INDIAN JOURNAL OF DENTAL ADVANCEMENTS

Journal homepage: www. nacd. in

REVIEW

Quick Response Code

doi: 10.5866/4.1.763

Role of Stress in Periodontal Disease

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Article Info
Received: January 16, 2012
Review Completed: February, 14, 2012
Accepted: March 16, 2012
Available Online: April, 2012

ABSTRACT:

Psychological stress, if sustained over an extended period of time can have deleterious effects on the body representing an example of the mind-body interaction. Human and animal studies have shown that dental plaque bacteria are important for the development of gingivitis and periodontitis in both healthy and immunocompromised humans. As with many chronic infections the onset and progression of periodontal infections are clearly modified by local and systemic host conditions or risk factors that markedly affect the resistance of the host to infecting periodontal organisms. Psychological conditions, particularly psychological stress have been implicated as risk indicators for periodontal disease. This article reviews the current literature with emphasis on the potential role of psychological stress in periodontal disease progression.

Key words: ***Stress, Periodontal Disease, Glucocorticoids, Cortisol and Smoking.***

INTRODUCTION

Periodontal disease is a multifactorial disease. Dental plaque which harbours specific periodontal pathogens is its primary aetiologic factor. In addition several risks and susceptibilities have been associated with periodontitis, like systemic diseases, some genetic polymorphisms, socio-economic or educational status, tobacco smoking and psychological stress.

Stress is considered as one of the important factors essential with etiology and maintenance of many inflammatory diseases including periodontal disease. The main concept of stress is an attempt to understand how the body regulates itself to maintain smooth, adaptive and homeostatic functioning when confronted with disruptive endogenous or exogenous forces.[1]

Since 1950s emotional factors have been related to periodontal disease. Now it is well established that psychological stress can down regulate the cellular immune response. It is said that Communication between the central nervous system and the immune system occurs via a complex network of bidirectional signals linking the nervous, endocrine, and immune systems. Stress disrupts the homeostasis of this network, which in turn, alter immune function.[2]

Chronic stress is commonly thought to have a net negative effect on the efficacy of the immune response, leading to an imbalance between host and parasites and consequently resulting in periodontal break down.[3] And is also said to increase allostatic load leading to malformation of some biological functions affecting many physiological systems essential to health maintenance, including both the cardiovascular and immune systems, making them more vulnerable for pathological alterations.[4]

Considering the fact that role of stress in human periodontal disease has a plausible patho-

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physiological basis. Most of the evidence has suggested an association of stress with more severe periodontal disease, as well as poorer healing response to traditional periodontal therapy.[5]

As Gingivitis and periodontitis are thought to result from an imbalance between the oral microorganisms which normally colonize tooth surfaces in close contact with gingival margins and the nature and efficiency of the host response. Even though bacteria are considered as triggering agents, the host defense mechanisms within the gingival or periodontal tissues seem to be responsible for most of the tissue damage and for the outcome and progression of the disease.[1]

Exposure to stress at critical periods of life is said to alter subjects hormonal and immune systems. It has recently been shown that emotional or psychological load may influence immune activities directly via nerve messenger substances or indirectly via hormones. The relationship between stress and periodontal disease might be mediated by alteration in gingival crevicular fluid, interleukin-1, depressed polymorpho nuclear leukocyte chemotaxis, phagocytosis and reduced proliferation of lymphocytes upon stimulation by mitogen.[4]

Although stress can be understood as part of a complex and dynamic system of transaction between individuals and their environment. It is considered as a part of human condition which is universally present, but to varying degrees and with different effects on individuals. And it is classified as one of the risk indicators for periodontal disease, which should be addressed before and after periodontal therapy.[2]

This article reviews the role of psychological stress in periodontal disease progression.

