The Effect of Mouthwashes on the Corrosion Resistance of Stainless Steel Wire

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ABSTRACT

Background: Stainless steel wires are widely used in fixed orthodontic appliance. In order to have good oral cleaning, an optimum orthodontic force, and desirable biological response and tooth movement, the current study was hence carried out to investigate the impact of Chlorhexidine and Listerine on the surface characteristics of stainless steel wire.

Materials and methods: The effect of chemicals was studied through immersing the wires in the solutions for 1.5 hour. The distilled water was considered as control. The samples consisted of 10 wire pieces in the form of U shape with dimensions of (25mm length of bridge,10mm length of arms). Such wires were cut and their straight form were used for corrosion test. Wires were then embedded in base of cold cure acrylic resin (3mm thickness,10mm width,65mm length). Next, The wires were connected to conductor rod. A potention state equipment was utilized for testing the samples and a Nikon digital optical microscope was used to identify the surface changes. ANOVA and LSD tests were utilized for statistical analysis.

Results: the results indicated that the Listerine group presented the highest mean of corrosion resistance; on the other hand, chlorhexidine group created a greater value of mean in comparison to control group. Furthermore, highly significant differences were observed between two groups (P<0.01). Moreover, there were significant differences among all groups (P<0.01).

Conclusion: The Listerine has a significant effect on the surface corrosion of stainless steel wire compared to chlorhexidine. The optical microscope found that there was an increase in presence of pit and scratched areas with Listerine compared with Chlorhexidine.

KEYWORDS

mouthwashes, stainless steel wire, corrosion resistances

المستخلص

إن هناك حاجة دائمة لوسائل أخرى عدا الوسائل الميكانيكية للسيطرة على الصفيحة البكتيرية من اجل الحصول على مستوى جيد من نظافة الفم لمرضى تقويم الأسنان, وحيث ان هناك رغبة دائمة لتحقيق المستوى الأمثل من القوى للحصول على أفضل الاستجابات من الناحية البايولوجية وبالتالي الحصول على حركة الأسنان, فقد تم إجراء هذه الدراسة لبحث ومقارنة تأثيرات نوعين من محاليل غسول الفم غير المفلورة وهي: الكورسوديل (الكلورهكسدين), أللسترين على الخصائص السطحية لأسلاك الحديد المقاوم للصدأ الذي يستخدم في جهاز التقويم الثابت. تم دراسة تأثير المواد أعلاه من خلال غمر الأسلاك في طول)U المحاليل لفترة ساعة ونصف, وقد تم استخدام الماء المقطر كمحلول ضابط. تألفت العينة من عشرة قطع سلكية في كل مجموعة فرعية بشكل الجسر25ملم,والذراعين 10ملم) . تم قطع جزء من الواير و ربط الجزء المستوي منه بقاعدة من راتنج الكريلك البارد(3ملم سمك,10ملم عرض, 65ملم لدراسة التغيرات السطحية. استخدم قياس تحليل (Nikon)طول),ثم ربطت بسلك موصل. تم استخدام جهاز التآكل للفحص والمجهر الضوئي الرقمي من نوع وقياس الفرق الدلالي الأصغر لتحديد التأثيرات لتلك المحاليل. جهاز التاكل بين ذلك, الكلورهكسدين يمتلك تاثير قليل على السلك من ANOVA))التباين اللسترين, المجهر الرقمي اكد حدوث تفاعل سطحي الذى تميز بزيادة مظهر المناطق المحفرة والمخدشة, الذي كان واضح مع اللسترين.

INTRODUCTION

The bacterial plaque at the gingival margin is considered as one of the main factors that cause inflammation. Patients with orthodontic appliances have a higher numbers of Streptococcus mutans and lactobacilli, which are responsible for decalcification and gingivitis. The plaque control, therefore, is important in orthodontic patients [1-2]. Improper oral hygiene causes the accumulation of plaque around the appliance, leading to gingivitis and enamel decalcification [3-4]. To overcome these problems, the orthodontist has to advise the his/her patients regarding the suitable ways of plaque control[5]. Brightman et al., (1991)[6] stated that "mouthwashes, as an adjunct to tooth brushing are effective in the control of gingival inflammation, although prolonged use may cause problems with staining". The use of pre-brushing rinses, on the other hand, recently indicated no differences in impact on either gingival health or plaque accumulation [7]. The surface changes such as discoloration and pitting are considered as main evident of corroding of the stainless steel wire [8-11]. The current study was undertaken to assess the effect of both chlorhexidine and Listerine on the corrosion resistance of stainless steel wires.

