Effect of Intraoral Conditions on the Performance of Stainless-steel Orthodontic Archwires

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Effect of Intraoral Conditions on the Performance of Stainless-steel Orthodontic Archwires

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ABSTRACT

Aim. This study aimed to evaluate the effects of intraoral use of two brands of stainless-steel (SS) archwires, 3B Ortho and American Orthodontics (AO), after 8 weeks of intraoral exposure.

Material and Methods. The study sample consisted of 144 sections of preformed SS orthodontic archwires (0.019” × 0.025”) from the AO and 3B brands, divided into two groups: as-received (control) group (n = 72) and retrieved group after 8 weeks of intraoral use (n = 72). Debris was evaluated using scanning electron microscopy, surface roughness (SR) was measured with a Talysurf-i60 profilometer, and frictional forces were assessed using a universal testing machine. Statistical analyses included Wilcoxon signed-rank test for comparisons and Spearman’s and Pearson’s correlation tests, with significance set at $P > 0.05$.

Result. Significant differences were observed between the as-received and retrieved groups. The retrieved group showed higher median debris ($p < 0.001$) and increased SR, with means of 0.503 for 3B and 0.563 for AO, compared with 0.059 and 0.037, respectively, in the as-received group ($p < 0.002$). Frictional forces were greater in the retrieved group, with means of 5.042 for 3B and 4.442 for AO, than in the as-received group, with means of 2.983 and 3.525, respectively ($p < 0.002$). Significant positive correlations ($P < 0.05$) were found among these three variables.

Conclusion. After 8 weeks of intraoral contact, a significant increase was detected in the debris amount, SR, and friction compared with the as-received archwires.

Key words: Archwires, Debris, Surface roughness, Friction, Intraoral aging

INTRODUCTION

Orthodontic handling combines biological and material knowledges and behavior for the esthetic and functional alignment of teeth and arches. Variations in orthodontic material inside the oral cavity are a substantial concern for an effective treatment steps and process [1]. Intraoral aging of orthodontic used materials can lead to alteration and variations in surface morphology, biochemical composition, and mechanical properties, which can impact factors like friction, debris accumulation, and biofilm retention [2]. These factors can affect the clinical performance of the materials over time.

During space closure, orthodontic archwire may need to be present intra-orally for several months, leading to an accumulation of debris, which can increase the surface roughness (SR) of the archwire and result in increased friction. High friction levels pose significant challenges for orthodontists, complicating anchorage control and making it harder to achieve the desired results [3]. This increased friction can consume a portion of the force applied to induce tooth movement, thereby reducing the efficiency of the orthodontic mechanics [4]. As a result, frictional stresses may result in a 50% or greater reduction in force applied through orthodontic appliances [5].

The coefficient of friction measures the relationship between frictional force and normal force. Friction occurs when a moving object, such as an archwire, contacts another object, such as a bracket slot, resisting movement and reducing treatment forces. In the oral setting and environment, surface films significantly affect friction, which is higher on rough or smooth surfaces [6]. Smooth surfaces increase adhesion, whereas rough surfaces create friction through interlocking peaks and valleys [6]. Biological aspects, such as saliva, pellicles, and plaque, increase friction on archwires by enhancing surface tension [7]. This friction reduces the effectiveness of forces applied for tooth movement, as some force is needed to overcome SR appliances [5]. Several in-vitro studies have examined friction in combinations of as-received wires and brackets, considering variations in alloy type, bracket type, and ligation methods [4,6,8,9]. Some research has looked at friction in the presence of fluids to mimic the intraoral environment. While certain studies reported that saliva reduces friction [10], others suggested that it may not act effectively as a lubricant [11]. The material of the bracket-archwire gathering is important for effective tooth movement utilizing sliding system; selecting the right material reduces friction and enhances outcomes. Rectangular SS wires are particularly beneficial in mechanical sliding owing to their low coefficient of friction and SR [6]. The SS bracket and archwire combination is regarded as the gold standard for its superior frictional properties [12].

