RESEARCH ARTICLE

Effects of Periodontal Disease and Periodontal Treatment on the Lipid Profile: A Sri Lankan Study

[1]A Tilakaratne, [2]WKL Perera, [3]EAAP Amaratunga, [4]R Sivakanesan

ABSTRACT

Aims: To compare the blood lipid levels of periodontitis group (of different severities) with a nonperiodontitis group and to evaluate any influence of periodontal treatment in altering blood lipid levels.

Materials and methods: The study sample consisted of 83 patients with periodontitis in the "test" group and a matched "control" group of 40, free of periodontitis according to prede-termined selection criteria. All subjects underwent periodontal assessments and blood lipid estimation prior to treatment planning, following which they received active periodontal treatment/oral prophylaxis. Twelve weeks after treatment, peri-odontal reevaluations were carried out and blood lipids were reassessed for pre- and posttreatment comparisons.

Results: Increases in lipid levels were observed in the periodon-titis group compared to the nonperiodontitis group at baseline. The test group had 5% higher mean total cholesterol than the control group at pretreatment/preinterventhion (albeit not sig-nificant: Student's t), while low-density lipoprotein cholesterol (LDL-Ch) was 6.6% higher in the test group than the control group (95% confidence interval). Mean triglycerides (Tri-G) were 5.7% higher in the control group than the test group, yet without statistical significance. All types of lipids in both the groups had decreased following periodontal therapy, while Tri-G levels demonstrated an opposite effect.

Conclusion: Patients with generalized severe periodontitis had higher LDL-Ch values than those with generalized mild-moderate periodontitis. Periodontal care was effective in low-ering unfavorable serum lipids. Prompt control of periodontal inflammation would minimize development of deep periodontal infection and cardiovascular risk.

Keywords: Cardiovascular disease, Cardiovascular disease risk, Lipid profile, Low-density lipoprotein cholesterol, Periodontal treatment, Periodontitis.

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INTRODUCTION

Hyperlipidemia and periodontitis are highly prevalent chronic diseases in the world population, with periodontal disease being the most prevalent adult oral health problem in Sri Lanka.[1] Periodontal disease is a chronic inflammatory disease caused by pathogens in plaque biofilms adherent to the tooth and its supporting tissues. The inflammatory response to plaque biofilm leads to destruction of tooth-supporting structures. The main organisms implicated in advanced periodontitis are Gram-negative anaerobes, which produce lipopolysaccharides (LPS). Although pathogen-derived LPS triggers acute-phase reactions, the occurrence and severity of periodontal disease also depend on many exposure factors, both local and systemic/genetic risk factors including immunological abnormalities.[2] The role of host immune response in periodontal infection has been reviewed and a dysregulated host response has been shown in more aggressive periodontitis.[3]

Dyslipidemia is diagnosed when low-density lipo-protein (LDL-Ch) cholesterol is raised, high-density lipoprotein (HDL-Ch) is low, and triglyceride (Tri-G) levels are high, which are associated with an increased risk of coronary heart disease (CHD). Literature reveals a bidirectional relationship between periodontitis and atherosclerotic cardiovascular disease (CVD), diabetes mellitus (DM),[4,5] and dyslipidemia. Dyslipidemia is an established causative factor for atherosclerosis and CVD,[6] thus explaining a possible multidirectional relationship among each other. Multivariate logistic regression analysis has revealed significant correlations between dyslipidemia and periodontitis.[7] It is known that pro-inflammatory cytokines, such as TNF-α and IL-6, which are produced in relation to periodontal infection, play a significant role in promoting dyslipidemia. Triglycerides, LDL, and glucose have also been significantly elevated in subjects with severe periodontitis and CHD.[8]

As evident in literature, systemic inflammation could alter blood lipid metabolism. Therefore, it is plausible that periodontitis, which is a deep periodontal infection, could lead to an altered blood lipid metabolism. Clinical trials indicate that treatment of periodontitis could result

