A Comparative Evaluation of Antimicrobial Effectiveness of Pulp-capping Agents

Anshul Gangwal

ABSTRACT

Aim: To analyze the antimicrobial properties of five pulp-capping agents calcium hydroxide powder, calcium hydroxide and glycerine 'Excela R', Metapex, Dycal, Septocal LC against Staphylococcus aureus, Streptococcus mutans, Peptostreptococcus species and Bacteroides melaninogenicus. The capping agents were tested 1, 3 and 7 days after manipulation.

Materials and methods: Caries sample collected from excavation from deep carious lesion. The samples obtained with each bur were immediately collected into test tubes containing BHI broth, and were incubated at 37°C and plated onto BHI agar. The zone of inhibitions was measured and analyzed.

The specimens were divided into five groups as follows:

- Group A—Calcium hydroxide powder and distilled water,
- Group B—calcium hydroxide and glycerine 'Excela R',
- Group C—Metapex 5,
- Group D—Dycal,
- Group E—Septocal LC.

Results: The group D Dycal was found most effective antibacterial pulp-capping agents while group B (calcium hydroxide with glycerine) was the least effective antibacterial pulp-capping agent.

The group E (Septocal LC), group C (Metapex) and group A were in descending order between groups D and B.

Conclusion: Intergroup comparisons for zones of inhibition during the overall period of study revealed significant differences against all the bacterial strains under the study. Between all the comparisons made, the most significant difference was between groups B and D and least significant difference between groups C and E. Thus, indicating that group D was the most effective antibacterial pulp-capping agent while group B was least effective.

Keywords: Bacteria, Calcium hydroxide, Pulp-capping.


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Conflict of interest: None

INTRODUCTION

Pulp damage might be resulted from the leftover microorganisms in dentin after the cavity preparation. This damage makes it necessary to use pulp-capping agents with antimicrobial activity underneath permanent restorations. The treatment can fail when the microorganisms in dentin, pulp and periapical tissues persist and reproduce, especially in the long-term.

Calcium hydroxide is widely used in endodontics and restorative dentistry, especially as a sublining to stimulate osteodentin bridge formation in cases of pulpal exposure. Vital pulp therapies consist of indirect and direct pulp-capping, partial (superficial) pulpotomy and cervical pulpotomy.

Currently, pulp-capping is the primary method for preserving vital pulp, but the success rate of this approach during the treatment of deep caries is low at only 33%. The presence of bacteria is the major reason for failure. Bacteria located in deep caries can induce severe inflammatory reactions in the pulp and even cause pulp necrosis. Therefore, the prevention of bacterial infections is an important objective for improving pulp-capping methods in the treatment of deep caries.

In general, an ideal pulp-capping material should possess both excellent antibacterial properties and the ability to induce mineralized tissue formation. The most common pulp-capping materials used clinically include various formulations of calcium hydroxide [Ca(OH)₂].

Calcium hydroxide has been shown to be effective in eliminating bacteria. The antimicrobial activity is believed to be related to its alkalinity although other components could be implicated.

The purpose of this study was to evaluate the antibacterial properties of three different pulp-capping agents using agar diffusion test.

MATERIALS AND METHODS

Micro-organisms, for this study, were obtained from carious teeth with a spoon excavator. The samples were separately placed in the tight screw-capped bottles containing the Robertson’s cooked meat media. The samples were collected under rubber dam isolation to avoid any salivary contamination. Caries samples were inoculated in the Robertson’s cooked meat media and were incubated for 24 hours at a temperature of 37 ± 1°C. The bacterial species were isolated on the basis of colony character, morphology and gram’s staining and biochemical reactions.
The test materials evaluated in this study were calcium hydroxide powder (Rolex Chemical Ltd, Mumbai) glycerine ‘Excela R’ (Qualigens Fine Chemicals Ltd, Mumbai) Metapex (Meta Dental New York, Elmhurst, New York) Dycal (Dentsply), Septocal LC (Septodont, France). All materials were prepared in strict compliance with the manufacturer’s recommendation.

The test strains include: *S. aureus*, *S. mutans*, *P. species* and *B. melaninogenicus*. The isolated bacteria were subcultured in petridishes. Wells were cut in petridishes and then the pulp-capping agents were added. The petridishes were incubated and observed for zones of inhibition at an interval of 1, 3 and 7 days. Agar diffusion test (Fig. 1) was used to determine the antibacterial activities of the materials. Zone of inhibition was measured using Vernier caliper and divider.

Analysis of zone of inhibition around pulp-capping agents against micro-organisms was done using one way analysis of variance test.

**RESULTS**

Table 1 shows the mean zone of inhibition scores for various bacteria with different the pulp-capping agents after 7 days which depicts that mean zone of inhibition for various pulp-capping agents are found higher against *S. aureus*, *S. mutans*, *P. species* and *B. melaninogenicus* in group D (Dycal) showed maximum effectiveness while group B [Ca(OH)₂ + glycerine] found to be least effective.

Bar graphs (Graphs 1 to 3) shows the overall scores for different bacterial strain inhibition as against all the experimental pulp-capping agents at different time intervals.

**DISCUSSION**

The pulp is the formative organ of the tooth. Even in compromised situations when the pulp becomes infected the tooth ought to be preserved in dental arch to maintain integrity of stomatognathic system.

Micro-organisms can invade the dentinal tubules of both teeth with vital and nonvital pulps, but the invasion is less severe with vital pulps because of the protective function of the pulp. Bacteria entering either the pulpal surface or periodontal surface of the root can exist within the dentinal tubules. If viable, these bacteria could act as reservoirs of infection.

The agar diffusion test is a quantitative and reproducible method designed to simulate the contact of the micro-organism with the root repair materials in the root canal. The antibacterial activity of dental cements has been intensively tested. Calcium hydroxide (CH) is still considered the reference material for pulp-capping, due to its antibacterial properties and its capacity to induce enzymatic reactions leading to the formation of a dentin bridge. Antibacterial activity of calcium hydroxide based materials depends on the ionization that releases hydroxyl ions causing an increase in pH. Cellular membrane enzymes of the micro-organism might be reversibly or irreversibly inactivated by a pH.

The present study compared the antibacterial activity of commercially available pulp-capping materials. The results for various bacterial growth consistently demonstrated that the experimental material Dycal exhibited stronger antibacterial activity. These findings are consistent with the study done by McComb D and Ericson D (1987).

Calcium hydroxide mixed with glycerine produced low inhibitory range in accordance to previous study by Gomes BPEA et al.

Studies report that pulp response after direct capping is linked to bacterial microleakage. Microbes interfere with the pulpal response to capping materials. It was noted that bacteria stimulate pulpal inflammatory activity and

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**Table 1:** Zone of inhibition (in millimeter) after 7 days

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
<th>Group E</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em></td>
<td>10.32 ± 0.41</td>
<td>7.96 ± 0.26</td>
<td>15.82 ± 0.53</td>
<td>25.08 ± 0.11</td>
<td>17.84 ± 0.22</td>
</tr>
<tr>
<td><em>S. mutans</em></td>
<td>12.30 ± 0.24</td>
<td>8.30 ± 0.28</td>
<td>16.18 ± 0.23</td>
<td>25.96 ± 0.22</td>
<td>16.32 ± 0.33</td>
</tr>
<tr>
<td><em>P. species</em></td>
<td>9.50 ± 0.16</td>
<td>7.92 ± 0.18</td>
<td>15.24 ± 0.18</td>
<td>21.82 ± 0.28</td>
<td>14.42 ± 0.38</td>
</tr>
<tr>
<td><em>B. melaninogenicus</em></td>
<td>12.80 ± 0.41</td>
<td>6.98 ± 0.36</td>
<td>15.86 ± 0.13</td>
<td>20.58 ± 0.32</td>
<td>15.26 ± 0.30</td>
</tr>
</tbody>
</table>
reduce the area of dentin bridge formation irrespective of the material used for pulp-capping. Many studies indicate that it is not an agent’s potential bioactivity but its capacity to protect the pulp from bacterial exposure that plays a role in pulpal survival after an oral exposure.²,⁹

Calcium hydroxide also presents some deficiencies: (i) It incites pulp necrosis during the first days, then the pulp reacts by establishing an atubular tertiary dentin bridge, but this dentin formation is made to the detriment of the pulpal volume with long-term biological consequences, (ii) when the paste is only Ca(OH)₂, its application in the root canal system is easy but the low hardening and the retraction by drying do not allow tight fillings, consequently it is only used as temporary material in this indication for which hermeticity is a priority, (iii) to get round this disadvantage, i.e. to increase the crushing strength and to decrease the setting time, polymeric bases were added, but under these conditions the setting time is too short to use these materials as root canal filling.

Furthermore, the present study only evaluated the antibacterial activity in an in vitro study and additional important parameters for pulp capping materials, such as the physical properties, chemical properties, bioactivity and biological properties, need to be evaluated in further experiments.

REFERENCES

Effects of Smoking on Recurrent Aphthous Stomatitis: Does Salivary Immunoglobulin-A play a Role?

1Astha Durgvanshi, 2Saurabh Goel

ABSTRACT

Patients who stop smoking often complain of aphthous (mouth) ulcers. This symptom is sometimes attributed to the use of smoking cessation medications, but little is known about it. After stopping smoking, some 40% of patients developed mouth ulcers, mostly in the first 2 weeks. The problem was generally mild, but 8% reported severe ulceration. The ulcers resolved within 4 weeks in 60% of patients affected. The ulcer ratings in patients using oral nicotine replacement products were higher than in those using patch, nasal spray or bupropion in the first week of abstinence but not afterward. Mouth ulcers were more prevalent in more dependent smokers, and the occurrence of ulcers correlated with other tobacco withdrawal symptoms. Our reviews confirm that mouth ulcers are a common result of stopping smoking, affecting two in five quitters. Patients should be reassured that the lesions are a result of stopping smoking and not a side-effect of smoking cessation medication.

Keywords: Immunoglobulin-A, Recurrent aphthous stomatitis, Saliva, Smoking cessation.

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INTRODUCTION

There are clinical and epidemiological evidences regarding the adverse effects of tobacco on oral health. Numerous studies have shown that tobacco use would lead to an increased incidence and severity of periodontal diseases and a higher rate of tooth loss. The adverse effects of cigarette smoking and other forms of tobacco are numerous and tobacco use has been associated with gingival, oral mucosa and dental alterations.1

Saliva is a complex and important body fluid which is very essential for oral health.3 Saliva is required for protecting the oral mucosa, teeth remineralization, digestion, taste sensation, pH balance and phonation. It includes a variety of electrolytes, peptides, glycoproteins, and lipids which have antimicrobial, antioxidant, tissue repair and buffering properties. Therefore, altered whole-mouth salivary flow rate (SFR) has an important role in the pathogenesis of oral and dental diseases. Saliva is the first biological fluid that is exposed to cigarette smoke, which contains numerous toxic compositions responsible for structural and functional changes in saliva.1

There are also several studies concerning the effect of chewing tobacco and smoking on salivary secretion. While some of these studies have shown an increase in SFR especially in short-term, no significant changes in tobacco user’s flow rate was reported as opposed to non-tobacco users.

The oral cavity is a moist environment which is kept at a relatively constant temperature (34–36°C) and a pH close to neutrality in most areas and thus supports the growth of a wide variety of microorganisms. However, the mouth must not be considered a uniform environment. There are several habitats in the oral cavity, each being characterized by different physicochemical factors and thus supporting the growth of a different microbial community. This is partly due to the great anatomical diversity of the oral cavity and the interrelationship between the different anatomic structures. The oral cavity possesses both hard (teeth) and soft (mucosa) tissues. The tooth can be described as a nonsheding hard surface that offers many different sites for colonization by bacteria below (subgingival) and above (supragingival) the gingival margin. In contrast, the oral mucosa is characterized by a continuous desquamation of its surface epithelial cells, which allows rapid elimination of adhering bacteria. The mucosa that covers the cheek, tongue, gingiva, palate, and floor of the mouth varies according to the anatomical site. The epithelium may be keratinized (palate) or nonkeratinized (gingival crevice). The tongue, with its papillary surface, provides sites of colonization that are protected from mechanical removal. The area between the junctional epithelium of the gingiva and teeth, referred to as the gingival crevice, also provides a unique colonization site that includes both hard and soft tissues.2

The indigenous microbiota plays an important role in health and diseases of the humans and animals. It
contributes to the development of the immune system and provides resistance to colonization by allochthonous or pathogenic microorganisms. It also constitutes a reservoir of potentially pathogenic bacteria that may infect host tissues. Oral diseases seem to appear after an imbalance among the indigenous microbiota, leading to the emergence of potentially pathogenic bacteria.1

The oral surfaces are also constantly bathed by two important physiological fluids, the saliva and the gingival crevicular fluid. These fluids are essential for the maintenance of the oral ecosystems by providing water, nutrients, adherence and antimicrobial factors. The supragingival environment is bathed by saliva, while the subgingival environment (gingival crevice) is bathed mainly by the gingival crevicular fluid. Saliva is a complex mixture that enters the oral cavity via the ducts of three pairs of major salivary glands, the parotid, the submandibular, and the sublingual, and the minor salivary glands. Saliva contains 99% water but also contains glycoproteins, proteins, hormones, vitamins, urea and several ions. The concentrations of these components will vary according to the salivary flow. Generally, a slight increase in the secretion rate leads to an increase in sodium, bicarbonate, and pH and a decrease in potassium, calcium, phosphate, chloride, urea and proteins. At higher secretion rates, the concentrations of sodium, calcium, chloride, bicarbonate, and proteins increase while the concentration of phosphate decreases. Saliva helps maintain tooth integrity by providing ions, such as calcium, phosphate, magnesium, and fluoride for the remineralization of tooth enamel.

