Effects of The Interactions of Irrigant Solutions in Endodontics

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ABSTRACT

Introduction: Endodontics is a dental treatment that consists of the instrumentation of the root canals, which is indicated when there is a definitive pulp damage, the product of this procedure is the smear layer which is eliminated through irrigation with various chemical substances such as: halogen compounds, chelating solutions, and various solutions. Objective: the objective of this review is to characterize the effects that occur when combining these irrigating solutions. Methods: to carry out this scientific article or bibliographic review, it was through scientific articles similar to the main topic duly verified and truthful. Results: Irrigating solutions must meet several characteristics to be considered ideal irrigants, their combinations can cause undesirable effects within the dental structure, which can be noticeable or reflected at the level of the dental crown and periapical tissues. Conclusions: to avoid the formation of new aforementioned during the irrigating phase and prevent post-treatment consequences, managing to improve the care and ensuring a satisfactory procedure in the aesthetic and functional part of each patient who attends the consultation to the UAO clinic.

Keywords: Irrigation-irrigating solutions – effects.

1. Introduction

It is essential to perform the search in the Google Scholar web search engine and in the repository of the Uniandes in order to demonstrate the existence or not of the topic to be presented, in this way we can argue the article in a better way, after a thorough investigation gives as a negative result, but if we obtain similar derivations, being the main article: "Interactions between irrigating solutions during endodontic treatment". (1)

The limitations that occur in the disinfection of the root canals is granted to the dentinal barrel, due to the anatomical structure, composition of the dentin and restrictions associated with the different irrigation solutions that occur during manual or mechanical instrumentation in endodontic treatment. So endodontic irrigation is one of the most important steps of root canal treatment that consists of washing and aspirating the remains and substances that may be inside the pulp chamber and / or root canals, without there being side effects on healthy tissues. (2)

It is necessary that the professional knows the different chemical solutions to be used and the effects that they can cause when mixed, since through irrigation it is desired to achieve the dissolution of pulp or necrotic remains, the cleaning of the walls of the ducts to eliminate the residues that are located at the entrance of the dentinal tubules and lateral ducts and accessories, the destruction of bacteria and neutralization of their harmful products, the lubrication of the instruments facilitating their passage and cutting capacity, prevent reinfection, last but not least prevent darkening or staining of the dental crown. (3)

Nowadays there are several irrigation techniques for the elimination of the dentinal barrel or smear layer, in which different chemical substances are used since the effectiveness of a single irrigation solution does not comply with all the aforementioned actions, so it must be known the effects that can cause when these substances are combined or failing when they do not perform an adequate technique of irrigation and complete drying of the root canals. (4)

Once the chemical substances to be used during the irrigation phase of the treatment have been recognized and identified, caution must be taken

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when combining them since new components are obtained, so we must carry out the treatment with enough time and not in a hurry; At the same time manage a good irrigation technique since this also acts as a determining factor for obtaining excellent effects in each patient. (6)

Endodontics as a specialty has gone through several periods of time to be recognized as such and thus helped the preservation of dental organs to avoid wear, decrease of alveolar ridges and resorption of the maxillary and mandibular bones, so that other specialties can continue with the treatment of the patient, reducing the time and costs of the same; In addition to: prevention, health and preservation of the oral cavity. (7)

During the endodontic treatment protocol we emphasize that the irrigation phase is the essential part of the procedure since through the single or combined handling of irrigation solutions it allows us to neutralize bacterial toxins and bacterial disinfection of the duct or ducts due to suspension and mechanical dragging. Irrigation must be carried out before, during and after the instrumentation of the ducts, before to neutralize toxic products and organic debris; during in order to preserve the wet walls of the duct and facilitate the sliding of the file; then to remove the smear layer produced by the widening and filing of the duct, thus avoiding accumulation on periapical living tissues since it would make the positive action of intraduct medication impossible. (8)

The technical aspects to consider in root canal irrigation with respect to waste removal and bacterial cancellation depend on various elements such as: needle penetration depth, root canal diameter, needle internal and external diameter, irrigation pressure, irrigant viscosity, irrigation tip speed and needle bezel type and orientation. (9)

