

Comparison of Galvanic Currents Generated Between Different Combinations of Orthodontic Brackets and Archwires Using Potentiostat: An *In Vitro* Study

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Abstract:

Background: Technological advances in wire selection and bracket design have led to improved treatment efficiency and allowed longer time intervals between appliance adjustments. The wires remain in the mouth for a longer duration and are subjected to electrochemical reactions, mechanical forces of mastication and generalized wear. These cause different types of corrosion. This study was done to compare the galvanic currents generated between different combinations of brackets and archwires commonly used in orthodontic practices.

Materials and Methods: The materials used for the study included different commercially available orthodontic archwires and brackets. The galvanic current generated by individual materials and different combinations of these materials was tested and compared. The orthodontic archwires used were 0.019" × 0.025" heat-activated nickel-titanium (3M Unitek), 0.019" × 0.025" beta-titanium (3M Unitek) and 0.019" × 0.025" stainless steel (3M Unitek). The orthodontic brackets used were 0.022" MBT laser-cut (Victory Series, 3M Unitek) and metal-injection molded (Leone Company) maxillary central incisor brackets respectively. The ligature wire used for ligation was 0.009" stainless steel ligature (HP Company). The galvanic current for individual archwires, brackets, and the different bracket-archwire-ligature combinations was measured by using a Potentiostat machine. The data were generated using the Linear Sweep Voltammetry and OriginPro 8.5 Graphing and Data Analysis Softwares. The study was conducted in two phases. Phase I comprised of five groups for open circuit potential (OCP) and galvanic current (I), whereas Phase II comprised of six groups for galvanic current alone.

Results: Mean, standard deviation and range were computed for the OCP and galvanic current (I) values obtained. Results were

subjected to statistical analysis through ANOVA. In Phase I, higher mean OCP was recorded in stainless steel archwire, followed by beta-titanium archwire, heat-activated nickel titanium archwire, laser-cut bracket and metal-injection molded bracket, respectively. The difference in mean OCP recorded among the groups was found to be statistically significant in aerated phosphate buffered saline solution. The galvanic current (I) for metal-injection molded stainless steel brackets showed significantly higher values than all the other materials. Phase II results suggested that, in the couples formed by the archwire-bracket-ligature combinations, the bracket had more important contribution to the total galvanic current generated, since there were significant differences between galvanic current among the 2 brackets tested but not among the 3 wires. The galvanic current of the metal-injection molded bracket was significantly higher than that of laser-cut bracket. Highest mean current (I) was recorded in metal-injection molded bracket when used with heat-activated nickel titanium archwire while lowest mean current (I) was recorded in laser-cut bracket when used with beta-titanium archwire.

Conclusion: The present study concluded that the bracket emerged to be the most important factor in determining the galvanic current (I). Higher mean current (I) was recorded in metal-injection molded bracket compared to laser-cut bracket. Among the three archwires, higher mean current (I) was recorded in heat-activated nickel-titanium, followed by stainless-steel and beta-titanium respectively. When coupled together; highest mean current (I) was recorded in metal-injection molded bracket when used with heat-activated nickel titanium archwire while lowest mean current (I) was recorded in laser-cut bracket when used with beta-titanium archwire.

Key Words: Aerated phosphate buffered saline solution, beta-titanium archwire, galvanic current (I), heat-activated nickel-titanium archwire, laser-cut bracket, linear sweep voltammetry, metal-injection molded bracket, open circuit potential (OCP), potentiostat, stainless steel archwire

Introduction

Technological advances in wire selection and bracket design has led to improved treatment efficiency and allowed longer time intervals between appliance adjustments.

The wires remain for a longer duration in the mouth and are subjected to electrochemical reactions, mechanical forces of mastication and generalized wear. These cause different types of corrosion. (It is an electrochemical process which results in loss of essential properties of a metal).

Galvanic corrosion is an electrochemical reaction that occurs when two different metals, immersed in the same solution, are electrically coupled to each other.¹

When two dissimilar metals are in contact and immersed in an electrolyte, a potential difference usually exists between them and an electrolytic (or corrosion) cell is formed. The metal that is less corrosion resistant becomes anodic and starts to corrode for the benefit of the most resistant metal. Both metals are polarized, anode experiences increased corrosion rate while the rate of corrosion of cathode decreases.

