

## Evaluation of postoperative pain after endodontic treatment with foraminal enlargement and obturation using two auxiliary chemical protocols

*Avaliação da dor pós-operatória de tratamentos endodônticos realizados com ampliação e obturação foraminal utilizando dois protocolos de substâncias químicas auxiliares*

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### Resumo

**Objetivo:** Este estudo clínico prospectivo randomizado analisou a influência de duas substâncias químicas auxiliares, com diferentes potenciais de toxicidade, na dor pós-operatória observada em 301 tratamentos endodônticos concluídos em uma única sessão, com ampliação do forame apical e sobre-extensão de cimento para o periápice. **Material e método:** Foram usados gel de clorexidina a 2% (CHX 2% gel; n = 145) e hipoclorito de sódio a 5,25% (NaOCl 5,25%; n = 156). A incidência de dor pós-operatória e desconforto foi avaliada em 24 horas, e foi expressa em porcentagem. O teste exato de Fischer e o teste de Qui Quadrado foram utilizados para comparar a variação da dor pós-operatória. Os fatores analisados foram dor prévia, estado pulpar, idade e número de canais radiculares. **Resultado:** Nos dentes com dor prévia e instrumentados com CHX 2% gel, a incidência de dor pós-operatória foi 22,22% (6/27), contra 11,11% (3/22) nos dentes instrumentados com NaOCl 5,25%. Nos dentes sem dor prévia e instrumentados com CHX 2% gel, a incidência de dor pós-operatória foi 5,08% (6/118), contra 2,33% (3/129) nos dentes instrumentados com NaOCl 5,25%, sem diferenças estatisticamente significativas entre os grupos. Os resultados mostraram que a dor prévia exerceu uma influência significativa no estado pós-operatório ( $p < 0,001$ ). Após 24 horas, 93,7% (282/301) dos dentes não apresentaram dor, ao passo que 6,3% (19/301) tiveram algum nível de dor pós-operatória e fizeram uso de uma ou duas doses da medicação. **Conclusão:** Diante dos resultados, podemos concluir que a substância química auxiliar não está associada à dor pós-operatória.

**Descritores:** Tratamento do canal radicular; clorexidina; hipoclorito de sódio; dor pós-operatória.

### Abstract

**Aim:** This prospective randomized clinical study examined the influence of two different auxiliary chemical substances on postoperative pain in 301 single-visit endodontic treatments, with enlargement of the apical foramen and extrusion of cement into the periapical region. **Material and method:** The two auxiliary chemicals used were 2% chlorhexidine (2% CHX gel; n = 145) and 5.25% sodium hypochlorite (5.25% NaOCl; n = 156). The incidence of postoperative pain and discomfort was assessed at 24 hours and expressed as percentages. The Fisher exact test and the Chi-square test were used to compare variation in postoperative pain. The variables analyzed were previous pain, pulp status, age, and number of root canals. **Result:** In teeth with previous pain instrumented with 2% CHX gel, the incidence of postoperative pain was 22.22% (6/27) versus 11.11% (3/22) in teeth instrumented with 5.25% NaOCl. In teeth without previous pain instrumented with 2% CHX gel, the incidence of postoperative pain was 5.08% (6/118) versus 2.33% (3/129) in teeth instrumented with 5.25% NaOCl, with no statistically significant difference between the groups. Results showed that previous pain had a significant influence on postoperative status ( $p < 0.001$ ). After 24 hours postoperatively, 93.7% (282/301) of the teeth had no pain and 6.3% (19/301) had some level of pain, and used one or two doses of medication. **Conclusion:** Based on the results, it can be concluded that the auxiliary chemical substances had no influence on postoperative pain.

**Descriptors:** Root canal therapy; chlorhexidine; sodium hypochlorite; pain, postoperative.

## INTRODUCTION

Pain and discomfort immediately after endodontic treatment are significant problems for dentists and patients<sup>1-3</sup>, and their occurrence and management are of fundamental importance in endodontics.

