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A Retrospective Assessment of Alterations in Gingival CrevicularFluid (GCF) after applying Fixed Orthodontic Appliances: An Original Research Study

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ABSTRACT

Aim: The sole aim of this study was to retrospectively evaluate alterations in gingival crevicular fluid (GCF) after applying fixed orthodontic appliances.Assessment of changing levels of nickel and chromium was attempted with their clinical correlation.

Materials and Methods: Total twenty patients were selected for the study in which 8 were females and 12 were males. Gingival crevicular fluid collection was attempted at four prefixed sites in all participants. Firstly, gingival crevicular fluid collection was attempted before applying fixed orthodontic appliances. Samples were analyzed as per their collection groups i.e., group two (3 months), group three (5 months), group four (7 months). Standardized Perio Paper was inserted at designated sites for one minute to absorb adequate fluid. All strips were analyzed for levels of nickel and chromiumby spectrophotometer. Mean of all four strips per patient per visit was taken as final and sent for further analysis.

Statistical Analysis & Results: Statistical analysis was performed using Statistical Package for Social Sciences (SPSS). P value <0.05 was considered to be statistically significant. Results clearly show that there was an increasing pattern of nickel and chromium in GCF at consecutive visits. For group I,mean value for Nickel was 2.83 while for Chromium it was1.92. For group II; mean value for Nickel was 9.23 and 6.39 for Chromium in GCF. For group III; mean value for Nickel was 11.80 and 8.62 for Chromium in GCF. Measured p value was significant. For group IV; mean value for Nickel was 12.12 and 10.18 for Chromium in GCF. Measured p value was highly significant.

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Conclusion: Within the limitations of the study, it was concluded that Nickel and Chromium levels in gingival crevicular fluid typically increase after fixed orthodontic appliances. In addition, fixed orthodontic treatment up to seven months can exaggerate the levels of nickel and chromium in the gingival crevicular fluid. Our study outcomes should be considered as suggestive during clinical decision making.

Keywords: Orthodontic Appliances, Gingival Crevicular Fluid, Chromium, Nickel

I. INTRODUCTION

Orthodontic treatment is one of the longest dental treatments that can lasts up to two years. It usually involves younger population suffering from dental malocclusion and other alignment issues.[1] Owing to its longer treatment time, all orthodontic components and appliances experience uninterrupted interaction with saliva and other fluids. Therefore, biocompatibility is deemed necessary among all these objects.[2]Any substance is considered biocompatible if it does not have a harmful influence on its surrounding living environment. Biocompatiblematerials must not be reactive to other substances.[3]Also, the physical behaviors of biocompatible substancemust not be changed when used in mouth. Corrosion is the process of actual surface destruction which is affected by numerous intraoral factors.The corrosion of orthodontic metals is an crucial clinical problem.[4] Metal which is designed to be used intra-orally, should not generate injurious by products. Usually allergic reactions and responses are seen in orthodontic therapy primarily because of nickel and chromium of different orthodontic components. Primary purpose of adding nickel into orthodontic elements is to enhance physical properties like strength and toughness.[5]Several studies have estimates levels of nickel and chromium in the saliva after fixed orthodontic therapy. Additionally, researchers have also explored the composition of salivary nickel and chromium following fixed appliances.[6]Few studies have confirmed that increasing levels of nickel and chromium accelerate inflammation process of gingiva.Literature has shown variousmethods to determine nickel and chromium ion levels in orthodontic patients.[1,4,7]The ultimate aim of this study was to retrospectively evaluate alterations in gingival crevicular fluid (GCF) after applying fixed orthodontic appliances. Assessment of changing levels of nickel and chromium was attempted with their clinical correlation.

