**Post-operative Pain Analysis between Single Visit and Two Visit Root Canal Treatments using Visual Analogue Scale: An In Vivo Study**

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**Abstract:**

The purpose of this clinical study was to evaluate post-operative pain, after root canal therapy, performed in one appointment versus two appointment using calcium hydroxide intracanal medicament. **Study design:** In this in-vivo study, 60 patients requiring root canal therapy on permanent 1st molars were included. Patients were randomly divided into two experimental and one control group. Group1: One visit therapy (n=20)  Group2: Two visit therapy with 1 week of calcium hydroxide dressing (n=20) Group3(Control): Two visit therapy with 1 week of sterile dry cotton pellet dressing (n=20) **Materials and method:** The standard protocol for all the patients included local anaesthesia, isolation & access cavity preparation, chemomechanical preparation with Rotary Protaper NiTi instruments, and irrigation with 3% sodium hypochlorite, 17% EDTA, 0.9% saline and 2% chlorhexidine. Teeth in group1 (n=20) were obturated on the same appointment using single cone technique (6% gutta percha points) and AH Plus sealer. Teeth in group 2(n=20) and group 3(n=20) were given a dressing of calcium hydroxide and dry cotton pellet respectively for a week followed by double seal with Cavit G and IRM. These teeth were obturated on the 2nd appointment using same material and techniques as in group 1. Teeth in all three groups were restored with dual cure composite resin. A modified Visual Analogue Scale was used to measure preoperative pain and postoperative pain after 6, 12, 24 & 48hrs interval. Statistical analysis was performed using an independent-sample t test. There was no statistically significant difference between groups at any of the four postoperative intervals. There was no significant difference among all the three groups studied after 12, 24hrs & 48hrs. **Conclusion:** Within the limitations of this in vivo study, it may be concluded that Single Visit Endodontics provides excellent results, if care in diagnosis and proper case selection is given importance. Calcium hydroxide has no relation in eliminating or reducing postoperative pain.

**Key words:** Single-visit endodontics, Visual analogue scale, Post-operative pain, Calcium hydroxide.

**Introduction:**

Post treatment endodontic pain is one of the widely studied topics in endodontics. During recent years, the gold standard metaphor for something painful has become "a root canal". There are several factors associated with pain after root canal treatment; Preoperative factors like acute exacerbation of chronic lesion, non-vital tooth, unusual canal anatomy, periapical cysts, and abscesses are responsible for more flare-ups and pain. Intraoperative factors like working without rubber dam isolation, irrigating canal medications and irrigation, apical extrusion of filling materials and instruments, procedural complications, and missed canals can give rise to more pain. Post-operative factors like leaky temporary and permanent filling material and lack of post-operative medicament placement can also give rise to pain.

Patients experiencing severe preoperative pain have an increased incidence of moderate to severe post-endodontic pain, when compared to those having no pain prior to conventional endodontic therapy. Pain experienced as a result of pulpal and/or periapical insult is often attributed to inflammation. Elevated tissue concentrations of prostaglandins are responsible for initiating pain and also vasodilation which is seen clinically as erythema and edema. The biological reason "why pulpectomies reduce pain is based on reducing tissue levels of inflammatory mediators." Thus, the effective debridement of the infected root canal system, combined with incision for drainage and occlusal reduction if indicated, provides predictable pain reduction strategies in endodontic emergency patients. Anti-inflammatory drugs (NSAIDs) are commonly used in the management of endodontic pain. NSAIDs reduce pain and inflammation by inhibiting the synthesis of prostaglandins. Pain perception can be mild, moderate, severe or throbbing, depending on patient pain threshold. It is impossible to quantify pain, and hence various scales have been introduced to measure the intensity of pain. To name a few, Wong-Baker Faces pain scale, Visual Analogue scale, McGill Pain Questionnaire, Descriptor Differential scale, Numerical 11 point box (BS-11), Numeric Rating scale (NRS-11), Dolorimeter Pain Index, Brief Pain Inventory, Walid-Robinson Pain Index and Verbal Rating scale.

