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Periodontal Findings and Blood Analysis of Blood Donors: A Pilot Study

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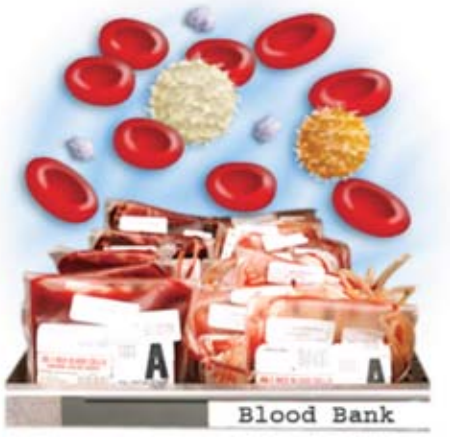

Abstract

Aim: Before blood donation a medical check-up is mandatory to ascertain the health of the donor and to detect infections clinically. Although gingivitis and periodontitis are also bacterial infections, the oral cavity is only inspected superficially. The purpose of this study was to investigate the periodontal condition of blood donors and whether this affects the results of their blood tests.

Methods and Materials: A total of 192 blood donors were examined. The investigation included a periodontal examination to determine the Community Periodontal Index (CPI), an analysis of blood chemistry, as well as the determination of hematologic, coagulation, and immune parameters C-reactive protein (CRP), Neopterin, Procalcitonin (PCT), and tumor necrosis factor (TNF-α). Groups were formed according to periodontal status: "healthy" (n=47, mean age 24±4 years), "gingivitis" (n=65, mean age 24±4 years), and "periodontitis" (n=80, mean age 29±8 years). Most parameters of the routine blood test as well as the immune parameters were unremarkable with regard to the periodontal status. The values for SGPT, GGTP, uric acid, triglycerides, total protein (TP), RBC, hemoglobin (Hb) and hematocrit (HC), Eos, and Baso were also within the normal range. Nevertheless, statistical analysis showed some significant differences in these parameters between the "healthy" group and the "periodontitis" group ($p \leq 0.05$).

Results: The results of this study show some blood donors have infections of the gingiva and/or of other periodontal tissues. Whether this is a sufficient reason to exclude them from blood donation, or in which

case potential donors should be excluded, is not yet known. Nevertheless, it seems reasonable to integrate a screening method for revealing at least severe periodontitis in the medical check-up of blood donors.

Keywords: Periodontal findings, Community Periodontal Index, CPI, blood donor, blood analysis, immune parameters

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Introduction

Aside from plaque-induced gingivitis, periodontitis is the most common of the periodontal diseases. Worldwide 50% of the adult population is affected by this disease.[1] Currently, two distinct forms of periodontitis are recognized: chronic periodontitis (CP) and aggressive periodontitis (AP).[2,3] The imbalance between certain bacteria and the immune defense mechanism of the host organism is decisive for the development and progression of both forms of the disease.[4] Only a few of the estimated 500 bacterial species physiologically colonizing in the oral cavity are classified as important for the progress of periodontitis.[5,6] These are predominantly gram-negative anaerobic bacilli whose metabolic products damage the tissues or which can directly invade the tissues.[7] Local protective barriers are intended to prevent penetration of periodontopathic bacteria from subgingival plaque, but ironically these defense mechanisms causally actually participate in the destruction of periodontal tissue.[8]

Periodontopathic microorganisms activate monocytes and macrophages which in turn induce the production of cytokines, e.g., Interleukin-1 and tumor necrosis factor (TNFα). Moreover, the individual course of periodontitis depends on the body's own ability to regulate the immunological defensive reaction.[9] In such cases neutrophile granulocytes (PMN) in the blood may exhibit disturbed function or be reduced in number.[10,11]

