



Use of sodium hypochlorite in root canal irrigation. Opinion survey and concentration in commercial products

Hipoclorito de sodio en irrigación de conductos radiculares: Sondeo de opinión y concentración en productos comerciales

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ABSTRACT

Objective: To determine hypochlorite concentration of solutions used for root canal irrigation and compare them with concentrations deemed as «ideal» in scientific literature (5.25 and 2.5% (w/v)). **Methods:** Opinion survey among endodontic specialists to ascertain sodium hypochlorite commercial brand most used in root canals irrigation. Iodometric titration to determine solution concentrations. Clorox Regular Bleach (Oakland, California) commercial brand most referred to in literature. Mean comparison of different commercial brands and lots. Concentrations deemed ideal 5.25 and 2.5% (w/v). **Results:** Commercial brands of sodium hypochlorite most used by 192 endodontic specialists were as follows: Cloralex (43.2%), Concentrated Clorox (30.2%), Viarzone-T (16.7%), Great Value (1.0%), «Los Patitos» (0.5%) and other brands (8.3%). Concentration (mean IC 95%) of Clorox Regular Bleach (6.34%, 6.32-6.36) Concentrated Clorox (5.43%, 5.42-5.45), Cloralex (5.40%, 5.38-5.41), Great Value (6.21% 6.19-6.23) and «Los Patitos» (5.82%, 5.80-5.83) exceeded a 5.25% sodium hypochlorite concentration. Viarzone-T (2.86%, 2.85-2.87) rated above the 2.5% hypochlorite concentration. There were statistically significant differences ($p \leq 0.001$) among averages of different commercial brands and lots, with respect to concentrations deemed as ideal (5.25 and 2.5% (w/v)). **Conclusion:** Hypochlorite concentrations in commonly used commercial products are not the concentration recommended in scientific literature (5.25 w/v and 2.5% w/v). This can cause tissue damage in cases when hypochlorite solutions are improperly used without field isolation.

RESUMEN

Objetivo: Determinar la concentración de hipoclorito de soluciones empleadas en la irrigación de conductos radiculares y comparar con las concentraciones mencionadas como adecuado en la literatura (5.25 y el 2.5% (w/v)). **Métodos:** Sondeo de opinión en endodoncistas para conocer la marca comercial de hipoclorito de sodio más empleadas en la irrigación de conductos radiculares. Titulación yodométrica para determinar la concentración de las disoluciones. Clorox Regular Bleach (Oakland, California) marca comercial más referida en la literatura. Comparación de las medias de las diferentes marcas comerciales y lotes. Concentraciones referidas como idóneas 5.25 y 2.5% (p/v). **Resultados:** Las marcas comerciales más empleadas en 192 endodoncistas de hipoclorito de sodio fueron Cloralex (43.2%), Clorox concentrado (30.2%), Viarzone-T (16.7%), Great Value (1.0%), Los patitos (0.5%) y otros (8.3%). La concentración (media, IC 95%) de Clorox Regular Bleach (6.34%, 6.32-6.36), Clorox concentrado (5.43%, 5.42-5.45), Cloralex (5.40%, 5.38-5.41), Great Value (6.21%, 6.19-6.23) y Los patitos (5.82%, 5.80-5.83), exceden la concentración de 5.25% de hipoclorito. Viarzone-T (2.86%, 2.85-2.87) está por arriba de la concentración de 2.5% de hipoclorito. Existen diferencias estadísticamente significativas ($p \leq 0.001$) entre las medias de las diferentes marcas comerciales y lotes con las concentraciones referidas como idóneas (5.25 y 2.5% (p/v)). **Conclusión:** Las concentraciones de hipoclorito en los productos comerciales empleados comúnmente, no son las concentraciones recomendadas en la literatura (5.25 y 2.5% p/v); esto puede derivar en daño tisular cuando se irrigan las soluciones de hipoclorito en forma inadecuada y sin aislamiento.

Key words: Sodium hypochlorite, root canal irrigation, iodometric titration.

Palabras clave: Hipoclorito de sodio, irrigación de conductos radiculares, titulación yodométrica.

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INTRODUCTION

Biomechanical use of instruments as well as root canal cleansing require the use of a chemical solution.¹ Solutions of sodium hypochlorite have been widely used to this effect. Their concentration can vary from 0.5 to 5.25%.²⁻⁵ These concentrations can be used directly from the bottle or derived from a solution.