THE DEFINITION OF STRESS

According to Lumsden in 1975 the concept of stress was " one of the most significant and integrative concepts ever developed in social and biomedical sciences" and "its potential as a prime intellectual tool for not only understanding, but also explaining, individual and collective human behavior and disorders".[6]

Within the scientific area, the concept of stress has been widely used in a variety of different disciplines and contexts. As a result, a multiplicity of definitions and methodologies, theories and models have arisen and therefore is no easy agreement when a precise scientific definition is required.

- The term "stress" is thus to be treated as an economic descriptor of a particular problem-oriented process.
- Stress simply means pressure or tension.
- Stress can be defined as the individual's response to activation of life events and intense physical exercise.
- Stress can be defined as any physical or psychological event perceived as being able to cause harm or emotional distress.

PATHO PHYSIOLOGY OF THE STRESS RESPONSES

Stress can result in the deregulation of the immune system, mediated primarily through the hypothalamic-pituitary-adrenal and sympathetic-adrenal medullary axes (Fig. 1).

Activation of the hypothalamic-pituitary-adrenal axis by stress results in the release of an increased concentration of corticotropin-releasing hormone from the hypothalamus. The pituitary gland is connected to the hypothalamus by the infundibulum, a stalk of tissue that contains nerve fibers and small blood vessels. Corticotropin-releasing hormone acts on the anterior pituitary resulting in the release of adreno-corticotropic hormone (corticotropin). Its acts on the adrenal cortex and causes the production and release of glucocorticoid hormones (predominantly cortisol) into the circulation. This glucocorticoids pro-duce a myriad of effects throughout the body such as suppressing the inflammatory response, modifying cytokine profiles, elevating blood glucose levels and altering levels of certain growth factors.[5]

The second major pathway to be activated is the sympathetic nervous system. A well-known example of this is the so-called 'flight or fight' response to potentially harmful stimuli. Stress activates the nerve fibers of the autonomic nervous system, which innervate the tissues of the immune system. The

adrenal medulla is actually a modified sympathetic ganglion. Its nerve bodies, instead of possessing axons, secrete their products directly into the bloodstream. The release of catecholamine's results in the hormonal secretion of nor epinephrine and epi-nephrine from the adrenal medulla, which results in a range of effects that may act to modulate immune responses. Catecholamine's released during stress; contribute to the development of hyperglycemia by directly stimulating glucose production and interfer-ing with the tissue disposal of glucose. In addi-tion, the sympathetic nervous system has a role in regulating immune cell activities.

So it is apparent that the response of the human body to stressful stimuli is at once helpful and potentially therapeutic, even though a potentially harmful imbalance occurs when the stressful stimuli, or perceived stimuli, are pro-longed. Examples include chronic anxiety states and depression.

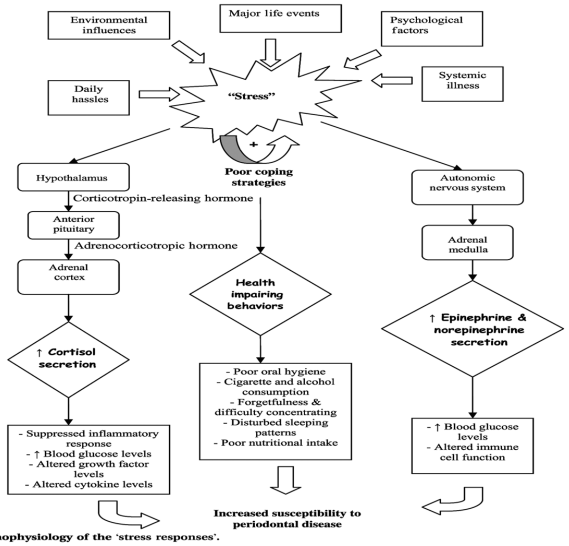
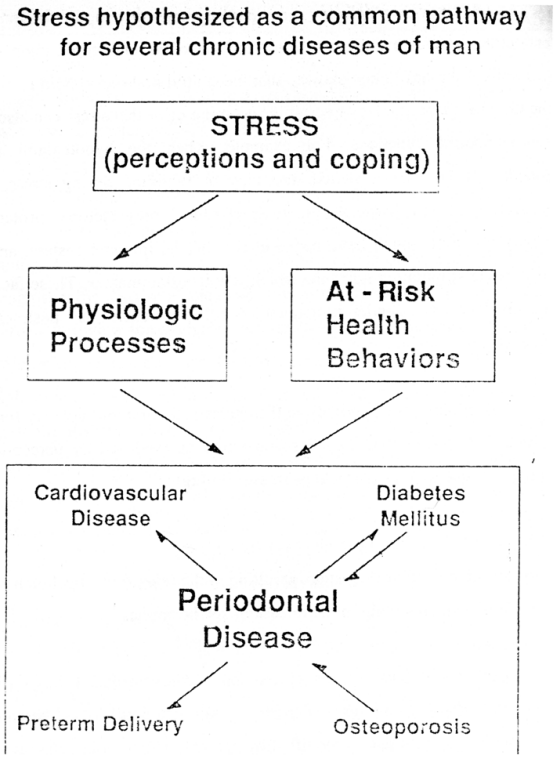


