

# Periodontal condition and periodontal risk assessment in adult patients with cystic fibrosis

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## Abstract

**Introduction.** The presence of chronic inflammation in the mouth, such as infectious disease of the periodontal tissues, may be the reservoir of microorganisms that are not usually present, including *Pseudomonas aeruginosa*.

**Objective.** The purpose of the study was to create a profile of periodontal conditions and periodontal risk assessment in adult patients with cystic fibrosis.

**Materials and method.** The study involved 22 patients with cystic fibrosis (CF) aged 29.43 years. The following parameters were included in the clinical study: number and cause of permanent teeth loss (excluding third molars), the presence of plaque (PCR), bleeding on probing (BOP), probing pocket depth (PPD), clinical attachment level (CAL). On the basis of obtained clinical data, the periodontal status and the periodontal risk were determined.

**Results.** The study showed healthy periodontal tissues in 9 people (41%), gingivitis in 5 (23%), and mild periodontitis in 8 (36.36%). The periodontal risk in the vast majority of patients (90.91%) was at a low level – only 2 people, on average.

**Conclusions.** The poor oral hygiene in CF patients indicates the need to develop standards of dental care for this group aimed at education and elimination of risk factors for oral diseases. The obtained results of clinical trials do not rule out the likelihood of auto-infections of the respiratory system originating from periodontal tissues, which, in CF patients, may adversely affect the general state of health and conducted therapy.

## Key words

cystic fibrosis, periodontal diseases, periodontal condition, periodontal risk assessment

## INTRODUCTION

The oral cavity is colonized by about 700 microorganisms and can be a potential reservoir for various medically important pathogenic bacteria, especially in individuals with poor oral hygiene or periodontal diseases. The role of oral condition and oral microbiota in infection of the respiratory track seems to be ignored in medical care. The presence of chronic inflammation in the mouth, such as infectious disease of the periodontal tissues, may be the reservoir of microorganisms that are not usually present, including *Pseudomonas aeruginosa* [1, 2].

Periodontal disease is a multifactorial infectious chronic disease. It is the second leading cause of tooth loss, immediately after dental caries [3]. According to the World Health Organization (WHO), the most common form of periodontal disease is dental plaque biofilm-induced gingivitis, but more advanced periodontitis affects 10–15% of the adult population [3, 4, 5, 6]. Clinical manifestation of periodontal disease is very much diversified. The mildest form, associated mainly with ineffective removal of oral pathogens during daily oral hygiene, is gingivitis, manifested by gingival bleeding on probing [5, 6]. However, it is often the first symptom indicating the likelihood of more advanced forms [3]. Untreated inflammation may spread to the supporting tissues of the tooth – alveolar bone and periodontal ligament [5, 6], leading to changing of the connective tissue levels and

formation of periodontal pockets, bone loss and subsequent loss of the tooth [6, 7, 8]. In addition to local factors, in the pathogenesis of periodontal disease, systemic factors should also be considered [4, 9, 10].

The primary pathogens, the presences of which are responsible for gingival inflammation, are virulent plaque bacteria. But an important role in the progression of periodontal disease play also the sensitivity of the host and risk factors, which can modify the body's defence mechanisms and significantly determine the severity and clinical signs of the disease [7]. The periodontitis risk group includes patients with immunodeficiency and chronic systemic diseases. However, the presence of chronic oral inflammation, such as periodontitis, may have a negative impact on underlying systemic diseases or therapy [1, 2, 9, 10, 11]. Gram-negative microorganisms of periodontal infection, such as *Porphyromonas gingivalis*, *Tannerella forsythia*, *Aggregatibacter actinomycetemcomitans*, and *Prevotella intermedia* can contribute significantly to the course of the systemic disease and affect distant organs of the body [8, 9, 10, 11]. Periodontal disease may be associated with such systemic diseases as cardiovascular disease, premature low-birth-weight babies, respiratory diseases, and chronic kidney diseases [1, 2, 7, 8, 9, 10].

