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Effect of Agitation Techniques on Removing the Vapor Lock Effect in Endodontic Treatment: A Systematic Review

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ABSTRACT

The very important thing related to the long-term success of endodontic treatment is a thorough debridement. The success of debridement depends on its ability to carry out thorough irrigation to the teeth' apical root canals. It has been reported that air bubbles possibly appear in the apical third of the root during irrigation, which can prevent the penetration of irrigation material. This phenomenon is called apical vapor lock, and several agitation techniques have been reported in removing the effects of vapor lock. This study's objective was to evaluate the effect of agitation techniques in removing vapor lock in endodontic treatment. A systematic search in the online library of PubMed, Wiley, and Google Scholar was carried out to identify journals published between 2009 and 2019 on the effect of apical vapor lock on the removal of the smear layer in endodontic treatment. Manual selection of journals with full text was made, and from 384 journals in the initial search, there were only five journals that were compatible with the inclusion criteria. The initial search resulted in 384 journals. All full-text journals are reviewed and selected based on inclusion criteria. Four journals fit the inclusion criteria. Based on the study conducted, the vapor lock effect can influence the removal of the smear layer in endodontic treatment, especially when irrigating root canals. Agitation during irrigation can eliminate the vapor lock effect to the third apical area of the root canal and improve the smear layer's removal process.

Keywords: Therapeutic irrigation, Endodontic, Vapor lock, Smear layer removal.

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INTRODUCTION

Preparation of the root canal plays an important role in endodontic success, and can cause smear layers consisting of organic and inorganic materials (including odontoblastic fragments, pond microbes, and other necrotic materials). The smear layer has prevented the sealer from entering the tubules and the penetration of the disinfectant, causing seals infiltrated from obtaining a root canal. This is also supported by Yamada et al., those who state that dissolving organic tissue to eliminate debris and smear layers are very effective by doing proper irrigation. Chlorhexidine (CHX) and sodium hypochlorite (NaOCl) is the most frequent irrigation materials used in endodontic treatment. The antimicrobial properties of the materials that are used more specific. Although there is no material that can effectively eliminate the smear layer, ethylenediaminetetraacetic acid (EDTA) is the solution to eliminate the smear layer on root canal is.[1,2]

The root is surrounded by periodontium tissue so that it resembles a closed canal. This results in a vapor locking effect where there is an air trap when the irrigation fluid is used, which obstructs the irrigation liquid entering the apical area. Hydrolysis can be caused by sodium hypochlorite reacting with the organic tissue in the dentin walls, resulting in the release of carbon dioxide and ammonia. This triggers the formation of microbubbles in the apical root canals, which coalesce into large apical vapor lock bubbles.[3,4] Some advances in endodontic irrigation techniques have increased the yield of root canal debridement, particularly to eliminate the vapor lock effect of one-third root canals apical.[4]

To clean the apical third of the root canal, eliminate the steam-locking effect, improve circulation, and the depth of penetration of the irrigation fluid into the tubular dentin requires special irrigation. Thus, it is important to use techniques that can allow the production of dynamic hydro effects as a safe irrigation solution in the apical third of the root canal. This can be achieved using manual dynamic, sonic and ultrasonic irrigation.[4,6]

Although the effectiveness of irrigation techniques with agitation, many studies have reported apical third of the canals using a vapor lock, on the other hand there are clinicians who only use irrigation needles in their endodontic procedures. either for economic reasons or because they do not follow developments in irrigation techniques. Therefore, this systematic review will emphasize the effectiveness of activated irrigation techniques compared to conventional irrigation needles in reducing the effect of vapor lock and increasing the ability to eliminate the smear layer.

MATERIAL AND METHOD

A systematic review is based on a reference for a review of Systematic reporting to report on the effectiveness of irrigation techniques in removing vapor locking effect in endodontic treatment.[6] The population Intervention Comparison outcome (PICO) question is on teeth with endodontic treatment, with use of agitation techniques on irrigation to eliminates the effect of vapor lock on the apical third of the root canals, which produce comprehensive debridement and increasing the removal of smear layers.