The characteristics that an irrigating agent must meet are: Effective germicidal and fungicidal, non-irritating to periapical tissues, stable solution, prolonged antimicrobial effect and antimicrobial substantivity after use, active in the presence of blood, serum and tissue-derived proteins, which can completely remove the smear leyer, low surface tension, which allows to disinfect dentin and dentinal tubules, Do not interfere with periapical repair processes, do not pigment the tooth structure, non-toxic, non-carcinogenic with the tissues surrounding the tooth, do not possess adverse effects on the physical properties of dentin, do not alter filling materials, easy to use and apply, low cost. (10)

So the purpose of this scientific review article is to publicize the effects that occur during the irrigation stage when combining irrigation solutions in endodontic treatment, in addition to capturing a brief investigation of the most used chemical substances in the specialty of Endodontics, in this way it would contribute to colleagues of lower levels take greater care in the irrigation stage since it is an elementary step to continue with the final filling of the root canal.

2. Materials and Methods

In the work presented, a documentary analysis was carried out, since information that has been scientifically evidenced will be compiled; which will help to highlight, compare and clarify the importance of not making combinations with the different irrigation substances that affect the dental organ and its surrounding tissues during the treatment of root canals, emphasizing during the irrigation phase.

Information was collected from a total of 30 publications that were found as follows: Journal of Endodontics 12 articles, Scielo 2 articles, Postgraduate thesis 5 circulars, Google Scholar 6 works, Google Books 3 books and Thesis of grade 2 advertisements; which in turn was subdivided by the year of publication, these being in 2010: 1 publication, in 2011: 2 publications,

in 2016: 3 publications, in 2017: 5 publications, in 2018: 5

publications, in 2019: 9 publications and in 2020: 5 publications. Research was obtained from these websites due to their veracity, reliability, which helped in the preparation of this registered study.

This documentary analysis led to several inquiries, it began with the qualitative approach since, with the similar articles consulted, they provided great information about the results obtained by combining irrigating solutions during endodontic treatment, as there was no caution throughout the irrigation phase of the root canal(s); Then, the descriptive scope raised the most relevant in terms of the preparation of the ducts with the different irrigants of endodontic use, that is, the effects that this generates, through the characteristics of these chemical substances that were obtained from the bibliography references and finally all the investigations were applied for the resolution of the effects appeared during the treatment of ducts.

3. Results

Endodontics is a specialty of Dentistry (USA 1964) that consists of a set of systematic knowledge about the structure, morphology, physiology, and pathology of the dental pulp and perriradicular tissues; including the differential diagnosis, prevention and adequate treatment of orofacial pain, in order to preserve the dental organs in the mouth. The American Association of Endodontists as well as the European Society of Endodontics have established protocols and guidelines to evaluate the quality of diagnosis, endodontic therapeutics and the degree of difficulty that may exist. (10)

Endodontics as a specialty has gone through several periods of time that are: The Empirical Stage, the Focal Infection Stage, the Scientific Stage, the Scientific-Technological Stage and the Regenerative Stage, so we have to realize the great scientific advance that this science has led, in addition to the

difficulty that involves people becoming aware of oral health, Prevention of pathologies and conservation of teeth Through this period of time, root canal treatment is an extremely cautious alternative to provide a better quality of life, both functionally and aesthetically for each patient. (11)

Irrigation

The irrigation phase consists of the elimination of the dentinal barrel or smear layer and the disinfection of the root canal or canals through endodontic irrigants, this cycle being fundamental during the treatment of root canals. (30)

Ideal irrigation solutions should meet several characteristics:

1. Be effective germicidal and fungicide.
2. Do not irritate the periapical tissues.
3. Stay stable in solution.

- Have a prolonged antimicrobial effect.
- Be active in the presence of blood, serum and tissue protein derivatives.
- Having a low surface tension.
- Do not interfere with the repair of periapical tissues.
- Do not stain the tooth structure.
- Be able to be inactivated in a culture medium.
- Do not induce a cellular immune response.
- To be able to completely remove the dentinal barrel and to be able to disinfect the underlying dentin and its tubules.
- Have no adverse effects on the physical properties of the exposed dentin.
- Have no adverse effects on the sealing capacity of sealing materials.
- Be of practical application.
- Be relatively inexpensive.
- Not be toxic or caustic to periodontal tissues or have the potential to cause anaphylactic reaction. (9)

Irrigation solutions in endodontics

In the absence of a single ideal irrigant that has effectiveness in both organic matter and inorganic matter alternately, other substances are used during root preparation. It should be noted that the interactions produced by mixing these irrigants form new precipitates and the properties of each substance change.