The corrosion resistance of metals can be explained by the galvanic series of metals and alloys. Each metal is either electronegative or electropositive. The more electronegative a material is, the more prone it is to corrosion.

The rate and speed of galvanic corrosion is dependent on: (1) The atmospheric conditions surrounding the system, especially in those areas where moisture in the atmosphere contains dissolved salts making it more conductive and thus more corrosive. (2) The surface area of the two metals in contact. A small anode next to a large cathode will increase the corrosion rate, whereas a large anode in contact with a small cathode will have the reverse effect.

Since most of the orthodontic materials are metallic, i.e., bands, brackets, face bows, arch wires, retainers, etc. they are subjected to galvanic and other types of corrosion.

Many studies involved detection of corrosion on the surface of various orthodontic appliances. Other studies concentrated on the measurement of ion release, with nickel being the major concern. Fewer studies have been done regarding galvanic corrosion with various combinations of brackets and wires. Monitoring galvanic current provides more relevance because it quantifies the extent of corrosion and is an indirect measure of elemental release, since the flow of electrons (i.e., current) corresponds to the release of metal into the solution.^{2,3}

Galvanic corrosion of Orthodontic materials depends on many factors, such as: The passivating oxide films that form on stainless steel and titanium, the surface area of the brackets and wires, the material of brackets and wires, and the presence of dissimilar metal components in a single bracket creates a galvanic cell on the bracket itself and this effect can be intensified when the bracket is coupled to the wire. Galvanic corrosion is sensitive to relative areas of anode and cathode.

As the metal injection molded (MIM) brackets are made up of a single piece of metal, they are less prone to the galvanic effects even when they are coupled with a wire. They possess lower galvanic current values than the multi-component brackets.⁴ As a result of ion release from galvanic corrosion there are issues of biocompatibility. Several studies have investigated galvanic corrosion between brackets and wires,^{5,6} but the present study differs in terms of materials and couples tested and methodology. Nickel, in particular, is a cause of concern because of its reported ability to induce Allergic Contact

Dermatitis in patients with previous cutaneous piercings or a history of allergy.⁷

Hence, due to decreased susceptibility to galvanic corrosion, MIM stainless steel brackets might release less nickel. Since, the galvanic current is greatest when the wire and brackets are first coupled and then decreases over time, ion release would be expected to be greatest shortly after archwire placement. The greatest nickel concentration in patient's saliva occurs after bracket and wire placement.⁸

Hence, the purpose of this study was to compare the galvanic currents generated between different combinations of brackets and archwires commonly used in orthodontic practices.

Materials and Methods

The study was conducted in two phases. Phase I comprised of five groups for open circuit potential (OCP) and galvanic current (I) whereas Phase II comprised of 6 groups for galvanic current (I) alone. Phase I groups consisted of 0.019" × 0.025" heat-activated nickel-titanium archwires, 0.019" × 0.025" beta-titanium archwires, 0.019" × 0.025" stainless steel archwires, 0.022" MBT maxillary central incisor laser-cut stainless steel brackets and 0.022" MBT maxillary central incisor metal-injection molded stainless steel brackets respectively.

Phase II groups consisted of a combination of the above archwires and brackets. Each group consisted of 10 samples. The samples were immersed in aerated phosphate buffered saline solution of pH = 7.4 at room temperature (23°C ± 1°C). The galvanic current for individual archwires, brackets, and the different bracket-archwire-ligature combinations was measured by using a potentiostat at the Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bengaluru, India. The data was generated using the Linear Sweep Voltammetry and OriginPro 8.5 Graphing and Data Analysis Softwares.