Second important entity which has received attention in the recent years is the presence of micro-organisms and their effect on treatment outcome. Hence, root canal treatment must also aim to eliminate bacteria from the infected root canal system to create an environment that is most favorable for healing. Several studies have shown that, it is impossible to achieve a bacteria-free root canal space in all cases, even after thorough shaping and cleaning is performed. Therefore concern exists as to the fate and consequences of the remaining microorganisms in the canal. In some cases,
they may multiply rapidly within 2-4 days to almost the initial number, if the canal is left empty.\textsuperscript{10} It is believed that the remaining bacteria can be eliminated or be prevented from repopulating the root canal space by introducing an interappointment dressing such as calcium hydroxide in the root canal.\textsuperscript{12,15} However, it has been shown that calcium hydroxide fails to consistently produce sterile root canals, and even allows regrowth in some cases.\textsuperscript{11,14,16} Apart from this, it does not repeatedly kill the intracanal rest flora. It needs atleast two visits to be optimally potent.

Another approach is to eliminate the remaining microorganisms or to render them harmless by entombing them by complete obturation immediately after shaping and cleaning the canal space at the same visit (Single Visit Endodontics). This way the remaining microorganisms may be killed by the antimicrobial activity of the sealer or the Zinc ions of gutta percha,\textsuperscript{17-20} or may be deprived of nutrition and space to multiply.\textsuperscript{21-23}

Paul J Ashkenas defines single visit endodontics as, "Conservative nonsurgical treatment of an endodontically involved tooth, consisting of complete biomechanical cleaning, shaping and obturation of root canal system during one visit."\textsuperscript{24}

Single-visit root canal treatment offers several advantages over multivisit treatment such as reduced flare-ups,\textsuperscript{25-27} good patient acceptance\textsuperscript{28} and practice management considerations.\textsuperscript{28} Few flare-up rates are seen with single-visit procedures\textsuperscript{29} due to the fact that the remaining bacteria and other irritants are not allowed to remain in the empty canal isolated from the healing system. Isolating areas of inadequate instrumentation and/or other irritants within the canal is yet another possible reason for higher two-visit flare-up rate. Other advantages of completing treatment in one session include immediate familiarity with the internal canal anatomy, early sealing of the canal system which eliminates ingress of oral microflora from a leaking restoration, lateral canals and caries.\textsuperscript{29}

However this issue is very controversial and opinions vary greatly as to the relative risks and benefits of single versus two-visit root canal treatment and the effect of these two treatment modalities on incidence of post-operative pain.

**Material and Method**
Subject Enrolment, Ethical clearance was obtained before proceeding with the study. In vivo study subjects were recruited from the regular pool of patients referred to Postgraduate Endodontic Clinic for initial nonsurgical root canal treatment.

**Inclusion criteria -**
1. Maxillary and mandibular 1st molars
2. Presence of sinus tract
3. Vital teeth (intentional root canal therapy)
4. Teeth with irreversible pulpitis, with or without apical periodontitis.

**Exclusion criteria -**
1. Patients with a positive history of antibiotic use within the past month.
2. Pregnant patients.
3. Patients needing antibiotic premedication for dental treatment (including infective endocarditis, prosthetic joint and immunocompromised disorders)
4. Diabetic patients
5. Patients with acute apical abscess
6. Teeth with weeping canals
7. Teeth with periapical radiolucency greater than 0.5cm (5mm)

The treatment plan and the purpose of the study were explained to the patient, and a written consent form was obtained. Patients were randomly assigned to two experimental & one control group. Each group had a sample size of 20 (n = 20). Patients were asked to place a mark anywhere on the horizontal visual analogue scale, depending on the intensity of pain, and were instructed to use the verbal descriptors as a guide. Values assigned on VAS were between 0-170. Patients marked their preoperative pain level in the presence of the clinician to ensure that they understood the instructions. Postoperative pain after 6, 12, 24 & 48 hrs was also evaluated. The patients were given the VAS form, along with a stamped, addressed envelops for return of the form after 48 hours. VAS forms were coded as Group 1, Group 2, & Group 3 for identification.

