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The Associations between Periodontitis and Respiratory Disease

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ABSTRACT

Researches have shown positive correlation between periodontitis and respiratory diseases such as chronic obstructive pulmonary disease. We reviewed the literature to assess the relationship between periodontitis and respiratory diseases. This study involved a review of relevant English literature published regarding periodontitis and respiratory diseases during the period of 1994-2015. The analysis of literature related to the topic showed there is association between periodontitis and respiratory diseases such as chronic obstructive pulmonary disease and pneumonia. It was found that periodontitis is associated with respiratory diseases due to poor oral hygiene and low immunity state.

Keywords: Inflammation; oral hygiene; periodontitis; respiratory illness. .

INTRODUCTION

The tissues supporting the teeth are collectively called the periodontium of the teeth. The inflammatory process involving the periodontium is called periodontitis that causes progressive loss of alveolar bone surrounding the tooth structure with loosening and subsequent loss of teeth. It is usually caused by microorganisms that get adherent to tooth surface and grow in its vicinity with aggressive immune response against these and thus causing swelling, redness, congestion, and pain in tissues surrounding the teeth.[1]

Many researches have defined a probable role for periodontal disease as a risk factor for systemic diseases,[2] consists of diabetes,[3] osteoporosis,[4] cardiovascular diseases,[5] adverse pregnancy outcome,[6] rheumatoid arthritis,[7] and respiratory disease such as chronic obstructive pulmonary disease (COPD). [8,9]

The chronic obstructive pulmonary disease is an inflammatory condition with progressive deterioration of pulmonary function and increasing airway obstruction[10,11] consists of emphysema and chronic bronchitis.[10] Oral microorganisms can be easily carried into the lungs and cause infection.[12] Also, COPD and periodontitis have common risk factors, such as obesity, older age, smoking, low socioeconomic status, etc.[2]

Many researches[13-33] have defined the positive association between periodontitis and COPD. However, different researches have assessed different populations and applied various assessment methods.[34]

Globally, hygiene control is improving; but, it is inadequate and the COPD burden will rise in near future due to population rise as suspected.[1] We will discuss if the periodontitis is associated with any respiratory illness or not and what are the causes and subsequent outcomes of the pathological process along with diagnostic, treatable, and preventive measures available to control the disease.

LITERATURE ANALYSIS

The research was undertaken by reviewing the English published articles on periodontitis and respiratory illnesses since 1994 to 2015. The following search terms were used: (1) periodontal disease, periodontitis, periodontal, periodontium, and (2) respiratory illnesses/ infections, asthma, COPD, and pneumonia. The sites that were searched include PubMed, Journal of Clinical Periodontology, Journal of Medicine and Life, Public Library of Science (PLoS), Springer, Expert Review of Respiratory Medicine, International Journal of Dental Research, Annals of Periodontology and BMC Medical Journal. The sorted results were first evaluated on the basis of their respective titles and abstracts and afterwards complete text of the selected published study was obtained on the basis of selection criteria as described below. Proper literature analysis was done with analyzing scales grading these diseases as per WHO criteria. Abstract-only studies, letters, animal model

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studies, and case reports were excluded from the search.

SELECTION OF STUDY

Studies conducted on periodontitis and respiratory illnesses were selected and reviewed. Only studies based on human patho-physiology rather than animal model studies were selected. Study types including cross-sectional, case control, or cohort design was included. The studies that mentioned diagnostic criteria for periodontitis and respiratory infections along with those showing the association between these two were selected to collect data from.

DATA COLLECTION

Patient data with significant periodontal and respiratory illness was extracted and evaluated from the selected studies to achieve the understanding for the presence of any relationship if present between these two diseases of periodontitis and respiratory infections. Data extracted was recorded as per first author's last name, the year of publication, and the country in which it was carried out along with number of participants and those with periodontitis and respiratory infections. Periodontitis was defined and graded as per WHO criteria[35] on the basis of degree of gingival inflammation, loss of connective tissue and alveolar bone, and increasing probing depths up to pockets. Gingival inflammation was evaluated on the basis of gingival index, plaque index, and oral hygiene index[35] all of which are key points to be noted while checking for the degree of tissue inflammation. Similarly, data related to probing depths in pockets was sorted and critically analyzed to evaluate the association between tissue inflammations at different sites in teeth in relation to the size of pocket while examining probing depth.

Data showed that there is association between periodontitis and respiratory diseases such as COPD, pneumonia, asthma, and other upper respiratory illnesses, which is mostly associated with poor oral hygiene and low immunity status. In present study, a total of 51 articles were searched for assessment of relation between periodontitis and respiratory disease specially COPD.

These articles were evaluated by the reviewers. The results were as follows: 1) A weak association between periodontal disease and COPD was defined in one study; 2) some studies noted that the link between periodontal disease and respiratory disease remains somewhat controversial; 3) one study reported that associating periodontal disease and COPD are preliminary and large-scale longitudinal and epidemiologic and RCTs are needed; 4) some studies reported that their findings do not support interaction between periodontal diseases and COPD; 5) many studies demonstrated that periodontitis were associated with respiratory disease such as COPD.

