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# Anti-Corrosive Effect of Tablets on Ni-Ti alloy in presence artificial saliva

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#### ABSTRACT

The corrosion behavior of Ni-Ti alloy in artificial saliva with and without of Brufen 400mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets has been examined by AC impedance spectra, polarization study and Scanning Electron Microscope. Orthodontic wires commonly made of various metals and alloy. Various tablets are orally taken. During the oral environment these orthodontic wires suffer many types of corrosion. The present investigation the corrosion actions of orthodontic wire made of Ni-Ti alloy, with artificial Saliva in the existence of tablets namely, Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg. Electrochemical studies indicates the corrosion resistance increases forNi-Ti alloy electrode in the presence artificial saliva with Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg. Corroscope indicates the presence of a film deposited on the metal surface. This protective film is due to the deposition of the active ingredients present in theBrufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg. So, people having orthodontic wires made of Ni –Ti alloy without any dither to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg. So, people having orthodontic wires made of Ni –Ti alloy without any dither to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg. So, people having orthodontic wires made of Ni –Ti alloy without any dither to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets.

**Reywords:** Of thoughtic wires, Ni – IT alloy, AC impedance specifia, polarizati

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# INTRODUCTION

In dentistry, metallic materials are used as implants in reconstructive oral surgery to replace a single tooth or in the fabrication of dental prostheses such as metal plates for complete and partial dentures crowns, and bridges, essentially in patients requiring hypoallergenic materials. Corrosion of metallic implants is of vital importance, because it can unfavorably change the bio-compatibility and mechanical reliability of implants. Various metals and alloys have been used in dentistry. The corrosion behavior of Ni-Ti alloy in artificial saliva with and without of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets has been investigated. Variations in surface characteristics and corrosion behaviour of metal brackets and wires in different electrolyte solutionshas been investigated by C. T. Kao[1].Corrosion behaviour of Ni – Ti alloy and SS 18/8 in artificial saliva in the presence of Ferkind tablet has been examined by Anandan [2]. I. A. von Fraunhofer has been inestigated "Corrosion of orthodontic devices [3]. Corrosion Behaviour of Metals in Artificial Tear Solution has been examined by c.kumar [4].M. K. El Kouifat has been investigated the Fretting-corrosion of orthodontic arch-wire/bracket contacts in saliva environment[5].P. Chitra has been reported the effect of fluoride agents on surface characteristics of NiTi wires. An ex vivo investigation [6].Ion release and galvanic corrosion of different orthodontic brackets and wires in artificial saliva has been exaamined by S. Tahmasbi[7]. Many researchers have been reported by using Ni -Ti alloy with artificial saliva. The present study leads to examine the anti-corrosive action of orthodontic wire made of Ni -Ti alloy in artificial saliva with Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets orally taken has been examined by AC impedance spectra, polarization study and Scanning Electron Microscope. The composition of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets are given in Table 1.

Table 1: The composition of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg

Brufen 400 mg	Ibuprofen 400 mg
Nimesulide 100 mg	Nimesulide Bp 100 mg
Deriphyllin retard 150 mg	Theophylline 35 mg and Etophylline115 mg

# **MATERIAL AND METHODS**

The composition of Ni-Ti alloy is Ni – 55.5 % and balanced Ti. The orthodontic wire was encapsulated in Teflon. The wire was polished to a mirror finish and degreased with trichloroethylene. The electrochemical studies were carried out in a three electrode cell assembly. The three electrodes were immersed in Fusayama Meyer artificial saliva (AS), whose composition is given in Table 2.

Table2: Composition of Artificial saliva				
Name of the salt	Weight (g/lit)			
KCl	0.4			
NaCl	0.4			
CaCl <sub>2</sub> .2H <sub>2</sub> O	0.906			
NaH <sub>2</sub> PO <sub>4</sub> .2H <sub>2</sub> O	0.690			
Na <sub>2</sub> S.9H <sub>2</sub> O	0.005			
urea	1			

The pH of the solution was 6.5. In electrochemical studies, the metal specimens were used as working electrodes. Artificial saliva (AS) was used as the electrolyte. The temperature was maintained at  $37 \pm 0.1^{\circ}$ C.