The electronic literature search was carried out using PubMed, Wiley and Google Scholar for articles published from January 2009 to October 2019 (last search date: 15 November 2019), with combination terms medical subject heading (MeSH) "Therapeutic irrigation," "Endodontic," Vapor lock, "and" Smear layer removal. "

The search is limited to articles in English and human species. Besides, a manual search of the article reference list is performed to find other articles that meet the requirements that are not available in the electronic database. The search resulted in 384 relevant articles, of which only 4 met the inclusion and exclusion criteria.

Inclusion criteria used are articles less than the last ten years, use English, are clinical trials, or case reports. The method is appropriate and can be open as a whole. While the exclusion criteria are all articles which constitute systematic reviews and studies in animals.

We use specific keywords to get articles based on readings on abstract and full text. We independently choose articles based on the inclusion criteria. Then download the abstract and full text and evaluate them individually to identify this systematic review adopted the eligibility criteria.

Data were taken with the following parameters: year of publication, all articles discussing irrigation techniques related to removing the vapor lock effect and increasing the removal of smear layer. to make this systematic review All full text deserves to be read and evaluated independently.

RESULTS

in the initial search obtained 384 articles. After filtering out the title and abstract, 118 articles were obtained without duplicates, relevant about the effect of vapor lock and elimination of smear layer and performed on human teeth. Then out of 118 articles, 93 articles can be accessed in full text, from 93 articles were then discussed and adjusted to the exclusion and inclusion criteria that are used and finally ends up with four articles. The study selection process is explained in Figure 1. In the first study in table 1, radiographic testing showed that the group that more effective in preventing vapor lock was laser group. In microscopic testing, the use of a laser to remove vapor lock from the apical third was effective than that used in the PUI group in the statistical analysis.[5] The Cohen kappa coefficient of agreement between ratings was 0.74, while the intra-observer reliability score was 0, 9 and 0.92. Conventional irrigation removes significantly less debris from grooves than laser.[7] In the third study in table 1, it was found that sonic irrigation technique was more effective in clearing the apical third than manual dynamic irrigation technique. However, there was no significant difference between the two.[4] In the fourth study in table 1, p value <0.05 in this study concluded that the smear layer can't be removed by irrigation which was tested in this study. However, the system showed a reduction endoVac better smear layer compared with conventional irrigation on all the testing, but it is better than the system endoVac endoActivator in removing the smear layer at the level of 1 mm and 3 mm.[8]

DISCUSSION

This study has the main objective to see the effect of root canal irrigation techniques using agitation to eliminate the effect of vapor lock on the apical third of the root canal thereby increasing apical debridement which ultimately removes the smear layer formed during preparation. in this systematic review all studies were carried out in the last ten years and are in vitro studies on human teeth. These studies report the effectiveness of irrigation techniques with conventional irrigation needles and irrigation techniques with agitation. Almost all reviewed articles show that irrigation with agitation is more effective in removing vapor lock in the apical third of the root canal. Ineffective removal of smear layers by conventional irrigation techniques can be caused by the lack of interference ability in the smear layer due to static irrigation and also because of the effect of vapor lock which limits the penetration of irrigation fluid to the apical and effective contact with the smear layer on the dentinal wall.[8]

The results of this study also answer previous findings, which show that the smear layer can be removed effectively using a laser. Peeter HH, in a previous study, reported a microscope scan evaluation that described all laser treatments that discussed removing the smear layer,[9] and key-saving findings by previous studies from George and Walsh that supported liquid extrusion studies using dyes from the peak using laser Er, Cr: YSGG.[10] Research conducted by Emptying and Verdaasdonk showed that when a compilation of Er, Cr: YSGG lasers is used in root canals with endodontic fiber tips, fluid movement can be performed immediately after each pulse transmission. the Er, Cr: YSGG laser compilation is used with high energy to activate irrigation channels, which can cause clumping, as previously described.[11] The formation of bubbles or cavities that produce bubbles in the liquid is referred to as cavitation. [12] In liquids, use a laser with a large ellipse. This volume can lead to an increase in volume up to 1600 times the agreed volume. This process allows the solution to irrigate root canals easily and allows irrigation of root canals of various shapes.[7,13]

