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Research Article

The Implantation of Orthodontic Arch Wire: Pharmaceutical Agent

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ABSTRACT

Orthodontics is a dental specialty concerned with the diagnosis and treatment of dental and facial abnormalities. For many people of all ages, the benefits of orthodontic treatment can be dramatic: beautiful smiles improved dental health and improved quality of life. The oral cavity provides an ideal and unique environment for studying the biological processes involving metallic dental aids. Biomaterials are used in the production of a wide range of prosthetic devices around the world. Prosthetic devices are artificial parts that are employed in biological systems, such as the human body, to perform the function of the original part. Depending on the intended function, these devices are often built of polymeric, metallic, and ceramic materials, or mixtures of these materials. Metals alloys are used as surgical implants in the human body primarily for orthopedic purposes.

Keywords: Sepsis;Treatment; Vital parameters; Early identification; Nurse education

INTRODUCTION

Corrosion is defined as the process of interaction between a solid material and its chemical environment that results in the loss of substance, change in structural characteristics, or loss of structural integrity. Electrochemical corrosion is possible in the oral environment because saliva is a weak electrolyte. Saliva's electrochemical properties are determined by the concentrations of its constituents, pH, surface tension, and buffering capacity. Each of these factors can influence the strength of any electrolyte. As a result, these variables will govern the magnitude of the subsequent corrosion process. Over the last two decades, the features that influence how and why dental materials erode have been oxidation and reduction reactions, as well as passivation, or the creation of a metal oxide passive coating on a metal surface with the rapid advancement of tissue engineering, the need for synthetic and natural biomaterials has skyrocketed. Metals and alloys' corrosion behaviour in artificial saliva has been studied [1-8]. Human saliva comprises 98% water, plus electrolytes, mucus, white blood cells, epithelial cells, glycoproteins, enzymes, antimicrobial agents such as secretory IgA. Furthermore, lysozyme Saliva enzymes are necessary for the initial stages of digestion of dietary carbohydrates and lipids. These enzymes also help to break down food particles lodged in tooth fissures, preserving teeth from bacterial damage. Orthodontic arch wires can be made from a variety of alloys, the most common of which are stainless steel, Nickel-Titanium Alloy (NiTi), and beta-titanium alloy, among others. When orthodontic arch wires are put in the hostile electrolytic environment given by the human mouth, corrosion graded degradation of materials by electrochemical attack is a cause for worry. Corrosion processes may be influenced by factors such as temperature, pH, foods, and tablet circumstances. Hence it investigates the corrosion resistance and effect on orthodontic archwire with tablets.

MATERIALS AND METHODS

Ni-Ti super elastic shape memory alloy were utilized as test materials for this work. The chemical composition of the alloys is presented in Table 1.

Table 1: NiTi super elastic memory alloy wire and its composition.

S.NO	Types of wires	Composition
1	Ni-Ti super elastic shape	55.5% Ni and 4 4.5% Ti

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Prior to the surface treatment, metal wires were employed, and the wires were surface polished. They were degreased with trichloroethylene vapours before being mechanically polished using various polishing papers (Course, Medium, Fine, and Extra Fine). The specimens were cleaned in ethanol, and then distilled water, before being dried with clean tissue paper. Finally, the specimens were stored in a dessicator until they were needed.

Preparation of the stock solutions

The Artificial Saliva (AS) was used as corrosive medium to explore the inhibition potential of various tablets such as Limcee, Shelcal, Ferikind (Table 2). Artificial saliva is prepared in laboratory and the composition of artificial saliva is as follows:

KCl - 0.4 g/lit, NaCl - 0.4 g/lit, $CaCl_2 .2H_2O$ - 0.906 g/lit, $NaH_2 PO_4 .2H_2O$ - 0.690 g/lit, $Na_2S.9H_2O$ - 0.005 g/lit, Urea - 1 g/lit.

Table 2: Composition of Tablets used for the corresive medium for Artifical Saliva.

Representation	Tablet names	Composition
Tablet-A	Limcee	Ascorbic Acid
	vitamin C chewable	Sodium Ascorbates
Tablet-B	Shelcal	Calcium Carbonate
	Calcium With Vitamin D3	Vitamin D3
Tablet C	Ferikind	Ferikind Elemental Iron
	Ascorbic Acid	Folic Acid