MATERIALS AND METHODS

The materials and their manufacturer address which used in the current study were demonstrated in the table 1 and figure 1.

Table 1 : The materials

Material	Ingredients	Expiry date	Lot number	Ph	Manufacturer address
corsodyl:0.2% chlorhexidine	Chlorhexidine Digluconate 0.2%, Ethanol, Macrogolglycerol hydroxystearate	2/2019	5142396	6.71	Glaxo Smith Kline(gsk), UK
Listerine	Agua, alcohol , Sorbitol,benzoic acid, sodium fluoride	07/2018	643180	4.19	pfizer ,USA
Distilled water				7.0	Iraq

Figure 1: Chemical reagents

Methods

1.Preparation of wire pieces:

Thirty pieces of stainless steel wire 0.019(inch) (MORELLI, BRAZIL) in form of U shape with dimensions of (25mm length of bridge, and 10mm the length of arm) were utilized in the current study(figure 2). Such wires were cut and their straight form were used for corrosion test. All pieces were then cleaned with acetone for five min to take the debris out. After that, they were rinsed with distilled water; and cleaned with alcohol for another 5 minutes. Next, they were rinsed with distilled water. Then, plastic tweezers were used to handle the wires [12]. Then all groups were ready for attachment with cold cure acrylic resin before immersion process in chlorhexidine and Listerine as well as distilled water for 1.5 h to assess the corrosion resistance of stainless steel wires[14].

2. Preparation of acrylic model:

Thirty pieces of wax were made with dimensions of (3mm thickness, 10mm width,65 length). These pieces were then invested in dental plaster to fabricate acrylic samples from cold cure. The fabricated U shape wires were positioned in acrylic mould before acrylics were set. The acrylic samples then removed from plaster mould. Then the arm of each wire from down side using cold cure acrylic was attached to electrode rode

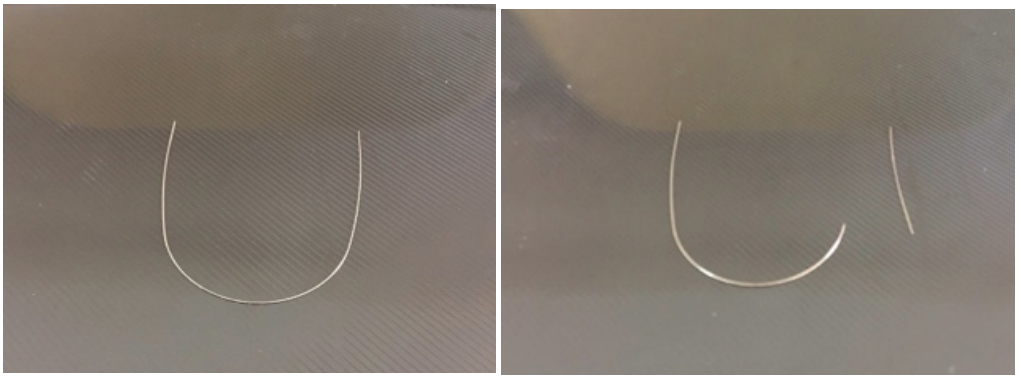

Figure2.stainless steel wire in U shape

3.Immersion procedure:

In the present study, there were two experimental groups and control group with each group had

10 samples: the experimental groups were as follow: the chlorhexidine group was immersed in chlorhexidine for 1.5 hour at a temperature 35.5 ± 0.5 ° C according to a study which carried out by Omidkhoda *et al.*,2016[13]. The immersion period was selected since chlorhexidine used for a short-term only for a duration up to three months because of their adverse effects on tooth color and normal flora in the mouth[14].The Listerine group was immersed in Listerine for the same period. While the control group was immersed in distilled water for the same period. The solution was placed in the container of potention state equipment. The anode was then connected to the wire and cathode to the electrode rod after two hours and values were recorded.

