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RESEARCH ARTICLE

"A COMPARATIVE EVALUATION OF MICRONUTRIENT (ZINC, COPPER AND SELENIUM) LEVELS IN THE SERUM OF HEALTHY, GINGIVITIS AND CHRONIC PERIODONTITIS PATIENTS"- A CLINICO BIOCHEMICAL STUDY

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Key words:-
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Key Message:-
Serum Levels of Zinc and Selenium is Decreased while Copper is Increased in Patients with Periodontitis Compared to Healthy Individuals and Gingivitis Group. Serum Levels of Zinc and Selenium is Increased and Copper Levels Decreased Post Treatment compared To Pre-Treatment Levels

Abstract

Context: Periodontitis is a complex disease in which disease expression involves intricate interactions of the biofilm with the host immune inflammatory response. Micronutrients like zinc, copper and selenium play an important role in antioxidant defense, immune regulation, and neutralization of the inflammation process at the cellular level. It has been reported that deficiencies of several macro and micronutrients adversely influence the prognosis of periodontal infections.

Aims: This study has been designed to estimate and compare the serum levels of micronutrients (zinc, copper and selenium) in healthy, gingivitis and periodontitis patients before and after non-surgical periodontal therapy.

Settings and Design: This study is a case-control study.

Methods and Material: The comprised of 75 patients who were divided into three groups - Group I consisting of 25 periodontally healthy subjects, Group II consisting of 25 subjects with chronic gingivitis and Group III consisting of 25 subjects with chronic periodontitis. Atomic absorption spectrophotometry method was used to measure the clinical level of selenium, zinc and copper in serum.

Statistical analysis used: One way ANOVA with Tukey Post-Hoc test and Paired t-test was used.

Results: Results show highly significant increase in copper levels and decrease in zinc and selenium levels in periodontitis group compared to the control. There is an increase in the zinc and decrease in copper pre and post treatment levels.

Conclusions: Imbalance of Zinc, copper and selenium levels in the serum can predispose an individual to the risk of developing periodontitis.

Introduction:-

Periodontitis is a complex disease in which disease expression involves intricate interactions of the biofilm with the host immune inflammatory response. [1]

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Periodontitis is modified by numerous risk factors. It is recognized that the nature and severity of periodontal disease is associated with nutritional deficiency, blood dyscrasias, drug interactions and a compromised immune system. [2, 3]

The integrity of periodontium is dependent upon adequate supply of essential nutrients and their deficiencies influence the prognosis of periodontal infections.[4] Micronutrients like zinc, copper and selenium play an important role in antioxidant defense, immune regulation, and neutralization of the inflammation process at the cellular level.

Materials and Methods:-

The subjects were selected from the Department of Periodontics, A.B.Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore. Written informed consent was obtained from each subject.

Ethical clearance:
Ethical clearance was given by ethical committee of A.B.ShettyMemorial Institute of Dental Sciences.

Informed consent was taken from all the subjects before the commencement of the study.

75 subjects were selected anddivided into 3 groups, 25 in each group. Group I: 25 subjects who were periodontally healthy between 25 and 55 years of age. Group II: 25 subjects with gingivitis between 25 and 55 years of age. Group III: 25 subjects with chronic periodontitis between 25 and 55 years of age.

Inclusion criteria:
Subjects who were periodontally healthy were taken as group I. Subjects who have a pocket probing depth and/or clinical loss of attachment of equal to or >5mm in at least 30% of sites in group III.Subjects with minimum complement of 20 teeth. All subjects were systemically healthy with no medical condition that would affect their participation in the study.

Exclusion criteria:
History of any antibiotic/anti-inflammatory therapy for 3 months prior to study. History of any systemic diseases/conditions. Pregnant/lactating women. Subjects with a history of smoking, tobacco consumption subjects using vitamin/minerals or antioxidants supplements intake during the last 3months.Subjects who had undergone any periodontal therapy 3 months prior to study.

Medical and dental history of the subjects was recorded. Gingival index was recorded according to criteria given by Loe and Silness. Probing depth and loss of attachment was recorded using Williams graduated periodontal probe. Group II and III patients after undergoing non-surgical periodontal therapy were followed up after 3weeks for investigations of various blood parameters.

