EFFECTS OF DIFERENT SALIVARY pH ON THE SURFACE AND ROUGHNESS OF DIFFERENT ORTHODONTIC WIRES

ABSTRACT

AIM: The aim of this study was to evaluate the effects of different salivary pH on the surface of orthodontic wires. **MATERIAL AND METHODS:** Two hundred and seventy wire segments of titanium-molybdenum alloy (TMA), and Cr-Ni stainless steel , subjected to saliva pH 2.0 , 5.0 and 7.6 , in three different times of storage, divided into 3 groups (n=30). Group 1: TMA (Morelli), Group 2: TMA (Ormco) and Group 3: Stainless steel Cr-Ni (Morelli). To read the roughness profilometer was used Mitutoyo Surftest Digital-301. Observation of the surface morphology was performed by scanning electron microscope (SEM). **RESULTS:** Between the results is that the lower the pH more roughness was found. No changes were observed on the wires roughness of group 3. In the evaluation of SEM, changes were found in surface TMA wires in pH 2 and 5, the steel wires no changes superficias. **CONCLUSION:** The acidic pH and time showed effects on TMA's wires. The stainless steel wires showed no changes. We conclude that the stainless wires have greater resistance to salivary pH.

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KEYWORDS

Roughness. Surface property. pH.

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INTRODUCTION

The evolution of dental materials demands increasing durability, quality, biocompatibility and minimized costs, which has increasingly improved the efficiency of treatments[1]. In this sense, the materials used in Orthodontics have accompanied this evolution, through laboratory and clinical research studies have been conducted to promote suitable material properties against factors that daily decrease the survival rate, but the perfect material has not yet been achieved[2].

The composition of saliva and its properties can be affected by many variables such as physiological nutritional factors, diet and salivary flow[3]. Saliva can also be influenced by hormones, drugs and various diseases[4]. The oral cavity is a damp, dark place, with changes and individualities of pH, which can help trigger undesirable reactions produced by the response of this environment, such as the acceleration of the process of corrosion in metals[5].

The surface defects of the wires may be triggering factors of corrosion[6], plaque buildup[7] and possibly an increase in the release of unwanted ions in the oral cavity[8]. The wire used in orthodontics must withstand mechanical, thermal and chemical stresses to which it is exposed in the oral cavity environment. The superficial roughness can also change the effectiveness in dental movement, mainly because the surface defects interfere with friction, and consequently, can influence unfavorably on the sliding mechanics[9].

The biocompatibility of dental alloys is mainly related to its corrosion behavior. The higher the corrosion of a wire, the more elements are released and higher can be the risk of unwanted reactions in oral tissues[10].

The corrosion process occurs through the loss of metal ions directly in the solution or gradual dissolution of surface film, the level of corrosion of any metal depends on the chemistry of the solvent in which the metal will be submerged. Stainless steel, alloys of cobalt chromium and titanium are used due to the formation of a passive surface film of oxide, which contributes to a greater resistance to corrosion, without being completely infallible[11]. At higher pH the corrosion current of basic metal alloys decreases due to the alloy passivation[12]. The passivation based on electrochemical kinetics results in the formation of protective films on the surface of metals by imposing electrical currents. The role of passivation is to ensure corrosion resistance to the metal alloy and therefore its durability. With noble alloys, however, the dissolution of the precious metals decreases with increasing pH, according to Matos de Souza R[13] et al. (2008), gold base alloys are used in contemporary orthodontics.

The corrosion of metallic alloys in the oral cavity could cause both local and systemic effects as well as their effects on the physical properties and performance of clinical orthodontic braces[14]. Some authors also comment that the pH of the saliva contributes significantly to corrosion of orthodontic wires, especially low pH[15]. According to Bouraruel[9] et al. (1998) the surface roughness of orthodontic wires is an essential factor that determines the effectiveness of dental movement led in the arc. Kappert[16] et al. (1988), states that this factor is extremely important, because it determines the surface area of contact and thus it influences the behavior of corrosion and biocompatibility. Aware that the surface defects of the orthodontic wires may compromise their aesthetic and mechanical properties, the proposal of this research was to evaluate the influence of artificial saliva during different times and with different pH, checking for possible changes of roughness on the surface of different yarns.

