatic dental injury, fracture of instrument, AP, root resorption, etc.[7- 11]

Systemic and periodontal conditions should be carefully examined before RCT. Preoperative diagnosis of dental pulp and/or periapical tissues is an important reference to establish case prognosis. The dentist's health represents a human aspect that is frequently neglected and can also be a risk factor for the occurrence of intraoperative procedural errors. Human error may be associated with stress, working conditions, and lack of attention, adequate planning

and sufficient knowledge of new technologies. Renouard and Charrier discussed some human factors that could induce accidents and reported that as far as the interactions between the individual and the working environment, errors could be related to other people (life ware), technology (hardware), documentation (software) and environment.[12- 15]

This assessment process is important because the quality of root canal obturation greatly affects the prognosis of therapy. Several factors determine the technical quality of root canal obturation, including the distance between the end of the root canal obturation material and the root apex, density, presence of voids, and taper. Radiographic evaluation of root canal obturation depends on these factors. The radiographic appearance of an appropriate root canal obturation is characterized by a uniformly tapered canal from the coronal to apical ends, a dense root canal obturation without voids, and presence of filling materials 0.5–2 mm below the radiographic apex. In root canal obturation, each 1-mm loss of working length in teeth with apical periodontitis increases the failure rate by 14%. Underfilling and overfilling of a root canal obturation will also compromise the success rate of RCT. In addition, other iatrogenic errors such as instrument fracture, ledge formation, and apical perforations can cause failure of nonsurgical RCT.[16- 19]

The failure to localize and treat all of the canals of the root canal systems on the part of the operator is considered as one of the major causes of the root canal treatment failures. It has been shown that in majority of cases the general dental practitioners were responsible for the endodontic failures. The risk of missing anatomy is enhanced due to the intricacy of the root canal system. All the teeth may be found with extra roots/or canals, but the incidence of this observation is maximum in premolars and molars.[20- 24]

REVIEW

Hülsmann M, Stotz S (1997) evaluated the efficacy, cleaning ability and safety of five different devices and techniques to remove gutta-percha root canal fillings. One hundred and twenty extracted single-rooted anterior and premolar teeth were enlarged to ISO size 35 and obturated with laterally condensed gutta-percha using AH 26 as the sealer. Removal of gutta-percha was performed with the following devices and techniques: (a) Gates-Glidden and Hedstrom files, (b) only Hedstrom files, (c) Hedstrom files and chloroform, (d) the Endotec and Hedstrom files, and (e) the XGP drill and Hedstrom files. The following data were recorded: time taken to reach the desired working length, time required for the removal of the gutta-percha, and the amount of material extruded apically. The teeth were split longitudinally and photographed. Cleanliness of the root canal walls was scored using the projected slides with a total magnification of approximately 70x. The fastest technique to reach the working length was using the XGP drill (e), followed by the Gates-Glidden drills (a), Hedstrom files and chloroform (c), and the Endotec device (d). The use of Hedstrom files (b) without any additional support proved to be most time-consuming. Differences were statistically significant (U-test, $P > 0.05$) between the rotary devices and the manual techniques. Time for complete removal of gutta-percha was again shortest with the XGP drills (e), followed by the Gates-Glidden burs (a), the Endotec device (d), Hedstrom files with chloroform (c), and Hedstrom files alone (b). The XGP burs and the Gates-Glidden drills worked significantly faster than the other techniques. The amount of debris and filling material extruded apically in most cases did not exceed 0.1 mg. No significant differences could be detected between the groups (U-test, $P > 0.05$). Root canal cleanliness proved best following the use of Hedstrom files without additional support (b) and the Gates-Glidden drills (a), followed by Hedstrom files in combination with chloroform (c), the XGP-gutta-percha remover (e), and the Endotec device (d). When using the XGP two instrument fractures occurred in the apical parts of the root canals preventing further instrumentation to the apical foramen. When using the Gates-Glidden burs four instrument fractures occurred, but all fragments could be removed with forceps immediately. The results suggested that the XGP gutta-percha remover and the Gates-Glidden drills are efficient and time saving devices to remove gutta-percha but include a certain risk of instrument breakage and may leave some filling material inside the root canal.[10]