Wires were sectioned at 3.5 cm length, which corresponds to half the length of all standard archwires and covered with poly tetrafluoroethylene (PTFE) insulating tape. One end of the wire was connected to the electrochemical measuring equipment and the other end submerged in the solution, i.e., aerated phosphate buffered saline solution of pH = 7.4 at room temperature (23°C ± 1°C). The submerged end was painted with nail polish to expose only 9mm of wire, which corresponds to the width of the maxillary central incisor. Each bracket was connected to a 15.2 cm insulated copper wire. The flattened end was secured to the pad of the bracket with sticky wax exposing only the face of the bracket. Remaining copper was insulated with PTFE insulating tape and the electrical continuity was maintained with a multi-meter. Electrochemical measurements were made using a potentiostat machine connected to a desktop computer. The data was generated using the Linear Sweep Voltammetry and OriginPro 8.5 Graphing and Data Analysis Softwares.

The experiment was conducted in two phases: Phase I: In this phase, galvanic current for each bracket and archwire was measured with saturated calomel being the reference electrode and platinumized platinum, the counter electrode in the electrochemical cell. Ten samples of each bracket and wire type were tested with the fresh solution being used each time. OCP was monitored for 10 hours and a linear sweep voltammetry scan was conducted. Phase II: In this phase, the galvanic current between each combination of ligated bracket and archwire was measured. Platinumized platinum was the counter electrode and saturated calomel was the reference electrode in the electrochemical cell. The current was monitored for 10 hours. Ten specimens of each combination of bracket and archwire were tested, and the total galvanic current was calculated by OCP versus current graph.

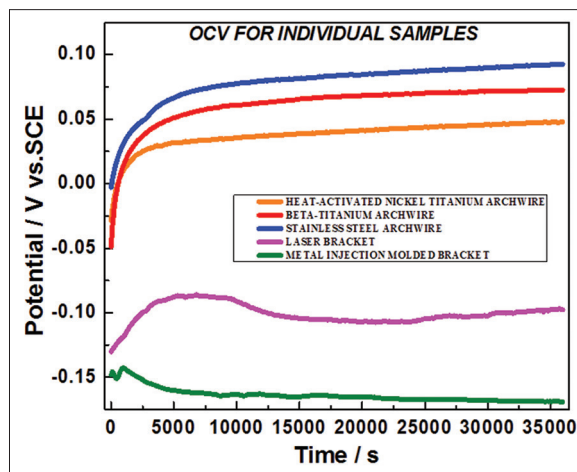
Results

In Phase I, higher mean OCP was recorded in stainless steel archwire, followed by beta-titanium archwire, heat-activated nickel titanium archwire, laser-cut bracket and MIM bracket respectively. The difference in mean OCP recorded among the groups was found to be statistically significant in aerated phosphate buffered saline solution (Graph 1 and Table 1). The corrosion current (I) for metal-injection molded stainless steel brackets showed significantly higher values than all other materials (Graph 2 and Table 2).

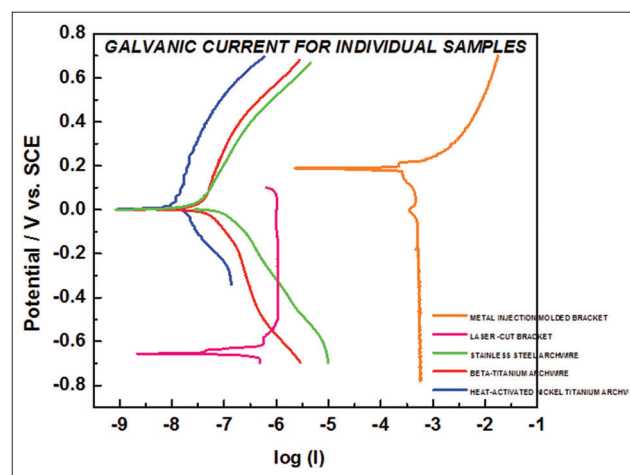
Phase II results suggested that, in the couples formed by the archwires and brackets, the latter had more important contribution to the total galvanic current generated, since there were significant differences between galvanic current among the 2 brackets tested but not among the 3 wires (Graph 3 and Table 3). The galvanic current of the metal-injection molded bracket was significantly higher than that of laser-cut bracket (Table 4). The results also indicated that manufacturing technique may affect galvanic corrosion susceptibility along with bracket composition.

Discussion

Orthodontic brackets and archwires are made up of varied compositions of different kinds of metals, especially stainless steel containing traces of chromium and nickel and nickel-titanium alloys. In a clinical situation, when two dissimilar



Graph 1: Open circuit potential for individual materials.