MATERIAL AND METHODS

270 segments of 1.5 cm, divided in 3 groups of n = 90 were used, namely: Group 1) TMA-Morelli (Sorocaba-Brazil), Group 2) TMA – Ormco (Glendora-CA-USA) and Group3) stainless steel Cr-Ni Morelli (Sorocaba-Brazil).

TREATMENT OF SAMPLES:

Each group was subjected to three times of evaluation (M0 = control group; M1 = one month after and M2 = two months) and three types of pH (2.0; 5.0 and 7.6). According to the following flowchart below (Figure 1).

ROUGHNESS:

Five wire segments were used, secured with double-sidedtape (Adelbras, São Paulo, Brazil), in a glass plate of 3.0 cm, for analysis of roughness of each experimental group, Digital Mitutoyo Surftest roughness tester-at 301 n. de 15700438 series (Surftest SJ-401, Mitutoyo Sul Americana Ltda, Santo Amaro, São Paulo). For each body of evidence the length of surface scan was 0.25 cm. In order to quantify changes in topography, surface roughness parameters were selected along with orthodontic practice related Ra (average area of variation of peaks and valleys) and Rz (average between the amplitudes of the highest peaks and deeper valleys). The Ra and Rz parameters were chosen, translating the value of the arithmetic mean and standard deviation of all samples for analysis of results of rugosimeter. In order to assess possible changes of roughness in three types of wireless in pHs and different times, an analysis of bifatorial variance was performed (two way ANOVA) and the Fisher LSD test for identifying changes in roughness retrospectively. The data were tested according to the assumptions of normality and scapular (homogeneity of variance) by means of the Shapiro-Wilk test and Levene, respectively. These analyses were performed on Statistical 7.0.

SCANNING ELECTRON MICROSCOPE (SEM):

Each experimental group took five segments of wire to observe the surface morphology of each group into the scanning electron microscope (SEM) Shimadzu SSX-550 of the State University of Ponta Grossa, following the methodology of Machado[17] et al. (2007).

RESULTS

The values of the mean and standard deviation of roughness (Ra and Rz) at different pH and different treatment times are presented in table 1.

Change of roughness of the G1 group under the influence of pH and time. M0 = control group, M1 = M2 = 1 month and 2 month. Same letters indicate significant mean difference ($p<0.05$) (Figure 1).

Change of roughness of the G2 group under the influence of pH and time. M0 = control group, M1 = M2 = month 1 and month 2. Same letters indicate significant mean difference ($p<0.05$) (Figure 2).

The roughness of the wires of the Group 2 (G2) increase pH 2 with respect to the control group, especially for the time 2 (M2). The same effect was observed for the wire in time pH5 1 (M1) for the time 2 (M2). In pH7 significant difference of roughness was not observed for these wires (Figure 3).

In group 3 (G3) independent of time and pH at which the wires were submitted, there was no significant difference between the averages of roughness.

With the increase of 1000 times (MEV), we note that the wires of the G1 and G2 both immersed in pH 2 pH 5 as in the control group (Figures 4, 5, 6 and 7), showed a more homogeneous surface compared to wires in immersion in these pHs after two months. These wires have suffered greater change in the surface, being possible to observe more defects such as pores, cracks and grooves, (Figures 8, 9, 10 and 11). The G2 wire immersed in pH 5 was the only one that showed change after one month of treatment (Figure 12). Superficial alterations were not observed relevant between the images of the wires from the control group and subjected to different pHs and the times group G3, as noted in Figure 13, 14 and 15.

