EVALUATION OF METABOLIC BIOCHEMICAL TESTS, BODY MASS INDEX VALUES AND PERIODONTAL / PERI-IMPLANT CLINICAL PARAMETERS OF PATIENTS REHABILITATED WITH PROSTHETIC DENTAL IMPLANTS OF AT LEAST 1 YEAR

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Abstract

The aim of this study was to evaluate the possible correlations between the results of metabolic biochemical tests, the value of body mass index and periodontal / peri-implant clinical parameters in patients in the study group. All patients in the study group (n = 71), attending at least 1 year after implant prosthesis, were investigated and the following anthropometric, clinical and paraclinical parameters were analyzed: height, weight, body mass index, abdominal circumference, blood pressure, blood glucose, periodontal probing depth, bacterial plaque index, total bleeding index on probing, lipid profiling (total cholesterol, triglycerides (TGL), high-density lipoprotein (HDL), LDL). The data obtained after the epidemiological-statistical analysis indicated the existence of the correlations between metabolic biochemical markers and BMI (body mass index), also between abdominal circumference and age as well between bacterial plaque indicators and the presence of the disease in peri-implant tissues. In the case of correlations between metabolic biochemical markers and peri-implant disease as well as dyslipidemia and periodontal disease, no significant association was observed.

Keywords: ***body mass index, lipid profiling, periimplantitis***

1.Introduction

Peri-implantitis is an inflammatory process developed around a dental implant affecting both the soft tissue and the hard-bone tissue and it might result in time in progressive loss to a higher level than that conferred by biological bone remodeling (1).

Recent epidemiological studies have indicated a high prevalence of this disease

worldwide, affecting between 24% and 45% of people with implants. (1,2,3,4)

Implant disease cause also systemic changes similar with the periodontal disease, in the way that the epithelium of the inflamed and ulcerated peri-implant pouch allows locally produced inflammatory mediators (e.g., leukocytes and cytokines) to enter the bloodstream, evoking an acute systemic and inflammatory immune response that may subsequently interact. with lipid metabolism, thus increasing the blood levels of total cholesterol and low-density lipoprotein (LDL) cholesterol, which in turn may increase the risk of atherosclerotic disease (5). There is also evidence indicating that infection and inflammation may contribute to a pro-atherogenic lipid profile through the overproduction of oxidized LDL (6).

Patients with periimplantitis may have a systemic condition similar to that seen in patients with periodontitis. As far as we are aware, there is a lack of clinical trials to assess whether patients diagnosed with peri-implantitis have an exacerbated systemic proinflammatory condition with dyslipidemia. (7)

Abdominal obesity is commonly reported as a waist-to-hip, ratio but is most easily quantified by a single circumferential measurement obtained at the level of the upper iliac crest (10). The original US national guidelines classify men as having a relatively high risk of comorbidities, such as diabetes and cardiovascular disease, if they have a waist circumference greater than 102 cm (40 inches) and women if their waist circumference exceeds 88 cm (35 inches) (8). These waist circumference thresholds are also used to define the "metabolic syndrome" of the latest guidelines from the American Heart Association and the National Lipid Association (9, 10, 11).

2. The aim of the study

The aim of this study is to analyze the possible correlations between the results of metabolic biochemical tests, the value of body mass index and periodontal / peri-implant clinical parameters in patients in the study group. A descriptive analysis of the epidemiological and socio-demographic characteristics of the patient group has also been performed.

3. Materials and methods

This study has been approved by the Ethics Commission of the U.M.F Craiova and informed written consent has been obtained from all patients.

In this study, a number of 80 patients who presented to the private clinic Dental Hospital Romania for regular prophylactic control of the oral cavity during 2018-2020 and who had in the oral cavity at least one prosthetic dental implant of at least one year have been selected.

