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# Microscopic analysis of surface characteristics and chemical composition spectroscopy of different orthodontic archwire

**Análise microscópica de características de superfície e espectroscopia da composição química de diferentes arcos ortodônticos**

**Análisis microscópico de las características superficiales y espectroscopia de la composición química de diferentes arcos de ortodoncia**

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**Abstract**
The aim of this study was evaluate the superficial characteristics and chemical composition of thermally activated archwires used in self-ligating systems. NiTi and CuNiTi of 0.014 diameter (Ormco, Aditek, Orthometric, Morelli and Smart4Y) submitted to variable conditions using segments measuring 10-mm divided in 3 groups according to the immersion: not submitted to immersion, artificial saliva (Kin Hidrat) and acid solution (pH 4.3) using 2 mL of solution and kept at 37oC for 28 days. Then, the samples were evaluated in scanning electron microscopy Personal SEM© eXpress™ (Aspex Corporation, Oregon, EUA). Semi-quantitative analysis performed in energy dispersive x-ray spectroscopy mode evaluated surface chemical composition. CuNiTi wire (Ormco) showed higher roughness, while thermally activated wire (Morelli) the lower. In the wires immersed in artificial saliva, the superficial alteration was evident. In the chemical composition analysis, the CuNiTi wires presented percentages of Cu near to 6%. Low

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percentages (<0.3%) of Cu were detected in the other wires evaluated. For all groups there was predominance of Ni and Ti ions. In the wires immersed in artificial saliva, the ions Na, Cl and K were detected, suggesting saliva deposition components in the surface of wires. CuNiTi wires showed roughness surface characteristics in comparison to the other evaluated wires. The immersion in artificial saliva altered the surface of wires with deposition of ions.
**Keywords:** Orthodontics; Scanning Electron Microscopy; Surface Properties.

**Resumo**
Este estudo teve como objetivo avaliar as características superficiais e composição química de arcos ativados termicamente utilizados em sistemas autoligados. Arcos de NiTi e CuNiTi com diâmetro 0,014 (Ormco, Aditek, Orthometric, Morelli e Smart4Y) foram submetidos à condições variáveis utilizando segmentos de 10 mm divididos em 3 grupos de acordo com a imersão: não submetidos à imersão, saliva artificial (Kin Hidrat) e solução ácida (pH 4,3) utilizando 2 mL de solução e mantidos a 37ºC por 28 dias. Em seguida, as amostras foram avaliadas em microscopia eletrônica de varredura Personal SEM© eXpress™ (Aspex Corporation, Oregon, EUA). A análise semi-quantitativa realizada no modo de espectroscopia por energia dispersiva de raios X avaliou a composição química da superfície. O fio CuNiTi (Ormco) apresentou maior rugosidade, enquanto o fio termicamente ativado (Morelli), o menor. Nos fios imersos em saliva artificial a alteração superficial foi evidente. Na análise da composição química, os fios CuNiTi apresentaram porcentagens de Cu próximas a 6%. Baixas porcentagens (<0,3%) de Cu foram detectadas nos demais fios avaliados. Para todos os grupos houve predomínio dos íons Ni e Ti. Nos fios imersos em saliva artificial íons Na, Cl e K foram detectados, sugerindo componentes de deposição de saliva na superfície dos fios. Arcos CuNiTi apresentaram características de rugosidade superficial mais irregular em comparação aos demais fios avaliados. A imersão em saliva artificial alterou a superfície dos fios com deposição de íons.
**Palavras-chave:** Ortodontia; Microscopia Eletrônica de Varredura; Propriedades de Superfície.

**Resumen**
Evaluar las características superficiales y la composición química de los arcos ortodónticos activados térmicamente utilizados en sistemas autoligados. Se analizaron arcos ortodónticos de NiTi y CuNiTi con un diámetro de 0,014” (Ormco, Aditek, Orthometric, Morelli y Smart4Y), los cuales fueron sometidos a condiciones variables. Se utilizaron segmentos de 10 mm, divididos en tres grupos según el tipo de inmersión: sin inmersión, inmersión en saliva artificial (Kin Hidrat) e inmersión en solución ácida (pH 4,3). Las muestras fueron expuestas a 2 mL de solución y mantenidas a 37 °C durante 28 días. Posteriormente, se evaluaron mediante microscopía electrónica de barrido Personal SEM© eXpress™ (Aspex Corporation, Oregón, EE. UU.). La composición química superficial fue analizada mediante espectroscopia de energía dispersiva de rayos X en modo semicuantitativo. El arco CuNiTi (Ormco) presentó la mayor rugosidad superficial, mientras que el arco activado térmicamente (Morelli) mostró la menor. En los arcos inmersos en saliva artificial, la alteración superficial fue evidente. En el análisis de composición química, los arcos CuNiTi mostraron porcentajes de Cu cercanos al 6%. Se detectaron bajas concentraciones (<0,3%) de Cu en los demás arcos evaluados. En todos los grupos analizados, predominaron los iones Ni y Ti. En los arcos inmersos en saliva artificial, se identificaron iones Na, Cl y K, lo que sugiere la deposición de componentes salivales en la superficie de los arcos. Los arcos CuNiTi presentaron una rugosidad superficial más irregular en comparación con los demás arcos evaluados. La inmersión en saliva artificial modificó la superficie de los arcos debido a la deposición de iones.
**Palabra clave**: Ortodoncia; Microscopía Electrónica de Rastreo; Propiedades de Superficie.

## 1. Introduction

Researches in Orthodontics have sought to improve the efficiency of materials and protocols in order to increase the efficiency of mechanics, reduce treatment time, costs and discomfort to patients, while preserving the integrity of the structures involved (Čelar et al., 2013). Self-ligated systems are increasingly present in clinical practice, presenting great treatment efficacy (Turnbull & Birnie, 2007). The development of new elastic metal alloys combined with concepts of minimum friction, light and continuous forces was an essential part in Orthodontics mechanic evolution (Savoldi et al., 2017).

