ABSTRACT

Success of root canal treatment is attributed to numerous factors. Instrumentation technique and irrigant used can be considered as one of the major factors upon which the post-operative pain depends. The aim of this study was to compare the extent of post-operative pain in patients after using three different instrumentation techniques and two different irrigants in a single visit root canal therapy. A total of 60 patients with mandibular molars requiring root canal treatment were selected and divided into three groups of 20 patients each. Group I was instrumented with stainless steel hand K-files, Group II was instrumented with Revo-S file system and Group III was instrumented with WaveOne reciprocating system. Each group was further divided into subgroups of 10 patients each, based upon the irrigant used. Subgroup A was irrigated using 3% sodium hypochlorite, and subgroup B was irrigated using 2% chlorhexidine. All canals were instrumented and obturated in a single visit. Post-operative pain response of patients was evaluated immediately after 6 h, 24 h, 3 days and 7 days post-operatively using the Visual Analogue Scale (VAS) score. For VAS pain scores, significantly more pain was found in WaveOne group 6 h post-operatively. There was no statistically significant difference between the subgroups in post-operative pain. It can be concluded that the difference in the post-operative pain is related to the instrumentation technique. Reciprocating system, WaveOne resulted in more pain followed by hand K-files and Revo-S file system. Both NaOCl and CHX showed an insignificant difference in post-operative pain.

KEYWORDS continuous rotary systems, post-operative pain, reciprocating systems, single visit root canal treatment, sodium hypochlorite, chlorhexidine

INTRODUCTION

The most important objective of root canal therapy is total tissue debridement and to minimize the number of microorganisms in root canal system followed by fluid tight obturation of the prepared space. Since apical periodontitis originates from an infected or affected pulp, it is axiomatic that the root canal must be thoroughly debrided and obturated. The completion of endodontic therapy can be done in a single appointment or in multiple visits. Clinical reports have shown that patients generally tolerate and prefer single-visit endodontic therapy. Therefore, single-visit root canal treatment has become a common practice as it offers several advantages, including a decreased number of operative procedures and no risk of inter-appointment leakage through temporary restorations.

Teeth indicated to be treated in single-visit include:

- Vital teeth with pulp exposures caused by trauma, caries or mechanical reasons;
- Teeth with subgingival breakdown;
- Teeth with multiple coronal walls missing;
- Full coverage restorations with carious margins;
- Fractured anterior or bicuspids requiring temporary restorations;
- Teeth to be used as over-denture abutments, full jacket crowns on mandibular anterior;

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Physically disabled patients or patients who require sedation.

The main contraindications are:

- The presence of anatomic anomalies (receded pulp chambers, calcified canals, sharply curved canals, bifurcated canals, and dilacerations) or
- Procedural difficulties (broken instruments, perforations, ledge formation) that extend treatment time, patients suffering from physical (muscular dystrophy) or
- Mental disability (neuromuscular disorders) as it is difficult to obtain sufficient cooperation from these patients for SVE.

The most controversial condition is non-vital teeth with apical periodontitis and re-treatment cases in which maximum failures are seen. An inter-appointment dressing of calcium hydroxide reduces the number of bacteria in root canals in such cases. SVE for the successful treatment of such cases is controversial. The reason could be the ineffectiveness of an inter-appointment antibacterial dressing. Introduction of more effective irrigants (MTAD) superior BMP techniques (rotary NiTi files systems) and disinfection systems (ultrasonic PAD) may solve the problem but studies are needed to validate this.

As a consequence, innovative manufacturing processes to produce better instruments have been commercialized. To further simplify and improve the safety of treatment, reciprocation motion is used instead of continuous rotation that reduces the number of nickel titanium (NiTi) instruments and subsequently instrumentation time.

Revo-S is a NiTi rotary file comprising of three instruments SC1, SC2 and SCU for root canal preparation. It has an inactive tip and an extended helical machining up to the coronal region which increases the instrument flexibility. Reduction of the contact lengths of the blade on the dentine reduces stress. The progressive pitch avoids screwing effect.

In 2010, Dentsply Maillefer (Baillagues, Switzerland) developed nickel titanium instruments of greater tapers (WaveOne) which was designed to be used with an innovative, proprietary reciprocating movement and allow root canals to be prepared with one single instrument: in the majority of cases a taper 0.08 size 25 instrument is selected.

Elimination or reduction of post-operative pain is related to the immediate success of endodontic treatment. Apical extrusion of infected debris to the periapical tissues is possibly one of the principal causes of post-operative pain. Rotary, hand or hybrid instrumentation alone is inadequate to clear all the debris from the root canal system and thus, irrigating solutions complement them. The chemical irrigants include organic acids, sodium hypochlorite, EDTA, hydrogen peroxide, chlorhexidine, normal saline, etc. But their role in post-operative pain is still uncertain. Bashetty et al. concluded that more pain was present in teeth irrigated using 5.25% sodium hypochlorite when compared to that in teeth irrigated using 2% chlorhexidine solution.