Active phases of periodontitis are typified by acute, bacterially-induced inflammation. In such phases rod and juvenile granulocytes enter the bloodstream so that a shift to the left is evident in a blood smear.[12] The course of the inflammatory reaction is controlled by a number of cell- or plasma-mediated inflammation mediators. They are characterized by their exclusive occurrence at the site of inflammation, an antagonist-controlled effect suppression, and catabolism by the organism. Cell-mediated mediators become active in the immediate vicinity of their place of synthesis and are not transported any great distance. In stored form they occur in certain cells or are immediately synthesized by the cells when the need arises. They are primarily responsible for the early inflammatory reaction. Macrophage products, among others, are representatives of these mediators. They also activate TNF-α. TNF-α is an acute-phase protein produced by neutrophile granulocytes and activates the T- and B-lymphocytes; that is, a cellular immune response occurs.[13,14] Along with interleukin-1 and interleukin-6, TNF-α is one of the most important immune mediators.[15]

Plasma-mediated mediators must be enzymatically activated because only inactive precursors are synthesized. C-reactive protein (CRP) belongs to this group. CRP is also an acute-phase protein; it is formed in hepatocytes and is part of the non-specifically functioning immune response of the organism to inflammatory processes in the body. CRP synthesis is activated by macrophage products and prostaglandin E and F.

Other inflammation markers are neopterin and procalcitonin. Neopterin is a metabolic product of guanosine triphosphate (GTP). The activity status of cellular immunity at a given point in time can be determined based on the neopterin concentration in serum or other body fluids. Increased neopterin concentrations are primarily known from viral infections. They occur during the acute phase before antibodies in the blood are even detectable.[16] Increased neopterin concentrations are also found when a bacterial infection exists.[17-19] Procalcitonin (PCT) is the prohormone of calcitonin which is synthesized in

the C-cells of the thyroid. In healthy patients PCT is usually not detectable because it is immediately metabolized to calcitonin. For instance, in severe bacterial infections a marked rise in PCT serum values up to 1000 ng/ml is observed without an increase in calcitonin concentration.[20] PCT is an infection parameter which only increases during a systemic reaction of the body to infection. Locally limited infections, encapsulated processes, or bacterial colonization all lead to only a slight rise in PCT concentration, if at all.[21]

The transfusion of blood and the use of blood products are very common, helpful measures. Currently, donated blood is meticulously examined to ensure it is safe for the recipient. Blood donors have to pass a medical examination, including an examination of the blood, for infections that would disqualify the potential donor from giving blood. In preparing for the present study it was learned this medical examination does not include a thorough examination of the oral cavity apart from a superficial look at the teeth and gingiva even though gingivitis and periodontitis are common bacterial infections (Figures 1-6). It is also true the examining physicians are not usually trained in intraoral examination procedures. (While looking at the clinical images in Figures 1 to 5, try to imagine that you are a physician

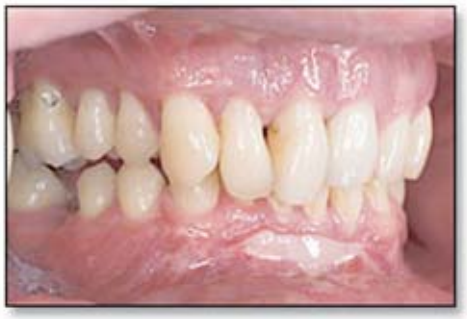

Figure 1. Right side intraoral view of a patient with severe periodontitis.

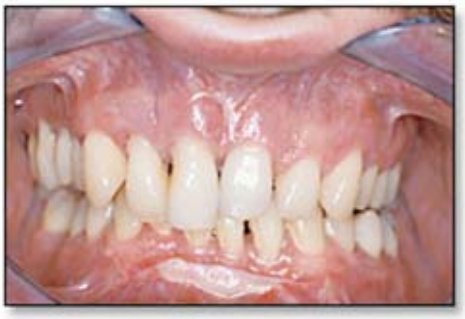

Figure 2. Anterior intraoral view of a patient with severe periodontitis.

Figure 3. Left side intraoral view of a patient with severe periodontitis.