Within the irrigator solutions (chemical substances) we have a classification that consists of:

- Halogen compounds: Sodium hypochlorite (NaOCL) 0.5%, 1%, 2.5% 5.25%; Chlorhexidine gluconate (CHX) 2%.
- Chelating solutions: EDTA (ethylenediaminetetracetic acid) 10-17%; citric acid solution.
- Miscellaneous solutions: sterilized distilled water, calcium hydroxide (CaOH2), hydrogen peroxide (H2O2), physiological serum. (5)

Sodium hypochlorite possesses the greatest amount of properties of an irrigant, making it the most ideal of all irrigating substances, this substance acquires antimicrobial capacity, eliminates bacteria, fungi, spores and viruses; it has also shown efficacy against Prevotella intermedia, Peptostreptococcus micro, Streptococcus intermedius, Fusobacterium nucleatum, E. faecalis. Among its disadvantages is its high potential for toxicity when it crosses the periapex and does not completely eliminate the smear layer or dentinal barrel. (5)

Chlorhexidine has a property of substantiveness, that is, preventing microbial colonization on the dentinal surface, acts especially on Gram-positive bacteria and little in Gram-negative bacteria and even fungi (Candida Albicans), so it is proposed as an alternative in the final irrigation of the root canal or root canals. (12)

Ethylenediaminetetraacetic acid one of the qualities is to favor other irrigators to penetrate the interior of the dentinal tubules, also increases the adhesion of resinous endodontic sealants. It has antimicrobial activity less than E. faecalis, in addition, it acts against C. albicans. (16)

Citric acid is used in different industries, but in medicine it proceeds as a chelator by heavy metal poisoning, it can act instead of EDTA since it has similar characteristics; its antibacterial property allows it to act on aeroginous Pseudomonas, Escherichia coli and Candida albicans, it should be noted that it is not effective against Enterococcus faecalis. (18)

Calcium hydroxide has a chemically pure presentation (powder), which can be dissolved in different types of aqueous, viscous and oily type vehicles. It has antiseptic, bactericidal characteristics at the local level, controls inflammatory exudates, is biocompatible, also acts in pulp coating therapies and intraduct medication, another fundamental role is in the control or prevention of postoperative pain. It is effective in intraradicular bacteria, with the exception of E. faecalis. In combination with NaOCl they dissolve pulp tissue. (15)

Maleic acid is an organic acid found in the form of white crystals. (23)

Interactions between irrigation solutions:

Interaction of sodium hypochlorite with chlorhexidine: sodium hypochlorite (NaOCl) acts as an antibacterial and solvent of organic tissue, while chlorhexidine (CHX) exerts bacteriostatic action; when combined aOrange-brown precipitate called parachloroaniline is carcinogenic, mutogenic and toxic that reduces dentin permeability, compromises the sealing of the filling and the color change of the dental organ. (6)

Interaction of sodium hypochlorite with ethylenediaminetetraacetic acid: these endodontic irrigators are frequently used during treatment, EDTA softens dentin and widens the atrial root canals; when mixed EDTA reduces the amount of chlorine thus losing antimicrobial activity. (7)

Interaction of sodium hypochlorite with citric acid: citric acid (CA) is an antimicrobial, softens dentin and increases its permeability; by

binding these compounds the pH drops, this interaction releases chlorine gas being harmful to the human body, therefore, NaOCl dissipates its ability to liquidate organic tissue. (12)

Interaction of chlorhexidine with EDTA: **the mixture of** these irrigants forms a milky white saline precipitate that lines the dentinal tubules, apparently decreases the properties of EDTA. (13)

Interaction of chlorhexidine with citric acid: they form a milky solution and this solution can be removed with greater use of CHX, producing less damage to the periapical tissues. (17)