A number of factors reported in the related literature have been associated with the process of postoperative pain, including the presence of preoperative pain<sup>1-3</sup>, pulp and periapical changes<sup>1,2</sup> as well as location and tooth type<sup>3,4</sup>. Other factors described in the literature may also be associated with postoperative symptoms, such as number of visits<sup>4-6</sup>, original treatment or retreatment<sup>2</sup>, iatrogenic technical procedures associated with chemical<sup>7</sup> or mechanical<sup>8</sup> injuries, as well as injury caused by microorganisms and their products<sup>9,10</sup>.

Among mechanical factors, some authors found no correlation of overinstrumentation and overfilling with postoperative pain<sup>11-15</sup>. Nevertheless, overinstrumentation with enlargement of the apical foramen can predispose to extrusion of auxiliary chemicals. Therefore, the objective of the present prospective randomized study was to assess the influence of different auxiliary chemical substances on postoperative pain in 301 single-visit endodontic treatments with the enlargement of the apical foramen and extrusion of endodontic cement into the periapical region.

## MATERIAL AND METHOD

The present study was approved by the institutional ethics committee for research involving human subjects, under process number 2011/0115. Three hundred and one single-visit endodontic treatments were performed in 240 patients aged 13-79 years by the same endodontist. Oral and written consent was obtained from all participants. Data related to personal information, general health status, probable diagnosis, treatment indicated, and pre-, intra- and post-operative procedures were recorded and filed. All patients seeking treatment at the research venue during the study period who did not meet the exclusion criteria were selected by order of arrival for inclusion in the study. Given that pulp and periapical diagnoses and the tooth to be treated were not known, this selection was carried out randomly. Primary endodontic treatments and retreatments of all dental groups were included in the study. Teeth with open apices, root resorptions, dental trauma, treatments not finished within a single session, root canals in which patency of the apical foramen was not achieved and teeth without overfilling, were all excluded from the study.

Pulp and periapical diagnoses of the teeth were determined using periapical radiographs and the cold pulp vitality test. The initial clinical exam included checking for the presence of pain, fistula, swelling, sensitivity on palpation and cold pulp tests. All examinations were carried out on both affected and control (contralateral unaffected) teeth. Intraoral periapical radiographs were used to determine the presence of any periapical lesions.

The teeth were divided into 2 groups according to the auxiliary chemical used. In Group 1 (n = 145), the auxiliary chemical used for root canal preparation was 2% chlorhexidine gel (2% CHX gel; Essencial Pharma, Itapetinga, SP, Brazil), whereas in Group

2 (n = 156) 5.25% sodium hypochlorite (5.25% NaOCl; Fórmula & Ação, São Paulo, SP, Brazil) was used. The auxiliary chemical substances were introduced into the root canals using a 3 mL hypodermic syringe with a 20 × 5.5 needle, only to act during the action of the instruments. For irrigation of the root canals in both groups, physiological saline solution was employed, introduced into the root canals under pressure using a 5 mL hypodermic syringe with a 20 × 5.5 needle upon each change of instrument. The auxiliary chemical substance was reintroduced after irrigation with physiological saline solution.