Local immune factors may play a role in protection against oral diseases and these defences may be related to 6 immunoglobulin (Ig) A and G subclass responses. Immunoglobulins are proteins of the animal origin endowed with known antibody activity and for certain other proteins related to them by chemical structure. Immunoglobulins are synthesized by plasma cells and to some extent by lymphocytes also. All antibodies are immunoglobulins, but all immunoglobulins may not be antibodies. Immunoglobulins constitute 20 to 25% of the total serum proteins.2

Five distinct classes of immunoglobulin molecules are recognized in higher mammals, namely IgG, IgA, IgM, IgD and IgE.3 The immunoglobulins responsible for the protection are IgA and IgG.4 Secretory IgA (SIgA) constitutes the predominant immunoglobulin isotype in secretions, including saliva. It is considered to be the first line of defense of the host against pathogens, which colonize or invade surfaces bathed by external secretions.5

Immunoglobulin-A is the primary protective antibody at mucosal surfaces. Immunoglobulin-A is produced by plasma cells in the minor salivary glands. Secretory IgA can traverse mucosal membranes; in this way, it helps to prevent the entry of infectious microorganisms.4 Several factors may influence the IgA levels in serum as well as in secretions. The secretion rate is an important factor. An increase in the secretion rate is accompanied by a decrease in concentration of SIgA in saliva. Another factor is cigarette smoking, which has been reported to decrease SIgA concentrations.6 Smoking has been shown to affect T-cell subsets, natural killer cells, and serum immunoglobulin concentrations.7 Decrease of SIgA may be due to an influence on the salivary gland cells responsible for the completion of the SIgA or on the cells of immunologic system involved in the production of the IgA molecules.8

Many studies were performed relating the physiology of IgA secretion occurrence of recurrent aphthous stomatitis (RAS).9 Recurrent aphthous ulceration (RAU) is a common oral disease appearing usually on nonkeratinized oral mucosa, especially on the tongue, vestibulum, palate and buccal mucosa. Recurrent aphthous stomatitis is one of the most common oral lesions seen by dentists.10 Recurrent aphthous stomatitis affects approximately 20% of general population, but when specific ethnic or socioeconomic groups are studied, the incidence ranges from 5 to 50%.11 The most common presentations are minor recurrent aphthous ulcers: round, painful ulcers up to 10 mm in diameter that heal within 10 to 14 days without scarring. Major ulcers are larger than 10 mm in diameter, and can last for several weeks and frequently scar. The etiology of RAS may be immunological one. Increased circulating levels of antibody against oral mucous membrane may be found in affected individuals. These increased antibody levels may be due to an immunologic cross-reaction between oral epithelium and indigenous microorganisms or the exposure, by ulceration, of previously sequestrated, hidden antigens setting up cycles of recurrent disease. Thus, there will be increased IgA levels in RAS patients.12

INTERRELATIONSHIP OF SMOKING AND INCIDENCES OF RECURRENT APHTHOUS STOMATITIS

In the early 1960s, it was reported that aphthous ulceration was relieved by the resumption of cigarette smoking (Brookman,1960; Dorsey, 1963), and in a 1970 population study, Shapiro et al (1970) showed a negative correlation between self-reported smoking histories and RAS. This was confirmed in a further study by Axell in 1985 (Axell and Henricsson 1985). Smokeless tobacco has also been noted to have a negative correlation with RAS (Grady et al 1992). These studies, relying on self-reporting of
tobacco habits, have shown that there appears to be a negative epidemiological association between smoking and aphthous stomatitis.

Significant differences in the prevalence of RAS in the group who were cigarette smokers were related to the dose and duration of the smoking habit. The ‘protective effect’ of tobacco on RAS was only noticed when persons were heavy smokers or smoked for longer periods of time. Of course this lower prevalence of RAS in the heavy smokers should not encourage smokers who suffer from RAS to increase their consumption. Data upon the ‘protective effect’ of smoking on RAS are controversial particularly with respect to a possible underlying mechanism. Some researchers thought that this protective effect is related to the increased keratinization of the oral mucosa in smokers and that this keratin layer acts as a mechanical and chemical barrier against trauma or microbes. In contrast, some have hypothesized that nicotine may be the responsible agent for the reduction in RAS prevalence rate in smokers. Nicotine has been shown to affect the immune response in inflammatory conditions by inducing the production of adrenal steroids through the hypothalamic-pituitary-adrenal axis and reducing the production of tumor necrosis factor-α (TNF-α) and interleukins 1 and 6 through its direct effect on macrophages. Some investigators support the belief that nicotine may act as protector of the oral mucosa in the patients with RAS while subjects who quit smoking often complain of RAS and resumption of smoking results in the faster resolution of RAS. In addition, those who quit smoking are less likely to develop RAS, if they use nicotine replacement therapy (NRT) as compared to those who do not use NRT. Few investigators suggested that smokers may be less psychologically stressed than nonsmokers and that some psychological trigger might affect RAS development.13

Smokers have been shown to have lower sIgA levels than non-smokers (Barton JR et al 1990; Evans et al 2000), while non-smokers and ex-smokers have been shown to have similar levels of sIgA (Barton JR et al 1990), suggesting that the immunosuppressive effects of smoking are reversed following smoking cessation.14 Nataf found that elevated levels of serum IgA and IgG were present in patients with RAU, and that salivary IgA did not differ in patients with RAU compared to the control group. Guven also found elevated levels of serum IgA and IgM in patients with RAU. However, the author did not find any changes in serum IgG levels. Porter et al described IgG subclass levels in the serum of patients with minor oral aphthous stomatitis, and concluded that there is no evidence to suggest that changes in IgG subclass are present in patients with RAU. In that study, patients did not have active lesions of the oral mucosa. A more recent study by Vincente et al suggested that low serum levels of IgG2 in patients with acute ulcers might play an important role in the pathogenesis of RAU. The same authors also reported that serum IgG subclass level as well as total IgA may undergo changes which are dependant on different periods of activity and quiescence of the disease. Ben-Aryeh et al found that salivary IgA and serum IgA and IgG in patients with either dormant or acute RAU were within the physiologic range for healthy people. Authors found lowered serum IgA in patients with acute RAU. Bennet and Reade found that salivary IgA in patients with minor aphthous ulceration undependable of stage disease showed no deviation from the control group. Both in patients with minor and major RAU, during acute phase, remission and in controls salivary flow rate was within normal ranges and we can conclude that the quantity of saliva is unchanged in patients with RAU.

Similarly, we found that mean levels of SlgA in saliva were significantly decreased in tobacco smokers either with or without dental caries when compared with non-smokers. Moreover, smokers with dental caries had lower concentrations of salivary SlgA compared to caries-free smokers.15 Some investigators have shown that smoking influences the salivary Ig content as well as systemic responses to antigens encountered in nasal and respiratory mucosa.15

Another study observed a striking and reproducible influence of cigarette smoking on salivary Ig in healthy smokers, found reduced concentration of IgA in pure parotid saliva, compared with nonsmokers, and showed that smokers had a dose dependent and probably reversible humoral mucosal immunodeficiency, as reflected either directly or otherwise by salivary IgA concentrations. The decrease in salivary IgA in tobacco smokers can be explained on the basis of immunosuppressive effects of combustion products of tobacco. Secondly, smoking markedly increases the flow rate of saliva leading to increased calcium levels in the oral cavity during smoking. However, an earlier study reported a level of salivary IgA reduced by 56% after physiological stimulation and its authors opined that these findings indicated that a considerable portion of salivary IgA is produced locally, depending on selective transport and the release from the local storage sites.16

Increased IgG levels in acute RAU patients implies the possible importance of IgG1–4 subclasses in acute RAU together with intense response to possible microbial etiologic factor. During the remission period, IgG2–3 remained increased whereas IgG1 and IgG4 returned to the values seen in healthy controls. Certainly, IgG
subкласс levels play a role during the period of disease activity and quiescence, and might support the role for an infective causative agent in the development of RAU.

Healthy smokers had significantly lower salivary IgA concentrations, and higher salivary IgM, when compared with non-smokers. There was no influence of smoking on salivary IgG concentration. There was a strong inverse correlation between salivary IgA concentration and the number of cigarettes currently smoked daily (10–60); however, no such relationship existed for salivary IgG, or IgM concentrations.

**CONCLUSION**

In the oral cavity, indigenous bacteria are often associated with many major oral diseases. These diseases seem to appear following an imbalance in the oral resident microbiota, leading to the emergence of potentially pathogenic bacteria. To define the process involved in such diseases, it is necessary to understand the ecology of the oral cavity and to identify the factors responsible for the transition of the oral microbiota from a commensal to a pathogenic relationship with the host. The regulatory forces influencing the oral ecosystem can be divided into three major categories: host related, microbe related, and external factors. Among host factors, SlgA constitutes the main specific immune defense mechanism in saliva and may play an important role in the homeostasis of the oral microbiota. Naturally, occurring SlgA antibodies that are reactive against a variety of indigenous bacteria are detectable in saliva. These antibodies may control the oral microbiota by reducing the adherence of bacteria to the oral mucosa and teeth. It is thought that protection against bacterial etiologic agents of oral diseases could be conferred by the induction of SlgA antibodies via the stimulation of the mucosal immune system. However, elucidation of the role of the SlgA immune system in controlling the oral indigenous microbiota is a prerequisite for the development of effective vaccines against these diseases. The role of SlgA antibodies in the acquisition and the regulation of the indigenous microbiota is still controversial. Data upon the ‘protective effect’ of smoking on RAS are controversial particularly with respect to a possible underlying mechanism. Some researchers thought that this protective effect is related to the increased keratinization of the oral mucosa in smokers and that this keratin layer acts as a mechanical and chemical barrier against trauma or microbes. In contrast, some have hypothesized that nicotine may be the responsible agent for the reduction in RAS prevalence rate in smokers. Nicotine has been shown to affect the immune response in inflammatory conditions by inducing the production of adrenal steroids through the hypothalamus-pituitary-adrenal axis and reducing the production of tumor necrosis factor-α (TNF-α) and interleukins 1 and 6 through its direct effect on macrophages.

**REFERENCES**

Virus and Their Effects on Periodontal Disease Progression

Akanksha Singh, Deepak Singla, Rika Singh, RG Shiva Manjunath, Hirak S Bhattacharya, Shankar T Gokhale

ABSTRACT

Periodontitis is a multifactorial, chronic disease followed by destruction of supporting structures of teeth. The main etiological factor for development of periodontitis is oral biofilm containing anaerobic microorganisms. Besides bacteria, viruses can also be present within periodontal pockets. The role of viruses is significant, as they may induce abnormalities in the adhesion, chemotaxis, phagocytosis, and bactericidal activities of polymorphonuclear leukocytes. Associated with one another, viruses and bacteria have stronger periodontopathogenic potential, than individually. For full understanding of the pathogenesis of periodontitis, it is significant to know all etiologic factors and host immune response; such an understanding should also guide the adequate treatment of this disease.

Keywords: Cytomegalovirus, Epstein-Barr virus, Herpes viruses, Periodontal disease.

INTRODUCTION

Periodontitis is one of the most complex infectious diseases of the human body. Periodontitis typically occurs in otherwise healthy individuals, and is statistically associated with various environmental and demographic factors. The pathogenesis of human periodontitis was placed on a rational footing for the first time by Page and Schroeder in 1976. Microbiological culture and culture-independent molecular studies have identified more than 1,200 bacterial species and 19,000 phylotypes in the oral cavity. Despite the long list of different bacteria in periodontitis, fewer than 20 species are considered to be major periodontal pathogens.

The shift in the periodontal microbiota with disease development is the result of a multifaceted interaction of microbial-specific traits, host immune responses and ecosystem-based factors. Herpesviruses, besides periodontopathogenic microbiota, have important role in etiopathogenesis of periodontitis. Periodontal herpesviruses comprise an important source for triggering the periodontal tissue destruction. Their genomes have been found in chronic periodontitis, aggressive periodontitis and periodontitis associated with systemic diseases. Herpesvirus-productive infection may initiate or accelerate periodontal tissue destruction. Virally-mediated release of cytokines and chemokines from inflammatory and non-inflammatory host cells, or a virally-induced impairment of the periodontal defense result in a heightened virulence of resident periodontopathogenic bacteria.

Herpesviruses

The herpetoviridae family contains only the genus herpesvirus. Herpesviruses share at least four characteristics: (1) the typical particle morphology consists of an icosahedral capsid assembly of 162 capsomers enclosed in a viral envelope, (2) the genome comprises a single double-stranded deoxyribonucleic acid (DNA) molecule ranging in size from 120 to 250 kbp, (3) viral infection exhibits tendency to tissue tropism, i.e. highly selective in regard to the surfaces or organs that they infect or invade, and (4) the viral productive phase is followed by a latent phase in host cells which ensures survival of the viral genome throughout the lifetime of the infected individual. Till now, eight different types of human herpesviruses are discovered. The species of herpesvirus family are classified into three subfamilies according to their pathogenicity, type of cell, site infected and depending upon the properties of their growth. Alpha-herpes viruses include herpes simplex virus type 1 (HSV-1), type 2 (HSV-2) and varicella zoster virus (VZV). The viruses of these subclasses grow rapidly, lead to lysis of the cells and remain latent in sensory nerve ganglia. Beta-herpesviruses are categorized into human herpes virus 6 (HHV-6), human cytomegalovirus (HCMV) and human herpesvirus 7 (HHV-7). The replication of these viruses is slow and they produce large and often multinucleated cells. The viral genome remains in latent phase in lymphoreticular tissues, kidneys, secretary...
glands and other tissues. Human cytomegaloviruses are capable to induce severe forms of diseases in immunocompromised patients, particularly pneumonia. Gamma-herpesviruses include human herpesvirus 8 (HHV-8) and Epstein-Barr virus (EBV). They are located in lymphoid tissues latently.\textsuperscript{10} Various studies have shown that EBV and HCMV are detected frequently in aggressive periodontitis sites.\textsuperscript{11}

**Epstein-Barr Virus**

Epstein-Barr virus infects and replicates in the oral and oropharyngeal epithelium and in B-lymphocytes.\textsuperscript{12} It is transmitted through blood and saliva. In the developing countries, EBV usually infects most of the children asymptotically, before 2 years of age. In developed countries, primary EBV infection occurs mainly in adolescents, often in the form of infectious mononucleosis.\textsuperscript{13} Symptoms of infectious mononucleosis include fever, malaise, lymphodenopathy and sore throat. Oral manifestations including oral ulcers, multiple palatal petechia, infrequent periorciteritis, acute ulcerative gingivitis or gingival ulcerations have been reported.\textsuperscript{14} Latent form of EBV infection can be reactivated, which leads to viral shedding into oral mucosa. Two different types of EBV types exist: EBV types 1 and 2. The EBV-1 predominates in the western hemisphere and EBV-2 in Africa.\textsuperscript{15} Individuals which are human immunodeficiency virus (HIV)-infected experience frequent EBV-2 infection or dual EBV-1 and EBV-2 infections.\textsuperscript{16} The EBV-infected epithelial cells may lead to oral hairy leukoplakia in HIV-positive patients.\textsuperscript{17} There is evidence of EBV which replicates within epithelial cells of oral hairy leukoplakia lesions.\textsuperscript{16} The presence of oral hairy leukoplakia in HIV-positive patients may be suggestive of development of acquired immunodeficiency syndrome (AIDS).\textsuperscript{17} However, oral hairy leukoplakia can also appear in the absence of HIV infection and can be found in patients who are immunosuppressed for reasons other than HIV.\textsuperscript{18} Additionally, oral lesions which are similar to oral hairy leukoplakia can occur in patients who do not have evidence of EBV infection.\textsuperscript{16}

Epstein-Barr virus may cause malignancy, including nasopharyngeal carcinoma, Burkitt’s lymphoma, B-cell lymphoma and oral carcinomas.\textsuperscript{19} Oral non-Hodgkin’s lymphoma may involve,\textsuperscript{20} causing tooth mobility and tooth exfoliation.\textsuperscript{21} Midline granuloma is an EBV-associated lymphoma\textsuperscript{22} that can cause severe gingival and periodontal destruction.