Despite the superior properties of SS archwire, it is exposed to surface changes resulting from accumulation of food debris and calculus deposits. and these changes may alter vital properties such as SR and friction [13]. Nikhil et al. reported that after 16 weeks of intraoral use, rectangular SS archwires exhibited a substantial increase in the quantity of debris, leading to enlarged levels of frictional resistance among the archwire and braces surfaces during sliding mechanics [14]. Previous studies have shown a strong relationship between friction and debris [6], and others have emphasized the correlation between debris accumulation and SR [15].

For an enhanced knowledge on SS archwire, which is very important for orthodontic practitioners, and due to the lack of literature, two brands from the same material were evaluated in this study. Bhat et al. reported that even though archwires were made from the same materials and had similar dimensions, they probably have different mechanical properties if manufactured by different manufacturers [3]. Therefore, the main objectives of this study are to evaluate the effects of intraoral aging on the debris, surface roughness and friction.

MATERIALS AND METHODS

Study design and sample size calculation

This study aimed to evaluate the effects of intraoral use of two different brands of SS materials, 3B Ortho and AO, after 8 weeks of intraoral use. This study was approved by the Ethics Committee of the Faculty of Medicine and Health Sciences at USTY (MECA No.: EAC/UST170). The sample size was calculated using OpenEpi software to assess the friction differences between the control (T0) and retrieved (T1) groups. A power of 80% was assumed to detect a mean difference of 1.02 N, with standard deviations of 0.43 (T0) and 0.96 (T1) (Normando et al., 2013), at a bilateral alpha level of 5% [16]. The calculated sample size was 144 archwire samples divided into four groups.

Inclusion criteria

Two brands of SS archwires were used: AO (American Orthodontics Corporation, Sheboygan, Wisconsin, USA) and 3B Ortho (Hangzhou Xingchen 3B Dental Instrument & Material Co. Ltd., Hangzhou, China). Both archwires are sized 0.019” × 0.025”, have a preformed shape, and are FDA certified. The retrieved archwires were from participants with fixed appliances with first premolar extractions as a treatment protocol, with good oral hygiene, and on the verge of completion of their first stage (leveling and alignment) of treatment. Consent was obtained from the participants through a form that outlined the nature and purpose of the investigation, allowing them the freedom to accept or decline participation.

Samples preparations grouping

The 144 archwire section samples were randomly divided into two groups, one group in the as-received state (group A) and the other retrieved from orthodontic patients (group B), with 72 samples in each group. The effects of intraoral exposure were assessed using 72 archwire sections, consisting of 36 from the 3B brand and an equal number from the AO brand.

During the intervention, the orthodontist inserted the preformed SS archwire, securing it with elastomeric modules and SS ligature wire. A closed elastic chain was then placed from the first molar to the canine, applying a force of 150 gm as measured by a force gauge. The wire remained in the mouth for approximately 8 weeks (± 5 days) before retrieval, with a reference mark made on the distal aspect of the canine bracket.

All hemi-arch samples from the 3B and AO brands were randomly allocated into three groups: debris, SR, and frictional forces. The amount of debris, SR, and frictional forces of SS archwire samples was assessed in segments of control and test groups by the same operator for standardization.

Assessments of debris

Each 10 mm segment was cut from the distal aspect of the canine bracket and fixed with double-sided tape on a 22 mm × 22 mm glass slide. The central area of each sample was marked to standardize debris assessments.

Debris was evaluated using scanning electron microscopy (SEM) using a Quanta 250 FEG (Drive Hillsboro ،Oregon, USA) 2000x magnification, and images were obtained with xT microscope Control Software (**Figure 1**). The modified debris index was used for evaluation based on the criteria of Marques et al. (2010), [13] as shown in **Table 1**.

