Periodontitis - As a Risk Factor for Pulmonary Diseases

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Abstract:

Respiratory diseases are responsible for a significant number of deaths and considerable suffering in humans. Poor oral health and low immunity state plays a very important role in pathogenesis of respiratory infection. The colonization of the respiratory tract with various oral periodontopathogens may result in respiratory diseases such as bacterial pneumonia. The teeth may also serve as a reservoir for respiratory pathogen colonization and subsequent nosocomial pneumonia. The overreaction of the inflammatory process that leads to the destruction of the connective tissue is present in both periodontal disease and emphysema. The mechanisms of infection could be the aspiration into the lung of oral pathogens capable of causing pneumonia, colonization of dental plaque by respiratory pathogens followed by aspiration, or facilitation of colonization of the upper airway by pulmonary pathogens by periodontal pathogens. Many pulmonary disorders like respiratory obstructive diseases, systemic diseases with pulmonary involvement, lung cancer, cystic fibrosis or tuberculosis all have clinical and/or therapeutic involvement of the oral cavity, which underlines the necessity of regular dental services and careful oral cavity exam, as well as an active collaboration between dental practitioners and pulmonologists.

Keywords:- Periodontitis, chronic obstructive pulmonary diseases, respiratory illness, oral care.

Introduction:

The tissues supporting the teeth are collectively called the periodontium of the teeth[1]. Periodontitis is a destructive inflammatory disease of the supporting tissues of the teeth and is caused by specific microorganisms or group of specific microorganisms resulting in progressive destruction of periodontal ligament and alveolar bone with periodontal pocket formation, gingival recession or both[2]. These diseases are highly prevalent and may affect up to 90% of the worldwide population[3]. Periodontal disease as a risk factor for systemic diseases, consists of diabetes, osteoporosis, cardiovascular diseases, adverse pregnancy outcome, rheumatoid arthritis,

and respiratory disease such as chronic obstructive pulmonary disease (COPD)[1]. Oral lesions are indicators of disease progression and oral cavity can be a window to overall health. Bacteria are the prime etiological agents in periodontal disease, and it is estimated that more than 500 different bacterial species are capable of colonizing the adult mouth and the lesions of the oral cavity have an immense impact on the quality of life of patient with complex advance diseases[2]. It has been suggested that dental plaque may act as a reservoir of respiratory pathogens, especially in patients with periodontal disease. Respiratory diseases are responsible for

a significant number of deaths and considerable suffering in humans. These diseases are widely prevalent. Respiratory infection is thought to rely in part on the aspiration of oropharyngeal flora into the lower respiratory tract and failure of host defence mechanisms to eliminate the contaminating bacteria, which then multiply to cause infection. The defence mechanisms are so efficient that, in healthy patients, the distal airway and lung parenchyma are sterile, despite the heavy bacterial load (106 aerobic bacteria and 107 anaerobic bacteria per millilitre) found in the upper airway body's to defeat these pathogens from entering the respiratory tract. This is the reason why healthy individuals are not affected in spite of the heavy bacterial load found in the oral reservoir and upper respiratory tract[5]. Respiratory infectious diseases such as bacterial pneumonia and bronchitis are common and costly, especially in institutionalized and elderly in patients[2]. Most often examination of the oral cavity in cases of pulmonary diseases is neglected. The oral cavity will help in the clinical diagnosis of the pulmonary diseases. Therefore, early diagnosis by a dental professional can lead to early referral to the appropriate health professional.[2]

Dental Plaque: The Repository of Pulmonary Pathogens

The spread of infection occurs in two ways: hematogenous spread and through aspiration. Hematogenous spread of bacteria occurs after dental treatment which may include simple prophylactic procedures, but in this case the primary source of infection is the periodontal anaerobic bacteria. Aspiration of the materials from the upper respiratory tract occurs in 45% of the individuals who are healthy during their sleep and it occurs in 70% of people with impaired consciousness. Pathogens increase in the quantity as well as complexity of dental biofilm as observed in hospitalized and critically ill patients because of their inadequate oral hygiene maintenance.[6] The interaction between the resident dental plaque flora and established respiratory microbes[7] ultimately leads to colonization by the latter in the niches of oral cavity. Consequently, dental plaque may shed into the salivary fluids due to a number of physiological forces contaminating the respiratory tree distally on aspiration[fig.1]

Figure 1: Link between periodontal bacteria and pulmonary infections. Due to the movement of the muscles of tongue and cheek during speech and mastication and by the flow of saliva, the dental plaque gets dislodged into saliva and contains pathogenic bacteria and salivary fluids contains inflammatory cytokines that seeps along with gingival crevicular fluid may initiate and progress pulmonary infection by stimulating a local inflammatory process.