[1]Professor, [2]Postgraduate Trainee, [3]Medical Officer, [4]Senior Professor

[1]Department of Oral Medicine and Periodontology, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka

[2]Division of Periodontology, Faculty of Dental Sciences University of Peradeniya, Sri Lanka

[3]Base Hospital – Matale, Sri Lanka

[4]Department of Biochemistry, Faculty of Medicine, University of Peradeniya, Sri Lanka

Corresponding Author: A Tilakaratne, Professor, Department of Oral Medicine and Periodontology, Faculty of Dental Sciences University of Peradeniya, Sri Lanka, Phone: 0094812397450 e-mail: tlkrtn@yahoo.com

in an improvement in dyslipidemic status. In light of the above, the aims of this research were to compare blood lipid levels of "periodontitis patients" with a "control group" (free of periodontitis); and to assess any possible relationship between the severity of periodontitis and blood lipids as well as to evaluate any influence of periodontal interventions in altering blood lipids.

MATERIALS AND METHODS

Study Population

This was an experimental study design. The study population was purposively selected and it consisted of all suitable subjects who attended the Study Centre during the recruitment period. The study population consisted of a "test" group (n = 83) and a "control" group (n = 40) matched in relation to age (35–50 ± 5 years), socioeconomic parameters, dietary habits, and oral hygiene practices. The study was carried out in the Division of Periodontology, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka, following approval of Faculty Research Ethics Review Committee. All participants gave informed written consent, and they were selected according to the inclusion criteria of the study. These criteria were: (1) No history of known confounding systemic conditions, such as hyperlipidemia, DM, ischemic heart disease, obesity, or pregnancy; (2) no family history of dyslipidemia; (3) no evidence of infection within the preceding 3 months; (4) not on lipid-lowering medication or other medication; (5) not undergone periodontal treatment for the past 6 months; and (6) never smoked. As DM is an increasingly common perplexing factor, all subjects were screened by conforming to fasting blood sugar (FBS) assessments.

Sample Size

Sample sizes of 100 for the "test" group and 100 for the "control" group were originally projected. This was after going through the "New Patient Register" maintained in the clinic for the preceding 2 years, which directed the possibility of recruiting the above numbers approximately.

The originally recruited numbers for test and control groups were 112 and 78 respectively. After screening for DM, all subjects underwent pretreatment (pre-Rx) blood lipid assessment, followed by periodontal evaluations and treatment. However, only 83 subjects (out of 112) in the test group and 40 (out of 78) in the control group were available/qualified for the 12-week posttreatment (post-Rx) evaluations, hence the reason for including test = 83 and control = 40 in the analysis of results to compare pre-Rx and 12-weeks' post-Rx data.

Since dropout of patients was a drawback in the study, it was not possible to sustain an adequate sample size beyond 12 weeks for the intended long-term post-Rx evaluations.

Periodontal Assessments

All subjects underwent a full-mouth clinical periodontal assessment (FMCPA) in order to rationalize the presence/absence of periodontitis. Full-mouth clinical periodontal assessment was performed at six sites per tooth, using a William's periodontal probe. Periodontal parameters included percentages of plaque, bleeding on probing (BOP), probing depths (PD) in mm, gingival recession (in mm), loss of attachment (LOA), furcation involvement, and grading of tooth mobility. In the presence of gingival recession, LOA was obtained by adding recession and PD measurements. Where there was no recession, LOA was obtained by subtracting the "distance from gingival margin to cemento-enamel junction" from the "total PD."

The test group included patients with periodontitis according to the FMCPA and established diagnostic criteria followed in the Unit.[9] The control group included subjects free of periodontitis (adjudged by the FMCPA) with slight marginal gingival inflammation who attended for dental consultations, followed by oral prophylaxis.