Potentiodynamic polarization study

As an electrochemical phenomenon, it is of importance for corrosion typically lowering corrosion rates. Increasing polarization of either the cathode or anode usually by using corrosion inhibitors-help reducing the corrosion rate. Polarization methods such as potentiodynamic polarization often used for laboratory corrosion testing. These approaches can provide helpful information about corrosion mechanisms, corrosion resistance, and the susceptibility of specific materials to corrosion in various settings. Polarization methods entail varying the working electrode's potential and measuring the current produced as a function of time or potential. Polarization experiments were conducted in the current investigation using a CHI Electrochemical workstation I analyzer, model 660A. It came with an automatic iR compensation feature. It was a three-electrode cell arrangement that was employed. Orthodontic wire used as the working electrode. The reference electrode was a Saturated Calomel Electrode (SCE), while the counter electrode was platinum. A moment in time 5-10 min was given for the system to attain a steady state open circuit potential. In the absence and presence of tablets, the working electrode and platinum electrode were soaked in artificial saliva. A salt bridge connected a saturated calomel electrode to the test fluid. Corrosion characteristics such as corrosion potential (Ecorr), corrosion current (Icorr), Tafel slopes (ba and bc), and Linear Polarization Resistance (LPR) were estimated based on the polarization research. The scan rate (V/s) for the polarization research was 0.01; the hold time at Ef (s) was zero; and the quiet period (s) was two.

AC impedance measurements

Electrochemical impedance is typically measured by providing an AC voltage to an electrochemical cell and then measuring the current through the cell. A modest excitation signal is usually used to test electrochemical impedance. AC impedance studies were carried out in electrochemical impedance workstation analyzer model CHI 660A three electrode cell assemblies was used. The working electrode was the orthodontic wire. A Saturated Calomel Electrode (SCE) served as the reference electrode, while a rectangular platinum foil served as the counter electrode. AC impedance spectra were recorded after iR correction. The fundamental part (Z') and imaginary part (Z") of the cell impedance were measured in ohms at various frequencies. As corrosion parameters, charge Transfer Resistance (Rt) and Double Layer Capacitance (Cdl) were calculated. To capture AC impedance spectra, the scan rate (V/s) was 0.005, the hold time at Ef(s) was zero, and the quiet time (s) was two. Cdl values were calculated using the following relationship. Analysis of potention dynamic polarization curves and polarization experiments, for example, have been used to confirm the findings. During corrosion inhibition, a protective coating is generated on the metal surface process. The corrosion current is reduced if a protective coating is developed on the metal surface. The value (Icorr) falls. The value of Linear Polarisation Resistance (LPR) rises.

RESULTS

Corrosion behavior of Ni-Ti super elastic shape memory alloy in artificial saliva in the absence and presence of tablets

The polarization research and AC impedance spectra were used to analyze the corrosion behavior of Ni-Ti super elastic shape memory alloy in artificial saliva in the absence and presence of tablets. The creation of a protective coating on the metal surface during the corrosion inhibition process has been confirmed using electrochemical investigations such as polarization tests. The Corrosion Current Value (Icorr) drops when a protective coating forms on the metal surface. The value of Linear Polarisation Resistance (LPR) rises [9-15]. Corrosion potential (Ecorr mV versus SCE), Tafel slopes (bc mV/decade; ba mV/decade), and linear polarization resistance (LPR ohm cm2) are the corrosion characteristics (Table 3).

Table 3: Corrosion parameters of Artificial Saliva (AS) in the absence and presence of Tablets obtained from polarization study.

System	LPR(ohm cm^2)	Score(A/ cm^2)	Ecorr(mV *versus* SCE)	bc(mV/ decade)	ba(mV/ decade)
AS	419028	11.68 x 10^{-8}	-521	205	249
AS+Tablet-A	548343	9.619 x 10^{-8}	-478	209	287
AS+Tablet-B	368464	19.27 x 10^{-8}	-490	232	549
AS+Tablet-C	574015	8.322 x 10^{-8}	-474	187	265

When Ni-Ti Super elastic shape memory alloy immersed in Artificial Saliva (AS), the corrosion potential is -521mV vs. SCE. When Tablet-B is added to the above system the corrosion potential is shifted to the anodic side -490 mV vs. SCE. This indicates that the anodic reaction is controlled predominantly. That is the anodic reaction formation of OH- is controlled by formation of a protective film on the anodic sites of the metal surface. However, the shift in corrosion potential is not much. Hence it is inferred that the system functions as mixed type of inhibitor. Tablet-B contains ingredients like carbonate which have been adsorbed on the metal surface forming metal complexes on the anodic sites. Polarization study can be used to confirm the formation of a protective film on the metal surface. When a protective film is formed the LPR value decreases from 419028 ohm cm^2 to 368464 ohm cm^2 whereby the corrosion current increases from 11.68*10^{-8} A/cm^2 to 19.27*10^{8} A/cm^2. All these observations lead to the conclusion that in presence of Tablet-B (300 ppm) the corrosion resistances of Ni-Ti Super elastic shape memory alloy decreases. Thus polarization study leads to the conclusion that people having orthodontic wires made of Ni-Ti Super elastic shape memory alloy should avoid Tablet-B.

Analysis of AC impedance spectra

Table 4: AC impedance parameters of NiTi Super elastic shape memory alloy in Artificial Saliva (AS).