Figure 3. container of potention state equipment

RESULTS

1.Microscopically examination:

A Nikon optical microscope (china) was utilized to find whether there are any surface changes in the surface of the wire or not. This microscope is able to perform 50X, 100X, 200X,500X,and 1000X(figure 4). The surfaces revealed a randomly distributed discolorations with irregular sizes and sh apes.

Figure 4: optical microscope

2. Immersion procedure

2.a. immersion in Distilled water:

For each sample after immersion in the solution for 1.5 hour, the corrosion of the wire increased according to reading of the potention state equipment. the Nikon optical microscope indicated that numbers of white spot increased as illustrated in the figure 5.

Figure 5: the surface of stainless steel wire after immersion for 1.5 h in distilled water

2.B.Immersion in chlorhexidine:

For each sample after immersion in the chlorhexidine solution for 1.5 hour, the corrosion of the wire increased compared with distilled water. It was found that there was an increase in the number of lines and white spots, that appear to be scattered over all the surface as shown in figure 6.

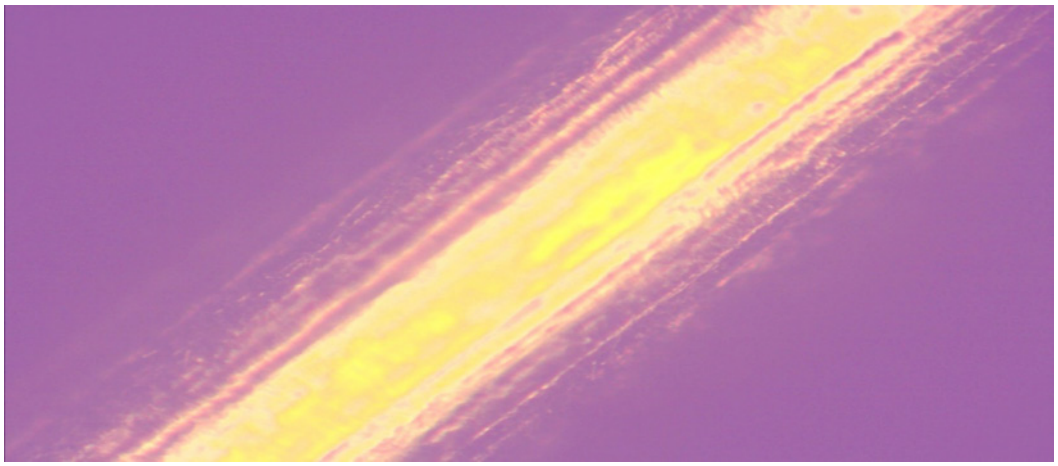

Figure 6: the surface of stainless steel wire after immersion for 1.5 h in chlorhexidine

2.C. Immersion in Listerine:

The corrosion following immersion in Listerine increased compared with other groups (distilled water and chlorhexidine) . as well, it was found that the white spots increased in size and numbers only but also in size (figure 7).

Figure 7: the surface of stainless steel wire after immersion 1.5 hour in Listerine

The results of the present research were affected by the type of mouth wash used. The mean , standard deviation, maximum and minimum values of corrosion resistance (are shown below in table 2.

Table 2. mean and standard deviation of all groups.

Groups	*Mean (mm)*	*SD*	*Min*	*Max*
Distilled water	17.6	1.202	15.5	18.9
Chlorhexidine	46.5	0.913	45.4	47.8
Listerine	76.6	0.831	75.3	77.7

As shown in table 2, the Listerine group presented the highest mean of corrosion resistance; on the other hand, chlorhexidine group created a greater value of mean in comparison to control group.

The ANOVA test confirmed that there were statistically significant differences among all groups (P<0.01) as demonstrated in table 3.