Jiang et al. reported that clearing dentinal debris was more effective using sonic irrigation technique over other techniques.[14] Al-Obaida also reported in a study evaluating dentinal debris removal and smear layers, which showed that sonic irrigation technique was more effective than a conventional technique that uses needle rigation.[15]

The sonic vibration action produces 1-6 kHz vibrations, and dynamic manual movements produce 3.3 Hz vibrations. Each of these can produce hydrodynamic effects that contribute to the physical displacement and breakdown of fluids. This might be the reason why there are no significant differences between the two techniques. However, the presence of a higher vibration frequency than manual vibration means that the sonic irrigation technique is more efficient due to the speed, acoustic and frequency movements. In addition, the vibration tips in the sonic irrigation technique are combined with up and down movements that reach 10,000 cycles per minute (cpm), optimally this synergistic movement will produce strong hydrodynamic phenomena that can further destroy and clean debris and biofilms..[16] The sonic irrigation technique can produce alternating oscillation amplitudes with up and down movements in both horizontal and vertical directions. Thus, leading to more optimal hydrodynamics for irrigation fluids. Also, in dynamic manual techniques, dynamic hydro irrigation fluids are produced by hand movements, which can result in operator fatigue in clinical settings, so it is assumed that the expected 3.3 Hz vibration does not occur.[17] This concludes that sonic irrigation technique is better than manual dynamic irrigation, however it does not show statistically significant difference between the two techniques, as indicated by the overall score results.[4]

Ultrasonic irrigation techniques (EndoVac) clean the smear layer better than conventional techniques (Max-I-Probe). This is consistent with the study of Ahuja et al., Who demonstrated the superior efficiency of the ultrasonic irrigation technique (EndoVac) over conventional irrigation needles in the coronal, middle and apical sections of curved root canals.[18] Some studies also show superior debridement on ultrasonic irrigation techniques (EndoVac) when compared to

conventional irrigation techniques (Max-I-Probe) and sonic irrigation techniques (EndoActivator) at 1 mm of Working Length (WL).[19,20] This is supported by research Jiang et al., That there is more contact between the tip EndoActivator the dentin walls, thus inhibiting the free oscillations in an efficient edge needed to generate pressure on the irrigation solution and cavitation effects.[14]

CONCLUSION

The apical third of the root canal can occur vapor lock, preventing effective debridement of the entire root canal. The use of conventional irrigation techniques do not effectively eliminate vapor lock in the apical third of the root canal to limit the irrigation fluid penetration into the apical root. But irrigation techniques with laser, sonic and ultrasonic agitation can eliminate the effects of vapor locking and more effective in cleaning the dirt and stains in the lining of the root canal..

