ORIGINAL ARTICLE

# SACRIFICIAL PROTECTION METHOD DURING DISINFECTION TO AVOID CORROSION

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**ABSTRACT**

*Alloys are used in every aspect of dentistry. Corrosion of an alloy is a major issue during disinfection and method adopted for anti-corrosion treatment is very costly. The purpose of this paper was to demonstrate the sacrificial protection (SP) technique and preventing the corrosion of dental metals. The method used in the present was Sacrificial protection (SP) techniqueto control the corrosion of a metal surface by attachment of ametal (i.e., aluminum,) with a higher ionization potential to the original metal which acts as the anode of an electrochemical cell. The study was conducted at Dr Ishrat-ul-Ebad Khan Institute of Oral Health Sciences, Dow University of Health Sciences in September-November 2013. The results of the present were that there is no corrosion found on the surface of the metal while immersing them into electrolyzed water for 7 days. It was concluded that during immersion into functional waters for disinfection, dental metals often undergo tarnishing and corrosion due to which their properties will be compromised. Therefore, to prevent the corrosion of dental metals, the present study revealed an effective and simple method. Sacrificial protection is very simple and cost effective method to prevent the dental material from corrosion.*

**Key Words:** *Corrosion, Sacrificial protection and Electrolyzed water.*

## INTRODUCTION

In almost all aspects of dental practice, metals and alloys are used including the direct and indirect dental restorations, instruments used to prepare teeth in dental laboratory.[1,2,3] These metals and alloys are in long term direct or indirect contact with bone, connective tissue and epithelium.[4] ISO type 1-4 Au-based casting alloys have been widely used as dental restorative and prosthodontic materials due to their excellent mechanical properties, castability, and corrosion resistance.[5] These alloys contact with tissues may be susceptible to corrosion.[4] Chemical disinfectants containing $H_2O_2$ probably corrode dental metals. Al-Salehi et al[6] showed that metal ion release from dental casting alloys increasedwith increase in $H_2O_2$ concentration.

Nonetheless, the corrosion behavior of dental metals is susceptible to being altered by the environment. For example, a drop in the pH of the oral environment increases the risk of corrosion of dental metals. Similarly, a difference inelectric potential between two or more dental metals incontact with each other in the corrosive oral environmentcan cause galvanic corrosion to occur.[7] These dental alloys need for the disinfection in order to prevent the transmission of infectious disease in dentistry.[8] Most popular method is Functional Water because of its outstanding virucidal and bactericidal activities and its less adverse effects on environment and the biological tissues.[8,9] Functional water is defined as an aqueous solution thatacquires useful functions and has reproducibility with artificialprocessing; those where scientific basis makes clear in regard toprocessing and function.[10] This includes electrical, magnetic,electromagnetic (infrared, microwave or etc.), ultrasound, andvortex implosion.[9] Among these electrolyzed water is most common in routine dental practice.[9]

For medical appliances acidic electrolyzed water is used as disinfectants.[9] Moreover, toxicsubstances are also removed after disinfection with this water.[9,10] Therefore, such waters are widely used in clinicalpractice for the disinfection of fingers, hands, endoscopes and medical devices.[9,10]

Sacrificial protection (SP) is a technique to control the corrosion of a metal surface. It involves the attachment of adifferent metal (i.e., aluminum, zinc)

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with a higher ionization potential to the original metal as the anode of an electrochemical cell.[10] This method is used to protect metal structures from corrosion.[10] The sacrificial protection technique is most commonly used to protect steel, water and fuel pipelines, storage tanks, steel pier piles, ships, and so on.[10] The purpose of this paper was to demonstrate the SP technique and preventing the corrosion of dental metals.

## METHODOLOGY

The dentalmaterials used as the test metals were stainless steel wire (ALL STAR orthodontics Columbus IN USA), Nickel titanium wires (ALL STAR orthodontics Columbus IN USA) and stainlesssteel file (Zipperer, VDW GmbH, Munch, Germany). Aluminumwas used as sacrificial anode metals. Each sacrificial anode plate (5 mm x 5 mm x1 mm) wasattached to the dental metal by using a polypropylene clip, andthen the component was immersed in the solution for 7 days. The surface was observed using a stereoscope before and afterimmersion. An oxidable functional waters (electrolyzed water) were used which was preparedusing a denture cleaner (Dentipur rapid cleansing tablets manufacturer by HelagoPharmagmbHRheinallee 11 D 53173 Bonn. Germany). The preparation of denture cleanser was carried out according to the manufacturer recommendations. Dental metals are directly connected or/and wound by using apure commercial aluminumplate with high ionization tendency (Fig 1). The combination of the dental metal andthe anode metal is then immersed in functional water. Corrosioncaused by the oxidation of the functional water can be protectedby the sacrificial anode, which is made of a metal that is moreeasily oxidized than the dental metals.