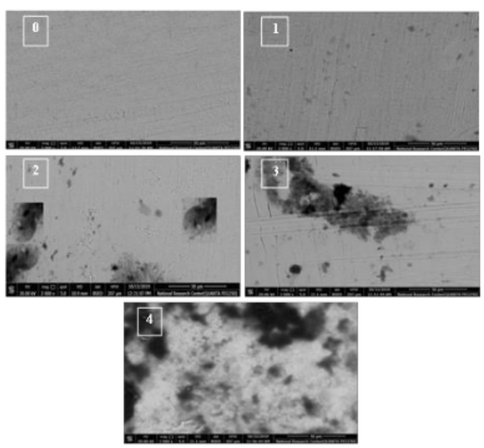

Figure 1: SEM images show the amount of debris at 2000x magnification

Table 1: Scores and criteria of modified debris index

Score	Criteria
0	Total absence of debris
1	Debris covering up to 25%
2	Debris covering between 25-50%

3	Debris covering between 50-75%.
4	Debris covering over 75%

Evaluation of Surface Roughness (SR)

Test sample groups and control groups wires were examined for SR by the same operator using a Surface Profilometer. A 20 mm piece of archwire was cut from the distal canine bracket for standardization. The samples were placed in a Talysurf-i60 contact stylus Profilometer (Talysurf- i60, stylus Profilometer, Taylor Hobson, England, S. No. 4932, U= ±0.3 nm). The machine automatically determined the mean roughness from 12 profilometric scans per sample. Arithmetic mean roughness was measured in micrometers (µm) according to ISO 3274:1996, with a cut-off of 5×0.8 mm and a scanning speed of 0.5 mm/s. Data were digitized using Metrology 4.0- Smart Software (Taylor Hobson® Ltd). The uncertainty evaluation was carried out in accordance with the JCGM 100:2008, U= ±0.100µm (U is the expanded uncertainty using a coverage factor K = 2), providing a level of confidence of approximately 95 %. All measurement equipment was traceable to roughness standards calibrated at VTT MIKES, Finland (certificate No. M-19L090). Measurements were conducted at a controlled temperature of 20˚C ± 1˚C.

Measurements of Frictional Forces

For testing the frictional forces, a metal MBT bracket (Shinye, China), with a 0.022 inch × 0.028-inch slot, 0° angulation, and 0° torque, was used. Bracket were bonded to upper right second premolar by using light-cure composite (SIA, Italy), then tooth was invested in an acrylic block (30 mm × 20 mm × 15 mm). Then the wire was tied to brackets using elastic ligature (0.12-in DTC, China). Samples were mounted on a Universal Testing Machine (Model 3345; Instron Industrial Products, Norwood, MA, USA) with a load cell of 5 kN and data were documented using desktop computer software (Instron® Bluehill Lite Software). The acrylic block was secured to the machine's lower compartment, and the wire was attached to the upper compartment, then pulled out at the cross-head speed of 1 mm/min up to a distance of 5 mm **Figure 2**. Dynamic frictional force was assessed and recorded in Newtons (N), using the mean force employed from the starting of the movement till the end of the assessment. The maximum static friction force was recorded during the first movement, while the kinetic frictional force was the average during movement from 1–5 mm and recorded using computer software (Bluehill® Central | Lab Management Software from Instron®).

Figure 2: Test setup with acrylic block model in Instron Universal Testing Machine.

Statistical analysis

Statistical analysis

The debris index scores showed non-normal distribution (nonparametric), whereas the SR and frictional force data showed normal distribution (parametric distribution). Therefore, the descriptive statistics were presented as mean and the standard deviation (SD) values for parametric data, and nonparametric data were presented as median and interquartile range values. SPSS (version 23.0, IBM Corp., Armonk, NY) was used to input and analyzed the data. Wilcoxon signed-rank test was used to compare between the effects of intraoral aging on the debris, SR, and frictional forces of SS archwire samples. P > 0.05 was set at the significant level. The correlation analysis between frictional forces and degree of debris and between SR and degree of debris was performed by Spearman's correlation test, whereas the correlation between SR and frictional forces was examined by Pearson's correlation test after normality analysis.