Due to the shortened life expectancy of CF patients in the past, oral health was not a high priority health problem. Nowadays, the development of diagnostics and effective therapies contributes to the increasing comfort and life expectancy of this group of patients, which means that periodontal prevention should be considered as an integral part of comprehensive infection prophylaxis plan in CF

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patients. The few previous reports of periodontal status in cystic fibrosis (CF) patients concerned mainly children and adolescents [12, 13, 14, 15, 16, 17, 18].

## OBJECTIVE

The aim of the study was to create a profile of periodontal conditions and periodontal risk assessment in adult patients with cystic fibrosis.

## MATERIALS AND METHOD

The study involved 22 patients with cystic fibrosis, treated in the Department of Pulmonology, Allergy and Respiratory Oncology of the University of Medical Sciences in Poznań, Poland. The ethical principles expressed in the World Medical Association Declaration of Helsinki were adhered to in this study. The study was approved by the Ethical Committee of the Poznań University of Medical Sciences (No. 427/16). The study was undertaken in both male or female patients, aged  $\geq 18$  years, with the confirmed diagnosis of cystic fibrosis, at least 10 natural teeth in the mouth, and after the aim of the study and its procedure was explained to them, gave informed consent to participate. Exclusion criteria included: pregnancy, diabetes or other systemic condition that could affect the periodontal condition, any acute infection, including acute upper or lower respiratory infections and pulmonary exacerbations.

Dental clinical examinations were carried out by 2 professionals in the same room under artificial light, using a dental mirror, dental probe, and the WHO 621 periodontal ballpoint probe, according to the recommendation for oral epidemiological surveys by the World Health Organization [19]. Before the study, investigators were calibrated. Calibration was performed by the clinical examination of people who were not included in the study. The kappa value was 0.85, thus representing a satisfactory level of concordance. The obtained data were recorded on specially designed charts.

In the patient's medical history the habit of cigarette smoking was taken into account. The following clinical parameters were included in the clinical study: the number and cause of permanent teeth loss (excluding 3<sup>rd</sup> molars), the presence of dental plaque (PCR index), bleeding on probing (BOP index), probing pocket depth (PPD index), clinical attachment level (CAL index).

For the presence of plaque, the O'Leary et al., Plaque Control Record (PCR) (1972) [20] was used. The presence (+) or absence (-) of supragingival dental plaque on all 4 surfaces of all teeth, except 3<sup>rd</sup> molars, was recorded as recommended by the index. Modified PCR (without the use of a disclosing agent) was applied to determine tooth surface covered with plaque. Plaque incidence in the oral cavity was expressed as an exact percentage. A score under 10% was considered as good oral hygiene [20]. Due to the lack of standards for the PCR index, the criteria of the API index were adopted, which differs from the one used in the study in that it includes only one tooth surface: a score  $>70\%$  =, 70–40% = average, 39–25% = rather good and  $<25\%$  = optimum oral hygiene.

Bleeding was assessed using the Ainamo et al. Bleeding on Probing (BOP) index (1975) [21]. The index was determined through gentle probing of the orifice of the gingival crevice

of all 4 surfaces of all teeth, except 3<sup>rd</sup> molars. If bleeding occurred within 10 seconds, a positive finding was recorded. The number of positive sites was recorded and then expressed as a percentage of the number of sites examined. Values below 10% mean low, more than 25% high, and between 10% and 25% average risk index [22].

The depth of the gingival sulcus/pocket, which is the distance the gingival margin to the bottom of the gingival sulcus/pocket was measured using the Probing Pocket Depth index (PPD). The connective tissue levels, which is the distance from cemento-enamel junction to the bottom of probeable gingival/periodontal pocket was established using the Clinical Attachment Level index (CAL). Periodontal probe WHO 621 was used for the measurements. These parameters were evaluated for all teeth, except 3<sup>rd</sup> molar teeth, examined in 6 sites (distofacial, facial, mesiofacial, distolingual, lingual and mesiolingual).

