Measurement the Chemical Composition and Topography of Copper Nickel Titanium Arch Wires at Dry and Wet conditions (An *In-Vitro* Study)

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Abstract

Background: The characteristics surface, such as, topography, and rigidity of orthodontic arch wires are essential determining factor of the effectiveness,of arch wire-guided tooth movement. They also affect, in the potential of corrosion,and the aesthetics,of orthodontic components. This study was considered to evaluate the chemical composition and topography of Cu-NiTi arch wires from different companies in,dry and,wet condition(acidic and,neutral artificial saliva). **Materials and methods** Three,types of CuNiTi orthodontic,archwires from,different brands were,used: CuNiTi (Ormco brand),, CuNiTi (IOS brand) and,CuNiTi (Orthotechnology brand).,They were rectangular,(0.018*0.025 inch) in cross,section and cut into pieces,of 20 mm in length.,30 pieces,from each,company were separated into 3 groups; one group was left dry condition,and other,2 groups, ten pieces,for each group were submerged in,artificial saliva,(pH=6.75 ± 0.015) and,(pH=3.5 ± 0.015) at 37ºC ,for 2 months. The SEM and EDS was used to assess surface analysis of wholly samples.,**Results:** After soaking period, CuNiTi wires from orthotechnology brand,exhibited the highest change in chemical composition and topography among the study groups. Instead, the least change in chemical composition and topography surfaces were CuNiTi wires from Ormco brand,when compared to,analogous arch wires. **Conclusion:** The CuNiTi arch wires from Ormco brand were the greatest and the most appropriate alignment in orthodontic archwires in term of the least changes in surface of Cu-NiTi initially and during the course of this study period.

Keywords: *Copper Nickel Titanium arch wires, scanning-electron microscopy and Energy dis persive x-ray spectrophotometer .*

Introduction

An appliance continued fixed on teeth within, attachment by,which the request of force occurred by arch wires or auxiliaries is called fix orthodontic appliance **(1)**. The one of most main portions of fixed appliance is arch wire, the perfect one should have capacity to move the tooth with a,continuous ,light force applied to it **(2).** Nickel titanium- Copper chromium Alloy,(CuNiTi):This alloy was advanced by Dr.Rohit Sachdeva and Miyasaki,in 1994. It composed of (49.87%),nickel, (5.64%),Copper, (42.99%) titanium ,and (0.5%) chromium'''**(3)**. To increase the thermal-reactive assets of the archwire and increase the transformation of the temperature to above the oral cavity and to recompense for this, copper additional to the alloy, the chromium is added to reduction the transformation of the temperature. Originally,'' Copper NiTi was produced with four altered austenitic transformation temperatures covering both thermoelastic archwires and pseudoelastic ''**(4).** The cobalt-chromium, stainless-steel,, and titanium alloys were,used in the orthodontic,appliances depend on the formation of passive oxide surface films to corrosion resist. These layers of protective are not,reliable.They are prone to both chemical and mechanical degradation.

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Even,without t destruction, oxide,films regularly dissolve slowly only to alteration as metal surface is,exposed tooxygen the from surrounding medium or from air [5].

The purpose of the present study was to analysis chemical composition and topography of copper nickel titanium archwires at dry and neutral , acidic of artificial saliva.

Materials and Methods

Formation of Artificial Saliva

The mechanisms of artificial saliva '' 0.7g NaCl , 1.2g KCl , 0.26g Na2HPO4 , 0.2g K2HPO4 , 1.5g NaHCO3 , 0.33g KSCN , 0.13g,urea and 1000,ml deionized water''.'' NaOH and Lactic acid were used to alter ''the pH of artificial saliva using the pH-meter'' and kept in,37°C using incubator using filter paper after filtering to get clear of any unsolvable impurities and salts. The,pH of artificial saliva,was attuned to 6.75±0.015 and 3.5±0.015 using a pH meter (Jenway,,Cyprus and model 3320, equivalent to the pH of human salivary'' **(6-8).**

The Samples

The samples,were made of (3)types of maxillary archwires rectangular in cross-section ((0.018*0.025 inch)):

1. CuNiTi,archwires (Ormco corp., Glendora, CA, USA),

2. Copper Nickel,Titanium archwire,(((Ortho Technology®, USA, TruFlex™, full form))

And 3. CuNiTi archwires (IOS, International Orthodontic Services, Stafford, USA).