RESULTS

Differences in intraoral aging effects between the as-received (control) and retrieved SS archwire samples were analyzed using Wilcoxon signed-rank test, as shown in Table 2. The results indicated statistically significant differences in debris accumulation, with the retrieved group showing a median of 4 (IQR = 0) compared with an absence of debris in the as-received group ($p < 0.001$). SR differed significantly, with mean SR values of 0.503 (SD = 0.001) for 3B and 0.563 (SD 0.001) for AO in the retrieved group in comparison with 0.059 (SD = 0.001) and 0.037 (SD = 0.001), respectively, in the as-received group ($p < 0.002$). The frictional forces were significantly higher in the retrieved group, with means of 5.042 (SD = 0.601) for 3B and 4.442 (SD = 0.425) for AO, than the as-received group, with means of 2.983 (SD = 0.413) and 3.525 (SD = 0.286), respectively ($p < 0.002$). **Figure** 3 describes the measurement values of the effects of intraoral aging on SS archwires.

Table 2: Comparison the effects of intraoral aging on SS archwires

Variable	As-Received				Retrieved				*P-value*
	3B (n=12)		AO (n=12)		3B (n=12)		AO (n=12)		
	M/Med	SD/IQR	M/Med	SD/IQR	M/Med	SD/IQR	M/Med	SD/IQR	
Debris	0	0	0	0	4	0	4	0	< 0.001*
SR	0.059	0.001	0.037	0.001	0.503	0.001	0.563	0.001	< 0.002*
Friction	2.983	0.413	3.525	0.286	5.042	0.601	4.442	0.425	< 0.002*

(*) Significant at $P \leq 0.05$, (Median/IQR) for debris, (Mean/SD) for roughness and friction, (µm) micrometers for (Ra), and (N) Newton for friction.

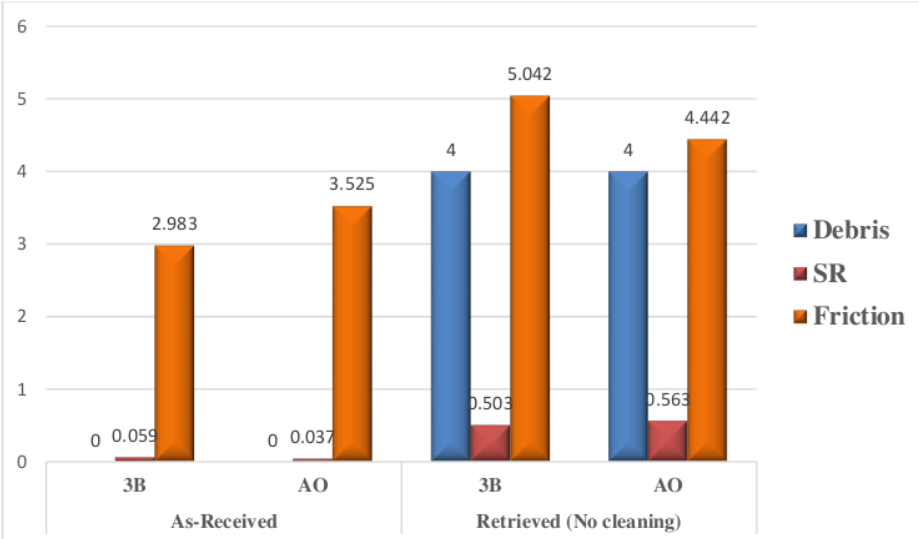

Figure 3: the values of measuring the effects of intraoral aging on SS archwires.

Correlation between amount of debris, surface roughness and frictional forces

Spearman's correlation analysis showed a positive correlation between frictional forces and debris measured at 2000× magnification ($r = 0.67$, $P = 0.02$). Moreover, a positive correlation was found between debris and SR ($r = 0.63$, $P = 0.03$; Table 3), and Pearson's correlation analysis showed a positive correlation between frictional forces and SR ($r = 0.64$, $P = 0.03$; Table 3). **Figures** 4, 5, and 6 represent the correlation between frictional forces and debris, debris and SR (Ra) and frictional forces and SR (Ra), respectively.

Table 3: Correlation analyses between debris, surface roughness, and friction.