**Human Cytomegalovirus**

Human cytomegalovirus is mainly detected in blood and in many of the body secretions including semen, maternal milk and saliva. It is a ubiquitous herpesvirus, usually acquired in early childhood. Most primary infections are asymptomatic and the site of HCMV latency is still not known, although the virus is often recovered from the salivary glands.\textsuperscript{23} The HCMV may target endothelial and ductal epithelial cells,\textsuperscript{24} and it can also infect the gingival monocytes/macrophages and T-lymphocytes.\textsuperscript{25} Human cytomegalovirus is emerging as one of the most important opportunistic pathogens in immunocompromised individuals, especially those patients having AIDS and organ transplant patients.\textsuperscript{26} Human cytomegalovirus infection produces three recognizable clinical syndromes: perinatal disease and HCMV inclusion disease, acute acquired HCMV infection and disease in the immunocompromised host.\textsuperscript{27} Mothers who had a primary infection during pregnancy present microcephalia associated with mental retardation and hearing impairment in their child. When HCMV infection is acquired neonatally, it resembles infectious mononucleosis or may progress asymptomatically. The second HCMV-related syndrome is very much similar to infectious mononucleosis, except for the absence of pharyngitis and heterophilic antibodies. The third syndrome is observed in immunocompromised individuals, including HIV-infected individuals and tissue and bone marrow transplant patients. Human cytomegalovirus infection can enhance the immunosuppressiveness of HIV and can aggravate opportunistic infections.\textsuperscript{28} Oral ulcerations in immunosuppressed patients are often related to HCMV.\textsuperscript{29} In HIV-positive patients, 53% of persistent ulcers showed HCMV and another 28% HCMV and HSV co-infection.\textsuperscript{30} The HCMV-related oral ulcers can occasionally involve gingiva and periodontium with underlying bone destruction or osteomyelitis.\textsuperscript{31} Gingival overgrowth can also occur due to HCMV.\textsuperscript{32}

**Varicella-Zoster Virus**

Varicella-Zoster virus (chickenpox) (VZV), as primary infection mainly affects children; whereas when reactivation of this virus occurs in adults, it causes herpes zoster (shingles). Varicella is a highly infectious disease which is transmitted by inhalation of infective droplets or by direct contact with lesions. Oral lesions include vesicles on the lips and hard and soft palate.\textsuperscript{33} Both primary and secondary VZV infections can produce gingival lesions.\textsuperscript{14} Following primary infection, VZV remains latent in the dorsal root ganglion cells for possible later reactivation. Herpes zoster results when reactivation of latent VZV occurs. Vesicles quickly break to form ulcerated lesions with prominent red borders, resembling aphthous ulcers. Lesions are unilaterally distributed along the infected nerve.\textsuperscript{33} Herpes-Zoster
may also give rise to necrosis of the periodontium and mandibular bone, dental hypoplasia and retarded tooth eruption. Varicella may appear in HIV-positive patients as an atypical, persistent form of the disease. Clinical presentation and occurrence of complications from VZV reactivation are related to severity of immunodeficiency.

**Human Herpesvirus-6**

Human herpesvirus-6 was originally named human B-lymphotropic virus, but was recently reclassified as herpesvirus. The two variants (A and B) identified have affinity for CD4+ lymphocytes. The HHV-6 is isolated from saliva of most individuals and can also occur in gingiva of periodontitis lesions. It may be involved in oral squamous carcinoma. In a study of 51 squamous cell carcinomas, 18 non-malignant lesions and seven normal mucosa samples, HHV-6 was detected in 79% of malignancies and 67% of lichen planus lesions and leukoplakia, but was absent in normal mucosa. The HHV-6 variant B was detected in 60% of the squamous carcinoma lesions.

**Human Herpesvirus-7**

Human herpesvirus-7 is a ubiquitous herpesvirus. It is closely related to HHV-6 and the two beta herpesviruses exhibit serological cross-reactivity with each other. Infection of HHV-7 is usually acquired in childhood and most adults are HHV-7 seropositive. It is found in saliva, which presents the major mode of transmission, and is secreted for many years following initial infection. Minor labial salivary glands often harbor HHV-7 and may sometimes be the site of viral replication. In a study of more than 100 specimens from major salivary glands, HHV-7 was detected in 100% of submandibular, 85% of parotid and 59% of minor lip salivary gland samples. Human herpesvirus-7 has also been detected in inflamed gingiva.

**Human Herpesvirus-8**

Recently discovered, HHV-8 is believed to be the key agent of Kaposi’s sarcoma. The DNA sequences of HHV-8 were identified in 53 out of 54 AIDS-related oral Kaposi’s sarcoma lesions. Human herpesvirus-8 has been identified in periodontitis lesions of HIV-positive patients. Kaposi’s sarcoma has become relatively prevalent, although the disease can also occur with dermal bullous pemphigoid in HIV negative immunosuppressed patients. Kaposi’s sarcoma debuts in the oral cavity in 60% of patients and may later progress to extraoral sites. Oral Kaposi’s sarcoma frequently involves oral keratinized mucosa. The most common oral site is the palate, followed by attached gingiva. Also, Kaposi’s sarcoma may progress from gingiva to the underlying alveolar bone. Oral Kaposi’s sarcoma lesions become symptomatic in 25% of patients.

Herpesviruses may exert periodontopathic potential through at least 5 mechanisms, operating alone or in combination (Flow Chart 1).

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**Flow Chart 1: Herpesviral—bacterial model of periodontitis**

1. **Healthy gingiva**
2. **Bacterial biofilm**
3. **Gingivitis**
4. **Herpesvirus activation**
5. **Periodontopathic properties**
6. **Cytokines/chemokines/enzymes**
   - 1. Interleukin-1 beta
   - 2. Tumor necrosis factor-alpha
   - 3. Prostaglandin E2
   - 4. Matrix metalloproteinases
7. **Immunosuppression and upgrowth of exogenous-like pathogenic bacteria**
   - 1. P. gingivalis
   - 2. T. forsythia
   - 3. A. actinomyces/ectomitus
   - 4. P. intermedia
8. **Cytotoxicity/tissue necrosis with severe immunosuppression**
   - 1. HIV-infection
   - 2. Nutritional stressed children/adolescents
9. **1. Inflammation**
10. **2. Collagen degradation**
11. **3. Bone resorption**
12. **Sufficient time span**
13. **Destructive periodontal disease**
First, herpesviruses may cause direct cytopathic effects on fibroblasts, keratinocytes, endothelial cells on inflammatory cells, such as polymorphonuclear leukocytes, lymphocytes, macrophages, and possibly on bone cells.\(^4\) Since the above cells are key constituents of inflamed periodontal tissue, herpesvirus-induced cytopathic effects may hamper tissue turnover and repair.

Secondly, herpesviral periodontal infections may impair cells involved in host defense, thereby predisposing to microbial superinfection. The HCMV and EBV-1 can infect and/or alter functions of monocytes, macrophages and lymphocytes; herpesvirus genomes are present in inflammatory cells of adult periodontitic lesions.\(^2\) Thirdly, gingival herpesvirus infection may promote subgingival attachment and colonization of periodontopathic bacteria, similar to the enhanced bacterial adherence to virus-infected cells observed in medical infections.\(^2\) Viral proteins expressed on eukaryotic cell membranes can act as bacterial receptors and generate new bacterial binding sites. Also, loss of virus-damaged epithelial cells can expose the basement membrane and the surface of regenerating cells, providing new sites for bacterial adhesion.\(^2\)

Fourthly, herpesviral infections can give rise to altered inflammatory mediator and cytokine responses. In periodontitis, HCMV-induced expression of cytokines is particularly intriguing.\(^4\) The HCMV infection can upregulate interleukin 1-beta (IL-1β) and tumor necrosis factor-alpha (TNF-α) gene expression of monocytes and macrophages. Increased production of the proinflammatory cytokines IL-1β and TNF-α by macrophages and monocytes has been associated with enhanced susceptibility to destructive periodontal disease. In turn, IL-1β and TNF-α may upregulate matrix metalloproteinase, downregulate tissue inhibitors of metalloproteinase and mediate periodontal bone destruction.\(^5\) Fifthly, herpesviruses can produce tissue injury as a result of immunopathological responses to virally infected cells.\(^1\) The HCMV and HSV can induce cell-mediated immunosuppression by reducing the cell surface expression of MHC (major histocompatibility complex) class I molecules, thereby interfering with T-lymphocyte recognition. Human cytomegalovirus can cause metabolic abnormalities in lymphocytes and monocytes.\(^6\) In addition, HCMV can suppress antigen-specific cytotoxic T-lymphocyte functions, resulting in decrease in circulating CD8+ cells and increase in CD8+ suppressor cells; which, in turn, may lead to global impairment of cell-mediated immunity.\(^7\) T-lymphocyte functions and immunopathological reactions similar to those associated with herpesvirus infections have been implicated in the pathogenesis of human periodontal disease.\(^8\)

## CONCLUSION

Researches of the virus impact on periodontitis are intended to lead to better understanding and clarification of etiopathogenesis of this disease. Based on different studies, it could be concluded that viruses affect the development of periodontitis. Periodontopathogenic bacteria, EBV and HCMV seemed to act synergistically and result in increased risk for the occurrence and spread of periodontitis. Detection and determination of viruses’ quantitative presence has prognostic significance for periodontitis. Future researches of virus impact on periodontitis can lead to progress in prevention and treatment of this disease.

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Periodontal Vaccines: A Vision or Mission

Veritika Srivastava, Neeraj Chandra, Shankar T Gokhale, Sakshi Singhal

ABSTRACT

Vaccine is the name applied generally to a substance of the nature of dead or attenuated living infectious material, introduced into the body with the object of increasing its power to resist or get rid of a disease. Vaccines are generally prophylactic, i.e. they ameliorate the effects of future infection. One such vaccine considered here is the ‘periodontal vaccine’. Till date, no preventive modality exists for periodontal disease and treatment rendered is palliative. Thus, availability of periodontal vaccine would not only prevent and modulate periodontal disease, but also enhance the quality of life of people for whom periodontal treatment cannot be easily obtained. The aim of the research should be development of a multispecies vaccine targeting the four prime periodontal pathogens, viz Porphyromonas gingivalis, Tannerella forsythia, Treponema denticola and Aggregatibacter actinomyctecomitans. Success is still elusive in case of periodontal vaccine due to the complex etiopathogenesis of the disease.

Keywords: Immunization, Multispecies, Periodontal disease, Vaccine.


Source of support: Nil
Conflict of interest: None

INTRODUCTION

Gingival and periodontal diseases, in their various forms, have afflicted humans since the dawn of history. It can be considered as one of most common chronic inflammatory disease affecting humans. With advancements in molecular diagnostic techniques, better understanding of role of specific pathogens and host immune response in initiation and progression of periodontal disease has been possible to some extent, though not completely.

Various animal and human studies are under trial to develop a vaccine against periodontal diseases. Vaccines can be prepared from weakened or killed microorganisms, subcellular segments, inactivated toxins, toxoids derived from microorganisms or immunologically active surface markers extracted from microorganisms.

HISTORY OF PERIODONTAL VACCINE

Louis Pasteur coined the term ‘vaccine’. These are preparations of live or killed microorganisms or their products used for immunization.

Vaccines increase host immune response by artificially producing a degree of resistance, sufficient to prevent a clinical attack of natural infection, without causing ill effects to the recipient.

Vaccines may be live, attenuated, component, recombinant, synthetic oligopeptide and deoxyribonucleic acid (DNA). A new type called subunit vaccine, prepared by purifying important antigens of microorganisms, has also been developed.

Periodontal vaccines were new additions to the vaccine family and were invented in early 20th century.

BACKGROUND FOR DEVELOPMENT OF PERIODONTAL VACCINES

Periodontal disease comprises a group of infections involving supporting tissues of teeth. These range in severity from mild and reversible inflammation of gingiva to chronic destruction of periodontal tissues with eventual loss of teeth.

Classification of various manifestations of periodontal disease is continuously changing and the diseases also range in severity, rate of progression, number of teeth affected and at different age groups. Nature of pathogenic agents varies among different diseases, and even between different sites within a patient because of site specificity. Though there is great amount of information about human diseases, little has been accomplished by way of preventing or treating the disease. There remains a need for safe and effective vaccine for treating and preventing periodontal disease.

Some microorganisms were considered as key pathogens in periodontal disease as they were strongly associated with disease status, disease progression and unsuccessful therapy. These were Porphyromonas gingivalis, Tannerella forsythia and Aggregatibacter actinomyctecomitans. These were considered as key organisms as they satisfied the Socransky’s modification of Koch’s postulate.
Periodontal vaccines under trial are hence being developed mainly against these few microorganisms.

PATHOGENESIS OF PERIODONTITIS

Pathogenic bacteria produce an array of antigens which stimulate proinflammatory cells and leads to production of wide variety of cytokines. These antigens may stimulate T-helper cells 1 or 2 (Th1 or Th2 respectively) cells. Antigens are taken up by dendritic cells and presented to CD4 or CD8 cells along with major histocompatible complex (MHC) antigens.\(^4\)

Host produces antibacterial substances, like defensins and cathelicidins which protect host tissues from bacterial products and form first line of defense. However, sometimes these are inactivated by bacterial virulence factors.

Once bacteria break this barrier, cytokines are produced, which can be both proinflammatory and anti-inflammatory. Production of inappropriate cytokines results in periodontitis.

BASIS FOR DEVELOPMENT OF PERIODONTAL VACCINE

The bacteria most frequently associated with periodontitis include *P. gingivalis, P. intermedia, T. forsythia* (forsytheinsis), *Treponema denticola, Aggregatibacter actinomycetemcomitans*, and *Fusobacterium spp*.\(^5\) Such bacteria and their by-products can elicit strong immune responses.\(^6\)

As it was found that few key pathogenic microorganisms were almost always responsible for development of periodontal diseases, an attempt was made to immunize against these common pathogenic microorganisms by vaccines; which, in turn, helps in preventing the occurrence of periodontal disease.

