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Selected aspects of the oral environment in cleft palate patients – a problem evidently beyond dentists' scope

Wybrane aspekty środowiska jamy ustnej pacjentów z rozszczepem podniebienia – problem ewidentnie nie tylko stomatologiczny

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Summary

Introduction: The oral cavity is a specialized ecosystem composed of dentition and mucosa exposed to the effects of saliva and gingival liquid. Its structure provides advantageous conditions for various microorganisms, both aerobic streptococci and anaerobic bacilli. The dynamic balance of the oral cavity ecosystem can be threatened by various factors. Lip and palatal clefts are the most frequent disorders in embryonic facial development. The aim of the study was to evaluate whether *Streptococcus mutans* and *Lactobacillus acidophilus* and oral cavity hygiene in patients with cleft palate treated orthodontically are significantly different compared with patients without these congenital malformations.

Material/Methods: The study group consisted of 200 patients aged 6–21 who were divided into two groups depending on the presence of cleft palate and treatment method. Group C (control) consisted of 50 orthodontically untreated patients with occlusal dental defects. The performed studies consisted of 2 parts: the clinical-laboratory part and statistical analysis.

Clinical-laboratory part

Results: High bacteria levels of *Streptococcus mutans* and *Lactobacillus acidophilus* in saliva of patients were comparably frequent between groups, but there were statistically significant differences in inter-group comparisons.

Conclusions: As the orthodontic treatment changes the oral environment, control of proper hygienic behavior is an essential element of health education. Introduction of preventive programs is also very important.

Key words: **PI index • GI index • cleft palate • cleft lip**

Streszczenie

Wstęp: Jama ustna człowieka jest wyspecjalizowanym ekosystemem złożonym z uzębienia oraz błony śluzowej, poddawanych działaniu śliny i płynu dziąsłowego. Budowa tych struktur stwarza korzystne warunki do osiedlania się różnych rodzajów drobnoustrojów zarówno tlenowych paciorkowców jak i beztlenowych pałeczek. Dynamiczna równowaga ekosystemu jamy ustnej może być zagrożona różnymi czynnikami. Przykładem mogą być rozszczepy wargi i podniebienia – naj-

częstsze zaburzenia w rozwoju embriologicznym twarzy. Celem pracy było ustalenie czy poziomy bakterii *Streptococcus mutans* i *Lactobacillus acidophilus* oraz higiena jamy ustnej pacjentów z rozszczepem podniebienia leczonych ortodontycznie są istotnie różne niż w przypadku pacjentów bez tej wady rozwojowej.

Materiał/Metody: Do badań wybrano 250 pacjentów w wieku 6–21 roku życia, których podzielono na grupy w zależności od występowania rozszczepu podniebienia i techniki leczenia. Grupę C (kontrolną) stanowiło 50 pacjentów z zaburzeniami zgryzowo-zębowymi nieleczonymi ortodontycznie. Przeprowadzone badania składały się z części kliniczno-laboratoryjnej i analizy statystycznej.

Wyniki: Wewnątrzgrupowo duże stężenia bakterii *Streptococcus mutans* i *Lactobacilus acidophilus* w ślinie badanych występowały porównywalnie często, natomiast istotne statystycznie różnice dotyczyły porównań międzygrupowych.

Wnioski: Ponieważ leczenie ortodontyczne zmienia środowisko jamy ustnej, kontrola nawyków higienicznych jest podstawowym elementem w edukacji zdrowotnej. Niezwykle ważne jest też wprowadzanie programów prewencyjnych.

Słowa kluczowe: **wskaźnik PI • wskaźnik GI • rozszczep wargi • rozszczep podniebienia**

