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Periodontology

RESEARCH IN PERIODONTICS – WHERE HAVE WE COME, WHERE ARE WE HEADED.

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ABSTRACT The field of periodontology has seen tremendous leaps in the past decade with regards to its concepts, diagnosis and treatment modalities. Various diagnostic aids such as the different types of probes, radiography techniques, microbiological analysis, immunodiagnostic assays and molecular biology may be employed in detecting the periodontal pathogens. Specific treatment plan can therefore be advised to the patients rather than an empirical form of treatment as was seen in the past. Advances in therapeutic procedures, host modulation therapy, platelet rich plasma and platelet rich fibrin, lasers and implants have all evolved to provide a near perfect result. This literature review aims at providing valuable insights of the research in the vast field of periodontology.

KEYWORDS : Diagnostic aid, Periodontology, Periodontal therapy, Research

INTRODUCTION

Research is the continual search for truth using scientific method. It is a quest for knowledge through diligent search or investigation or experimentation aimed at the discovery and interpretation of new knowledge. Research and scientific methods may be considered a course of critical inquiry leading to the discovery of fact or information, which increases our understanding of human health and disease.[1] Oral health research refers to laboratory, clinical and field investigation that lead to improvement in the control of oral diseases and health care delivery; The ultimate goal being improvement of quality of life.[2]

Research over the past 30 years, in the field of periodontology, has had a marked impact on our understanding of periodontal diseases, our concepts of treatment and its effectiveness.[3] Yet the objectives of treatment have remained constant for almost 100 years. In 1886 G. V. Black stated: "The most important measure in the treatment of calcic inflammation of periodontal membrane and gums is the removal of the concentrations from the teeth, and next an arousing in the mind of the patient of an active determination to keep them clean in the future."

The treatment of most diseases has developed on an entirely empirical basis, and periodontal therapy is no exception to this rule. Before the era of modern pathology and microbiology, the doctor could not possibly know what caused most diseases and how the various etiologic factors led to lesions, diseases and death. Under these circumstances a casual treatment, aimed at eradicating the etiologic factors could be developed only in the few cases where these factors were macroscopic and obvious. Most of the procedures that came into common usage in periodontal therapy did so, primarily because of the vehemence with which they were introduced by their inventors and the research procedures behind them.[4] The basis for the prevention of periodontal disease has changed radically over the last few decades. The etiology of the periodontal diseases has been clarified to such an extent that preventive measures can be instituted.[5] There is ample evidence that periodontitis is caused by different micro-organisms which are concentrated in the plaque.[6-9]

Pathogenesis of periodontal organisms

One criterion of pathogenicity in periodontitis is that the organisms are capable of producing a 'cementing' substance that is sufficiently tenacious to hold the bacteria to the tooth surface, and later to one another; The essential component of the 'glue' being levan – a polymer of fructose.[4] Another criterion of pathogenicity is that the bacteria of the plaque are capable of producing tissue damaging substances, or substances capable of activating collagen destroying enzymes in the gingiva.[10] Bacteria localized in the plaque have been shown to produce a number of enzymes causing tissue damage. In addition, on disintegration of the gram-negative organisms of the plaque, endotoxins are released from their bacterial walls which are potent agents in the initiation and maintenance of inflammation.[11] The destruction of the attachment apparatus leading to pocket formation and exfoliation of the tooth, as related to plaque formation, has been extensively studied under the light microscope.[12] The disintegration of the Sharpey's fibers associated with gingival inflammation has also been demonstrated in the electron microscope.[13] At this level of magnification one can see how the collagen fibrils below the epithelial cuff are split into microfilaments. Immunological research has revealed the presence of gamma globulins in the gingival tissues in association with bacterial inflammation.[14] This indicates that a local as well as generalized production of antibodies is an important feature of gingival inflammation.

Diagnostic aids

Recent studies with appropriate microscopy has aided in demonstrating the number and proportion of different subgingival bacterial groups varied in periodontal health compared with diseased state.[15-17] Advanced diagnostic aids have made it possible to ascertain the etiologic factors associated with the various periodontal diseases, thus making it easier to find specific treatment regimens for the ailment. Temperature sensitive probes (PerioTemp), Pressure sensitive probes, Florida Probe System have been developed to substitute the conventional periodontal probe which was once considered to be the 'gold standard'.[18] Digital radiography along with serial radiographs which can be superimposed to compare the initial stages of the treatment procedures to the final outcomes.[19,20] Computer-Assisted Densitometric Image Analysis (CADIA) has replaced the conventional radiographs making them more sensitive along with high degree of reproducibility and accuracy.[21]

Along with the various advances in diagnostic aids, the microbiological analysis has also taken giant leaps in the past decade. The gold standard of bacterial culturing which would restrict the diagnosis only to live bacteria and also show decresed sensitivity have been replaced by Dark-field or phase-contrast microscopy due to its ability to assess rapidly the bacteria in the plaque sample.[22] Immunodiagnostic methods like Direct IFA, Cytofluorography, Latex Agglutination and ELISA have shown to provide a quantitative or semi-quantitative estimate of target micro-organisms. These methods also have higher sensitivity and specificity than bacterial culturing.[23] Diagnostic kit like Perioscan have been developed to record the activity of trypsin like enzyme N-benzoyl-*d L*-arginine-2-naphthylamide (BANA) which is a common enzyme produced by the activity of *T. Forsythia, P. Gingivalis, T. Denticola* and *Capnocytophaga.*[24]

The development of techniques in molecular biology aimed at detection of bacterial pathogens not only has allowed the acquisition of knowledge in microbial genetics, but also has set the bases for the development of improved diagnostic techniques. The principles of molecular biology techniques reside in the analysis of deoxyribonucleic acid (DNA), ribonucleic acid (RNA) and the structure or function of protein.[25] The genetic material of the bacteria is composed of chromosomal DNA and transferring RNA (tRNA), ribosomal RNA (rRNA) and messenger RNA (mRNA). Diagnostic assays employing molecular biology techniques require specific DNA fragments that recognize complementary specific bacterial DNA sequences from target micro-organisms; Thus allowing to extract the bacterial DNA from the plaque and amplify the specific DNA sequence of the target pathogen.