Thus, this study was undertaken with the purpose of evaluating the effect of different instrument techniques and irrigants on post-operative pain following single visit root canal therapy in multi-rooted mandibular teeth.

MATERIALS AND METHODS

The sample comprised of adult patients that required root canal treatment in multi-rooted mandibular molars. A total of 60 teeth were selected for the study.

At initial appointment an informed consent was taken from the subjects to include them in the study.

A thorough clinical examination including the case history was documented. A preoperative radiograph was taken to check for the number and anatomy of roots and root canals, condition of periodontal tissues and for the presence of any periapical radiolucencies. Then the subjects were divided into three main groups (I, II & III) of 20 patients each according to the biomechanical preparation. Each group was further subdivided into two subgroups (A & B) of 10 patients each on the basis of irrigant solution used.

**Group I:** Biomechanical preparation using hand instrumentation (Stainless Steel K-files, Dentsply Maillefer, Germany).

- Group I(A): Teeth treated using 3% sodium hypochlorite (NaOCl) solution.
- Group I(B): Teeth treated using 2% chlorhexidine (CHX) solution.

**Group II:** Biomechanical preparation using rotary instrumentation. (REVO-STM, Micro Mega, France)

- Group II(A): Teeth treated using 3% sodium hypochlorite (NaOCl) solution.
- Group II(B): Teeth treated using 2% chlorhexidine (CHX) solution.

**Group III:** Biomechanical preparation using reciprocating instrumentation. (WaveOne, Dentsply Maillefer, Germany)

- Group III(A): Teeth treated using 3% sodium hypochlorite (NaOCl) solution.
- Group III(B): Teeth treated using 2% chlorhexidine (CHX) solution.

Root canal treatment

Local anaesthesia was administered with Lignocaine, 1:80,000 adrenaline. Access cavity was prepared with high-speed airrotor handpiece using no. 4 round carbide bur and Endo Z bur under rubber dam isolation. Debridement of pulp was done and patency of the canal was checked using no. 10 K-file.

The working length was determined radiographically using Ingle’s method.

Biomechanical preparation of the teeth was done using the different instrumentation techniques group-wise. Group I was treated using Stainless Steel hand
K-files, in step back technique with the apical preparation of size 30 K-file and step back up to size 45 K-file. Group II was treated with crown down technique using REVO-S rotary files which include three shaping instruments; the shaping and cleaning instrument (SC1) #25/0.06 taper rotary instrument to enlarge the coronal two thirds of the canal. (SC2) #25/0.04 taper instrument used till the working length, and universal shaper (SU) #25/0.06 taper also used till the working length. Group III was treated with crown down technique using WaveOne reciprocating files. It is a single file system consisting of three sizes as #21/0.06 (small) for fine canals, #25/0.08 (primary) for the majority of the canals and #40/0.08 (large) for large canals. In this study, most of the cases were done with the primary WaveOne files.

Throughout biomechanical preparation, irrigation was done using 27 gauge side vented needle with 3% sodium hypochlorite in group IA, IIA and IIIA followed by 17% EDTA for 1 min. In groups IB, IIB and IIIIB, irrigation was done with 2% chlorhexidine solution followed by 17% EDTA for 1 min.

Master cone was selected on the basis of master apical file size and checked with a radiograph. It was followed by drying of the root canal with paper points. Obturation was done with AH Plus sealer and corresponding gutta-percha points using the lateral condensation method. Later post-obturation restoration was done.

Post-operative pain was evaluated using Visual Analogue Scale (VAS). All patients received a VAS form to record the intensity of pain experienced after the procedure immediately, after 6 h, 24 h, 3 days and 7 days.

The degree of pain was categorized as: Visual Analogue Scale (VAS) score (Figure 1)

- No pain - 0
- Mild pain - 0.1–3
- Moderate pain - 3.1–7
- Severe pain - 7.1–10

The observations thus recorded were then put to statistical analysis for results.

RESULTS

Firstly, the pre-operative pain scores of individuals in each group were checked by paired ‘t’ tests for standardization.

The data showed that there was a significant difference between the groups at 6 h and 24 h post-operatively and no significant difference in pain scores pre-operatively as well as 3 days and 7 days post-operatively (Table 1).