Viducić D, Jukić S, Karlović Z, Bozić Z, Miletić I, Anić I (2003) examined the use of an Nd:YAG laser in removing gutta-percha fillings from root canals when used in conjunction with eucalyptol, dimethylformamide (DMF) or no solvent. Root-canal fillings (sealer and gutta-percha) were removed with laser irradiation of 20 Hz/1.5 W from 30 roots randomly divided in three groups. In group 1, the solvent was eucalyptol; in group 2, the solvent was DMF; and in group 3, no solvent was used. Laser irradiation was performed until the temperature measured on the root surface increased by 4 degrees C over room temperature. The treatment was deemed complete when the apical foramen was reached with the optical fibre and a reamer. The samples were split longitudinally, and the area of remaining gutta-percha on the root-canal walls was determined with the aid of a computer program. The total number of laser pulses to achieve length and the highest temperature recorded was determined for each tooth. The average temperature increase in group 1 was 9.17 +/- 0.56 degrees C; in group 2, 9.56 +/- 0.28 degrees C; and in group 3, 8.29 +/- 0.41 degrees C. The shortest time to achieve length was in group 3 (6.4 +/- 0.49 min), then in group 1 (6.7 +/- 0.85 min) and group 2 (7.05 +/- 0.79 min). The area of remaining gutta-percha was the largest in group 2 (6.13 +/- 5.76%), whilst the

smallest was for group 3 (4.69 +/- 4.03%), but the difference was not statistically significant. The number of pulses was not statistically significant between the groups. Use of an Nd:YAG laser alone is capable of softening gutta-percha. The addition of solvents did not improve the retreatment, either in terms of the time required for the procedure or in terms of the area of remaining gutta-percha on root-canal walls.[11]

Kosti E, Lambrianidis T, Economides N, Neofitou C (2006) compared the efficacy of ProFile rotary Nickel-Titanium (Ni-Ti) instruments and Hedstroem-files (H-files) combined with Gates-Glidden (GG) drills during removal of gutta-percha root fillings used in combination with one of the four representative sealers. Forty-eight single-rooted human teeth, with fully formed apices and straight root canals were used. The root canals were accessed and instrumented using a stepback technique with H-files. They were randomly assigned to four groups and subsequently filled with a combination of lateral and vertical condensation of gutta-percha and one of the following sealers: Roth 811, AH26, Endion and Roekoseal. The root fillings were removed 1 year later, using either H-files in combination with GG drills or the ProFile Ni-Ti system. Teeth were then grooved longitudinally and split. The amount of gutta-percha and sealer remaining on the root canal walls was traced and scored visually with the aid of a stereomicroscope. Sealer remnants were observed with both techniques mainly in the middle and apical third of the root canal. The ProFile system and the H-files were associated with similar amounts of remaining filling material ($P > 0.05$). In the cervical third of the root canal all sealer remnants were removed with both techniques. In the middle and apical third AH26 was associated with a statistically significant greater quantity of remnants on the root canal walls with both removal techniques ($P < 0.05$). Endion, Roth 811 and Roekoseal were associated with approximately the same amount of filling material in the middle third of the root canal ($P > 0.05$), whereas in the apical third Endion was associated with significantly more remnants of filling material than the other two sealers with either ProFile or H-files ($P < 0.05$). None of the methods used for the removal of root fillings was totally effective, especially in the apical third of the root canal.[12]

Schirrmeister JF, Hermanns P, Meyer KM, Goetz F, Hellwig E (2006) compared the detectability of residual Epiphany and gutta-percha after root canal retreatment using a dental operating microscope and radiographic examination with the residual area measured after rendering the roots transparent. Sixty extracted single-rooted maxillary central incisor teeth were enlarged to apical size 40. Thirty canals were filled using vertically compacted Epiphany, the remainder were filled with vertically compacted gutta-percha and AH Plus sealer. After re-instrumentation to apical size 50, radiographs of the roots were taken in buccolingual and mesiodistal direction. Residual filling material was categorized by three observers using the radiographs and a dental operating microscope. The area of remaining material that was made visible by radiographs was measured with the aid of a computer image analysis programme. After clearing the roots, areas of residual filling material on the root canal wall were measured using a microscope. Computer image analysis of the radiographs showed significantly smaller areas of remaining gutta-percha and Epiphany compared with the analysis of the transparent teeth that revealed only one absolutely clean root (Epiphany). Especially in the gutta-percha group, the scores determined by the observers using radiographic examination gave an over-optimistic impression of cleanliness compared with the scores determined by the visualization through the microscope. Especially for remaining gutta-percha, the operating microscopes provided better detection of residual root filling material in retreated maxillary incisor teeth.[13]