Variable	***r***	***P***
Friction-debris	0.67	0.02
Debris-roughness	0.63	0.03
Friction-roughness	0.64	0.03

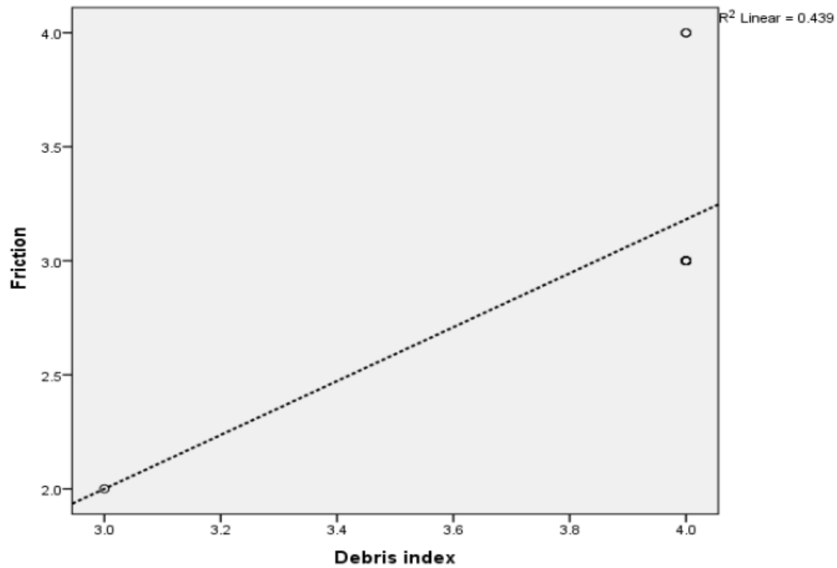

Figure 4: correlation between frictional forces and debris.

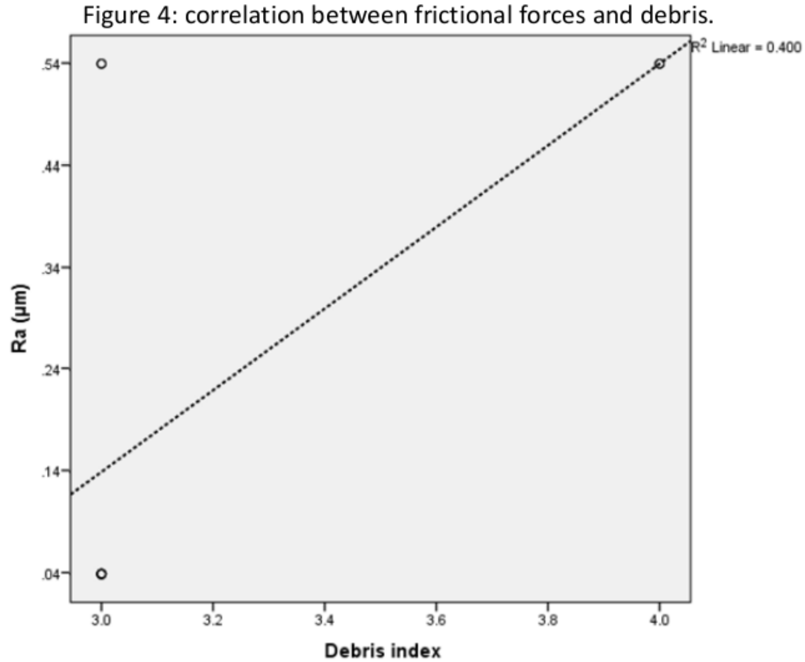

Figure 5: correlation between debris and SR (Ra).

