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Research Article

Salivary Sodium and Potassium Concentrations in Patients with Fixed Orthodontic Appliances

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Abstract

Objectives: This study was aimed to assess salivary sodium and potassium concentrations in patients with fixed orthodontic appliances.

Methods: In this case-control study, saliva samples (5 cc) were collected from 13 patients with fixed orthodontic appliances before, and 1 week, 1 month and 3 months after the beginning of the orthodontic treatment using the spitting method. Saliva samples were also collected from 10 healthy individuals as controls. The saliva samples were centrifuged at 3000 rpm for 10 minutes and the salivary sodium and potassium concentrations were measured by spectrophotometry. Data were analyzed using independent and paired *t*-tests. P-value < 0.05 was considered as significant.

Results: The salivary sodium and potassium concentrations were almost the same in both groups at baseline ($P > 0.05$). A significant reduction in sodium and an increase in potassium levels were noted in the case group at 1 week compared with baseline ($P < 0.001$). At 1 week, the potassium concentration was significantly higher and the sodium concentration was significantly lower in the case group ($P < 0.01$). The salivary sodium significantly increased while the salivary potassium significantly decreased at 1 month compared with 1 week ($P < 0.001$). The differences with the control group were also significant ($P < 0.05$). No significant differences were noted between the two groups at 3 months ($P > 0.05$).

Conclusions: Time has a significant effect on the release profile of sodium and potassium ions from orthodontic appliances. The salivary sodium and potassium concentrations returned to their normal pretreatment values within 3 months after the start of fixed orthodontic treatment.

Keywords: Saliva, Sodium, Potassium, Fixed Orthodontic Treatment

1. Background

Fixed orthodontic treatment can be associated with several complications such as enamel decalcification and development of white spot lesions (1-6). In addition, evidence shows that fixed orthodontic treatment may affect saliva secretion and composition (2-4). Saliva is a complex mixture of water and organic and inorganic compounds. The majority of salivary constituents are produced by the salivary glands and the rest come from the systemic blood circulation (5).

Recently, saliva has been suggested as an important parameter for diagnosis of a number of systemic conditions (7). Saliva is currently used for the assessment of viral infections, alcohol intoxication, hormonal levels and screening for drug abuse. Also, research is ongoing on the use of saliva for cancer screening and detection of other systemic conditions (5). Some studies showed significant changes in the level of electrolytes such calcium, inorganic phosphorus, potassium and magnesium in the saliva of patients undergoing fixed orthodontic treatment (1, 8). It was revealed that salivary proteins probably play a role in the demineralization of tooth structure (9). Proteins bind to calcium and phosphate ions and decrease the deposition of positively and negatively charged ions and electrolytes on tooth surfaces and can play a role in the incidence and extent of dental caries (6). Although the relationship between the potassium in the saliva and dental caries is not established, there are some studies indicating an inverse relation between them (10).

Evidence shows that the saliva volume is affected in the first month after the start of fixed orthodontic treatment. Also, the salivary levels of sodium and chloride particularly increase while the levels of calcium, phosphorous and potassium decrease during this time period. However, these changes return to normal after about 3 months (1).

Evidence shows alterations in the level of salivary electrolytes in the first couple of months after the beginning of fixed orthodontic treatment, mainly due to the presence of orthodontic appliances (1). The literature shows a modification in several electrolyte rates, probably associated with a disturbance in the ionic balance on tooth surfaces leading to WSLs in patients undergoing orthodontic treatment. This treatment can also affect salivary electrolytes by inducing gingival inflammation and affecting the existing lesions; as previous studies have confirmed an increase in some electrolyte concentrations in severe periodontal disease (11).

2. Objectives

Considering that there is limited information regarding the salivary level of cations after the beginning of fixed orthodontic treatment, the current study aimed to assess the salivary sodium and potassium concentrations in patients with fixed orthodontic appliances.