Graph 2: Galvanic current (I) for individual materials.

Table 1: Mean OCP recorded among the materials.

Material	Mean	SD	SEM	95% CI for mean		P value	Sig diff bw
				Lower bound	Upper bound		
Archwire 1 (1)	48.60	1.78	0.56	47.329	49.871	<0.001*	1 versus 2, 3, 4, 5 (P<0.001)
Archwire 2 (2)	77.30	2.75	0.87	75.332	79.268		2 versus 3, 4, 5 (P<0.001)
Archwire 3 (3)	98.40	2.27	0.72	96.776	100.024		3 versus 4, 5 (P<0.001)
Bracket 1 (4)	-143.00	12.35	3.90	-151.832	-134.168		4 versus 5 (P<0.001)
Bracket 2 (5)	-172.10	5.22	1.65	-175.832	-168.368		

*Denotes significant difference. OCP: Open circuit potential, SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval

Table 2: Mean current (I) recorded among the materials.

Material	Mean	SD	SEM	95% CI for mean		P value	Sig diff bw
				Lower bound	Upper bound		
Archwire 1 (1)	12.19	0.88	0.28	11.561	12.819	<0.001*	1 versus 2,3,4,5 (P<0.001)
Archwire 2 (2)	38.77	0.81	0.26	38.190	39.350		2 versus 3, 5 (P<0.001)
Archwire 3 (3)	49.70	1.77	0.56	48.436	50.964		3 versus 4, 5 (P<0.001)
Bracket 1 (4)	38.24	1.63	0.51	37.077	39.403		4 versus 5 (P<0.001)
Bracket 2 (5)	512862.69	5.75	1.82	512858.571	512866.803		

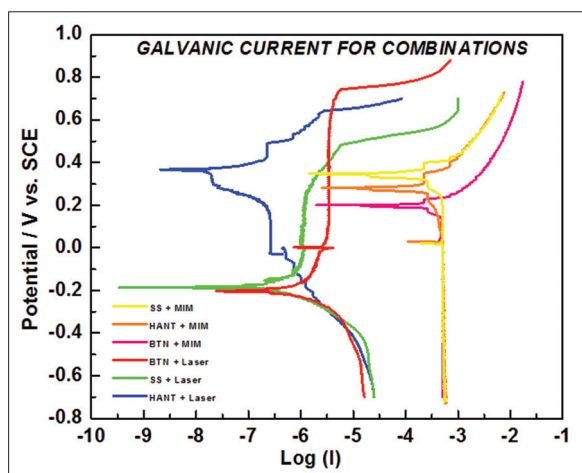
*Denotes significant difference. OCP: Open circuit potential, SD: Standard deviation, SEM: Standard error of mean, CI: Confidence interval

alloys having different corrosion potentials are often placed in contact such as in orthodontic brackets and archwires, it can cause galvanic corrosion that leads to preferential release of metal ions from the anodic metal or alloy. Both the metals are polarized where anode experiences increased corrosion rate, whereas the rate of corrosion of cathode decreases. In 1780, Luigi Galvani⁹ was the pioneer who discovered that when two different metals are connected electrically, a current is generated due to the oxidation-reduction (Redox) reaction in the electrochemical solution.

The oral environment is very ideal for the biodegradation of metals because of its ionic, thermal, microbiologic and enzymatic properties which lead to patient exposure to the corrosion products of these alloys. The surface area ratio of the two dissimilar alloys and the surface smoothness are also very important factors because they affect the galvanic corrosion behavior. An unfavorable area ratio which consists of a large cathode and a small anode might lead to greater corrosion rate from the anodic alloy. Reed and Willman¹⁰

demonstrated the presence of galvanic currents in the oral cavity probably for the first time in detail. The health hazards caused due to the exposure to nickel, chromium, and other corrosion products have been investigated for many years, and it has been established beyond doubt that these metals cause hypersensitivity, dermatitis, etc. Also these metals have also been reported to have a potential carcinogenic and mutagenic effect. In contrast, it was emphasized that nickel containing alloys are superior in hardness and strength and nickel gives an alloy good spring back the property due to its high modulus of elasticity.¹¹ Above all, nickel is highly resistant to tarnish and corrosion.