The American Endodontics Association has defined sodium hypochlorite as a clear, pale, yellowish-greenish, extremely alkaline liquid, with strong scent to chlorine. It exerts dissolving action over organic remains as well as necrotic tissue. It is also a potent anti-microbial agent.⁶

During 1915, in World War I, Dakin introduced sodium hypochlorite solution (concentrations 0.45 to 0.50%) for disinfection of open or infected wounds.^{7,8} In 1917, Barret spread the use of Dakin solution in dentistry, especially for root canal irrigation. He informed that the solution was a very efficient antiseptic.⁹ Years later, Coolidge used sodium hypochlorite to improve root canal cleansing and disinfection procedures.^{10,11}

Dr. Blass was one of the pioneers in the use of 5% sodium hypochlorite (chlorinated soda) as organic material solvent as well as potent germicide. His experiences were published in the 5th Edition of the National Formulary, in 1936, Walker described usage of 5% sodium hypochlorite for preparation of root canal in tooth with necrotic pulps.¹²

In 1954, Lewis informed of use of sodium hypochlorite, commercial brand- name Clorox, due to the fact that this product contained 5.25% available chlorine concentration¹³. In 1970 Shih studied *in vitro* antibacterial action of 5.25% sodium hypochlorite on *E. faecalis* and *S. aureus*. To this effect, Shih used the commercial brand Clorox, since this product possessed a 5.25% sodium hypochlorite concentration.¹⁴

In an *in vitro* study, Trepagnier & et al, concluded that 5% sodium hypochlorite was a potent tissue solvent. Dilution of this solution with water, at equal parts, (2.55) did not appreciably alter its solvent action.¹⁵

Even though sodium hypochlorite is widely used in endodontics, to this date there is no consensus on ideal concentration. Frequent and abundant irrigation with 2.5% sodium hypochlorite solution, can preserve sufficient stock of chlorine to eliminate significant amounts of bacterial cells, compensating thus the irritant effect caused by use of higher concentrations.¹⁶⁻¹⁸

Organic tissue dissolution capacity shown by these solutions cause that solid pulp fragments be dissolved

by the irrigating solution itself, facilitating removal from the inside of root canal system. Scientific literature review showed the fact that commercial solutions of sodium hypochlorite had not been thoroughly reviewed. The aim of the present study was, with the help of iodometric titrations, to determine sodium hypochlorite concentrations in commercial products used for root canal irrigation, as well as comparing them to concentrations deemed "ideal" in literature (5.25% and 2.5% (w/ v))

MATERIALS AND METHODS

OPINION SURVEY

In May 2010, an opinion survey of endodontic specialists of the Mexican Endodontic Academy was conducted. The aim of the survey was to assess which disinfectant solution they used for irrigation of root canal systems during cleansing and conformation procedures. Participants were asked to only identify the most frequently used solvent. When sodium hypochlorite was used, participants were asked whether they themselves performed dilution, or whether a dental assistant was requested to perform this function. Participants were then asked whether they followed dilution protocols when conducting the dilutions. According to responses given, they were then asked how they diluted sodium hypochlorite. When they answered they used diluted sodium hypochlorite, they were then questioned about how frequently they prepared the solution.

SODIUM HYPOCHLORITE COMMERCIAL PRODUCTS

All sodium hypochlorite solutions samples were purchased at different commercial stores in Mexico City. Clorox Regular Bleach (Oakland, Ca.) was purchased in Laredo, Texas, USA. 10 samples were gathered from each commercial brand. They were then divided into two different lot numbers. They were then subjected to 15 titrations, so as to obtain a total of 150 samples for each commercial brand.

IODOMETRIC TITRATIONS

Iodometric titration (IT) was undertaken to ascertain sodium hypochlorite concentration in products destined to dental and domestic uses¹⁹. The following agents were incorporated into a flask with distilled water: reactive degree potassium iodide (J.T. Baker, USA), glacial acetic acid (J.T. Baker,

Mexico) as well as sodium hypochlorite solution to be titrated. Available chlorine oxidized iodide ions to produce iodine, this discolored the solution towards a brownish hue. Resulting solution was titrated with standard reactive grade sodium thiosulfate solutions, at a 0.1N concentration (Hycel, Chemical Reagents, Mexico), up to the point when the brownish hue of the solutions turned yellowish; at that point in time, liquid starch was incorporated into the solutions as an indicator of the final reaction point.

Sodium hypochlorite concentration of each sample was processed with 150 titrations for each brand and lots markings. Hypochlorite concentrations were given by the following evaluation: (3.7722 "A" N/V) in which: A is equivalent to mL of sodium thiosulphate rated solution required for sample titration; N represents normality of sodium thiosulphate rated solution; V to sample volume taken in mL: 3,722 represents equivalent hypochlorite weight value according to 1mL of 0.1N sodium thiosulphate solution.^{19,20}

STATISTICAL ANALYSIS

Mean and standard deviation (SD) were determined for each product and lot containing sodium hypochlorite. Presence of statistical significant differences were determined among Ideal (5.35 and 2.5% (w/v)) reference values and average product-lot containing sodium hypochlorite, with the use of «t» Student test for a simple sample. Confidence level was 95%.