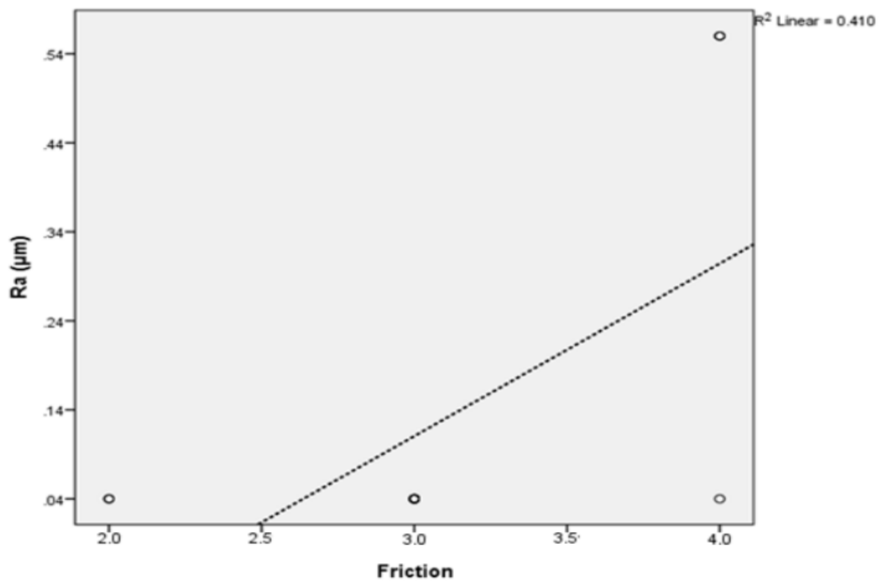

Figure 6: correlation between frictional forces and SR (Ra).

DISCUSSION

SS archwires are frequently utilized in sliding mechanics owing to their low frictional coefficient [17]. As these wires remain for months throughout space closing, assessing their mechanical properties is crucial. In aqueous environments, metals can become thermodynamically unstable, with factors like surface morphology, metal phase, solution composition, galvanic interactions, pH, and temperature influencing this instability [18]. These elements can accelerate aging, leading to increased SR, debris accumulation, and changes in frictional characteristics [15]. The current clinical study intended to evaluate, assess, and measure the effects of intraoral use on (3B and AO) brands of preformed SS orthodontic archwires subsequently 8 weeks of intraoral use. SS archwires are widely regarded as the most common choice in orthodontic treatment owing to their favorable properties, including elastic modulus, low friction, formability, and biocompatibility [19]. The present study examined the clinical application of rectangular 0.019” × 0.025” SS archwires, which remain passive in the mouth for approximately 8 weeks to enable torque expression during the ending stage of leveling and alignment. Their low coefficient of friction and reduced SR make them particularly effective for mechanical sliding [19]. Pre-adjusted edgewise SS brackets were utilized in this research because they are standard in clinical settings, with the archwires secured using SS ligatures.

The outcomes displayed that the as-received SS archwires had no visible debris, but after being retrieved from the oral environment, the 3B and AO groups had a debris particle median of 4, indicating a statistically significant increase in debris accumulation ($p < 0.001$). In routine clinical practice, as-received SS archwires appear smooth and uniform, whereas those used intraorally show significant surface changes. These alterations can be effectively analyzed using SEM, which provides detailed images at various magnifications. Many studies have documented surface modifications on orthodontic archwires under in-vitro conditions and noted the growth of debris and corrosive products on archwires used in the oral setting and environment [4,5,13,14].

The results of this study are inconsistent with those of other in-vivo studies focused on SS orthodontic archwires. Normando et al. found that the degree of debris was significantly increased and larger for wires that persisted in the oral environment for 8 weeks ($P < 0.05$). The median scores after clinical use were 2 at 18× magnification and 3 at 200× magnification [16]. Nikhil et al. reported that after being exposed to intra-oral environment for 16 weeks, SS rectangular archwires exhibited a significant increase in the amount and volume of debris accumulation, causing increased levels of frictional resistance between the archwire and bracket surfaces through the sliding mechanic time of orthodontic treatment [14].

SR is an important property of orthodontic archwires because it can affect their corrosion behavior, biocompatibility, appearance, hygiene, and the amount of friction encountered during tooth movement [5]. An increase in SR can directly lead to increased friction between the archwire and the bracket/tooth surfaces [6]. In the present study, the SR of SS archwires significantly increased after intraoral aging. Under the as-received condition, the 3B and AO groups had median SR values of 0.059 and 0.037 µm, respectively. Under retrieved condition, the 3B and AO groups' median roughness values increased to 0.503 and 0.563 µm, respectively, with statistical significance ($p < 0.002$). Normando et al. reported that as-received 3M Unitek SS wire exhibited very low values and numbers of SR, with an average of 0.03 µm. After intraoral exposure for 8 weeks, a significant increase in SR was found at 1.7 µm [16].