This study was conducted to compare the galvanic currents generated between different combinations of brackets and archwires commonly used in orthodontic practices and to assess, which metal alloy is more susceptible to galvanic corrosion. The study was conducted in two phases. Phase I comprised of 5 groups for OCP and galvanic current (I) whereas Phase II comprised of 6 groups for galvanic current (I) alone. Phase I groups consisted of 0.019" × 0.025" heat-activated nickel-titanium archwires, 0.019" × 0.025" beta-titanium archwires, 0.019" × 0.025" stainless steel archwires, 0.022" MBT maxillary central incisor laser-cut stainless steel brackets and 0.022" MBT maxillary central incisor metal-injection molded stainless steel brackets, respectively. Phase II groups consisted of combination of the above archwires and brackets. Each group consisted of 10 samples. The samples were immersed in aerated phosphate buffered saline solution of pH = 7.4 at room temperature (23°C ± 1°C). The galvanic current for individual archwires, brackets and the different bracket-archwire-ligature combinations was measured by using a Potentiostat machine. The data were generated using the Linear Sweep Voltammetry and OriginPro 8.5 Graphing and Data Analysis Softwares.



Graph 3: Galvanic current (I) for combinations of materials.

Table 3: Mean (I) recorded in combination of bracket and archwire.

Bracket	Archwire	Mean	SD	SEM	Median	Minimum	Maximum
Laser-cut bracket	Archwire 1	87.00	0.94	0.30	87.00	85.00	89.00
	Archwire 2	14.06	0.10	0.03	14.00	14.00	14.30
	Archwire 3	52.40	2.22	0.70	53.50	48.00	54.00
Metal-injection molded bracket	Archwire 1	537032.60	3.53	1.12	537031.00	537031.00	537042.00
	Archwire 2	490907.80	1.75	0.55	490907.00	490907.00	490912.00
	Archwire 3	512861.20	0.42	0.13	512861.00	512861.00	512862.00

SD: Standard deviation, SEM: Standard error of mean,

Table 4: ANOVA.

Source	df	SS	Mean SS	F	P value
Bracket	1	3955994485475.770	3955994485475.770	1100676522617.480	<0.001*
Archwire	2	5339663742.225	2669831871.113	742827440.902	<0.001*
Bracket×Archwire	2	5306047964.172	2653023982.086	738150981.187	<0.001*
Error	54	194.084	3.594	-	-
Total	59	3966640197376.250	-	-	-

SS: Sum of squares. *Denotes significant difference. Higher mean current (I) was recorded in metal-injection molded bracket compared to laser-cut bracket and the difference between them was found to be statistically significant (P<0.001). Higher mean current (I) was recorded archwire 1 compared to archwire 3 and archwire 2 respectively and the difference between them was found to be statistically significant (P<0.001). The interaction (joint effect) of bracket and archwire on current (I) was found to be statistically significant (P<0.001)

In Phase I, higher mean OCP was recorded in stainless steel archwire followed by beta-titanium archwire, heat-activated nickel titanium archwire, laser-cut bracket, and MIM bracket, respectively. The difference in mean OCP recorded among the groups was found to be statistically significant in phosphate buffered saline solution (Graph 1 and Table 1). Although the wires and brackets had different compositions, this finding might be due to the passivating oxide films that form on stainless steel and titanium.² A study¹² showed that electrolytic or electrochemical corrosion occurs in oral cavity due to the saliva and its pH. A metal in an aqueous solution will be thermodynamically unstable if its tendency to pass from solid state to an ionic state is associated with a decrease in energy. The direction of energy change is influenced by factors such as the metal itself, surface morphology and phase of the metal, galvanic coupling of dissimilar metals, solution composition, pH and temperature. If the metal is unstable, it may corrode, releasing ions into solution. This process will continue until some ions are released. A passivating film may form on the metal surface which prevents its contact with the solution. The surfaces of all the metals react with oxygen to form an oxide layer, which inhibits an attacking substance from reaching the metal surface. Corrosion of metal that is covered by a protective film is dependent upon the properties of the film. Metals and alloys which rely on passivating films for corrosion resistance all share the property that at sufficiently high potentials the passive layer can be broken down and the alloy or the metal will no longer be protected from corrosion. As long as the passivating oxide layer is present the metal is not prone to galvanic corrosion. However, when the breakdown potential of an alloy is reached, the oxide layer dissolves thereby leading to corrosion. Corrosion has been defined as a reaction of a metal with electrolyte resulting in solution equilibrium concentration of metal-bearing ions greater than 10^{-6} M.¹³