Data were analyzed with Statistical Package of the Social Sciences (SPSS), Windows software, version 20.0.

RESULTS

OPINION SURVEY

An opinion survey was conducted on 192 (48.8%) endodontics specialists, selected out of the 397 forming the directory of the 2010 Mexican Endodontic Academy directory. 77.1% specialists surveyed only used sodium hypochlorite solutions to irrigate root canals. The most favored commercial brand was Cloralex, 43.2% (n = 83). The next was Concentrated Clorox 30.2% (n = 58). Then came Viarzoni-T 16.7% (n = 32), Great Value 1.0% (n = 2), combinations of the above or other commercial brands 8.3% (n = 9).

Concentrations mostly used by surveyed specialists were 5.0% and 2.5 sodium hypochlorite with 19.8% (n = 38) for each concentration. 35.9% (n

= 69) surveyed population used sodium hypochlorite straight from the bottle, whereas 17% (n = 33) diluted it at equal parts. The remaining surveyed population used it in different manners, varying amounts of sodium hypochlorite and water. According to this survey, 60.7% surveyed population informed they performed the dilution themselves or their assistants. 86.9% surveyed population informed they performed the aforementioned dilution following a dilution protocol. 70.2% daily prepared their sodium hypochlorite solutions.

IODOMETRIC TITRATION

1,800 iodometric titrations were performed on commercial products included in this study. (Clorox Regular Bleach, Concentrated Clorox, Cloralex, Viarzoni-T, Great Value, «Los patitos») to ascertain sodium hypochlorite concentration of each brand and commercial lot.

The following was observed: concentration (mean IC- 95%) of Clorox Regular Bleach (6.34, 6.32-6.36), Concentrated Clorox (5.43, 5.42-5.45) Cloralex (5.40, 5.48-5.41), Great Value (6.21, 6.19-6.23) and «Los patitos» (5.82, 5.80-5.83) exceeded the ideal 5.25% hypochlorite concentration. Viarzoni-T (2.86, 2.85-2.87) showed concentration higher than the ideal one (2.5% w/v).

Comparison of different commercial brands and lots using ideal concentrations of 5.25% and 2.5% (w/v). Statistically significant differences were observed ($p \leq 0.001$) among averages of different commercial brands and lots, when compared to concentrations deemed «ideal» (5.25 and 2.5% (w/v). *Table I* presents results of the aforementioned comparisons.

Figure 1 shows differences among averages of each brand an commercial lot, according to 5.25 and 2.5% (w/v) ideal concentrations.

DISCUSSION

Among auxiliary solutions presently used in the biomechanical procedures of current endodontic treatments, sodium hypochlorite in different concentrations was the most widely used. This was due to the following properties: clarification, organic tissue dissolution, saponification, transformation of acids into chloramines and amino acid salts, deodorization as well as anti-microbial action.²¹⁻²³ Our results showed that more than two thirds of surveyed endodontics specialists used the aforementioned solution for root canal irrigation.