Fig. 1. Pathophysiology of the 'stress responses'.

STRESS AND SYSTEMIC INFLAMMATORY DISEASES

A number of chronic recurrent conditions in addition to periodontal disease are characterized by a fluctuating course, with ongoing disease punctuated by bouts of greater severity. The more severe bouts of all these conditions involve activation of the immune response and an associated increase in inflammation. The possible role of stress in these disease exacerbations is beginning to be understood through psycho-neuro-immunological studies. Although specific disease mechanisms may differ from condition to condition, it is heuristic to review the evidence concerning stress and disease activity in some of these inflammatory diseases, because it may shed light on possible pathways through which stress could affect periodontal disease. It has become clear that not only do systemic diseases such as diabetes and osteoporosis increase the risk for periodontal disease, but also that periodontal disease may increase the risk of systemic diseases such as cardiovascular diseases. Periodontal disease may also increase the risk for preterm delivery[1,7] (Fig. 2).

It is well established that cardiovascular disease, diabetes mellitus, preterm delivery, osteoporosis, rheumatoid arthritis, inflammatory bowel disease, systemic lupus erythematosus etc. are related to stress either as a physiological response to stress or as a behavioral response. It is a significant common risk factor for diabetes mellitus, cardiovascular disease, preterm delivery, and osteoporosis, as well as periodontal disease. Of course, different stressors and different responses to stress may be operative in each disease.



Communication between the central nervous system, immune and endocrine systems has given rise to the field of psychoneuroimmunology. For example, Ader and Cohen showed that the central nervous system is involved in the immune response. However, it is becoming clear that stress can also regulate neuroendocrine functions. For example, when the hypothalamic-pituitary-gonadal (HPG) axis is called into play or inhibited during stress, there is production of sex hormones such as estrogen, progesterone, prolactin and growth hormone which have major effects on the immune system, and alpha-melanocyte-stimulating hormone which is anti-inflammatory. These factors may be involved in gender-associated conditions such as postmenopausal osteoporosis.

Accordingly, they hypothesize that stress is a common pathway for several chronic diseases of man. Psychosocial stress as modified by perceptions and coping can lead to physiological processes through:[7]

1) The HPA axis, resulting in glucocorticosteroids;
2) The autonomic nervous system, resulting in the release of catecholamines;
3) The HPG axis, resulting in the release of sex hormones.