To be eligible, subjects had to meet the following study inclusion criteria:

- to be over 18 years old
- to present at least one year old implant
- to be non-smoking at the time of treatment
- to be enrolled in the periodic monitoring program
- to be balanced occlusally, without parafunctions, premature occlusal contacts or occlusal interferences

Patients who did not meet the above criteria were excluded from the study, thus establishing the following criteria considered ineligible;

-Pregnant or lactating women, (n = 2)

-subjects with blade-type implants or smooth surface (n = 1),

-those who had taken known medications that alter the oral inflammatory condition or hormone levels for 3 months before the visit, (n = 4)
- subjects with a history of aggressive periodontitis (n = 2)

Based on analyzing the initial group of patients and applying the above mentioned inclusion and exclusion criteria, we succeded to select a study group of 71 patients.

All patients in the study group (n = 71), attending at least 1 year after implant prosthesis, were investigated clinically and radiologically at the time of presentation in the dental clinic. The following anthropometric, clinical and paraclinical parameters were analyzed: height, weight, body mass index, abdominal circumference, blood pressure, blood glucose, periodontal probing depth, bacterial plaque index, total bleeding index on probing. Patients were referred to testing laboratories for lipid profiling (total cholesterol, triglycerides (TGL), high-density lipoprotein (HDL), LDL).

Anthropometric parameters, such as waist circumference, were measured midway between the edge of the lower palpable rib and the iliac crest at the end of the expiratory phase of the current breath, in a relaxed posture, as recommended by the WHO. (12)

The evaluation of periodontal parameters was recorded in the model periodontogram at the University of Bern, saved in a pdf format, printed and attached to the observation sheet of each patient, at the initial visit which was made at least 1 year after implant prosthesis.

During the clinical examination for the registration of periodontal parameters, the following stages of dental and periodontal examination were taken into account:

-notation of the teeth present on the arch, their number being recorded
-notation of the existing implants at the level of the dental arches, their number being recorded
-measuring the depth of the gingival groove or the remaining peri-implant / periodontal pockets for each vestibular / oral face of each tooth and implant: (UNC-Hu-Fridey periodontal probe, Chicago, USA). All measurements were performed by the same examiner.
- measuring the level of the gingival margin in relation to the package of the respective tooth in relation to the abutment-implant connection
- the degree of bleeding at the survey was calculated and noted.

All the data included in the periodontics were systematized and centralized, the following information for each patient being extracted:
- the number of teeth present on the dental arches
- the number of implants present in the oral cavity
- the maximum probing depth of the present periodontal pockets
- the maximum depth of peri-implant sounding
- the level of bleeding at the level of the teeth / implants
- the level of supragingival bacterial plaque
- the number of implants lost

For the statistical analysis, the collected data were recorded in an Excel program, and in order to make the correlations between the variables Pearson's coefficient correlation coefficient r, $p < 0.05$ for statistical significance was used as a statistical method and Fisher's exact test two-sided.

4. Results:

Following the analysis of the study participants, the distribution of the group by sex was made as follows: out of a total of 71 patients, we have a percentage of 53.5% women and 46.5% men.

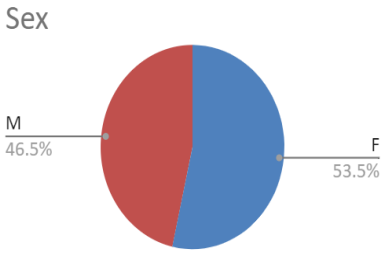

Fig. 1 Graphic representation regarding the distribution of the study group by sex

The distribution of the study group according to the age of the patients indicate that the majority was included in the range of 40-60 years (n = 42, 59.15%). The average age of the entire study group is 53.66 + _ These results are represented graphically in Figure 2.

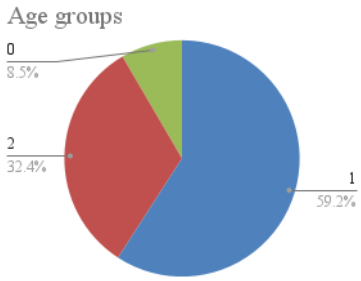

Fig. 2 Distribution of the study group by age groups

Regarding the environment of the patients in the study group, a large percentage (90.1%) come from urban areas, therefore they have much easier access to dental services, and a small percentage of 9.9% come from rural areas.

The general pathological antecedents were collected from the medical file completed by the patient, and a percentage of 39% of the study group presented various systemic diseases whereas and a percentage of 61% stated at the time of the treatment that they were in good health.

