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Oral health in India: Researchers' Perspective Part 2- Periodontal Diseases, Geriatric Dentistry and Special Health Care Needs

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Abstract

Periodontal disease, a cumulative result of neglected oral hygiene, is one of the biggest oral health problem in India. Although the latest researches have paved way to splendid measures for regeneration and rehabilitation, the most feasible strategy is still the prevention at the earliest possible stage of periodontal destruction. Other major areas of neglect and lack of public awareness are geriatric dentistry and patients with special health care needs. This paper attempts to elaborate on the burden, past research and future research directions in less addressed aspects of Periodontal diseases, Geriatric Dentistry and patients with special health care needs.

Keywords: Biosensor, Oral Cancer, Oral Health, Periodontal Regeneration, Research

1. Prelude

The oral health in India remained neglected due to lack of awareness, education, and limited access to the oral health care system for a huge population which further lay a heavy burden on the limited public funded infrastructure[1]. The Federal Government has taken new initiatives through National Oral Health Program (NOHP) and Health Policy, 2017. World Health Organisation (WHO) and Federation Dentaire Internationale (FDI) have always expressed their concern for existing inequity in oral health care throughout the globe[2–4]. The developed and developing sections of society have different data on oral health and pattern of dental diseases which are not encouraging for the developing world. To address the above mentioned and related issues, multiple "Working Groups" has been created by the FDI and WHO, which are expected to generate time-bound outcomes.

Dental caries and periodontal diseases are the two leading causes of dental morbidity, pain and infections in the oral cavity. The course of the periodontal disease is particularly insidious, cumulative and highly destructive with little regeneration capacity. The consequences are more important for the elderly, and those with Special Health Care needs, as the rate of destruction and the cumulative effects become more pronounced. Additionally, awareness regarding oral health and consequences of periodontal breakdown is hard to be understood by patients, who may not be able to realise the benefits of interventional treatments entirely. Therefore, prevention of dental diseases and the need for increasing the awareness on periodontal health becomes more significant.

Attention is required to direct the oral health research towards development of indigenous diagnostic and treatment modalities which can be affordable and

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accessible to the community and serve the needs of millions[5–7]. In the continuity with the part I, this paper attempts to elaborate the burden, past research and future research directions in much-neglected aspects of periodontal disease. The research aspects of geriatric dentistry and on patients with special health care needs are also included in this section.

2. Periodontal Disease: Spectrum and Gravity of the Problem

Globally, periodontal disease is one of the leading causes of tooth loss, which affects both, adolescents and adults with variable frequency[8]. The prevalence and severity of periodontal disease are intimately related to a level of oral hygiene maintained by the population. Severe forms of periodontitis affect around 11% of the world population[9]. Recent reports on the association of severe periodontal diseases with coronary artery disease, poor glycemic control in people with diabetes, low birth weight and preterm birth have raised the alarm of its significance as a public health problem[10].

Periodontal destruction is an irreversible phenomenon and the tissue lost cannot be replaced, leaving the interventions only to disease limitation. Traditional research in periodontics remained limited to aetiology, predisposing factors, systemic associations, management and genetic susceptibility.

Reports citing the prevalence of periodontal disease in India, are limited to certain sections of society or limited geographical areas. The available data further losses it significance for weak study design, lack of consistent methodology in recording the findings and no calibration of the examiners.