NiTi alloys have high resilience and low elasticity modulus and stiffness. Since the 1980s, the development of new memory alloys has produced high resilient arcs to withstand greater deflections, with lower force modules compatible with the force levels required for the self-ligating Orthodontic systems (Fernandes et al., 2011; Aboalnaga & Shahawi, 2023). In the 1990s, thermoactivated NiTi alloys initiated its use, presenting constant force and superelasticity properties of the previous alloys allied with thermodynamic properties. Thermal activation enabled shape memory, so, at low temperatures this alloy type is easily deformed, while with temperature increase, the original shape configuration was reestablished (Gravina et al., 2014; Jain et al., 2024).

Copper (Cu) used in conjunction with NiTi, results in an alloy with great clinical potential called CuNiTi, especially because Cu is an effective heat conductor. Ormco introduced copper-nickel-titanium (CuNiTi) wires on the market in 1994 (Sufarnap et al., 2023). Its manufacture uses phase transformation between the martensitic and austenitic crystalline phases at different temperatures (27ºC, 35ºC and 40ºC) (Biermann, Berzins & Bradley, 2007). Thus, these wires are considered to be thermoactivated by body temperature, becoming functional at such temperatures with biologically compatible forces and lower drop of the homogeneous discharge force when compared to other NiTi wires allowing an increase in the time to exchange the wire (Gil & Planell, 1999).

Studies have shown that CuNiTi wires have approximately 6% of Cu in their composition (Fernandes et al., 2011). Although many manufacturers of thermoactivated wires claim that their alloys contain Cu in their composition, there is little evidence of comparison between different brands. In addition, manufacturers do not specify the percentage of each element present in the metal alloys of orthodontic wires.

Another essential property for the efficacy of self-ligating system mechanics is low friction (Gurgel et al., 2001; Marzal et al., 2025). This characteristic is one of the main advantages of self-ligation over the conventional system (Leite et al., 2014). For this reason, available components for this mechanic system (wires and brackets) must present surface roughness free (Pizzoni, Ravnholt & Melsen, 1998). The change in the surface of orthodontic wires due to corrosion may result in an increase in the coefficient of friction and/or friction, compromising sliding in the bracket slots reducing mechanical efficiency (Mane et al., 2012). Studies have shown that CuNiTi wires may undergo degradation in the oral cavity, which increases the roughness of these arches (Jaber et al., 2014).

Few studies are available in the literature demonstrating the chemical composition of thermoactivated metal alloys available and the surface characteristics when subjected to different conditions. The objective of the study is to compare, by scanning electron microscopy (SEM), the chemical composition and surface characteristics of 0.014 "orthodontic wires of different brands commercially available in Brazil. In addition, using energy dispersive x-ray spectroscopy (EDS) mode evaluate surface chemical composition when subject to variable conditions (dry, after exposure to artificial saliva and acid solution).

## 2. Methodology

Laboratory research was carried out, of a qualitative nature in the visual identification of the surface morphology of the metallic threads, and a quantitative nature in the chemical composition values of the artificial saliva (Pereira et al., 2018) and using descriptive statistics on mean values and standard deviation in the analysis of chemical elements in EDS (Shitsuka et al., 2014).

The study was conducted at the Faculty of Dentistry of Bauru, University of São Paulo (FOB/USP). Evaluation used five different brands 0.014" thermoactivated orthodontic wires applied in initial alignment phase for most Orthodontic cases, CuNiTi 27ºC thermoactivated Ormco (Orange, California, EUA), Damon Universal Aditek (Cravinhos, São Paulo, Brazil), NiTi thermoactivated Orthometric (Marília, São Paulo, Brazil), NiTi thermoactivated Morelli (Sorocaba, São Paulo, Brazil) and NiTi thermoactivated Smart4Y (Heilongjiang, China).

The arches were segmented with 10 mm long fragments using orthodontic pliers for distal cutting (Orthometric, Marília, São Paulo, Brazil). Segments distribution was random in three groups, according to the exposure to the solution, Group 1, not subjected to immersion. Group 2 used 2 mL artificial saliva (Kin Hidrat, Kin) for sample immersion. Artificial saliva composition elements are in Table 1. Group 3 used a 4.3 pH solution (Folium et Vitae, Pharmacy compounding) according to a previous study (Jaber et al., 2014). All segment samples tested were kept in separate flasks at 37°C during the 30-day trial period, even the not immersed group.

**Table 1** - Chemical composition of artificial saliva.

| Component | Concentration (g/dm$^3$) |
|---|---|
| $K_2HPO_4$ | 0.20 |
| KCl | 1.20 |
| KSCN | 0.33 |
| $Na_2HPO_4$ | 0.26 |
| NaCl | 0.70 |
| NaHCO3 | 1.50 |
| Urea | 1.50 |
| Lactic acid | until pH = 6.7 |

Source: Authors.

After this period, the samples were dried with absorbent paper and prepared to SEM eXpress™ (Aspex Corporation, Oregon, USA). The surface characteristics performed verified roughness, irregularities and superficial degradation after contact with the solutions. Representative photomicrographs of each sample were performed with magnification of 500x, 1000x and 2000x (Gravina et al., 2014). The semi-quantitative analysis of the wires chemical composition was performed in EDS mode in three different areas of each sample. The chemical elements present in the sample composition were identified (Gravina et al., 2014; Savoldi et al., 2017; Fischer-Brandies et al., 2003).

## 3. Results

***Surface characterization***

The photomicrographs of the wires obtained by SEM are shown in the Figures 1, 2 and 3. The wires presented different surface characteristics. The CuNiTi (Ormco) and NiTi (Aditek) wires presented a surface with high irregularity compared to the other evaluated wires. Longitudinal striations were observed on the surface of these samples. Similar structures were also observed in the Smart4Y wire, but with less intensity. The Orthometric brand NiTi wire showed randomly arranged ridges on its surface. The Morelli NiTi thermoactivated showed the least number of surface irregularities, suggesting a surface polishing.