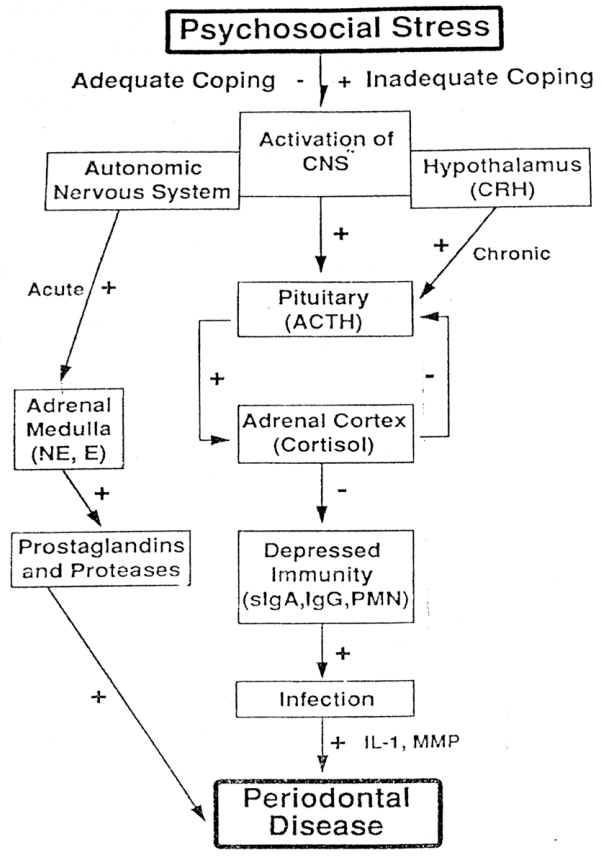
STRESS AND PERIODONTAL DISEASE

The literature relating stress to periodontal disease focuses on psychosocial stressors and their influences on susceptibility to gingival infection and/or the inflammatory aspects of periodontal disease.

Breivik et al.(1996)[1] have stated "The issue facing us is no longer whether the psyche influences immune cell activities....but rather how this may influence the development of chronic infections such as gingivitis and periodontitis. In humans, periodontal infections may act as models to study these psychosomatic interactions and the effects upon chronic inflammation in general".

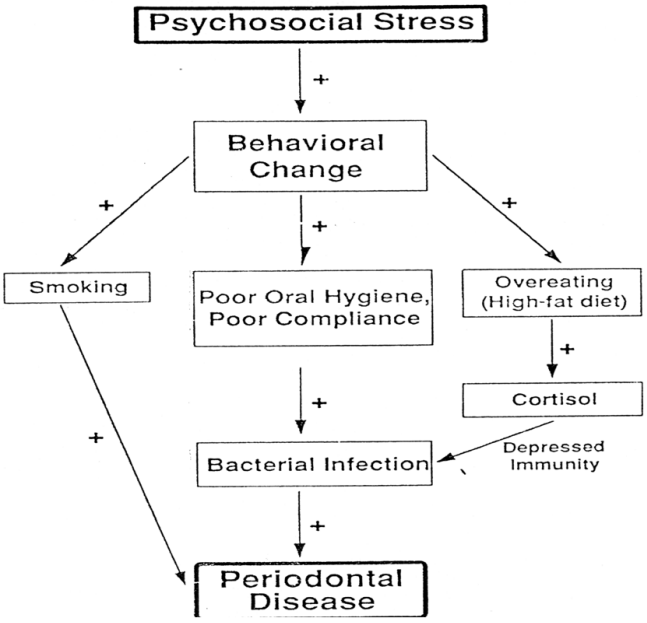
Genco et al. (1998)[8] (MODEL-1) (fig. 3) offered a schematic model which demonstrates the potential role that psychosocial stressors may play in initiating a cascade of events in the corticotrophin releasing hormone/hypothalamic-pituitary-adrenal axis, the autonomic nervous system and the central nervous system, the physiological consequences of which are to depress immunity, enhancing likelihood of infection and, specifically, periodontal disease. They also proposed that at-risk health behaviors such as poor oral hygiene and smoking may influence periodontal disease directly. (MODEL-2) (Fig. 4)

According to (MODEL-1)[8], psychosocial stress can activate the central nervous system. The hypothalamus releases CRH which, stimulates release of ACTH from the pituitary, which in turn results in production of Cortisol by the adrenal cortex. Glucocorticosteroids, including Cortisol, then depress immunity including secretory IgA, IgG, and neutrophil functions, all of which may be important in protection against infection by periodontal organisms.