Depending on the association of high blood pressure, as well as its degree of compensation, the distribution of the group of patients is represented in the following graph (Fig.3)

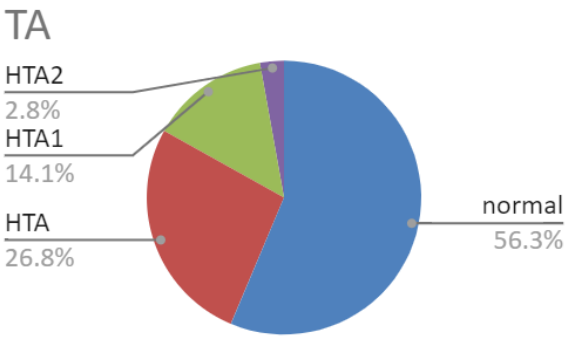

Fig.3 Association of high blood pressure in the study group

Next, the study group was analyzed according to the value of the body mass index (BMI). Thus, it was observed that the largest number of patients had a BMI value corresponding to different degrees of overweight (BMI = 25-29.9). The results are represented graphically in Fig. 4.

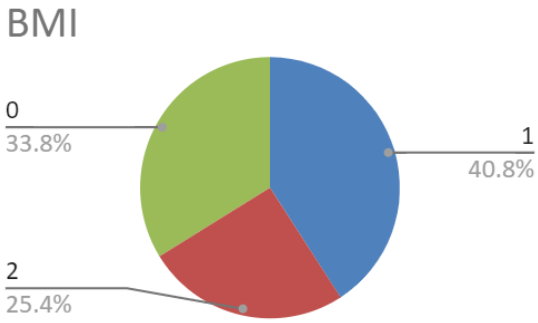

Fig. 4 Distribution of the study group according to the BMI value

Analyzing the blood glucose values in the patients from the study group, its normal values were observed in a percentage of 81.7%, and a percentage of 18.3% showed high values (Fig.5). The average blood glucose value in the analyzed group was 91.80 mg / dl + -9.70.

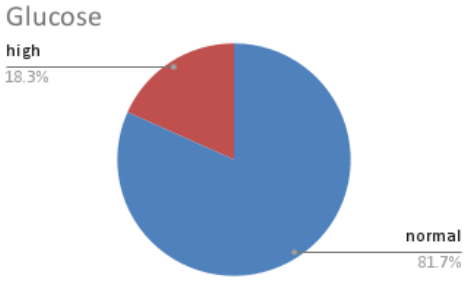

Fig.5 Distribution of the study group according to blood glucose value

In the study group analyzed, the transaminase values did not show changes that exceeded the limits of the reference intervals in any of the patients (Table 1).

Table 1 The value of the transaminases of the group of patients in the study group

Transaminases	**Average**
GOT	**22,93 U/L+-3.53**
GPT	**22,42U/L+-7.05**

Analyzing the lipid profile of the patients in the study group, it was observed in terms of cholesterol values that a percentage of 57.75% of the total had an increased value (Fig.6).

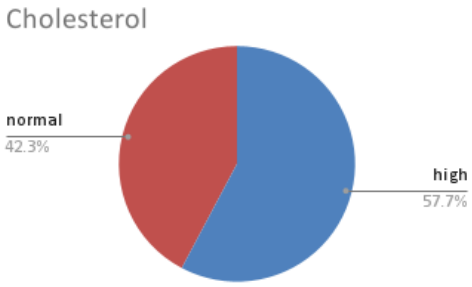

Fig.6 Distribution of the group of patients according to the value of total cholesterol

When analyzing patients with dyslipidemia and higher blood total cholesterol levels, a higher percentage (61.36%) of patients with mucositis / periimplantitis was found compared to patients without peri-implant disease (51.85%) but with a higher total cholesterol value.

Analyzing the value of triglycerides in the study group, it was noticed that they fell within the reference range of 59.2% of patients (Fig. 7).