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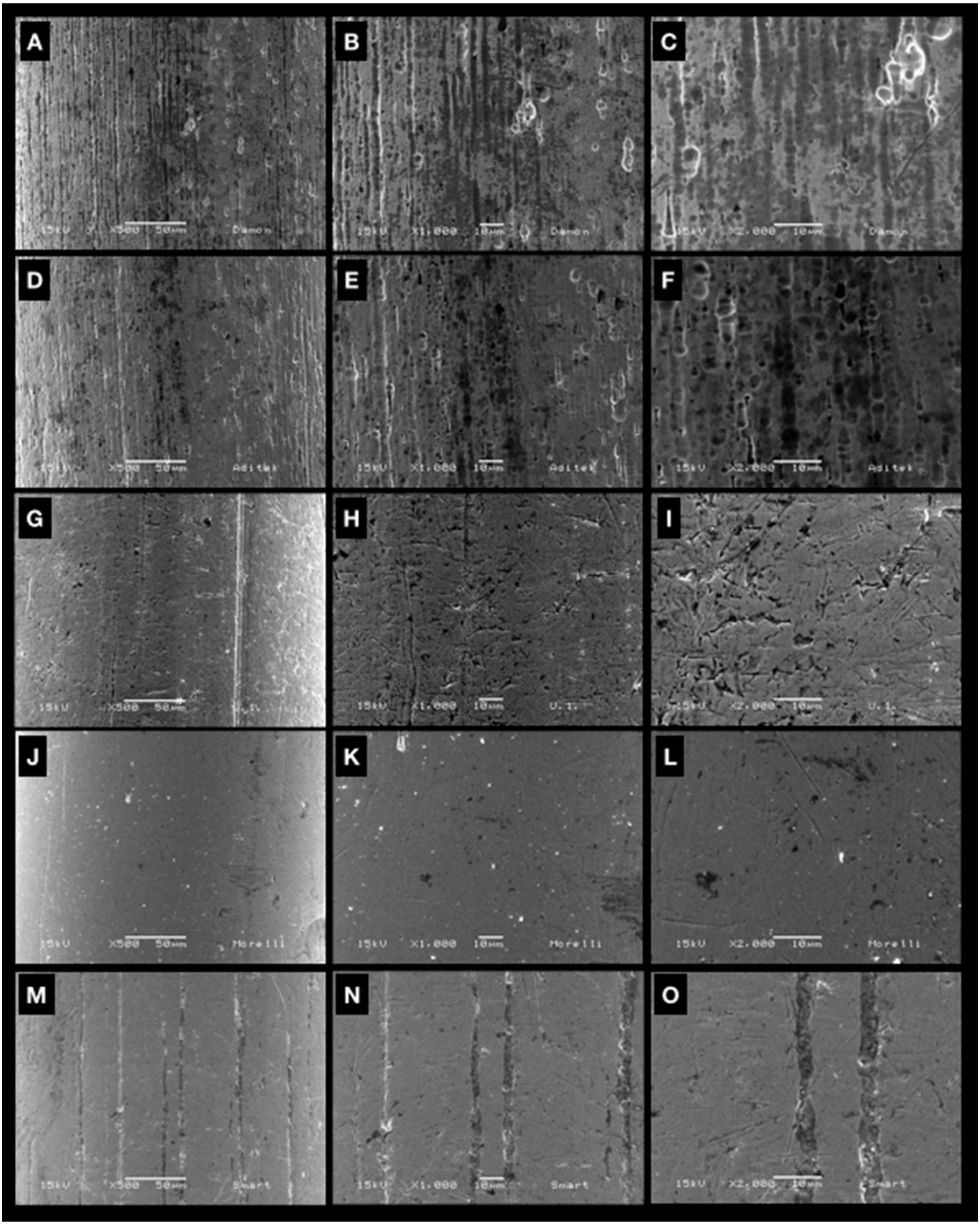
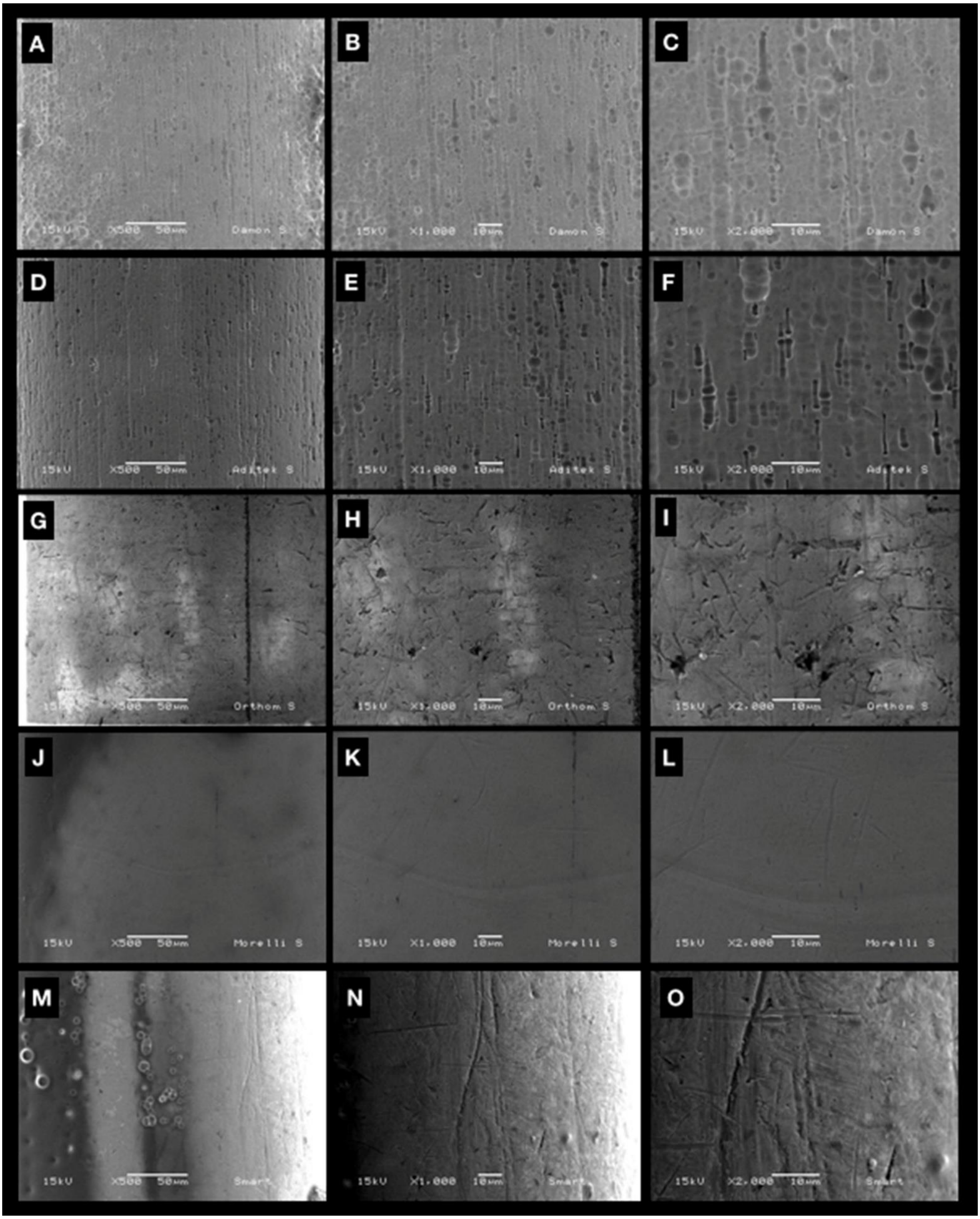
**Figure 1** - Surface morphology of Group 1 CuNiTi and NiTi wires (not immersed). (A-C) CuNiTi Damon Wire, Ormco. (D-F) Universal Damon Wire, Aditek. (G-I) Thermoactivated Orthometric Wire. (J-L) Thermoactivated wire, Morelli. (M-O) Smart4Y thermoactivated wire. (A, D, G, J, M) Magnification of 500x. (B, E, H, K, N) Magnification of 1000x. (C, F, I, L, O) Magnification of 2000x.