The corrosion current for metal-injection molded stainless steel brackets showed significantly higher values than all other materials. The increased corrosion current might be the result of surface roughness of the bracket compared with the smooth surface of the laser-cut bracket and the wires. Irregular surface areas tend to allow the formation of corrosion cells thereby leading to corrosion. This can be related to the earlier study wherein a straight metal was flexed which experienced tensile stress on its convex surface and a compressive stress on its concave surface.¹³ This produced an electrochemical potential difference, which made the convex surface anodic with respect to the rest of the metal. This led to the formation of corrosion pits secondary to tensile rupture of the passive film and accelerated corrosion attack of the convex surface. A similar process can be expected in regions of highly loaded areas. High stress bearing areas in the close vicinity of stress mediators will corrode more when compared to less stress-bearing areas. A study¹⁴ also concluded that individual components of the orthodontic appliances when used in the

oral cavity are mechanically activated which causes movement of teeth. This is a dynamic activity as opposed to the static state in the *in vitro* studies, which increase surface roughness leading to frictional stresses in the brackets and wires resulting in corrosion. E.g., fretting corrosion, which increases the release of constituents from the brackets and wires.

In this study, the data were not normalized for surface area because it was desired to replicate the clinical situation for a single tooth. Hence, brackets with all surfaces exposed except the adhesive base were tested along with the proportionate length of wires. Since all were maxillary central incisor brackets, their surface areas were comparable.

Phase II results suggested that, in the couples formed by the archwires and brackets, the latter had more important contribution to the total galvanic current generated, since there were significant differences between galvanic current among the 2 brackets tested but not among the 3 wires (Graph 3 and Table 3). Galvanic current of the metal-injection molded bracket was significantly higher than that of the laser-cut bracket. The presence of dissimilar metal component compositions in a single bracket would also create a galvanic cell forming on the bracket itself. Further intensification of this effect is probable when coupled to a wire of a different composition. Galvanic corrosion is sensitive to the relative areas of the anode and the cathode. When a small anode and a large cathode are present, it increases the galvanic current at the anode. This scenario is consistent with the increased galvanic current associated with the metal-injection molded bracket.

This study confirmed that metal-injection molded brackets possessed high galvanic current when compared to the laser-cut brackets. These results were not similar to the previous study,⁴ which stated that MIM stainless steel brackets of single composition possess significantly low galvanic current values than the multicomponent, brazed brackets.

Several studies have investigated galvanic corrosion between brackets and wires, but this report substantially differs from those in terms of materials and couples tested and methodology.^{3,6,15} A study¹⁵ evaluated disks of stainless steel and titanium bracket materials coupled to disks of stainless steel, nickel-titanium, beta-titanium, or cobalt-chromium-nickel wire materials. Although the material composition matched that of commercial orthodontic bracket and wire end products, the disks differed in terms of material-processing history (level of cold working, heat treatment, and so on), which has an effect on properties, since residual stresses associated with manufacturing affect corrosion and account for variations between similar materials.

A study⁶ examined only couples between the wing portion of a bracket and a wire, neglecting the influence of the base and the brazing alloy if present, depending on the brackets

method of fabrication. In a clinical situation, the entire bracket, with the exception of the adhesive bonding side of the base, will be exposed as examined in this present study. In terms of methodology, some studies evaluated surface condition and the potential difference between the bracket wing and wire. Although these methods yielded important information, monitoring galvanic current provides more relevance because it quantifies the extent of corrosion and is an indirect measure of elemental release, since the flow of electrons (i.e., current) corresponds to the release of metal into the solution.⁵ Measuring only galvanic current is not always relevant as the identity and quantity of the specific ions released are not known.