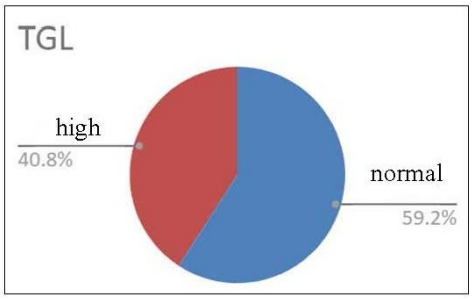

Fig.7 Distribution of the study group according to the triglyceride value

Abdominal circumference is a benchmark in diagnosing the presence of metabolic syndrome and is recognized as an important risk factor for obesity. In our study group, depending on the values resulting from the measurement of the abdominal circumference, high values were observed in 39.47% of women, compared to 31.39% in men (Table 2, Fig.8).

Table 2. Distribution of the study group according to the value of the abdominal circumference

Abdominal circumference	**No**	**Percent**	**Average**	**Women no**	**Percent**	**Men no**	**Percent**
normal	**43**	**60.6%**	**80,69cm+-14.56**	**23**	**60.53%**	**20**	**60.61%**
increased	**28**	**39.4%**	**103.64 cm +-14.55**	**15**	**39.47%**	**13**	**31.39%**

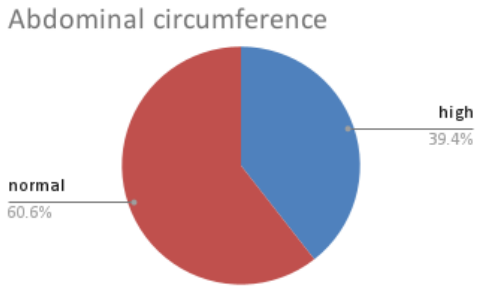

Fig.8 Distribution of the study group according to the value of the abdominal circumference

57.75% of all patients included in this group have a medical history of periodontal disease, compared to 42.25% of patients who did not have such a history.

Patients included in the study group have at least one rehabilitation in the oral cavity using dental implants. Thus, a total number of 312 implants are present in all patients in the research. Their distribution by sex groups and number of implants present in each patient is described in the following tables (Table 3-4).

Table 3. Distribution of the number of implants according to the sex of the patients

Implant no	No	Average
Men	159	4.82-+3.67
Women	153	4.02+-3.05
Total	312	

Table 4. Distribution of the number of patients in the study group according to the number of implants

Number of group implants	Patient no	Percent
1-3 implants	41	57.74%
3-6 implants	16	22.54%
>6 implants	14	19,72%

Following the clinical and radiological investigations performed on the study group, the presence of peri-implant diseases was evaluated. Thus, the presence of mucositis was observed in 19 patients (26.8%), in 25 patients (35.2%) the diagnosis of periimplantitis was established, and in a number of 27 patients (38%) there were no signs of peri-implant disease (Fig.9)

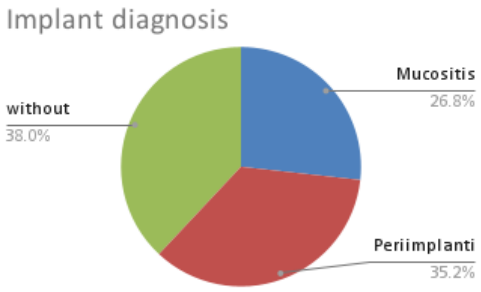

Fig.9 Distribution of the study group according to the implant diagnosis

Analyzing the hereditary-collateral antecedents of periodontal disease in the patients in the study group, it was noticed its association for 32 (45.07%) of them, and in 39 of the cases (54.93%) no history of periodontal disease was declared in first and second-degree relatives.

After completing the information on the frequency of oral brushing, 80.23% of the analyzed patients reported a brushing frequency of 2-3 times and a percentage of 19.77% only one brushing per day.

Out of the whole study group, 41 patients had an increase in the total cholesterol value (57.75%): 14 of them did not have peri-implantitis disease (34.15%) and 27 with mucositis or peri-implantitis (65.85%). Fisher's exact test two-sided had a p-value of 0.4666 and odds ratio=1.475 (95%CI 0.55 to 4.0).

In the case of the comparative analysis of patients diagnosed with mucositis or peri-implantitis and periodontal disease compared to patients diagnosed with peri-implant disease but without periodontal disease, a statistically significant association with a p-value = 0.0072 was observed according to Fisher's test (Table 5).