The straight parts of the arch wire were cuting into 20 mm in length(9). Tottaly was 90pieces of arch wire, 30,pieces from each type, of arch wires, were divided in,the groups that 10 parts from each,company retain in a dry,condition ''as a control group'', although the other,20 parts,were submerged,in artificial saliva,for 2 month ,ten pieces,from each,groups were submerged,in pH,of artificial,of saliva 6.75 and ,pH = 3.5.

Afterward, samples,was employed,in glass containers,seperated and held in from its,ends held by,dental floss .Then, ,added of artificial,saliva so that,sample,was submerged,completely. **(Figure1)**.

Figure(1): samples in the artificial saliva.

Then,the samples, were saved in an ,incubator, at 37 0C in (Fisher scientific) for two month .Then, artificial saliva was changed regularly every seven days with a fresh solution to evade its,saturation with ,the products,of the, degradation (10,11).After the 2 month the ,samples were,washed by distilled water. Then, left to dry and,preserved in,petri dishes.

Specimens

then, it desires to use,minor slides With the determination of use scanning electron microscope and energy dispersive x-ray spectrophotometer for analysis the sample .The cut of slide by a diamond,cutting instrument. Then, the sample fixed on a,the slide.

The studies of orthodontic materials in artificial salivas on the corrosion, resistance are very ,popular. In the current work, the ,changes of the surfaces of CuNiTi alloy of the orthodontic wires in neutral artificial saliva ph=6.75 and acidic artificial saliva ph= 3.5 after 2 month are examined by the Scanning Electron Microscopy and Energy dis persive x-ray spectrophotometer EDS methods.

Results

Surface micromorphology of the Copper Nickel Titanium in dry and neutral ,acidic artificial saliva

Surface micromorphology of the Copper Nickel Titanium was evaluated before and after immersion in neutral and acidic of artificial saliva, visualized at 2000X magnification using SEM and the surface topography was assessed using EDS, as shown in (figues: 2) in dry condition.

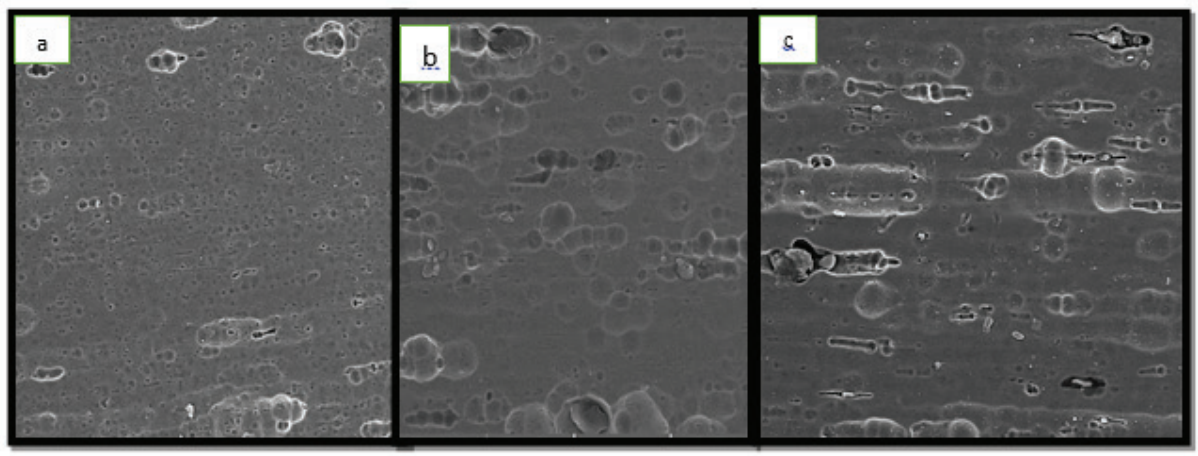

Figure (2): Surface micromorphology of CuNiTi arch wires at 2000X magnification using SEM. A) represents the surface of ormco brand at dry condition ; b) represents the surface of IOS brand at dry condition ; c) represents the surface of orthotechnology brand at dry condition.

