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MICROBIOLOGIC EVALUATION OF 2 METHODS OF ARCHWIRE LIGATION

МИКРОБИОЛОШКА ЕВАЛУАЦИЈА НА 2 МЕТОДА НА ЛИГИРАЊЕ НА ОРТОДОНТСКИТЕ БРЕКЕТИ

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Abstract

Aim: The aim of this study was to determine the changes in microbial flora after orthodontic bonding and whether two different archwire ligation techniques affect these changes. **Material and method:** twenty-four orthodontic patients undergoing treatment with fixed appliances took part in the present study. Each orthodontic arch was fixed with elastomeric rings on one side of the midline, and on the other side with steel ligatures. The BANA test was used to detect Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola from the bottom of the periodontal pockets of the maxillary premolars and the mandibular incisors on both sides of the jaws. Microbial records were collected before bonding (T1), one week later (T2), and three months after the bonding (T3). ANOVA Chi Sqr test and Cochran Q test were used to statistically compare the groups. **Results:** Teeth ligated with elastomeric rings contained greater numbers of microorganisms one week and three months after the bonding than teeth ligated with steel ligature wires. A significant difference in the values of BANA test was also determined between all three examined periods in the teeth ligated with elastomeric rings, while an insignificant difference in relation to T1, T2, and T3 was observed in the teeth ligated with wire ligatures. **Conclusion:** The method of archwire ligation has a significant impact on the microbiological flora of patients with fixed orthodontic appliances. Elastomeric rings stimulate the growth of periodontopathogenic bacteria which is a predisposing factor for the occurrence of caries and inflammation of the gingiva. **Key words:** archwire ligation, microbial flora, elastomeric rings, periodontopathogens, fixed orthodontic appliances.

Апстракт

Цел: Цел на оваа студија беше да се утврдат промените во микробиолошката флора кај пациенти со фиксни ортодонтски апарати, како и да се утврди влијанието на различниот метод на лигирање на брекетите врз овие промени. **Материјал и метод:** Испитувањата беа спроведени кај дваесет и четири пациенти со фиксни ортодонтски апарати. Кај сите испитаници, на едната половина од вилицата брекетети беа лигирани со еластични лигатури, а на другата половина со жичени лигатури. За детекција на Porphyromonas gingivalis, Tannerella forsythia and Treponema denticola од дното на пародонталниот џеб во предел на максиларните премолари и мандибуларните инцизиви, од двете страни на вилиците, беше применет BANA тестот. Микробиолошките наоди беа одредувани пред започнувањето на ортодонтската терапија (T1), една недела по поставувањето на фиксниот апарат (T2) и три месеци по поставувањето (T3). Разликите меѓу групите беа анализирани со ANOVA Chi Sqr тестот и Cochran Q тестот. **Резултати:** Резултатите покажаа сигнификантно зголемување на бројот на микроорганизми една недела и три месеци по поставувањето на фиксниот апарат кај забите лигирани со еластични лигатури, во споредба со забите лигирани со жичени лигатури. Статистички сигнификантна разлика во вредностите на BANA тестот беше утврдена и меѓу сите три испитувани периоди кај забите лигирани со еластични лигатури, додека незначајна разлика во релација T1, T2 и T3 беше забележана кај забите лигирани со жичени лигатури. **Заклучок:** Методот на лигирање на ортодонтските брекети има значајно влијание врз микробиолошката флора кај пациентите со фиксни апарати. Еластичните лигатури го стимулираат растот на пародонтопатогените бактерии кои се предиспонирачки фактор за појава на кариес и инфламација на гингивата. **Клучни зборови:** метод на лигирање на брекетите, микробиолошка флора, еластични лигатури, пародонтопатогени бактерии, фиксни ортодонтски апарати.

Introduction

During orthodontic therapy with fixed appliances, the risk of periodontal inflammatory lesions and enamel demineralization increases as a result of the reduction of physiological self-cleaning mechanisms and increased retention of plaque on the surface of the component elements of the fixed appliances. These elements as plaque retention sites lead to bacterial colonization and an increased number of microorganisms[1,2].

Orthodontic therapy followed by poor oral hygiene can cause severe damage to the periodontium[3-5]. Several clinical and microbiological studies have shown that in the absence of good oral hygiene, the placement of orthodontic bands in children results in periodontal pocket formation. In addition, there is a quantitative

increase in the microbial composition of subgingival plaque formation, which resembles the plaque typically found in periodontal disease where Tannarella forsythia, Porphyromonas gingivalis, and Treponema denticola are present[6-12].

Several authors have investigated the impact of fixed orthodontic appliances on the microbiological flora and periodontal status[5,13-17]. Their findings showed that therapy with fixed appliances increases the values of all periodontal indices and stimulates the growth of periodontopathogenic bacteria. However, despite causing periodontal changes, it has no destructive effects on the deeper periodontal tissues.