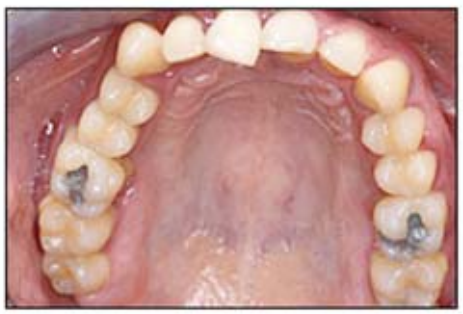

Figure 4. Intraoral palatal view of a patient with severe periodontitis.

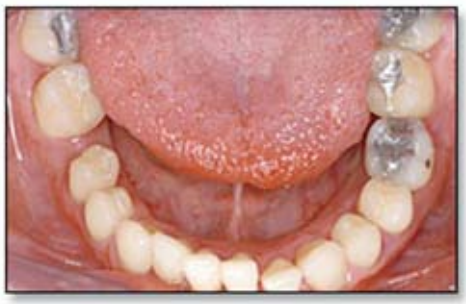

Figure 5. Intraoral mandibular view of a patient with severe periodontitis.

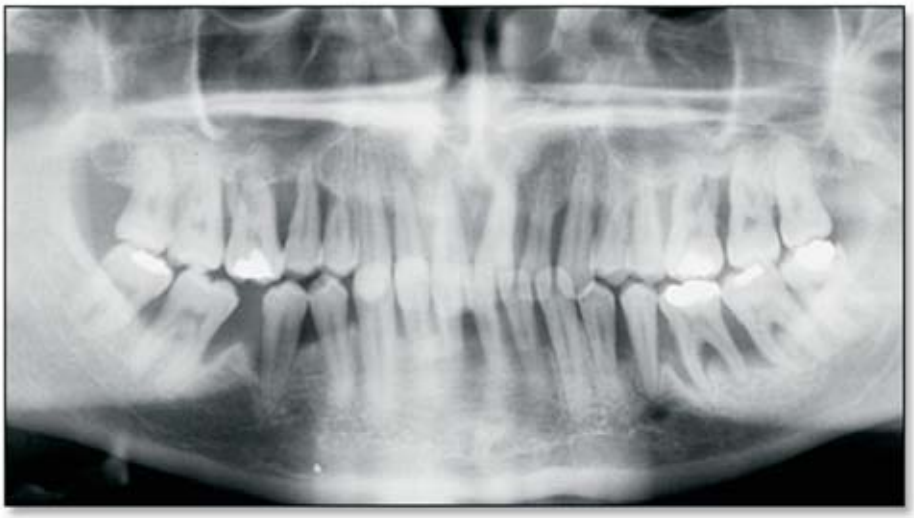

Figure 6. The corresponding panoramic radiograph shows severe generalized bone loss, most of the teeth are "hopeless."

examining the oral cavity of this 28-year-old man in a medical check-up before a blood donation. Would you notice the generalized inflammation of the gums and the periodontal destruction?)

The purpose of this pilot study was to investigate the periodontal status of a population of patients, routine parameters in their peripheral blood chemistry, and some specific immune parameters which indicate infections.

Methods and Materials

Study Population

The study took place in the Department of Transfusion Medicine at the University of Goettingen in Goettingen, Germany during a three-month period. After filling out a detailed medical questionnaire and passing the obligatory medical examination, all persons who were accepted for their first blood donation were asked to participate in the study. Volunteers for the study included 192 (109 males and 83 females) first time blood donors aged between 18 and 54 years (mean 25.7±5 years). Volunteers conveyed informed consent prior to their participation.

Methods

The Periodontal Examination (CPI)[22]

The oral examination included a questionnaire to collect personal data (age, gender) and a periodontal examination (CPI). According to the

CPI, the following index teeth were examined:

17/16	11	26/27
47/46	31	36/37

Participants who showed a CPI score of 3 for any index tooth received a full-mouth exam. Prior to the periodontal examination, the following three groups were defined with regard to periodontal status:

- **"Healthy":** CPI score of 0, a CPI score of 2 only at the lingual aspect of the lower anterior teeth
- **"Gingivitis":** CPI score of 1, a CPI score of 2 in one sextant at the most, a CPI score of 3

Table 1. Number of persons, age, and gender per periodontal status category.