Next, according to the criteria of a new classification scheme for periodontal and peri-implant diseases and conditions reported by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP) (2017) [6], on the base of the results of clinical dental examination, the periodontal status was determined, i.e., the presence or absence of gingivitis or periodontitis, and the severity of periodontal diseases (initial, moderate, severe). The assessment tool for modified periodontal risk was used, developed by Lang and Tonetti (2003) [22], and the individual risk of periodontitis determined.

Statistical analysis was carried out using Statistica v. 10. The results of the statistical analysis were assumed to be significant for the level of  $p < 0.05$ . For all parameters, compliance of the data with the normal distribution was checked using the Shapiro-Wilk test. Spearman's rank correlations were used to show the correlation between received values of the indices.

## RESULTS

None of the examined CF patients smoked cigarettes. They also did not report any symptoms of periodontitis. Table 1 present periodontal clinical parameters of examined patients. Over 77% of the 2,220 assessed tooth surfaces were covered with bacterial plaque. In 15 subjects (68%), its presence was found on more than 70% of the surfaces; the oral hygiene condition was therefore defined as poor. In 5 CF patients (23%), bacterial plaque covered 40–70% of the tooth surfaces: oral hygiene – average. The study did not report any patient with a percentage of plaque-covered surfaces less than 10%,

**Table 1.** Periodontal clinical parameters

GENDER	AGE	PT	PTE	PCR%	BOP%	PPD	CAL
FEMALE	27.00 ±6.01	25.64 ±3.48	2.57 ±4.07	69.94 ±26.43	7.04 ±10.16	1.10 ±0.25	0.11 ±0.12
MALE	33.38 ±6.37	25.25 ±3.92	2.75 ±3.92	89.81 ±11.56	12.40 ±7.77	1.2 6±0.26	0.38 ±0.38
TOTAL	29.43 ±6.78	25.50 ±3.56	2.64 ±3.92	77.17 ±23.93	8.99 ±9.54	1.16 ±0.26	0.21 ±0.27

PT – number of present teeth; PTE – number of extracted teeth; PCR – Plaque Control Record by O'Leary et al. (1972); BOP – Bleeding on Probing by Ainamo & Bay (1975); PPD – Probing Pocket Depth; CAL, Clinical Attachment Level

which means there were no patients showing good oral hygiene.

Gingival bleeding was reported in only 9% of the 2,220 assessed gingival units corresponding to the surfaces of the teeth examined for the presence of bacterial plaque. In 13 patients (59%), the percentage of bleeding on probing was less than 10%, with no bleeding on probing (BOP=0) in 7 subjects (32%). Statistical analysis showed a very high correlation between the PCR and BOP indices ( $p < 0.0001$ ). There was no patient with gingival pockets exceeding the depth of 4mm and in 14 patients (64%) CAL=0. In every third patient (8 people), pocket depths were 3–4mm, while in the others they were <3mm. Statistical analysis showed a relationship between the values of PCR and PPD indices and between BOP and PPD ( $p < 0.0001$ ) (Tab. 2).

**Table 2.** Evaluation of periodontal status and periodontal risk.

		RISK		
		LOW	MODERATE	TOTAL
PERIODONTAL STATUS	PERIODONTAL HEALTH AND GINGIVAL HEALTH	9 (40.91%)	-	9 (40.91%)
	GINGIVITIS	4 (18.18%)	1 (4.55%)	5 (22.73%)
	INITIAL PERIODONTITIS	7 (31.82%)	1 (4.55%)	8 (36.36%)
	TOTAL	20 (90.91%)	2 (9.09%)	22 (100%)

No periodontal disease was recorded in 9 people (41%), 5 (23%) had gingivitis, and 8 (36.36%) initial periodontitis. There was no patient with a more severe form of periodontitis than initial. Analysis of individual periodontal risk showed that in the vast majority of patients (90.91%) it was at a low level, and only in 2 people – at a moderate level. Statistical analysis did not show a significant relationship between the current periodontal status and the periodontal risk.

