

Evaluation of root - filling quality when using Reciproc - a rotary system, and conventional manual instrumentation

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Master thesis by: Sitora Artykova

Supervisor: Dag Ørstavik

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A good root filling quality is essential to prevent the flow of bacteria and their toxins to the periapical tissue and to impede reinfection. Over the past years several methods of instrumentation and associated obturation systems have been introduced in order to improve the root filling quality. Both the instrumentation process and the filling technique influence the outcome of the quality of the root filling. It has been shown that there may be an improvement in root filling quality when using newly introduced rotary NiTi systems and obturation with their matching tapered single cones (E.Schafer et al. 2013). The use of tapered cones with sealer may improve adaption and thereby sealing ability without the use of accessory cones and may save time compared to conventional lateral or vertical condensation techniques (T.Tasdemir et al. 2009). Other obturation techniques that have been studied are lateral condensation (LC) of Resilon, mechanical lateral condensation (MLC) of gutta-percha, Thermafil technique , Active GP and GuttaFlow (T.G. Gound et al. 2009, F.Samadi et al. 2014)). In their study Samadi et al. (2009) show that techniques involving thermal or frictional heat to plasticize gutta-percha such as Thermafil obturation technique and warm vertical condensation technique, gives a denser apical and coronal filling compared to lateral condensation. Even though these techniques seem to give a higher quality of seal, Gound et al. (2009) discuss that lateral condensation is still the preferred technique.

Rotary nickel-titanium (NiTi) instruments are in conjunction with matching gutta-percha cones (M.A. Baumann& A.Roth 1999, Schafer et al. 2013). Such obturation technique may allow a high amount of gutta-percha to be packed into the canal, while the amount of the sealer is kept to a minimum (Schafer et al. 2013). It is believed that root fillings with minimum of sealer and maximum of gutta-percha provides optimum root-filling quality (E.G. Kontakiotis et al. 1997, I.S. Jarrett et al. 2004)

In addition to different sealing techniques the instrumentation process is of interest when evaluating the quality of the root filling. Manual instrumentation and obturation with cold lateral compaction with standardized gutta-percha is currently the most common method (I.S. Jarrett et al.2004). However, rotary instrumentation with matching single cones seem not only to be time-saving compared to manual instrumentation, but may also improve root filling quality (S. Roman-Richon et al. 2014, L.Dahlstrom et al. 2014, L.Dahlstrom et al. 2011).

In our research we wanted to evaluate the quality of the root filling performed by undergraduate students applying both manual instrumentation and rotary instrumentation with NiTi-files. The following factors were considered of interest: the distance from apex-GP to apex of the tooth, the size of the taper created, the width of the first mm of gutta-percha and the presence of apical or coronal voids. The purpose of our investigation was to study and compare the differences in the quality of root filling when using traditional manual instrumentation and obturation technique versus rotary instrumentation with Reciproc, followed by filling with its matching single cones. Our null hypothesis was that there is no difference in root filling quality when comparing manual versus rotary instrumentation.

MATERIALS AND METHODS

Radiographs of teeth that had been treated at the University of Oslo, Faculty of Dentistry, during the period 2012-2013 were the source for evaluation. Ninety patients that were treated with manual instrumentation and 108 patients that were treated with Resiproc were randomly selected from the electronic records. The assessment of quality was performed on immediate postoperative x-rays. Some patients did not have any satisfactory pictures and were therefore excluded from the research. The selection process left x-rays of 166 roots treated with manual instrumentation and 247 with Resiproc. Salient features in the x-rays were then scored and the root filling areas of interest were measured in a metric system by using a plug-in addition to the ImageJ software (National Institutes of Health, public domain). Using the data and results from this software we measured a) the distance from root apex to apex gutta-percha, b)