In their roughness analysis, Kumar et al. showed a highly significant difference among the SR average of test and as-received archwires (*P* = 0.0001) [6].

Increased friction between archwires and brackets correlates with debris levels, resulting in a force loss of 20.8% (1.48 N), which is significant for space closure calculations [2]. The growth of debris and the increase in SR due to intraoral aging can lead to increased frictional forces at the archwire–bracket interface, thereby reducing the applied forces. When the frictional force of the 3B group was examined under the as-received condition, the friction force was 2.983 N. After clinical use, the friction force increased to 5.042 N. The results of this study showed an average increase of 2.437 N. Meanwhile, the AO group had a median of 3.525 after clinical use. The friction force increased to 4.442 N, with an average growth of 0.917 N. This increase in friction was statistically significant ($p < 0.002$). This finding contradicts that of Normando et al., who showed 3M Unitek SS with an average increase of 2.19 N in friction force, possibly since of variances between the materials utilized to production the wires and the duration length of intraoral exposure and contact [16]. In general, an increase in SR can lead to an increase in friction, especially in dry or boundary-lubricated conditions, because rougher surfaces have a higher contact area and produce more asperity (microscopic peaks and valleys) interactions, which can cause greater resistance to sliding.

This study found a significant positive correlation between debris accumulation and SR and frictional forces and a notable correlation between frictional forces and SR of SS archwires **(Table 3)**. These findings align with those of previous studies [6,14-16]. However, Marques et al. reported stronger correlations ($P < 0.0001$, $r = 0.80$ for 18× and $r = 0.78$ for 200×) [15]. Kumar et al. noted that the association between friction and debris was more significant than that between friction and SR ($r = 0.82$, $P = 0.0001$) [6]. This variance may be due to testing of the same area of the archwire for debris and friction, whereas SR was evaluated separately.

This study examined and observed the effects of three aspects of intraoral aging, but it did not analyze changes in the physical characteristics of the archwire surface. All evaluations were conducted within 1 week of removing the archwires from the oral environment. Furthermore, the frictional testing was carried out under dry conditions, overlooking the potential lubricating effect of saliva, which may have influenced the results. Future research could investigate additional factors related to archwire degradation in the intraoral environment by examining various time intervals. Additionally, studies should consider the role of archwire cleaning during each appointment and explore cleaning methods across different brands and materials of archwires.

CONCLUSION

This study demonstrated that intraoral aging significantly affects the performance of SS archwires. The retrieved group exhibited higher levels of debris, increased SR, and greater frictional forces than the as-received group. The correlation analyses indicated positive relationships among frictional forces, debris, and SR.

REFERENCES

1. Baidas L, Alkawari H, Alshihah N, Almashaan G, Alwaalan H.Impact of Simulated Gastric Acid on Surface Roughness and Frictional Resistance of Orthodontic Archwires: An In vitro Study.J Clin Diag Res.2020; 14(12):ZC10-ZC15. doi.org/10.7860/JCDR/2020/45051/14297
2. Selvaraj M, Mohaideen K, Sennimalai K, Gothankar GS, Arora G. Effect of oral environment on contemporary orthodontic materials and its clinical implications. J Orthodont Sci 2023;12:1. DOI: 10.4103/jos.jos_73_22
3. Bhat KRR, Ahmed N, Joseph R, Younus A A. Comparative Evaluation of Frictional Resistance Between Different Types of Ceramic Brackets and Stainless Steel Brackets With Teflon-Coated Stainless Steel and Stainless Steel Archwires: An In-Vitro Study. Cureus. 2022 Apr 15;14(4):e24161. doi: 10.7759/cureus.24161.
4. Alam MK, Alfuhigi MZ, Hajeer MY, Alsenani FN, Eldosary FA, Alsayil LN. Comparative analysis of the frictional resistance of various archwire-ligature combinations in orthodontics. J Pharm Bioall Sci 2024;16:S2506-8. **DOI:** 10.4103/jpbs.jpbs_324_24
5. Ashique Abdulhameed S, S B, Sunny J, Goswami DS, Abraham N, Asha Ambroise M. Comparison of Surface Roughness of Different Orthodontic Archwires: Atomic Force Microscopic Study. Cureus. 2024 Jan 2;16(1):e51516. doi: 10.7759/cureus.51516
6. Kumar A, Khanam A, Ghafoor H. Effects of intraoral aging of arch-wires on frictional forces: An *ex vivo* study. J Orthodont Sci 2016;5:109-16. **DOI:** 10.4103/2278-0203.192112
7. Arici N, Akdeniz BS, Oz AA, Gencer Y, Tarakci M, Arici S. Effectiveness of medical coating materials in decreasing friction between orthodontic brackets and archwires. Korean J Orthod. 2021 Jul 25;51(4):270-281. doi: 10.4041/kjod.2021.51.4.270.
8. Khalid SA, Kumar V, Jayaram P. The comparison of frictional resistance in titanium, self-ligating stainless steel, and stainless steel brackets using stainless steel and TMA archwires: An in vitro study. J Pharm Bioall Sci 2012;4:203-11. **DOI:** 10.4103/0975-7406.100203.