Periodontal Status	Number of Persons		Mean Age	Gender	
	n	%	*Years*	*M*	*F*
"Healthy"	47	24.5	24±4	22	25
"Gingivitis"	65	33.8	24±4	42	23
"Periodontitis"	80	41.7	29±8	45	35

only at the distal aspect of tooth 7 or 8, or in a maximum of two sextants (pseudo pocket)

- **"Periodontitis":** CPI score = 3 or 4 in any sextant

Blood Findings

The analysis of blood chemistry included hematologic parameters and one immune parameter (CRP) in the peripheral blood as a routine blood test as follows:

- **Blood Chemistry, Enzymes etc.:** Sodium, potassium, calcium, iron, SGOT, SGOP, GGTP, LDH, creatine kinase (CK), amylase, creatinine, urea nitrogen, uric acid, total bilirubin, triglycerides (Trigl), cholesterol, total protein (TID), glucose
- **Hematology:** Hemoglobin (Hb), hematocrit (HC), RBC, MCV, MCH, MCHC, WBC, (Segs, Lymph, Mono, Eos, Baso), platelets, antihemophilic factor (AHF), fibrinogen, blood group, Rh blood-group antigen

The analysis of three immune parameters (neopterin, PCT, TNF-α) in the peripheral blood was also included.

Statistical Analysis

The results were statistically analyzed using the Student t-test for unpaired data. The level of significance was set at $p \leq 0.05$ for all blood parameters.

Results

Table 1 shows the distribution of the periodontal status regarding the number of persons, age, and gender who participated in the study.

Periodontal Status

The periodontal screening showed 49% of the sextants had a CPI score of 0, 3.7% a score of 1, and 7.5% had a score of 2. A CPI score of 3 was found in 33% of the sextants and in 6.7% a CPI score of 4 (Figure 7).

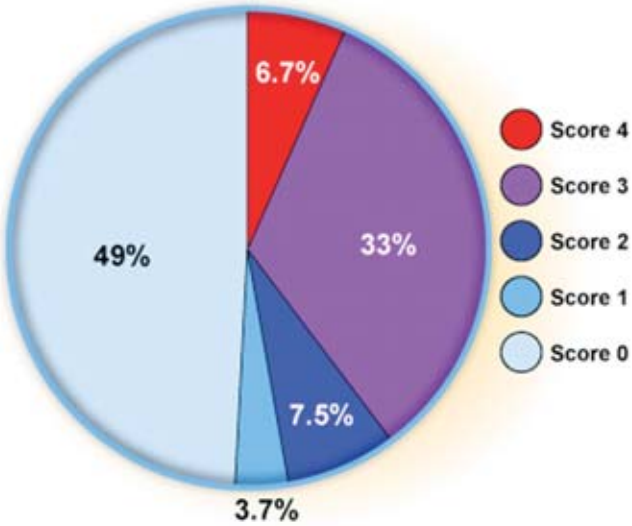

Figure 7. Frequency of the CPI scores related to all the sextants.

The distribution of the CPI scores in each of the different sextants is depicted in Figure 8. Table 1 shows the distribution of the three groups with regard to the number of persons, mean age, and gender.