Table 1. Total number of articles searched and included in the review.

Total articles	Numbers relevant	Numbers excluded	Numbers included for analysis
51	34	10	26

Bansal et al.,[36] Cullinan and Seymoor,[37] and Moghadam et al.[38] have concluded that periodontitis is associated with systemic diseases, e.g., respiratory disease, chronic kidney disease, rheumatoid arthritis, atherosclerotic cardiovascular disease, aplastic anemia and cancers as well as minor disorders including cognitive impairment, obesity, and metabolic syndrome. In this paper, our focus will stay on respiratory diseases occurring secondarily to periodontitis.[36-38]

PERIODONTITIS AND RESPIRATORY ILLNESSES

Periodontitis is an inflammatory condition of tissues surrounding teeth. It may result in loss of surrounding alveolar bone and eventually the tooth. Many criteria exists globally for diagnosis of periodontitis but commonly agreed upon is WHO recommendation that includes gingival inflammation, loss of connective tissue and alveolar bone, increases in probing depths, and formation of periodontal pockets.[35] On this basis, a clinician is able to suspect and diagnose the process of periodontitis. If there is uncertainty then it should be focused that the patient might have any other underlying disease conditions which should be evaluated for suitable treatment. The severity of this disease process is measured by grading it into 3 grades of mild, moderate and severe on the basis of classification through clinical attachment by measuring with a periodontal probe from cementoenamel junction to the base of periodontal pocket.[39] As reported periodontitis is a major cause of systemic disturbances including respiratory diseases, mainly chronic obstructive pulmonary disease and pneumonia.[36,40] Aspiration of unhygienic oral secretions[36,41] possibly induce an inflammatory response in airway mucosa causing respiratory illnesses.[36,42]

Data showed that there is association between periodontitis and respiratory diseases such as COPD, pneumonia, asthma, and other upper respiratory illnesses which is mostly associated with poor oral hygiene and low immunity status. As per the available data in various research papers, 60% of people with periodontitis face some form of respiratory illness at some point during the diseases process varying in severity.

Table 2. Association between periodontitis and respiratory diseases

Prevalence of periodontitis according to WHO	People with periodontitis due to poor oral hygiene	People with respiratory disease due to periodontitis
15-20% of world's population	90%	60%

World Health Organization (Fact sheet N°318, April 2012)

PATHOGENESIS OF PERIODONTITIS AND RESPIRATORY INFECTIONS

Periodontitis, as discussed, is an inflammatory condition of gums. Contributing factors include poor oral hygiene, smoking, drug abuse, chronic plaque buildup causing dental caries, altered immune mechanism, old age, diabetes, etc. Periodontitis is mainly a neutrophil mediated inflammatory process. Therefore, excess of neutrophil reaction in periodontal tissues activate inflammatory focus in periodontium due to excessive neutrophilic enzymes leading to swelling, congestion, bleeding and eventually loosening of periodontium from dentures causing the teeth loss. All this occurs due to multiple effects including bacterial buildup, accumulation of food particles, poor hygienic control, genetic factors, and sometimes immunosuppressive states too. Therefore, intrinsic, environmental and genetic factors play a complex role in the process of periododntitis.[43]

Similarly, respiratory pathology of COPD is also a neutrophil induced response and has risk factors including pulmonary pathogen buildup in airway, poor oral hygiene, aspiration of irritant material into the airway, smoking and inadequate cough reflex. Lower airways are usually sterile[36,44] despite secretion buildup from upper airway which is highly contaminated from oral and nasal surfaces. The sterility of lower airway passage is maintained through intact cough reflex, and outward beating of mucociliary layer that propels inhaled bacteria and irritant particles outward to the oropharynx and also due to intact immune and non-immune defense responses including surfactant layer containing fibronectin, complement proteins, immunoglobulins, and phagocytic cells to remove particulate debris. There are three main pathways for spread of infection to lungs, including hematogenous, airway contamination, and spread from other contagious sites[36,45] nearby, such as oral cavity. Species of oral flora implied in lung infection includes *Actinomyces israelii, Eikenella corrodens, Porphyromonas gingivalis, Actinobacillus actinomycetemcomitans, Prevotella intermedia,* and *Streptococcus constellatus*.[36,45] These organisms may get adherent to mucosa, can be aspirated along with oral secretions, may get resistant to salivary degradation enzymes, and may alter the cytokine composition that may affect respiratory epithelium to promote infection by these pathogens.[36]

COMMON DISEASES IN LUNG POSSIBLY DUE TO PERIODONTITIS AS SUPPORTED BY COPD

Periodontitis may worsen systemic diseases, including pulmonary diseases. Study form India mentioned that patients with pulmonary disease usually have poor oral hygiene and smoking is also a major risk factor for both periodontitis and pulmonary disease.[30] The COPD is a chronic inflammatory condition of airway passage characterized by airflow obstruction with progressive inflammation of pulmonary mucosa. Airflow obstruction in this process seems to be due to those harmful particles or gases that are inhaled during breathing. Major risk factors for COPD are chronic smoking, variant α1-, α2-macroglobulin, and defective α1-antitrypsin gene, vitamin D binding protein, antichymotrypsin, and blood group antigen genes.[36,46]