System	Rt(ohm/cm^2)	Cdl (F/cm^2)	Impedance (Log(z/ohm))
AS	7281	7.004 x 10^{-10}	4.167
AS+Tablet-A	8025	6.355 x 10^{-10}	4.181
AS+Tablet-B	5994	8.508 x 10^{-10}	4.042
AS+Tablet-C	8540	5.971 x 10^{-10}	4.17

It is inferred from Table 4 that the charge Transfer Resistance (Rt) increases from 7281 ohm cm^2 to 8025 ohm cm2, the Cdl value decreases from 7.004*10^{-10} F/cm^2 to 6.355*10^{-10} F/cm^2, when Tablet-B (300 ppm) is added to artificial saliva. The AC impedance value increases from 4.167 to 4.181; thus analysis of AC impedance spectra leads to the conclusion that a protective film is formed on the metal surface in presence of tablet -A (300 ppm). Consequently the corrosion resistance of Ni-Ti elastic shape memory alloy in contact with artificial saliva increases. This suggests that people having implanted with orthodontic wires made of Ni-Ti Super elastic shape memory alloy need not hesitate to take Tablet-A. The active ingredients of the tablets have not corroded the orthodontic wires made of Ni-Ti Super elastic shape memory alloy; rather they have protected the wire by formation of protective film on the surface of the wires consequently the corrosion resistance of Ni-Ti Super elastic shape memory alloy in contact with artificial saliva decreases. This suggests that people having implanted with orthodontic wires made of Ni-Ti Super elastic shape memory alloy should avoid Tablet-C. The active ingredients of the tablets have corroded the orthodontic wires made of Ni-Ti Super elastic shape memory alloy; rather they have not protected the wire by formation of protective film on the surface of the wires.

Artificial Saliva (AS) in the presence of tablet-B (bode plots)

The corrosion resistance of Ni-Ti Super elastic shape memory alloy in contact with artificial saliva rises in the presence of Tablet-B, Tablet-C (300 ppm), according to the results of electrochemical investigations. People who have orthodontic wires made of Ni-Ti Super elastic shape memory alloy should not hesitate to take these pills, according to the findings of the study. The active chemicals in the tablets did not corrode the Ni-Ti Super elastic shape memory alloy orthodontic wires; instead, they safeguarded the wires by forming a protective film on their surface. But corrosion resistance of Ni-Ti Super elastic shape memory alloy with artificial saliva decreases in the presence of Tablet C. Hence people having orthodontic wires made of Ni-Ti Super elastic shape memory alloy should avoid Tablet C.

DISCUSSION

Biomaterials are used in the production of a wide range of prosthetic devices around the world. Prosthetic devices are artificial parts that are employed in biological systems, such as the human body, to perform the function of the original part. Depending on the intended function, these devices are often built of polymeric, metallic, and ceramic materials, or mixtures of these materials. Metals alloys are used as surgical implants in the human body primarily for orthopedic purposes. The primary prerequisite for any material inserted in the human body is that it is biocompatible and does not produce any adverse reactions. Metallic materials are utilized in dentistry as implants to replace a single tooth or a group of teeth, or in the manufacture of dental prostheses such as metal plates for complete and partial dentures, crowns, and bridges, mainly in patients who require hypoallergenic materials. Corrosion of metallic implants is critical because it can compromise the implants' biocompatibility and mechanical integrity. Many metals and alloys have been used in dentistry. Their corrosion behaviour in Artificial Saliva has been investigated. In the present study, the corrosion behaviour of metals Ni-Ti alloy, in Artificial Saliva and in the presence and absence of tablets (antibiotics and antacid) has been evaluated.

CONCLUSION

The corrosion behaviour of metals in Artificial Saliva in the presence and absence of tablets is based on the results obtained from polarization study and AC impedance measurements. The corrosion resistance of Ni-Ti super elastic shape memory alloys in artificial saliva with and without tablet (Limcee, Shelcal, Ferikind) has been studied. But in the presence of tablet (Limcee, Shelcal, Ferikind,) corrosion potential is shifted to anodic side. Polarization and AC impedance studies leads to the following order of corrosion resistance Ferikind>Limcee>Shelcal. Hence the Shelcal tablet should be avoided when people are clipped with Ni–Ti super elastic shape memory alloy. The primary prerequisite for any material inserted in the human body is that it is biocompatible and does not produce any adverse reactions. Metallic materials are utilized in dentistry as implants to replace a single tooth or a group of teeth, or in the manufacture of dental prostheses such as metal plates for complete and partial dentures, crowns, and bridges, mainly in patients who require hypoallergenic materials. Corrosion of metallic implants is critical because it can compromise the implants' biocompatibility and mechanical integrity. Many metals and alloys have been used in dentistry. Their corrosion behaviour in Artificial Saliva has been investigated. In the present study, the corrosion behaviour of metals Ni-Ti alloy, in Artificial Saliva and in the presence and absence of tablets (antibiotics and antacid) has been evaluated.

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