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Introduction

The oral cavity is a specialized ecosystem composed of dentition and mucosa exposed to the effects of saliva and gingival liquid. Its structure provides advantageous conditions for various microorganisms, both aerobic streptococci existing in natural dentition grooves, and anaerobic bacilli. Present knowledge about methods of intraoral microflora colonization in humans is rather limited. However, it is known that a few days after birth in the infant's oral cavity Streptococcus salivarius appears while *Streptococcus sanguis* correlates with the eruption of primary dentition. Their hard, non-scaling surfaces are conducive to colonization of *Streptococcus mutans*, which plays a significant role in caries initiation. *Streptococcus mutans* colonizes the human oral cavity at the age of 7 to 24 months, i.e. during the eruption and presence of deciduous dentition (first infection period), and at the age from 6 to 12 years, i.e. during the period of eruption and presence of permanent dentition (second infection period). Thus a time of the child's life stands out when a child is less subject to colonization of the oral cavity by *Streptococcus mutans*, that is between eruption of the last deciduous tooth and the first permanent tooth. Transverse and review studies prove that mothers – *Streptococcus mutans* carriers – play a significant role in transferring these bacteria to the oral cavity of offspring and in caries development [1]. The main sites of colonization are the grooves and depressions of masticatory surfaces, seldom the facet [23]. Other places of microorganisms' location in the oral cavity are contiguous surfaces and buccal/lingual surfaces of dental crowns, gingival clefts and the papilliform lingual surface.

In the oral cavity ecosystem, when functioning properly, pathogens are weakened by bacteriostatic and bactericidal properties of salivary gland secretions. Saliva not only plays a mechanical role in microorganism removal but also it fights them actively with defensive factors (specific and non-specific) such as: leucocytes, lysozyme, peroxidase and y-globulin. Saliva buffer (phosphate, carbonate and albumin) neutralizes acid products of bacterial metabolism, which allows the proper pH to be maintained for non-pathogenic, permanent microflora of the oral cavity. Local lowering of pH is a factor conducive to acid precipitation of saliva protein and organic stroma for bacterial plate formation. There are two types of saliva flow: highway and byway. The first type concerns fast, abundant saliva flow through the lingual surfaces of the lower molars. The second type involves slow, scant saliva flow through the labial surfaces of the upper incisors. Slow saliva flow is conducive to localization of dental plaque, and increased – in inflammatory gingival state – secretion rich with limestone ion of gingival pouch liquid can cause dental deposits, forming another layer of organic matrix for future bacterial colonization. Accumulation of polysaccharide – both bacterial (dextran) and nutritive (saccharose) – causes increased concentration of microorganisms: *Streptococcus mutans* (Sm) and *Lactobacillus acidophilus* (Lb) with their proteolytic enzyme. Concretion is a source and place of varied biochemical processes whose products – with diminished saliva secretion and a change of its natural composition or with supply of saccharic substratum [8,16,17] – induce caries and periodontal disease which retard the digestive system effect.

Knowledge of the presented physiological mechanisms, both bacterial colonization and immunological ones, allowed the

Table 1. Group comparison of study material

Group	Subgroup	Defect description	Appliance	Number (n)
A	A_1	Palatal cleft, malocclusion	Fixed	50
	A_2	Palatal cleft, malocclusion	Removable	50
B	B_1	Occlusal disturbance	Fixed	50
	B_2	Malocclusion	Removable	50
C (control)		Malocclusion	----------	50

creation of effective prophylactic methods for systemic diseases – contemporary rules of oral cavity hygiene. However, the dynamic balance of the oral cavity ecosystem can be threatened by various factors which most often act synergically. Lip and palatal clefts are the most frequent disorders in embryonic facial development which arise in the first trimester, once in every 600–800 neonates. Disconnection of tissue continuity in alveolar and palatal clefts not only retards suction, swallowing and breathing function but also allows pathological migration of bacterial colonies between the oral and the nasal cavity. The risk to oral cavity microflora balance is intensified by the necessity of occlusal disturbance treatment in patients with cleft palate because better developed appliances give more room for bacterial plate retention and block main saliva flow [15]. Alarming data from the literature show the scale of risk, with retention of bacterial plaque in more than 50% of patients with cleft palates regardless of monthly tooth brushing training and detailed hygienic recommendations [2,3,18,19].

A particularly important question arises at the present time of contamination and environmental disturbances: whether microbiology and thus ecosystem physiology of the oral cavity changes in the case of anatomical disorders accompanying cleft palate? It can be a serious medical problem: the development risk of alimentary canal disorders resulting in caries and periodontosis with an unknown pathomechanism.

The aim of the study was to evaluate whether caries initiating bacteria (*Streptococcus mutans*) and caries developing ones (*Lactobacillus acidophilus*) as well as the oral cavity hygiene in patients with cleft palate treated orthodontically are significantly different compared with patients without such congenital malformations.