II. MATERIALS ANDMETHODS

Twenty young patients who require fixed orthodontic therapy, were included in the study. Out of twenty patients, 8 were females and 12 were males.The objectives of the study were not differentiatedas per patient diagnosis and type of fixed orthodontic appliance.Patients with un-erupted permanent teeth were excluded from the study. Methodology and purpose of the study was explained in detail to all participating patients. Signed informed consent was also obtained from them. Gingival crevicular fluid collection was attempted at four prefixed sites in all participants (figure 1) i.e., centre of buccal surface of right and left maxillary central incisors and inter-dental spaces between maxillary central and lateral incisors (both sides). Initially, gingival crevicular fluid collection was attempted before applying fixed orthodontic appliances (served as control: group one). After applying fixed orthodontic appliances, patients were recalled after 3 months, 5 months and 7 months. Samples were analyzed as per their collection groups i.e., group two (3 months), group three (5 months), group four (7 months). Gingival crevicular fluid collection and assessments were attempted in these follow ups to estimate changing levels of

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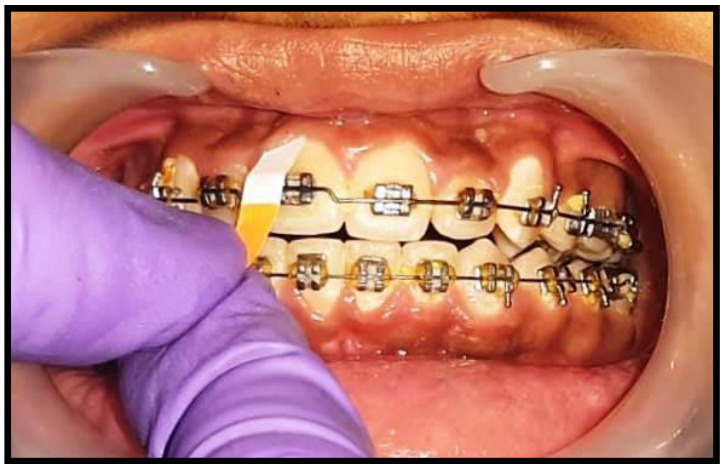
nickel and chromium. On the day of gingival crevicular fluid collection, patients were asked to report in the morning appointment slot with no liquid drinksin breakfast. Patients were also advised to avoid any edible rich in nickel and chromium for one day before the follow up appointment. During collection procedure, any air water spray was avoided and tooth surface was dried smoothly and kept absolutely dry with cotton. Standardized Perio Paper was inserted at designated sites for one minute to absorb adequate fluid. Perio Paper (GCF Collection Strips) is a special paper strips that absorb fluid (Perio Paper; GCF Collection Strips, OraFlow Inc. Smithtown, Hewlett, NY, United States of America). Total four strips were used per patient per visit and stored carefully in glassware at freezing temperature. All strips were analyzed for levels of nickel and chromium (by spectrophotometer services at National Chemical Laboratory [NCL], Pune, India). Mean of all four strips per patient per visit was taken (in µg/gm)as final and sent for further analysis.

Figure 1: Gingival crevicular fluid collection at buccal surface of maxillary central incisors



III. RESULTS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 22.0 for windows (SPSS Inc., Chicago, IL) statistical analysis software. The resulting data was subjected to suitable statistical tests to obtain p values, mean, standard deviation, chi- square test, standard error and 95% CI. Results were very striking with significant clinical explicabilities.P value <0.05 was considered to be statistically significant. Table 1 showed Sample allocation in all four groups. Group one was fixed as control in which samples were obtained before fixation of appliances.Graph1 clearly shows that there was an increasingpattern of nickel and chromium in GCF at consecutive visits [from group I to IV]. Table 2 illustratebasic statistical description with level of significance evaluation using Pearson chi-square test [for group I; Control]. Mean value for Nickel was 2.83 while for Chromium it was1.92. Therefore, it was considered to be at baseline at this stage.Calculated p value was not significant here. Table 3 depicts basic statistical description with level of significance evaluation using Pearson chi-square test [for group II; 3 months]. Mean value for Nickel was 9.23 and 6.39 for Chromium in GCF. Measured p value was not significant here. Table 4 demonstrates essential statistical description with level of significance evaluation using Pearson chi-square test [for group III; 5 months]. Mean value for Nickel was 11.80 and 8.62 for Chromium in GCF. Measured p value was significant (0.02). Table (5) shows basic statistical description with level of significance evaluation using Pearson chi-square test [for group IV; 7

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months]. Mean value for Nickel was 12.12 and 10.18 for Chromium in GCF. Measured p value was very significant (0.01).