After FMCPA, radiographic evaluations were performed on the test group in order to decide on the definitive treatment plan. Periodontal diagnoses were made according to the severity and distribution of periodontitis. Severity was categorized based on the guidelines denoting the clinical attachment levels and radiographic evidence of bone levels.[9] Thus, the categorization included four distinct groups, namely, "Localized Periodontitis-Mild-Moderate," "Localized Periodontitis-Severe," "Generalized Periodontitis-Mild-Moderate," and "Generalized Periodontitis-Severe." This categorization reflected the overall magnitude and disease burden where "Localized Periodontitis-Mild-Moderate" was considered as the least severe category and "Generalized Periodontitis-Severe" as the most severe category. The guidelines for severity grading were: (1) Mild-Moderate = LOA of less than 5 mm (clinically) and loss of bone up to half the root length radiographically; (2) severe = LOA 5 + mm and loss of bone greater than half the root length with or without furcation involvement. The distribution was categorized as "localized" if the total sites involved were less than 30% of all the examined sites, while more than 30% site involvement was considered as of "generalized" category.

All periodontal assessments were carried out by a well-trained practitioner, following intraexaminer calibration and informed consent of the subjects.

Laboratory Assessments

All subjects were first screened to exclude DM by conforming to FBS measurement. Within 3 days following

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Table 1: Comparison of lipid and triglyceride levels in the test and control groups before (pre-) and after (post-) treatment/intervention

Groups		TOTAL-Ch (mg/100 mL)		HDL-Ch (mg/100 mL)		LDL-Ch (mg/100 mL)		Triglyceride (mg/100 mL)	
Control		Pre-I	Post-I	Pre-I	Post-I	Pre-I	Post-I	Pre-I	Post-I
	Mean	205.71	195.41	42.62	38.08	137.18	127.74	142.67	149.11
	N	40	40	40	40	40	40	40	40
	Standard deviation	38.8025	40.2500	10.9400	13.1368	30.9354	28.6228	62.466	61.967
Test		Pre-Rx	Post-Rx	Pre-Rx	Post-Rx	Pre-Rx	Post-Rx	Pre-Rx	Post-Rx
	Mean	215.53	204.67	43.66	39.74	146.31	137.515	134.99	136.79
	N	83	83	83	83	83	83	83	83
	Standard deviation	45.2613	38.7155	11.4660	10.3018	39.7814	34.4733	65.082	56.724
Statistical significance (Student's t-test)		t = 1.975	t = 1.226	t = 0.833	t = 0.762	*t = 2.09	t = 1.553	t = 1.075	t = 1.09

Pre-I: Pre-intervention; Post-I: Post-intervention [Control Group]; Pre Rx: Pre-treatment; Post-Rx: Post-treatment [Test Group]; N: Number; *Statistically significant (According to the t Table, the t value should be ≥ 1.99 to be significant at 95% confidence level)

recruitment of subjects, prior to periodontal treatment or any intervention, their lipid profile (Table 1) was assessed. Venous blood (5 mL) was obtained from each subject after 12 hours of fasting. Blood samples were obtained in the Haematology Laboratory in the Study Centre and then transported to the Department of Biochemistry, Faculty of Medicine, University of Peradeniya, Sri Lanka, for assessment. Plasma lipids and triglyceride levels were determined by routine enzymatic methods. [The following cut-off points were considered as pathological according to the laboratory's recommendations: Total cholesterol (TOTAL-Ch) > 230 mg/dL; LDL cholesterol > 160 mg/dL; HDL cholesterol < 45 mg/dL; Total cholesterol/HDL ratio > 5.5].[10]

Experimental Protocol

All patients in the test group underwent treatment for periodontitis, while the control group received routine oral prophylaxis. Both groups were followed up for 3 months' periodontal maintenance care.

The periodontal treatment protocol for the test group included sessions of plaque control methods, elimination of plaque-retentive areas, systematic quadrant-wise scaling and closed root surface debridement (SC and RSD), and stringent maintenance care. Following active treatment, patient compliance was reviewed at 2-weekly intervals during maintenance phase for 12 weeks. Similarly, the control group was also followed up for the maintenance phase for 12 weeks at 2-weekly intervals, after oral prophylaxis.