Material and Methods

Study material

The study group comprised 200 patients aged 6–21 years chosen consecutively, based on the type of orthodontic approach (fixed or removable appliances) and cleft palate presence. Additionally, the control group C (50 individuals) consisted of untreated patients with malocclusion and no cleft palate (Tab. 1).

Study methodology

The performed studies consisted of 2 parts: the clinical-laboratory part and statistical analysis.

Clinical-laboratory part

During the clinical phase, apart from case history taking and diagnosis, stating cleft extension on the basis of the topographic classification by Bardach and the anatomical one by Kernahan and Stark, and malocclusion, in artificial lighting, with the use of a mirror and calibrated probe, the dental plaque level was studied. The indirect and direct study included teeth surfaces being in contact with elements of the appliance: brackets, arch wires, retainers, coil-spring, acrylic plate. Oral hygiene state was described by an indirect method with the plaque index (PlI) according to Löe and Silness [14] and by a direct method using the gingival index (GI) according to Silness and Löe [21]. The plaque index was used to estimate the layer thickness of dental plaque on selected dental surfaces. Evaluation criteria were as follows: 0. lack of plate; 1. thin layer of plate adjacent to gingival margin and cervical zone but invisible to the naked eye; 2. moderate plaque deposits on gingival edge and on tooth surface and gingival pouch visible to the naked eye; 3. abundant plaque deposits in a pocket and/or on gingival edge and tooth surface.

Qualitative changes of gingival state were assessed on a 4-grade scale, the gingival index (GI): 0. healthy gingiva, rose colored; 1. mild inflammation, slight change in gingival color, lack of bleeding on probing; 2. moderate inflammation: redness, swelling, gloss and gingival overgrowth, bleeding with pressure or on probing; 3. severe inflammation: considerable redness and gingival swelling, ulceration, tendency to independent bleeding. Common level values for both indices were stated: low – not exceeding 1, average – more than 1 and not exceeding 2, and high – more than 2.

In order to evaluate halitosis – unpleasant odor of the oral cavity made by bacteria metabolizing volatile sulfur compounds – deposits from the dorsum of the tongue were taken with layer and were evaluated using a value scale as follows: 0. lack of odor, 2. mild odor (imperceptible from a distance of 3 cm), 3. strong odor (perceptible from a distance of 3 cm).

After performing clinical and survey studies, from patients with the highest and the lowest plaque index values, saliva specimens were collected in order to determine the presence of *Streptococcus mutans* (Sm) and *Lactobacillus acidophilus* (Lb). In total, saliva of 100 patients was taken. Saliva samples were taken after paraffin-stimulating salivation had been administered. Material from the oral cavity was taken with a pipette on a selected basis in special test-

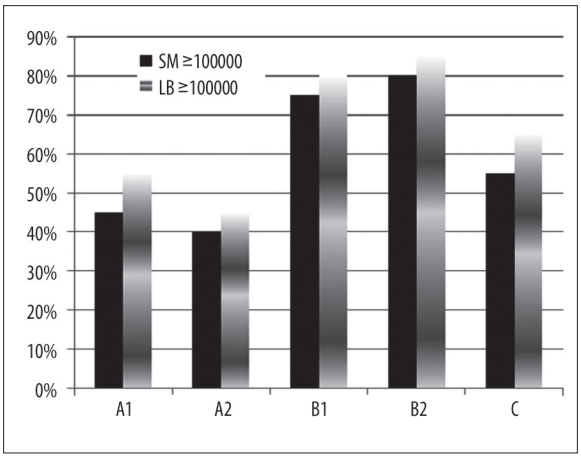

Fig. 1. High levels of carious bacteria Sm and Lb percentage distribution in study material *p<0.05