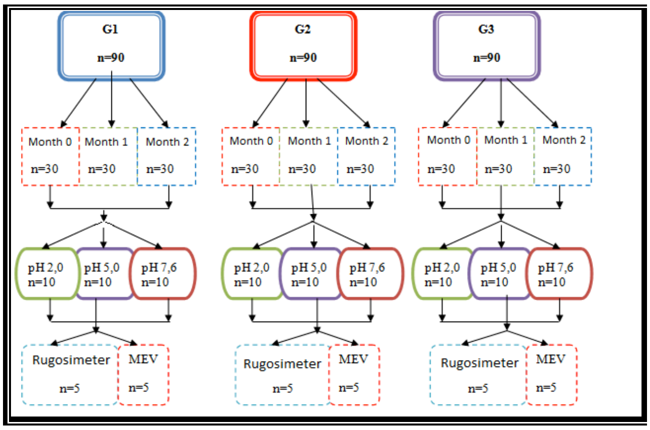
DISCUSSION

Currently the orthodontic appliance has long been used in adolescents, which have a diet rich in foods that can result in acidic pH for the oral environment. Knowing that it is the duty of the orthodontist to guide the patient and parent about the importance of reducing these foods and the correct oral hygiene. The diet presents direct correlation with pH variations, because food intake leads to decrease of pH, especially when it comes to a diet rich in acidic foods, such as, excess intake of soft drinks mainly colas, which present indexes of pH 2, these present greater risks to the beginning of the process of degradation of orthodontic wires[17].

Table 1. Values of the averages and standard deviation of the roughness (Ra-Rz)of the analyzed ones in different times and pH. G1 = TMA-Morelli G2 = TMA-Orthometric G3 = stainless steel Cr-Ni Morelli.

		pH 2			pH 5			pH 7,6		
Group		**Control**	**1 month**	**2 month**	**Control**	**1 month**	**2 month**	**Control**	**1 month**	**2 month**
G1	Ra	0,08±0,02	0,10±0,01	0,10±0,03	0,08±0,01	0,09±0,01	0,11±0,02	0,10±0,00	0,09±0,02	0,10±0,02
	Rz	0,60±0,16	0,89±0,31	0,74±0,17	0,64±0,11	0,58±0,04	0,89±0,25	0,70±0,10	0,90±0,62	0,78±0,15
G2	Ra	0,08±0,01	0,10±0,01	0,11±0,02	0,08±0,01	0,11±0,01	0,10±0,02	0,09±0,01	0,10±0,02	0,10±0,02
	Rz	0,64±0,05	0,70±0,07	1,00±0,45	0,60±0,07	0,90±0,17	0,70±0,12	0,64±0,15	0,90±0,19	1,00±0,42
G3	Ra	0,03±0,00	0,03±0,00	0,04±0,03	0,03±0,01	0,03±0,01	0,02±0,01	0,03±0,00	0,03±0,01	0,03±0,01
	Rz	0,24±0,05	0,28±0,08	0,52±0,19	0,28±0,04	0,40±0,25	0,36±0,25	0,26±0,05	0,28±0,13	0,28±0,13

Figure 1. Division of the wire segments in function of time, pH, and methodologies.



The pH of the environment has great relevance in the bucal oxidative process, because the metals installed in the oral cavity when exposed to acidic medium, suffer degradation[18]. In the present research we noticed the increased roughness of the TMA after two months of immersion in pH 2 and pH 5. In this respect Maijer and Smith[11] (1987), commented that the stainless steel loses its passivity when there is a decrease in the pH of 7.0 to 5.0. In this study superficial changes for stainless steel were not found. Second Matasa[19] (2002), the corrosion of orthodontic alloys occurs in intraoral environment, regardless of the metallurgical structure of the League. Different from the present research, in which an increase of roughness was observed only on exposed wires after two months in pHs 2 and 5 consisting of TMA, CrNi stainless steel wire, didn't notice this increase.

Figure 2. Change of roughness of the G1 group under the influence of pH and time. M0 = control group, M1 = M2 = 1 month and 2 month.

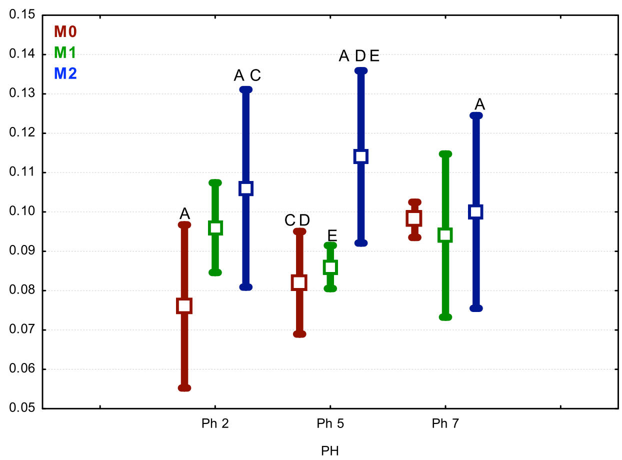


Figure 3. Change of roughness of the G2 group under the influence of pH and time. M0 = control group, M1 = M2 = month 1 and month 2.