Table 5. Comparative analysis of patients diagnosed with mucositis or peri-implantitis and periodontal disease compared to patients diagnosed with peri-implant disease but without periodontal disease

	With periodontal disease	Without periodontal disease	Total
With mucositis or peri-implantitis	31 (75.61%)	13 (43.33%)	44
Without mucositis or peri-implantitis	10 (24.39%)	17 (56.67%)	27
Total	41	30	71

Fisher's exact test two-sided: p-value=0.0072 (statistically significant, <0.01)
Odds ratio=4.054 (95%CI 1.47 to 11.13)

Performing a comparative analysis between patients with normal or increased plaque indices (Ip Silness and Loe) and bleeding indices (PBI) and diagnosed or not with mucositis + peri-implantitis,

a statistically significant association was observed according to Fisher's test with values of p <0.0001 between the increased indices and the presence of mucositis or peri-implantitis (Table 6,7).

Table 6. Comparative analysis between bacterial plaque indices values (Ip Silness and Loe) and the presence of mucositis or peri-implantitis.

	IP- Silness and Loe>1	IP- Silness and Loe=0 or 1	Total
With mucositis or peri-implantitis	24 (100%)	20 (42.55%)	44
Without mucositis or peri-implantitis	0	27 (57.45%)	27
Total	24	47	71

Fisher's exact test two-sided: p-value<0.0001 (statistically significant)

Table 7. Comparative analysis between bleeding indices (PBI) values and the presence of mucositis or peri-implantitis.

	PBI>1	PBI=0 sau 1	Total
With mucositis or peri-implantitis	20 (100%)	24 (47.06%)	44
Without mucositis or peri-implantitis	0	27 (52.94%)	27
Total	20	51	71

Fisher's exact test two-sided: p-value<0.0001 (statistically significant)

A statistically insignificant result was observed in the comparison between the sex groups and the presence of mucositis or peri-implantitis having a p-value <0.2316 (Table 8**).**

Table 8. Comparative analysis between sex groups and the presence of mucositis or peri-implantitis.

	Women	Men	Total
With mucositis or peri-implantitis	21 (55.26%)	23 (69.70%)	44
Without mucositis or peri-implantitis	17 (44.74%)	10 (30.30%)	27
Total	38	33	71

Fisher's exact test two-sided: p-value<0.2316 (ns)

Analyzing the correlation between body mass index and periodontal diagnosis, no statistically significant association between these variables was observed (p = 0.699; rho = -0.047). Also, no statistical correlation was observed between the environment and the history of periodontal disease (p = 0.848; rho = 0.023) not between the age group and the presence of the history of periodontal disease (p = 0.321; rho = 0.119). Analyzing the correlation between abdominal circumference and the age of the patients in the study group, we noticed the presence of a statistically significant association between these 2 variables (p = 0.005; rho = 0.327).

On the other hand, a strong statistical association was observed between the value of body mass index (BMI) and cholesterol level (p <0.0001; rho = 0.440), but also between BMI and triglyceride value (p <0.001; rho = 0.390). These results are represented graphically in Fig. 10 and Fig.11).