Table 1: Sample allocation in groups

Sample allocation in Groups			
1st visit at 3 months	2nd visit at 5 months	3rd visit at 7 months	Control (before fixation)
Group II	Group III	Group IV	Group I

Graph1: Increasing levels of nickel and chromium in GCF at consecutive visits [from group I to IV]

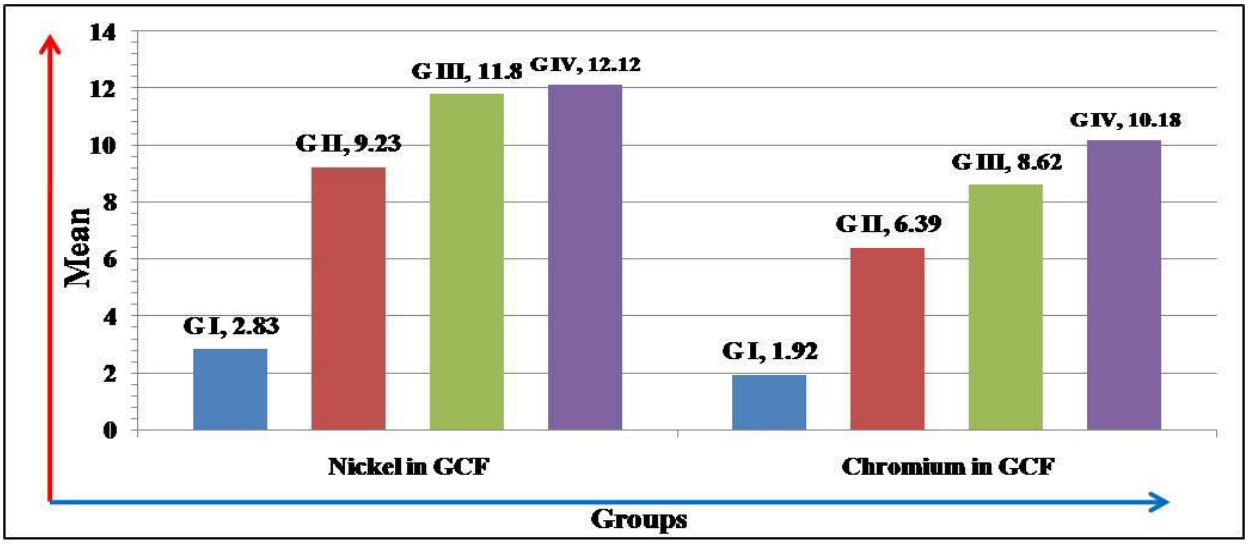

Table 2: Statistical description including mean (µg/gm) andlevel of significance evaluation using Pearson chi-square test [for group I; Control]

Variables	Mean (µg/gm)	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Nickel in GCF	2.83	0.736	0.029	1.34	1.537	1.0	0.50
Chromium in GCF	1.92	1.437	0.530	1.90	1.038	1.0	

Table 3: Statistical description including mean (µg/gm) andlevel of significance evaluation using Pearson chi-square test [for group II; 3 months]

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Variables	Mean (µg/gm)	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Nickel in GCF	9.23	0.736	0.029	1.03	1.837	1.0	0.10
Chromium in GCF	6.39	1.038	0.130	1.96	1.003	1.0	

Table 4: Statistical description including mean (µg/gm) andlevel of significance evaluation using Pearson chi-square test [for group III; 5 months]

Variables	Mean (µg/gm)	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Nickel in GCF	11.80	0.125	0.129	1.96	1.037	1.0	0.02*
Chromium in GCF	8.62	1.043	0.193	1.60	1.433	1.0	

Table 5: Statistical description including mean (µg/gm) andlevel of significance evaluation using Pearson chi-square test [for group IV; 7 months]