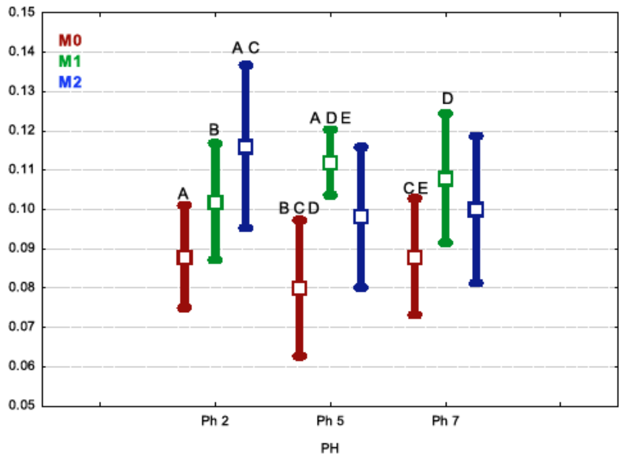


Figure 4. Change of roughness of the G3 group under the influence of pH and time. M0 = control group, M1 = M2 = 1 month and 2 month.

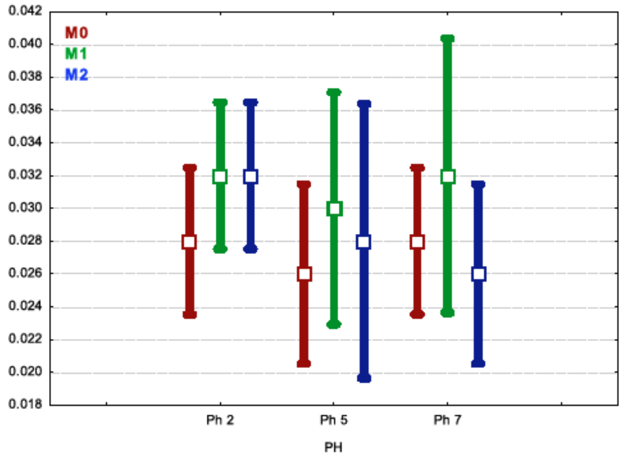


Figure 5. G1, pH2, control group.

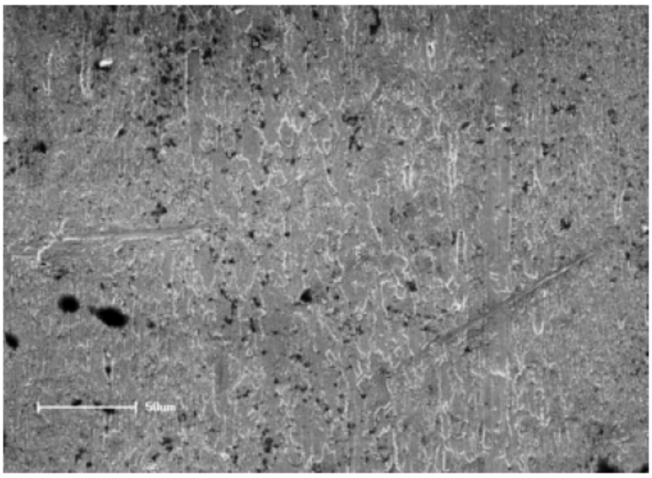


Figure 6. G1, pH2, after 2 months.

