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Efficacy of Anti-Rusting Agents on Sterilization of Instruments used in Orthodontic Practice

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ABSTRACT

Autoclaving (a process of sterilization) of instruments can lead to rust formation and corrosion especially the cutting instruments because they have a carbide steel tip. The aim of this study was to check the microbial load of instruments after treatment with any of these agents viz. sodium hypochlorite, vinegar, lemon and coconut oil followed by autoclaving and to assess the instruments for corrosion treated by these above mentioned agents followed by autoclaving. A sample of twenty five orthodontic pliers and cutters were selected for evaluation. They were divided into five groups depending on the agent used. After ultrasonic cleaning of these pliers, they were immersed in the respective solutions for 10 minutes, dried and then subjected to autoclaving. Microbial swabs were collected at two stages: before treating the instruments(T0) with anti rusting agents and after autoclaving(T1). Quantitative culture was performed using standard technique. The working edge of each instrument was examined visually on the amount of corrosion seen. The mean difference in colony forming units of each group were sodium hypochlorite-48.6, vinegar-32.2, coconut oil-31.4, lemon-7.4 and control group-16.8. In this study, use of additive agents like sodium hypochlorite, vinegar, lemon and coconut oil did not alter the process of sterilization, wherein, the CFU's of all the four experimental groups were similar to the control group. Visual examination reveals that the anti-rusting property of coconut oil is far superior compared to all other agents used.

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INTRODUCTION

Infection control is a critical issue in the practice of dentistry. Sterilization is a practice by which all microbial forms, including viruses, are destructed. Most dental instruments are cleared off of all pathogens by means of steam sterilization which has the disadvantage of producing corrosion and rusting of orthodontic pliers (Robert and Matlack, 1979). Use of ethylene oxide gas and dry heat sterilization method is a safe alternative and a convenient system to overcome rusting and corrosion, but it has a disadvantage of long exposure time. The center for disease control [CDC] and prevention have given special recommendations for the prevention of cross infection in dental clinics (Kumar and Lavanya, 2016). A disease can be transmitted from patient to dentist or dentist to patient or between patients through cross contamination (Sriraman and Neelakantan, 2014).

Various studies have shown that corrosion of orthodontic pliers is frequent and is of utmost problem to an orthodontist (Digital India, 2017). This topic is of interest in recent times because of its biological responses and the likelihood to reduce its lifetime (Kratzenstein *et al.*, 1985). No steel available currently is resistant to rust or corrosion. A protective layer of chrome oxide formed over the stainless steel aids in the protection of the instrument from rusting. The major problem in orthodontic pliers is the hinge area which is more prone to rust compared to any other parts or instruments. Considerable damage would occur in conjunction with heat sterilization. Two major studies by Thompson (Thompson and Bogues, 1977) and Draegar (Kratzenstein *et al.*, 1985) show that the most important component of rust formation in orthodontic pliers subjected to heat sterilization/ autoclave is the formation of heat and moisture together.

A corrosion inhibitor is a substance that retards corrosion when added to an environment in small concentrations (Norman and Nathan, 1973). Theory provides enough guidelines of corrosion inhibitors, but its value is not scientifically proven, or performance tested. A variety of inhibitors and inhibitor combinations in different concentrations have been tested under the most adverse conditions (Oliet and Sorin, 1978).

Gluteraldehyde at 2% concentration is the most commonly used chemical method of sterilization (Masunaga, 1987). This colourless, pungent smelling high level disinfectant is effective in inactivating bacterial spores. It is non corrosive, non toxic and used to sterilize heat sensitive instruments. 1% sodium hypochlorite, also used as a disinfectant, is more commonly used.

Use of more commonly available chemicals of day to day activity should be assessed for its action on disinfection or sterilization of dental instruments without altering the process of sterilization. Thus, the purpose of this study was to evaluate if the application of certain commonly available products hinders the efficacy of the sterilization process.

MATERIALS AND METHODS

A variety of orthodontic pliers and cutters were chosen for the study. These instruments were routinely used in the department of Orthodontics. A sample size of 25 was chosen for this study. They were randomly divided into five groups. Each group was treated with their respective solutions to prevent corrosion and a fifth group; the control group was left untreated. All the instruments were presoaked, washed manually and completely dried before subjecting to anti corrosive agents.

Group 1

Randomly selected orthodontic pliers and cutters that were coated with a thin film of sodium hypochlorite.

Group 2

Randomly selected orthodontic pliers and cutters coated with a thin film of pure coconut oil.

Group 3

Randomly selected orthodontic pliers and cutters that were coated with a thin film of vinegar.

Group 4

Randomly selected orthodontic pliers and cutters that were coated with a thin film of lemon extract.

Group 5

Randomly selected orthodontic pliers and cutters sent directly to sterilization without coating with any agent.

The process of obtaining a swab was performed under sterile conditions. A separate swab was used for each sample. The cap was twisted to break the seal and the swab was taken out carefully without contaminating it using a gloved hand. The entire surface was swabbed and the swab was replaced into the container without coming in contact with any other surface. The containers were then labelled appropriately and sent to the laboratory for performing the microbiological culture.