INVENTION OF PERIODONTAL VACCINES

The invention relates to novel bacterial isolates which are identified by their 16S rRNA, DNA that causes periodontal disease in companion animal. Polynucleotide sequences are contained in them. The polypeptides encoded by such polypeptide sequences and vaccines comprising such bacterial isolates have been inactivated or attenuated.\(^7\) They also provides the methods for treating and preventing periodontal disease and kits for detecting, treating, and preventing periodontal disease. In addition, methods for assessing efficacy of a vaccine against periodontal diseases in an animal are provided.

Vaccine Candidate Antigens of *P. gingivalis*

*Porphyromonas gingivalis* is a potential vaccine candidate because this pathogen carries several high-potent antigens, a lipopolysaccharide capsule, lipids and outer membrane proteins. Whole-cell formalin-killed *P. gingivalis* has been used as the target antigen.\(^8\)

Studies have shown that immunization with RgpA–Pgp induces an immunoglobulin G2a response, with a restricted colonization by *P. gingivalis* and periodontal bone loss in the rat.\(^8\)

Studies have also demonstrated that transcutaneous immunization of mice with a 40 kDa outer membrane protein of *P. gingivalis* induces specific antibodies that inhibit coaggregation by *P. gingivalis* to *Streptococcus gordonii*.\(^9\)

VACCINE TRIALS

Vaccine trials in animal models are required for safety and efficacy testing of vaccines. The ideal animal research model for vaccine trials against periodontitis with naturally occurring periodontitis based on the same etiology, pathogenesis, and prevalence in animals as well as in humans does not exist.

Page and Schroeder\(^10\) concluded that because of continuous eruption patterns of teeth and alveolar bone changes, mice, rats, and hamsters might not be suitable for clinical periodontitis vaccine efficacy studies.

Dogs have not been considered for periodontal vaccine studies. It is of interest that sheep (bovine) appear to develop naturally occurring periodontitis. At least for *P. gingivalis* in sheep, there is homology to human strains. There is also a similarity in humoral immune responses and periodontitis responses in sheep and humans.\(^11\)

Nonhuman primates, including *Macaca fascicularis, Macaca nemestrina*, marmosets, baboons and chimpanzees, have been considered for periodontal vaccine trials. Naturally occurring periodontitis in *M. fascicularis* (wild caught or domestically bred) is less than 5%.\(^12\)

Studies have demonstrated that key pathogens associated with periodontitis can be identified in samples taken from adult *M. fascicularis* and *M. nemestrina* and identified by DNA probes, aimed for studies of strains found in humans.\(^13\) Thus, the patterns of bacterial presence in older vs young *M. nemestrina* are consistent with what is known from bacterial patterns in humans.

STUDIES CONDUCTED TO PROVE EFFECTIVENESS OF PERIODONTAL VACCINES

In particular, various studies and trials are under progress for vaccine against *P. gingivalis* and also few studies against *A. actinomycetemcomitans* and *T. forsythia* in animals like rats, dogs, sheeps, etc. Here, few studies are mentioned which were conducted on animals against these organisms.

In a study conducted by Choi J et al on mice, regarding using capsular polysaccharide-fimbrial protein conjugate
vaccine, it was found that it helped in reconstructing human peripheral blood lymphocytes. Study concluded that capsular polysaccharide-fimbrial protein conjugate from P. gingivalis could potentially be developed as vaccines against periodontal infection by it. In a study conducted by Torbjorn and Graham on Wistar rats, it was found that treatment with SRII72 (heat killed Mycobacterium vaccae) inhibited progression of established experimental periodontal disease. The SRII72, a preparation of heat killed M. vaccae had shown to down regulate Th2 responses and increase Th1 responses to bacteria, and hence have therapeutic effect in periodontal disease.15

Another study conducted by Lee et al, it was found that P. gingivalis heat shock protein-vaccine reduces the alveolar bone loss induced by multiple periodontopathic bacteria.16 In a study conducted by Decarlo et al on rat periodontitis model, it was found that pre-inoculation with the P. gingivalis HA2 binding domain for hemoglobin provided protection from disease. Protection was associated with induced anti-HA2 immunoglobulin G (IgG) humoral antibodies. The IgG subclass ratios suggested that relatively lower Th2/Th1-driven responses were directly associated with protection when rHA2 was administered in saline. Koizumi et al found that nasal immunization with P. gingivalis outer membrane protein decreases P. gingivalis induced atherosclerosis and inflammation in spontaneously hyperlipidemic mice.16

Persson et al demonstrated that immune responses to whole bacterial cell and purified protein preparations as vaccine candidates was found in nonhuman primate models. Data suggested that immunization reduces the rate and severity of bone loss and it is also possible to alter the composition of subgingival microflora. Natural active immunization by therapeutic interventions results in antibody titer enhancement and potentially improves treatment outcome. Passive immunization of humans using P. gingivalis monoclonal antibodies temporarily prevents its colonization.

FUTURE TRENDS

Advanced human periodontal disease is a common problem in many developing countries, where it often results in multiple tooth loss by early middle age. Giving the vaccine in early adolescence before periodontitis has developed may enhance the quality of life for people for whom periodontal treatment cannot be obtained easily. Therefore, availability of a vaccine for preventing or modulating periodontal disease in humans, dogs and other mammals would be of great benefit in both developed and developing countries.

WHY PERIODONTAL VACCINE REMAINS A DREAM TILL DATE?

Though lots of researches have been made and many are still in progress, the concept of vaccination against periodontal disease in humans still remains complex and unresolved. The most probable reason for this failure is that all the studies were conducted on experimental animals and no sufficient data is available to imply the same in humans. Evidence-based literature is necessary to accept the effectiveness of these vaccines in humans. Moreover, most of the studies conducted were against a particular microorganism. Though the aimed organism was a key pathogenic microorganism, its effectiveness in preventing disease like periodontal disease, which has multifactorial etiology, was questionable.

Proper etiology for periodontal disease is not completely clear as it is multifactorial; it is not only caused by few of these microorganisms but also due to many other local and systemic factors, like smoking, diabetes, emotional stress, and few genetic factors also play role in occurrence of disease.

Therefore, the attempt to prevent periodontal disease by means of periodontal vaccines remains a failure. As studies have concluded, various periodontal vaccines are found to be effective in animals. But, impact of such immunization in humans and its feasibility should be explored. So, further research and study should be carried out to use periodontal vaccines effectively and safely in humans and make it a reality.

DREAM OR REALITY?

Although till now periodontal vaccines are not a reality, they surely can be considered as a dream, which may come true as the future looks very bright and promising as per the various researches going on in the field.

Unlike other treatment modalities available today which can only treat the existing disease, vaccines not only treat but also prevent the occurrence of disease. As the saying ‘Prevention is better than cure’, its ability to prevent disease may overtake all other treatment modalities if it succeeds. However, the invention is still in infancy stage and has a long way to go before it can be used in routine practice. Somebody has correctly said ‘Do not’ be afraid of space between your dream and reality. If you can dream it, you can make it so’.

Thus, development of immunotherapy for periodontitis is though a groundbreaking work, it will prove to be an emerging treatment modality in near future.

CONCLUSION

The current evidence collected from a large series of diverse and independent studies have clearly demons-
treated that active immunization using vaccines against microorganisms will induce a significant humoral response across animal study models. If passive immunization studies are included, such evidence can also be gathered from human observational studies.

Immunization against microorganisms results in a reduction of the quantity of the target organism in animal models. Microorganism levels at infected periodontal sites are inversely correlated with antibody titers against the pathogen. Collaborative efforts are needed to ensure successful vaccine development against periodontitis.

Hence, from the various efforts taken to develop a periodontal vaccine—‘A magical bullet’, we can see that these efforts are making a dream turn into reality.

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Obesity and Periodontal Disease

1Rika Singh, 2Deepak Singla, 3Akanksha Singh, 4Hirak S Bhattacharya, 5RG Shiva Manjunath, 6Veritika Srivastava

ABSTRACT

Obesity is increasing in prevalence and is a major contributor to worldwide morbidity. One consequence of obesity might be an increased risk for periodontal disease, although periodontal inflammation might, in turn, exacerbate the metabolic syndrome, of which obesity is one component. This positive association was consistent and coherent with a biologically plausible role for obesity in the development of periodontal disease. This review aims to compile the evidence of an obesity-periodontal disease relationship from epidemiologic studies and to derive a quantitative summary of the association between these disease states.

Keywords: Body mass index, Obesity, Periodontal disease.


Source of support: Nil

Conflict of interest: None

BACKGROUND

Obesity is a chronic low-grade inflammatory disease which occurs due to changes occurring in adipose tissue. Obesity is characterized by excess adipose tissue that results in elevated levels of proinflammatory cytokines and hormones named adipokines, resulting in an imbalance between increased inflammatory stimuli and decreased anti-inflammatory mechanisms, leading to persistent low-grade inflammation. This review aims to emphasize upon the obesity-periodontal disease relationship.

INTRODUCTION

Obesity is one of the most significant health risks of urban population and is now recognized as a chronic disease with a multifactorial etiology. The incidence of obesity and elevated body mass index (BMI) has rapidly been increasing in the western world. It has been suggested that obesity is associated with increased morbidity and mortality and is either an independent or aggravating factor for a number of diseases, such as hypertension, coronary heart disease (CHD), osteoarthritis and type two diabetes mellitus.

DEFINITION

Obesity can be defined as a BMI ≥ 30.0 kg/m². The definition of obesity is based on BMI, also called Quetelet index, which is the ratio of body weight (in kg) to body height (in m²).

CLASSIFICATION

Body mass index is a measurement which compares weight and height; defines people as overweight (pre-obese) if their BMI is 25 to 30 kg/m², and obese when it is greater than 30 kg/m². The BMI is calculated by dividing the subject’s weight by the square of his or her height, typically expressed either in metric or US customary units:

Metric BMI = kilograms/meters
US customary and imperial BMI = lb × 703/in²

Where ‘lb’ is the subject’s weight in pounds and ‘in’ is the subject’s height in inches.

PREVALENCE

The prevalence of overweight and obesity among adults and children was relatively constant. Among them, 13% of adults and 5% of children were obese and overweight respectively, over the period of 1960 to 1980. The prevalence of obesity among adults has doubled, and overweight children and adolescents has tripled over a short period of time. In the year 2004, about 34.1% of the US population was overweight and about 32.2% was obese.

CAUSES

A combination of excessive calorie intake and lack of physical exercise is thought to be the main etiologic factor for obesity. The other etiologic factors are genetic, medical reasons or psychiatric illness. A review concluded 10 different possible factors contributing to the recent increase in obesity like: insufficient sleep, endocrine disturbances, decreased variability in ambient temperature, increased rates of smoking, some medications (e.g. atypical antipsychotics), some ethnic races, pregnancy at a higher age, epigenetic risk factors...
passed on generationally, natural selection for higher BMI, and assortative mating leading to increased concentration of obesity risk factors. The literature supports the influence of these mechanisms on the increased prevalence of obesity. Recently, obesity is considered as one of the risk indicators of periodontal disease and conversely, the remote effects of periodontal disease on various systemic diseases have been proposed.

**OBESITY AND PERIODONTAL DISEASE INTERRELATIONSHIP**

Obesity is not the primary etiologic factor for periodontal disease; however, in response to bacterial plaque accumulation, inflammation and destruction of periodontal tissues were more severe in obese animals. In obese and hypertensive rats, plaque accumulation caused even more pronounced periodontal destruction than in obese animals, suggesting that a combination of risk factors, such as those defined by the metabolic syndrome, elicit the most severe periodontal effects. In 1998, Saito et al examined 241 healthy Japanese individuals and concluded the association between obesity and periodontal disease in humans. They applied the community periodontal index of treatment needs (CPITN) and estimated that the relative risk for periodontitis after adjustment for confounders, such as age, gender, oral hygiene status and smoking, was 3.4 in persons with BMI of 25 to 29.9 kg/m², and 8.6 in those with BMI above 30 kg/m². Studies have indicated the crucial role in fat distribution pattern and its association with periodontitis. Saito et al found that high upper body obesity and high total body fat were correlated with a higher risk of periodontal disease. Woods et al noted the correlation between BMI, waist:hip ratio and the periodontal measures. Also, high waist circumference was especially associated with periodontal disease in 18- to 34-year-old persons, but not in older adults. A cross-sectional survey on 4,246 subjects by Eun-Jin K with a community periodontal index (CPI) with code 3 as criteria for periodontitis revealed that a high waist circumference appears to be associated with periodontitis, while BMI does not. This finding shows that abdominal obesity is significantly correlated with periodontitis. Dalla Vecchia et al found a strong correlation in obese females rather than males in south Brazilian individuals. Genco et al examined the third National Health and Nutrition Examination Survey (NHANES) data showed that BMI had a positive correlation with the severity of periodontal destruction and it is modulated by insulin resistance. Regular physical exercise has beneficial effect on periodontal health and the individuals have lower plasma levels of inflammatory markers, such as IL-6 and C-reactive protein (CRP), and show an increased insulin sensitivity. Shimazaki et al used multivariate logistic regression analyses on 1160 subjects, keeping CPI codes 3 or 4 as marker for periodontitis. This study suggests that obesity and physical fitness may have some interactive effect on periodontal health status.

**Obesity and Inflammation**

Adipose tissue is an inert organ that stores triglycerides. This tissue constitutes adipocytes, preadipocytes and macrophages, collectively called adipokines or adipocytokines. These organs play a major role in maintaining metabolic and vascular biology, which in turn, may modulate periodontitis. Some adipokines act locally, while others act on the systemic circulation as signaling molecules to the liver, muscle and endothelium.

**Leptin**

It is a pleiotropic cytokine which is secreted by adipocytes and is involved in various biological processes. It acts by passing signals through the central nervous system and peripheral pathways to diminish appetite and increase energy expenditure. Leptin decreases the hepatic glucose production, and thereby increases the glucose uptake in muscles and adipose tissues. Several studies have suggested that elevated levels of leptin can be found during infection and inflammation. In humans, leptin production can be increased in inflammatory bowel disease and rheumatoid arthritis. Different authors consider leptin resistance as contributing factor in obesity’s pathology, such as atherosclerosis and cardiovascular disease. Kardeşler et al studied 13 well-controlled [glycated hemoglobin (HbA1c) <7%] and 12 poorly controlled (HbA1c ≥ 7%) patients with type two diabetes and chronic periodontitis, and 15 systemically healthy patients. Within the limits of this study, patients with type two diabetes and chronic periodontitis exhibited similar clinical periodontal improvements as their systemically healthy counterparts. Initial periodontal treatment appeared to improve glycemic control in poorly controlled patients with diabetes. Decreases in levels of IL-6, TNF-α, CRP and leptin, and an increase in adiponectin levels after periodontal therapy may be a function of glycemic control in patients with type two diabetes.