Interaction of sodium hypochlorite with maleic acid: maleic acid (MA) is used in dental surgery as a conditioner in dental adhesives, in the area of endodontics it helps in the demineralization of root dentin and dentinal barrel; these two components do not promote the formation of precipitates, but a marginal reduction in the availability of NaOCl. (18)

Interaction of calcium hydroxide with chlorhexidine: calcium hydroxide (CaOH2) is solubilized and reabsorbed in living tissues, increases radioopacity, prevents bacterial growth; the antimicrobial activity of CHX decreases when combined with CaOH2 because the pH tends to alkalize. (19) Interaction of calcium hydroxide with sodium hypochlorite: when using joints these irrigators reinforce the dissolving capacity of tissues, optimizing the antimicrobial effect. (20)

4. Discussion

They indicate that the primary goal of irrigation is to remove biofilm bacteria from the non-instrumented and anatomical portions in the complexities of the root canal system without inducing adverse effects on healthy tissues. (10)

He points out that, in order to increase the efficiency of mechanical preparation and the removal of bacteria, instrumentation must be supplemented with active irrigation solutions. Irrigation is defined as washing a cavity or bodily wound with water or a medicated liquid. The objectives of irrigation are mechanical and biological. The mechanical objective is to remove waste, lubricating the duct and dissolving organic and inorganic tissue. The biological function of irrigants is related to their antimicrobial effect. (11)

He states that irrigation, accompanied by aspiration, is a valuable aid in the preparation of the root canal. Although it is defined as an auxiliary procedure, its use is an indispensable accompaniment of endodontic instrumentation whose objectives are: cleaning, disinfection and lubrication. (28) They considered that no irrigation solution covers all the qualities of an ideal irrigator, therefore alternative irrigating substances should be used with the care not to merge them within the CR when changing from one irrigant to another, guaranteeing a correct treatment to each patient and therefore their satisfaction.

Since you can not mix the irrigating solutions with each other, due to the toxicity and even because of their carcinogenicity of the product or in turn decreases the effectiveness of one or another solution, an aid is through aspiration and drying with paper cones, followed by profuse irrigation with physiological serum that are indicators to have the power to change irrigating solution, without causing post-operative ailments or adverse results. (22)

It is the opposite of what some students believe, because they deduce that by joining these solutions they increase the potential for action of irrigators or accelerate the process of elimination and disinfection of root canals, what they do not take into consideration are the possible precipitates that form inside the duct, consecutive to complications for the final restoration of the implicit dental organ.

Most authors agree that NaOCl is the most effective substance against most bacteria but not ideal, due to the complications caused by poor irrigation technique during washing and disinfection of root canals.

In the articles cited, professionals make use of physiological serum as a neutral irrigator, in order to avoid the formation of new precipitates by carrying out a rigorous, profuse and thorough washing to change from one irrigant to another during endodontic treatment.

Among the natural compounds with antimicrobial action is curcumin, which is extracted from turmeric plants, in turn is attributed antioxidant and anticancer effects; That is why it has been used in medicine. In the area of Dentistry (Endodontics) it has been used as a root canal irrigator, showing effective and promising results in disinfection due to the permeabilizing effect causing damage to bacterial membranes, they are still conducting studies to check on which specific bacteria act. (14)

Propolis or propólis is a resinous substance which is transferred by bees to their hive for different activities, since ancient times it has been used in the area of medicine. It has been proven to have antibacterial, antifungal, antiviral, anti-inflammatory, hepatoprotective, antioxidant, antitumor, and immunomodulatory effects. Due to its antibacterial action acts with greater potential in Gram-positive bacteria, it should be noted that the solvent used for the extraction of propolis influences the potency of its antimicrobial activity. (2)

Ozone in the area of endodontics is used gaseously as a complement in the disinfection of root canals, acting on Gram negative bacteria (P. endodontalis, P. gingivalis) these have greater susceptibility than in Gram positive bacteria (oral streptococci) and C.

albicans. (26) Additionally, photodynamic therapy can be counted on, its action being by means of laser, which acts by eliminating bacteria inside the ducts (root canal therapy).