The results of most of the studies conducted relate to issues of biocompatibility as a result of ions released from galvanic corrosion. Nickel, in particular, is a cause of concern because of its reported ability to induce allergic contact dermatitis in patients with previous cutaneous piercings or a history of allergy. A major shortcoming of the case studies of allergic reactions to metals is the lack of information about the composition of the dental appliances used in each instance. Other factors that influence the development of hypersensitivity to nickel are mechanical irritation, skin laceration, individual susceptibility, temperature, climate, intensity and duration of exposure. Mechanical irritation and skin laceration promote sensitivity. An increase in temperature causes increased sweating and the chloride ion present in perspiration ionizes the nickel present in the alloys, which causes the formation of nickel salts leading to hypersensitivity reactions.

The results of the present study suggested that, since the laser-cut brackets are nickel-free and are manufactured with 17-4 stainless steel; they have decreased susceptibility to galvanic corrosion. MIM stainless steel brackets might release less nickel than brazed stainless steel brackets. Based on the results of the present study, the galvanic current is greatest when the wire and brackets are first coupled and then decreases over time. The release of the ions is increased shortly after archwire placement.⁸

Many electrolytes have been used in dental-materials corrosion research with limited ability to replicate the characteristics of saliva and other fluids observed in the oral environment. A study⁵ showed that anodic and cathodic rankings of orthodontic alloys might be different in fluoride-containing mouthwashes compared with artificial saliva. Similar conclusions can be expected in other types of artificial saliva and electrolytes. In addition, the results were obtained from *in vitro* conditions. Several factors limit the applicability of *in vitro* results to the clinical realm, including the lack of intraoral flora and plaque, the use of non-agitated storage solutions, and the absence of the simulation of ligation.¹⁶ A study¹⁷ concluded that the MIM bracket showed decreased susceptibility to

corrosion than conventional brackets with copper nickel-titanium wire. Both MIM and conventional bracket showed similar corrosion resistance potential in association with nickel-titanium archwires. Both the brackets were more compatible with copper nickel titanium archwires regarding the decrease in the consequences of galvanic reaction. The energy dispersive spectroscopy showed that the MIM brackets with copper nickel-titanium wires released less metal ions than conventional bracket with copper nickel-titanium wires.

Corrosion of orthodontic wires is crucial for both the orthodontists and the patients. Since corrosion is a multifactorial process, its prevention depends mainly on the quality control by the manufacturer and the proper selection of archwires by the orthodontists. Further studies to measure the extent of nickel and other ions released with these archwire-bracket couples would be beneficial.

Conclusion

It was concluded from the study that the bracket emerged to be the most important factor in determining the current (I). Higher mean current (I) was recorded in metal-injection molded bracket compared to laser-cut technique bracket. Among the three archwires, higher mean current (I) was recorded in heat-activated nickel-titanium followed by stainless-steel and beta-titanium respectively. When comparing the OCP for the individual materials; higher mean OCP was recorded in stainless-steel archwire followed by beta-titanium archwire, heat-activated nickel titanium archwire, laser-cut technique bracket and metal-injection molded bracket respectively. The difference in mean OCP recorded among the groups was found to be statistically significant in aerated phosphate buffered saline solution.

When comparing the galvanic current (I) for individual materials; higher mean current (I) was recorded in metal-injection molded bracket followed by stainless steel archwire, beta-titanium archwire, laser-cut technique bracket and heat-activated nickel titanium archwire respectively. The difference in mean current (I) recorded among the groups was found to be statistically significant. When considering the galvanic current (I) for the individual group of archwire-bracket-ligation combinations, there was significantly higher mean current (I) recorded in metal-injection molded bracket groups followed by laser-cut bracket groups. Since the wires remain for a longer duration in the mouth, they are subjected to electrochemical reactions, mechanical forces of mastication and generalized wear. These cause different types of corrosion. Corrosion of dental materials is a pertinent clinical issue. Orthodontic alloys must have excellent corrosion resistance to the oral environment, which is highly important for biocompatibility as well as for the orthodontic appliance durability. It was also concluded that manufacturing technique might have equal or greater relevance to galvanic corrosion susceptibility along with bracket composition.

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