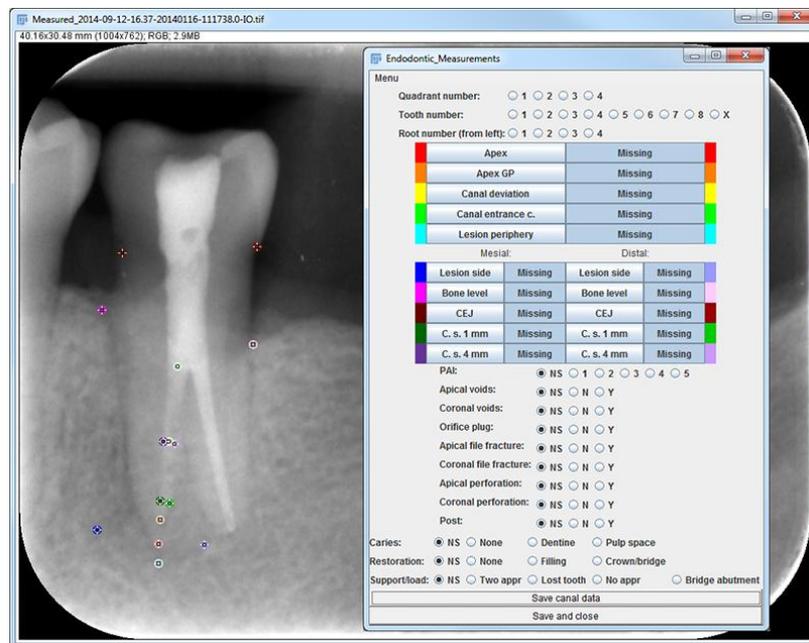
the taper and the width of apical gutta-percha and c) the quality of seal. The quality of the seal was evaluated visually based on the presence of voids either in the apical or coronal half of the root filling. The quality of the seal was hence further differentiated qualitatively as adequate (no voids), questionable (voids either in the apical or coronal part) or poor (voids in both apical and coronal part). Due to the quality of the x-rays not all of the roots were scored for root filling quality. Students t-test and Chi-square test were used to evaluate significant differences between manual instrumentation and Reciproc.

Table X. Root filling qualities evaluated.

Property	Code	Unit
Apex-to-root filling distance	AGP	mm
Root filling width at 1mm	RFW	mm
Root filling taper 1 to 4mm	RFT	proportion
Presence of voids (quality of seal)	QoS	A/Q/P*

*A, adequate; Q, questionable; P, poor

Figure 1. Image J – endodontic measurements plug-in. An overview of data entries.



RESULTS

There was no significant statistical difference between Resiproc and manual instrumentation in the AGP and RFW (table Y). The size of the taper, however, showed a significant statistical difference between the two methods, with greater taper obtained with Resiproc.

A chi-square test with a significance level of 95% was performed to evaluate and study the statistical difference in the quality of the seal between the two groups (Table Z). With $p < 0.05$, the test implies that Resiproc leads to a significantly better outcome on the quality of seal than ordinary manual instrumentation.

Numerical presentations of the findings are shown in tables Y and Z and the distribution of scores in figures 2-5.

Table Y. Summarizes the findings for the distance from apex to root filling tip, the width of the root filling 1 mm from its apical tip and the taper of the filling from 1 to 4 mm from the tip.

	AGP		RFW		RFT	
	Manual	Reciproc	Manual	Reciproc	Manual	Reciproc
Average	1.596*	1.628*	0.540 [§]	0.517 [§]	0.072*	0.083*
St. Dev.	1.151	1.060	0.227	0.123	0.053	0.054
Max	7.699	6.941	3.056	0.954	0.208	0.375
Median	1.445	1.316	0.522	0.495	0.070	0.076
Min	0	0	0.253	0.288	-0.060	-0.080

* $p = 0.783$; [§] $p = 0.222$; * $p = 0.040$

Figure 2. Distribution of apex to guttapercha distance (AGP, mm)

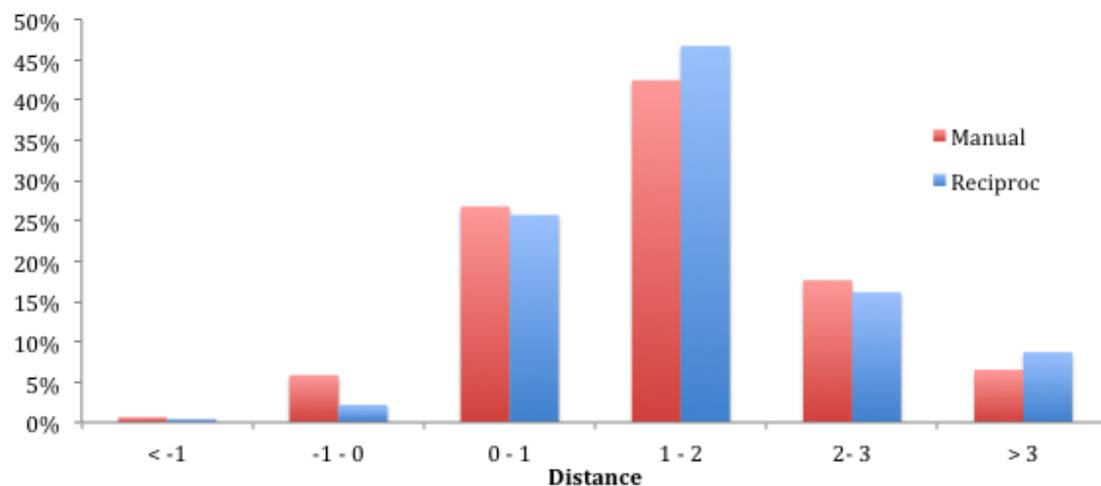


Figure 3. Distribution of the apical width gutta-percha (RFW, mm)