Pathogenesis of Respiratory Bacterial Infection

The lung is composed of numerous units formed by the progressive branching of the airways. The airway of each terminal respiratory unit (bronchiole, alveolar duct, alveolar sac and alveoli) is lined by epithelial cells in close proximity on their basal aspect to capillaries, which permits the efficient exchange of gases. The lower airways are normally sterile, despite the fact that the secretions of the upper airways are heavily contaminated with microorganisms seeded from the oral and nasal surfaces. Sterility of the lower airway is maintained by intact cough reflexes, the action of tracheobronchial secretions

and mucociliary transport of inhaled microorganisms and particular material from the lower respiratory tract to the oropharynx, and immune and non immune defense factors (cell mediated immunity, humoral immunity, and polymorphonuclear leukocytes).[4] According to Scannapieco and Mylotte(1996)[8]

microorganisms can contaminate the lower airways by four possible routes: 1) Aspiration of oropharyngeal contents, 2) Inhalation of infectious aerosols, 3) Spread of infection from contiguous sites, and 4) Haematogenous spread from extrapulmonary sites of infection (e.g., translocation from the gastrointestinal tract).[5]

Figure 2: Flow chart describing a basic mechanism of pathogenesis of periodontitis and pulmonary diseases

Role of Oral Bacteria in the Pathogenesis of Respiratory Infection

The oral bacterial species implicated in causing pneumonia and lung abscesses are *Actinobacillus actinomycetemcomitans*, *Actinomyces israelii*, *Capnocytophaga* species, *Eikenella corrodens*, *Prevotella intermedia*, *Porphyromonas gingivalis* and *Streptococcus constellatus*. Scannapieco and Genco(1999) [9] has proposed several mechanisms to explain the potential role of oral bacteria in the pathogenesis of respiratory infection:

- Aspiration of oral pathogens (such as *Porphyromonas gingivalis*, *Actinobacillus*

actinomycetemcomitans, etc.) into the lung to cause infection, (fig.3)

- Periodontal disease-associated enzymes in saliva may modify mucosal surfaces to promote adhesion and colonization by respiratory pathogens, which are then aspirated into the lung, (fig.4)

- Periodontal disease-associated enzymes in saliva may destroy salivary pellicles on pathogenic bacteria to hinder their clearance from the mucosal surface (fig.5)

By cytokines originating from periodontal tissues, which may alter respiratory epithelium to promote infection by respiratory pathogens. (fig.6)

Figure 3: Aspiration of oral pathogens

Figure 4: Pathogen produces enzymes that alter mucosal surface adhesion receptors for respiratory pathogens

Figure 5: Enzyme degrade salivary pellicle on mucosal surface thereby exposing adhesion receptors for respiratory pathogens

Figure 6: Cytokines upregulate the expression of adhesion receptors on the mucosal surfaces to promote respiratory pathogen colonization

Pulmonary Diseases and its Oral Manifestations 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. Oral cavity

and upper respiratory track are the main ports of entry of microorganisms into the human body[1]

Periodontitis and Chronic Obstructive Pulmonary Diseases

Chronic obstructive pulmonary disease is a type of obstructive lung disease characterized by long term- breathing problem and poor airflow. . It occurs as a result of exaggerated inflammatory response within airways and lungs that is chronic in nature. It is manifested in different variants such as emphysema, chronic bronchitis, and small airway diseases. The pathophysiology of COPD

involves systemic inflammation that is common to periodontitis .The common attributed factor is the alteration in neutrophil function. Periodontitis

is associated with hyperactive and hyper-reactive neutrophil. They exhibit reduced movement and accuracy in reacting to chemoattractants [10,11], and they are induced to produce large amount of proinflammatory cytokines that spill into systemic stream and cause alveolar damage in lung. The role of periodontal disease as a risk factor for COPD has received exponential interest of the researchers over the last two decades due to the possibility of aspirating periodontal pathogens since oral cavity and lungs harbor anatomical

communication. Furthermore, acute exacerbations are prevalent in COPD patients, majority of which remain unreported and deteriorate quality of life. Microaspiration occurs in healthy situations, but the local defense (mechanical and immunological) mechanism provides protection to the distal airways and parenchyma of lungs. However, in pulmonary disease patients with poor oral hygiene and periodontitis, the bacteria-laden oral secretions may not be cleared off, resulting in respiratory airway colonization and inflammation.