All teeth, irrespective of pulp and periapical diagnoses, were treated using the procedures outlined below. All patients were previously anesthetized (2% lidocaine with 1:100.000 adrenalin; DFL<sup>®</sup>, Taquara, RJ, Brazil). Canals were instrumented using the crown-down technique which entailed removal of caries and restorations; standard access opening; rubber dam isolation; decontamination and enlargement of the cervical and middle thirds using a Hero 20/.06 rotary instrument (HERO 642; MicroMega<sup>®</sup>, Besançon, Franche-Comté, France) with concomitant use of the auxiliary chemical. When required, enlargement of the canal body was complemented using Gates-Glidden #4 to #2 drills (Dentsply-Maillefer<sup>®</sup>; Ballaigues, Jura-Nords Vaudois, Switzerland) in the crown-apex direction to promote adequate tapering. The apical third was explored using a #10 K-type hand file (Hi-5; Miltex<sup>®</sup>, York, PA, USA) for progressive decontamination until achieving patency. Actual root canal length was defined using an electronic apex locator (Novapex; Forum Engineering Technologies<sup>®</sup>, Richon LeZion, Israel) by step-back withdrawal of the patency instrument to point zero. The working length (WL) was established as 1 mm beyond the actual root canal length in order to overinstrument the apical foramen area, keeping this area clean and debris-free. Subsequently, canal instrumentation and shaping was performed using rotary instruments (Mtwo system; VDW<sup>®</sup>, Bayerwaldstraße Munich, Germany ) numbers 10/.04, 15/.05, 20/.06 and 25/.06, according to the manufacturer's recommendations. Root canals in both groups were copiously irrigated with 5 mL of physiological saline solution under pressure upon each change of instrument. After root canal preparation and shaping, the final diameter of the foramen was determined (anatomical finishing file) by establishing the size of the K-type hand file (CC+; VDW<sup>®</sup>, Bayerwaldstraße, Munich, Germany) which provided the best fit within the prepared apical foramen. This diameter was taken as the reference for calibrating the master gutta-percha cone (Konne<sup>®</sup>, Belo Horizonte, MG, Brazil) for filling the root canal. In the absence of an apical stop for anchoring, the diameter for calibration of the cone was defined as two sizes larger than the final diameter of the apical foramen. The root canal was filled with chlorhexidine gel and the cone shaped (by applying apical pressure) to give a snug fit against the root canal walls until attaining an ideal lodgment point approximately 2 mm short of the actual root canal length, as verified radiographically.

Preparation of the root canal dentin (removal of smear layer) for obturation was effected with 3 successive flushes using 17% EDTA (Fórmula e Ação, São Paulo, SP, Brazil), introduced into the canal and agitated ultrasonically for 10 seconds with final irrigation using physiological saline solution. The root canals were dried with the aid of a silicone cannula (Capillary Tips; Ultradent<sup>®</sup>, South

Jordan, UT, USA) and paper points calibrated to the actual root canal length (Endpoints®, Paraíba do Sul, RJ, Brazil).

Root canals were filled with endodontic sealer (Pulp Canal Sealer EWT; (SybronEndo®, Orange, CA, USA) using the De Deus obturation technique<sup>16</sup>. Sealer was placed in the root canal with the aid of the gutta-percha cone to fill the whole length of the canal. The gutta-percha cone was then placed at the lodgment point for thermoplasticization and vertical compaction.

The cervical portion of the root canal was sealed with Coltosol (Vigodent®, Bonsucesso, RJ, Brazil) and the coronal access cavity was restored using composite resin or glass fiber post cementation, as required. The necessary occlusion adjustments were then made.

After the treatment procedures, patients were instructed to use medication (100 mg of Nimesulide every 12 hours for 3 days) only in the event of severe pain. All patients were contacted by the operator by telephone after 24 hours to check postoperative status. In cases of persistent symptomatology, patients were requested to pay a return visit to the clinic for management of the symptoms.

Evaluation of postoperative pain was categorized into either absence or presence of pain, regardless of the intensity of pain experienced by the patient<sup>17</sup>.

The incidence of postoperative pain and discomfort was recorded and expressed as percentages. Data were submitted to statistical analysis using the Fisher exact test and the Chi-square test for non-parametric data. The statistics applications package Bioestat 5.3 (Mamirauá Institute of Sustainable Development, Tefé, AM, Brazil) was employed and differences were considered significant for p-values ≤ 0.05.

## RESULT

A total of 301 teeth endodontically treated with foraminal enlargement were assessed. After 24 hours, 93.7% (282/301) presented no pain and 6.3% (19/301) had some level of postoperative pain (sensitivity, mild pain, moderate pain or severe pain) and used one or two doses of medication. Among the latter, only 0.66%

(2/301) had severe spontaneous pain (flare-up) and returned for further assessment.