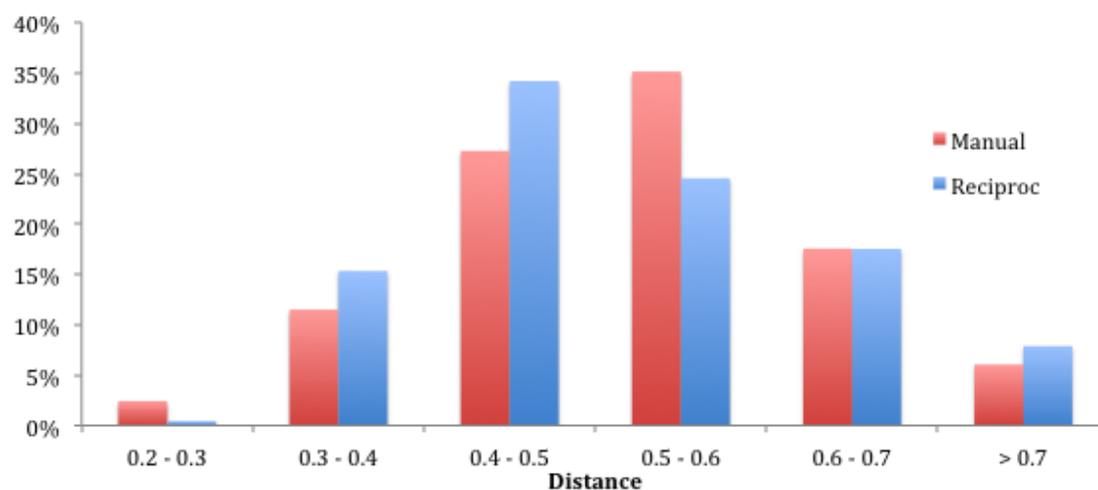


Figure 4. Distribution of taper (RFT, mm)

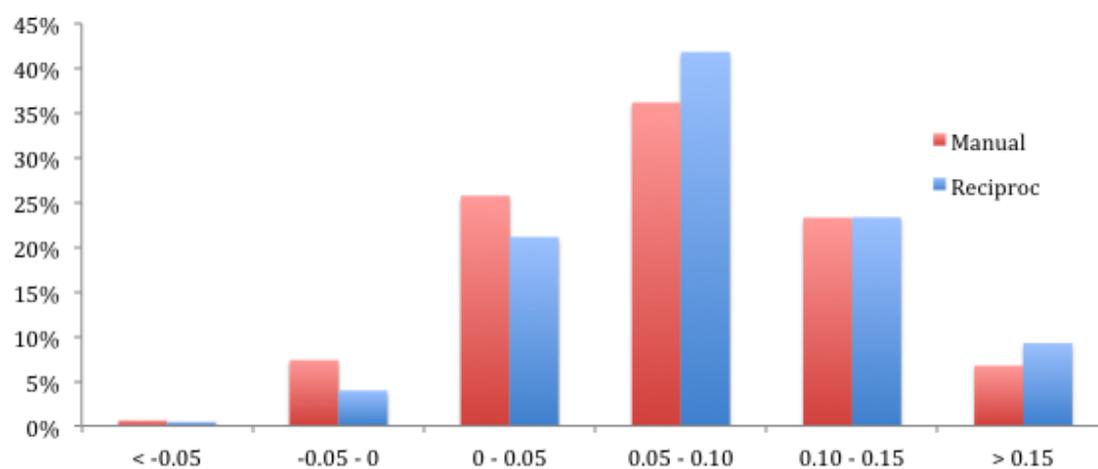


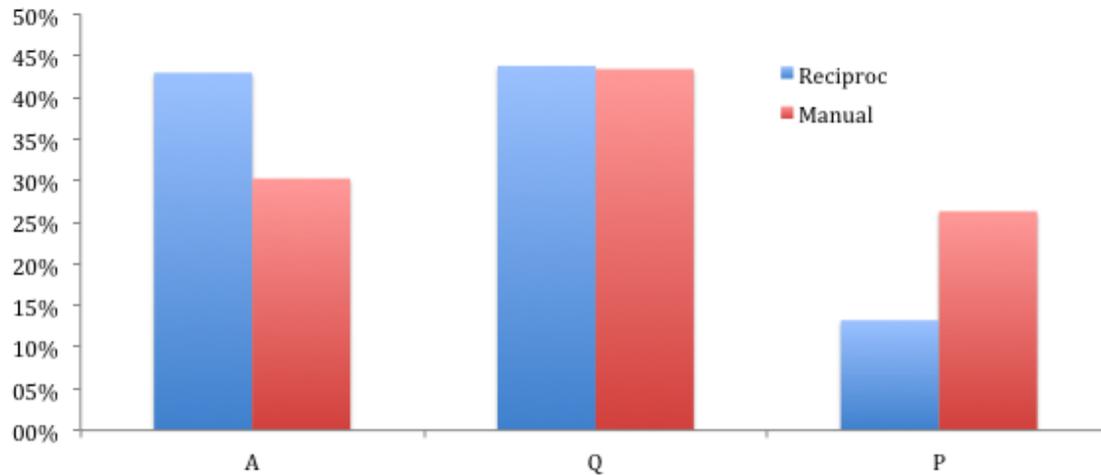
Figure 4 illustrates the difference in the size of taper between Resiproc and manual instrumentation. Resiproc instrumentation creates a significantly larger taper.