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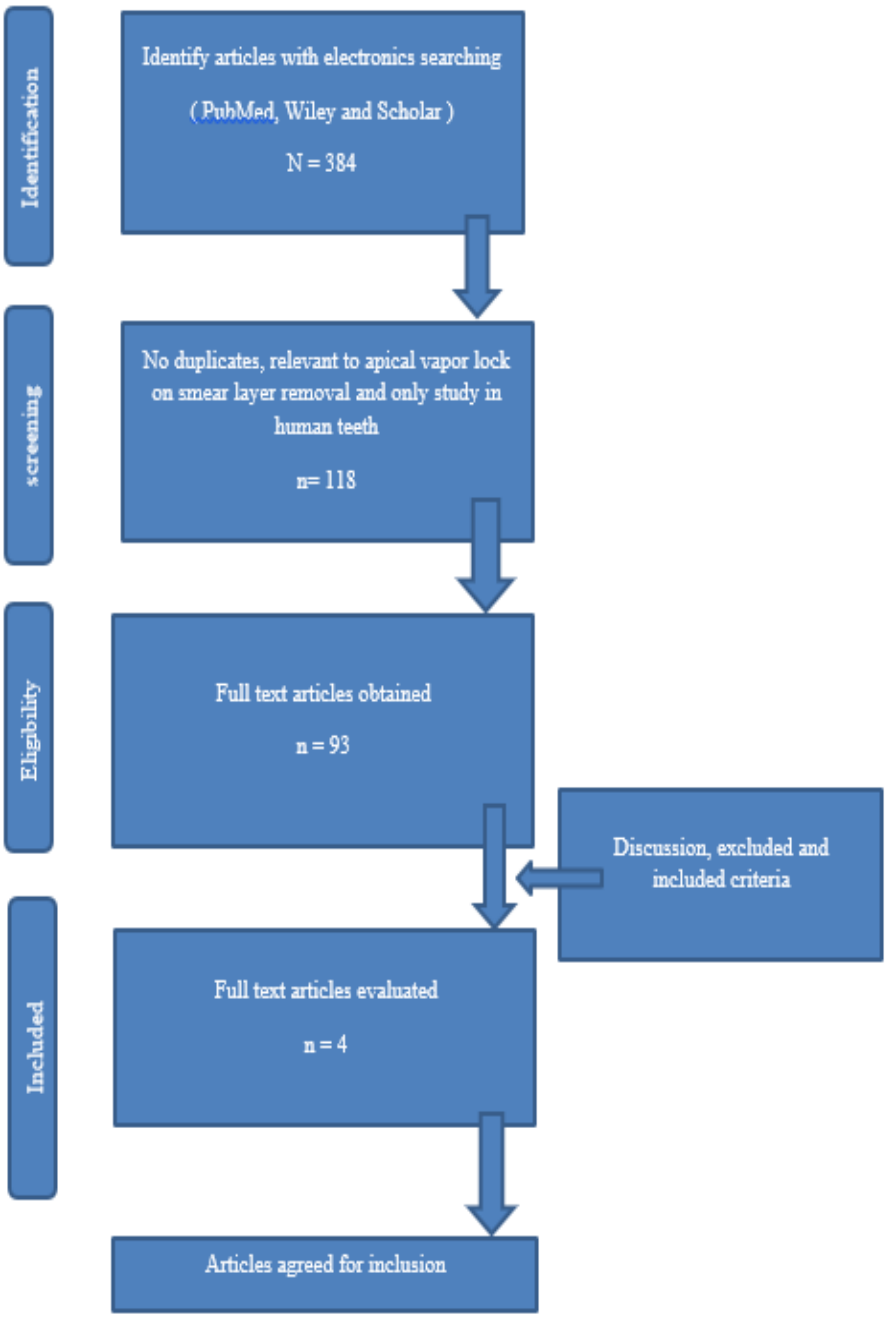

Figure 1. Study Selection Flow Chart

Table 1. Data extraction from selected journals

Study	Type of Study	Sample	Type of canal	Agitation techniques	Number of Sample	Irrigant Solution	Result
Harry Huiz Peeters & Norbert Gutknecht	in vitro	Mandibular molar	Narrow canal	laser driven	40	3% NaOCL	Laser cavitation > PUI
				ultrasonic		17% EDTA	χ^2= 61,3 d.f = 1 & χ^2= 68,8 d.f= 1
Roeland JG De Moor et al.	in vitro	Maxillary Canine	Straight root	Manual Dynamic,	25	2.5% NaOCL	LAI > PUI >Conventional iriigation
				Laser activated irrigation,			p-value <0.001, The Cohen Kappa 0.74
				PUI			
Aditya Wisnu Putranto et al.	in vitro	Mandibular Premolar	Straight root	Sonic irrigation	32	2.625% NaOCL	Sonic Irrigation > MDA
				Manual Dynamic,		17% EDTA	p-value<0.05
Dinesh Kowsky et al.	in vitro	Mandibular Molar	Curved canal	conventional irrigation	20	2.5% NaOCL	EndoVac>EndoActivator>Conventional
				Sonic irrigation		17% EDTA	p-value<0.05
				Ultrasonic Irrigation			