3. Methods

This study evaluated 13 patients with metal fixed orthodontic appliances presenting to the Orthodontic Department of School of Dentistry, Qazvin University of Medical Sciences. The sample size was calculated to be 13 assuming alpha = 0.05, d = 1 and power of 80%. Thirteen patients were thoroughly informed about the study and willingly signed informed consent forms prior to participation in the study. The participants were all females aged between 15 - 30. In addition, 10 healthy female controls were selected using convenience sampling.

The exclusion criteria included systemic diseases affecting the saliva volume (such as diabetes mellitus), intake of medications affecting the saliva volume, smoking, pregnancy, and oral ulceration.

After patient selection, saliva samples were collected prior to the start of orthodontic treatment and 1 week, 1 month and 3 months after the beginning of the treatment; 5 cc of saliva was collected using the spitting method from each participant. Samples were collected between 9 a.m. to 12 p.m. from all patients. The patients were requested to refrain from eating and drinking, or mechanical stimulation such as toothbrushing for 90 minutes prior to the saliva sampling. The collected saliva samples were immediately transferred to a laboratory and stored at -20°C. Next, the saliva samples collected in sterile Falcon tubes were transferred to test tubes and centrifuged at 3000 rpm for 10 minutes. Afterwards, 1 cc of the clear acellular supernatant (liquid without cells floating on the surface) was transferred into another tube and frozen at -20°C. The samples were analyzed regarding the concentration of sodium and potassium ions all at the same time. A spectrophotometer (Easy Late, Medica Co., USA) was used for this purpose and the values were reported in micrograms per liter.

Data were analyzed using the SPSS software. Normal distribution of data was evaluated using the Kolmogorov-Smirnov test. The salivary sodium and potassium concentrations in the four time points were analyzed using independent and paired *t*-tests at $P < 0.05$ level of significance.

4. Results

Table 1 shows the salivary sodium and potassium concentrations in the patient and control groups at different times. The difference in the salivary sodium and potassium concentrations in the patient and control groups was not significant at baseline ($P > 0.05$).

4.1. At 1 Week

The values indicated a significant reduction in salivary sodium concentration in the patient group compared with the baseline value (paired *t*-test, ($P < 0.001$). In contrast, a significant increase in salivary potassium concentration in the patient group was noted compared with the baseline value (paired *t*-test, ($P < 0.001$). The change in salivary sodium and potassium concentrations was not significant at 1 week compared with baseline in the control group. Comparison of patient and control groups at 1 week revealed that the salivary potassium concentration in the patient group was significantly higher than that of the control group ($P < 0.01$); while the salivary sodium concentration in the patient group was significantly lower than that of the control group ($P < 0.01$).

4.2. At 1 Month

Paired *t*-test revealed significant differences in salivary sodium ($P < 0.001$) and potassium ($P < 0.001$) concentrations between the patient and control groups. The differences between the salivary sodium ($P < 0.001$) and potassium ($P < 0.001$) concentrations at 1 week and 1 month were also significant. In other words, the salivary sodium concentration in the patient group was significantly lower than that of the control group. However, the salivary sodium concentration in the patient group experienced a

Table 1. Salivary Sodium and Potassium Concentrations in the Patient (N = 13) and Control (N = 10) Groups at Baseline and After 1 Week, 1 Month and 3 Months

Ion	Time, Mean ± SD			
	0	1 Week	1 Month	3 Months
Na^+ Micrograms per liter				
Patient	24.78 ± 1.57	8.94 ± 1.21	14.48 ± 1.41	124.42 ± 1.66
Control	24.62 ± 1.93	23.83 ± 1.95	22.67 ± 1.62	24.08 ± 1.46
K^+ Micrograms per liter				
Patient	9.22 ± 0.74	18.64 ± 1.04	14.76 ± 1.35	9.77 ± 0.68
Control	9.65 ± 1.46	8.96 ± 0.62	9.16 ± 1.26	9.25 ±0.97

significant increase compared with the value at 1 week. The salivary potassium concentration in the patient group was significantly higher than that of the control group. Nevertheless, the increase in salivary potassium concentration at 1 month had a slower gradient than at 1 week. The salivary sodium concentration at 1 month had significantly increased compared to the value at 1 week, while the salivary potassium concentration at 1 month significantly decreased compared with the value at 1 week ($P < 0.001$).