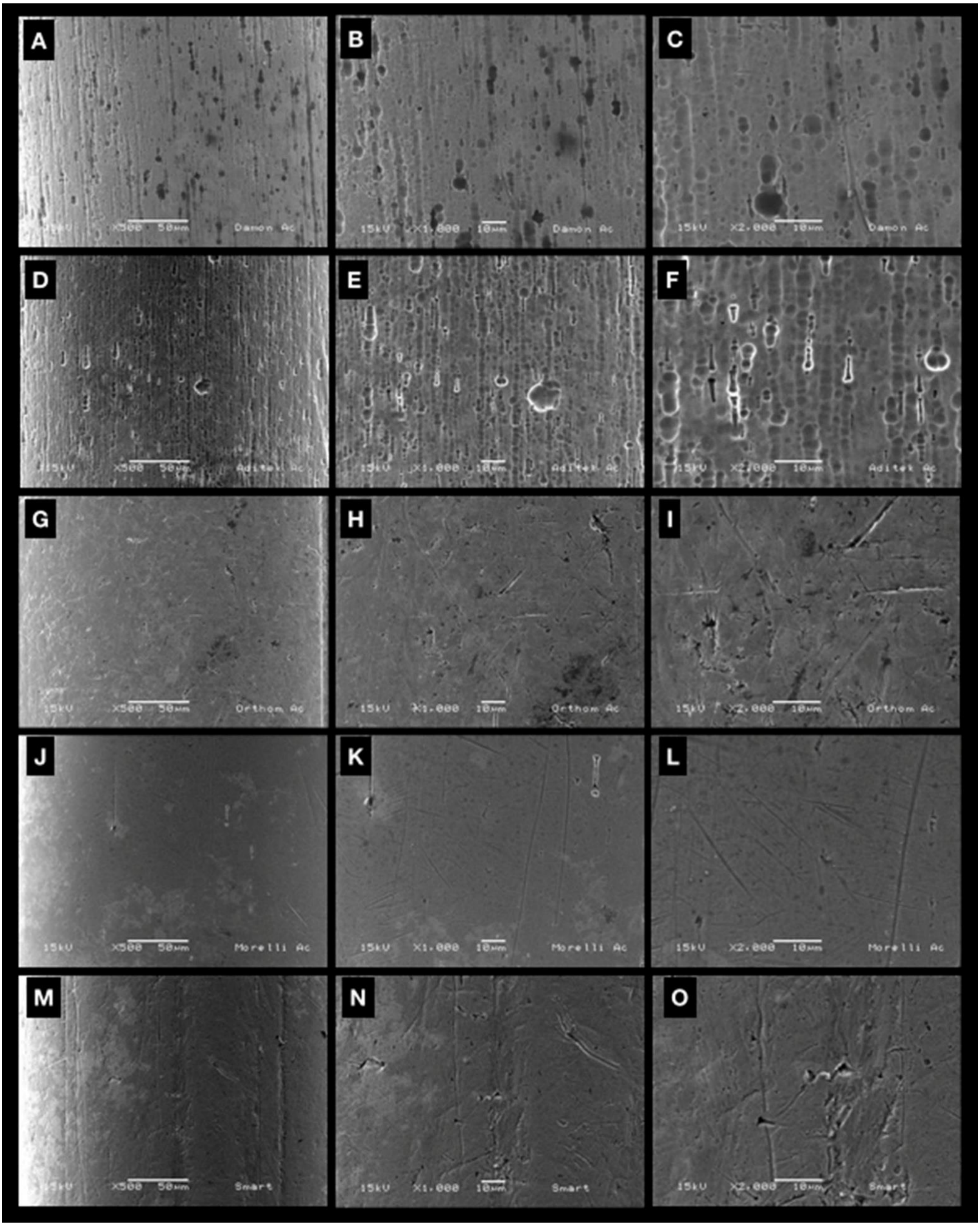

Source: Authors.

**Figure 2** - Surface morphology of CuNiTi and NiTi Group 2 (submitted to immersion in artificial saliva). (A-C) CuNiTi Damon Wire, Ormco. (D-F) Universal Damon Wire, Aditek. (G-I) Thermoactivated Orthometric Wire. (J-L) Thermoactivated wire, Morelli. (M-O) Smart4Y thermoactivated wire. (A, D, G, J, M) Magnification of 500x. (B, E, H, K, N) Magnification of 1000x. (C, F, I, L, O) Magnification of 2000x.