**Adiponectin**

Adiponectin is a circulating hormone which is secreted by adipose tissues and is involved in glucose and lipid metabolism, which accounts for about 0.05% of total serum proteins. It is decreased in obese subjects, especially those
with abdominal obesity, insulin resistance or type two diabetes. It improves insulin sensitivity and has anti-atherogenic and anti-inflammatory properties. Low level of plasma adiponectin has been shown to predict type two diabetes, coronary heart disease in humans and other features of the metabolic syndrome. Resistin belongs to the family of resistin-like molecules (RELM) and is considered to be secreted by adipocytes to cause insulin resistance in animal models. In contrast to mice, human resistin is expressed at lower levels in adipocytes, but at higher levels in circulating blood monocytes. Interestingly, the amino acid sequences of resistin and of RELM-α and RELM-β are identical to the previously discovered proteins FIZZ3, FIZZ1 and FIZZ2 respectively, which are involved in inflammatory processes. Resistin levels were found in persons with coronary heart disease. Recently, various adipokines have been introduced, which include visfatin eliciting insulin-like effects and serum-retinol-binding protein 4 (RBP4).

In a study, 40 subjects (20 males and 20 females; age range: 23–53 years) were analyzed with their gingival index, probing pocket depth, clinical attachment level and radiologic parameters (bone loss). This study concluded that gingival crevicular fluid (GCF) and serum visfatin concentration increases with severity of periodontal disease. Therefore, visfatin values can be considered as an inflammatory marker in periodontal disease in GCF and serum.

Tumor Necrosis Factor-α

Obesity-associated tumor necrosis factor-α (TNF-α) is primarily secreted from macrophages. The studies have not shown completely consistent results; it is suggested that increased circulating TNF-α increases insulin resistance, induces C-reactive peptide production and general systemic inflammation. It helps in monocyte recruitment into developing atherosclerotic lesions and is a potent inhibitor of adiponectin.

Interleukin-6

Interleukin-6 is a procoagulant cytokine and increases plasma concentrations of fibrinogen, plasminogen activator inhibitor-1, and C-reactive peptide. Data also suggest its roles in inducing lipolysis and diminishing appetite and weight gain. Zuza EP observed 27 obese subjects and 25 normal weight subjects with visible plaque index (VPI), bleeding gingival index (BGI), bleeding on probing (BOP), probing depth (PD) and clinical attachment level (CAL). Periodontal therapy significantly decreased visible plaque index, bleeding gingival index, bleeding on probing, probing depth of 4 to 6 mm, probing depth ≥7 mm, clinical attachment level of 4 to 6 mm, and clinical attachment level ≥7 mm in both groups (p < 0.05). Circulating proinflammatory cytokines significantly decreased in obese and normal-weight subjects after periodontal treatment. The levels of IL-6 and TNF-α remained higher in obese subjects 3 months after treatment. Shimada et al analyzed 33 chronic periodontitis patients (22 nonsmokers and 11 smokers) and 18 healthy subjects along with their mean PD, mean CAL and mean alveolar bone loss. They found periodontal treatment to be effective in reducing serum leptin, IL-6 and CRP levels. The results suggest that leptin, IL-6 and CRP could be mediating factors that connect metabolic syndrome and periodontitis.

Plasminogen Activator Inhibitor-1

It is a regulatory protein of the coagulation cascade produced by stromal cells surrounding the increased adipocytes. It prevents the dissolution of clots by inhibiting extracellular matrix degradation and fibrinolysis. It includes the development of type two diabetes and coronary thrombi.

Angiotensinogen

Angiotensinogen, mostly from abdominal fat stores, is increased in obesity. Angiotensinogen has vasoconstrictive effects on blood vessels and contribution to hypertension.

Vascular Endothelial Growth Factor

Obesity is associated with increased levels vascular endothelial growth factor (VEGF), which also plays a role in hypertension and atherogenesis. Although VEGF is necessary for vascular remodeling after angioplasty and for the development of collaterals in diabetic peripheral vascular disease, it also contributes to the initial development of atheromatous changes and post-catheterization restenosis.

C-reactive Peptide

Elevated C-reactive peptide levels are associated both with obesity and with increased risk of cardiovascular disease; it predicts both the development of cardiovascular disease and the risk of progression to type two diabetes mellitus. Yasumasa et al observed obese Zucker rats and their lean littermates; in which, 24 rats were included in the study, divided into four groups, and found that systemic low-grade inflammation after experimental periodontitis was associated with increased gene expression for hepatic levels of TNF-α and CRP and adipose tissue levels of IL-6 and CRP in the obese-rat model.
LIVER AND PERIODONTAL DISEASE

Liver has an important role in glucose and lipid metabolism. The mechanism for the development of non-alcoholic steatohepatitis, which is accompanied by obesity or diabetes, is not clear; it is suggested that there is an association with lipopolysaccharide, an endotoxin of Gram-negative microorganisms. An increase in the level of hepatic triglycerides is dependent on the influx of free fatty acids, which are mainly derived from visceral adipose tissue, and is associated with insulin resistance.

Periodontal treatment decreases the serum level of glycosylated hemoglobin and has a beneficial effect on diabetic control. If lipopolysaccharide derived from Gram-negative bacteria in periodontal pockets mediates TNF-α release from adipose tissue, it may be associated with hepatic dyslipidemia. The hypothesis is supported by our study, in which periodontal disease was associated with the results of blood tests, especially those associated with liver function; the subjects with deep pockets had elevated serum levels of aspartate aminotransferase, alanine aminotransferase, and cholinesterase, and an aspartate aminotransferase-to-alanine aminotransferase ratio less than one, suggesting that they have a tendency toward steatohepatitis.

CONCLUSION

Obesity is a complex disease, and its relationship to oral status has been realized by the scientific community in recent years. Periodontists must be aware of the increasing numbers of obese persons and of the significance of obesity as a multiple-risk-factor syndrome for overall and oral health. Proinflammatory cytokines may be a multidirectional link among periodontitis, obesity and other chronic diseases. The adipose tissue is a large reservoir of biologically active mediators, such as TNF-α and other adipokines. Studies have demonstrated a close involvement of the adipokines, such as leptin, resistin and adiponectin, in inflammatory processes. However, their role in periodontal inflammation is yet to be defined. Although this relationship needs further investigation, periodontists should counsel obese persons regarding the possible oral complications of obesity, to diminish morbidity for these individuals. This includes the measurement of BMI and waist circumference for periodontal risk assessment on a regular basis.

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Present Trends in Maxillofacial Prosthetic Material: 
An Inclination toward Silicones

Praveen Chandra, Farah Ahmad, Swarajya Bharathi, Chandana Nair, Alok Kumar

ABSTRACT
Craniofacial region suffers from many defects due to carcinoma, trauma and other iatrogenic causes. Surgery leaves defects ranging from minor cosmetic discrepancy to major functional limitation. Rehabilitation of these patients with disabilities due to either congenital or acquired defects is challenging. To achieve this, several maxillofacial materials have been used that best suit the ideal selection criteria to satisfy the functionality, biocompatibility, esthetics as well as the durability. The aim of this article was to accentuate about their evolution and current trends in using these materials.

Keywords: Foaming silicones, Maxillofacial prosthesis, Polyphosphazenes, Room temperature vulcanized, Silicone block copolymers, Silicone elastomers heat vulcanized.


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Conflict of interest: None

INTRODUCTION
Anaplastology is a branch of medicine dealing with the prosthetic rehabilitation of an absent, disfigured or malformed anatomically critical location of the face or body. Maxillofacial prosthesis is defined as any prosthesis used to replace part or all of any stomatognathic and/or craniofacial structures. Materials for maxillofacial prosthetic reconstruction include those with physical properties ranging from hard, stiff alloys, ceramics and polymers to soft, flexible polymers and their formulation as latex and plastisols. However, till date no material has emerged that possesses all the distinct and desirable characteristics.

Silicones (1960 to 1970)

Silicones were introduced in 1946, but were used in fabrication of maxillofacial prosthesis only for the past few years. It consists of alternate chains of sodium and oxygen which can be modified by attaching various organic side groups to the silicon atoms or by cross-linking the molecular chains. They have properties ranging from rigid plastics through elastomers to fluids. When adequately cured, they resist absorbing organic materials that lead to bacterial growth; so, with simple cleaning, these materials are relatively safe and of adequate sanitary quality as compared to other materials.

Silicones are classified into four groups according to their applications as follows:
1. **Class I**: Implant grade, which requires the material to undergo extensive testing and must meet ‘food and drug administration’ requirements. These materials are used in breast implantation.
2. **Class II**: Medical grade, which is approved for external use. This material is used for fabrication of maxillofacial prosthesis. Some studies tested the cytotoxicity of this material; however, none has reported any negative side-effects.
3. **Class III**: Clean grade, this material is applied to use in food coverage and packaging.
4. **Class IV**: Industrial grade, commonly used for industrial applications. Vulcanization makes the silicone resistant to ultraviolet (UV) light. Depending whether the vulcanizing process uses heat or not, silicones are available as heat vulcanized (HTV) or room temperature vulcanized (RTV), and both exhibit advantages and disadvantages.

Heat-vulcanized Silicones

Heat-vulcanized silicones are seldom used for maxillofacial prostheses. They include a polydimethyl vinyl siloxane copolymer with approximately 0.5% vinyl side chains, 2,4-dichlorobenzoyl peroxide as an initiator (vulcanizing agent), and a silica filler obtained from burning methyl silane; catalyst of HTV is platinum salt (salt of chloroplatinic acid). By altering the ratio of the...
matrix and the filler particles, the desired physical and mechanical properties can be achieved. The process of vulcanization requires greater milling of the solid HTV stock elastomer for mixing the catalyst for cross-linking and pigments. Chalian et al explained the milling of HTV silicone using a two-roll mill with a motor drive so that greater translucency can be obtained with increased dispersion of internal pigments used. Vulcanization or cross-linking occurs by free radical addition. The processing temperature ranges from 180 to 220°C for about 30 minutes under pressure using metal molds. They have excellent tear strength and highest tensile strength at 5.87 MPa (polyurethane has the lowest at 0.83 MPa), excellent thermal, color and chemical stability (rendering it more biologically inert) and high percent elongation.

The examples of HTV are Silastic S-6508, Silastic 382 and Silastic 399.

Room Temperature Vulcanizing Silicones

There are two types of room temperature vulcanizing silicones (RTVS):

1. Cross-linkage occurs by condensation reaction: They have reactive groups, such as silarilols (hydroxyl-terminated polysiloxanes), cross-linking agent, e.g. tetraethyl silicate, and a catalyst, such as triacetoxy silane is used as the cross-linking agent. Their use has been limited to that of an extrinsic colorant carrier applied to the surface of the prosthesis.

2. Cross-linking of polysiloxanes by addition reactions: These involve the addition of silyl hydride groups (—SiH) to vinyl groups (CH—=CH—) attached to the silicone in presence of platinum as catalyst. These silicones are not truly room vulcanized silicones as curing of these silicones require heating the material at 150°C for an hour. Prostheses are polymerized by bulk multiple packing. Recently, epoxy resins and stainless steel molds are being used. The examples are Silastic 382, 399, 891, MDX4-4210, cosmesil, A-2186 and A-2186F.

Silastic 382 and 399 are viscous silicone polymers which are color stable and biologically inert. They are available as clear solutions that enable the fabrication of translucent prosthesis. The MDX4-4210 is a clear-to-translucent two-part (10:1, basecatalyst) silicone which was introduced to the maxillofacial prosthetics field in the 1970s. According to Beumer, in a survey by Andres, 41% of the clinicians used this material for fabrication of maxillary prosthesis. Moore et al stated that it exhibited improved qualities relative to coloration and edge strength, has adequate tensile strength, is nontoxic, color stable and biologically compatible.

The silicone ‘A-2186’ was introduced in 1986 by Factor II (lakeside, AZ). It was the first commercial platinum-catalyzed silicone elastomer. A fast polymerization rate version of A-2186 with higher platinum content ‘A-2186F’ became commercially available in 1987, which was not a very preferred material for prosthesis purpose. A-2000: In 2000, factor II introduced A-2000 as the first generation of a 1:1 mixture platinum silicone followed by A-2006 in 2006. Silastic 891: Udagama and Drane first reported the use of this material. It is also known as silastic medical adhesive silicone type A and is also compatible with wide range of colorants.

Several other commercially available silicone products include—cosmesil, realistic, VerSilTal (VST) and liquid silicone rubber (LSR).

Properties of HTV and RTV

In comparison to other materials, both HTV and RTV have high tear resistance. Room temperature vulcanizing has the lowest dynamic modulus of 2.12 MPa. According to a survey by Montgomery and Kiat-Amnuay, MDX4-4210 and A-2186 RTV silicones along with silastic medical adhesive type A (for extrinsic coloring of prostheses) were the most preferred maxillofacial prosthetic materials used; due to hydrophobic nature, these have low adhesion than nonsilicone adhesive material and suffer from limited working time. Later, researchers have found stronger enhancement through the use of nano silica powder, which has a larger surface area than micrometer-sized silica powder.

Commercially Available Newer Materials

They include acrylic resin copolymer, vinyl polymers and copolymers, polyurethane elastomers, silicone elastomers—RTV and HTV, Silastic 372 and 373, dow corning Mich A-2186, factor zinc ariz and cosmol.

ALTERNATIVE MATERIALS

Silicone Block Copolymers

The silicone block copolymers can, to some extent, overcome the problem caused by silicone (especially with regard to its interaction with the body on a molecular level, foreign body reaction) as the more hydrophilic part of these amphiphilic polymers provides improved wettability and thus tissue compatibility.
Cosmesil

Cosmesil can be processed to varying degree of hardness as described by Wolfaardt et al.19 It is a RTV silicone showing a high degree of tear resistance.

Foaming Silicones

Silastic 386 is a type of RTV material. The purpose of the foam forming silicones is to reduce the weight of the prosthesis.

Siphenylenes

These exhibit improved edge strength, low modulus of elasticity and color stability over the more conventional polydimethylsiloxane.

POLYPHOSPHAZENES

Fluoroelastomer has been developed for use as a resilient denture liner and has the potential to be used as a maxillofacial prosthetic material.

CONCLUSION

The demand for both intra- and extraoral prosthetic rehabilitation is increasing with the increasing rate of head and neck cancers being diagnosed each year. Prosthetic rehabilitation is not always considered mandatory as a course of treatment, but it should be noted that it is not a vanity issue; rather, it is a psychological issue that impacts more and more people throughout the world each year. Till date, none of the commercially available materials satisfy all the requirements of an ideal maxillofacial material. Every material has its own advantages and disadvantages. The possibility of fabricating a high quality life-like prosthesis directly on the face requires an excellent skill of the prosthodontist and the role of a dental material scientist who can help by providing a perfect material with improved properties and color stable coloring agents to rehabilitate the patient with maxillofacial defect.