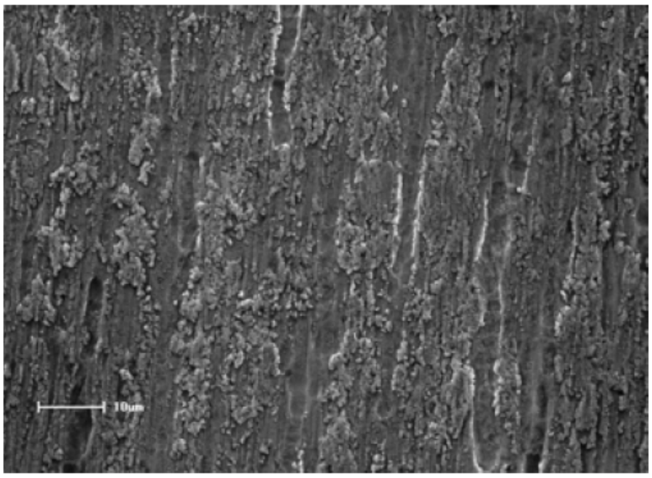


Figure 7. G1, pH5, control group.

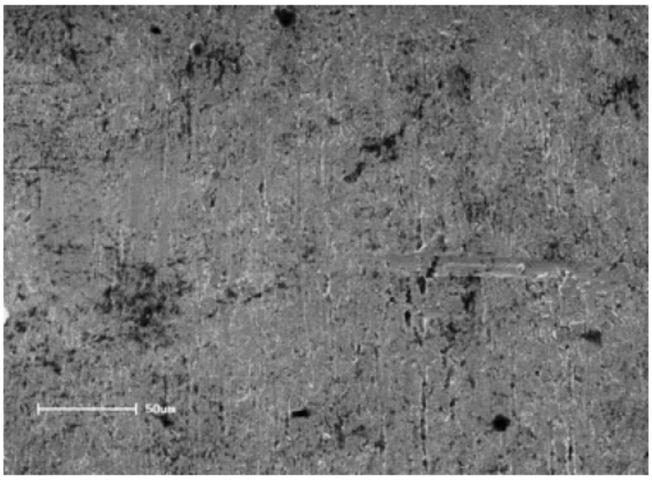


Figure 8. G1, pH5, after 2 months.

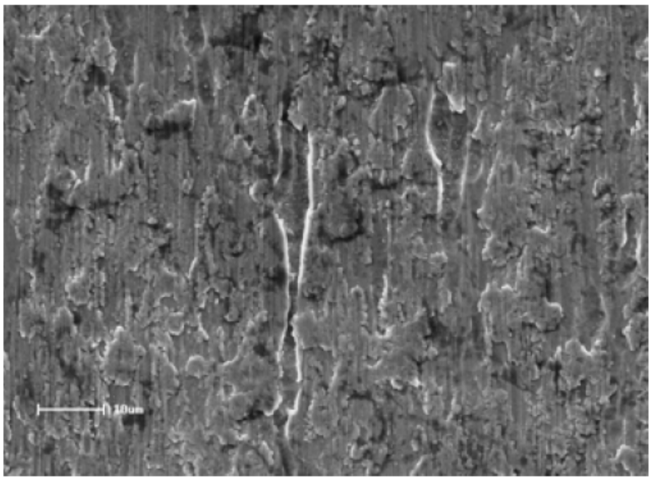


Figure 9. G2, pH2, control group.

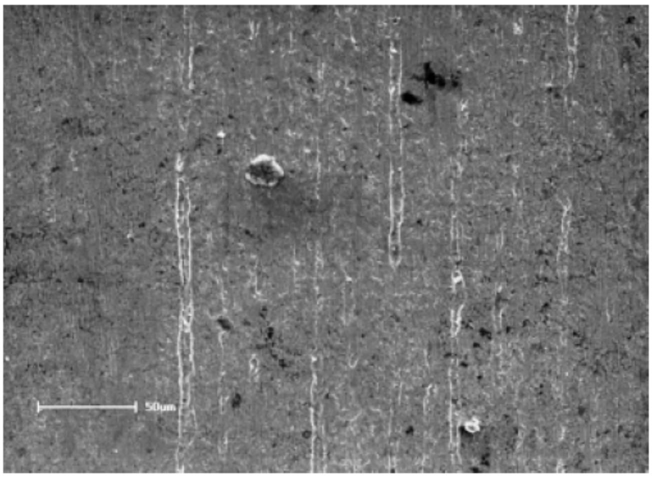


Figure 10. G2, pH2, after 2 months.