Nonetheless, most of the surveys do indicate a very high incidence of periodontal disease in India[11]. Vandana et al. (2007) evaluated periodontal status in 1029 subjects in a population in Davangere and found a higher prevalence of periodontal disease in the elderly population[12]. Singh et al. in 2005 evaluated the presence of calculus in 100 subjects from rural and urban backgrounds in Ludhiana. He found a presence of calculus in 96.8% subjects while 11-22% had deep pockets[13]. Shah and Sundaram also showed that the periodontitis increased with increasing age and periodontal health was directly related to oral hygiene practices[14]. Srivastava et al reported a prevalence of gingival bleeding in 96% and periodontal pockets in 89% whereas a loss of attachment in 80% of the studied population[15]. Similar results were also highlighted in a multicentric study done by Shah et al (2007), which reported the incidence of periodontal disease as 96.2%[1]. It was also evident that the severity of periodontal disease is higher in subjects with smokers, and the consumption of oral chewing products such as paan and masalas with or without tobacco. Despite the gravity of the problem, sadly, only a few nationalised surveys are present which address the issue of periodontal disease. According to National Oral Health Survey of India (2002-03), the prevalence of periodontal disease was 57%, 67.7%, 89.6% and 79.9% in the age groups 12, 15, 35-44 and 65-74 years, respectively[16]. Severe periodontitis was observed in 7.8% of 35-44 years age group and 18.1% in the 65-74 years age group, whereas, moderate periodontitis was seen in 17.5% of 35-44 years age group and 21.4%, of 65-74 years age group. Marginally higher prevalence of periodontal disease was observed in rural subjects[16]. WHO estimated the prevalence of severe periodontitis in Indian population between 19-32%[2]. The different figures suggest a need for an organised survey representing Indian population. The periodontal diseases and their pattern should be assessed in association to oral hygiene trends and practices, diet, and habits of chewing betel nut, paan, quid and related products[10–17].

3. Association of Periodontal Disease with Systemic Diseases

Periodontitis is a chronic inflammatory polymicrobial disease with potentially adverse effects on systemic health. Prospective and cross-sectional epidemiological studies have explored a directly proportional relationship between poor glycemic control and susceptibility to periodontitis. It has also been observed that successful periodontal interventions and management also improve glycemic control in type 2 diabetes patients. An association between periodontal diseases and coronary artery disease and pregnancy related adverse complications have also been established. Research studies have also reported its association with other systematic diseases: chronic kidney disease, obesity/metabolic syndrome, rheumatoid arthritis, cognitive impairment, and Chronic obstructive airways disease[10].

4. Periodontal Regeneration

Traditional regenerative periodontal therapy was limited to root surface conditioning, placement of bone graft and the use of organic or synthetic barrier membrane. Future regenerative approach lies in utilising minimally invasive surgical techniques and reducing morbidity through novel regeneration techniques of alveolar bone and enhancing gingival attachment. Further research is required to develop scaffolding matrices acceptable to host, which can carry growth factors with the osteogenic potential.

In the field of oral implantology, the development of 3-D bioprinted scaffolds, which can be customised to the defect, at and around implant site, carrying stem cell-based regenerative therapy is likely to be the future of periodontal regeneration. The implant site development, maxillary sinus augmentation and regeneration in larger alveolar bone defects can be achieved through the integration of 3d printing technologists, biologists and biochemists.

5. Early Biomarkers of Periodontal Disease in Gingival Crevicular Fluid (GCF) and Saliva

Biomarkers of periodontal disease are found in oral fluids. GCF and saliva have been explored for host-derived enzymes, inflammatory mediators & products, micro-organisms and tissue breakdown products of periodontal and other diseases[18,19].

Biomarkers identified in saliva include lactate dehydrogenase, matrix metalloproteinase, esterase, lysozyme, chitinase, aspartate aminotransferase, alkaline phosphatase, lactoferrin, cysteine, c-reactive protein, epithelial keratins, platelet activating factor, hepatocyte growth factor, osteoprotegerin, 8-hydroxy deoxyguanosine, nitric oxide, immunoglobulin, melatonin, cortisol, calcium, and periodontal bacteria[18].

Biomarkers identified in GCF include aspartate aminotransferase, alkaline phosphatase, beta-glucuronidase, elastase, cathepsin B, matrix metalloproteinases, leptin, hepatocyte growth factor, cytokines, substance P, tumour necrosis factor-alpha, laminin, osteopontin, and osteocalcin[19]. There is a need for extensive research to investigate the use of these biomarkers[18,19] in the following ways:

- To predict disease initiation at currently healthy sites
- Indicate the current disease activity
- To predict disease progression and prognosis
- We propose the development of a smart strip or chip which when contacted with GCF or Saliva should indicate possible invisible disease conditions early enough before the clinical eyes can detect these changes.