For the disinfection of ducts, high power lasers are used, but caution must be taken in the wrong proportions as this would cause carbonization of the dentin, ankylosis, cement fusion, root resorption and periradicular necrosis. It acts effectively on highly resistant bacteria (E. faecalis). (29,49,41)

5. Conclusions

Students must possess qualities such as patience, warmth, delicacy, integrity, agility and dexterity in their fingers because with time endodontics, take into consideration the duration of the treatment in order to carry out the work done.

The irrigation phase is a very necessary and indispensable step because it helps the exclusion of organic and inorganic matter; It acts in turn as a lubricant of the treated duct, in this way it avoids recurrent infections, fracture of instruments.

The combination of endodontic irrigators cause postoperative problems that affect the health of periapical tissues, the aesthetic part of the dental organs and ultimately extraction of the compromised tooth, leading to the dissatisfaction of patients with the treatment performed.

Conduct research on the interactions of the different existing endodontic irrigants, in order to raise awareness among students about the adverse reactions that can occur due to poor management of them.

References

Falcón B. Guevara L. Interactions between irrigating solutions during endodontic treatment. Revista Médica Basadrina. 2017; 11(1):56-59.

Salmerón P. Antibacterial Effect of Sodium Hypochlorite, Photodynamic Therapy, Chlorhexidine 2%, Triantibiotic Paste, Propolis and Ozone in Channels Experimentally Infected with Enterococcousfaecalis: In Vitro Study [Doctorate]. University of Murcia; 2017.

Moradas M. Álvarez B. The dentinal barrel and its importance in endodontics. RCOE. 2020; 25(2):2-6.

Santeliz Y. Endodontic irrigation activating systems [Internet]. Tuxtla. University of Chiapas; 2017. [cited June 8, 2020]. Available in: https://repositorio.unicach.mx/bitstream/20.500.12114/187/1/END%20617.6 342%20S26%202017.pdf

Navarrete N. Effect of the alternating controlled flow of chelating agents Na2EDTA and Na4HEBP on the dissolution capacity of sodium hypochlorite, NaOCl [Doctorate]. Complutense University of Madrid; 2018.

Marín M. Gómez B. Cano A. Cruz S. Castañeda D. Castillo E. Sodium hypochlorite as a duct irrigator. Clinical case, and literature review. Scielo.2019;35(1):37-40.Available in: http://scielo.isciii.es/scielo.php?pid=S0213-12852019000100005&script=sci_arttext&tlng=en

Blandón B. Haslam G. Proposal of irrigation protocol for the disinfection of root canals, SpecialtyofEndodontics UNAN-León.

University of Nicaragua. 2016 [Internet]. Lion. JOIN; 2016. [cited]

June 8, 2020]. Available in: http://riul.unanleon.edu.ni:8080/jspui/bitstream/123456789/6897/1/240549.p df

Martín M. Irrigating solutions used in endodontic treatment [Undergraduate]. University of Seville; 2016.

Gavilanes D. Efficacy of Ethylenediaminetetraacetic Acid and Peracetic Acid in the removal of Dentinal Barrel in root canals; in vitro study [Internet]. Quito. Central University of Ecuador; 2019. [citadoel8dejuniodel2020]. Disponibleen: http://200.12.169.19/bitstream/25000/18362/1/T-UCE-0015-ODO-128.pdf

Del Campo G, Cervantes J, Gonzalez A. Irrigation in Endodontics. In: Alcalá K, Del Campo G, Alcalá R. Basic principles of clinical endodontics. First edition. Mexico: Centro Universitario de los Altos; 2018. pp. 177-187

Peters O. and Peters C. Cleaning and shaping of the root canal system. In: Cohen S, Hargreaves K, Berman L. Pulp pathways. Tenth edition. Spain: Elsevier; 2011. pp. 283-348

Ruksakiet Kasidid y col. Antimicrobial efficacy of chlorhexidine and sodium hypochlorite in root canal disinfection: a systematic review and meta- analysis of randomized controlled trials. JOE. 2020; 46(8):1032. Disponible en: (http://creativecommons.org/licenses/by-nc-nd/4.0/). https://doi.org/10.1016/j.joen.2020.05.002