The descriptive frequency distribution of clinical factors analyzed in the sample is given in Table 1 showing that, of the factors assessed, only previous pain had a significant influence on the presence of postoperative pain (p < 0.001). Among those patients with previous pain, 16.67% experienced postoperative pain versus only 3.64% of patients without previous pain.

The auxiliary chemical substances used had no statistically significant influence on the outcome of postoperative pain, irrespective of pulp status of the teeth (p > 0.05). Of the 123 vital teeth, 4.07% (5/123) had postoperative pain, compared with 6% of non-vital teeth (6/100) and 8.87% (7/78) of endodontically retreated teeth. Analysis of postoperative pain by patient age and number of root canals revealed that these factors had no statistically significant influence on postoperative pain. Likewise, the chemical substances used had no effect on pain outcome (p > 0.05).

Table 2 depicts the analyses of the influence of the auxiliary chemical substances in teeth with and without preoperative pain. Neither of the auxiliary chemical substances reduced or exacerbated postoperative pain after 24 hours.

## DISCUSSION

Postoperative pain following endodontic treatment remains common, with a prevalence of 3% to 58%<sup>18</sup>, and can stem from chemical, mechanical or microbiological injuries in periradicular tissues. Psychological factors have also been suggested as a possible cause of postoperative pain<sup>9,10</sup>.

Unfortunately, the etiological factors are not yet clearly elucidated, and results available in the literature fail to clarify the true role of the suggested etiological factors of postoperative pain.

The results of the present prospective randomized clinical study revealed a rate of 93.7% for absence of postoperative pain, irrespective of the associated factors analyzed such as history of previous pain, auxiliary chemical substance, pulp status and number of root canals. These results differ from the findings of

**Table 1.** Frequency distribution of descriptive clinical factors analyzed in the sample

Clinical factors	Categories	Total n (%)	Absence of pain	Presence of pain	p-values
Previous pain	Yes	54 (17.94%)	45 (83.33%)	9 (16.67%)	p < 0.001
	No	247 (82.06%)	238 (96.36%)	9 (3.64%)	
Pulp status	Vital tooth	123 (40.86%)	118 (95.94%)	5 (4.07%)	p > 0.05
	Non-vital tooth	100 (33.22%)	94 (94.00%)	6 (6.00%)	
	Retreatment	78 (25.92%)	71 (91.03%)	7 (8.97%)	
Number of root canals	1	121(40.20%)	118 (97.52%)	3 (2.48%)	p > 0.05
	2	47 (15.61%)	42 (89.36%)	5 (10.64%)	
	3	114 (37.87%)	106 (92.98%)	8 (7.02%)	
	4 or more	19 (6.31%)	17 (89.47%)	2 (10.53%)	
Age	Up to 35 years	64 (21.26%)	58 (90.63%)	6 (9.37%)	p > 0.05
	36 to 45 years	98 (32.56%)	91 (92.86%)	7 (7.14%)	
	46 to 55 years	80 (26.58%)	77 (96.25%)	3 (3.75%)	
	Over 55 years	59 (19.60%)	57 (96.61%)	2 (3.39%)	

p-values calculated using the Fisher exact test or Chi-square test.

previous studies in the literature reporting rates of between 15.2% and 69%<sup>3,4,19-22</sup>.

The present study included vital, non-vital and endodontically retreated teeth. Pulp status and modality of treatment had no significant influence on postoperative pain. This result corroborates the findings of investigations in the literature<sup>2,3,19,21,22</sup> that found no difference between original endodontic treatments and retreatments as regards the occurrence of postoperative pain.

The results of this study demonstrated that apical overinstrumentation and overfilling had scant influence on postoperative pain given that all teeth assessed were overinstrumented and overfilled (Figure 1). These data are in line with previous investigations showing that achieving apical patency and overinstrumentation with enlargement of the apical foramen<sup>11,15</sup> did not increase the incidence, severity or duration of postoperative pain<sup>8</sup>.