REFERENCES

Alternative Restorative Therapy: An ‘ART’ in Conservative Treatment

1Ankita Mehrotra, 2Sumit Mohan, 3Anuraag Gurtu, 4Anurag Singhal, 5Radhika Lekhi

ABSTRACT
The number of studies investigating atraumatic restorative treatment (ART) approach has increased in recent years. This tissue preservative treatment approach appears to be less traumatic and is, therefore, more patient-friendly than conventional caries treatments. The investigations have shown that the ART approach is effective for the management of single-surface cavities in both deciduous and permanent dentitions. There appears to be no difference in survival results between ART restorations and amalgam restorations. This article gives a brief overview of ART.

Keywords: Atraumatic restorative treatment, Conventional treatment, Glass-ionomer cement, Tooth preservation.


Source of support: Nil
Conflict of interest: None

INTRODUCTION
The need to develop a new approach to oral care for use in economically less developed countries was most strikingly reinforced by World Health Organization’s (WHO) regional advisor for oral health for the African region SA. Thorpe, in his keynote address at the seventh meeting of the Southern and Eastern African section of (IADR), held in Harare in 1992. He commented that: ‘More than 90% of dentinal lesions in Africa go untreated’. Implied in Thorpe’s statement is that, because restorative care is not available to the majority of Africans, teeth are left to decay to the extent that they become painful and have to be removed. In common with most economically less developed countries and regions, extraction is the predominant oral care procedure performed by both dentists and dental therapists.1

The prevalence of dental caries has shown changing patterns in different parts of the world. The WHO global data bank indicates improvements in most industrialized nations and deterioration for most developing countries, where it is becoming a public health problem. Dental caries is virtually left untreated in the majority of populations in these economically underdeveloped countries, often leading to many large painful cavities. If any treatment is provided at all, it is in the form of extraction. The main reason for not providing care revolves around the need for expensive dental equipment and extensively trained personnel. There has been a general lack of appropriate techniques to allow primary healthcare under conditions that provide no electricity or dental equipment.2

The atraumatic restorative treatment (ART) technique for dental caries is an innovative, largely pain free, minimal intervention approach for treating carious teeth, particularly in countries where highly trained dentists and electricity needed for clinical equipment are not readily available or affordable.3 The ART technique is based on removing infected tooth material, using only hand instruments and filling the subsequently clean cavity with adhesive material, such as glass-ionomer. The development has led to a shift from the concept of ‘disease’ (filling holes in teeth) toward that of ‘health’ (trying to preserve the teeth and gums through small intervention and oral health promotion activities).

The technique was developed in Tanzania in the mid 1980s and has also been field tested in north-eastern Thailand now for more than 3 years.1,2

HISTORY
Minimal or small cavity design was proposed by black almost 100 years ago, when he meticulously developed and tested the principles for restorative management of dental caries. It was advised that for artificial restorations to be successful, they must be very minutely (accurately) performed.2,4 Cavities must be absolutely dry and clean when restorations are placed and the restorations must hermetically seal the cavities if recurrences of decay are to be prevented. Extension for prevention only applies to
smooth surfaces, never to occlusal surfaces. Extension of cavity should be done to secure smooth margins of the restoration.\textsuperscript{3,5}

This tooth preservation method was followed by the development of the sealant-restoration or preventive resin restoration and the preventive glass-ionomer restoration, thereby starting the current movement for tooth preservation.\textsuperscript{1}

The WHO adopted ART as a principle theme on World Health Day for the opening session of the year of oral health in April 1994. Since then, interest in ART from all parts of the world has been overwhelming. The ART field trials are in progress in 11 countries and a further 17 countries have plans to begin them.\textsuperscript{2}

New Approach for Controlling Dental Caries

The treatment approach that can provide curative care to disadvantaged populations is called ‘ART’. The ART consists of an elementary technique of caries removal using hand instruments only, combined with the use of a modern restorative material with adhesive characteristics. Currently, glass-ionomers that leach fluoride and minimize the onset of secondary caries, are used. The often cited disadvantages of glass-ionomers, namely low wear resistance and strength, are minimized because the cavity preparations of the ART technique usually result in relatively small restorations. Furthermore, new glass-ionomers with improved wear resistance and strength are being developed specifically for the ART technique.\textsuperscript{6}

PRINCIPLES OF ART\textsuperscript{2}

The two main principles of ART are as follows:

- Removing carious tooth tissues using hand instruments only, and
- Restoring the cavity with a restorative material that sticks to the tooth.

The reasons for using hand instruments rather than electric rotating handpieces are as follows:\textsuperscript{2,7}

- It makes restorative care accessible to all population groups.
- The use of a biological approach, which requires minimal cavity preparation that conserves sound tooth tissues and causes fewer traumas to the teeth.
- The low cost of hand instruments as compared to electrically driven dental equipments.
- The limitation of pain that reduces the need for local anesthesia to a minimum and reduces psychological trauma to patients.
- Simplified infection control. Hand instruments can easily be cleaned and sterilized after every patient.

The reasons for using glass-ionomer are:\textsuperscript{1}

- As the glass-ionomer sticks chemically to both enamel and dentine, the need to cut sound tooth tissue to prepare the cavity is reduced.
- Fluoride is released from the restoration site to prevent and arrest caries.
- It is rather similar to hard oral tissues and does not inflame the pulp or gingiva.

The ART can be applied when there is a cavity involving the dentin and is accessible to hand instruments. The ART should not be used when:\textsuperscript{2}

- There is presence of swelling (abscess) or fistula (opening from abscess to the oral cavity) near the carious tooth.
- The pulp of the tooth is exposed.
- Teeth have been painful for a long time and there may be chronic inflammation of the pulp.
- There is an obvious carious cavity, but the opening is inaccessible to hand instruments.
- There are clear signs of a cavity, e.g. in a proximal surface, but the cavity cannot be entered from the proximal or the occlusal directions.

DESCRIPTION OF THE ART TECHNIQUE

As with any other oral treatment procedure, ART requires a proper patient-to-operator position. This requirement usually is not a problem in a dental surgery, but requires particular attention in other working environments.\textsuperscript{8}

Since its inception, the ART technique has undergone revisions aimed at improving the basic technique. Unlike many other restorative procedures, usually there is no need to give local anesthesia when using the ART technique because temperature-induced pain from using a drill is avoided. Because the technique mainly involves the removal of decalcified tooth tissue, pain can be minimized, and often does not occur at all. Thus, fear of dental procedures is reduced.\textsuperscript{2,9}

Atraumatic Restorative Treatment Techniques

According to the ‘ART—WHO manual (1994)’,\textsuperscript{2} before actually starting the ART, the following preparations should be made:

- Set up a good working environment.
- Know the essentials of the glass-ionomer cement (GIC).
- Know how to select the proper instruments and to maintain infection control.

Work Position Setting\textsuperscript{2,10}

Oral healthcare tasks often require precise work and high levels of control and are performed in restricted
situations. The position of both the operator and patient is very important in achieving a very successful restoration.

A description of the most appropriate position for both oral examination and treatment is as follows:

**Operator’s Work Posture and Position**

A desirable position for the operator is one in which the body is in a static position, with the back straight, and the hands and fingers that control the work brought to a midline position.

**Chairside Assistant Position**

The assistant works at the left side of the operator and does not change position relative to the patient. The assistant sits as close to the patient support as possible, facing the operating point. The assistant’s head should be 10 to 15 cm higher than the operator so that the assistant can see the operating field and can pass the instruments when needed.

**Patient’s Position**

A patient lying on the back on a flat surface will provide safe and secure body support as well as comfort and stable position for lengthy periods of time. The comfort of the patient also depends on the correct head rest which can be made of soft foam or rubber ring with a cover. The patient can assist the operator by tilting or turning the head and opening the mouth wide enough to provide access to the area of operation. These three movements need to be varied to improve access and vision during oral care procedure.

**Essential Instruments and Materials**

The essential instruments and materials needed to carry out the ART have been listed in Tables 1 and 2.

**Treatment Material**

The material used for restoring cavities and sealing surfaces is the glass-ionomer cement. A brief description of the properties, characteristics and working mechanism of glass-ionomer as a restorative material are discussed hereby.

The glass-ionomer cements (GICs) were introduced to the profession by Wilson and Kent in 1971; they provided adhesion to both enamel and dentin through an ion exchange with the additional benefit of a continuing fluoride release throughout the life of the restoration. Acceptance of the early versions was slow because of perceived problems with water exchange, poor color range and a lack of translucency. The new Fuji IX glass-ionomer cement is being widely used in the ART of caries control in developing countries; developed in 1990s and successfully manufactured since then by GC Corporation for the ART. The Fuji IX GIC exploits self-cure and caries inhibiting properties of GIC at minimal resources, and Fuji IX GP is one of these specially designed formulations that can be handled in field conditions. Main advantages of the material, no shrinkage on setting and native adhesion to dentine, are as typical for GIC. It exhibits efficient antibacterial activity. High viscosity on mixing due to large preset ratio of powder to liquid provides with reasonable mechanical strength and low moisture sensitivity, which are otherwise known two poor attributes of GICs. High concentration of fluoride in the glass formulation provides beneficial fluoride release over time that could be extended or regulated via exposing to fluoride containing media, e.g. toothpastes, fluoridated water, etc.3,15

Due to its fast setting, easy handling and good performance, this material now widely dominates in the ART

<table>
<thead>
<tr>
<th>Table 1: Instruments used in ART</th>
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<tbody>
<tr>
<td>Mouth mirror</td>
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<td>Explorer</td>
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<tr>
<td>Pair of tweezers</td>
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<tr>
<td>Dental hatchet</td>
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<tr>
<td>Spoon excavator (small)</td>
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<tr>
<td>Spoon excavator (medium)</td>
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<tr>
<td>Spoon excavator (large)</td>
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<tr>
<td>Applier/carver</td>
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<tr>
<td>Glass slab or paper mixing pad</td>
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<td>Spatula</td>
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<table>
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<th>Table 2: Materials used in ART</th>
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<tbody>
<tr>
<td>Cotton wool roll</td>
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<tr>
<td>Cotton wool pellet</td>
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<tr>
<td>Clean water</td>
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<tr>
<td>Glass-ionomer restorative material</td>
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<tr>
<td>Liquid, powder and measuring spoon</td>
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<tr>
<td>Dentin conditioner</td>
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<tr>
<td>Petroleum jelly</td>
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<tr>
<td>Wedge</td>
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<tr>
<td>Plastic strip</td>
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<tr>
<td>Articulation paper</td>
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<tr>
<td>Others</td>
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<tr>
<td>Examination gloves</td>
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<tr>
<td>Mouth mask</td>
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<tr>
<td>Operating light</td>
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<tr>
<td>Operation bed/headrest extension</td>
</tr>
<tr>
<td>Stool</td>
</tr>
<tr>
<td>Methylated alcohol</td>
</tr>
<tr>
<td>Pressure cooker</td>
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<tr>
<td>Instrument forceps</td>
</tr>
<tr>
<td>Soap and towel</td>
</tr>
<tr>
<td>Sheet of textile</td>
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<td>Sharpening stone and oil</td>
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restorative market. Despite its leading position among the restoratives, the setting mechanism for these systems is largely unknown.

**Microleakage:** In an investigation, the leakage that occurs after placement of a glass-ionomer sealant was studied and found that extensive leakage was seen in all glass-ionomer specimens with dye penetration throughout the materials as well as the interface between cement and enamel.3

**Adhesion:** Glass-ionomer was able to bond to dentin when used as a liner in vital teeth but not when used in extracted teeth.3

**Remineralization:** Glass-ionomer cements have been credited for the absence of secondary caries. In a study for the effects of GIC restorations on demineralization and remineralization of enamel and dentin lesion, it was concluded that the fluoride released from GIC or the decreased permeability as a result of hypermineralization causes lower susceptibility of the dentin of the cavity walls.3

**Anticariogenic property:** Glass-ionomer cement presents a broad anticariogenic effect and may be of value in preventing secondary caries, even under conditions of high caries risk.3

**Longevity:** The clinical longevity of GIC was shown to be very acceptable and appeared to be equal or superior to that of other direct restorative materials.3

**Physical properties:** A study done for measuring the compressive, tensile and shear bond strengths to enamel and dentin of a conventional ART-GIC (Fuji IX) and two resin modified GICs (Fuji plus, and advance) reported that Fuji IX had the highest compressive strength and the resin modified advance had the lowest strength.2,3

**Antimicrobial action:** The GIC restorative margins have been found to have lower levels of *Streptococcus mutans* and plaque, which suggests that plaque formed on GIC restorations has less potential to induce recurrent caries. Studies link the antibacterial effect to fluoride ion release, which reduces the plaque’s acidogenicity that does not favor *S. mutans*. The fluoride release from GICs is greatest in the first few days after placement, after which it decreases to a constant level over a prolonged period.3

For obtaining antibacterial GICs for ART based on Fuji IX, incorporation of 1% chlorhexidine diacetate has been shown to give appropriate antibacterial, physical and bonding properties while not affecting mechanical properties, bonding abilities or setting time.

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**ADVANTAGES OF ATRAUMATIC RESTORATIVE TREATMENT**2,16-19

- The use of relatively easily available and inexpensive hand instruments rather than electrically driven dental equipments.
- A biologically friendly approach involving the removal of only decalcified tooth tissues.
- The limitation of pain and minimized need of local anesthesia.
- A straightforward and simple infection control practice without the need to use sequentially autoclaved handpieces.
- The chemical adhesion of glass-ionomers that reduces the need to cut sound tooth tissue for retention of the restorative material.
- The leaching of fluoride from glass-ionomers which prevents secondary caries development and probably remineralize carious dentin.
- The combination of preventive and curative treatment in one procedure.
- The ease of repairing defects in the restoration.
- Low cost.

**LIMITATIONS OF ATRAUMATIC RESTORATIVE TREATMENT**2

- Long-term survival rates are not yet available; the longest study so far is of 3 years duration.
- Acceptance of the technique by oral healthcare personnel is not yet assured.
- At the moment, its use is limited to small and medium-sized one-surface lesions because of the low wear resistance and strength of existing glass-ionomer materials.
- The possibility exists for hand fatigue from the use of hand instruments over long periods.
- Hand mixing might produce a relatively unstandardized mix of glass-ionomer, varying among operators and different geographical and climatic situations.
- The misapprehension that ART can be performed easily is actually not true.
- The apparent lack of sophisticated technique makes it difficult for ART to be easily acceptable by the dental professionals.