Ivica A, Zehnder M, Ghayor C, Weber F. Biomimetic conditioning of human dentin using citric acid. JOE. 2019; 45(1):45. Disponible en: (http://creativecommons.org/licenses/by-nc-nd/4.0/). https://doi.org/10.1016/j.joen.2018.09.015

Sotomil Julian y col. Curcumin—A natural medicament for root canal disinfection: Effects of irrigation, drug release, and photoactivation. JOE. 2019; 45(1):1. Disponible en: https://doi.org/10.1016/j.joen.2019.08.004

Naseri M, Eftekhar L, Gholami F, Atai M, Dianat O. The effect of calcium hydroxide and nano–calcium hydroxide on microhardness and superficial chemical structure of root canal dentin: An ex vivo study. JOE. 2019; 6(2):1. Disponible en: https://doi.org/10.1016/j.joen.2019.06.002

Uslu G, Ozyurek T, Yılmaz K, Plotino G. Effect of dynamic immersion in sodium hypochlorite and EDTA solutions on cyclic fatigue resistance of wave one and wave one gold reciprocating nickel-titanium files. JOE. 2017; 11(1):1. Disponible en: https://doi.org/10.1016/j.joen.2017.11.014

Kafantari N, Gulabivala K, Georgiou G, Knowles J, Ling Y. Effect of heated sodium hypochlorite on the viscoelastic properties of dentin evaluated using