MODEL-1 Fig. 3

In the second model it is hypothesized that the main effects of stress occur through behavioral changes which affect at risk health behaviors such as smoking, poor oral hygiene and poor compliance with dental care. There is also a possibility that stress leads to other behavioral changes such as overeating, especially a high-fat diet, which can lead to immunosuppresion through increased Cortisol production. There are certainly many other possible behaviors that could be affected by stress and inadequate coping and distress, such as depression, which would have significant effects on periodontal disease.



MODEL-2 Fig. 3

Possible mechanisms of action of psychosocial factors on periodontal tissue

Chronic diseases are the result of long-term interactions between a host and its environment. The causes of chronic diseases are multifactorial rather than specific, arising from cellular dysfunction initiated by aging, environmental, and genetic factors.

The distinction between necessary and sufficient causes is important in the understanding of chronic disease. A necessary factor must be present if the disease is to occur but that factor alone is not sufficient to cause the disease. The necessary cause may be a bacterium or virus that will not produce clinical manifestations until sufficient causes (often psychosocial) provide the impetus for alteration in the homeostasis of the host. Whether health is maintained or illness supervenes depends upon the environment and the ability of the organism to withstand environmental stressors. 3 components form an etiological matrix for chronic disease:[2]

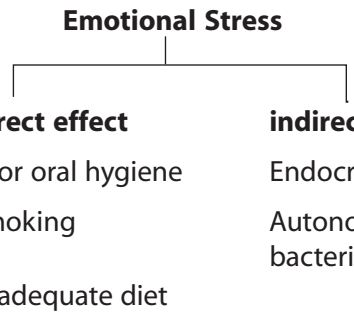
1. The virulence of the microorganism or agent.
2. Host resistance or susceptibility
3. Environmental conditions (social structure, management of emotions, diet, health care, and conflict).

A number of mechanisms have been proposed which could mediate the putative relationship between psychosocial conditions and inflammatory periodontal diseases. Such mechanisms include neglect of oral hygiene, changes in diet, increase in smoking and other pathogenic oral behaviors, bruxism, alterations in gingival circulation, endocrine imbalance and lowered host resistance. By examining these mechanisms it is evident that some may involve psychologically related changes in behavior, which enhance vulnerability to periodontal breakdown.

Psychosocial factors and ANUG[2]

ANUG is most studied periodontal disorder in relation to psychosocial predisposing factor which favours bacterial overgrowth and weakening host resistance. Pseudo epidemics can be attributed to the fact that populations may be simultaneously subjected to similar disease provoking circumstances, including war, military service, examination in schools, divorce etc.

According to Walter D. Shields (1977)[9] the possible etiological scheme in ANUG can be tabulated as:



Similarly, May OA Jr. (1984) gave emotional stress as one of systemic factor and Gergory M Horning and Cohen (1995)[10] gave emotional or psychological stress as predisposing factor in the etiology of ANUG.

Guidelines for evaluation of the role of psychosocial stress in periodontal disease

Genco et al.[8] propose guidelines for the evaluation of the role of psychosocial stress in periodontal disease for future studies.