The swab for microbiological culture was obtained at two levels. After using the instruments, they were cleaned with a soap solution and pre cleaned prior to sterilization (Masunaga, 1987). They were dried and the first swab was obtained at this stage. Respective solutions were applied on the instruments as a thin coating using a cotton roll. The instruments were allowed to dry completely. Each instrument was then packed in an airtight sealed sterilization indicator pouch and sterilized. The autoclave was used for the sterilization of these instruments. It was used at a temperature of 121 degree Celsius for 15 minutes at 15 psi pressure.

Once the sterilization process is complete, the indicator change in the sterilization indicator pouch was noted and then the seal was broken to remove the instrument out of the pouch. The second stage swab of the instrument was obtained now. Care was taken to note down the correct series of instruments and not to interchange its sequence.

The effectiveness of sterilization was studied by assessing the colony forming units (CFU) on nutri-

ent agar. The swab was streaked on a plate of nutrient agar and incubated at 37 degree Celsius for 24hours. The number of colony forming units formed was counted and compared between each group. The results obtained were then subjected to statistical evaluation.

The working edge of each instrument was assessed visually for the presence of corrosion of various degrees and recorded. No previous standardized methods are available for grading the degree of corrosion. A new grading system was developed for our study, where the amount of corrosion seen was graded from a scale of 0 to 4, which is described in Table 1.

RESULTS

Table 1: Description of grading of the degree of corrosion

Grade	Description of Grade
0	No Corrosion
1	Mild Spots of Rust
2	<25% - Working Tip of Instrument Corroded
3	25%-50% - Working Tip of Instrument Correded
4	>50% Working Tip of Instrument Corroded

The mean and standard deviations for each group sample is described in Table 2. The mean difference in colony forming units in decreasing order is sodium hypochlorite, vinegar, coconut oil, control group and lemon.

Paired student t-test was used to assess the significance levels of each group at two different time intervals, T0 and T1, T0 being the CFU at the first stage before applying the solution and T1 being the second stage after sterilization (Table 3). The significance values of all groups were sodium hypochlorite (0.024) , vinegar (0.015) , coconut oil (0.043) , lemon (0.060) and control group (0.0.42).

As far as the degree of corrosion is taken into account, it was found that more corrosion seen in the lemon group followed by the vinegar group.There is no corrosion in the coconut oil group, mild spots of corrosion seen in the sodium hypochlorite group.

1. coconut oil – Grade:0
2. sodium hypochlorite – Grade:1
3. vinegar – Grade:3
4. lemon –Grade:4

DISCUSSION

In the current study, a comparison was made of the sterilization of orthodontic pliers using sodium hypochlorite, vinegar, coconut oil and lemon before the sterilization process. The above mentioned solutions were used because of their ease of availability and their properties towards sterilization and anti-rusting.

All groups except lemon produced a statistically significant reduction in the colony count. Lemon produced a marked reduction in colony count, and it was very close to the significance level. With the results of this study, it could be said that all groups when sodium hypochlorite, vinegar, lemon and coconut oil are used does not affect the process of sterilization. However, their anti-rusting properties need to be paid attention to. This is a study of its first kind; hence literature regarding the use of sodium hypochlorite, vinegar, lemon and coconut oil for sterilization as well as anti-rusting is very limited.

In a study conducted by wichelhaus et al., they compared the corrosion resistance between two orthodontic pliers upon different sterilization methods. Their study concluded that heat sterilization produced more corrosion compared to the cold sterilization method (Wichelhaus *et al.*, 2004).

Visual examination of rusting of orthodontic pliers is not often standard. Therefore, light and electron microscopic examination to study the surface characteristics of the instrument is often necessary to validate the efficacy of an anti-rusting agent. In this study, visual examination of the sterilized instrument was carried out and it was found that coconut oil produced a markable reduction in rusting of instruments compared to that of all the other instruments used.

One of the simplest ways to prevent corrosion formation is to prevent the formation of an oxide layer over the instrument. But practically, it is impossible to prevent oxide layer formation in the autoclave environment (Bertolotti and Hurst, 1978). A little more practical approach is to provide a passive layer over the instrument (John *et al.*, 1969). Inorganic oxidizing substances are the commonly used passivators that produce a thin oxidizing layer over the instrument's surface and separate the instrument from the environment. Several studies have been performed to see the effect of vapour-phase inhibitors for preventing corrosion. It was, however, found to be toxic (Fajers, 1967).

Table 2: Descriptive statistics showing the mean difference and standard deviation between the study groups

Group	Mean Difference	Significance (p<0.05)
Group 1 Sodium Hypochlorite	48.6	0.024
Group 2 Vinegar	32.2	0.015
Group 3 Coconut Oil	31.4	0.043
Group 4 Lemon	7.4	0.06
Group 5 Control	16.8	0.042

Table 3: Paired Student t-test to describe the significance between two time periods in each group

Group	Mean difference	Std. dev	Significance (P<0.05)
Sodium hypochlorite	48.6	33.07	0.024
Vinegar	32.2	17.5	0.015
Coconut oil	31.4	23.9	0.043
Lemon	7.4	6.3	0.060
Control group	16.8	12.7	0.042

CONCLUSIONS

The use of additive materials like sodium hypochlorite, vinegar, lemon and coconut oil did not alter the process of sterilization. Moreover, the visual examination also suggested that the anti-rusting property of coconut oil is far superior compared to all other solutions used. This, however, has to be supported by further studies.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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