Twelve weeks following interventions, periodontal reevaluations were performed with a FMCPA, and the same parameters (BOP, PD, LOA, mobility) and plaque scores were reassessed. Blood lipid profiles were also assessed at 12 weeks following treatment/oral prophylaxis.

Statistical Design

The data were processed and the mean values and standard deviations of TOTAL-Ch, LDL-Ch, HDL-Ch, and Tri-Gs for test and control groups at pretreatment and posttreatment were tabulated. Paired sample correlations were analyzed and the Student's t-test was applied to denote any significance of the results. Accordingly, a t-value of ≥ 1.99 in the t-table was denoted as the cut-off value for a significant result at 95% confidence interval.

In order to test for a reliably matching control group for test group comparisons, socioeconomic status (SES) was established by obtaining a composite index for their occupation and education, which has previously been validated as a method to categorize SES in a study carried out in Sri Lanka.[11] Thus, the information on occupation and education was amalgamated to represent the SES of subjects where a scale (1–10) from correspondence analysis was obtained and the subjects were categorized into three groups (Low-, Middle-, and High-Socioeconomic groups). Only the subjects belonging to "middle SES" category were included in the analysis. Similarly, matching for dietary habits was carried out cautiously only to include those who could be considered as "conformists," of typical Sri Lankan diet. With the corresponding analyses, subjects were categorized into three groups based on their overall consumption of fats, sugars, and carbohydrates (FSC). The categories were Low-, Moderate- and High-FSC consumers. Only the "moderate FSC consumers" were included in the analysis.

RESULTS

Mean values of TOTAL-Ch, HDL-Ch, LDL-Ch, and Tri-G in mg/100 mL for control and test groups were compared at preintervention/pretreatment (Table 1). Accordingly,

the test group had 5% higher mean TOTAL-Ch than the control group prior to interventions. Nevertheless, this increase was not statistically significant. Yet, neither the test nor the control group revealed abnormal values of TOTAL-Ch. Similarly, LDL-Ch values of test and control groups were within the normal range. However, it was 6.6% higher in the test group when compared to the control, and the difference was statistically significant at 95% confidence interval (t = 2.09). A similar trend was apparent with regard to HDL-Ch in both the groups. Although HDL-Ch values were within the normal range, the value for the test group was 2.6% higher than that of the control, though not statistically significant. In contrast, the mean value of Tri-G was 5.7% higher in the control group than the test group, without any statistical significance.

Notably, 12 weeks after interventions/treatment, it was observed that TOTAL-Ch, HDL-Ch, and LDL-Ch levels had reduced in both the groups when compared with their respective pretreatment values, while the Tri-G levels have shown an opposite effect (increase) in both the groups.

Table 2 depicts paired sample correlations for the control group. Accordingly, the reductions in TOTAL-Ch, HDL-Ch, LDL-Ch, and TOTAL-Ch/HDL ratio were statistically significant at 95% confidence interval, although the difference in mean Tri-G was not statistically significant.

Table 3 represents paired sample correlations for the test group before and after treatment. Here too, a similar

Table 2: Paired sample correlations for the control group

	Paired samples test (control group) *Paired differences*							
	Mean (mg/100 mL)	*Std deviation*	*Std error mean*	*95% confidence interval of the difference*				
				Lower	*Upper*	*T*	*df*	*(2-tailed)*
Pair 1: Pre-TOTAL-Ch Post-TOTAL-Ch	10.30000	21.34348	3.37470	3.47402	17.12598	3.052	39	0.004*
Pair 2: Pre-HDL-Ch Post-HDL-Ch	4.53560	7.53329	1.19112	2.12634	6.94487	3.808	39	0.000*
Pair 3: Pre-LDL-Ch Post-LDL-Ch	9.44500	9.16680	1.44940	6.51331	12.37669	6.516	39	0.000*
Pair 4: Pre-TOTAL-Ch_ HDL-Ch Post-TOTAL-Ch_ HDL-Ch	–0.39667	0.73672	0.11649	–0.63229	–0.16106	3.405	39	0.002*
Pair 5: Pre-Tri-G Post-Tri-G	–6.43250	47.05132	7.43947	–21.48024	8.61524	–0.865	39	0.393