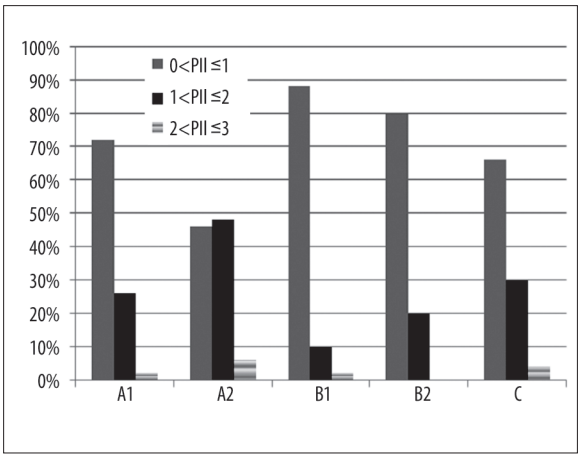

Fig. 2. Percentage distribution of index value ranges of PII in study material * p<0.05

tubes (CRT-bacteria test, Vivadent company) which were placed in a container with NaHCO3 and then transferred to an incubator. After 48 hours of growth at a temperature of 370C, colony-forming units (CFU) of bacteria Sm and Lb were observed and the company pattern attached to a test was used for visual assessment of bacterial growth. The level of Sm and Lb in stimulated saliva was evaluated as high in the case of CFU/ml $\geq 10^5$ or low when CFU/ml $<10^5$.

Statistical analysis

Test of significance and correlation coefficient were used to study the dependences of variables in analysis, appropriately to the applied measurement scale. In the case of study variables measured on nominal scales – *Streptococcus mutans* and *Lactobacillus acidophilus* – Pearson's chi-squared independence test was applied. To study the distribution of continuous variables (PII and GI) the Kolmogorov-Smirnov test was used. In the case of compound force between ordinal quality and continuous with asymmetrical distributions Spearman's rank correlation coefficient was used and significance was assessed with Student's t-test.

Data were analyzed with the program SPSS for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA) and Statistica v. 8.0 (StatSoft Inc, Tulsa, OK, USA). Significance level was established at p<0.05.

Results

High bacteria levels of *Streptococcus mutans* and *Lactobacillus acidophilus* in saliva of patients were comparably frequent between groups, but statistically significant differences (p<0.05) were observed in intergroup comparisons: A_1 and B_1 and A_2 and B_2 (Fig. 1). In patients without cleft palate a higher percentage of high Sm and Lb bacteria levels was noted than in the control group. High levels of Sm and Lb concerned respectively 75% and 80% of subgroup B_1 and 80% and 85% of subgroup B_2. Different results were obtained in patients with cleft palate (group A). High levels of Sm and Lb were observed respectively in 40% and 45% in subgroup A1 and 45% and 55% in subgroup A_2. In group A percentages of high levels of Sm and Lb were lower than in the control group.

The distribution of index value PII in patients with cleft palate was different than in patients without a developmental anomaly (Fig. 2), and the observed intergroup difference was statistically significant, which was confirmed with the Kruskal-Wallis ANOVA by ranks. A low value range for PII was noted in 59% of group A and 84% of group B. High values of PII were observed in 54% of subgroup A_2 (patients with cleft using removable appliances). In this subgroup 6% of patients had a plaque index with the maximum value. Simultaneously, in every patient from subgroup A_2 there was no PII=0. In subgroup A_1 the maximum value of index PII was 2.07 and the percentage of patients with a medium or high value of PII was 28%. In the subgroup without cleft but treated with fixed appliances (subgroup B_1) the value of the PII index was the highest (PII=3) in 2% of patients but a low range of value of PII was observed in 88% of cases. The highest value of PII in the subgroup of patients without cleft treated with removable appliances (subgroup B_2) was 1.88; at the same time in 80% of cases the value did not exceed 1.

A statistically significant correlation of high PII values with growth of *Streptococcus mutans* and *Lactobacillus acidophilus* bacteria colonization was observed.

GI values and halitosis did not differentiate patients statistically significantly (p>0.05). A low value range of GI and halitosis value equal to 0 was found respectively in 94% and 99% of patients.

Discussion

The performed studies allowed us to assess oral cavity hygiene in patients during orthodontic treatment. Poor hygienic state in the oral cavity was found.