<table>
<thead>
<tr>
<th>Time</th>
<th>Comparison</th>
<th>Mean square</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>Between groups</td>
<td>0.617</td>
<td>0.858</td>
<td>0.429</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>0.718</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain 6 h</td>
<td>Between groups</td>
<td>6.817</td>
<td>8.206</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>0.831</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain 24 h</td>
<td>Between groups</td>
<td>3.050</td>
<td>3.660</td>
<td>0.032*</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>0.833</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain 3 days</td>
<td>Between groups</td>
<td>0.717</td>
<td>2.117</td>
<td>0.130</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>0.339</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain 7 days</td>
<td>Between groups</td>
<td>0.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>0.000</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

*These values show a significant difference in pain scores as these are > 0.05

Group I vs Group II had insignificant differences whereas Group I vs Group III and Group II vs Group III had significant differences 6 h post-operatively.

Hand filing motion group and rotary filing motion group did not show any significant difference in post-operative pain incidence. The reciprocating filing motion group showed a significant difference in post-operative pain incidence from both the other groups.

The mean pain scores at 6 h post-operative time interval in: hand filing motion group was 2.40, rotary filing motion group was 2.00 and reciprocating filing motion group was 3.15. Hence, post-operative pain was significantly higher in reciprocating filing motion group after 6 h (Tables 2 and 3).

The data showed that there is no significant difference between the hypochlorite subgroup and chlorhexidine subgroup. The irrigant used does not have any significance on post-operative pain.

<table>
<thead>
<tr>
<th>Time</th>
<th>Comparison</th>
<th>Mean difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>Group I vs II</td>
<td>0.150</td>
<td>0.855</td>
</tr>
<tr>
<td></td>
<td>Group I vs III</td>
<td>0.200</td>
<td>0.758</td>
</tr>
<tr>
<td></td>
<td>Group II vs III</td>
<td>0.350</td>
<td>0.432</td>
</tr>
<tr>
<td>6 h</td>
<td>Group I vs II</td>
<td>0.400</td>
<td>0.388</td>
</tr>
<tr>
<td></td>
<td>Group I vs III</td>
<td>0.750</td>
<td>0.041*</td>
</tr>
<tr>
<td></td>
<td>Group II vs III</td>
<td>1.150</td>
<td>0.001*</td>
</tr>
<tr>
<td>24 h</td>
<td>Group I vs II</td>
<td>0.050</td>
<td>0.985</td>
</tr>
<tr>
<td></td>
<td>Group I vs III</td>
<td>0.650</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>Group II vs III</td>
<td>0.700</td>
<td>0.061</td>
</tr>
<tr>
<td>3 days</td>
<td>Group I vs II</td>
<td>0.050</td>
<td>0.964</td>
</tr>
<tr>
<td></td>
<td>Group I vs III</td>
<td>0.300</td>
<td>0.273</td>
</tr>
<tr>
<td></td>
<td>Group II vs III</td>
<td>0.350</td>
<td>0.173</td>
</tr>
</tbody>
</table>

*These values show a significant difference in pain scores as these are > 0.05

Fig. 1 Visual Analogue Scale (ranging from 0 to 10).


DISCUSSION

SVE has certain inherited advantages that include:

- Reduction in number of appointments.
- Avoidance of inter-appointment contamination leading to reduction in incidence of flare-ups.
- No need of tooth anatomy refamiliarisation by the clinician.
- Reduced chances of immune reaction that may be caused by intracanal medicaments.

Pain after endodontic procedures is not an uncommon finding. Prevalence of post-operative pain after endodontic treatment has been reported to range from 3% to more than 50%.

During root canal treatment of teeth with vital pulp, mechanical and chemical injuries could be the main reasons for acute inflammation, usually associated with iatrogenic factors, such as over instrumentation, apical extrusion of tissue remnants, debris, irrigants or medicaments, leaving behind pulp tissue in canals, perforations, and so on. Pulp is being severed at the cementodentinal junction and strong irrigants & medicaments like sodium hypochlorite, hydrogen peroxide, formocresol etc. are being used to remove the tissues from the canals. This results in irritation of periapical tissue, releasing a group of chemical substances which initiate inflammatory responses. Release of these substances can either directly lower the response threshold of sensory nerve fibers or cause pain indirectly by increasing the vascular permeability and producing edema and swelling.

For standardization, lower molars with no acute symptoms were selected.

Successful instrumentation depends on the ways the material, design and technique relate to the forces exerted on the instrument. Stainless steel files were the pioneers followed by Ni Ti files which were more elastic, flexible, resistant to fracture and minimize transportation during instrumentation.

In our study, the results have depicted that there was a significant difference in pain between the three main groups, 6 h and 24 h post-operatively whereas the difference in post-operative pain after 3 days and 7 days was insignificant among the groups. On further analysis by comparing individual groups in pairs it was observed that the hand filing motion group (Group I) and rotary filing motion group (Group II) showed insignificant difference in post-operative pain.