All measurements and readings were taken before the collection of the blood sample. For group II and III subjects, one set of readings were taken before periodontal treatment, the next set of sample was taken 21 days after periodontal treatment. The samples were coded before being sent for laboratory investigations.

Atomic absorption spectrophotometry method was used to measure clinical level of zinc, selenium and copper in serum.[5]

Results:-

Table 1:- Comparison of the three groups: one way ANOVA with Tukey Post-Hoc test.

Concinmg/lt PRE Rx	GROUPS	N	Mean	Std. Deviation	Statistics/ mean squares	df2(welch) / F(Anova)	P VALUE
ZINC	Healthy individuals	25	75.468	5.046263	11.181	42.406	0.302
	Gingivitis	25	74.78	136.5269			
	Periodontitis	25	69.2704	4.382694			
	Total	75	82.27013	79.15148			

COPPER	Healthy individuals	25	77.4348	4.11952	24.269	43.756	<0.001
	Gingivitis	25	81.907	7.458351			
	Periodontitis	25	89.492	7.649179			
	Total	75	82.9446	8.223361			
SELENIUM	Healthy individuals	25	196.944	8.602717	94.697	47.283	<0.001
	Gingivitis	25	183.3996	6.339131			
	Periodontitis	25	166.044	7.38236			
	Total	75	182.1292	14.7246			

Table 1 shows highly significant increase in copper levels in periodontitis group compared to the control group. It also shows significant decrease in zinc levels and highly significant decrease in selenium levels in periodontitis group compared to the control group.

Table 2:- Comparison of the pre and the post values in gingivitis and periodontitis separately: paired t-test.

						Paired Differences				
			Mean	N	Std. Deviation	Mean	Std. Deviation	t	df	P VALUE
GINGIVITIS	Pair 5	Zinc Conc. in mg/L PRE Rx	102.072	25	136.5269	27.104	136.1998	0.995	24	0.33
		Zinc Conc. in mg/L POST Rx	74.968	25	4.618777					
	Pair 6	CopperConc. in mg/lt PRE Rx	81.907	25	7.458351	0.487	2.317597	1.051	24	0.304
		CopperConc. in mg/lt POST Rx	81.42	25	8.676021					
	Pair 7	Selenium µg/dl PRE Rx	183.3996	25	6.339131	-0.3404	1.470137	-1.158	24	0.258
		Seleniumµg/dl POST Rx	183.74	25	6.451873					
PERIODONTITIS	Pair 5	Zinc Conc. in mg/L PRE Rx	69.2704	25	4.382694	-0.5896	0.369194	-7.985	24	**<0.001**
		Zinc Conc. in mg/L POST Rx	69.86	25	4.370545					
	Pair 6	CopperConc. in mg/lt PRE Rx	89.492	25	7.649179	0.48	0.248328	9.665	24	**<0.001**
		CopperConc. in mg/lt POST Rx	89.012	25	7.629347					
	Pair 7	Selenium µg/dl PRE Rx	166.044	25	7.38236	-0.12	0.67082	-0.894	24	0.38
		Seleniumµg/dl POST Rx	166.164	25	7.657833					

Table 2 shows highly significant change in levels of pre and post treatment levels of zinc and copper. There is an increase in the zinc levels and decrease in the copper pre and post treatment levels. Mean and standard deviation of zinc, copper and selenium pre and post treatment levels between gingivitis and periodontitis patients.

Discussion:-

The immune-inflammatory response that develops in the gingival and periodontal tissues in response to the chronic presence of plaque bacteria results in the destruction of structural components of the periodontium leading, ultimately, to clinical signs of periodontitis.

Trace elements, defined as metals found in biological fluids at concentrations below 1 µg/g of wet tissue, play a crucial role in physiological processes. Among these, zinc, copper, and selenium are integral to the activity of numerous enzymes involved in essential biochemical reactions, thereby supporting health across the lifespan. Furthermore, micronutrients are fundamental for continuous tissue regeneration, effective oxidative stress management, and the maintenance of robust immune responses.