Figure 7: Mechanism explaining destruction of salivary pellicle by periodontal bacteria in chronic obstructive pulmonary diseases Periodontitis and Pneumonia

Pneumonia is a life-threatening infection especially of the old and immune compromised with high morbidity and mortality rates. Bacterial pneumonia, in brief, is a parenchymal infection of lungs caused by a wide spectrum of microorganisms, i.e., bacteria, parasites, viruses, and fungi. It can develop either as de novo or as a superimposed infection due to a primary viral infection. The etiopathogenesis involved in adult bacterial pneumonia is through aspiration of oropharyngeal secretions loaded with pathogens

into the lower respiratory tree. This leads to collapse in host immune system responsible for eliminating the aspirated oral pathogens, which get a fair chance to multiply and flourish causing pulmonary infection[12]. Streptococcus pneumoniae is the leading cause of community acquired pneumonia, responsible for 20% to 60% of all cases. Chlamydia pneumoniae, mycoplasma pneumonia, staphylococcus aureus and several viruses etc are the other microorganisms associated with this disease.[13]

Avoiding or limiting aspiration, minimizing colonization, careful use of antibiotics, and invasive devices are some preventive measures. **Linden et al. in 2013[14]** showed that poor oral hygiene and periodontitis, especially among smokers, is an important cause of increase in nosocomial pneumonia. hospital-acquired pneumonia (HAP) is associated with a high morbidity and mortality with long patient stay and economic burden on the patient. 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.

Association between Asthma and Chronic Periodontitis

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. The most important etiological agent for asthma is mainly a Type E antibody-mediated allergic hypersensitivity reaction. This is characterized by the recruitment of the mast cells with the resultant elaboration of chemical mediators such as histamine. Asimilar kind of cellular picture is noticed in cases of gingivitis that give direction toward a similarity at immunological level between allergic reactions and periodontal diseases.[15]

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. 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. 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. 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.[1]

Drugs Taken for Pulmonary Diseases and its Oral Manifestations

Patients affected by pulmonary drugs often take inhaled medications, and a bigger portion of these inhaled medications are usually present in the oropharyngeal region. The general symptoms seen in patients taking medications for pulmonary diseases are erostomia, dental cavities, halitosis, ulcerations, candidiasis, mucosal changes, gingivitis, periodontitis, gastro-esophageal reflux . Beta2-mimetic drugs which are used for asthmatic patients causes reduction in the production and secretion of saliva which in turn causes dental caries, increases the Lactobacillus sp. And Streptococcus mutans population, relaxes the smooth muscles of the lower esophageal sphincter causing gastro-esophageal reflux, because of the reflux the pH of the saliva will also decrease causing enamel demineralization. Also these inhaled drugs will contain fermentable carbohydrates which further increase the risk of dental caries. Corticosteroids are used by patients with asthma and COPD. It is usually used as

inhaled medication. So a significant dosage of the drugs remains persistent in the oropharyngeal region causing topical effects like candidiasis, dysphonia, tongue hypertrophy, perioral dermatitis. Oral candidiasis lesion has characteristic features like whitish papulae and plaques, inflamed or bleeding tissues under the lesion. A high incidence of gingivitis is also seen in some cases.[4]

Conclusion

The various pulmonary disorders and its manifestations in the oral cavity. It is necessary for the dental surgeons to know about the signs, symptoms, and presentations of the medical diseases to provide a good dental care with safety precautions so as to avoid discomfort to the patient's health, also regular oral examinations can always give a clue for the diagnosis of major systemic illness like respiratory diseases. So the oral manifestations in the pulmonary diseases are often required for early recognition of the diseases such that the patients get the ultimate benefits from it.

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