**Clinical procedures**
In this in vivo study, sixty maxillary and mandibular first molars were included. Standard protocol for Local anaesthesia administration (Xylocaine 2% Adrenaline 1:2,00,000), rubber dam isolation (Hygenic Dental Dam, Coltene/Whaledent Inc.) & disinfection of the operating field (30% hydrogen peroxide and 10% iodine) were followed. Initial caries excavation was performed using #4 round bur (Access Cavity Set Dentsply Maillefer, Ballaigues, Switzerland). Standard access cavities were prepared using #4 round bur & Ex24 safe ended tapered fissure bur (Access Cavity Set Dentsply Maillefer, Ballaigues, Switzerland). Coronal shaping and enlargement was performed with low-speed Gates Glidden drills (Mani, Japan) using micromotor
contra angled handpiece (NSK Japan), to obtain straight line access to the apical thirds of each root. Pulp was extirpated with barbed broaches (Pulpdent, Switzerland). Canals were then irrigated with 2ml of 3% sodium hypochlorite (Comdent India), using 5cc irrigation syringe with 23 gauge needle (Becton, India). Initial canal working length was established by using Propex electronic apex locator (Dentsply Maillefer, Ballaigues), and a ISO size #15 stainless steel K file. Working length was confirmed radiographically using paralleling technique and two angled radiographs (200 mesial and distal). Canal instrumentation was performed with Protaper NT System (Dentsply Maillefer, Ballaigues, Switzerland), and 1:16 gear reduction handpiece (X-Smart, Dentsply Maillefer, France) at a speed of 300rpm. Torque was adjusted for each instrument according to the manufacturer’s specification for protaper rotary files. 17% EDTA (RC-Help, Prime Dental) was used as a lubricant during instrumentation. The master apical file size for each canal was set at 3 sizes larger than the first file to bind at the working length (after coronal enlargement with Gates Glidden drills). Canals were irrigated with 5ml of 3% sodium hypochlorite after each instrumentation cycle. Recapitulation was maintained by passing a #10 stainless steel K file approximately 0.5-1mm beyond the working length. After completion of instrumentation, all canals were coated with 17% ethylenediaminetetraacetic acid (EDTA) for 1min, followed by 5ml of 0.9% saline. All canals were then dried with sterile paper points. Teeth in group 1 were then dried with sterile paper points. Teeth in group 1 were obturated at the same appointment using single cone obturation technique with 6% gutta percha points (Dentsply Maillefer, Ballaigues, China) and epoxy resin based sealer AH Plus (Dentsply Maillefer, Konstanz, Germany). Access cavities were etched with 37% phosphoric acid, bonding agent was applied, and restored with dual cure composite resin (Luxa Core, Germany DMG). Teeth were deoccluded after completion of the treatment.

In experimental group 2, after completion of chemomechanical preparation, access cavities were closed with a sterile dry cotton pellet, followed by double sealing with Cavit G and IRM for a week. At the 2nd appointment, canals were properly irrigated with 5ml of 3% sodium hypochlorite. Canals were then coated with 17% EDTA, followed by 5ml of saline and final irrigation with 5ml of 2% chlorhexidine. Canals were dried & obturated with the same technique as described for group 1.

Group 1 - (n=20) One visit therapy
Group 2 - (n=20) Two visit therapy, with one week intracanal calcium hydroxide dressing.
Group 3(control) - (n=20) Two visit therapy, with one week dry sterile plain cotton dressing.

Each patient was given a prescription for 600mg of ibuprofen (Cipla), with instructions to take only if pain was present. They were given instructions to fill the form after 6, 12, 24 and 48 hours, and post it to the stamped address. Patients were asked to report to the hospital in case of severe pain, which was not controlled with prescribed analgesics.