4.3. At 3 Months

Paired *t*-test revealed no significant differences in salivary sodium ($P = 0.103$) or potassium concentrations in the patient group compared with the control group ($P = 0.088$). Nonetheless, significant differences were noted in salivary sodium concentrations in the patient group at 3 months compared with the value at 1 week ($P < 0.001$), and also salivary potassium concentration in the patient group at 3 months compared with the value at 1 week ($P < 0.001$). In other words, the salivary sodium concentration at 3 months after the start of the orthodontic treatment increased compared to the value at 1 month. In addition, the salivary potassium concentration at 3 months after the beginning of orthodontic treatment decreased compared to the value at 1 month. The results showed that the salivary sodium and potassium concentrations at 3 months in the patient group approximated the normal values in the control group.

5. Discussion

This study aimed to assess the salivary sodium and potassium concentrations in patients with fixed orthodontic appliances. The salivary sodium and potassium concentrations were almost the same in both groups at baseline ($P > 0.05$). A significant reduction in sodium and an increase in potassium were noted in the patient group at 1 week compared with baseline ($P < 0.001$). At 1 week, the potassium concentration was significantly higher and the sodium concentration was significantly lower in the patient group ($P < 0.01$). The salivary sodium significantly increased while the salivary potassium significantly decreased at 1 month compared with 1 week ($P < 0.001$). The differences with the control group were also significant ($P < 0.05$). No significant differences were noted between the two groups at 3 months ($P > 0.05$). However, the changes compared with baseline were significant ($P < 0.001$).

Kuhta et al. (12) assessed the effect of the type of wire and bracket, and the degree of acidity of the environment on the release profile of metal ions from orthodontic appliances. They showed a significant change in salivary levels of titanium, chromium, nickel, iron, zinc and copper at 1 week after the beginning of the orthodontic treatment, which was in line with our findings; although the ions evaluated in their study were different from those evaluated in our study (12). Petoumenou et al. (13) reported a significant increase in salivary concentrations of potassium after orthodontic treatment and its subsequent reduction within 10 weeks after the start of the treatment. Their results regarding significant changes in salivary concentrations of sodium and potassium in short-term and return of these ions to their baseline concentration in long-term were in agreement with our findings (14-17). Li et al. (1), analyzed the unstimulated saliva of orthodontic patients before treatment and at 1, 3 and 6 months after the beginning of the treatment using the spitting method. They reported a significant increase in concentrations of Cl and Na during the first month while the concentration of K, P and Ca had decreased. The salivary concentration of all ions returned to normal at 3 and 6 months. Their results were in agreement with our findings (1). Moghadam et al measured the serum level of electrolytes such as Cr, Cu, Fe, Mn, Ni, and Zn in the patients undergoing fixed orthodontic treatment and showed a significant increase in the concentration levels of all metal ions except Cr in the serum of the group treated with fixed orthodontic appliances (18).

Dallel et al. (11) attempted to evaluate the effect of orthodontic appliances on enzymes, electrolytes, and oxidative stress markers changes in salivary parameters at baseline, 1 month, and 9 months after the beginning of the treatment. In this cohort study, 112 healthy patients were chosen and their salivary samples were taken at three time points. The results of this study showed salivary parameters of patients using aligners were less effected (11).

Our results were also in line with some other studies that reported the significant effect of time on the release profile of ions from orthodontic brackets and wires (15, 19, 20).

5.1. Conclusions

Time has a significant effect on the release profile of sodium and potassium ions from orthodontic appliances into the saliva. The salivary sodium and potassium concentrations return to their normal pretreatment levels within around 3 months after the beginning of fixed orthodontic treatment.

Footnotes

Authors' Contribution: ME supervised the project and got the main idea. BMZ performed the project and reviewed the literature and interpreted the data. SA consulted in orthodontics part and reviewed and corrected the manuscript. FH consulted in Ion measurements and interpreted the data. MV prepared the manuscript and searched the literature.

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