Source: Authors.

**Figure 3** - Surface morphology of the CuNiTi and NiTi wires of Group 3 (submitted to immersion in acid solution). (A-C) CuNiTi Damon Wire, Ormco. (D-F) Universal Damon Wire, Aditek. (G-I) Thermoactivated Orthometric Wire. (J-L) Thermoactivated wire, Morelli. (M-O) Smart4Y thermoactivated wire. (A, D, G, J, M) Magnification of 500x. (B, E, H, K, N) Magnification of 1000x. (C, F, I, L, O) Magnification of 2000x.




Source: Authors.

In Group 2, superficial alteration was evident after the contact with the artificial saliva. The wires presented areas with altered surface, suggesting the deposition of solution components. CuNiTi (Ormco) and NiTi (Aditek) showed high surface roughness as well as in Group 1. The thermoactivated NiTi Orthometric and Smart4Y wires showed an evident surface change. In this Group 2, thermoactivated Morelli had fewer surface irregularities.

In Group 3, submitted to immersion in acid solution, samples showed less superficial change in relation to the artificial saliva. As in Group 1, the CuNiTi (Ormco) and NiTi (Aditek) wires presented the highest surface roughness, with the presence of longitudinal striations. The thermoactivated NiTi Orthometric and Smart4Y samples presented similar surface, with random striations. The thermoactivated Morelli also presented the surface with less roughness in relation to the other evaluated wires when immersed in acid solution.

***Semi-quantitative analysis of chemical composition***

Analyzes in EDS are represented in the Figures 4, 5 and 6. The ions percentages present in the chemical composition of the evaluated wires are in Table 2. The semi-quantitative analysis of the elements present in the Group 1 wires (not subjected to solution immersion) the highest peak detected was for the Ti element, although in percentage the Ni ion has stood out. In the thermoactivated Aditek, Orthometric, Morelli and Smart4Y NiTi wires, the Ni percentage exceeded 50%. As for the thermoactivated CuNiTi wire from Ormco, the ratio between Ni and Ti was approximate. Cu was detected only in the Ormco and Smart4Y wires, being close to 6% in the Damon wire. Aluminum, a contaminant in the manufacturing process, was found only in the Orthometric and Morelli NiTi samples.