The objective of this study was to evaluate and compare serum micronutrients (zinc, copper and selenium) levels in healthy, gingivitis and periodontitis patients.

The study findings revealed decreased levels of zinc and selenium and elevated levels of copper in individuals with periodontitis and gingivitis compared to the control group. Notably, the differences in serum selenium and copper levels were statistically significant ($p < 0.001$). These results align with previous studies by Polenik et al., Frithiof et al., and Tulin et al., which similarly reported reduced zinc levels and increased copper levels in individuals with periodontitis relative to the control group. [3,6,7,8,9]

The study also found a significant increase in the post treatment serum levels of Zinc in periodontitis groups ($p <0.001$).The findings indicated an inverse relationship between zinc and copper levels, a pattern corroborated by other studies that have observed similar trends in inflammatory conditions such as inflammatory bowel disease. This inverse relationship is likely attributed to the reduced absorption of zinc in the small intestine in the presence of copper.[10]

Zinc serves as an intracellular signaling molecule, playing a pivotal role in immune function and exhibiting potent antioxidant properties. It is indispensable for the optimal activity of nearly 300 enzymes. Zinc deficiency has been linked to decreased osteoblastic activity, impaired collagen and proteoglycan synthesis, and reduced alkaline phosphatase activity. Evidence indicates that sufficient zinc intake supports a Th1-mediated immune response and is critical for maintaining the structural integrity of skin and mucosal membranes (Starcher et al.). Research has also demonstrated that zinc deficiency in gingival tissues increases the permeability of the gingival epithelium to bacterial infiltration and shows an inverse correlation with both marginal alveolar bone loss and serum zinc levels.

Moreover, studies suggest that reduced serum zinc levels impair several cellular components of innate immunity, including macrophage and neutrophil phagocytosis, natural killer (NK) cell activity, oxidative burst generation, antibody production, and cytotoxic CD8+ T-cell activity (Th1 response). Zinc also influences immune function indirectly by modifying the structure of α2-macroglobulin, enhancing its interactions with cytokines and proteases. Additionally, zinc deficiency disrupts the metabolism of androgens, estrogens, and progesterone, likely due to the involvement of zinc finger proteins in regulating membrane and nuclear receptor activity, ultimately leading to compromised immune responses.[12]Studies have shown that Zinc exerts its effects in an indirect manner by stabilizing the cell membrane structure, contributing, to the structure of the SOD and maintaining the metallothionein tissue concentrations.It can be suggested that inadequate intake of zinc may lead to suppressed immunity along with increased oxidative stress and poor regenerative capacity in an individual which can predispose to periodontitis and the possible mechanism as to why post treatment zinc level has increased compared to the pre treatment levels.[12]

Copper ions participate in radical reactions such as the conversion of superoxide to hydrogen peroxide and hydroxyl radicals. Thus, elevated levels of copper in individuals could lead to increased oxidative stress and ultimately increased periodontal destruction.[13,14] It has also been reported that elevated serum copper levels alter collagen metabolism and hence promote periodontitis.[15]Elevated serum copper levels have been associated with impaired immune function, as they disrupt the complement system and suppress various immune responses in animal models.

These effects include a reduction in neutrophil counts, inhibited lymphocyte proliferation, and decreased production of antigen-specific antibodies.[13,14] It has been proposed that a leukocyte endogenous mediator serves as a feedback signal to facilitate hepatic copper mobilization, which may explain the elevated serum copper levels observed in individuals with periodontitis. Lysyl oxidase, a copper-dependent monoamine oxidase, plays a critical role in collagen stabilization. Elevated serum copper levels may also result from the accumulation of lysyl oxidase or other copper-dependent enzymes in the bloodstream.[15] This study revealed significantly lower serum selenium levels in patients with periodontitis and gingivitis compared to the control group. However, no significant increase in serum selenium levels was observed in the periodontitis group following treatment. The study also aimed to assess serum levels of zinc, copper, and selenium in healthy individuals using atomic absorption spectrophotometry. These findings align with recent research indicating that reduced serum levels of zinc and selenium are associated with periodontitis.[16,17,18,19]Selenium plays an important role in balancing the redox state, and helping to protect the host from oxidative stress generated by the microbicidal effects of macrophages and during inflammatory reactions. [19]Hence, level of selenium is expected to be inversely related to periodontal disease severity.