Ring J, Murray PE, Namerow KN, Moldauer BI, Garcia-Godoy F (2009) compared the effectiveness and working time of two rotary instrumentation file systems with two solvents for the removal of gutta-percha (GP) (ProTaper Universal, Dentsply Tulsa Dental, Tulsa, Okla.) or resin-based composite (RBC) (RealSeal 1 Bonded Obturator, SybronEndo, Orange, Calif.) endodontic obturation materials. The authors instrumented 88 human extracted teeth and obturated the root canals of 80 of the teeth with either GP with AH Plus root canal sealer (Dentsply Maillefer, Tulsa, Okla.) or RBC with adhesive according to the manufacturers' instructions. They re-treated each tooth by using one of two rotary instrumentation file systems. They assessed each file system by using chloroform or orange solvent re-treatment agents. The authors measured the time needed to remove the obturation material from each tooth. They processed the teeth for scanning electron microscopy, and two blinded reviewers categorized the micrographs according to several criteria. The authors observed more RBC remnants on the root canal surfaces compared with GP remnants after re-treatment. The re-treatment solvents and file systems were equally effective in removing the obturation materials. The study results showed that the quickest root canal retreatment can be accomplished by using EndoSequence rotary files (Brasseler, Savannah, Ga.) and orange solvent to remove RBC obturation material. Re-treatment with EndoSequence rotary files was quicker than re-treatment with ProTaper Universal re-treatment files (Dentsply Tulsa Dental). However, in this study, the file systems were similarly effective in removing GP and RBC.[20]

Marfisi K, Mercade M, Plotino G, Duran-Sindreu F, Bueno R, Roig M (2010) evaluated the efficacy of ProTaper Retreatment files, Mtwo Retreatment files and Twisted Files for removal of gutta-percha and Resilon in straight root canals. Ninety single root canals were instrumented and randomly allocated into 6 groups of 15 specimens each with regards to the filling material and instruments used. Group 1: gutta-percha/ProTaper; Group 2: Resilon/ProTaper; Group 3: gutta-percha/Mtwo; Group 4: Resilon/Mtwo; Group 5: gutta-percha/Twisted Files; Group 6: Resilon/Twisted Files. For all roots, the following data were recorded: procedural errors, duration of retreatment, canal wall cleanliness through optical microscope and cone beam computed tomography (CBCT). No system completely removed the root filling material from root canal walls. No significant differences were observed between the rotary systems in terms of the area of filling material left within the canals (P>0.05). There were statistically significant differences between the filling materials: Resilon/Real Seal had less residual material than gutta-percha/AH plus (CBCT: P=0.01; microscope: P=0.018). Mtwo Retreatment files were more rapid when removing filling material than ProTaper Retreatment files (P=0.19) and Twisted Files (P=0.04). No system removed the root filling materials entirely. Mtwo Retreatment files required less time to remove root filling material than the other instruments.[21]

Dadresanfar B, Mehrvarzfar P, Saghiri MA, Ghafari S, Khalilak Z, Vatanpour M (2011) compared the efficacy of two retreatment rotary systems in removal of gutta-percha (GP) and sealer from the root canal walls with and without use of solvent. Sixty single-canalled distal roots of mandibular molars were prepared and root filled with gutta-percha and AH26. Each canal was randomly allocated to receive one of the retreatment techniques, Mtwo R or ProTaper. The groups were further divided into two subgroups: with or without the use of solvent. The cleanliness of canal walls was determined by stereomicroscope and scanning electron microscopy. The results showed that Mtwo R without the use of solvent was more efficient in material removal compared to ProTaper D (P<0.05). Most remnants were found in the apical third of the canals (P<0.05). Mtwo R seems to be an efficient rotary system for endodontic retreatment of root canal with GP.[22]

Marques da Silva B, Baratto-Filho F, Leonardi DP, Henrique Borges A, Volpato L, Branco Barletta F (2012) assessed the efficacy of different retreatment rotary files in removing gutta-percha and endodontic sealer from canals. Ninety straight single-rooted premolars were prepared up to a size 30 and filled with gutta-percha and sealer and then randomly assigned to six retreatment groups (n = 15). Groups I, III, and V were retreated using rotary systems ProTaper Universal Retreatment (PTUR), D-RaCe, and Mtwo Retreatment, respectively. Groups II, IV, and VI were retreated using the additional instruments F4, size 40, .04 taper RaCe, and size 40, .04 taper Mtwo, respectively. The roots were split vertically, and images of the halves were obtained using a high-resolution scanner and evaluated with AutoCAD software to calculate the percentage of residual material. There were no statistically significant differences (P > 0.05) between groups when additional instruments were used. The percentage of residual material was lowest in the PTUR group and was statistically significant only when compared to the D-RaCe system (P = 0.0038). All root canals had residual filling material after retreatment even when additional instruments were used.[23]