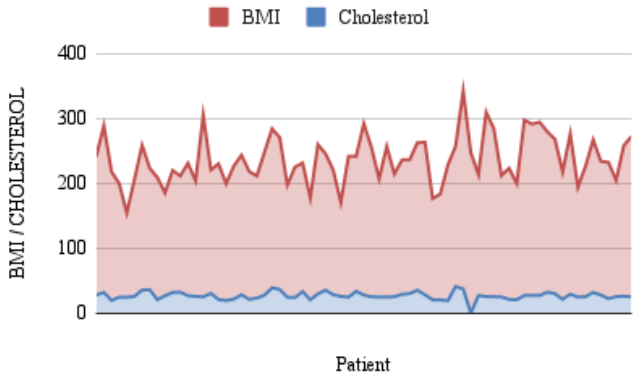

Fig. 10: Statistical correlation between BMI and cholesterol

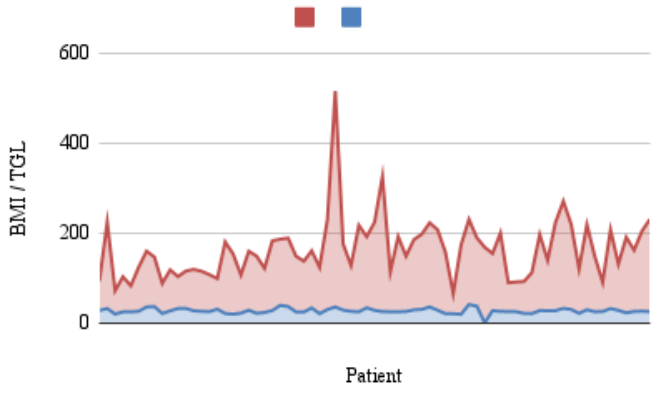

Fig. 11. Statistical correlation between BMI and triglycerides

A low statistical association was observed in the case of the analysis of 2 other

parameters, namely the presence of periodontal disease and peri-implant diagnosis (p = 0.021; rho = 0.274).

No statistical association was observed between body mass index and peri-implant diagnosis (p = 0.934; rho = -0.010), and no statistically significant correlation was observed between the parameters represented by abdominal circumference and peri-implant diagnosis (p = 0.471; rho = 0.087).

Regarding the periodontal indices represented by bacterial plaque and bleeding indices, no statistically significant correlation was observed with the body mass index (p = 0.342; rho = 0.114). On the other hand, analyzing the correlation between the plaque and bleeding indices with the implant diagnosis, a strong significant association was noticed (p <0.0001; rho = 0.714), the latter being represented graphically in Fig.12.

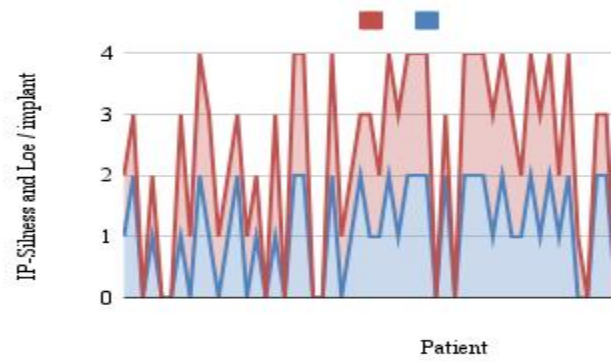

Fig.12: Statistical correlation between bacterial plaque index and implant diagnosis

5. Discussions

Given the variable predictability and invasive potential of periimplantitis management, it is relevant to understand the underlying pathophysiological mechanism, as early diagnosis can help prevent more serious aspects of the disease and the morbidity associated with its treatment (13,14).

Studies on the possible correlations between metabolic biochemical markers and peri-implant / periodontal disease are few in number, but there is a pilot study that notes the association of dyslipidemia in patients with peri-implantitis compared to people with osseointegrated implants with no signs of peri-implant inflammation. (15)

Our research has shown statistically significant correlations in terms of BMI and metabolic biological markers (total cholesterol and triglycerides). On the other hand, no statistical results were observed regarding the association of increased BMI with the presence of peri-implant disease.

Obesity is known as a condition found in a large number of the general population, and abdominal circumference (WC) is a benchmark of it. Studies that looked at groups of adult patients in an evolving stabilized periodontal disease monitoring therapy program found a statistically significant correlation between abdominal circumference (WC) and peri-implant diagnosis. In the same direction, a study was performed, the result of which showed for the first time a low but statistically significant correlation between WC and IL-1β expression in peri-implant sulcular fluid (PISF). These data support the result of the personal study, namely the statistically significant correlation between WC and peri-implant disease. (16)

Obesity can be assessed with several anthropometric measurements, but abdominal circumference seems to be the most reliable parameter of visceral fat and a good predictor of obesity-related comorbidities, including mortality. (17,18)

It is also well known in the medical literature that BMI does not assess the thickness and distribution of visceral adipose tissue as accurately as WC, but it is more harmful and independently contributes to mortality. (19)

The possible association between obesity and periodontal / peri-implant disease is difficult to demonstrate because many other factors are known, such as oral hygiene habits, smoking, diabetes and educational level. (20) This study sought to eliminate these factors by including research of non-smoking patients at the time of presentation, with a good level of oral hygiene, without parafunctions. Thus, regarding oral hygiene, 80.23% of the analyzed patients reported a brushing frequency of 2-3 times a day.