6. Saliva and Oral Fluids as Diagnostic Aids in Systemic Diseases

The great potential of salivary secretion as a source of significant information of human physiology is beginning to be realised. The changing paradigms in oral and systemic diagnostic aids are moving towards a new era of noninvasive modalities which are accurate and exhibit reliability, validity, specificity and sensitivity[31]. Use of saliva as a screening tool for diabetes, Alzheimer's disease and some degenerative diseases has been investigated[31]. Similarly, the blood from crevicular probing has been tested for estimating the Hb1Ac levels in diabetic patients[31]. These investigations are cost effective, easy to collect samples and non-invasive in manner. Such diagnostic modalities can have a major impact on early diagnosis in communities with large populations, such as India[32,33].

Also, deviations in flow rate and composition of saliva have been observed in other diseases tests for salivary electrolyte changes may prove useful in the diagnosis of aldosteronism and of essential hypertension. However, the challenge remains to develop techniques which are specific, sensitive and reliable through saliva.

7. Genetic Association Studies for Periodontal Disease

The aetiology of periodontal disease is multifactorial and results from an interaction between bacterial, immunological, environmental, and genetic factors.[20,21] Some individuals have higher predispositions for periodontal disease which might indicate a role of heritable factors governing the host's interrelationships

with the external environment. Following genetic polymorphisms[20,21] have been associated with periodontal diseases:

- Gene modification on chromosome 11 responsible for cathepsin C activity has been associated with Papillon-Lefevre syndrome and severe chronic periodontitis patients
- Matrix metalloproteinase (MMP)-1 is a proteolytic enzyme abundant in periodontitis sites and is responsible for types I and type III collagen degradation. There is increasing evidence from the systematic reviews about the individuals carrying MMP-1-1607 2G allele being susceptible to chronic periodontitis
- Interleukin (IL)-1α, IL-1β, IL-1RN, IL-6, and IL-10 gene variations have been associated with chronic periodontitis
- Vitamin D receptor (VDR) Taq1 genetic polymorphism has been shown to increase the susceptibility to chronic periodontitis

Further studies are needed to investigate the potential role of genetic polymorphisms in the etiopathogenesis of periodontitis and their interaction with environmental and microbial factors.

8. Research on Herbal Oral Hygiene Products

Natural/herbal dental products are categorised under 'unconventional dental practices', or as 'alternative' to pharmaceutical, dental oral hygiene products. Natural products and herbs like Neem, Bloodroot, Caraway, Chamomile, Echinacea, Myrrh, Peppermint, Rosemary, Sage, Thyme, Aloe Vera and Propolis have been shown to possess anti-inflammatory and anti-microbial properties useful for control and prevention of periodontal diseases[22]. Neem green stick and similar vegetation have traditionally been used for oral hygiene in India and subcontinent.

Some oral hygiene products add these herbal formulations and promote their enhanced benefits. Therefore, herbal dental hygiene products need evaluation both in the laboratory and through scientifically designed clinical trials. Therefore, extensive research is required to substantiate the efficacy and safety of herbal oral hygiene products before they are included in mainstream periodontal therapy.

9. Geriatric Oral Health

9.1 Problem

The geriatric population, who suffer from a host of multiple physical and mental handicapping conditions due to ageing affected diseases and multidrug therapy also has unique and complicated issues related to dental health and prosthetic rehabilitation. With limited studies on the oral health status, the real spectrum of disease and burden of care among the geriatrics population is not known for Indian population[23]. The National Oral Health Survey (2002-03) showed that 85% of the subjects between 65-74 years showed the presence of dental caries with a mean DMFT of 14.9 while 80% had periodontal disease[16]. Shah and Sundaram highlighted similar results[14].

The cumulative effects of neglected oral hygiene through long years lead to chronic oral diseases with broken and unrestored teeth, dental caries at unusual sites and advanced periodontal diseases with mobility. The loss of teeth and aberrant occlusion further aggravates inability to chew food. The long-term effects are poor nutrition and its consequences[24].

Dental treatment also requires long duration and frequent appointments which are poorly tolerated by many geriatric patients. Geriatric patients need special care during their dental treatment[23–25].

There is often loss of autonomy and increased dependence on nursing care. Further, polypharmacy due to systemic diseases leads to hyposalivation, multimorbidity, dementia, depression, impairment of the musculoskeletal system, loss of hearing and vision, and subsequently, reduced social interactions[26].