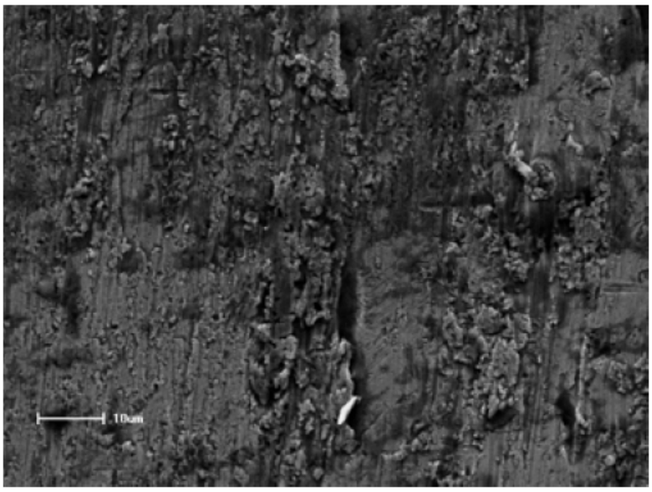


Figure 11. G2, pH5, control group.

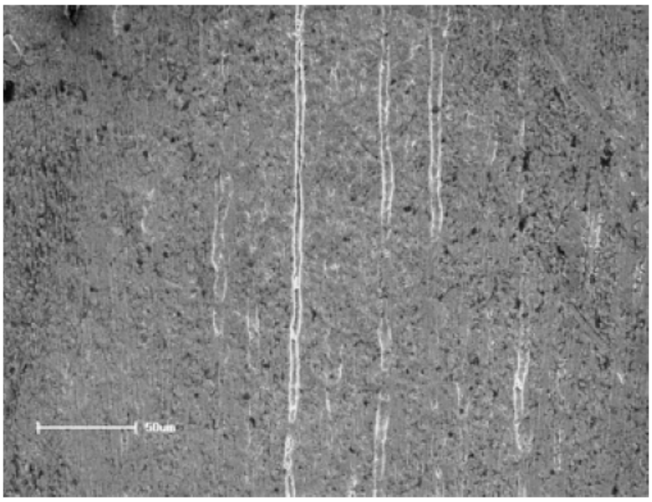


Figure 12. G2, pH5, after 1 months.

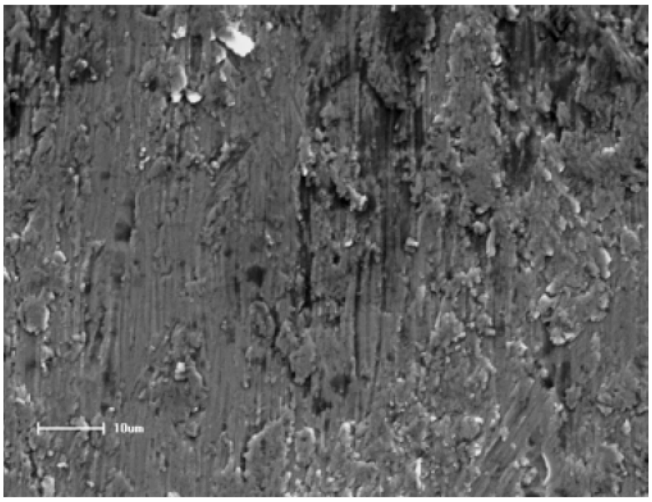


Figure 13. G2, pH5, after 2 months.