Martin-González et al. found that hand or rotary instrumentation did not affect the post-operative pain in the patient. On the other hand, Kashefinejad et al. showed in their study that the use of rotary instruments (Mtwo®) in root canal preparation contributed to lower incidence of post-operative pain than hand K-files attributing it to the fact that rotary systems could reduce the amount of extrusion of debris, since the flutes of these instruments tend to pull debris back towards the orifice. Conversely, in the manual step-back method, the file acts as a piston in the apical one-third tending to plunge debris through the apical foramen, leaving not enough space to expel it coronally, thus, it is more likely to cause inflammation and pain.

Mean pain scores of reciprocating filing group (Group III) were significantly higher than hand filing group (Group I) and rotary filing group (Group II), 6 h and 24 h post-operatively.

Gambarini et al. found that WaveOne reciprocating single file system caused more significant post-operative pain when compared to twisted files rotary multi file system and twisted files adaptive filing system.

WaveOne technique uses a quite rigid, big single-file of increased taper (usually 0.08 taper, size 25), which directly reach the apex. In many cases, in order to reach the apical working length, reciprocating instruments are used with force directed apically, which makes an effective piston to propel debris from a patent apical foramen. Since instruments are used without preliminary coronal enlargement, this results in a greater engagement of flutes and, consequently, more torque or applied pressure needed. The reciprocation movement is formed by a larger cutting angle and a smaller releasing angle. The file travels apically during releasing angle. Thus, instead of removing debris in the releasing angle, it gets pushed apically.

It has been reported that extrusion of microorganisms, materials, or dentin debris into the periradicular area causes inflammation and may be related to post-operative pain and flare-ups. The amount of debris extrusion and neuropeptides released from C-type nerve fibers present in the periodontal ligament differ between instrumentation techniques, and this difference has been suggested as a reason why there are differences in post-operative pain experienced by patients.

<table>
<thead>
<tr>
<th>Time</th>
<th>Comparison</th>
<th>Mean square</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-op</td>
<td>Between subgroups</td>
<td>0.017</td>
<td>0.023</td>
<td>0.880</td>
</tr>
<tr>
<td></td>
<td>Within subgroups</td>
<td>0.727</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>6 h</td>
<td>Between subgroups</td>
<td>0.017</td>
<td>0.016</td>
<td>0.900</td>
</tr>
<tr>
<td></td>
<td>Within subgroups</td>
<td>1.051</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>24 h</td>
<td>Between subgroups</td>
<td>0.267</td>
<td>0.290</td>
<td>0.592</td>
</tr>
<tr>
<td></td>
<td>Within subgroups</td>
<td>0.920</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>3 days</td>
<td>Between subgroups</td>
<td>0.000</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Within subgroups</td>
<td>0.357</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>7 days</td>
<td>Between subgroups</td>
<td>0.000</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Within subgroups</td>
<td>0.000</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>
Sodium hypochlorite (subgroup A) and chlorhexidine (subgroup B) were taken as endodontic irritants in the study to assess their effect on post-operative pain. However, on comparison between the subgroups, it was seen that there was no comparison of significant difference between the post-operative pain in the subgroups at 6 h, 24 h, 3 days or 7 days interval.

Heling et al. found that chlorhexidine and sodium hypochlorite were similarly effective in killing bacteria in vitro24.

da Silva et al. evaluated post-operative pain using 5.25% sodium hypochlorite (NaOCl) or 2% chlorhexidine (CHX) irrigation in nonvital single-rooted teeth after reciprocating instrumentation. Post-operative pain showed no statistically significant difference at any observation period when using 5.25% NaOCl or 2% CHX25.

VAS scale was selected to record post-operative pain as it is a relatively simple valid and reliable measure for measuring intensity and unpleasantness of human pain in accordance with Price et al.26.

Although the protocols in the study were standardized but the cause of pain and injury causing pain were not taken into considerations. Post-operative pain after root canal treatment depends on etiological factors, pathology of the periapical disease, extent of the periradicular injury, severity and intensity of the inflammation, virulence of microorganisms, host defense etc. The host defense may vary from patient to patient. Moreover, threshold of pain is also variable from one subject to another.

CONCLUSIONS
Since the incidence of preoperative pain along with tooth, pathology and other variables were identical; we may conclude that the difference in post-operative pain can be mainly related to the different instrumentation techniques. Post-operative pain after 6 and 24 h was significantly more in WaveOne followed by hand K-file instruments. Hence, a well formulated prescription for initial pain should be given to patients treated with WaveOne. Both NaOCl and CHX showed no statistically significant difference at any observation period when using 5.25% sodium hypochlorite or 2% chlorhexidine.

REFERENCES