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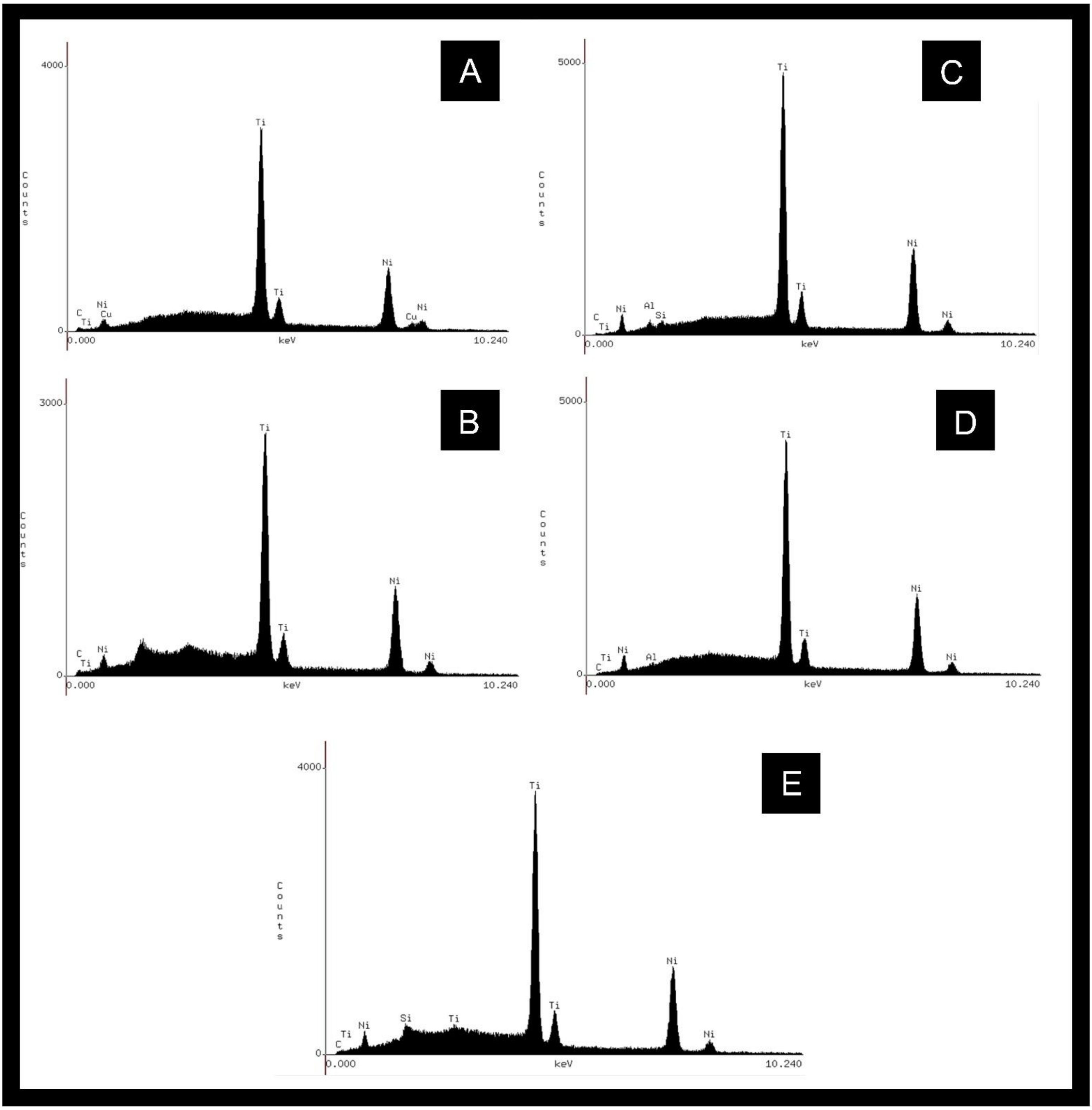
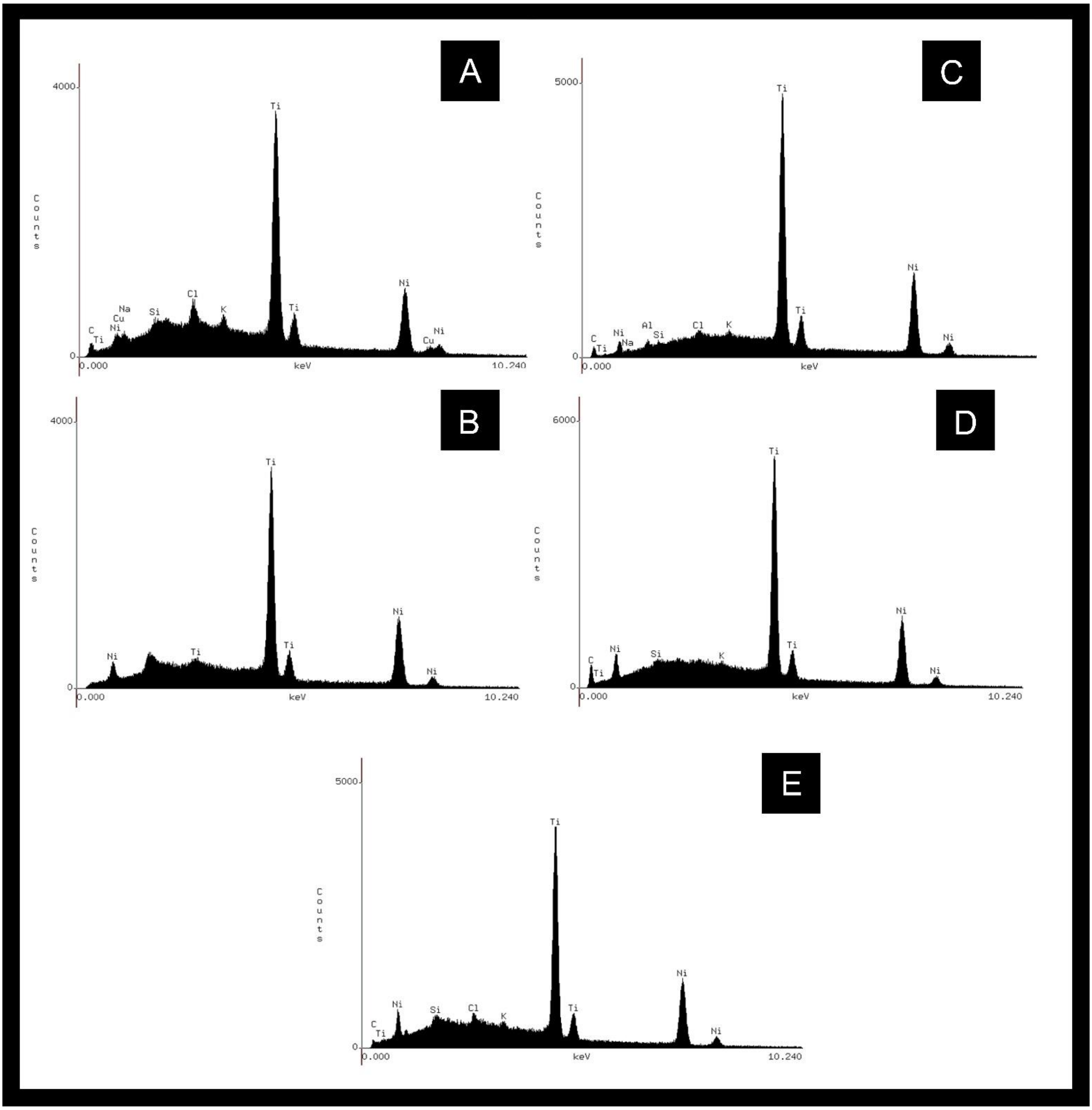
**Figure 4** - Photomicrographs and semi-quantitative analysis in EDS of the chemical elements present in the composition of the samples evaluated from Group 1 (not subjected to immersion). (A) CuNiTi Wire Damon, Ormco. (B) Damon Universal Wire, Aditek. (C) Thermoactivated Orthometric Wire. (D) Thermoactivated wire, Morelli. (E) Smart4Y thermoactivated wire.