Table 3. ANOVA between groups

	F-test	*p-value*	*Sig*
Between groups	87.925	P<0.01	HS

***H.S: High significant**

As well, between two groups, highly significant difference were observed as illustrated by LSD test (table 4 and figure 8) (P<0.01)

Table 4. LSD between groups

groups	*Mean difference*	*P-value*	*Sig*
Chlorhexidine & distilled water	28.93	P<0.01	HS
Chlorhexidine & Listerine	-30.09	P<0.01	HS
distilled water & Listerine	-59.02	P<0.01	HS

****H.S: High significant**

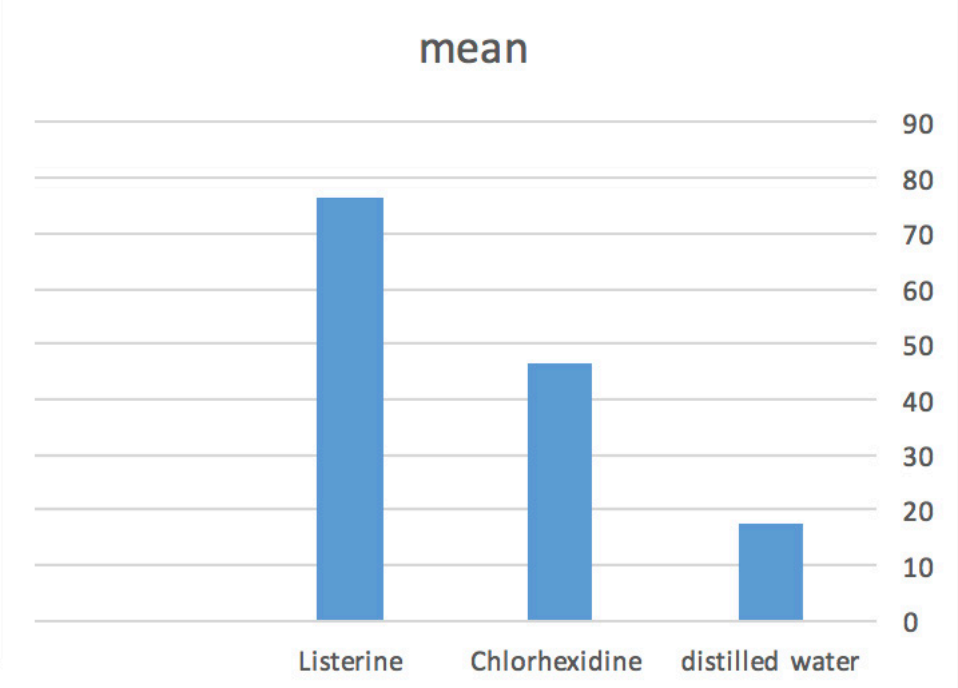

Figure 8. Bar chart of the corrosion test

DISCUSSION

for several months, orthodontic wires (i.e fixed or removable orthodontic appliance) often remain in oral cavity. Therefore, wires should must have good corrosion resistance in order remain with stand attack from oral fluid.

The corrosion resistance is considered as one of most important factors which affect the success the dental prosthesis due to possible biological reactions and destruction of the restoration[15]. Several factors can affect the corrosion resistances such as heat treatment, surface roughness of the alloy, composition and type of alloy, and immersion period and ph solution[16-18]. Patients with orthodontic treatment

must be instructed to take care of his /her teeth. Such patients have significantly a greater number of lactobacilli and *Streptococcus mutans* in comparison with non-orthodontic patients. The process of plaque removal can generally reduce chronic gingivitis. orthodontic patients must be motivated to remove all plaque using scaling or during tooth cleaning. In general, mouthwashes could be either non fluoridated or fluoridated. The fluoridated mouthwashes act to reduce the effects of enamel demineralization. On the other hand, non-fluoridated mouthwashes act as an antiplaque agent. The present study indicated that Listerine had a significant effect on the surface of stainless steel wires in comparison to Chlorhexidine because of its acidic nature where Listerine has a pH of 4.19; while Chlorhexidine has a pH of 6.71. these results were in agreement with Schweitzer (2006)[19] study which found that at higher acid concentrations the stainless steel wire corroded rapidly because of scratches and pits, which could make a significant increase to the surface area of the wire. From the present study, it has concluded that the Listerine has a significant effect on the surface corrosion of stainless steel wire compared to chlorhexidine. It suggested to assess the nature of the surface deposits via auger electron spectroscopy, X-ray fluorescence with investigating the impact of different mouthwashes on the NiTi arch wire.

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