Std deviation/Std error: Standard deviation/Standard error; T: t value; Pre-: Before intervention; Post-: After intervention; Ch: Cholesterol; Tri-G: Triglycerides; *Statistically significant. According to the t table, the t-value should be ≥2.02 to be significant at least at 95% confidence level (n = 40)

Table 3: Paired sample correlations for the test group

	Paired samples test (test group) *Paired differences*							
	Mean (mg/100 mL)	*Std deviation*	*Std error mean*	*95% confidence interval of the difference*				
				Lower	*Upper*	*T*	*df*	*Significance (2-tailed)*
Pair 1: Pre-TOTAL-Ch Post-TOTAL-Ch	10.85542	22.26980	2.44443	5.99267	15.71817	4.441	82	0.000*
Pair 2: Pre-HDL-Ch Post-HDL-Ch	3.92202	7.40484	0.81279	2.30513	5.53891	4.825	82	0.000*
Pair 3: Pre-LDL-Ch Post-LDL-Ch	8.79398	13.22243	1.45135	5.90678	11.68117	6.059	82	0.000*
Pair 4: Pre-TOTAL-Ch_ HDL-Ch Post-TOTAL-Ch_ HDL-Ch	–0.17333	0.68339	0.07501	–0.32255	–0.02411	–2.311	82	0.023*
Pair 5 Pre-Tri-G Post-Tri-G	–1.79711	31.73781	3.48368	–8.72725	5.13304	–0.516	82	0.607

Std deviation/Std error: Standard deviation/standard error; T: t value; Pre-: Before treatment; Post-: After treatment; Ch: Cholesterol; Tri-G: Triglycerides; *Statistically significant at least at 95% confidence level

Table 4: Comparison of the severity of periodontitis and lipid levels in the test group

Periodontitis-severity category	TOTAL-Ch	HDL-Ch	LDL-Ch	TOTAL-Ch/HDL-Ch	Tri-G
Localized Periodontitis ("Mild-Moderate" vs "Severe")					
T	0.069891439	–0.889925013	–0.040979256	–0.015148054	0.299648671
t ≥ 2.08, N = 23					
Generalized Periodontitis ("Mild-Moderate" vs "Severe")					
T	–1.408226193	1.321395	2.433667261*	–0.49217	0.243892
t ≥ 2.00, N = 58					

Ch: Cholesterol; T: t value; N: Number; *Statistically significant at 95% confidence; t ≥ value for a significant result

reduction was evident where the differences between pre- and posttreatment values for TOTAL-Ch, HDL-Ch, LDL-Ch, and TOTAL-Ch/HDL-Ch ratio were statistically significant at 95% confidence interval. However, the difference between pre- and post-Tri-G levels was not statistically significant.

Table 4 gives t values and their significance based on the mean lipid and Tri-G values obtained for patients categorized as "Localized Periodontitis" or "Generalized Periodontitis" and severity categorization as "Mild-Moderate" or "Severe" periodontitis. Thus, the analysis was based on the mean values for four distinct groups, namely: (1) Localized Periodontitis-Mild to Moderate, (2) Localized Periodontitis-Severe, (3) Generalized Periodontitis-Mild to Moderate, and (4) Generalized Periodontitis-Severe.

The previous categorization reflects the overall magnitude of disease, where "Localized Periodontitis-Mild to Moderate" was considered as the "least-severe" category and "Generalized Periodontitis-Severe" as "most severe."