In all patients whose tooth surfaces were covered by the bacterial plaque, in 70% periodontal disease was not observed (Tab. 3). However, among the 15 subjects whose tooth surface was 70% covered with bacterial plaque, periodontal health, and gingival health was found in only 2 patients. Statistical analysis showed statistically significant differences in the percentage of tooth surfaces covered with plaque (value of PCR index) between a healthy periodontium and gingivitis ( $p = 0.0009$ ), as well as between a healthy periodontium and initial periodontitis ( $p = 0.003$ ), which confirms the etiological significance of the bacterial component of this disease.

**Table 3.** Periodontal status of patients with regard to oral hygiene (PCR index values)

	TOTAL N (%)	PERIODONTAL STATUS		
		PERIODONTAL HEALTH AND GINGIVAL HEALTH	GINGIVITIS	INITIAL PERIODONTITIS
PCR* ≤70%	7 (31.81%)	7 (100%)	-	-
PCR* >70%	15 (68.18%)	2 (13.33%)	5 (33.33%)	8 (53.33%)

PCR – Plaque Control Record by O'Leary et al. (1972)

## DISCUSSION

Periodontal disease is an infectious disease of the tissues surrounding the tooth. According to the new classification

scheme for periodontal and peri-implant diseases and conditions reported by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP) (2017) [6], gingivitis is diagnosed when bleeding occurs on probing (BOP)  $\geq 10\%$  and the depth of gingival sulcus/pockets is  $\leq 3\text{mm}$ . The presence of  $>3\text{mm}$  pockets, probing attachment loss and the presence of bleeding on probing  $\geq 10\%$ , is the basis for diagnosing periodontitis. Its severity is determined by the depth of the pockets and loss of attachment [5, 6]. A clinical feature of gingivitis is gingival bleeding, which is associated primarily with the presence of microorganisms of bacterial dental plaque. More than 68% of the examined CF patients had poor oral hygiene, 23% – average, while periodontal health and gingival health were observed in 41% of the subjects. It was also shown that gingivitis or initial periodontitis occur only in patients with  $>70\%$  of the tooth surfaces covered with bacterial plaque, which confirms the infectious effect of the bacterial plaque on periodontal tissues.

Current scientific reports lack emphasis on the issue of periodontal diseases in adult cystic fibrosis patients [12, 13, 14, 15, 16, 17, 18]. The available literature concern mainly only children and adolescents. Only in the studies by Martens et al. [13], Aps et al. [16] and Dąbrowska et al. [18] both adolescents and adults were included. The study by Martens et al. [13] was undertaken in 37 patients, aged 6–19 (mean 16.3 years old), by Aps et al. [16] 20 patients – 9–34-years-old, and by Dąbrowska et al. [18] 10 patients aged 13–24. However, in some of them, there are no data on how many adult patients were included in the study. To the best knowledge of the authors of the current study, this is the first report of periodontal status in adult patients with cystic fibrosis, and included only patients aged 20–43 years.

To estimate individual risk of periodontitis, it is necessary to analyze various risk factors and risk indicators. Non-modifiable factors include, among others, age, gender and genetic factors. Modifiable factors are oral hygiene, systemic diseases, medications used, cigarette smoking, and stress as well as socio-economic status. Hygiene, and thus the control of bacterial plaque carried out through well-conducted hygienic procedures, is fundamental to good oral health and prevention of periodontal disease. The multifactorial analysis allows assessment of the individualized risk of periodontitis, and forming a periodontal disease prevention programme consisting mainly of eliminating or modifying the risk factors [22, 23].

To evaluate CF patients, a modified model of the Periodontal Risk Assessment (PRA) [22, 23] was used which is based on the results of the oral clinical examination, such as the number of teeth present, BOP, PPD and CAL indices, and the presence of a systemic disease. In this study, the risk assessment did not include evaluation of the alveolar bone as there were no clinical indications for X-ray imaging. None of the patients reported having diabetes, and none smoked cigarettes.