Table Z. Analysis of presence of coronal and apical voids.

	QoS*	
	Manual	Reciproc
A	46	104
Q	66	106
P	40	32

*p by Chi-square = 0.002

Figure 5. Distribution of quality of seal with manual and Reciproc instrumentation



The analysis shows that Reciproc instrumentation and filling produced fillings with less voids than manual instrumentation and root filling with conventional lateral condensation.

DISCUSSION

The length of the root filling or the distance from apex to gutta-percha is an important factor to consider when evaluating the quality of the root filling and hence the endodontic outcome of the tooth. While there may be conflicting data in the historical literature, several studies have discussed the impact of the apical extent of root filling on the endodontic outcome. In a review study performed by Ng et al. (2007) the authors concluded that the optimal distance from apex to guttapercha depends on the presence of an apical lesion pre-operatively. If there is a pre-operative lesion present, then flush root fillings, i.e. fillings that are 0-2 mm within the radiographic apex have higher success rate than short root fillings. Their findings are in general agreement with other large follow-up investigations (Sjogren et al. 1990). Extruded fillings may be associated with an especially poor prognosis (A.Halse & O.Moelven, 1987) .

One of the main arguments for not using Resiproc has been its lack of ability to widen the apical portion of the root canal. Traditional endodontics tries to

achieve a wide apical root canal as possible, in order to give the optimum cleansing of bacteria and debris. In our study, however, we could show that there is no significant statistical difference between manual instrumentation and Resiproc. This allows us to state that Resiproc and traditional instrumentation give no difference in the width of the apical portion of the root canal.

Taper of canal preparation is another important factor to consider when evaluating the quality of the root filling. In our study we showed that Reciproc gives a larger taper than manual instrumentation. According to Smith et al. (1993) a wide taper results in a significantly higher success rate than a conical and narrow taper. This may indicate that Reciproc leads to a higher success rate. However, some studies do not find any significant difference between narrow (0.05) and wide (0.10) canal tapers (Hoskinson SE, 2002) .

Based on the performed research it can be argued that when comparing Reciproc to traditional manual instrumentation, Reciproc leads to less voids, both coronal and apical, and larger taper. With matching tapered single gutta-percha cones it is believed that obturation performed with Reciproc gives a higher percentage of gutta-percha filled areas and lower percentage of sealer-filled areas in the apical portion of the canal (Schafer et al. 2013, M. Bidar et al. 2010, M.M Kocak& S. Darendeliler-Yaman, 2012) . Most of the sealers tend to shrink on setting and dissolve over time (E. G. Kontakiotis et al. 1997, R.B. Kazemi et al. 1993, E.Schafer& T.Zandbiglari, 2003) whereas gutta-percha is known to be dimensionally stable. An important part of the obturation process is therefore to achieve a higher percentage gutta-percha filled areas (PGFA) and lower percentage sealer filled areas (PSFA). In our research we can observe that Reciproc creates a statistically significant larger taper than manual instrumentation which allows a larger area of the apex to be filled with gutta-percha and sealer, creating a denser area and thus restricting remaining bacteria leaking to the periapical tissue. This is in disagreement with several other studies (L.M. Nica et al. 2012, M.K. Wu et al. 2009, Tasdemir et al. 2009, M.Hammad et al. 2009) which show that single-cone obturation prevents leakage as effectively as vertical and lateral compaction techniques (Schafer et al. 2013). Because of the shape of the Reciproc NiTi-file the canal entrance gets an oval

shape, which limits the use of accessory points. It can therefore be argued that the coronal part of the root filling is denser by manual instrumentation and lateral compaction. Therefore, it is recommended that single-cone obturation should be limited to round and straight canals. The quality of the obturation is not as good in irregularly shaped canals when using Reciproc (M.A. Marciano et al. 2011, M.V. Weis et al. 2004). Looking further into our hypothesis we can conclude that the quality of the root filling is dependent on several factors and that there are only a few differences to discuss when one compares Reciproc with manual instrumentation. However, since Reciproc is less time consuming while resulting in the same or perhaps better root filling quality than manual instrumentation, Reciproc is often preferred and may thus also be accepted as an equivalent alternative to the traditional manual instrumentation and obturation.

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