Although enlargement of the apical foramen predisposes to extrusion of irrigant, no statistically significant difference in the incidence of postoperative pain was evident after use of 5.25%

sodium hypochlorite, considered a highly toxic substance in the literature, when extruded into the periapical region. This result may be explained by the fact that the chemicals served as auxiliary substances during instrumentation and not as irrigants. The risk of extrusion was reduced given that the root canals and pulp chamber were instrumented with the auxiliary chemical substances within the root canal. Active irrigation using physiological saline solution, which is compatible with periapical tissues, may have helped cleanse the apical and periapical areas since these were intentionally irrigated under pressure within the canal.

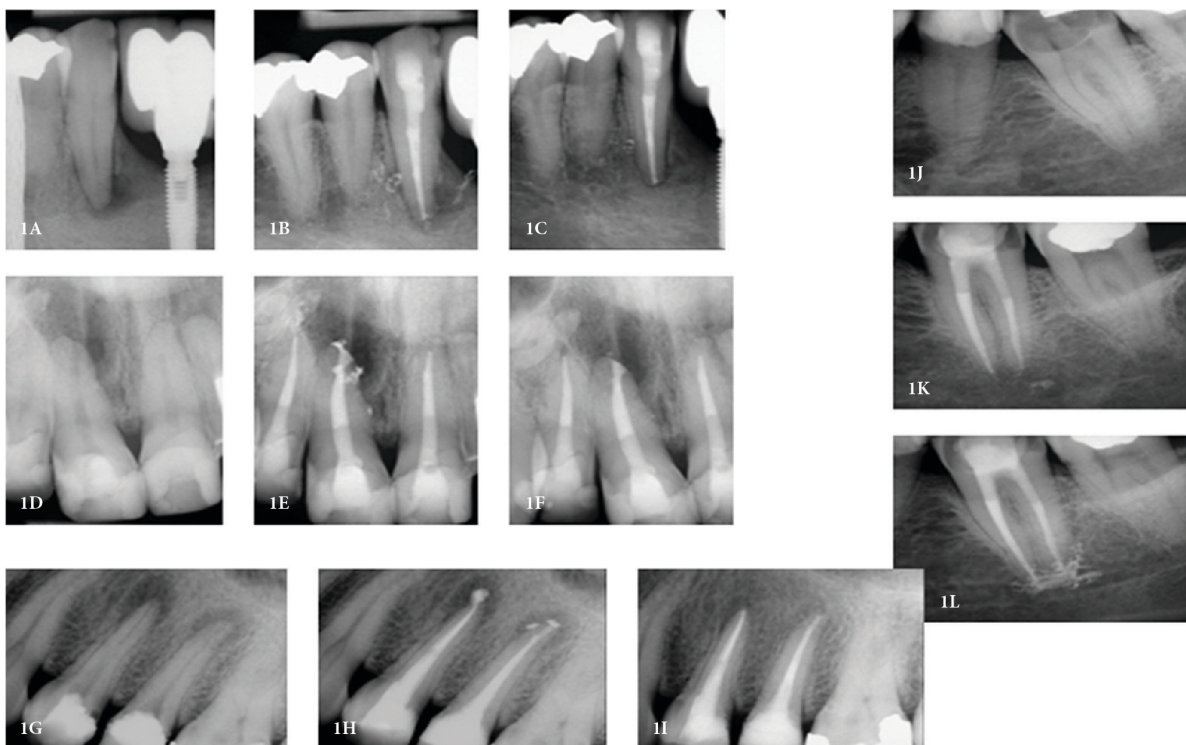
With regard to the factors analyzed, previous pain was found to have a significant influence on postoperative pain ( $p < 0.001$ ). Of the 54 teeth with previous pain, 9 (16.67%) had postoperative pain, whereas of the 247 teeth without previous pain, 9 (3.64%) had postoperative pain, a result in agreement with those of previous studies confirming the influence of this factor on postoperative pain<sup>1-3,22</sup>.