Various enzymes are released from host cells during the initiation and progression of periodontal disease.[26] Matrix components may be dissolved either by extra-cellular matrix metalloproteinase-dependent or plasmin-dependent cleavage reactions, and the subsequent larger fragments may be disposed of through a phagocytic pathway through cleavage by lysosomal proteinases. *Aspartate aminotransferase (*AST*), Alkaline phosphatase (*ALP*), β-Glucuronidase, cathepsins, Matrix metalloproteinases (*MMPs) are a few enzymes which have been associated with a diseased periodontium.[27] Thus, a concept of host modulation introduced by Golub et al[28], which aims to modulate the host responses involved in the pathogenesis of periodontal destruction, may be efficacious in slowing the progression of periodontitis. Host modulatory therapies used as an adjunctive with conventional periodontal therapy have shown to slow the progression of disease and allow for more predictable management of patients.[29] Chemotherapeutic agents include adjuncts such as locally applied and systemically delivered antimicrobials and host modulatory therapies. HMT can be used to reduce excessive levels of enzymes, cytokines and prostanoids as well as to modulate osteoclast and osteoblast function.[30]

Treatment and treatment outcomes

The basic healing process are the same after all forms of periodontal therapy. These processes consist of the removal of degenerated tissue debris and the replacement of tissues destroyed by disease.[31] Research is seeking to identify ways to improve regenerative therapy predictability. Periodontal regeneration involves the formation of new alveolar bone, cementum and functional periodontal ligament.[32] In the periodontium, gingival epithelium is replaced by epithelium and underlying connective tissue, and periodontal ligament are derived from connective tissue. Bone and cementum are replaced by connective tissue, which is the precursor of both. Newer periodontal treatment modalities to enhance regeneration include platelet-rich plasma (PRP) and low-level laser therapy (LLLT). Use of the biostimulatory effect of LLLT enhance wound healing and bone regeneration. LLLT has been shown to increase the gene expression of platelet derived growth factor (PDGF) and transforming growth factor-β (TGF-β), which are the most important growth factors in periodontium.[33] Platelets are a rich source of growth factors (PDGF,TGF-β) and vascular endothelial growth factor (VEGF), that modulate the wound healing response in both hard and soft tissues. In-vitro studies have demonstrated that PRP exerts positive effects on gingival fibroblasts, oral osteoblasts and PDL fibroblasts, making it an ideal candidate to facilitate periodontal regeneration.[34] Laser irradiation also induces platelet degranulation and the release of substances stored in the specific granules.

A number of studies have demonstrated successful regeneration of various organs and tissues in the body.[35,36] This technology is called Tissue Engineering and involves the morphogenesis of new tissue using constructs formed from isolated cells with biocompatible scaffolds and growth factors. The lost periodontium due to periodontitis can also be regenerated and restored using autologous and allogenic periodontal ligament stem cells (PDLSCs). However, limited sources and a relatively low proliferation rate of PDLSCs have greatly narrowed its clinical application. Stem cells from human exfoliated deciduous teeth (SHEDs), which could be easily acquired from exfoliated deciduous teeth have shown greater proliferation ability and are capable of generating robust amount of bone.[37]

Replacement of missing teeth by the use of dental implants have also not been spared to the trend of modifications and advances. The high predictability of endosseous dental implants has led to its routine use with a success rate almost reaching 95-97%.[38] Advances in surgical procedures like sinus elevation and bone augmentation along with guided bone regeneration or distraction osteogenesis allow clinicians to reconstruct bone deficiencies and replace missing teeth successfully even in the most complex cases.

Microsurgery which is an ergonomic methodology in which surgical manipulations are improved through better motor coordination. A variety of simple and complex magnification systems are available to dentists ranging from simple loupes to prism telescopic loupes and surgical microscopes which employ Galilean optics with binocular eyepieces. This aligns the eyes as if they were focused at infinity and permits a relaxed vision without eyestrain. Periodontal microsurgery introduces the potential for a less invasive surgical approach with the use of smaller surgical sites.[39]

Due to their excellent soft tissue ablation and hemostatic characteristics, the use of CO2, Nd:YAG and diode lasers have been approved for soft tissue management in periodontics.[40] However, due to the thermal damage caused by them to the root surfaces or the bone, their use is limited to gingivectomy, frenectomy and similar soft tissue procedures.

CONCLUSION

Thousands of years have passed and man has evolved from being a cave habitating homo sapien to a modernized and revolutionary species; and as man progresses each day he strives to better himself and learn from previous errors. The world of Periodontology, yet unknown to us will be revealed; Periodontology as we know it, would have changed and evolved into a much wider array of methodologies and techniques.

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