Caries danger with regard to bacteria number (CFU $\geq 10^6$) was quite high and it concerned 59% of patients with reference to Sm and 66% with reference to Lb. According to the literature, Sm levels were higher in studies performed in Łódź, Poznań and Szczecin. Lisiecka et al. stated on the basis of studies on 12-year-old teenagers that Sm increase was accompanied by Lb increase in saliva, which was confirmed in this study only in one group of patients without

cleft. It was found that Lb colony numbers were much higher in this study as well as in studies from Szczecin than in other reports: Lb occurred in 2.4% of children's saliva from Łódź [10,11,13]. A considerably lower percentage of patients with high levels of pathogenic bacteria was observed in Warsaw. In these studies there was a high titer of Sm bacteria in 16.8% [7]. Proportional distribution of high Sm levels observed in patients without cleft treated with fixed appliances compared with the control group, and Sm colony number increase with age and eruption, were consistent with reports from foreign papers [1,4]. Rosenbloom and Tinanoff [20] reported that increased Sm level during orthodontic treatment could be a causative factor of macula cariosa, which is quite often observed during treatment. The most important aspect of their work was to reveal a fourfold reduction of Sm level after finishing orthodontic treatment and during long-term observations. Using appliances can only temporarily disturb the oral cavity environment state [12].

Evaluation of oral hygiene state in patients treated orthodontically consisted of proportional distribution assessment of the PlI index value, which was higher in patients with cleft than in patients without this defect. Dental plaque quantity was in accordance with previous reports from the Lower Silesia region. 84% of patients were without cleft but with a PlI index value from 0 to 1; thus their number was almost 50% higher than in the group with cleft, although the percentage of patients with PlI=0 was similar in both groups (in group A – 14%, in group B – 16%). Patients with cleft using removable unimaxillary appliances (subgroup A_2) showed bigger problems with effective dental plaque elimination, which was proved by the high percentage of subgroup A_2 (54%) with PlI index values over 1 and the biggest in the whole study material, and the percentage (6%) with PlI=3. It corresponded with the results of the study conducted for 10 years in the Medical Academy in Wrocław [2,6]. Kościukiewicz-Michewicz et al. [9] mentioned that these results may be a consequence of appliance plate construction in which the appliance's acrylic shaft is thickened with a plastic mass penetrating the cleft slot. A much better hygiene state shown by the PlI index was observed in patients of group A, treated with fixed appliances. In this case, the percentage of patients with PlI>1 decreased almost twofold compared with subgroup A_2 and it was 28%.

This can be explained by the greater risk awareness with fixed appliances and more careful elimination of risk factors for development of caries or paradontosis.

Higher PlI values in the group of patients without cleft treated with removable appliances may indicate higher susceptibility of appliance material to dental plaque deposition. The presented results confirm another working hypothesis and support the conclusion that hygiene teaching with subsequent monitoring should be an integral element of the proper orthodontic treatment process [5]. This mainly concerns patients with cleft, using removable appliances (PlI=3 in 6% of subgroup A_2), but it cannot be omitted in any case, because both groups were not free from dental plaque.

The observed lack of gingivitis symptoms concomitant with high values of PlI may show accidental dental plaque accumulation. Studies confirmed earlier reports concerning significantly less gingival reactivity in children [8,22]. This fact results from the different bacterial flora composition compared with adults, lack of some components necessary for bacteria existence, and less reactivity of parodontium blood vessels.

A fundamental issue is oral cavity hygiene maintenance in patients with cleft while malocclusion correction is performed. After a long orthodontic treatment and several procedures a patient is convinced that the therapy is becoming out of control. Therefore if appliance wearing is not preceded with oral cavity hygiene teaching and parodontium recovery, this false idea will be preserved in a patient's mind. Effective help in the quality of oral cavity hygiene improvement requires time, patience and tolerance. The lip after corrective surgery can be thinner, which hampers proper toothbrush application to the anterior and lateral teeth, and a thin alveolar process can be revealed as a shallow vestibule in the cleft region. When recommending a new toothbrush we should take these circumstances into consideration and if necessary we should recommend to children a toothbrush with a short head. It is difficult to offer the whole range of instruments without taking into account individual needs, which is emphasized by Benington et al. [3].

Conclusions

The presented research clearly proves that the levels of caries initiating bacteria (*Streptococcus mutans*) and developing ones (*Lactobacillus acidophilus*), as well as oral hygiene level, differ in patients with and without cleft palate. The latter, despite evidently worse PlI, display significantly lower carious bacteria level. Considering that orthodontic treatment additionally changes the oral environment, meticulous supervision of caries development and its overall consequences may be challenging, especially in individuals with cleft palate. Therefore, since caries is a problem evidently beyond dentists' scope, proper oral hygiene seems to be an essential element of pro-health education, definitely requiring the introduction of programs of general disease prevention.

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