9. Jakob SR, Matheus D, Jimenez-Pellegrin MC, Turssi CP, Amaral FL: Comparative study of friction between metallic and conventional interactive self-ligating brackets in different alignment conditions. Dental Press J Orthod. 2014, 19:82-9. 10.1590/2176-9451.19.3.082-089.oar
10. Al-Khatib S, Berradja A, Celis JP, Willems G. In vitro friction of stainless steel arch wire-bracket combinations in air and different aqueous solutions. Orthod Craniofac Res. 2005 May;8(2):96-105. doi: 10.1111/j.1601-6343.2005.00321.x
11. Smith D, Rossouw E, Watson P. Quantified simulation of canine retraction: evaluation of frictional resistance. Semin Orthod. 2003;9(4):262-280. doi:10.1016/j.sodo.2003.08.006
12. Youssef A, Dennis C, Beyer JP, Grünheid T. Resistance to sliding of orthodontic archwires under increasing applied moments. J Appl Biomater Funct Mater. 2020;18: doi:10.1177/2280800020968027
13. Al Shayeb RA, Alhaija ESA, Al-Khateeb S, Rashaid AHB. The effect of intraoral aging of the working stainless steel archwire on the rate of premolar extraction space closure: a randomized clinical trial. Clin Oral Investig. 2022 Mar;26(3):3011-3020. doi: 10.1007/s00784-021-04283-y
14. Nikhil P, Hegde A, Nene S, Kalia A, Khan A. The effect of intraoral ageing and debris accumulation on the frictional resistance of orthodontic archwires: an in-vivo study. EC Dental Science. 2020;19(80):167-178
15. Marques IS, Araújo AM, Gurgel JA, Normando D. Debris, roughness and friction of stainless steel archwires following clinical use. Angle Orthod. 2010 May;80(3):521-7. doi: 10.2319/081109-457.1
16. Normando D, de Araújo AM, Marques Ida S, Barroso Tavares Dias CG, Miguel JA. Archwire cleaning after intraoral ageing: the effects on debris, roughness, and friction. Eur J Orthod. 2013 Apr;35(2):223-9. doi: 10.1093/ejo/cjr104
17. Alsabti N, Bourauel C, Talic N. Comparison of force loss during sliding of low friction and conventional TMA orthodontic archwires : An in vitro study. J Orofac Orthop. 2021 Jul;82(4):218-225. doi: 10.1007/s00056-020-00266-y
18. Eliaz N. Corrosion of Metallic Biomaterials: A Review. Materials (Basel). 2019 Jan 28;12(3):407. doi: 10.3390/ma12030407.
19. Selvaraj M, Mohaideen K, Sennimalai K, Gothankar GS, Arora G. Effect of oral environment on contemporary orthodontic materials and its clinical implications. J Orthod Sci. 2023 Mar 18;12:1. doi: 10.4103/jos.jos_73_22.

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Presented by: Ali Mohammed Ali Rasheed

Faculty: Dentistry, UST

And found that it has fulfilled the guarantees and safeguards for the medical research ethics and that the proposal is in compliance with the policy of the committee.

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