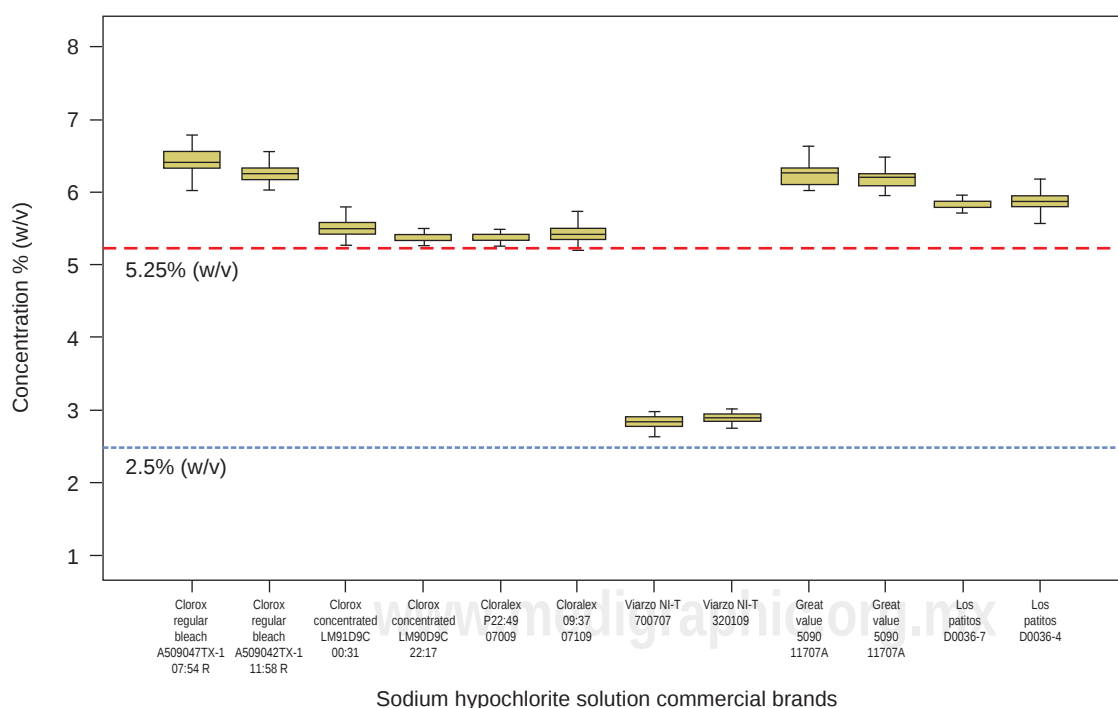
Table I. Hypochlorite concentration and mean differences among ideal concentrations 5.25 and 2.5% and commercial concentrations of sodium hypochlorite.

Name	Lot number	n	Mean	IC 95%		Proof value			
			%	Lesser %	Higher %	5.25% DM	P	2.5% DM	p
Regular clorox bleach	A509047TX-1 07:54R	150	6.42	6.39	6.45	1.169	≤ 0.001	3.919	≤ 0.001
	A509042TX-1 11:58R	150	6.27	6.24	6.29	1.015	≤ 0.001	3.765	≤ 0.001
Concentrated Clorox	LM91D9C 00:31	150	5.49	5.47	5.51	0.242	≤ 0.001	2.992	≤ 0.001
	LM90D9C 22:17	150	5.38	5.36	5.40	0.134	≤ 0.001	2.884	≤ 0.001
Cloralex	P22:49 07009	150	5.38	5.36	5.40	0.128	≤ 0.001	2.877	≤ 0.001
	09:37 07109	150	5.43	5.40	5.45	0.175	≤ 0.001	2.925	≤ 0.001
Viarzoni-T	700707	150	2.84	2.82	2.85	-2.412	≤ 0.001	0.388	≤ 0.001
	320109	150	2.89	2.88	2.91	-2.356	≤ 0.001	0.393	≤ 0.001
Great value	509011707 ^a	150	6.26	6.23	6.29	1.008	≤ 0.001	3.757	≤ 0.001
	509021403 ^a	150	6.18	6.15	6.21	0.930	≤ 0.001	3.679	≤ 0.001
Los patitos	D0036-7	150	5.81	5.79	5.82	0.558	≤ 0.001	3.307	≤ 0.001
	D0036-4	150	5.84	5.82	5.86	0.589	≤ 0.001	3.338	≤ 0.001

IC 95%: 95% confidence interval

MD :Mean difference

p: «t» Student test for simple sample.

**Figure 1.** Comparison of sodium hypochlorite concentrations with respect to ideal 5.25% and 2.5%.

Literature review revealed lack of studies on commercial sodium hypochlorite solutions.

In Mexico, manufacture of sodium hypochlorite commercial products must comply with the following norms:

a) Norma Oficial Mexicana (Mexican Official Norm) NOM-189-SSA1/SCFI-2002²⁴

b) Norma Mexicana (Mexican Norm) NMX-K-620-NORMEX-2008¹⁹

c) Norma Mexicana (Mexican Norm) NMX-K-621-NORMEX-2008²⁵

In spite of current regulations, there hasn't been found in any present Mexican Norm a clear disposition stating that labels on commercial products are constrained to specify sodium hypochlorite concentration percentages. For these reasons, a method was sought, through which sodium hypochlorite concentrations in commercial products available in Mexico were to be established, so as to compare them with ideal concentration mentioned in scientific literature.

According to opinion polls, it was observed that 86.9% of surveyed practitioners mentioned they used it straight from the bottle. They equally mentioned they followed a protocol to reach the concentration they were going to use for root canal irrigation in their clinical practice. We therefore cannot be sure of the fact that concentrations they used in clinical practice are not the desired or ideal ones for proper root canal irrigation.