The t values obtained for comparison of TOTAL-Ch, HDL, LDL, TOTAL-Ch/HDL ratio and Tri-G between "Localized Periodontitis-Mild-Moderate" group and "Localized Periodontitis-Severe" group were less than what is required (≥ 2.08) for a significant result. In other words, with localized disease, lipid and Tri-G levels have not been significantly different between the two severity categories. However, the t values obtained for the same comparisons in "Generalized Periodontitis-Mild-Moderate" category and "Generalized Periodontitis-Severe" category showed a significant result, only for the LDL-Ch levels (t > 2.00). This indicates that the patients affected with "severe" generalized periodontitis had significantly higher LDL-Ch level when compared to those having "mild–moderate" generalized periodontitis.

DISCUSSION

In the present study, the baseline mean values of TOTAL-Ch and LDL-Ch were higher in the test group than those in the control group. However, only the difference between LDL-Ch of the two groups showed significance statistically. Yet, the aforementioned result is in agreement with the trend already reported globally to explain the association between hyperlipidemia and periodontitis. This supports the notion that chronic infections, such as periodontitis could modify the serum lipid profile, promoting unfavorable lipids in a way that would increase the risk of atherosclerosis. Possible mechanisms linking hyperlipidemia and periodontitis report that hyperlipidemia could induce hyperactivity of leukocytes. A recent pilot study demonstrates a significant dyslipidemic profile and elevated levels of the inflammatory agents C-reactive protein, IL-6, and TNF-α in subjects with CHD and chronic periodontitis compared with those without periodontitis.[12]

However, dyslipidemia is implicated as a multifactorial condition, since numerous factors influence its occurrence in an individual. In this context, lipid profiles of the Sri Lankan study population with periodontitis are noteworthy. There is also evidence to validate the concept that treatment of periodontal disease has beneficial effects on lipid metabolism, with significant improvement in lipid profiles in response to periodontal treatment possibly due to decreased serum levels of pro-inflammatory cytokines.[13] It is interesting that, in the present study, all types of lipids in both groups were reduced with either periodontal treatment or interventions, while Tri-G levels have shown an opposite effect. While this highlights the importance of periodontal treatment and other therapeutic interventions in lowering the blood lipids, it may also indicate a possible balance maintained between serum lipids and triglycerides, albeit with undefined precision for such a mechanism. As such, a recent research has reported that higher levels of tri-glycerides and lower levels of HDL-Ch were associated with the presence of Treponema denticola in chronic periodontitis, suggesting a possible mechanism that these organisms could reduce anti-atherogenic potency of HDL-Ch.[14]

Even though the mean lipid values in the test and control groups in the present study have not exceeded the accepted normal values, these findings can be extrapolated to reinforce the importance of periodontal therapy and preventive care in bringing about a favorable lipid profile, if it is to be applied to individuals with abnormally altered lipid levels.

The findings of this study portray the impact of more generalized severe form of periodontitis with a greater inflammatory burden in influencing the rise of the most unfavorable serum lipid, LDL-Ch, in contrast to generalized, but mild–moderate category of periodontitis. It also highlighted that "localized" periodontitis, irrespective of its severity, may not be adequate to elicit significant changes in the lipid profile of such patients. Therefore, it is essential that periodontal inflammation is controlled promptly both by clinicians and by patients, without permitting it to establish in a generalized form, which in turn would lead to adverse systemic consequences, such as heightened cardiovascular risk markers.

It is anticipated that an expanded long-term follow-up study with a larger study sample would enable a more detailed analysis based on sex, age groups, and more specific severity categories of periodontitis. Such an analysis would provide aspects pertaining to specificity and clarity of this association.

CONCLUSION

Periodontitis is inflammation of the tissues surrounding the tooth affecting the gingiva, periodontal ligaments and the bone and in its severe forms there can be loss of bone that supports the tooth, resulting in the tooth becoming loose and even causing tooth loss.[15] Resultant tooth loss would not only be a local problem confined to the oral cavity and its function/esthetics, but would have adverse implications on the systemic health.

ACKNOWLEDGMENT

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