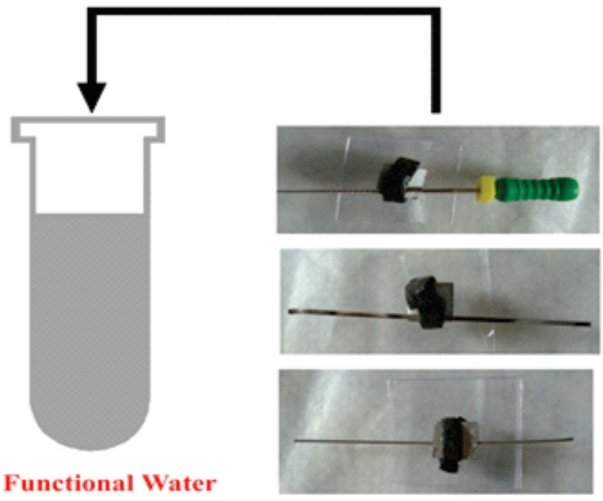


Fig 1: Dental metal are directly connected to pure commercial aluminum plate

## RESULTS

Fig 2 shows the appearance of stainless steel file before and after immersion in functional water. There is no corrosion found on the surface of the metal while immersing them into electrolyzed water for 7 days.

## DISCUSSION

Stainless steel wire, nickel titanium wires and stainless steel file were designated as typical dental metals for evaluation in this study because they are broadlyused in the various dental procedures. Aluminum was used as sacrificial anode metals. For metal components of dentures and dental implants nickel titanium is widely used. For dental instruments as well as orthodontic wires and brackets stainless steel is used. Stereoscope was used in the study to observe the surface of metals before and after immersion in the functional water. Functional waters in medical and dental fields could accelerate to become popular by using the SP method for preventing corrosion of dental metals. In previous study it was reported that there is no effect on dental materials while immersing them into functional water up to 8 hrs.[10] Cathodic protection is defined as one of the method to prevent corrosion of metals and alloys. In this method metal to be protected is used as a cathode.[11] Cathodic protection is distinctive among other methods used to prevent corrosion because of it system management, construction, economic design and construction. It increases the long time usage of the equipment and minimizes the cost.[12] The results of

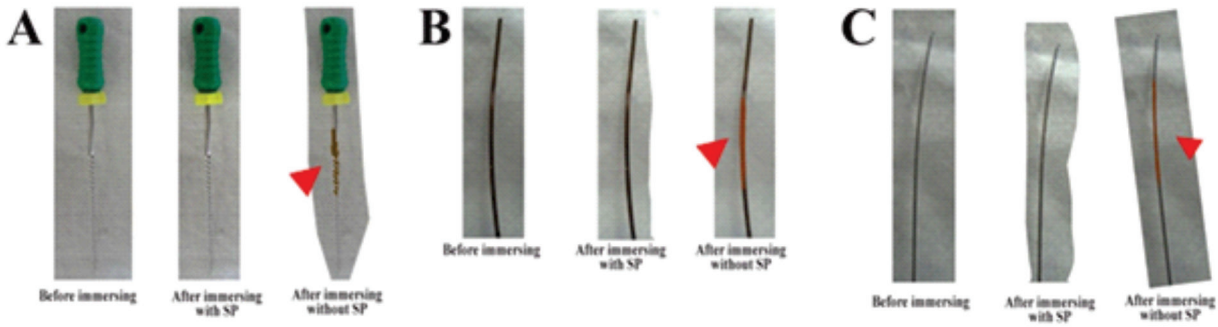


Fig 2: Dental metals before and after immersing in functional water

the present showed that there is no effect on materials while immersing into the functional water up to 7 days. In a study conducted by Dong H et al[9], authors used a 7-day immersion test in which they studied the tendency of dental alloys to corrode in neutral water, weak acid water and electrolyzed strong acid water. The greatest color change of the surface and dissolution of constituents of the Au-Ag-Pd alloy, silver alloy, precious metal alloys, gold alloy were in strong acid water. However, when these alloys were immersed in the neutral water, smallest amount of changes were observed. Co-Cr alloy showed lowest tendency to tarnish and corrode in the neutral water and weak acid water then in the strong acid water. Strong acid water showed marked increase concentration of aufrom gold alloy. X-ray microanalysis revealed that the silver chloride crystals deposits were the corrosion products on the precious metal alloys. Whereas corrosion products of the Co-Cr alloy as revealed by X-ray microanalysis were the thin brown products of cobalt and chromium oxides. In all three types of electrolyzed water Ti was present. It has been found in the study that the neutral water is the least corrosive to metals that have an equivalent bactericidal activity among all other immersion water. Similar results were found in a study conducted by Nakamura Ket al[13] in which authors used four metals to assess the corrosiveeffect of disinfection solution containing hydroxyl radicals ions on metals. These metals were: Co-Cr alloy, stainless steel, Ag-Pd-Cu-Au alloy and Ti. They used hydroxylradical's ions instead of the functional water that was used in our study for disinfection.

Some methods exits through which corrosion can be prevented. Among them most common methods includes plating, painting and application of enamel are the mostcommon methods adopted for anti-corrosion treatment. The treatment of metal surfaces is very costly and complicated fordisinfection by immersion alone. For this reason, it iseffective and simple to wind a metal more active that thedental metal, such as aluminum and zinc, around the dental metal. Aluminum metal is more widely available in themarket than zinc.

## CONCLUSION

During immersion into functional waters for disinfection, dental metals often undergo tarnishing and corrosion due to which their properties will be compromised. Therefore, to prevent the corrosion of dental metals, the present study revealed aneffective and simple method. Sacrificial protection is very simple and cost effective method to prevent the dental material.

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