dynamic mechanical analysis. JOE. 2019; 5(17):1. Disponible en: https://doi.org/10.1016/j.joen.2019.05.017
Wright P, Kahler B, Walsh L. The effect of heating to intracanal temperature on the stability of sodium hypochlorite admixed with etidronate or EDTA for [citadoel8dejuniodel2020]. Disponibleen: http://200.12.169.19/bitstream/25000/18362/1/T-UCE-0015-ODO-128.pdf
Del Campo G, Cervantes J, Gonzalez A. Irrigation in Endodontics. In: Alcalá K, Del Campo G, Alcalá R. Basic principles of clinical endodontics. First edition. Mexico: Centro Universitario de los Altos; 2018. pp. 177-187
Peters O. and Peters C. Cleaning and shaping of the root canal system. In: Cohen S, Hargreaves K, Berman L. Pulp pathways. Tenth edition. Spain: Elsevier; 2011. pp. 283-348
Ruksakiet Kasidid y col. Antimicrobial efficacy of chlorhexidine and sodium hypochlorite in root canal disinfection: a systematic review and meta- analysis of randomized controlled trials. JOE. 2020; 46(8):1032. Disponible en: (http://creativecommons.org/licenses/by-nc-nd/4.0/). https://doi.org/10.1016/j.joen.2020.05.002
Ivica A, Zehnder M, Ghayor C, Weber F. Biomimetic conditioning of human dentin using citric acid. JOE. 2019; 45(1):45. Disponible en: (http://creativecommons.org/licenses/by-nc-nd/4.0/). https://doi.org/10.1016/j.joen.2018.09.015
Sotomil Julian y col. Curcumin—A natural medicament for root canal disinfection: Effects of irrigation, drug release, and photoactivation. JOE. 2019; 45(1):1. Disponible en: https://doi.org/10.1016/j.joen.2019.08.004
Naseri M, Eftekhar L, Gholami F, Atai M, Dianat O. The effect of calcium hydroxide and nano–calcium hydroxide on microhardness and superficial chemical structure of root canal dentin: An ex vivo study. JOE. 2019; 6(2):1. Disponible en: https://doi.org/10.1016/j.joen.2019.06.002
Uslu G, Ozyurek T, Yılmaz K, Plotino G. Effect of dynamic immersion in sodium hypochlorite and EDTA solutions on cyclic fatigue resistance of wave one and wave one gold reciprocating nickel-titanium files. JOE. 2017; 11(1):1. Disponible en: https://doi.org/10.1016/j.joen.2017.11.014
Kafantari N, Gulabivala K, Georgiou G, Knowles J, Ling Y. Effect of heated sodium hypochlorite on the viscoelastic properties of dentin evaluated using dynamic mechanical analysis. JOE. 2019; 5(17):1. Disponible en: https://doi.org/10.1016/j.joen.2019.05.017
Wright P, Kahler B, Walsh L. The effect of heating to intracanal temperature on the stability of sodium hypochlorite admixed with etidronate or EDTA for continuouschelation. JOE.2018;9(14):1.Disponibleen: https://doi.org/10.1016/j.joen.2018.09.014
Dotto L, Onofre R, Bacchi A, Pereira G. Effect of root canal irrigants on the mechanical properties of endodontically treated teeth: A scoping review. JOE. 2020; 17(1):1. Disponible en: https://doi.org/10.1016/j.joen.2020.01.017
Dias J, Castro R, Dias A, Guerreiro M, Silva E, Brandão J. Final endodontic irrigation with 70% ethanol enhanced calcium hydroxide removal from apical third. JOE.2020;9(17):1.Disponibleen: https://doi.org/10.1016/j.joen.2020.09.017
Sasanakul P, Ampornaramveth R, Chivatxaranukul P. Influence of adjuncts to irrigation in the disinfection of large root canals. JOE. 2019; 45(3):332. Disponible en: https://doi.org/10.1016/j.joen.2018.11.015
Piperidou M, Sodhi R, Kolosowski K, Basrani B. Effects of final irrigation with smear OFF on the surface of dentin using surface analytical methods. JOE. 2018; 7(19):1. Disponible en: https://doi.org/10.1016/j.joen.2018.07.019
Wright P, Scott S, Kahler B, Walsh L. Organic tissue dissolution in clodronate and etidronate mixtures with sodium hypochlorite. JOE. 2019; 10(16):1. Disponible en: https://doi.org/10.1016/j.joen.2019.10.020
Benavides M, Hernández M, Soto V. Spectroscopic analysis of the precipitate formed from the mixture of Sodium Hypochlorite and Chlorhexidine. In vitro studio. Part II. Scielo. 2017; 19(3):1-9. Available at: https://www.scielo.sa.cr/pdf/odovtos/v19n3/2215-3411-odovtos-19-03- 00069.pdf
Escalante R. Evaluation of bacterial removal, in root canals irrigated with 5.25% sodium hypochlorite, using two irrigation activation systems: xp-endo finisher and ultrasonic activation, in vivo. [PhD]. Autonomous University of Nueva León; 2020.
González S. Effectiveness of different irrigation protocols in the disinfection of root canals. [PhD]. University of Granada; 2016
Castillo P. Comparative study of the formation of p-chloroaniline when using citric acid and saline during the application of endodontic irrigation protocol. Ex vivo study. [PhD]. University of Chile; 2019.
Soares I, Goldberg F. Auxiliary chemical procedures in surgical preparation. In: Soares I, Goldberg F. Technical endodontics and fundamentals. First edition. Argentina: Médica Panamericana; 2002. pp. 127-139.
Macedo N, Beltrán H, Caballero H, Postigo A. Influence of ultrasonic activation of sodium hypochlorite and chlorhexidine on biofilm: Ex vivo study. Scielo. 2018; 6(2):129. Available in: https://revistas.cientifica.edu.pe/index.php/odontologica/article/view/465/52 7
Montenegro M. Comparison in the elimination of smear layer with the use of different endodontic irrigants. Literature review. [Undergraduate]. Quito. University of the Americas; 2019 [cited 1 December 2020]. Available from: http://dspace.udla.edu.ec/bitstream/33000/10663/1/UDLA- EC-TOD-2019-13.pdf

Merly Claribel Moran Giler, Alexandra Dolores Molina Manzo, Nelson Francisco Freire Sánchez, Rene Estalin Portilla Paguay;Analysis of the Legal Treatment of Perfidy , Neutrosophic Sets and Systems, vol. 52, 2022, pp. 09-20. DOI: 10.5281/zenodo.7373312

Alex Fabián Solano Moreno, Josué Ramón Limaico Mina, Diego Vladimir Garcés Mayorga, Paul Orlando Piray Rodríguez;Alimony in Students of Legal Age as a Fundamental Right to Education (revisited), Neutrosophic Sets and Systems, vol. 52, 2022, pp. 01-08. DOI: 10.5281/zenodo.7373283