Blood Parameters

Several parameters of routine blood testing as listed below were unremarkable with regard to periodontal status:

- Sodium
- Potassium
- Calcium
- Iron
- SGOT
- LDH
- Creatine kinase (CK)
- Amylase
- Creatinine
- Urea nitrogen
- Bilirubin
- Cholesterol
- Glucose

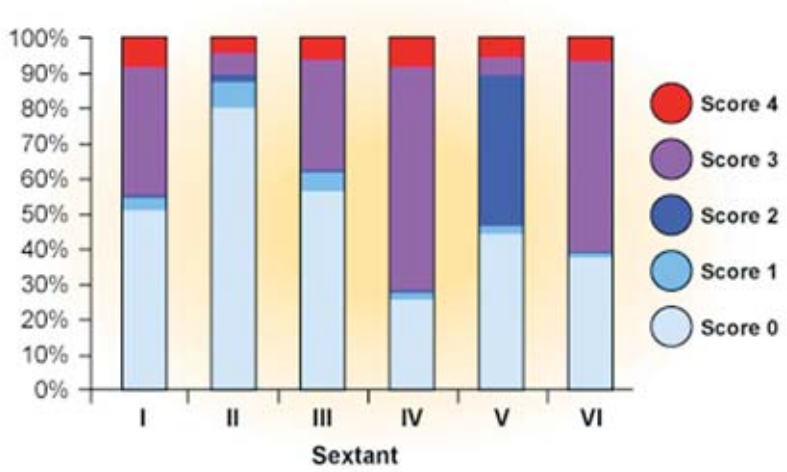

Figure 8. Frequency of the CPI scores in each sextant.

Table 2. Differences in the routine blood parameters between the "healthy" and the"periodontitis" groups.

Blood Parameter	SGPT	GGTP	Uric Acid	Trigl	TP	RBC	Hb	HC	Bas	Eos
Normal Value	≤ 22 U/l	≤ 29 U/l	2.6 – 7.4 mg/dl	50 – 250 mg/dl	6.6 – 8.3 g/dl	3.9 – 5.9 x 10^6/µ	11.5 – 17.5 g/dl	35 – 51 %	≤ 2 %	≤ 8 %
"Healthy"	9.87	6.97	4.79	78.9	7.41	4.57	14.0	40.9	0.51	2.2
"Periodontitis"	11.3	8.67	5.34	101	7.23	4.79	14.6	42.8	0.59	1.94
P ≤ 0.05	0.07	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.17	0.22

- WBC (Segs, Lymph, Mono, Eos, Baso)
- MCV
- MCH
- MCHC
- Platelets
- Antihemophilic factor (AHF)
- Blood group
- Rh blood-group antigen

The acute-phase protein, (CRP), was unremarkable as well. The values for SGPT, GGTP, uric acid, triglycerides, total protein (TP), RBC, hemoglobin (Hb), hematocrit (HC), Eos, and Baso were also within the normal range. Nevertheless, statistical analysis showed some significant differences in these parameters between the "healthy" group and the "periodontitis" group (Table 2). The differences between the "healthy" and the "gingivitis" group were not significant.

The analysis of the three additional immune parameters showed no striking findings. The value for neopterin was below the reference point (2.5 µg/l) in every participant. PCT was not detectable in the serum of 129 persons (67.5%). Among the remaining participants, the value was 0.4 ng/ml at maximum. The reference point for PCT in serum to indicate an infection is 1000 ng/ml and beyond. The values for TNF-α were in the normal range (5-15 pg/ml) for all participants. Differences between the groups did not occur.

Discussion

The purpose of this examination as part of this pilot study was to evaluate the periodontal status of blood donors and determine whether the presence of an inflammatory periodontal disease correlates with changes in parameters of the peripheral blood. To this end, the periodontal status and various blood and immune parameters of first-time blood donors at the University Clinic in Göttingen were examined.

Compared to representative studies of the periodontal status of large population groups, the periodontal condition of the first-time blood donors examined in the present study was above average when considered as a single group. This result is probably related to the fact the total group of subjects were relatively young with an average age of 27 years, which is seven years below the age at which periodontitis usually appears.[1,23] Thus, 49% of the examined sextants

were classified as "healthy" (a CPI score of 0) and 11.2% showed CPI scores of 1 and 2. A CPI score of 3 was found in 33% of the sextants and a score 4 in 6.7%. These findings are quite similar to those of Pilot et al.[1] who reported slight periodontitis in 30-50% and severe periodontitis in just 2-15% of their 20- to 65-year-old group of subjects.