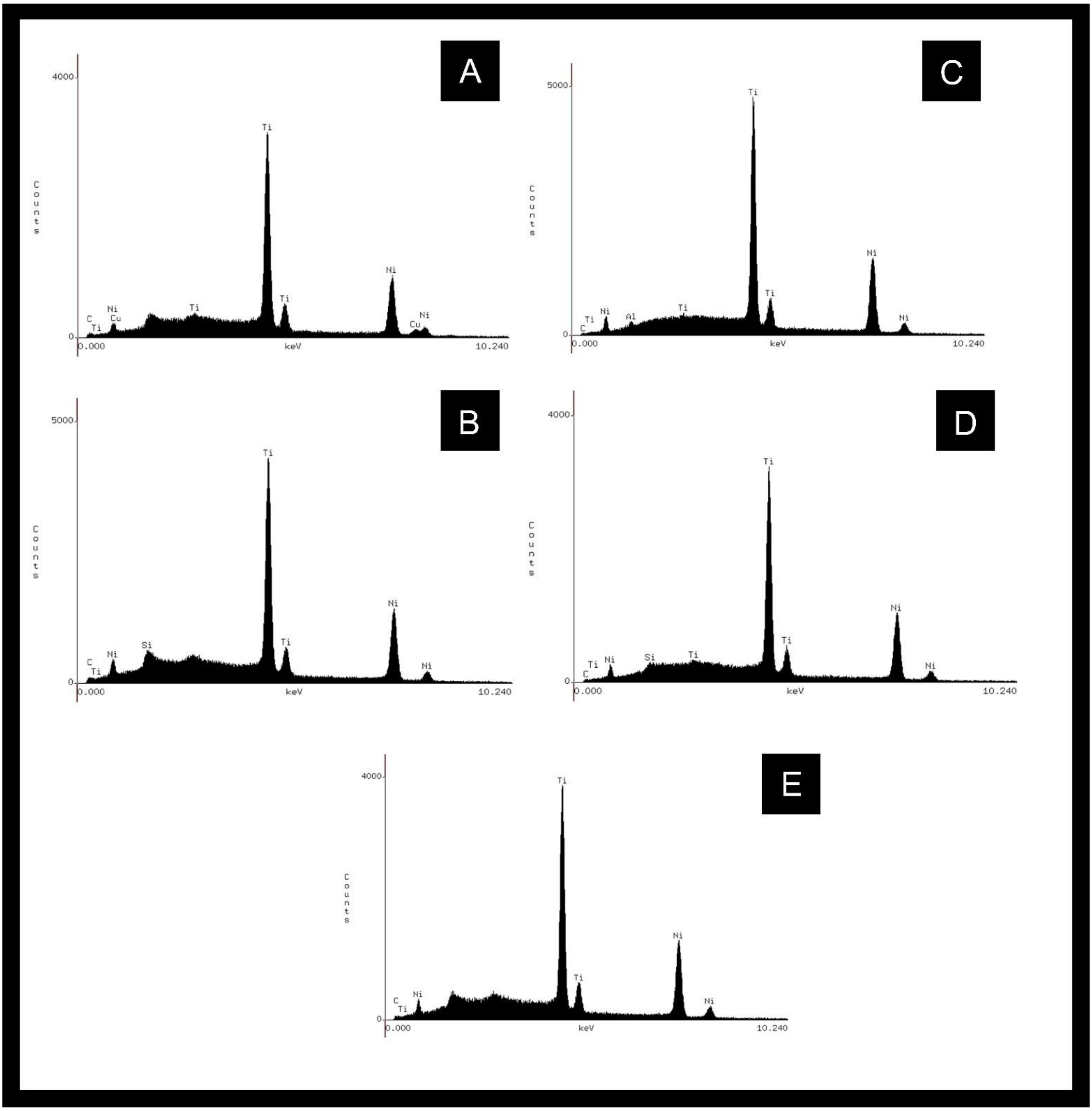

Source: Authors.

**Figure 5** - Photomicrographs and semi-quantitative analysis in EDS of the chemical elements present in the composition of the samples evaluated from Group 2 (submitted to immersion in artificial saliva). (A) CuNiTi Wire Damon, Ormco. (B) Damon Universal Wire, Aditek. (C) Thermoactivated Orthometric Wire. (D) Thermoactivated wire, Morelli. (E) Smart4Y thermoactivated wire.




Source: Authors.

**Figure 6** - Photomicrographs and semi-quantitative analysis in EDS of the chemical elements present in the composition of the samples evaluated from Group 3 (submitted to immersion in acid solution). (A) CuNiTi Wire Damon, Ormco. (B) Damon Universal Wire, Aditek. (C) Thermoactivated Orthometric Wire. (D) Thermoactivated wire, Morelli. (E) Smart4Y thermoactivated wire.




Source: Authors.

The semi-quantitative analysis of the elements present in the wires of Group 2 (artificial saliva) showed a variation between the ion with the highest percentage detected, although for all of them the highest peak occurred for Ti. For Aditek, Orthometric and Smart4Y, a higher percentage of Ni was verified in comparison with Ti. For the Ormco and Morelli, Ti was predominant, although the Ormco ratio was close to 1:1. The Cu ion was detected in a smaller percentage in Ormco compared to Group 1 (4.87%). This ion was found in low proportions in the Aditek and Morelli (0.21 and 0.03%, respectively). In this group, elements such as Na, Cl and K were detected, suggesting the deposition of artificial saliva components on the surface of the samples. The Sulfur ion was verified in the Morelli brand, suggesting a possible surface corrosion.

The semi-quantitative analysis of the elements present in the Group 3 wires (acid solution) again detected a higher Ti peak in comparison to the other ions. For all groups, the highest percentage found was Ni (approximately 50%). In this group the Cu ion was detected in all evaluated wires, the highest percentage being observed for Ormco CuNiTi wire (6.56%). The Al element was found only in the Orthometric brand.

**Table 2** – Percentage (%) of chemical elements detected in EDS analysis for each commercial brand arch.

| Segment wire | | Ni | Ti | Cu | Al | Na | Cl | K | S |
|---|---|---|---|---|---|---|---|---|---|
| **Ormco** | Non-immersed | 49.44±1.06 | 44.63±0.46 | 5.93±0.55 | - | - | - | - | - |
| | Saliva | 44.17±0.97 | 44.86±0.44 | 4.87±0.95 | - | 2.25±0.19 | 2.36±0.10 | 1.49±0.09 | - |
| | Acid | 49.38±0.96 | 44.06±0.40 | 6.56±0.49 | - | - | - | - | - |
| **Aditek** | Non-immersed | 56.25±1.14 | 43.75±0.33 | - | - | - | - | - | - |
| | Saliva | 55.32±1.01 | 44.47±0.42 | 0.21±0.41 | - | - | - | - | - |
| | Acid | 54.54±0.81 | 45.44±0.35 | 0.02±0.32 | - | - | - | - | - |
| **Orthometric** | Non-immersed | 53.81±0.67 | 45.03±0.28 | - | 0.70±0.06 | - | - | - | - |
| | Saliva | 53.82±0.75 | 44.07±0.31 | - | 0.50±0.04 | 0.49±0.06 | 0.51±0.09 | 0.43±0.05 | - |
| | Acid | 55.95±0.74 | 43.23±0.30 | 0.33±0.29 | 0.48±0.05 | - | - | - | - |
| **Morelli** | Non-immersed | 55.98±0.77 | 43.84±0.31 | - | 0.18±0.03 | - | - | - | - |
| | Saliva | 45.20±1.14 | 50.08±0.50 | 0.03±0.49 | - | - | - | 2.26±0.12 | 2.02±0.11 |
| | Acid | 54.55±0.77 | 44.67±0.32 | 0.21±0.30 | - | - | - | - | - |
| **Smart4Y** | Non-immersed | 53.31±0.78 | 45.59±0.33 | 0.09±0.30 | - | - | - | - | - |
| | Saliva | 51.37±0.77 | 43.48±0.32 | - | - | - | 0.85±0.06 | 0.78±0.12 | - |
| | Acid | 56.20±0.85 | 43.69±0.33 | 0.10±0.33 | - | - | - | - | - |

Source: Authors.

