International Journal of Dentistry Research

Research Article

ISSN: 2581-3218
IJDR 2021; 6(1): 7-8
Received: 15-09-2020
Accepted: 08-02-2021

www.dentistryscience.com

Electrolysis method to determine the amount of silver in occlusal and periapical films

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Abstract

Introduction: In diagnosing a disease in certain cases, the dentist also requires additional examinations such as radiographic examination. Many types of radiographs can help dentists in making diagnoses according to their indications, both intra-oral and extra-oral. The conventional X-ray photo technique requires a fixer solution as one of the stages in performing a process that serves to dissolve and inhibit the development of silver halide crystals in the emulsion process. Fixer solutions contain four components dissolved in water, namely the clearing agent, acidifier, preservative and hardener. The aim of the study was to determine the amount of silver contained in the fixer solution after fixing the occlusal film and periapical film using the electrolysis method. Method: was a laboratory experimental study, with a post-test study design. Results: showed that the occlusal film dissolved 6.0 grams while the periapical film dissolved 0.6 grams of silver in the fixer solution. Based on the results of the independent t test, p = 0,000 <0,05 was obtained. Conclusion: of the study was that there was a significant difference in the amount of silver from the fixer after fixing the occlusal film and periapical film using the electrolysis method.

Keywords: Electolysis, Radiographic, Fixer solution.

INTRODUCTION

The fixing process that is done manually on fixer solution takes two times longer than the developer solution. Silver [1,2]. In the waste produced by film processing becomes a risk for human health and the environment. However, little effort has been made to reduce environmental pollution caused by the radiographic developer of fixer solutions and radiographic washing water [3]. Study by Raoof *et al* showed that only 8.4% of general dental practices in Iran reported the use of digital radiography [4]. Silver waste comes from image processing services, radiology clinics or private dental practices, making it vulnerable to risks to human health and the environment. Fixer solutions must be disposed of at the waste disposal site, recycled or carried out silver recovery through electrolysis and precipitation methods [5]. Research by Chen *et al* explained the purification of silver in fixer solutions using electrolysis methods on electric currents 0.3A, 0.5A, 0.7A and 0.9A concluded that the greatest silver purification was obtained at 0.9A electric current of 98.31% [6].

The electrolysis method uses electricity flowed between two electrodes which are immersed in a fixer solution. Silver is electronically stored at the cathode. This silver can be separated from the cathode and obtained fine silver [7].

MATERIALS AND METHODS

In the research, fixer solutions were used which were carried out by fixing periapical films and occlusal films of 32 films each. After doing occlusal and periapical radiographs and carrying out the developing process, the research procedure is carried out in the following ways:

Place the fixer solution on two containers. Container 1 for occlusal film fixation process and container 2 for periapical film fixation process, each fixer solution is mixed with 1 liter of water so that it becomes 2 liters of fixer solution, each container has 32 fixation processes, each film is fixed for 5 minutes, then each fixer solution is put into a container measuring 2500 ml, then prepare the tool for the electrolysis process, cathode rod are measured using electronic scales before they are inserted into an electrolysis device, fixer solution is inserted into the electrolysis container, the electrolysis device is set at 0.9 amperes and the electrolysis process runs for 480 minutes (8 hours), after the electrolysis process is complete the appliance

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is left for 60 minutes, the cathode rod is removed from the tool and weighed using an electronic scale.

RESULTS

The process of taking X-ray photos and the process of fixing was carried out at the Dental Radiology Installation of the Dental and Oral Hospital. Data for this study were conducted from January to February 2019. The electrolysis process was carried out at the Laboratory of the Faculty of Mathematics and Natural Sciences, using a 2000 ml fixer solution for periapical films and occlusal films. The electrolysis method is carried out for 8 hours. The cathode bars used are carbon bars and stainless-steel bars.

Based on the results of the independent t test, the value of p = 0,000 <0,05, there was a significant difference in mass Ag (g) between the solution of the periapical film group fixer and the occlusal film group.

Table 1: Amount of silver in periapical and occlusal films

No	Sample	Current (A)	Voltage (V)	Mass (g)
1	Fixer Periapical	0,9	3,6	0,6
2	Fixer Oklusal	0,9	3,6	6,0

Table 2: Analysis of the results of the independent t test

Fixer solution	N	Average Mass Ag (g)	Standard Devation Mass Ag (g)	P-Value
Periapical film	32	0.6	0	p =0,000 < 0,05, significant
Occlusal film	32	6	0	

DISCUSSION

This research results in the amount of silver in the fixer solution for occlusal fixing greater than periapical film. This might be due to the size of the film used for this study, which was periapical # 2 (32 x 41 mm) and for occlusal was # 4 (57 x 76 mm). for occlusal films also seen throughout the maxilla or lower jaw. The occlusal jaw film has many radiolucent areas compared to the upper jaw which can conclude that silver in the mandibular occlusal film is larger than the maxilla.

Films are made in a package consisting of an outer wrap made of soft plastic, black paper, lead foil, a layer of adhesive and a protective layer. Black paper serves to protect the film from light that can damage the film, lead foil is located behind the film to prevent the remaining radiation that can pass through the film. film, which consists of plasti base which is a transparent base material, adhesive layer (gelatin) which fixes the emulsion attached to the base material, the protective layer which functions to protect the emulsion from mechanical damage.

This fixer solution serves to change the real image to permanent, dissolving the silver bromide crystal beads (AgBr) that are not exposed and removes the emulsion of the film that has swelling, so that it can be stored permanently. After the fixer solution is used repeatedly for the image fixation process, the ability to set the image decreases over time. One of the purposes of the fixation process is to dissolve the remaining silver halide which is not exposed to photon light. If the silver component in the form of a complex halide has many contents in the fixer, the fixer will be saturated and will cause the fixation power to decrease so that the treated film emulsion layer will be easily damaged due to lack of processing [8].

The fixer solution dissolves 35-45% silver halides that are not exposed to the developer from the film emulsion, depending on the object being exposed. The fixer solution used contains high levels of silver in the form of complex thiosulfates which are very stable and have low and constant dissociation. If fixer waste is disposed of in the trash, it can pollute the soil and water which causes health problems to the community [9].

Solution developer and fixer solution is a chemical reaction. Where the optimal deposition of silver by the amount of x-ray energy sent to the object takes place within a certain period of time and the developer solution at a certain temperature is called the time temperature technique. If the film is left in the developer solution for too long, the film will turn black and cannot be diagnosed or called overdeveloped film. Silver halide crystals that have received a small amount of radiation have less silver deposited and are gray. Silver halide which does not have energy by radiation such as the area in the film behind the gold crown, there is no silver and white and there is no radiopaque on x-ray film [8,10].

CONCLUSION

The conclusion of the study was that there was a difference in the amount of silver from the fixer solution after fixing the occlusal film and periapical film using the electrolysis method. The amount of silver in the occlusal film fixer solution was greater than the amount of silver in the periapical film fixer solution.

Financial Support

Nil.

Conflict of Interest

The author declares no conflict of interest.

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