# **Potentiodynamic Polarization**

Polarization studies were carried out in a CHI-electrochemical workstation with impedance, Model 660A. A three-electrode cell assembly was used (Fig 1). The working electrode was Ni-Ti alloy. A saturated calomel electrode (SCE) was the reference electrode and platinum was the counter electrode. From the polarization study, corrosion parameters such as corrosion potential ( $E_{corr}$ ), corrosion current ( $I_{corr}$ ), and Tafel slopes (anodic = ba and cathodic = bc) were calculated.



Fig 1: Three electrode cell assembly

# **AC Impedance Spectra**

The instrument used for polarization study was also used to record AC impedance spectra. The cell setup was also the same. The real part (Z') and imaginary part (Z") of the cell impedance were measured in ohms at various frequencies. The values of the charge transfer resistance ( $R_t$ ) and the double layer capacitance ( $C_{dl}$ ) were calculated from Nyquist plot Impedance: log (z/ohm) value was calculated from Bode plots.

# Analysis of Scanning Electron Microscope

The surface morphology measurements of the thin wire metal Ni-Ti alloy specimen were examined using scanning electron microscope. The surface morphology was examined for the thin wire Ni-Ti alloy metal specimen in absence and presence of the Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets system. The specimen immersed in the system for a period of one day was removed, rinsed with double distilled water, dried and observed in a scanning electron microscope to study the surface morphology.

# **RESULTS AND DISCUSSION**

# Analysis of potentiodynamic polarization studies

Electrochemical polarization studies have been used to verify the formation of protective film formed on the metal surface during corrosion inhibition process [8-16]. If a protective film is formed on the metal surface, the corrosion current value ( $I_{corr}$ ) decreases and corrosion potential value ( $E_{corr}$ ) increases. The potentiodynamic polarization curves of Ni –Ti alloy immersed in artificial saliva with Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets, obtained from polarization study are shown in Fig-2.The corrosion parameters, namely, corrosion potential ( $E_{corr}$  mV vs SCE), Tafel slopes( $b_{c}mV/decade$ ;  $b_{a}mV/decade$ ), linear polarization resistance (LPR ohm cm<sup>2</sup>) and corrosion current( $I_{corr}$  A/cm<sup>2</sup>) values are given in Table 3.



Fig 2: Polarization curves of Ni – Ti alloy is immersed in Artificial Saliva (AS) in the absence and presence of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets.
(a) Artificial Saliva (AS); (b) AS + Brufen 400 mg (400 ppm); (c) AS + Nimesulide 100 mg(400 ppm) ; (d) AS + Deriphyllin retard 150 mg (400 ppm)

AsNi-Ti alloy is immersed in Artificial Saliva (AS), the corrosion potential is (-617mV vs SCE). While Brufen 400 mg (400 ppm) is added to the above system the corrosion potential is shifted to (-689 mV vs SCE). The LPR value increases from 200651940hmcm<sup>2</sup> to 262284520hmcm<sup>2</sup> and the corrosion current decreases from  $2.156 \times 10^{-9}$  A/cm<sup>2</sup> to  $1.551 \times 10^{-9}$  A/cm<sup>2</sup>. Whereas Nimesulide 100 mg (400 ppm) is added to the above system the corrosion potential is shifted to(-624 mV vs SCE). The LPR value increases from 200651940hmcm<sup>2</sup> to 217647440hmcm<sup>2</sup>and the corrosion current decreases from  $2.156 \times 10^{-9}$  A/cm<sup>2</sup> to  $1.980 \times 10^{-9}$  A/cm<sup>2</sup>. While Deriphyllin retard 150 mg (400 ppm) is added to the above system the corrosion potential is shifted to(-625 mV vs SCE). The LPR value increases from 200651940hmcm<sup>2</sup> to 243580740hmcm<sup>2</sup>and the corrosion current decreases from  $2.156 \times 10^{-9}$  A/cm<sup>2</sup>. The entire observations show the way to the conclusion that the corrosion resistance increases for the Ni – Ti alloy electrode in the presence of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. Hence polarization study leads to the conclusion that people having orthodontic wires made of Ni-Ti alloy without any dither to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. The active ingredients of the Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets have not corroded wires made of Ni –Ti alloy.