Discussion
One appointment endodontic therapy gained popularity during World War II. The philosophy at that time was that, periapical surgery should be performed on all endodontically involved teeth because of limited time for treatment.30,34 Many authors stated that one-appointment therapy should be restricted to vital cases, or in those teeth where surgical procedures are indicated.21,30,32,34

Morse33 (1974) claimed that, once the canal are clean, smooth, tapered and dry, and the tooth is symptomless, obturation can be done. This may be the 1st, 2nd, 3rd or 4th visit. It is well known that, during shaping and cleaning procedures, dentin chips, micro-organisms, pulpal remnants, irrigating solutions or necrotic debris may be pushed into the periapical region causing inflammation and post-operative pain.30 Since this extrusion is a problem common to all root canal preparation techniques, modern procedures have been advocated to minimize this situation.

In 1985, Cervical flaring technique36,37 was introduced, where enlargement of cervical part of the canal using Gates Glidden drills or peeso reamers should occur prior to preparation of the apical portion.

Fava38 introduced the double-flared technique to improve the cleanliness of canal space before preparation of the apical third, thus reducing the probability of pushing debris towards the apex.
Crown-down preparation is the most known technique since the introduction of NiTi rotary instruments in endodontics. In the present study, protaper rotary files were used because of its specific design which allows their use with a brushing motion in the body of the canal. It is based on Schilder's concept of canal instrumentation.

In 1974, Herbert Schilder described the "Pre-enlargement technique". If this technique is strictly respected, the advantage of crown down and true step back techniques are gained.

Owing to the specific design of each file, the Protaper is the only rotary file system which respects the Schilder's concept of canal preparation where the shaping files S1, SX and S2 remove the cervical constriction, resulting in crown down preparation, and the finishing files F1, F2, F3, F4 and F5, prepare the apical portion of the canal.

Cleaning of prepared root canal space using irrigants with antimicrobial properties has strategic value. In a comparative study of vital and nonvital teeth, Saltanoff showed slightly more pain following single-visit treatment when saline is used as an irrigating solution. An irrigation protocol suggested by Zehander et al. was used in the present study. The protocol consists of irrigation with sodium hypochlorite during instrumentation to remove the organic debris followed by irrigation with 17% EDTA to remove the smear layer, and a final irrigation with chlorhexidine, which provides long term antibacterial effect because of its ability to bind to the canal walls. According to Zehander, this irrigation regimen provides maximum reduction in microbial load. However if chlorhexidine is used as a final irrigant, when hypochlorite is still present in the canal, there is formation of a precipitate known as parachloroaniline. So, to avoid the formation of this precipitate, saline was used to flush out the hypochlorite solution before using chlorhexidine as a final irrigant.

It is widely accepted that, inclusion of calcium hydroxide renders the canal sterile and ready for obturation. However, studies have shown that calcium hydroxide is not always effective, and that its action is unreliable. Comparison of success rate between two-visit endodontics with calcium hydroxide, and one-visit endodontic treatment of teeth showed no significant differences.

