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Comprehensive assessment of ionic changes in gingival crevicular fluid following the usage of fixed orthodontic appliances: An original research study

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Abstract

Aim of study: To assess the effect of fixed orthodontic appliances usage on the level of nickel and chromium in gingival crevicular fluid.

Materials and methods: For the study, 18 orthodontics patients were screened including 10 females and 8 males. For the purpose of Gingival Crevicular Fluid (GCF) collection, four different regions were arbitrarily chosen for each patient. This was done to omit any bias associated to site of collection of GCF. Finally, the GCF collection was completes using cellulose acetic acid derivation spongy strip with 45-mm micropores. The strips were introduced very softly in the gingival sulcus for 60 seconds.

Statistical Analysis and Results: Statistical analysis was done using statistical software 'Statistical Package for the Social Sciences (SPSS)'. The recorded data was subjected to suitable statistical tests to obtain p values and mean. $P \leq 0.05$ was considered as statistically significant. Statistical analysis & results further revealed that the mean age of the patients was 22.9±6.3 years, ranging from 15-28 years. Authors also noted that there was considerable raise in the mean level of nickel from 1st visit to 3rd visit and from 2nd visit to 3rd visit.

Conclusion: Authors concluded that levels of nickel and chromium in the GCF of studied patients were rising significantly as the duration for treatment progresses.

Keywords: orthodontic appliances, gingival crevicular fluid, orthodontic treatment, chromium, nickel

1. Introduction

As the nickel and chromium might induce hypersensitivity, they are of interest to orthodontists since many decades. Gingival crevicular fluid (GCF) is highly relevant to orthodontic treatments and could reveal systemic changes linked with the inflammatory response induced by orthodontic forces. Consequently, it can also be used to demonstrate metal ion changes. As we all know that in orthodontic management, hypersensitivity reactions often occur because of the content of nickel and chromium in brackets, bands, and stainless steel wire [1, 2]. Alloys in orthodontic metals hold approximately 6-12% nickel and 13-23% chromium. Nickel elements serve to provide superior properties in the bracket for formability, hardness, and heat resistance. Allergic, carcinogenic, mutagenic and cytotoxic processes can affects nickel and to a lesser extent, chromium. Allergic reactions include edema, mouth lining, and anaphylaxis. Fixed orthodontic appliances have numerous crucial components such as orthodontic wire and brackets. The orthodontic bracket function to deliver the required force on the teeth, hence the bracket used should be produced precisely. This preciseness must be in terms of shape, strength, and level of corrosion resistance and biocompatibility. Any material is defined biocompatible only if it does not have a harmful influence on its surrounding biological milieu [3, 4, 5, 6]. The stainless steel currently used in orthodontic Clinics is of type 302 or 304, both of which contain 8–10% nickel. Corrosion of these materials occurs inside the oral cavity due to numerous environmental or oral factors that act on them. These factors include temperature, pH variation, salivary conditions, mechanical loads, microbiological and enzymatic activity, and various food components. Appliances become weak due to the action of all these agents and start releasing Ni, chromium, and so on, into the oral cavity. Important role is played by Ni and chromium which comes under the category of trace elements. It is further thought that corrosion in capable of influencing the physical and chemical properties of stainless steel brackets and arch wires. These processes may also affect the clinical efficacies and physical behaviors of these materials. Few of these includes, increased friction between arch-wire and slot, and release metal or alloy ions, that consequently can end up in staining of enamel and soft tissues, localized pains, hypersensitive reactions in susceptible patient, and finally lead to dental caries.[7] Orthodontic therapy can also influence systemic milieu, which can be monitored by biomarkers in Gingival Crevicular Fluid (GCF). Varying GCF levels are highly concerned with orthodontic treatments and could illustrate systemic changes related with the inflammatory response induced by orthodontic forces. Hence, this study was executed to assess the overall effect of fixed orthodontic appliances on the level of nickel and chromium in gingival crevicular fluid.