1. Periodontal disease should be measured as a unique disease outcome, not included in a composite index with other oral diseases.
2. Stress and distress, as well as coping behaviors, should each be assessed by validated instruments. These instruments, of course, would be best validated by prior study but also should be validated on the particular population to which they are applied.
3. At-risk behaviors should be measured including oral health behaviors such as preventive dental visits, compliance with oral hygiene regimens and an assessment of plaque, gingivitis and other existing diseases as this may indicate compliance with oral health regimens.
4. Case series and case-control studies can generate hypotheses; however, large cross-sectional and longitudinal epidemiological studies may be needed to rigorously establish that psychosocial factors such as stress, distress, and coping behaviors are indeed true risk factors for periodontal disease.
5. Studies of mechanisms by which psychosocial stress or distress exert effects on periodontal disease are needed to establish the biological rationale for this relationship. Such studies may include assessment of biochemical mediators of stress, immune functions, or neurological and endocrine alterations, as well as behavioral changes. Animal models to test mechanisms may be instructive.
6. Intervention studies using stress management to reduce stress or distress with randomized controlled trial methodology are necessary to establish efficacy of modification of stress as a modality in the management of stress-associated disease.

DISCUSSION

Several clinical studies have investigated the possible relationship between psychological stress and periodontitis; have suggested that stress may play an important role in the development of periodontal disease. Furthermore, in a longitudinal study Linden et al. (1996)[11] established a relationship between occupational stress and the progression of periodontitis.

In contrary Castro GDC et al. (2006)[12] could not show any association between life events, anxiety and depression with periodontitis. The association between psychosocial factors and periodontal diseases is derived mainly from cross-sectional studies (Linden et al.1996, Genco et al.1999, Johannsen et al.2005, Klages et al.2005).[11, 13, 14, 15]

Moss et al. (1996)[16] conducted an exploratory case-control analysis of psychosocial factors and adult periodontitis, individuals with prevalent disease were found to be at higher levels of social strain than individuals without prevalent disease. According this study, a strong relationship was also found between prevalent disease and elevated antibody levels to Bacteroids forsythus among individuals with greater

evidence of depression. More recent studies by Solis (2004)[17],Vettore et al. (2003)[18] were not able to reproduce these findings.

There are two main paths by which stress influences the immune system. Psychosocial stress stimulates the brain, at this level maladaptive coping enhances the stimulation and an adaptive coping inhibits this stimulation. The autonomic nervous system leads to prostaglandins and proteases secretions. The hypothalamic-pituitary-adrenal axis (HPA) leads to a production of glucocorticoids (cortisol). The function of cortisol is to depress the immune system by diminishing the IgA and IgG secretions.

Klages U, Weber AG (2005)[15] discovered that mental stress could influence life-style and dental hygiene habits. This influence was not only decreases the frequency as well as the quality of the dental hygiene but also it increases tobacco use and alcohol consumption, changes in food habits leading to a diminution of the general health. This was in agreement with the study conducted by Suchday et al. (2006).

Deinzer Rennate et al.(2005)[19] have discussed that plaque is a valid indicator of oral hygiene behaviour even under academic stress conditions, there seems to be good evidence to add oral hygiene behaviour to the list of health behaviour's which gets adversely affected by stress. These results confirm the findings of Deinzer et al. (2001)[20] on stress associated alterations in oral health behaviour. It further extends by demonstrating an increase of gingivitis in exam going students as compared with controls 4 weeks after the exams .Gingivitis rates of posterior sextants of exam going students nearly doubled those of control participants. This data strongly support the notion discussed by several authors (Croucher et al.1997; Genco et al.1999, Deinzer, Kleineidam et al.2000)[21, 13, 22] that stress effects of periodontal health might be mediated, at least in part, by stress- induced neglect of oral hygiene.

There are several studies that have demonstrated a relationship between psychological stress and inflammatory diseases such as rheumatoid arthritis and periodontitis (da silva et al.1995, Genco et al. 1999).[2, 13] However, Breivik and Thrane (1996)[23] have studied why and how these factors are associated with increased periodontal disease susceptibility are poorly understood, the field of brain-neuroendocrine-immune interactions, is an important field to be explored.