Variables	Mean (µg/gm)	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Nickel in GCF	12.12	0.536	0.249	1.16	1.297	1.0	0.01*
Chromium in GCF	10.18	1.107	0.033	1.48	1.403	1.0	

IV. DISCUSSION

In the field of orthodontics, gingival crevicular fluid is one of the most studied topics since it directly affect the long term success of fixed orthodontic therapy. Gingival crevicular fluid has several proteins, ions and minerals including nickel and chromium.[9,10,17] Changing levels of nickel and chromium in gingival crevicular fluid is very crucial and imperative.[12,14,16,18]Heboyan and associates studied microbial compositions ingingival crevicular fluid and reported significant changes in composition following fixed therapy.[1]Nasri and co-workers effects of gingival crevicular fluid on root resorption and associated procedures. They stated that early detection in change in gingival crevicular fluid can help orthodontists in successful orthodontic therapy.[2] Aziz and Singh have recently explored compositions of gingival crevicular fluid samples.[11] Ağaoğlu and colleagues estimated the proportions of nickel and chromium ions in gingival crevicular fluidin patients with fixed orthodontic therapy. Theyconcluded that fixed orthodontic therapy typically discharge considerable amount of nickel and chromium particularly when fixed on dentitions. However, this rise in composition is well below to the toxic levels of nickel and

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chromium ions therefore clinically tolerable.[8]Eliades and Athanasiou studied effects of intraoral corrosion materials on fixed appliances. They stated that increasing concentration of nickel and chromium in salivary flow increases the incidence of corrosion process in fixed appliances. There results were highly comparable to our study since we also noticed somewhat similar patterns of change in compositions.[10]Amini and associates had explored the effect of fixed therapy (orthodontic) on proportions of nickel and chromium in salivary fluids including gingival crevicular fluid. There inferences were highly significant wherein they stated that fixed orthodontic therapy typically increase the levels of nickel and chromium in the gingival crevicular fluid. They added that this potential rise of concentration of nickel and chromium in salivary fluids is directly related to gingival inflammation and related symptoms.[13]Petoumenou and colleagues have studied in detail about composition of nickel in patients with fixed orthodontic appliances of Ni-Cr. They concluded that nickel leaking happens after installation of Ni-Ti based orthodontic components. Therefore, there is clear increase of nickel concentration in such patients.[15] Singh and colleagues had conducted a study to assess whether orthodontic therapy stimulates salivary concentration of nickel and chromium. They found that salivary concentration of nickel and chromium drastically increased after placing fixed orthodontic appliances.[19] Imani and coworkers have endeavored to check the outcome of fixed orthodontic therapy on composition of Nickel and Chromium in gingival crevicular fluid. There results were very significant and comparable with our inferences.[20]

V. CONCLUSION

Within the limitations of the study, it was concluded that Nickel and Chromium levels in Gingival crevicular fluid increases after application of fixed orthodontic appliances. Nickel and Chromium both showed increasing patterns in consecutive follow up periods. Maximum mean level of Nickel and Chromium was noticed in group IV wherein p value was highly significant. It was presumed that if appliance is used for longer time, they usually releases more ions those responsible for corrosion of brackets. Additionally, fixed orthodontic treatment up to seven months can exaggerate the levels of nickel and chromium in the gingival crevicular fluid. Our study outcomes must be treated as suggestive while clinical decision making.

REFERENCES

1. Heboyan A, Manrikyan M, Zafar MS, Rokaya D, Nushikyan R, Vardanyan I, Vardanyan A, Khurshid Z. Bacteriological Evaluation of Gingival Crevicular Fluid in Teeth Restored Using Fixed Dental Prostheses: An In Vivo Study. Int J Mol Sci. 2021;22(11):54-63.
2. MohdNasri FA, ZainalAriffin SH, Karsani SA, Megat Abdul Wahab R. Label-free quantitative proteomic analysis of gingival crevicular fluid to identify potential early markers for root resorption. BMC Oral Health. 2020;20(1):256.
3. Barrett RD, Bishara SE, Quinn JK. Biodegradation of orthodontic appliances. Part I. Biodegradation of nickel and chromium in vitro. Am J OrthodDentofacialOrthop 1993;103(1):8-14.
4. Maijer R, Smith DC. Corrosion of orthodontic bracket bases. Am J Orthod 1982;81(1):43-8.
5. Maijer R, Smith DC. Biodegradation of the orthodontic bracket system. Am J OrthodDentofacialOrthop 1986;90(3):195-8.