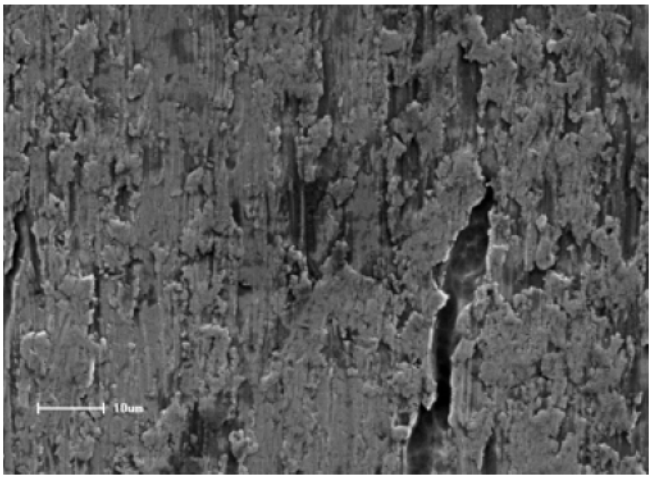
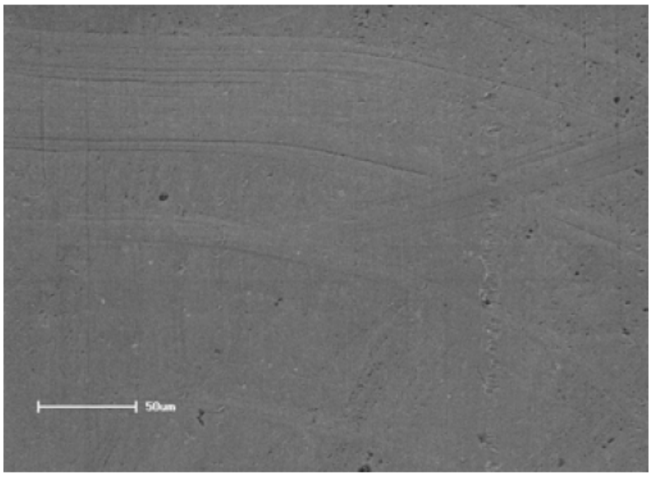


Figura 14. G3, pH2, control group.



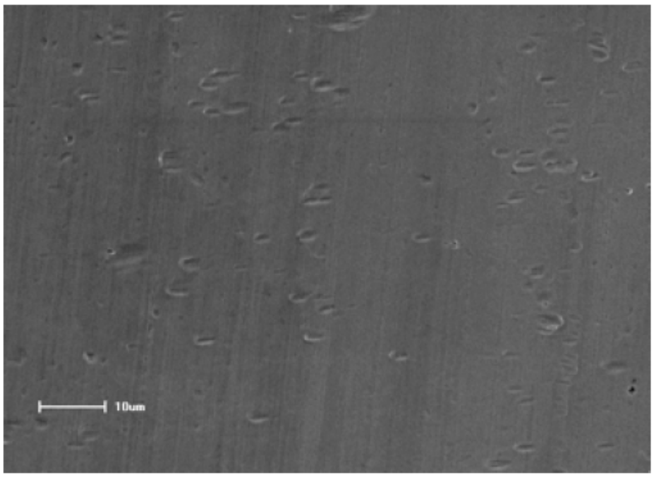


Figure 15. G13, pH2, after 2 months.

The research developed by Bay[20] et al. (2011) demonstrated greater corrosion on metal structures of TMA after two hours in artificial saliva, in acidic pH. In this study a similar result was detected having been observed a greater increase of roughness after a specific time in the TMA in more acidic pHs. In TMA at pH 7.6 was not detected significant difference of superficial material alteration. From the results obtained it was observed that no surface change occurred on wire NiCr.

According to Machado[17] et al. (2007) stainless steel releases nickel ions after corrosion which raises a concern in patients with allergy to nickel and other specific substances. Sutow[21] (2001) says that stainless steel owes its resistance to corrosion to the chrome, a highly reactive metal. The corrosion resistance of the League depends on a passive layer, which is formed spontaneously (passivation) and reforms (repassivation) in air and under most conditions of tissue fluid.

Machado[17] et al. (2007), conducted research with Mark Morelli, Abzil brackets, GAC and ORMCO, new and used. Each bracket has been analyzed in SEM before and after they are used in patients for a certain time, and the results showed that the national brackets Morelli and Abzil presented a higher concentration of surface defects before and after treatment showing the greatest amount of pores, cracks and grooves in the samples. The imported brackets GAC and ORMCO smoother surfaces, presented a slight edge to the ORMCO sample. The results obtained in this research, both the TMA brand wire Morelli (G1) and the Ormco (G2) showed changes of surface roughness in pHs 2 and 5 after two months, while the wires of stainless steel CrNi showed no such changes.

CONCLUSION

According to the methodologies employed and according to the results obtained, it can be affirmed that: TMA suffered increased roughness and surface changes when exposed to acidic pH for a certain time. Stainless steel, regardless of time and pH, did not suffer any changes of surface roughness increase.

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