Although several studies have examined the influence of fixed orthodontic therapy on the microbial colonization of the periodontium and the condition of the periodontal tissues, few authors have examined the method of ligation of brackets as an additional factor influencing the occurrence of these changes[1,2,18,19]. Most of these authors agree on the harmful influence of elastomeric rings in the accumulation of dental plaque and periodontal changes in patients with fixed orthodontic appliances.

The aim of this study was to determine the changes in microbial flora after orthodontic bonding and to determine whether two different archwire ligation techniques affect these changes.

Materials and method

The study population was comprised of twenty-four healthy patients, aged 13 to 18 years, who were patients at the Department of Orthodontics, PHO University Dental Clinical Centre "St.Pantelejmon"- Skopje. All patients included in this study had healthy periodontium and no previous orthodontic treatment with fixed appliances. Subjects who had taken antibiotics within three months before the study and those with a systemic disorder were excluded. The study was approved by the Teaching and Science Research Council of Ss. Cyril and Methodius University - Skopje.

All subjects had fixed orthodontic appliances, which include Master Series® metal brackets, LP® metal tubes, wires, and ligatures from American Orthodontics, USA. Brackets on the right side of the patient were ligated with elastomeric rings, and brackets on the left side were ligated with conventional stainless steel ligature wires. To determine the microbial complexes, the BANA test (BANA-Zymetm - Hexagon International (GB) Ltd) was used in all subjects at the Department of Oral and Periodontal Diseases, and the microbial swab was taken from the bottom of the periodontal pocket of the maxillary premolars and the mandibular incisors on both sides of the jaws. The presence of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola was determined. To collect the swab, a graduated periodontal probe and a Gracy curette were used to penetrate the deepest part of the subgingival space to take a sufficient amount of material for examination of the microbial complexes. Microbial records were collected before bonding (T1), one week later (T2), and three months after the bonding (T3).

Statistical analysis was conducted using the computer program Statistica 7.1 for Windows and SPSS 23.0. The presence of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola in the relations T1, T2, and T3 were analyzed using the Cochran Q test (Q/p). An analysis of variance (ANOVA) Chi Sqr and McNemar's test (p) were used to compare the presence of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola in relation to T1 and T3.

Results

The differences between the values of the Bana test between the examined teeth on both sides of the jaws before starting the orthodontic therapy, one week and three months after the placement of the fixed appliances are shown in table 1-5.

The results showed a significant increase in values ($p<0.001$) one week and three months after the place-

Table 1. BANA test differences between elastomeric rings and wire ligatures.

Variable	Rank Sum Elastomeric	Rank Sum Wire	U	Z adjusted	p-level	N Elastomeric	N Wire
Bana test T1	612,00	564,00	264,00	0,70	0,48	24	24
Bana test T2	764,50	411,50	111,50	4,18	**0,000**	24	24
Bana test T3	843,50	332,50	32,50	5,64	**0,000**	24	24

Table 2. BANA test differences in elastomeric rings in relation T1 & T2 & T3.

Variable	Average Rank	Sum of Ranks	Mean	Std.Dev.
Bana test T1	1.21	29.00	0.25	0.44
Bana test T2	2.15	51.50	1.04	0.36
Bana test T3	2.65	63.50	1.46	0.51

ANOVA Chi Sqr. = 35,57 and p<0,001

Table 3. BANA test differences in elastomeric rings between T1 & T2 & T3.

Pair of variables	Valid	T	Z	p-level
Bana test T1 & Bana test T2	24	0.00	3.62	**0.000**
Bana test T2 & Bana test T3	24	0.00	2.80	**0.005**
Bana test T1 & Bana test T3	24	0.00	4.01	**0.000**

Table 4. BANA test differences in wire ligatures in relation T1 & T2 & T3.

Variable	Average Rank	Sum of Ranks	Mean	Std.Dev.
Bana test T1	1.90	45.50	0.17	0.38
Bana test T2	2.15	51.50	0.38	0.58
Bana test T3	1.96	47.00	0.21	0.41

ANOVA Chi Sqr. = 2,17 and p>0,05

Table 5. test differences in wire ligatures between T1 & T2 & T3.

Pair of variables	Valid	T	Z	p-level
Bana test T1 & Bana test T2	24	15.00	1.27	0.20
Bana test T2 & Bana test T3	24	7.00	1.18	0.24
Bana test T1 & Bana test T3	24	12.00	0.34	0.74

ment of fixed appliances in teeth ligated with elastomeric rings compared to values in wire ligatures (Table 1).

A statistically significant difference in the values of the BANA test was also determined between all three examined periods in the teeth ligated with elastomeric rings (Table 2).