The ART is an example of the contemporary caries management philosophy of minimal intervention dentistry. In its principle, it differs from other examples of minimally invasive treatments. The ART is a patient-friendly, preventive and restorative treatment approach that has a place alongside traditional treatment approaches. It produces good short-term survival results for
the treatment of single-surface dentinal lesions in both deciduous and permanent dentitions. It is concluded that the ART approach is beneficial in improving the oral health of many, not only in developing but also in more advanced countries.

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Late Congenital Syphilis in a Pediatric Patient

Nidhi Gera et al

ABSTRACT

Syphilis is an infectious disease which is on rise these days due to various etiological factors, like HIV, intravenous drug usages, promiscuous sex. It is broadly of three types—primary, secondary and tertiary. Congenital syphilis comes under tertiary type. This case report describes about female child having late congenital syphilis infection. Congenital syphilis occurs due to the transmission of the disease from an infected mother to the unborn infant through the placenta. The child had symptomatic congenital syphilis with dental manifestations.

Keywords: Child, Dental teeth, Syphilis.

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INTRODUCTION

As we have ventured in 21st century, there is an upsurge of so many new types of infectious disease, affecting human race. Among these, bacterial infection syphilis which was long forgotten disease affects the pregnant women even today resulting in prenatal morbidity and mortality.1

Although worldwide incidence of syphilis decreased over the last 25 years and the disease was on the verge of being eliminated in many countries in 1998, infection rates have recently increased.2 According to the centers for disease control and prevention (CDC), a total of 49,903 cases of syphilis were reported in the United States in 2012.2

It has three types: primary, secondary and tertiary. The condition was well described in the 15th century and has long been recognized as a distinct syndrome in which the source is an infected adult.3,4 Transplacental transmission from an asymptomatic infected mother was first described in 1906.3,4

Congenital syphilis occurs due to the transmission of the disease from an infected mother to the unborn infant through the placenta. Syphilis is caused by Treponema pallidum, a spirochete that cannot survive for long outside the human body. Treponema pallidum enters through the mucous membranes or skin, reaches the regional lymph nodes within hours, and rapidly spreads throughout the body.5 Infection is usually transmitted by sexual contact (including genital, orogenital and anogenital) but may be transmitted nonsexually by skin contact or transplacentally.5 Risk of transmission is about 30% from a single sexual encounter with a person who has primary syphilis and 60 to 80% from an infected mother to a fetus. Infection does not lead to immunity against reinfection.5

Congenital syphilis is a severe, disabling infection often with grave consequences. Approximately, 66% of infected infants are asymptomatic at the time of birth and are identified in routine prenatal screening.6-8 World Health Organization (WHO) estimates that 2 million get infected with syphilis every year. Intrauterine infection with spirochetes T. pallidum can result in still birth, hydrops fetalis, or preterm birth or be asymptomatic at birth.9,10

Questions regarding prevention and management of congenital syphilis persists because the diagnosis of the suspected cases and management may be confusing, and the potential for severe disability is high when cases are missed. The venereal disease research laboratory (VDRL) test and rapid plasma reagin (RPR) are used to detect the antibody called reagin, which is produced by the immune system’s response to T. pallidum infection. ‘False negative’ results may occur when these tests are performed during the first 3 to 6 weeks following infection (primary syphilis); negative results do not rule out syphilis during this time. The continuing prevalence of the disease reveals the failure of control measures established for its prevention.

We put forth a case of symptomatic congenital syphilis with dental manifestations. The report stresses upon the importance of implementing WHO recommendation that all pregnant women should be screened for syphilis in the first antenatal visit.

CASE REPORT

An 11-year-old female patient (Figs 1 to 3) reported to the department of pedodontics and preventive dentistry with a chief complaint of discolored upper front and lower back teeth. As told by the grandmother, the child was adopted by her as she had found the child on road side.
As told by patient’s grandmother, child has habit of scratching her gingival sulcus, both in upper and lower arches during daytime. The child’s grandmother gave the history of rash and mucocutaneous lesions. The child did not have any snuffles or feeding difficulty. The child’s grandmother complained that child has continuous pain in her joints and self-limiting swellings in all joints.

Extraoral examination showed saddle shape nose. Anterior fontanel was flat, and there was no asymmetry of movements or cranial nerve palsy. On intraoral examination, screw driver shaped incisors were present wrt 11 and 21 (Figs 4 and 5). Mulberry molars were present wrt 36 and 46 (Figs 6 and 7). Incisors were screw driver’s shape discolored with notching (Huthinson’s incisor). Occlusal caries were present wrt 36, 46 and 55.

Gingiva was inflamed. Generalized stains were present.

After intraoral examination, the provisional diagnosis of congenital syphilis was made, taking into consideration of amelogenesis imperfecta, septic arthritis and traumatic arthritis as differential diagnosis.

Patient underwent routine blood investigation, VDRL test, eye and ear examination, neurological examination and skeletal examination. Ultrasound examination of abdomen and pelvis showed no abnormality. Leg anteroposterior X-ray was normal. There was no lymphadenopathy and no apparent bony abnormality. There was no evidence of neurological or cardiovascular involvement.

Investigations revealed normal blood picture and C-reactive protein. Neurological, cardiovascular ENT and ophthalmological examinations were normal. Venereal disease research laboratory result showed 1:4 dilution and was reactive (Fig. 8).

Based on reports of above-mentioned investigations, confirmatory diagnosis of congenital syphilis was made.

DISCUSSION

In 21st century when congenital syphilis is thought to be eradicated, it is re-emerging due to pitfalls in ANC or screening. One of the most striking features of congenital syphilis is that it may be transmitted from infected
parents to their offspring, the children exhibiting the manifestations that characterize the acquired form of the disease.

The more recent the syphilis in the parent, the greater is the risk of the disease being communicated to the offspring; so that if either parent suffers from secondary syphilis the infection is almost inevitably transmitted.

In contrast to the acquired form, inherited syphilis is remarkable for the absence of any primary stage, the infection being a general one from the outset. The spirochete is demonstrated in incredible numbers in the liver, spleen, lung and other organs, and in the nasal secretion, and, from any of these, successful inoculations in monkeys can readily be made. The manifestations differ in degree rather than in kind from those of the acquired disease; the difference is partly due to the fact that the virus is attacking developing instead of fully formed tissues.

Primary syphilis, the earliest stage, is characterized by the presence of lesions at the site of T. pallidum entry and subsequent development of regional lymphadenopathy. In secondary syphilis, which occurs about 2 to 10 weeks after infection hematogenous dissemination of T. pallidum causes several systemic findings, including fever, malaise, generalized lymphadenopathy and mucocutaneous lesions (papular, macular, annular or follicular lesions). The signs and symptoms of primary and secondary syphilis resolve spontaneously and patients then enter the latent stage of infection (Anderson et al, 1989; Hutchinson and Hook, 1990). After a variable period of latency, tertiary or late stage disease develops in about one third of untreated patients. Manifestations may take up to 10 years to appear and then present themselves as benign tertiary (gummatous lesions), cardiovascular syphilis, or neurosyphilis (Hook and Marra 1992). Conclusive diagnosis of syphilis infection is based on confirmation of the clinical signs and symptoms with laboratory tests (Hook et al).

Affections of the Bones

Swellings at the ends of the long bones, due to inflammation at the epiphyseal junctions, are most often observed at the upper end of the humerus and in the bones in the region of the elbow.

Changes in the Permanent Teeth

These affect specially the upper central incisors, which were dwarfed and stand somewhat apart in the gum, with
their free edges converging toward one another. They were tapering or peg-shaped, and present at their cutting margin a deep semilunar notch. These appearances are commonly associated with the name of Hutchinson, who first described them. Affecting as they do the permanent teeth, they are not available for diagnosis until the child is over 8 years of age. Henry Moon drew attention to a change in the first molars; these are reduced in size and dome-shaped through dwarfing of the central tubercle of each cusp. In our case also we made a provisional diagnosis based on intraoral examination which revealed characteristic Hutchinson’s incisors and Mulberry molars.

While a considerable number of syphilitic children grow-up without showing any trace of their syphilitic inheritance, the majority retain throughout life one or more of the following characteristics, which may therefore be described as permanent signs of the inherited disease: Dwarfing of stature from interference with growth at the epiphyseal junctions; the forehead low and vertical, and the parietal and frontal eminences unduly prominent; the bridge of the nose sunken and rounded; radiating scars at the angles of the mouth; perforation or destruction of the hard palate; Hutchinson’s teeth; opacities of the cornea from antecedent keratitis; alterations in the fundus oculi from choroiditis, deafness, depressed scars or nodes on the bones from previous gummata; ‘sabre-blade’ or other deformity of the tibia.

This article highlights the awareness of the importance of dental findings in systemic disease of late congenital syphilis, which is a very rare clinical entity and its importance to make early diagnosis, and its proper management can prevent further complications. Although an effective treatment is available since the introduction of penicillin in the mid-20th century, it still remains as an important public health problem.

CONCLUSION

Prevention of Congenital Syphilis

- Ensure that official public health statutes and/or regulations mandate STS on all pregnant women at the time of the initial prenatal visit and early in the third trimester.
- Encourage prenatal screening for syphilis wherever pregnant women are seen for healthcare, including women, infants and children (WIC) programs, methadone maintenance clinics, detention facilities, and prenatal care facilities; whenever possible, review existing clinic protocols and suggest specific amendments to the clinic medical director.
- Conduct selective serologic screening of women of childbearing age in groups with an increased risk of infection, e.g. women residing in neighborhoods that have a particularly high incidence of syphilis.
- Deliver educational messages to the medical community about laboratory tests, diagnostic criteria, treatment, and follow-up of patients who are at risk of infection and who may be pregnant.
- Develop and disseminate public service educational messages to women who share demographic characteristics with the women most often diagnosed with early syphilis.

Regardless of the stage of pregnancy, patients who are not allergic to penicillin should be treated with penicillin according to the dosage schedules appropriate for the stage of syphilis as recommended for nonpregnant patients. Recommended regimens for symptomatic or asymptomatic infant: aqueous crystalline penicillin G, 50,000 units/kg IM or IV daily in two divided doses for a minimum of 10 days or Aqueous procaine penicillin G, 50,000 units/kg IM daily for a minimum of 10 days.

For asymptomatic infants whose mothers were treated adequately with a penicillin regimen during pregnancy but whose follow-up cannot be ensured, many consultants recommend treatment with benzathine penicillin 50,000 units/kg IM in a single dose. Data on the efficacy of this regimen in congenital neurosyphilis are lacking; therefore, if neurosyphilis cannot be excluded, the 10-day regimen of aqueous crystalline penicillin or procaine penicillin are recommended. Only penicillin regimens are recommended for neonatal congenital syphilis. All patients with early syphilis or congenital syphilis should be encouraged to return for repeat quantitative nontreponemal tests at least 3, 6 and 12 months after treatment.

Syphilis is in rise among adult and pediatric population due to varied etiological factors. In this case, in spite of repeated medical visit child went undiagnosed for late congenital syphilis which may be due to improper documentations and missing out on small findings. Understanding the pathophysiology and progression of this disease still remains challenge even in the modern era.

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Reconstruction of Intraoral defects with the Pedicled Buccal Fat Pad: A Case Report and Literature Review

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ABSTRACT

Buccal fat pad (BFP) to cover intraoral defects was first described by Egyedi in 1977. The buccal fat pad is specialized fat tissue located anterior to the masseter muscle and deep to the buccinator muscle. Anatomically, the buccal fat pad consists of a central body and four processes: buccal, pterygoid, superficial, and temporal extensions, which provides separation allowing gliding motion between muscles, protects the neurovascular bundles from injuries, and maintains facial convexity. The buccal and deep temporal branches of the maxillary artery, the transverse facial branches of the superficial temporal artery, compose the primary blood supply. Because of its many advantageous functions, the use of the BFP during oral and maxillofacial procedures is promoted for the reconstruction of defects secondary to tumor resection, and those defects resulting from oroantral fistula caused by dento-alveolar surgery or trauma. We used the pedicled buccal fat pad in the reconstruction of intraoral defects, such as oroantral fistula, defect due to maxillectomy, buccal mucosal defects and for the closure of incised wound after surgical treatment of oral and maxillofacial surgery. Epithelialization of the fat tissue began 1 week after the surgery, healed without complication within 3 to 5 weeks in all patients. The surface of the fat converted to normal mucosa and demonstrated stable healing without complications over a long-term period. Through this article we want to share our clinical experience and highly recommend the BFP for the reconstruction of intraoral defect.

Keywords: Buccal fat pad, Oral reconstruction, Oroantral fistula.

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INTRODUCTION

Intraoral post surgical defect reconstruction is always a challenging one due to anatomical constraints and the specialized nature of intraoral tissues. Various surgical techniques have been suggested for the closure of oral defects, such as primary closure, buccal mucosal graft, split thickness skin graft, allogenic graft, regional rotational flap, and distant flap. The use of the buccal fat pad (BFP) as a grafting source in the closure of intraoral defects has gained popularity, because of the ease of access and rich blood supply.

Its use as a pedicle graft for oral reconstruction was first reported by Egyedi in 1977. The use of the BFP as a free graft for intraoral defects was reported. In 1983, by Neder, Tideman et al reported that the restoration of defects is possible with BFP without skin graft. In 1995, the pedicled fat pad graft was used in four cases of palatal reconstruction of cleft patients by Hudson et al.

Anatomically, the BFP is composed of the central body and four processes-buccal, pterygoid, pterygomaxillary, and temporal process. It is in the masticatory space between the masseter muscle and buccinator muscle, so it can be easily accessed by exposing in the mouth when cutting the buccinator muscle and is good for engraftment with sufficient blood supply, because it receives blood from superficial temporal artery, internal maxillary artery, facial artery, and maxillary artery. In the case of the oral recipient site, epithelialization begins 7 days after the surgery; histologically, epithelialization with surrounding tissues is completed after 4 to 6 weeks.

Buccal fat pad as a pedicle flap used for the closure of oroantral fistula, reconstruction of cleft palate, as an interpositional arthroplasty material, buccal defect after excision of oral submucous fibrosis and for surgical defect in situ. Through this case report the authors representing the closure of oroantral fistula done in department of oral and maxillofacial surgery with the help of BFP.