The majority of patients in the personal research study group had a normal fasting blood glucose level of less than 100 mg / dL (81.7%), while a small proportion (18.3%) had prediabetic values. 100 to 125 mg / dL); none were diabetic (> 126 mg / dL).

Other studies that look at the same subject have different results. Thus, in half of them (21,22,23) no significant correlations were observed between the association of diabetes and the success of implant osseointegration. On the contrary, Dowell et al. (23) did not notice a lower rate of integration of dental implants in patients with poorly controlled diabetes.

In another study (24) which included only patients with poorly controlled diabetes associated with peri-implant complications (mucositis, pain during the application of the healing abutment). In them, in 98% of cases the therapeutic success was noticed.

Oates et al. (25) observed that osseointegration during the first 4 months postoperatively was reduced in patients with higher levels of glycated hemoglobin (HbA1c). Only 57.1% of implants inserted in patients with poorly controlled diabetes stabilized after 16 weeks, compared with 80% in the group of patients with compensated diabetes (25).

Similar results were reported by Tawil et al. (26). They conducted a study in which they observed statistically significant correlations between HbA1c levels and the presence of peri-implantitis (P = 0.05) or peri-implant bone loss (P = 0.01). In fact, in all studies there was a general failure of osseointegration in patients with diabetes mellitus, although some reported positive results. (21,24)

The existence of a relationship between the presence of infections and lipid metabolism has been widely documented recently, with the current findings being that chronic infectious diseases have an impact on plasma lipid levels (27,28).

The results of studies that looked at the association of metabolic biochemical markers with periodontal disease reported higher levels of LDL cholesterol and total cholesterol in patients with periodontitis compared to healthy controls. (29,30,31)

Another recent study (32) evaluated serum biochemical parameters known as CVD markers in patients with periimplantitis. The results indicated significantly higher levels of triglycerides, uric acid and leukocytes in the group of patients with periimplantitis or mucositis compared to healthy patients. They also had the lowest levels of vitamin D. The authors found a positive correlation between uric acid, triglycerides and gingival index, bag depth, bleeding on probing and the amount of keratinized mucosa around the implants.

A recent study showed that an extremely high body mass index (≥40 kg / m2) was associated with more severe peri-implant conditions, increased systemic proinflammatory status and dyslipidemia. (33)

Dental materials frequently produce a desired potential gingival response, and different commercial products from the same category can behave extremely differently, one material being able to have a more negative impact on the periodontal response than another (34). Regarding periimplantitis, initial studies show the association of the presence of bacterial plaque in implants with mucositis and peri-implantitis (35,36). Experimental animal studies have also used processed, high-carbohydrate diets to induce peri-implant inflammation (37). However, the presence of severe peri-implantitis phenomena does not always cause such strong reactions on the neighboring implants, a study on dogs showing less tissue loss than we would have thought (38).

Some studies have shown that in cases where tooth loss has occurred as a result of periodontal disease, a full vegetarian diet supplemented with vitamin B12, vitamin D and omega-3 fatty acids may be advisable and beneficial in the pre-treatment period with dental implants (39,40). This nutritional formula has, in turn, a positive influence on the whole body. In patients at high risk, serological testing may be considered for a more accurate picture of their nutritional status and micronutrient levels. Indicative factors are cholesterol, HbA1c and vitamin D. In this case, interdisciplinary consultation with specialists and/or nutritionists is recommended.

6. Conclusions

The data obtained after the epidemiological-statistical analysis indicated the existence of the correlations between metabolic biochemical markers and BMI (body mass index), also between abdominal circumference and age as well as in the case of bacterial plaque indicators and the presence of the disease in peri-implant tissues.

In the case of correlations between metabolic biochemical markers and peri-implant disease as well as dyslipidemia and periodontal disease, no significant association was observed.

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