This population also suffers from age-related changes in oral mucosa and reduced salivary function. It has been estimated that xerostomia, secondary to regressive changes, nutritional deficiencies, multi-drug therapies, hormonal imbalance and systemic ailments is high in old age individuals in India[23]. This has a detrimental effect on the health of oral tissues, leading to root caries, tooth loss and difficulties in prosthetic rehabilitation.[27]

The presence of systemic disorders such as diabetes mellitus, hypertension, cardiovascular problems and psychological disturbances are primary considerations

during diagnosis and treatment planning of patients in such conditions[23]. This includes both the type of procedures performed and medications prescribed. The developing economies like India exhibit a large working population in the age group of 20-40 years which cannot give much time to older adults. This reflects on the lack of caregivers for the elderly[25]. Though the life expectancy has increased in recent times, the status of quality of life in geriatric population of India is questionable[23].

9.2 Geriatric Population: Research in Dental Health in Last Two Decades

ICMR sponsored a study titled "Oral Health Status and Treatment Needs of the Elderly Population in the Community", which evaluated the impact of socio-demographic variables on oral health and health care utilisation.[5] This study revealed that the socio-economic status and literacy rates were higher in urban slum than the rural elderly. Dental caries prevalence was high (61%) in these groups[23]. Gingival recession was more in rural elderly as compared to their urban counter-parts. The results showed that the magnitude of oral health problems and unmet treatment needs in the elderly population is high, which may compromise their oral intake, affect nutrition, social interactions and psychological well-being. A huge gap existed between treatment needs and availability/utilisation of oral health care services by old people even in metropolitan cities[23].

10. Future Areas of Research

With increasing life expectancy, the oral health needs of the geriatric patients are also rising. Affordable oral health which includes timely assessment and treatment are the major areas to be addressed in geriatric dentistry in India. The following facets deserve a special mention:

Need for effective control of dental caries and periodontal disease in elderly:

The elderly people are more prone to caries and periodontal disease due to altered manual dexterity; altered oral architecture, nutritional issues and change in the composition of saliva, amongst other variables[25]. Thus steps are needed to reduce the risk of caries and periodontal diseases in this group by cost effective and convenient techniques in addition to the routine methods for oral health maintenance. Studies have shown that use of fluoridated drinking water and use of fluoride supplements is effective in this age group too[26].

Use of fluoride-releasing glass ionomer restorative cement has also shown a significant promise[24]. Therefore, fluoride releasing GI is the material of choice for restorations in elderly which requires minimal tooth cutting and provides caries inhibitory effect.

Regeneration of teeth and supporting structures:

The best substitute for missing teeth is yet to be discovered. Stem cell research and its applications have now started to show substantial promise[28]. Human mesenchymal stem cells (MSCs) have been isolated from pulp (dental pulp stem cells- hDPSC), periodontal tissues (hPDLSC), exfoliated deciduous teeth (SHED) and apical papilla (SCAP)[28,29]. Inflammed human dental pulp has also been established as a source of mesenchymal stem cells[29]. The key elements of regeneration and tissue engineering revolve around stem cells, growth factors and scaffolds which can be utilised for regeneration of dental tissues[28]. Its most successful clinical application has been in regenerative endodontics, though an entire tooth bud has also been generated in experimental settings[29]. Stem cell research can lead us to explore the lost tooth using a regenerated tooth bud. Similarly, the problem of extensive ridge resorption in geriatric population can be managed by novel ridge augmentation methods utilising stem cells and regeneration strategies[30].

Centre for Dental Education and Research (CDER), All Institute of Medical Sciences (AIIMS), New Delhi, has collaborated with the Centre for Stem Cell Research: Basic & Translational, AIIMS (a centre of excellence of Department of Biotechnology, Government of India), New Delhi to characterize the dental stem cells and their possible clinical applications. Stem cells and regeneration is the exciting field, which needs to be pursued[29].

Early recognition of oral cancer:

The burden of oral cancers has been established to be the highest in India principally due to chewing habits of betel nut and smokeless tobacco[2,4,7,34]. Late detection further adds to high morbidity and mortality. Timely recognition of potentially malignant conditions has already been established[34]. Although screening is largely dependent upon recognition of precancerous lesions

through visual examination by an expert, testing can also be supplemented with Toluidine blue or Fluorescence staining[35]. These methods have a sensitivity ranging from 93.5% to 97.8%, and specificity from 73.3% to 92.9%[35].