Calcium hydroxide is rather insoluble, and the release of hydroxyl ions is dependent on an aqueous environment. According to the studies, when calcium hydroxide is suspended in water, there is an optimal release of hydroxyl ions; but in the instrumented canal, the release of hydroxyl ions may be limited by a decline in the availability of water molecules. Moreover, calcium hydroxide is effective when it is in contact with the substrate, which is unlikely the case in the instrumented canal. Bacteria may occur as small colonies in which the cells at the center could be protected by the cells lying at the periphery. Furthermore, microorganisms lining dentinal tubules may be exposed to hydroxyl ions initially only at the tubule orifice. Perez et al. in an in-vitro study observed that the depth of penetration of streptococcus in the dentinal tubules was 479 um. Orstavik and Haapasal found Enterococcus faecalis and Streptococcus sanguis 300-400um deep after 2-3 weeks, whereas Pseudomonas aeruginosa infected the dentin as early as in 3 days. Calcium hydroxide is ineffective at these distances even after seven days, and these microorganisms can survive even in high pH. Bacteria may also be enclosed within the lateral canals and the reticulated network of the pulp tissue. Prolonging treatment to multiple appointments leads to bacterial regrowth in the canal, with or without most inter-appointment medicaments including calcium hydroxide. Compared to instrumentation and irrigation with saline, calcium hydroxide dressing improves canal cleanliness, but does not always reduce bacteria more effectively than instrumentation and irrigation with sodium hypochlorite. Newer canal disinfection modalities like MTAD, UV light, Photo activated disinfection sterilize the root canal with a contact time of minutes, rather than days, thus allowing immediate obturation and restoration. Recent research demonstrates that Enterococcus faecalis and Candida albicans are highly resistant to calcium hydroxide. Also, it is ineffective against S aureus and B subtilis present in the infected canals. In a study of porcine muscular tissue, exposure to calcium hydroxide enhanced tissue-dissolving capability of low-concentration (0.5%) sodium hypochlorite, but adequately concentrated (2.5-5.25%) sodium hypochlorite (without calcium hydroxide) has been shown to remove all pulpial remnants and predentin in root canals of extracted teeth, even in regions untouched by instruments. Root canals are never cleaner than immediately, after proper instrumentation with sodium hypochlorite in adequate concentration. Also if calcium hydroxide is used indiscriminately, it can harm the periodontal membrane. Therefore, permanent filling with gutta percha and sealer eliminates bacteria as or more effectively than the temporary filling with calcium hydroxide. Once placed in the canal, complete removal of calcium hydroxide is difficult which, in long run can compromise with the apical seal.

A minimum period of 10-14 days is necessary for calcium hydroxide to be effective. Coronal leakage through temporary restoration is one of the contributing factor for flare-ups
during treatment. Liberman et al reported significant dye penetration as early as 4th day when the temporary fillings (Cavit, IRM) in endodontic access cavities were loaded and thermocycled. In the present study, teeth in group 2 and group 3 were given a double seal after first appointment. Cavit was placed as an underlying material within the pulp chamber, and then IRM was placed as an "external material". The advantage of double seal is that the cavit performs better as a barrier to fluid penetration, as long as it is not loaded in occlusal function; but it is quite soluble and weak material. Whereas, IRM is relatively strong and insoluble material that does not wear rapidly; but it does not prevent fluid penetration acceptably, especially under occlusal load. Hence a combination of these two materials seems likely to overcome the disadvantage of each other, while also utilizing the advantage of both the materials.

The results of the present study are consistent with those of majority of the published reports. Post-operative pain associated with single-appointment root canal treatment is same as the post-operative pain associated with two-visit treatment, with or without calcium hydroxide dressing. The results also agree with the consensus that "pulp extirpation alone is probably the most significant factor in reduction of post-operative pain, regardless of other variables". After 6hrs patients, in Group 1 had slightly more pain than the patients in group 2 and group 3; but the difference was not statistically significant. This can be related to the intensity of preoperative pain due to the presence of inflammatory products, bacterial byproducts & shreds of pulpal remnants. According to the data, patients in Group 1 had more preoperative pain when compared to patients in Group 2 & 3. There was no significant difference among all the three groups studied after 12, 24hrs & 48hrs.

In the present study, excellent results were obtained with both experimental groups. One patient from single visit group and two cases from two-visit group had moderate postoperative pain, which was well managed by 600mg ibuprofen. After 48hrs all the symptoms subsided. Richard Walton reported that calcium hydroxide as an intracanal medicament has no significance in preventing or reducing post-operative pain. In the present study, no root canal filling was removed due to flare-up. Greater care in diagnosis and case selection must be a part of treatment; since single-visit procedures are not considered appropriate for every endodontically involved tooth.

It is well known that pain perception is a highly subjective and variable experience. Pain reporting is influenced by many factors other than experimental procedures. In addition, measurement of pain is fraught with hazards and opportunities for error. In this study, a modified Heft Parker Visual Analogue Scale was selected because it is a bounded scale with absolute values at each end, and word descriptors of pain levels placed in ascending order along the horizontal axis. The patient is instructed to place a mark on the scale corresponding to the current level of pain, and has a visual remainder of previous reports for comparative purpose. The location of the mark was evaluated and assigned a value between 0 and 170. Heft and Parker state that the unequal spacing of words on the scale represents an accurate reflection of how patients perceive spacing between the different pain word descriptors. When properly assigned and administered, Visual Analogue is considered to be a valid and reliable ratio scale instrument for the measurement of human pain intensity and unpleasantness.