## 4. Discussion

Wires surface characteristics have a direct relation to the effectiveness of the mechanics. Low friction is an essential property for the efficiency of self-ligating systems (Gurgel et al., 2001; Li et al., 2025). Low levels of friction allow the use of forces of lesser intensity (biologically compatible) to produce tooth movement, which is one of the principles of the self-ligating system (Sachdeva, 2001). Thus, all the components used in the treatment (wires and brackets) must have surface free of roughness (Pizzoni et al., 1998). Orthodontic wires of different brands may present peculiar surface characteristics (Fischer-Brandies et al., 2003). Furthermore, degradation or deposition of saliva components may alter orthodontic wires surface, compromising the brackets' slip along the arch, thus reducing mechanical efficiency (Mane et al., 2012; Bharathi et al., 2024).

Surface analysis showed high irregularity in CuNiTi thermoactivated samples in comparison with thermoactivated NiTi wires, regardless of immersion or not. Similar results were described in previous studies (Bahije et al., 2011; Gravina et al., 2014; Jaber et al., 2014; Ashok et al., 2024). Results suggest that the alloy composition influences its surface characteristics. In the comparison between superelastic NiTi wires (Dentaurum, Forestadent and Lancer) and CuNiTi (Ormco), a study (Fischer-Brandies et al., 2003) have shown that NiTi superelastic wires have smoother surfaces compared to CuNiTi wires. Similar results were verified in the present study and reported by another study (Gravina et al., 2014). The development of CuNiTi alloy composite wires by different companies may in the future provide relevant data on the relationship between the metal alloy and its surface.

Trademark was also an important factor for surface properties. Ormco and Aditek wires presented pronounced grooves on their surface, while the other brands showed a smoother surface. Morelli had the lowest surface roughness, independent of the immersion condition. These results are also in agreement with those reported by a prior study (Gravina et al., 2014; Sufarnap et al., 2023). In surface comparison between, superelastic thermoactivated GAC, TP, Ormco, Masel, Morelli and Unitek with arcs with addition of copper CuNiTi 27 and 35ºC from Ormco, the authors (Gravina et al., 2014) verified that the superelastic Masel and Morelli NiTi wires showed the least roughness, while the Ormco CuNiTi arches the largest. This difference between trademarks may be related to the manufacturing process, which is quite variable among suppliers.

During Orthodontic treatment, the presence of saliva in contact with the accessories is constant and the variation of pH occurs frequently according to the patient´s diet. The effect of exposure of orthodontic wires to different pH conditions has been demonstrated in the literature (Guerrero et al., 2011). Surface alteration occurs in the presence of acidic pH. Saliva at different levels of acidity may increase the potential for corrosion and even lead to the deposition of residues on the wire surface (Huang, 2005). These factors increase frictional force compared to non-immersed wires (Guerrero et al., 2011).

In this study, solutions of artificial saliva and acid solution were evaluated in contact with NiTi and CuNiTi thermoactivated wires. The acid solution (pH 4.3) was prepared (Jaber et al., 2014) simulating an intraoral acidity condition. Results showed that the wire surface changed more strongly in the presence of artificial saliva. Areas suggestive of solution deposition were observed in some samples. The results found corroborate with those described in other studies (Jaber et al., 2014; Bahije et al., 2011). In the wires composition analysis, no relation was observed between the percentage of detected ions and the surface change. On the other hand, trademarks presented differences, being the wires Orthometric and Smart4Y the ones that had more changes. Wire exposure to the acid solution showed no change in surface area as pronounced as that observed for artificial saliva. These data indicated that there was no corrosion or degradation expected for the acid solution but component deposition instead. Component deposition on the surface can be a negative factor for wire friction as previously demonstrated (Huang, 2005; Kao et al., 2006; Nanjundan &Vimala, 2016; Mikulewicz et al., 2024).

The exact chemical composition of the metal alloys of the orthodontic wires is not widely disclaimed by the manufacturers, making it difficult to confirm results obtained in studies. Ormco reports that CuNiTi wires have approximately 6% copper in their composition. Studies of chemical analysis found values very close to that reported (Fischer-Brandies et al., 2003). In the present study, these data were also confirmed. In the CuNiTi wires, although a variation occurred, according to the immersion, the Cu percentage was close to 6%. After exposure to artificial saliva, the percentage of this detected ion was lower in relation to the wires kept dry or immersed in acid solution. Possibly, deposition of saliva components on the wire surface interfered with this ion detection, leading to a lower percentage found. Low percentages of Cu were detected in other brands wires, but with extremely low values (<0.3%), which showed no clinical significance. In all groups there was a predominance of Ni and Ti ions as expected. However, in other studies (Gravina et al., 2014), there was a predominance of Ni ions except for CuNiTi wires from Ormco and thermoactivated Morelli, in which there was a slightly higher percentage of Ti in relation to Ni.

In the wires immersed in artificial saliva, the ions Na, Cl and K were detected. These results reinforce the data observed in SEM that suggested the deposition of artificial saliva components on the surface of the wires. A higher percentage of these ions was observed in CuNiTi wires. Correlating these data with the analysis of the superficial characteristics, the greater roughness verified for these wires may have favored the deposition of saliva components on its surface. The same change was not observed in the wires immersed in acid solution, suggesting that in the condition of acidity there was no solution ion deposition. Future studies may be valuable in assessing the relationship between the deposition of components on the wires surfaces and the friction, a possible correlation between these two factors could indicate a deleterious effect on wire sliding.

## 5. Conclusions

Thermally activated Ormco CuNiTi and Aditek NiTi presented a more irregular surface characteristic than the other evaluated wires. Morelli thermoactivated wire presented the least surface irregularities. Immersion in artificial saliva alters the surface of the thermoactivated wires by ion deposition. Regarding the chemical composition, the CuNiTi wires presented approximately 6% of copper, not detected in a significant percentage in NiTi thermoactivated wires.

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