One of the periodontal risk factors is the number of missing teeth. Tooth lost reduces masticatory function and chewing ability, and may lead to temporomandibular joint dysfunctions and overloading of the remaining teeth [22, 23]. According to the PRA model, a loss of more than 8 teeth indicates a high-risk factor for periodontal diseases, between 5 and 8 – moderate, and less than 5 – low. Thus, the low periodontal risk is evidenced by the presence of at least 20



functional teeth, medium risk of 15–19, and high risk of  $\leq 14$  [22, 23]. In the majority of patients with cystic fibrosis, the number of teeth present was  $\geq 20$ ; therefore, this parameter was at a low level in the majority of patients.

Another risk factor analyzed in the PRA was gingival bleeding. It is assumed that the value of the BOP bleeding index below 10% indicates low, above 25% high, and between 10%–25%, medium risk of periodontal disease [22, 23]. In more than half of the patients studied, this risk index was defined as low and in every third respondent as medium. Only in one examined patient, the BOP index was 35%; therefore, in the individual analysis of the risk of periodontal disease, this factor was defined as high.

The indices used in the study concerning the formation and distribution of bacterial deposits on the tooth surface do not provide information about the periodontal status, but only allow conclusions to be drawn about the effectiveness of daily oral hygiene procedures performed by the patient. However, the individually differentiated response to inflammatory stimuli, such as plaque microorganisms, can be analyzed using the bleeding index. In the examined patients, a statistical relationship between the index describing the spread of plaque and the bleeding index, undoubtedly confirms the infectious etiology of periodontal disease. Previous studies [12, 13, 14, 15, 16, 17, 18] show that CF patients had significantly less gingival bleeding and similar amounts of dental plaque and dental calculus, in comparison with healthy people. This can be mainly explained by frequent and long-term antibiotic therapy (also via inhalations) in these patients [14, 16, 17]. However, the risk of inflammatory changes in periodontal tissues cannot be ruled out due to the high percentage of teeth covered by dental bacterial plaque.

Despite the widespread presence of bacterial dental deposits in CF patients, potential factors of gingivitis and periodontitis, dental examination did not show acute inflammation of the gingiva. On the one hand, this may be associated with the relatively young age of the examined patients, and therefore a quite short-term impact of causative factors, and on the other hand, with long-term pharmacotherapy, which may inhibit bacterial growth thereby preventing the inflammation of periodontal tissues.

The presented study included cystic fibrosis patients in whom the exclusion of systemic drugs, both antibiotics and immunostimulants, made application impossible. Medicines used by patients, also via inhalation, may influence the clinic parameter. The periodontal risk assessment model allows predicting periodontitis progression and individualized dental care for a particular CF patient [22, 23]. Unfortunately, despite frequent and long-term hospitalizations, which should promote an increase in the hygiene regimen, the oral hygiene of the patients was poor. It should be stressed that a large accumulation of dental bacterial deposits is not only a precursor of gingivitis and periodontitis leading to tooth loss, but may have a potentially negative impact on general health and the course of the patient's underlying condition [1, 2, 9, 10, 11]. It should be assumed that in CF patients, microorganisms of key importance for periodontal disease may be a source of a respiratory auto-infection. But there is a need to confirm the possibility of auto-infection by periopathogens in this group of patients. Unfortunately, studies carried out in many countries regarding knowledge of periodontal disease etiological factors, have shown that these factors are less well-known than those of dental caries

[4]. Therefore, it is necessary to educate and provide complex dental care to patients, especially those whose underlying disease may be adversely affected by microorganisms of periodontal infection.

## CONCLUSIONS

The poor oral hygiene in CF patients indicates the need to develop standards of dental care for this group, aimed at the education and elimination of risk factors for oral diseases. The obtained results of clinical trials do not rule out the likelihood of auto-infections of the respiratory system originating from periodontal tissues which, in CF patients, may adversely affect the general state of health and conducted therapy.

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## Conflict of Interests

The authors declare that they have no conflict of interests regarding the publication of this paper.

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