More longitudinal studies with a larger sample size should be carried out to have a better understanding of the inter-relationship between micronutrients imbalance and chronic disease processes like periodontitis. Further studies should also be carried out to evaluate the serum levels of micronutrients before and after periodontal therapy with a larger sample size to arrive at a more conclusive result.

Conclusion:-

Compared to the gingivitis group and healthy persons, patients with periodontitis have higher serum levels of copper and lower serum levels of zinc and selenium. After therapy, serum levels of copper dropped while those of zinc and selenium rose relative to pre-treatment values. To get a more definitive finding, more research should be done to compare the serum levels of micronutrients before and after periodontal therapy using a bigger sample size.

References:-

1. Kornman KS. Mapping the Pathogenesis of Periodontitis: A New Look. J. Periodontol 2008;79:1560-8.
2. Sahingur SE, Cohen RE. Analysis of host responses and risk for disease progression. Periodontology 2000 2004; 34: 57-83
3. Thomas B, Kumari S, Ramitha K, AshwiniKumari MB. Comparative evaluation of micronutrient status in the serum of diabetes mellitus patients and healthy individual with periodontitis. J Periodontol 2010;14:46-49.
4. Schifferle RE. Periodontal disease and nutrition:separating the evidence from current facts. Periodontol 2000 2009;50:78-89.
5. GhayourMobarhan M, Taylor A, New SA, Lamb DJ, Ferns GA. Determinants of serum copper, zinc and selenium in healthy subjects. Ann ClinBiochem 2005;42:364-75.
6. Ma ZJ, Zhang JZ. Changes in serum zinc levels of periodontitis with kidney Deficiency. ZhongguoZhong Xi Yi Jie He ZaZhi 1993;13:606-7.
7. Polenik P. Zinc in Etiology of Periodontal Disease. Med Hypotheses 1993;40:182-5.
8. Frithiof L, Lavstedt S, Eklund G, Soderberg U, Skarberg KO, Blomqvist J et al. The relationship between marginal bone loss and serum zinc levels. Acta Med Sc and1980;207:67-70.
9. Kuraner T, Beksac MS, Kayakirilmaz K, Cağlayan F, Onderoğlu LS, Ozgünes H. Serum and parotid saliva testosterone, calcium, magnesium, and zinc levels in males, with and without periodontitis. Biol Trace Elem Res 1991;31:43-9.
10. Mocchegiani E, Costarelli L, Giacconi R, Piacenza F, Basso A, Malavolta M. Micronutrient (Zn, Cu, Fe)-gene interactions in ageing and inflammatory age-related diseases: implications for treatments. Ageing Res Rev2012;11:297-319.
11. Starcher BC, Hill CH, Madaras JG. Effect of zinc deficiency on bone collagenase and collagen turnover. J Nutr 1980;110:2095-102.
12. Tapiero H, Tew KD. Trace elements in human physiology and pathology: zinc and metallothioneins. Biomed Pharmacother2003;57:399-411.
13. Prasad AS. Zinc in human health: An update. J Trace Elem Exp Med 1998;11:63-87.
14. Burch RE, Hahn HK, Sullivan JF. Newer aspects of the roles of zinc, manganese and copper in human nutrition. ClinChem 1975;21:501-20.
15. Freeland JH, Cousins RJ, Schwartz R. Relationship of mineral status and intake to periodontal disease. Am J ClinNutr 1976;29:745-9.

16. Chapple IL, Milward MR, Dietrich T. The prevalence of inflammatory periodontitis is negatively associated with serum antioxidant concentrations. J Nutr 2007;137:657-64.
17. Enwonwu CO, Ritchie CS. Nutrition and inflammatory markers. J AM Dent Assoc 2007;138:70-3.
18. West IC. Radicals and oxidative stress in diabetes. Diabet Med2000;17:171-80.
19. Chapple IL. Reactive oxygen species and antioxidants in inflammatory diseases. J Clin Periodontol 1997;24:287-96.