Commercial products most favored by our study population were Cloralex, followed by Concentrated Clorox. These two products did not state in their labels hypochlorite concentration percentages. Nevertheless, when subjected to iodometric titration, they showed average concentration of 5.40 and 5.43% respectively. Both these concentrations were very close to our comparison parameter of 5.25%.^{13,14,18,26-33}

The commercial container of product «Los Patitos» exhibited a label where 6% concentration was stated. Iodometric titration of this product showed a 5.82% average result, which exceeded in half a percentile point the 5.25% comparison parameter.

The commercial container of Great Value product, did not show any concentration value. Iodometric titration showed average 6.21% values, these exceeded in almost a percentile point the 5.25% comparison parameter.

The commercial container of Viarzone-T exhibited a label where a 2% concentration was stated. Iodometric titration showed a 2.86% average. In that test, reference value was 2.5%, so that comparison showed a 0.36% difference.

Clorox Regular Bleach showed in its label a 6% concentration. Iodometric titration results indicated a concentration exceeding one percentile point when compared to the 5.25% reference point. Average was calculated at 6.34%.

Out of the six titrated commercial products (Concentrated Clorox, Clorox Regular Bleach, Cloralex, Los Patitos, Viarzone-t, Great Value), Clorox

Regular Bleach showed greater difference rank between reference value (5.25%) and iodometric titration results (6.34%).

Cloralex was the commercial product closest to the reference value (5.25%). When subjected to iodometric titration it showed 5.40% concentration. They thus differed by only 0.15%. This fact made it the most recommended product for root canal irrigation.

When studying the 2.5% mentioned in scientific literature, Viarzone-t, when subjected to iodometric titration, showed a 2.86% concentration. A small 0.36% difference was thus observed, rendering the product highly advisable for root canal irrigation.

Besides Cloralex, Concentrated Clorox was as well very much used for root canal irrigation. In our study, we observed that the label stated 5% free chlorine, not hypochlorite. Nevertheless, iodometric titration showed 5.43%, which represented a figure very close to the reference value (5.25%), displaying a difference of only 0.18%. This rendered this product a very advisable agent for root canal irrigation.

Great Value and «Los Patitos» showed greater concentration differences when subjected to iodometric titration, 6.21% and 5.82% respectively. Great Value showed a 0.96% difference, which showed an almost 1 percentile point difference from the 5.25% reference point. This made this product the least advisable for root canal irrigation. «Los Patitos» showed a 0.57% difference, this showed a 0.57% difference from the 5.25% reference value; rendering the product as not advisable for the stated purposes.

Clorox Regular Bleach, displayed in its label a 6% sodium hypochlorite concentration. Results obtained with iodometric titration showed the product to be over one percentile point above the 5.25 reference value.

Viarzone-t showed in its label a 2% hypochlorite concentration. This was very near to the 2.5% ideal concentration.^{15-17,31-37}

When relating survey results with iodometric results, it could be concluded there was great criteria difference when dealing with knowledge about concentrations of commercial products, as well as different dilution techniques to reach certain concentrations.

Agencies for Toxic Substances and Disease Registry (ATSDR) as well as Centers for Disease Control and Prevention (CDC) mentioned the following: «sodium hypochlorite toxic effect is tissue damage due to liquefactive necrosis. In the presence of high hypochlorite and pH concentrations, tissue damage tends to increase. Symptoms can be immediately apparent, or can delay for some hours».³⁸

In this sense, we recommend to use sodium hypochlorite rationally, noticing concentrations stated

on labels of commercial products. We must remember that, the greater the concentration, greater will be tissue damage, in cases when irrigation is conducted without the help of rubber dam and with improper techniques or instruments. It is recommended to begin with a 5.35% concentration of sodium hypochlorite. With a 1:1 dilution, a 2.5% (w/v) concentration might be obtained, that is to say, use one part of 5.25% sodium hypochlorite with the same volume of water to arrive at the desired result.

An approximate 2.5% concentration (Viarzoni-t) can be used as long as it is a frequent and abundant irrigation to maintain sufficient chlorine reserve and thus eliminate a significant number of bacterial cells, and equally counteracting irritant effects caused by high concentrations.^{16,17}

CONCLUSIONS

Hypochlorite concentrations used in clinical practice for root canal irrigation are not ideal according to results gathered from opinion surveys conducted with endodontic specialty practitioners. Hypochlorite concentrations found in commercially available products are not those recommended in scientific literature. (5.25 and 2.5% w/v). This fact can cause tissue damage when hypochlorite solutions are improperly used for irrigation without following isolation protocols.

CONFLICT OF INTEREST

Authors stated there were no conflict of interest.

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