Stress diminishes saliva flow and increases dental plaque formation. Emotional stress modifies the salivary PH and its chemical composition like the Ig A secretion. According to Deinzer et al.(1999)[24] the impact of academic stress on students at university during their examination period on periodontal health and had shown academic stress as a risk factor for gingival inflammation with increasing Crevicular interleukin-1β levels and a diminution of the quality of the oral hygiene. Monteria da silva (1995)[2] established an association between people with aggressive periodontitis and depression and also were more socially isolated than people with chronic periodontitis.

Linder et al. (1996)[11] predicted the future attachment loss depending on the age, socio-economical level, a less satisfactory professional life and a passive and dependent character. Axtelius (1998)[25] has suggested that patients with psychosocial strain and passive dependent traits did not respond as well as patients with less stressful psychosocial situation and with a rigid personality to periodontal treatment.

The subjects who felt stress due to self health were more prone to develop periodontal disease than subjects without stress (Akhter R.2005).[26] This finding is similar to the results of a one year prospective study by Freeman and Gross (1993) showed stress due to physical ill health was related to an increase in pocket depth. On the other hand, Linden et al. (1996)[11] found no evidence of an association between self-assessed physical health status and periodontal disease progression.

Recently, several studies have been published analyzing the relationship between psychological stress and destructive periodontal disease, leading to the general conclusion that stress represents a risk factor for periodontitis. Previous reports by Deinzer et al. (2001)[19] have shown that psychosocial stress can affect oral hygiene behaviour and can increase plaque accumulation, in contrary the study by Trombelli L et al. (2005)[27] found no association between the current level of stress and their amount of plaque deposits or plaque accumulation rate.

Reners and Brecx M (2007)[3] explained the influence of coping with stress on periodontal therapy and concluded that patients with maladaptative coping strategies have more advanced disease and poor response to a non- surgical periodontal treatment. Thus maladaptative behaviour's, especially in association with other risk factors (like smoking) are of great importance in the medical history, treatment and maintenance of patients with periodontal disease.

SUMMARY AND CONCLUSION

The relationship between life events, stress, health and illness has been well documented. It is not a simple one-to-one re-lationship but rather a dynamic interaction in which the state of stress is mediated not only by behavioral or psychological factors but also by social interac-tions with family and friends.

Direct association between periodontal disease and stress remains to be proven which is partly due to lack of an adequate animal models and difficulty in quantifying the amount and duration of stress. Also multiple variables affect the severity of periodontal disease and there is uncertainty about the individual's onset of periodontal disease. Moreover it is not possible to separate the effects of physical stress from emotional stress in these animal studies.

Traditional methods of treating periodontal disease and optimizing wound healing after periodontal surgery include thorough debridement of root surfaces, optimizing oral hygiene, utilization of antimicrobial substances, and (more recently) adjunct use of growth factors in various delivery vehicles. The above literature demonstrates that stress reduction protocols may have some value in the management of periodontal disease. Assessment of a patient's stress levels (and perhaps more importantly, their ability to cope with stress) and stress-reduction protocols might be of value when instituted as part of routine periodontal treatment.

The available scientific evidence thus does not definitively support a casual relationship between psychosocial factors and inflammatory periodontal diseases. The information reviewed above does indicate the possible influence of psychosocial factors in the etiology of inflammatory periodontal diseases. Psychosocial stress represents as a risk indicator for periodontal disease. The clinical management of inflammatory periodontal diseases might benefit from an exploration of these relationships.

FUTURE CONSIDERATIONS

The mechanisms which may mediate possible relationship between psychosocial conditions and inflammatory periodontal diseases remain a fertile area for research. There appears to be no study, which has shown that stress has induced changes in behavior which in turn have worsened periodontal conditions. In relation to the physiologic pathways through-which psychosocial factors could influence periodontal breakdown the following proposed mechanisms remain to be tested by future research:

1) Gingival circulation
2) Endocrine alterations
3) Lowered host defense
4) Systemic disorders as risk factors for periodontal disease.

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