Materials and Methods

This study was planned and executed in the Department of Orthodontics of the institute. A total of 18 orthodontics patients were initially screened from the outpatient department. Personal and contact details of patients were recorded and comprehensive local examination was done to out any gross anomaly. All participating patients were informed in detail about the study and informed consents were obtained from all of them. Out of 18 patients, 10 were females and 8 were males. Inclusion criteria for the study included 1) Patient's cooperation to participate 2) age ranging from 15-28 years 3) completely erupted all permanent dentition 4) no known history of systemic disease such as diabetes, leukaemia 5) no gross anomaly related to maxillofacial structure 6) no habit of smoking or chewing tobacco. For the purpose collection of GCF, four sites were arbitrarily selected for each patient to omit any discrepancy related to site of compilation of GCF. Intentionally, the gingiva was not sprayed with water to maintain GCF in milieu. The gingiva on all four surfaces teeth were calmly air dried to clean out salivary residues if any. The area of interest was isolated using cellulose strips. The GCF collection was done using cellulose acetic acid derivation spongy strip with 45-mm micropores. The cellulose acetic acid derivation spongy strips were smoothly positioned in the gingival sulcus for 60 seconds. It was ensured to use only 1 mm of the strip inside the sulcus. Usually this procedure is free of localized bleeding however in case of obvious bleeding, the site was discarded and other site was chosen for examination. Also, in case of any calculus impediment in placing of strip in the gingival sulcus, some other site was arbitrarily selected. In few instances the authors noticed that even after placement of the strip in sulcus for 60 seconds, strip was not wet thoroughly. In all such cases, the strip was discarded and fresh strip was used at fresh arbitrary site. It was further ensured to use only one strip at one site. On completion of one mint in the suclus, the strip was withdrawn out and positioned top covered glass container. Maximum four strips were placed in every glass container. Samples thus obtained were cooled at 1^0C for maximum of 1 week. After that they were sent to laboratory for assessment and evaluation. All gingival sites Examined at first visit, were reexamined again at 2nd and 3rd consecutive visits. Authors have ensured to properly weight the test strips. Weighing procedure was done before and after the examination to determine the weight of the GCF collected. The overall comprehensive evaluation of gingival health as influenced by the positioning of orthodontic appliances was completed using Loe's gingival index. This index categorizes the gingival health into scores. Score 0 is for no inflammation; 1 for mild inflammation, minor discoloration, small edema, nonappearance of ulceration or uninterrupted bleeding; 2 for moderate inflammation and positive bleeding on probing; 3 for severe inflammatory response, ulceration with impulsive bleeding.

Results

Comprehensive statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 21.0 for windows (SPSS Inc., 233 South Wacker Drive, 11th Floor, Chicago, IL) statistical analysis software. Mean and standard deviation were determined for Cr and Ni level in saliva. The resulting data was subjected to suitable statistical tests to obtain p values, mean, standard deviation, chi- square test, standard error and 95% CI. Response evaluation and analysis exhibits some very intricate inferences. These inferences were shown to have clinical explicabilities too. A p-value <0.05 was considered to be statistically significant. The mean age of the patients was 22.9±6.3 years, ranging from 15-28 years. Table1 and Graph 1 illustrates the levels of nickel and chromium in GCF at different visits. Authors have seen significant increase in the mean level of nickel from 1st visit to 3rd visit and from 2nd visit to 3rd visit. Table 2 and Graph 2 shows the gingival health index of patients at successive visits. Authors noticed that on subsequent visits, the number of patients with moderate or severe inflammation increased with simultaneous decrease in patients with normal healthy gingivae or mild inflammation. Authors have noticed that the levels of nickel and chromium in the GCF of patients undergoing fixed orthodontic treatment were seen to increase significantly as the time for treatment progresses. Table 3 shows comparison of difference between groups and basic statistical description with level of significance evaluation using Pearson chi-square test. The p value was not significant.

Table 1: Varying levels of nickel and chromium in GCF at various visits

Variables	Visit number		
	1st visit	2nd visit	3rd visit
Value of Nickel in GCF (µg/g)	5.89±1.87	7.32±2.56	16.38±6.98
Value of Chromium in GCF (µg/g)	2.56±0.82	5.38±1.78	13.7±2.89

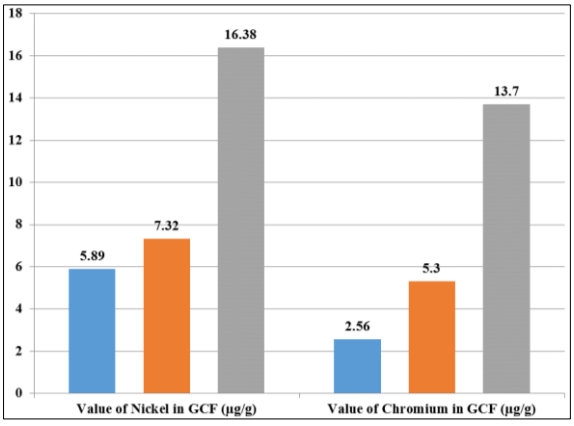

Fig 1: Varying levels of nickel and chromium in GCF at various visits

Table 2: Assessment of gingival health index at various visits

Visit number	No. of patients (n=18)			
	Healthy Gingiva (Control)	Mild inflammation	Moderate inflammation	Severe inflammation
1st visit	10	6	2	0
2nd visit	0	8	9	1
3rd visit	0	5	9	4