Modalities of oral cancer prevention should research best steps for mass awareness, mass screening, and self-evaluation methods. The need to develop reliable biomarker has been long wanted with a significant breakthrough, yet to come. Research is also needed in diagnostic methods and advanced chemotherapeutic management and rehabilitation approach[35,36]. In recent years, there has been the advent of a new term called "theranostics". It is defined as the development of diagnostic tests that can identify which patients are most suited for a drug and provide feedback on how well the drug is working. Theranostics can be beneficial in patients with oral cancer in geriatric population by early diagnosis and possible reversal of malignant changes[37].

11. Patients with Special Care Needs

Special Health Care Needs (SHCN) can be defined as "any physical, developmental, mental, sensory, behavioural, cognitive, or emotional impairment or limiting condition that requires medical management, health care intervention, and/or use of specialised services or programs. The condition may be congenital, developmental, or acquired through disease, trauma, or environmental cause and may impose limitations in performing daily self-maintenance activities or substantial limitations in a major life activity"[39]. Individuals with SHCN are highly susceptible to oral diseases imposed by some limitations such as chronic systemic conditions, lack of motor coordination, poor compliance with home oral care, long term use of sugar syrups and harmful effects of medications[39,40].

According to the National Sample Survey Organization (NSSO), the number of differentially abled persons in India was estimated to be 18.49 million which was about 1.8% of the total population (at that time). The population of the differentially abled with abnormal mentation accounts to 0.44 million individuals[41]. Children and people with neurological disorders as autism, epilepsy and neuromotor impairments present with poor oral health with a high prevalence of dental caries has been reported worldwide[2]. Al-Maweri et al. in a recent survey in Yemen observed the special health care needs children in the age group of 6-14 years had mean deft/DMFT scores of 4[27]. with highest seen in those with physical disabilities[42]. The studies in India also reveal poor oral health status with the prevalence of dental caries to as high as 83.92% in hearing impaired children in Udaipur. A high unmet treatment need of 87.4 % was also observed[43].

Some health aspects peculiar to people with a neurological disability include drooling and hypersalivation, infliction of self-injuries, high risk of dental trauma and lack of cooperative ability during dental procedures[42,44]. Similarly, the children and individuals undergoing chemotherapy for leukaemia and other malignancies suffer from conditions as oral mucositis, long-term adverse effects of drugs and poor oral health[39].

Disabilities such as Autism and individuals following verbal commands can mostly be managed with non-pharmacological behaviour management strategies, while other conditions often require pharmacological means as conscious sedation and general anaesthesia for dental treatments[41]. The SCHN patients, in India and certain African nations, without appropriate home care, have also been subjected to conditions such as "Myiasis" or oral infestation by a house fly[45]. Conditions like these have exclusively been reported from these nations and reflect their susceptibility to severe infections when appropriate care and assistance is lacking.

Although the health authorities and researchers have gathered substantial information about oral health issues and challenges faced in imparting standard oral care to the SCHN individuals in the western world, the studies and policies in developing nations like India are still lacking. CDER, AIIMS established guidelines for oral health promotion and intervention for the handicapped population in 2009 as a part of Government of India-WHO collaborative program[46]. It has been recommended that SCHN individuals and their caregivers must be educated for oral health care and should have full access to preventive procedures as systemic and topical fluoride protocols[46]. The future research in this field may be aimed at collection of data regarding the status of oral health and any special oral health issue in SCHN individuals. This can aid in formulation of oral health policy for SCHN group. Need for the specialised centres

for their dental treatments is also warranted. Another area of research is the development of indigenous, safe and cost effective techniques for behaviour management of SCHN individuals in dental clinics.

12. Summary

The series II of three articles (Oral health in India: Researcher's Perspective-I, II & III) has critically evaluated current research and needs on Periodontal Diseases, Geriatric Dentistry and Special Health Care Needs. The last and first part will focus on malocclusion & dentofacial anomalies and other potential areas for oral health research in India. It will also highlight the contemporary research done in this field along with envisaging the future research areas.

It is hoped that this article will serve as a template for the scientists in India to consider the issues highlighted in the context of each subject and relevance to India.

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