ISSN:0975-3583,0976-2833 VOL12,ISSUE04,2021

6. Pender N, Samuels RH, Last KS. The monitoring of orthodontic tooth movement over a 2-year period by analysis of gingival crevicular fluid. Eur J Orthod 1994;16(6):511-20.
7. Löe H. The gingival index, the plaque index and the retentionindex systems. J Periodontol 1967;38(Suppl 6):610-6.
8. Ağaoğlu G, Arun T, Izgi B, Yarat A. Nickel and chromiumlevels in the saliva and serum of patients with fixed orthodonticappliances. Angle Orthod 2001;71(5):375-9.
9. Barceloux DG. Nickel. J ToxicolClinToxicol 1999;37(2):239-58.
10. Eliades T, Athanasiou AE. In vivoaging of orthodontic alloys:implications for corrosion potential, nickel release, and biocompatibility.Angle Orthod 2002;72(3):222-37.
11. Aziz SB, Singh G. Cytokine levels in gingival crevicular fluid samples of patients wearing clear aligners. J Oral BiolCraniofac Res. 2020;10(2):199-202.
12. Eliades T, Zinelis S, Papadopoulos MA, Eliades G, Athanasiou AE.Nickel content of as-received and retrieved NiTi and stainlesssteel arch wires: assessing the nickel release hypothesis. AngleOrthod 2004;74(2):151-4.
13. Amini F, Shariati M, Sobouti F, Rakhshan V. Effects of fixedorthodontic treatment on nickel and chromium levels ingingival crevicular fluid as a novel systemic biomarker of trace elements: a longitudinal study. Am J OrthodDentofacialOrthop 2016;149(5):666-72.
14. Amini F, Mollaei M, Harandi S, Rakhshan V. Effects of fixedorthodontic treatment on hair nickel and chromium levels: a6-month prospective preliminary study. Biol Trace Elem Res2015;164(1):12-7.
15. Petoumenou E, Arndt M, Keilig L, Reimann S, Hoederath H, Eliades T, Jäger A, Bourauel C. Nickel concentration in the saliva of patients with nickel-titanium orthodontic appliances. Am J OrthodDentofacialOrthop. 2009;135(1):59-65.
16. Gujar AN, Baeshen HA, Alhazmi A, Bhandi S, Raj AT, Patil S, Birkhed D. Cytokine levels in gingival crevicular fluid during orthodontic treatment with aligners compared to conventional labial fixed appliances: a 3-week clinical study. ActaOdontol Scand. 2019;77(6):474-481.
17. Amini F, Harandi S, Mollaei M, Rakhshan V. Effects of fixedorthodontic treatment using conventional versus metalinjectionmolding brackets on salivary nickel and chromiumlevels: a double-blind randomized clinical trial. Eur J Orthod2015;37(5):522-30.
18. Tarallo F, Chimenti C, Paiella G, Cordaro M, Tepedino M. Biomarkers in the gingival crevicular fluid used to detect root resorption in patients undergoing orthodontic treatment: A systematic review. OrthodCraniofac Res. 2019;22(4):236-47.
19. Singh DP, Sehgal V, Pradhan KL, Chandna A, Gupta R.Estimation of nickel and chromium in saliva of patientswith fixed orthodontic appliances. World J Orthod 2008;9(3):196-202.
20. Imani MM, Mozaffari HR, Ramezani M, Sadeghi M. Effect of Fixed Orthodontic Treatment on Salivary Nickel and Chromium Levels: A Systematic Review and Meta-Analysis of Observational Studies. Dent J (Basel). 2019;1::21-6.