Seven days after the placement of elastomeric rings (T2), the value of the BANA test for Z = 3.62 and p<0.001 is significantly higher than the value of the BANA test before orthodontic therapy (T1), and three months after the placement (T3) the value of the BANA test for Z = 2.80 and p<0.01 is significantly higher than the value of the BANA test seven days after the placement of these ligatures (T2) (Table 3).

An insignificant difference in the values of this test was observed in the teeth ligated with wire ligatures in relation T1, T2, and T3 (Table 4).

Seven days after the placement of the wire ligatures (T2), the BANA test value for Z = 1.27 and p>0.05 is insignificantly higher than the value of the BANA test before orthodontic therapy (T1), while three months after the placement (T3) the value of the BANA test for Z = 1.18 and p>0.05 is insignificantly lower than the value of the BANA test seven days after the placement of these ligatures (T2) (Table 5).

Discussion

The analysis of the effect of different types of ligatures on the amount of periodontopathogenic bacteria from the red microbial complex revealed that the type of ligatures has a significant impact on the microbial colonization of the periodontium.

The results showed a progressive increase in the values of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola seven days and three months after the placement of the appliance on the side of the jaw where elastomeric rings were placed. On the side where the teeth were ligated with wire ligatures, an insignificant increase in values was observed seven days after the placement and an insignificant decrease in the same three months after the application of the fixed appliance. This finding is consistent with the results of several studies[1,18-23]. Souza et al. revealed a significant increase in gram-species with the use of elastomeric rings[19].

The degree of bacterial colonization associated with orthodontic appliances is affected by the energy and roughness of the appliance surfaces, as well as their design and dimensions[24]. This appears to be a key factor in the efficient performance of hygiene procedures[25]. Even though changes in the microbial system involve all types of orthodontic appliance, more rapid modifications occur during fixed orthodontic treatment. Perinetti et al. stated

that the role of subgingival bacteria in periodontal disease modifications need to be evaluated alongside the action of enzymes activated in response to the stimuli of orthodontic forces[26].

Fixed orthodontic appliances significantly increase the colonization of Streptococcus mutans and Lactobacilli[1-3,16] Periodontal pathogenic bacteria such as Actinobacillus actinomycetemcomitans and Tannerella forsythia are also significantly associated with gingival inflammation during orthodontic therapy[3,27]. Among the various types of bacteria found in individuals with periodontal disease are Porphyromonas gingivalis, Prevotella intermedia, P nigrescens, Bacteroides forsythus, A actinomycetemcomitans, Fusobacterium nucleatum and Treponema denticola[11]. The chemical and physical characteristics of these bacteria make them the most important members of the periodontopathogenic microbial flora[28]. However, not all patients with periodontal disease harbor all putative periodontal pathogenic species[8]. Porphyromonas gingivalis and Provotella intermedia are frequently found in prepubescent patients with periodontitis[29]. Lyons et al.[30] consider that irreversible damage to the host tissue occurs only when the level of bacteria reaches a critical level.

The analysis of the differences in the number of microorganisms from the red complex between the examined teeth ligated with elastomeric rings and wire ligatures indicated a significant level of values in T2 and T3 on the side of elastomeric rings, which is in agreement with the findings of Forsberg et al., Sukontapatipark et al., and Souza et al.[1,18,19] An increased number of microorganisms on the side of the elastomeric rings was also found by Türkkahraman et al.[2], but unlike previous authors, this difference was not statistically significant.

The differences in microbiological findings found in the literature are likely due to differences in the microorganisms analyzed, the type of microbial test, the period of evaluation, and host resistance factors[19]. The time necessary for gingival inflammation to develop when oral hygiene is poor varies from person to person and depends on the rate of biofilm formation. The results obtained within this research showed a strong correlation between elastomeric rings and the quantity of periodontopathogenic bacteria in patients with fixed orthodontic appliances. In patients with inadequate oral hygiene, elastomeric rings significantly increase the microbial accumulation on the surface of the teeth around the braces, which is a predisposing factor for the development of caries and inflammation of the gingiva. Therefore, the obtained results indicate the importance of the ligation of orthodontic brackets with wire ligatures as one of the necessary conditions for the preservation of periodontal health in patients undergoing fixed orthodontic therapy.

Conclusion

The archwire ligation technique has a significant impact on the microbiological flora in patients with fixed orthodontic appliances. The values of Porphyromonas gingivalis, Tannerella forsythia, and Treponema denticola progressively increased seven days and three months after the placement of the appliance on the jaw side with elastomeric rings. On the side of the jaw with wire ligatures, the amount of periodontopathogenic bacteria of the red complex insignificantly increased seven days after the placement and an insignificantly decreased three months after orthodontic treatment. The analysis of the differences in the number of microorganisms from the red complex between the examined teeth ligated with elastomeric rings and wire ligatures indicated significantly higher values in the T2 and T3 periods on the side of the jaw where elastic ligatures were placed.

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