Looking at our three groups formed on the basis of periodontal status, the different distribution of average age becomes apparent. The "healthy" group's average age was 24 years, clearly younger than the "periodontitis" group's average age of 29 years. The "periodontitis" group approximately reflects the disease status of the general population in persons 35-years-old and over when periodontal destruction is more frequently observed than in younger individuals.[24]

The analysis of the blood tests showed the values for all three groups were within the reference range for a given parameter. Nevertheless, there were some significant differences between the "healthy" and "periodontitis" groups in that uric acid, triglycerides, erythrocytes, hemoglobin, and hematocrit values in the peripheral blood were comparatively higher in the "periodontitis" group.

The literature contains only a few indications of possible correlations between inflammatory periodontal diseases and altered blood counts, although the latter were usually expressions of a manifestation of general disease. For instance, Grossi et al.[25] examined the most common general diseases for a correlation to periodontal destruction. A correlation with gout, a disease in which greatly increased uric acid levels are found, was not evident.

In addition to the triglycerides, eosinophile, and basophile granulocytes in the "periodontitis" group, this group also showed a tendency toward increased values. However, it remains questionable whether increased triglycerides alone indicate the presence of periodontitis or whether these are observed only with metabolic disorders, e.g., diabetes mellitus. The literature contains no data on this. Due to the tendentially increased values of erythrocytes, hemoglobin, and hematocrit, the fluidity of the blood might be diminished. Barbier et al.[26] described worsened flow behavior of the blood in connection with an increased hematocrit value. The values of erythrocytes, hemoglobin, and hematocrit are directly dependent on each other. To date, no studies or data showing a correlation between periodontitis and these three parameters exist.

The total protein (in blood) and factor VIII demonstrate opposite tendencies. The total protein in the "healthy" group was significantly higher than in the "periodontitis" group. The literature contains no information on total protein in persons with periodontal destruction. Furthermore, the subjects in the "periodontitis" group demonstrated a decreased factor VIII value. Further studies are needed to determine any possible associations in this regard.

No significant differences between groups were found for GPT and γ-GT. In this case as well the literature provides no indication of these values changing in association with periodontitis. Similarly, the fibrinogen value was also unremarkable.

Inflammation markers in the peripheral blood were found in neither the "gingivitis" nor the "periodontitis" group. In agreement with other studies no correlation was found between periodontal status and CRP.[27,28] In contrast, however, Ebersole et al.[29] determined increased CRP values in periodontitis patients. Other acute-phase proteins, such as transferrin and lactoferrin, similarly did not demonstrate any correlation.[30] Despite employing a high-sensitivity ELISA test, no association was found between existing

periodontitis and the TNF-α value in peripheral blood. In tissue samples and tests of the sulcular fluid, however, increased TNF-α values were found in periodontitis patients.[31-34] Agarwal et al.[35] also found increased TNF-α values in peripheral blood. However, the difference between "healthy" and "diseased" was very slight. In addition neopterin did not differ significantly between the "healthy" and "periodontitis" groups. Recko et al.[36] examined the urine and saliva of periodontitis patients. The neopterin value was slightly increased in urine but not significantly so in correlation with the number of periodontally diseased teeth. In saliva, however, there was a significant correlation with the number of affected teeth. Presumably the neopterin concentration in the peripheral blood of "periodontitis" subjects in the present study was too low.

Conclusion

Based on CPI results, this pilot study showed some blood donors have infections of the gingiva or other periodontal tissues. However, the analysis of blood chemistry, hematologic parameters, and four immune parameters indicating infections demonstrated no remarkable results. Although within the normal values, some blood parameters exhibited significant differences between the periodontally "healthy" group and the "periodontitis" group. It cannot yet be concluded whether the presence of periodontitis is a reason to exclude potential blood donors from blood donation or in which cases they should be excluded. Nevertheless, we recommend integrating a screening method for revealing (severe?) periodontitis in the medical check-up of blood donors.

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