Table 3: Corrosion parameters of Ni- Ti alloy is immersed in artificial saliva with Brufen 400 mg,
Nimesulide 100 mg and Deriphyllin retard 150 mg tablets, obtained from polarization study
obtained from polarization study

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System	bc	ba	LPR	Icorr			
	(mV/ decade)	(mV/	(ohm cm²)	(A/cm <sup>2</sup> )			
		decade)					
Artificial Saliva (AS)	137	361	20065194	2.156×10-9			
AS + Brufen 400mg (400 ppm)	126	357	26228452	1.551×10-9			
AS + Nimesulide 100mg (400 ppm)	131	405	21764744	1.980×10-9			
AS+Deriphyllin retard 150mg (400 ppm)	120	389	24358074	1.664×10-9			

# Analysis of AC Impedance spectra

AC impedance spectra (electro chemical impedance spectra) have been used to confirm the formation of protective film on the metal surface. If a protective film is formed on the metal surface, charge transfer resistance (R<sub>t</sub>) increases; double layer capacitance value (C<sub>dl</sub>) decreases. Impedance value increases. The AC impedance spectra of Ni-Ti alloy is immersed in Artificial Saliva (AS) in the absence and presence of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg, obtained from AC impedance spectra are shown in Figs.3-7.The AC impedance parameters namely charge transfer resistance (Rt) and double layer capacitance ( $C_{dl}$ ) derived from Nyquist plots (Fig 3) are given in Table 4.The impedance value derived from Bode plots (Figs 4, 5, 6 and 7) are also given in this Table 4. It is observed that when Brufen 400 mg (400 ppm) is added to artificial saliva, the charge transfers resistance (Rt) increases from 24827  $\Omega$  cm<sup>2</sup> to 31458  $\Omega$  cm<sup>2</sup>. The C<sub>dl</sub> value decreases from 5.040 X10<sup>-8</sup> F/cm<sup>2</sup> to 4.774 X10<sup>-8</sup> F/cm<sup>2</sup>.The impedance value increases from 1.053to 2.332. When Nimesulide 100 mg(400 ppm) is added to artificial saliva, the charge transfer resistance ( $R_t$ ) increases from 24827  $\Omega$  cm<sup>2</sup> to 33209  $\Omega$  cm<sup>2</sup>. The C<sub>dl</sub> value decreases from 5.040 X10<sup>-8</sup> F/cm<sup>2</sup> to 3.768 X10<sup>-8</sup>.The impedance value increases from 1.053 to 1.946.When Deriphyllin retard 150 mg (400 ppm) is added to artificial saliva, the charge transfers resistance (R<sub>t</sub>) increases from 24827  $\Omega$  cm<sup>2</sup> to 32433  $\Omega$  cm<sup>2</sup>. The C<sub>dl</sub> value decreases from 5.040 X10<sup>-8</sup>  $F/cm^2$  to 4.922 x10<sup>-8</sup>. The impedance value increases from 1.053 to 2.309.

# Table 4: AC impedance parameters of SS 18/8 is immersed in artificial saliva with Ciprofloxacin500 mg, Brufen 400 mg and Deriphyllin retard 150 mg tablets, obtained by AC impedance spectra

System	Rt (ohm cm²)	Cai (F/ cm²)	Impedance Log(z/ohm)
Artificial Saliva (AS)	1278.0	1.9398x10-11	1.587
AS + Brufen 400mg (400 ppm)	8192.3	1.2185x10-11	2.301
AS + Nimesulide 100mg (400 ppm)	8028.3	1.2434 x 10 <sup>-11</sup>	1.895
AS + Deriphyllin retard 150 mg (400 pm)	12399.0	1.926 x 10-11	1.970

All these observation reveals that the corrosion resistance increases for the Ni-Ti alloy electrode in the presence of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. Hence AC impedance spectra lead to the conclusion that people having orthodontic wires made of Ni-Ti alloyneed not hesitate to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. The active ingredients of the Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets have not corroded wires made of Ni-Ti alloy.