It was found that after CuNiTi archwires immersion in,artificial saliva exaggerates surface changes of the wires, this was represented by appearance of,numerous pits with different depth and size, as being reflected,by the increase,in number and height of beaks ,Concomitant with immersion,in artificial saliva for 2month.

So that the control groups (dry condition) exhibited increased number of pits with ,shallow depth. It is possible, that the pits ,represented that roughness ,and artificial ,saliva enhanced ,the depth ,and number ,of these pits. ,Indeed, with,orthotechnology and IOS brands, major changes occurred representative by presence of great fissures ,connecting pits and area of surface break. Nevertheless, with Ormco brand, the pits were more distributed regularly through the surface with the smallest changes, occurred compared,to other brands.

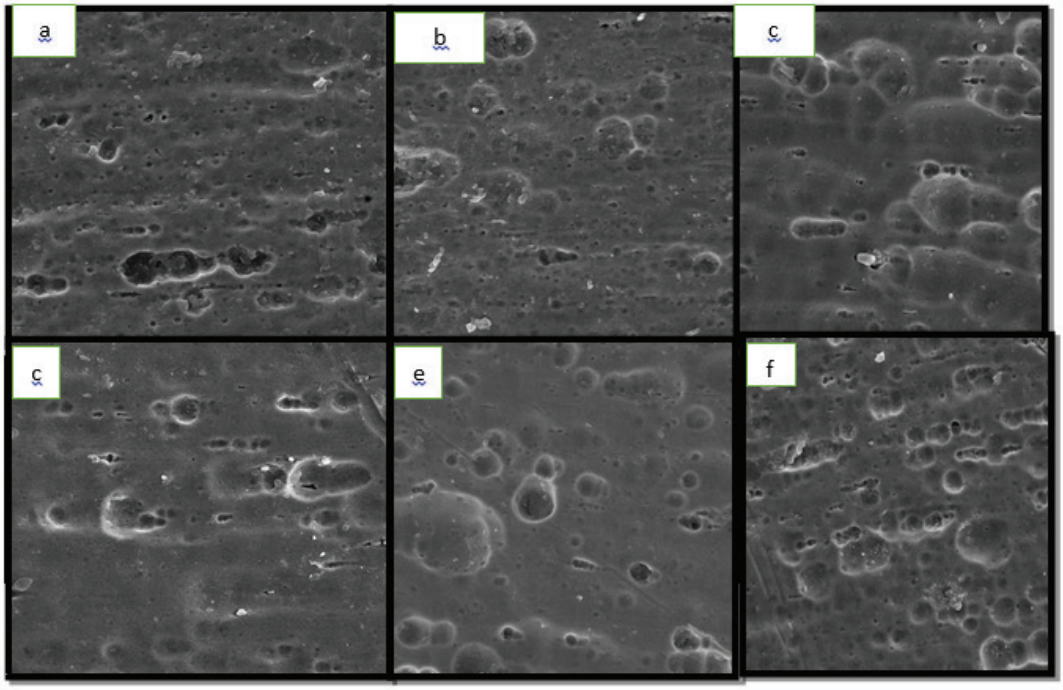

Figure (3) : Surface micromorphology of CuNiTi from different brands at 2000X magnification using SEM. A) represents the surface of ormco brand in media 3.5 of artificial saliva ; b) represents the surface of ormco brand in media 6.75 of artificial saliva ; c) represents the surface of IOS brand in media 3.5 of artificial saliva ; D) represents the surface of IOS brand in media 6.75 of artificial saliva; e) represents the surface of Orthotechnology brand in media 3.5 of artificial saliva; f) represents the surface of Orthotechnology brand in media 6.75 of artificial saliva.