The incidence of severe spontaneous pain (flare-up) was 0.66%, lower than the general incidence of flare-up in the literature, which

**Table 2.** Influence of auxiliary chemical substances on teeth with (n = 54) and without (n = 247) previous pain

	Auxiliary chemical substance	Total n (%)	Absence of Pain	Presence of Pain	p-values
Teeth with previous pain	CHX	27 (50%)	21 (77.78%)	6 (22.22%)	$p > 0.05$
	NaOCl	27 (50%)	24 (88.89%)	3 (11.11%)	$p > 0.05$
Teeth without previous pain	CHX	118 (47.77%)	112 (94.92%)	6 (5.08%)	$p > 0.05$
	NaOCl	129 (52.23%)	126 (97.67%)	3 (2.33%)	$p > 0.05$

CHX = 2% chlorhexidine gel; NaOCl = 5.25% sodium hypochlorite; "p" values calculated using Fisher's Exact test.



**Figure 1.** Examples of cases treated and followed-up with patency, foraminal enlargement and periodontal filling. Figures 1A, D, G, J depict initial radiographs. Figures 1B, E, H, K depict radiographs taken immediately after endodontic treatment. Figures 1C, F, I, L depict follow-up radiographs taken 6 months after completion of endodontic treatment.

reports rates ranging from 1.5% to 12%<sup>2-5,19,23</sup>. This disparity may be explained by the design of the studies, some of which were retrospective and others prospective, or by the undefined variables in a small number of patients<sup>23</sup>. Additional explanatory factors include the heterogeneous populations, variation in treatment modality and alternative assessment methods described. According to Walton, Fouad<sup>2</sup>, flare-ups are positively correlated with the presence of previous symptoms, but not with age or number of visits.

Our results differ from those of Georgopoulou et al.<sup>24</sup>, who showed increased flare-up when teeth were overinstrumented, and from those of Nobuhara et al.<sup>25</sup>, who reported that endodontic instruments forced beyond the apical foramen can extrude a variety of irritants into periapical tissues and increase both the incidence and severity of pain. Progressive crown-apex decontamination was decisive in preventing this occurrence.

The teeth were treated in a single visit because, given the combination of effective mechanical instrumentation, use of antimicrobial irrigant and three-dimensional obturation of the root canal, the single-visit treatment can effectively reduce the intracanal microbiota and allow a favorable outcome<sup>6</sup>. In addition, a number of previous studies failed to find any difference in incidence of pain between single- and multiple-visit treatments. Other studies have found that single-visit treatments are associated with a lower rate of postoperative pain<sup>1,2,5,6,22</sup>, although some authors have found the opposite results<sup>4</sup>. Sathorn et al.<sup>18</sup> found no convincing evidence of differing incidences of flare-up in single- or multiple-visits treatment.

In the present study, the rate of postoperative pain of 6.3% may be explained by factors associated with failures in occlusal adjustment of the coronal restoration, or by the pressure exerted on the periodontium by the rubber dam clamp during treatment.

The severe pain found in 0.66% (2/301) may have been caused by iatrogenic technical procedures associated with chemical<sup>7</sup> or traumatic mechanical<sup>8</sup> injuries, as well as those caused by microorganisms and their products<sup>9,10</sup>. Patients' individual pain thresholds and emotional factors may also have influenced outcomes. Patients can experience a wide range of different emotional responses for very similar levels of stimuli intensity, depending on their perceptions of the event.

In view of the dearth of clinical studies in the literature investigating the influence of auxiliary chemical substances on the postoperative pain related to endodontic treatment, there is a need for future prospective clinical trials correlating postoperative pain with different preparation and obturation techniques as well as filling materials.

## CONCLUSION

Based on the results of this study, it can be concluded that the chemical substances used in the single-visit endodontic treatments or retreatments with enlargement of the apical foramen and apical extrusion of the endodontic sealer had no influence on spontaneous postoperative pain.

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## CONFLICTS OF INTERESTS

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The authors declare no conflicts of interest.

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