It is often difficult to compare results from different studies because instrumentation and obturation techniques using same VAS scale for analysis vary widely, especially in studies that are more than several years old. The number of visits taken to complete the root canal therapy is only one of the many variables.

Success following root canal therapy will usually occur following an accurate diagnosis, proper case selection and use of standard techniques of treatment. These procedures are based upon known biological triad incorporated into the technique; chemomechanical preparation of the canal system, debridement and disinfection, and complete obturation of the prepared canals. Each of the objectives must be achieved in order to ensure a successful result.

"Single-visit procedure does not deviate from achieving these objectives. The major difference distinguishing single-visit from two-visit procedure is the completion of the entire procedure in a single-visit. The resulting advantage is the reduction of chair time without reduction in the quality of treatment".

Additional advantages are obvious: the patient is not disturbed by additional anaesthetic injections, by replacement of rubber dam, and with the placement of intracanal medicaments and temporary seal. It also spares the time spent by the clinician in refreshing his/her memory, and tactile sensation regarding the prepared canal anatomy, tooth length etc. Furthermore, there is no concern of inter-appointment leakage, loss of temporary seal and inter-appointment flare-ups.

Currently it is recommended that, teeth with infected root
Within the limitations of this in vivo study, it may be concluded that Single Visit Endodontics provides excellent results, if care in diagnosis and proper case selection is given importance. Calcium hydroxide has no relation in eliminating or reducing postoperative pain.

In the present study, 60 maxillary and mandibular molars were treated for root canal therapy in one visit and two-visit group, with and without calcium hydroxide dressing. Results were evaluated and tabulated. All three groups were compared at each interval using an independent sample t test. Level of significance used was p<0.05 (Table 1).

### Table 1: Comparison Between Groups At Different Postoperative Intervals

<table>
<thead>
<tr>
<th>Interval</th>
<th>Groups</th>
<th>Sample Size</th>
<th>Mean VAS</th>
<th>SD</th>
<th>Max possible VAS Marks</th>
<th>t</th>
<th>p</th>
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<tr>
<td>6 hrs. post-operative</td>
<td>1</td>
<td>20</td>
<td>46.5</td>
<td>20.6</td>
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<td>16.6</td>
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<td>30.95</td>
<td>16.6</td>
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After 6hrs, single visit group had slightly more pain but the difference was not statistically significant. After 12, 24 and 48 hrs there was no significant difference in post-operative pain in all 3 groups.

### Conclusion

- Post-operative pain associated with single-appointment root canal treatment is same as the post-operative pain associated with two-visit treatment, with or without calcium hydroxide dressing.
- After 6hrs patients, in Group 1 had slightly more pain than the patients in group 2 and group 3; but the difference was not statistically significant.

With advent of newer technologies and disinfection modalities, it seems appropriate to complete obturation at the same visit. Of course, if one has not followed the established protocols, or if time has prevented complete debridement, then an inter-appointment dressing should be placed, and treatment completed in the subsequent visit. Likewise, if the canals cannot be dried because of persistent apical exudates, then it is advocated to delay the obturation. When the biomechanical preparation is complete, and the canals are dry then why to wait? The objective of root canal treatment is to remove the source of infection from the surrounding apical tissues, so that the immune system can resolve any infective or inflammatory lesion in the periradicular tissues. If recent endodontic principles of irrigation and disinfection procedures using sodium hypochlorite, MTAD, laser disinfection are followed along with proper biomechanical preparation, then single-visit endodontics is highly successful. However, the decision of completing treatment in single-visit or multiple-visit in teeth with large periapical lesions and retreatment cases warrants further research.


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