Chemical element composition of Copper nickel titanium brands

Chemical composition of every CuNiTi brands was shown in, table (1) the percentage of element, of copper nearly the similar in all,brands in dry condition while copper element decrease in both Company of IOS and orthotechnology in acidic and neutral artificial saliva, while titanium element in all brand is increase in neutral and acidic condition while Ni element decrease in all brands and O element was increase in all brands in neutral and acidic artificial saliva condition.

Table: (1) chemical element composition of CuNiTi of each brand

Brand	Ormco			Orthotechnology			IOS		
Element	Wt%			Wt%			Wt%		
	Dry condition	Neutral Artificial saliva	Acidic Artificial saliva	Dry condition	Neutral Artificial saliva	Acidic Artificial saliva	Dry condition	Neutral Artificial Saliva	Acidic Artificial Saliva
O	5.34	10.88	11.21	5.16	11.10	10.93	5.96	11.91	12.76
Ti	41.96	59.18	59.56	42.21	61.09	60.41	42.16	60.43	57.80
Ni	47.37	24.21	24.22	47.14	24.54	24.80	46.16	24.24	23.38
Cu	5.33	5.74	5.01	5.49	3.27	3.85	5.72	3.43	6.05
Total	100	100	100	100	100	100	100	100	100

The SEM examination, ,formed oxide-based particles seem in dark - gray contrast (Fig.3). It is obviously seen concentration of oxygen is higher ,than in the matrix. This means that, Ti-based, oxide is,formed as result of tough interaction stuck between the solution and metal. The dissolution,of nickel, from the matrix, into the solution, is very,high. All effects,can be,traced by ,considering the ,concentration differences in the EDS,analyses. The EDS mapping shows to be very beneficial in understanding ,the elemental, distribution for,given materials. Nickel, and titanium,are the major elements on surface and oxide-based, particles can be simply separated from,the matrix because of their oxygen ,level.

The EDS ,studies show to be very beneficial in determining components,formed on the,surface of the,metal as result of corrosion,in the artificial saliva ,after a period ,of time.

The results OF EDS shown in (Table 1) indicate that a clear reduction in the amounts of Ni and Ti because of the dissolution,of the metals.From the,clinical point,of view,,the final result of orthodontic,treatment may,be compromised,by corrosion, and metal ions appearing as corrosion,products (Ni2+) may,result in,symptoms of,toxicity andallergic reactions [12]. The oxide,film behaves,as a protective,layer during,corrosion in,aggressive environments [13].

'' Titanium exists in the solution as TiO2 having a more stable form''. Ni element reduction in composition,of wires and,Ti increase,that because could be,attributed to,the fact that addition of small quantity,of Cu to,the structure of archwires reduced the,reactivity of Ti and increased resistance to,corrosion and,biocompatibility of CuNiTi arch wires[14].

'' However, the manufacturing process of archwires containing Cu in their composition uses a sensitive and not very consistent technique''[15]

The degree,of defects in manufacturing and the composition of orthodontic applanices are factors well-known to accelerate process of corrosion and release ion by archwires [14-16] these consider that unstable ''chemical structures'' might cause release of ion and affect on the biocompatibility of materials[17].

In regrard This result could also be attributed to the archwire manufacturing process. The afundmental part of biocompatibility is Resistance to corrosion and might be affected by altered factors[20] the main depends on, the type of archwire, manufactureing process and characteristics of the archwire surface.[20-23]. The studies by **Huang et al(2003)**[16] and **Huang et al(2005)**[24] decided that nickel titanium archwires of orthodontic from altered manufacturers would have resistance to corrosion in different degrees .

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq

Conflict of Interest: Non

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