Worldwide prevalence of COPD is 9-10% in age above 40 years with more population affected in developed countries due to increased smoking habits.[46] Moreover, COPD is shown to be aggravated by any other fungal, viral, or bacterial infection suppressing the primary condition. The link between periodontitis and COPD was shown in 1998 in NHANES data suggesting that periodontitis might be a co-factor for pulmonary involvement, but it was found that periodontal condition is not associated with the number of exacerbations of obstructive pulmonary diseases.[47]

PNEUMONIA

Oral cavity is important reservoir of pulmonary pathogens, *Staphylococcus aureus, Pseudomonas aeruginosa,* and other enteric species.[48] Avoiding or limiting aspiration, minimizing colonization, careful use of antibiotics, and invasive devices are some preventive measures. Linden et al. in 2013 showed that poor oral hygiene and periodontitis, especially among smokers, is an important cause of increase in nosocomial pneumonia.[46] It was also shown that efforts to reduce oral microbial load resulted in reduced cases of pneumonia. Saliva and plaques of patients containing pulmonary pathogens were proven to be a risk factor for aspiration pneumonia. Frequent professional oral health care has been shown to reduce and control the incidence and severity of associated respiratory diseases.[49]

PERIODONTAL DISEASE AND ASTHMA

Asthma is characterized by recurrent episodes of breathlessness, cough, wheezing, chest tightness, and

sometimes pus like discharge during recovery phase. The pus like discharge during recovery is suggested to be due to high level of eosinophils in white blood cell component as an allergic response. The association between periodontal disease and asthma is suggested to involve immune activation due to inflammatory nature of both disorders. Serum IgA of saliva secretions tend to be first line defense mechanism for the mucosa and play a major role in preventing periodontitis. Serum IgA is reduced in saliva secretions of asthmatic patients and also the destruction of periodontum is higher in these patients as assessed by Periodontal Disease Index (PDI). Similarly, gingival concentration of IgE in these patients is also elevated with periodontal disease.[14]

UPPER RESPIRATORY TRACT INFECTIONS

Conditions affecting upper respiratory tract have been shown to be associated with simultaneous periodontitis and productive cough. Productive cough, nasal secretions, post nasal drip along with periodontitis near maxillary sinus can lead to a syndrome called dent bronchial syndrome which is three times more common than in general population in those having cough and periodontitis due to chronic smoking for several years. Patients with upper respiratory involvement present with productive cough, nasal drips, and sometimes associated fever.[39] Oral cavity and upper respiratory track are the main ports of entry of microorganisms into the human body.[50]

FACTORS RESPONSIBLE IN INVOLVING LUNGS SECONDARY TO PERIODONTITIS

There are many conditions associated with poor oral hygiene such as dental caries, periodontitis, and gum infections and inflammatory conditions that changes the physiological flora and chemical composition in the oral cavity, causing reactions in tissues of oral cavity and other distant sites of body.[51-54] Patients with COPD were much older than control group with significantly high level of serum matrix metalloproteinases and tissue inhibitors of matrix metalloproteinases, especially MMP-13, MMP-8, and TIMP-1 as determined by immunofluorometric studies (IFMA) and ELISA which suggest that these systemic inflammatory markers tend to increase in COPD, but clinically in this study, the relation between periodontitis and respiratory disease was not supported due to lack of association between clinical appearance of periodontitis and biochemical findings.[55] Edentulism (total loss of teeth) increases risk of developing COPD like events and other respiratory illnesses, such as pneumonia and emphysema comparing to those having teeth and good periodontal hygiene. This risk was proven to be independent of sex, age, race, education, smoking, BMI, and hypertension. In addition to this, IL-6 and C - reactive protein (CRP) was also raised in these patients having symptoms of COPD. It was suggested that these events occur due to spill over of pulmonary system with organisms or irritants that accumulate in denture biofilms which caused periodontitis and simultaneously COPD like events a bit late in time.[43] Periodontal infections may not directly cause systemic involvement of lungs but it is clear from the above discussion that these two processes are interlinked through various common risk factors such as potentially common pathogenic organisms involved in both the diseases. Therefore, it is clear that periodontal diseases are not only limited to periodontum but involves a wide range of systemic processes and thus, a dentist need to take care of bigger responsibilities to look for overall health care of the patients. Many of the recent studies show an association between poor oral health and respiratory diseases in which high risk subjects are a major concern especially immune-compromised.[30]

CONCLUSIONS

Periodontitis influence the course of pulmonary illnesses and can be a source of aspiration of oral secretions into the lungs. It is also major source of pulmonary infections. In addition to the saliva enzymes, certain cytokines, such as IL-6, originating from periodontal infected tissues enhance the pathogenesis of respiratory infections. Good oral health and hygiene can reduce the load of oropharyngeal colonization by harmful pulmonary pathogens, and therefore, may reduce the overall risk of respiratory infections.

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