Akhavan H, Azdadi YK, Azimi S, Dadresanfar B, Ahmadi A (2012) compared the ability of Mtwo and D-RaCe retreatment systems to remove residual gutta-percha and sealer within the root canal after retreatment. This in vitro experiment was performed on sixty extracted human teeth. The samples were cut at the CEJ level, manually prepared, filled with gutta-percha and AH26 and finally stored at 37ºC for two weeks. Samples were then randomly divided into two groups. Group 1 was retreated with Mtwo and Group 2 with D-RaCe. Both groups were then divided into two subgroups retreated either with or without solvent. Teeth were then vertically sectioned for evaluation of residual filling materials on the canal walls. A microscopic assessment at 16× magnification was performed. T-test statistical analysis was used to compare the data. Comparison between the Mtwo and D-RaCe rotary systems revealed no significant differences in residual gutta-percha or sealer on canal walls (P=0.2). The study revealed a negative effect of solvent on removal of gutta-percha and sealer in both the Mtwo and D-RaCe systems. Mtwo and D-RaCe retreatment files removed residual gutta-percha and sealer similarly; there was no significant difference between them.[24]

Kesim B, Üstün Y, Aslan T, Topçuoğlu H S, Şahin S, Ulusan O (2017) compared the efficacy of manual and mechanical instrumentation techniques, including ProTaper Universal retreatment system, Mtwo retreatment system, Reciproc system, and Hedström files, regarding removal of overextended root canal filling material. Eighty extracted human mandibular premolar teeth were prepared at the apical foramen level using Revo-S rotary files and subsequently obturated. The root canal filling material was deliberately extruded from the apex. Samples were transferred to glass vials that simulated the periapical area. Eighty samples of overfilled teeth were randomly assigned to four equal groups (n = 20) for removal of the root filling material with ProTaper Universal retreatment files (Group 1), Mtwo retreatment files (Group 2), Reciproc system (Group

3), and hand files (Group 4). Removal of the root canal filling material and additional preparation were performed by individual instruments from each different system up to a #40 size. The external apical surface of the teeth and the surrounding glass vials were checked using a dental operation microscope with ×12.5 magnification. Samples were divided into two groups based on whether removal of the overextended root canal filling material was successful or not. The success rate for removal of overextended gutta-percha was greater for the Mtwo (30%) and hand files (30%) compared with the ProTaper (20%) and Reciproc (10%). However, no significant statistical differences existed among the experimental groups (P > 0.05). This study demonstrated that all tested systems had similar efficacy in removing overextended root canal filling material.[39]

Kaşıkçı Bilgi I, Köseler I, Güneri P, Hülsmann M, Çalışkan MK (2017) compared the amount of apically extruded debris and of remaining filling material during the removal of root canal filling material using three rotary NiTi retreatment instruments or Hedström files. Ninety-six severely curved human molars of both jaws were selected. The root canals were prepared to size X2 (tip size 25, .06 taper) using the ProTaper Next system (Dentsply Sirona, Ballaigues, Switzerland), filled with gutta-percha and AH Plus sealer (Dentsply De Trey, Konstanz, Germany) and then randomly divided into four experimental groups (n = 24 each) with two subgroups of maxillary and mandibular teeth each. An experimental model was used as a phantom head to simulate the upper and lower jaws. The root filling materials were removed with one of the following files using a crown-down preparation technique: I. Hedström files (H-files) (VDW, Munich, Germany), II. R-Endo (Micro-Mega, Besançon, France), III. Reciproc (VDW) and IV. ProTaper Universal Retreatment system (PTU-R) (Dentsply Maillefer). Apically extruded material was collected in vials, which were weighed with a microbalance (10-5 g) before and after the retreatment. The area of residual filling material in the coronal, middle and apical root level was assessed using digital analysis. Reciproc was associated with significantly less extruded debris than the H-files (P = 0.009). No significant differences were detected amongst the four retreatment techniques concerning residual filling material (P = 0.082). The amount of extruded debris and areas of remaining filling material were not correlated (P = 0.901). Location of teeth in the maxilla or mandible had no impact on the amount of extruded debris within each instrument group (P = 0.609). However, when teeth were evaluated in general irrespective of the instruments, significantly more debris was extruded in the mandibular location (P < 0.001). All retreatment systems were associated with apical extrusion of debris, but H-files extruded significantly more material than Reciproc.[40]

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