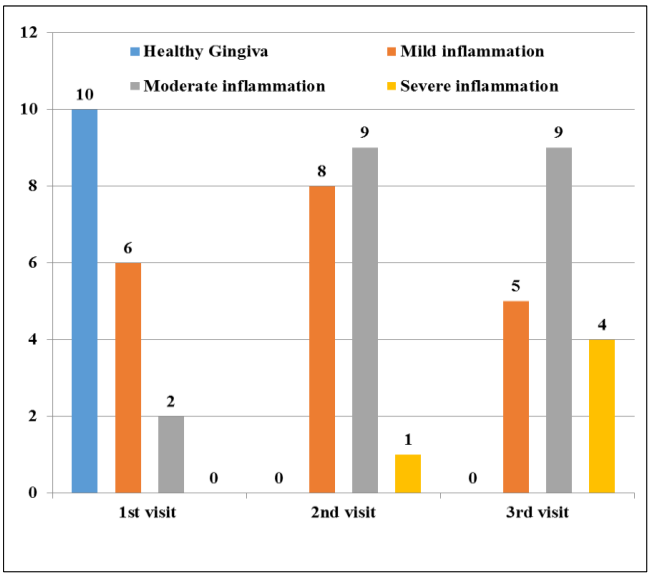

Fig 2: Graphical representation of Gingival Health index at various follow-up visits

Table 3: Comparison of difference between groups and basic statistical description with level of significance evaluation using Pearson chi-square test

Groups	Mean (grams)	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	DF	Level of Significance (p value)
Value of Nickel in GCF	14.76	0.785	0.459	1.96	2.532	1.0	0.20
Value of Chromium in GCF	11.62	1.905	0.798	1.87	2.908	1.0	

Discussion

As we all know that most of the orthodontic alloys have chromium and nickel. All such elements have capability of inducing allergic reactions, asthma, or hypersensitivity. Processes of corrosion of orthodontic alloys can release nickel and chromium ions into salivary flow. As a protective measure, chromium oxide usually creates an anticorrosive passive film over orthodontic appliances [7, 8, 9, 10]. However, in most of the clinical circumstances, such shielding film is disturbed due to chewing, brushing, saliva flow, biofilm microorganisms and their byproducts and enzymatic processes. Other procedures include repair of appliances, friction among brackets and wires, occlusal stresses, acidic drinks, mouthwashes and toothpastes. Literature has well evidenced that intraoral appliances usually experience different pressures, like masticatory stress, orthodontic movement force, changes of temperature, assortments of food, varying saliva pH, fluoride-containing toothpaste and mouthwashes, microbiological and enzymatic environment of the oral cavity [11, 12, 13, 14]. Furthermore, factors also work in the similar way like electrochemical reactions those can result into solubility of chemical compounds. Literature researches have also well demonstrated that orthodontic appliances liberate metallic ions during the release of electro-galvanic currents. In this process, with saliva plays an important role of electrolytic medium for smooth free flow of currant [15, 16, 17, 18]. Corrosion is a deleterious process of metal that usually happen inside oral cavity with umber of Intermingling factors. These factors include temperature, pH variation, salivary conditions, mechanical loads, microbiological and enzymatic activity, and various food components. Gingival crevicular fluid (GCF) is the liquid obtained from the gingival sulcus and could act as a possible source for different biomarkers in the orthodontic setup. This is being possible because inflammatory response is directly related to orthodontic forces in GCF. Not all elements but nickel had particular significance in the recent past. It was studies thoroughly to enlighten its association with different pathological circumstances. Many of the studied have shown confirmed these findings [19, 20]. Therefore, we planned this study to evaluate and estimate the changes occurring in Ni and chromium levels in the GCF during fixed orthodontic patients.

Conclusion

In the present study, the levels of nickel and chromium in the GCF of patients undergoing fixed orthodontic treatment were seen to increase significantly as the time for treatment progresses. Furthermore, it also seems to intensify the gingival inflammation gradually. Future research is required to be conducted using larger sample size and widened study objectives. Our study results must be considered as suggestive for presuming prognosis for similar clinical conditions. However, we expect some other large scale studies to be performed that might further establish certain standard and concrete guidelines in these perspectives.

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