Fig 3: AC impedance spectra (Nyquist Plots) of Ni –Ti alloy is immersed in ArtificialSaliva (AS) in the absence and presence of Brufen 400 mg,Nimesulide 100 mg and Deriphyllin retard 150 mg tablets.

(a) Artificial Saliva (AS) ; (b) AS + Brufen 400 mg (400 ppm); (c) AS + Nimesulide 100 mg (400 ppm) ; (d) AS + Deriphyllin retard 150 mg (400 ppm)



Fig 4: AC impedance spectra (Bode Plots) of Ni-Ti alloy is immersed in Artificial Saliva (AS) in the absence of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg (400 ppm)



Fig 5:AC impedance spectra (Bode Plots) of Ni-Ti alloy is immersed in Artificial Saliva (AS) in the presence of Brufen 400 mg(400 ppm)



Fig 6:AC impedance spectra (Bode Plots) of Ni –Ti alloy is immersed in Artificial Saliva (AS) in the presence of Nimesulide 100 mg (400 ppm)



Fig 7:AC impedance spectra (Bode Plots) of Ni-Ti alloy is immersed in Artificial Saliva (AS) in the presence of Deriphyllin retard 150 mg (400 ppm)

# Scanning Electron Microscope (SEM) Analysis of Ni -Ti alloy

SEM provides a pictorial representation of the surface of Ni –Ti alloy. SEM morphology has been studied to understand the nature of the surface film inNi -Ti alloy in artificial saliva with and without of Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. The SEM images of different magnification (x2) of Ni – Ti alloyis immersed in artificial saliva with Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets (400 ppm) for one day in the absence and presence of system are shown in Fig.8(a-d) respectively. The SEM micrographs in Fig. (8) shows the smooth surface of the Ni –Ti alloy. This shows the absence of artificial saliva on the surface of Ni – Ti alloy. The SEM micrographs in Fig. (8a) shows therough surface of the Ni -Ti alloywhich indicates the presence of artificial saliva in Ni -Ti alloysurface. The SEM micrographs of Ni -Ti alloyimmersed in artificial saliva with Brufen 400 mg (400 ppm) in Fig. (8b) shows the less rough surface of Ni –Ti alloy. This indicated the formation of protective layer on the surface of Ni –Ti alloy. The SEM micrographs of Ni –Ti alloyimmersed in artificial saliva with Nimesulide 100 mg (400 ppm) in Fig. (8c) shows the diminished rough surface of Ni –Ti alloy thereby denoting the formation of protective layer on the surface of Ni –Ti alloy. Fig. (8d) shows the increasing smoothness surface of Ni -Ti alloy than surface of Ni -Ti alloy in presence of artificial saliva. Which indicate the protective layer is formed on the surface of Ni -Ti alloyimmersed in artificial saliva with Deriphyllin retard 150 mg (400 ppm). The analysis of scanning electron microscope indicates the presence of a film deposited on the metal surface. This protective film is due to the deposition of the active ingredients present in the Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets.



Fig 8: Polished Metal Surface of Ni – Ti alloy



Fig 8a:Artificial Saliva (AS) Fig 8b: AS + Brufen 400 mg (400 ppm)



Fig. 8c: AS + Nimesulide 100 mg (400 ppm) Fig 8d: AS + Deriphyllin retard 150 mg (400 ppm)

# CONCLUSION

Results of the electrochemical studies and SEM analysis leads to the conclusion that the corrosion resistance increases for the Ni- Ti alloy electrode in the presence artificial saliva with Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets (400 ppm). Hence people having orthodontic wires made of Ni –Ti alloy without anydither to take Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets. The active ingredients of the Brufen 400 mg, Nimesulide 100 mg and Deriphyllin retard 150 mg tablets have not corroded wires made of Ni- Ti Alloy.

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