CASE REPORT

Oroantral Fistula

Last 6 months 5 cases reported to us with clinical signs and symptoms of oroantral fistula (OAF). All patients gave history of extraction. Diagnosis was confirmed after clinical examination and text, radiological findings (Figs 1A and B). Surgical closure of OAF performed under local anesthesia. Adjacent to fistula, a full thickness
mucoperiosteal flap raised (Fig. 1C), followed by excision of epithelial lining covering the tract, if necessary removed infected sinus lining, then the pedicle BFP was exposed at the posterior area of the maxillary first molar and moved it forward (Fig. 1D). OAF closed with BFP and advanced buccal flap (Fig. 1E). Patient kept on antibiotic coverage and nasal decongestant. Patients follow-up done on 1st and 4th week (Fig. 1F). Oroantral fistula closed completely without any symptoms and did not leak in the Valsalva maneuver.

DISCUSSION

Sufficient blood supply of the BFP is deemed to increase the success rate of surgery and reduce the side-effects by increasing the success rate of engraftment with the surrounding tissues after reconstruction, improving structural resistance to infection or other stimuli, and promoting fast epithelialization. The epithelialization of the BFP used in the reconstruction started within 1 week of the reconstruction and ended within 6 weeks. The histological examination revealed no fat cell, and the BFP can reportedly maintain the role of membrane. A side-effect of closure using BFP is the recurrence of fistula due to partial necrosis and loss of flap. In most cases, it is generated when the defect area is large. Since, Egyedi reported that it can be used for defects smaller than 4 cm, other studies have been conducted continuously. Most authors recommend the reconstruction of defects measuring under 5 × 4 cm without tension when using pedicled BFP, since, they believe it minimizes complications including recurrence of fistula and necrosis in reconstruction of the severe defects. Our cases also showed successful treatments with complete epithelialization without dehiscence for up to 5 × 3 cm.

Other complications include the infection of the restored area, loss of tissue due to necrosis or physical impact, hematoma, and bleeding. To prevent them, there is a need to perform proper disinfection and administer antibiotics as well as reduce tension using tensionless suture with the surrounding tissues to improve blood supply. Furthermore, Amin et al recommended using a cover or an oral closing device using acrylic resin (Obturator) to prevent stimulation and distortion of the operated area. In our cases, operations were performed in aseptic state and under local anesthesia, and tissues were sutured with minimizing tension. To achieve the aforesaid purposes, we exposed the pedicled BFP at the closest location and used enough amount of BFP. In addition, we kept patient on antibiotics for 4 to 7 days after the operation and performed intraoral dressing until the removal of stitches. There was no bleeding after the removal of sutures; though partial necrosis was detected, the patients were cured successfully without using any additional device.

We obtained successful results in reconstruction of the intraoral defects using pedicled BFP, which has many advantages as mentioned above. We report these cases
to recommend the use of pedicled BFP, because it can be utilized more widely with considering the post-surgery problems and complications.

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Full Mouth Rehabilitation of a Hydrocephalus Pediatric Patient

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ABSTRACT

Hydrocephalus is a clinical entity characterized by accumulation of cerebrospinal fluid in the lateral ventricles of brain, resulting in progressive ventricular dilatation. Children with hydrocephalus are at greater risk for caries and need both routine and emergency dental treatment. Dental practitioners must develop adequate treatment strategies to prevent risk factors occurring during their treatment. As far as in dental literature, there is lack of information about the management of hydrocephalus patients during dental treatment. Hence, this case report describes the chairside full mouth rehabilitation of a 12-year-old female child with hydrocephalus.

Keywords: Dental caries, Full mouth rehabilitation, Hydrocephalus, Physically challenged.

INTRODUCTION

Hydrocephalus is considered a congenital disease affecting the central nervous system (CNS), which is characterized by accumulation of cerebrospinal fluid (CSF) in the lateral ventricles of the brain causing progressive ventricular dilatation. Hydrocephalus is diagnosed through clinical neurological evaluation and by using cranial imaging techniques, such as ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), or pressure-monitoring techniques. A physician selects the appropriate diagnostic tool based on an individual’s age, clinical presentation, and the presence of known or suspected abnormalities of the brain or spinal cord.

Currently, among various congenital malformations which involve central nervous system, hydrocephalus accounts for 0.4 to 0.8 cases per 1,000 births. Over the years, improvement in social status, awareness, better nutrition and better perinatal care have resulted in reduction in major anomalies and associated hydrocephalus. Prenatal diagnosis has become a reality in most centers. Post-infective hydrocephalus has seen a decline. The treatment of hydrocephalus comprises of: the shunt assembly with a proximal catheter located in the cerebral ventricles and a distal catheter draining into selected site of CSF absorption, connected by a valve and reservoir which is incorporated into the shunt system.

To keep the intracranial pressure within normal range, hydrocephalus patients are always on medication. Hence, they are very prone to dental decay. Therefore, pediatric dentists should be well equipped and have proper knowledge of adequate treatment strategies to prevent risk factors occurring during their treatment.

In literature, there is lack of information about the management of hydrocephalus patients during dental treatment. Hence, this case report describes the chairside full mouth rehabilitation of a 12-year-old female child with hydrocephalus.

CASE REPORT

History

A 12-year-old female reported to the department of pedodontics and preventive dentistry with the chief complaint of pain and swelling in lower right back region since 3 days. History revealed that the birth was uneventful. Patient was born to nonconsanguineous parents. All the signs and symptoms of hydrocephalus were evident, i.e. increased intracranial pressure due to excessive CSF accumulation along with abnormal head growth. Parents also gave history of patient’s seizures attacks, irritability and vomiting.

Extraoral Examination

The patient presented with short stature, depression of the nasal bridge seen along with deviated nasal septum. This led to abnormal breathing habit due to which patient developed mouth breathing. Distended fontanels and frontal bossing with occipital bulge was evident. The orbits were deep sunken (Fig. 1A).

Patient had diffused extraoral swelling extending from the body of mandible till posterior border of ramus,
superiorly extending to lower border of zygoma and inferiorly till middle part of sternocleidomastoid muscle. Skin over the swelling was warm and tender. Right lymph nodes were palpable (Fig. 1B).

**Intraoral Examination**

Intraoral examination revealed a high arched palate. Dental caries were present in 11, 12, 16, 21, 26, 34, 36 and 46. Retained root stumps were present with respect to (wrt) 63 and 65. Gingival recession was present wrt 31 and 41 (Fig. 2). Patient had poor oral hygiene due to improper brushing habit. Also, due to other factors like carbohydrate rich diet, daily use of medications containing sucrose and lack of dental visits, the patient’s caries index was high. The child previously had ventricular peritoneal (VP) shunt and hence, accordingly antibiotic prophylaxis (cefotaxim 180 mg/kg/day) were given as they are more prone to bacterial endocarditis infection. The following treatment was planned and executed. Oral prophylaxis, restoration of the carious teeth 16, 12, 11, 21, 26 and 34, and extraction of retained root stumps 63 and 65 were done. There were deep occlusal caries associated with 36 and 46, which were tender on percussion. An intraoral periapical radiograph of 36 showed a radiolucent lesion involving the furcation area of the teeth. After evaluating all the data, a root canal treatment of both 36 and 46 was done (Figs 3 and 4). The teeth 36 and 46 were given full coverage restoration using composite.

**DISCUSSION**

Like any other congenital health problem, hydrocephalus patient too has several health problems like local pain, infections, abscess, difficulty in chewing, malnutrition, gastrointestinal disorders, difficulty in sleeping and low self-esteem; this all, in turn, impair the quality of his life. It has been reported that patient with hydrocephalus can present chronological changes in the eruption of their teeth, changes in the occlusion, greater accumulation of dental plaque and have a higher caries prevalence.

Hydrocephalus is most often treated by surgically inserting a shunt system. This system diverts the flow of CSF from the CNS to another area of the body, where it...
can be absorbed as part of the normal circulatory process, thereby reducing intracranial pressure and preventing brain damage through a system of small tubes known as catheters. A regulating device, also known as a valve, which may be more or less sophisticated, may be inserted into the pathway of the catheter. This technique allows the brain's enlarged ventricles to return to a normal size in an effort to relieve the symptoms of hydrocephalus. Invasive dental procedures can produce a transient bacteremia. Patients with ventricular atrial (VA) shunt that drains into the right atrium are considered to be at risk for shunt infections during invasive dental procedures than patients with VP shunts. The child in this treatment was given antibiotic prophylaxis (cefotaxime 180 mg/kg/day), even though no such case reports of infection of any shunt as a result of invasive dental procedure in the literature.\textsuperscript{5,7} Children with hydrocephalus treated with VP shunts have craniofacial asymmetry that is associated with unilateral insertion of the device. This is clearly seen in those patients who always have shunt on same side. The mandibular plane is higher where shunt is placed, possibly due to moderate growth restriction of that side.\textsuperscript{8} Only once, the VP shunt was placed in our patient. After 5 years, the patient got the shunt removed without undergoing the replacement with a new one (Fig. 5). Hence, our patient had characteristic huge head as seen in hydrocephalous patient. Postoperative intraoral view of maxillary arch is shown in Figure 6.

Another oral feature is maturation of their teeth, which seems to be advanced at initial stages of puberty and delayed during the final stages. The dental practitioner should be careful not to put pressure on the reticular-peritoneal. As there is always danger to compress the shunt during dental procedure, the use of pillows and cushions is advisable to make patient comfortable and give adequate posture to the patient while doing treatment.\textsuperscript{9} As our patient was epileptic, lower level of neuromuscular drug was used when the patient was undergoing treatment. In hydrocephalus cases, we generally see early dental maturation with early pubertal maturation because of increased levels of anterior pituitary sex hormones.\textsuperscript{10} These findings were in tandem with our patient.
Hence, it is recommended to pediatric dentist to have thorough knowledge of antibiotic prophylaxis while treating patient with hydrocephalus with stunts. Routine dental care is advised for prevention of dental caries and control over gingival hyperplasia if the child is receiving treatment for seizure control.11

CONCLUSION

Hydrocephalus in children is a neurological problem resulting in increase in head size from the normal growth pattern. Hydrocephalus child undergoes continuous medical treatment for the diseases. Due to regular intake of medication its been seen their is increase incidence of dental caries in such patient. Hence, as a pediatric dentist its our duty to properly treat the infected teeth and other oral health related issues so that child can have healthy dentition.

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Hemisection: A Conservative Approach to save a Tooth Doomed for Extraction

ABSTRACT

Hemisection denotes removal or separation of root with its accompanying crown portion of mandibular molars. This procedure represents a form of conservative dentistry, aiming to retain as much of the original tooth structure as possible. This case report describes the management of left mandibular first molar with subgingival caries involving mesial root and carious exposed 35. In this case, mesial root of 36 was removed and endodontic treatment was completed in 35 and in distal root of 36. Prosthetic rehabilitation was completed by metal ceramic fixed partial denture using 35 and distal root of 36 as abutment.

Keywords: Fixed partial dentures, Hemisection, Subgingival caries.

INTRODUCTION

Therapeutic measures that are taken to preserve a molar vary in complexity. In case of low edentulous interspersed area, bordered by multirooted teeth that are undergoing periodontal problems the root amputation is a viable solution to solve the issue, so that these teeth can be used as abutment teeth in a future dental bridge.1

A terminal abutment molar with extensive decay may be unsuitable for restoration. In such cases, the treatment options are limited and may include a removable partial denture or a dental implant to replace the missing tooth.2 Alternatively, if the decay is limited to one root, a hemisection procedure may be possible. This procedure represents a form of conservative dentistry, aiming to retain as much of the original tooth structure as possible.3

Hemisection (removal of one root) involves removing significantly compromised root structure and the associated coronal structure through deliberate excision.4 There are various periodontal, endodontic and restorative indications for hemisection.

Periodontal indications include severe vertical bone loss involving only one root of multirooted teeth, when there is through and through furcation destruction, in cases unfavorable proximity of roots of adjacent teeth, preventing adequate hygiene maintenance in proximal areas in teeth with severe root exposure due to dehiscence.

Endodontic and restorative indications include—mandibular molar with periodontal involvement within a fixed bridge, instead of removing the entire bridge, if the remaining abutment support is sufficient, the root of the involved tooth is extracted. In management of the roots of an endodontically involved tooth which cannot be instrumented, in cases of vertical fracture which involves one root while the other root is unaffected, the offending root may be amputated, tooth with severe destructive process due to furcation involvement or subgingival caries, traumatic injury and large root perforation during endodontic therapy.

The results of hemisection are predictable, and success rates are high if certain basic considerations are taken into account.6

Apart from various indications, there are some limitations to this procedure like—poorly-shaped roots or fused roots, poor endodontic candidates or inoperable endodontic roots patient unwilling to undergo surgical and endodontic treatments and undertake the care or the resulting restoration.7-9

The following clinical case will describe the management of left mandibular first molar with subgingival caries involving mesial root, by resecting the involved root and prosthetic management of the retained distal root.

CASE REPORT

A 35-year-old female patient was referred to the Department of Conservative Dentistry and Endodontics at Institute of Dental Sciences, Bareilly. Patient presented with pain in her left lower back tooth region since 2 weeks. Extraoral examination did not show any
abnormality. Intraorally, all the teeth were present. Oral hygiene was very poor and significant amount of plaque and calculus were present. Tooth #35 and 36 were tender on percussion. Tooth #35 had deep dentinal caries and tooth #36 had subgingival caries wrt mesial root. When cold test was done, tooth #35 showed a lingering response and tooth #36 did not respond to the test.

Intraoral periapical radiograph revealed that the tooth #35 had caries approximating pulp chamber and tooth #36 with deep carious lesion involving mesial root and furcation (Fig. 1).

According to the clinical and radiographic findings, the treatment was divided into endodontic phase, periodontic phase and prosthetic phase.

Endodontic Phase

The root canal treatment was initiated by giving an inferior alveolar nerve block and placing a rubber dam. The access opening was done using around and a straight fissure diamond point (Mani) for both tooth #35 and #36. Root canal of tooth #35 and only distal canal of tooth #36 was negotiated by using a 10 no. K file (Dentsply). A working length radiograph was taken (Fig. 2) and canal preparation was completed using protaper files (Dentsply) according to the manufacturer’s instructions in tooth #35 and distal root of tooth #36 up to F3. A radiograph was taken to check the master cone fit (Fig. 3). Obturation of canals was completed by F3 cones using single cone obturation technique with AH plus sealer (Dentsply) (Fig. 4). Post space was prepared using peesoreemers (Dentsply) up to number 3 (Fig. 5) leaving 5 mm of gutta percha (GP) at the apex. Fiber post number 3 (Dentsply) was placed using multilink (Ivoclar Vivadent) and a core was built with luxa core Z dental milestones guaranteed (DMG), simultaneously a guide prep was prepared that indicated the area of furcation (Fig. 6). Patient was recalled after 1 week to perform periodontal phase.

Periodontal Phase

After appropriate local anesthesia, a crevicular incision was made from 1st premolar to 2nd molar region (Fig. 7). A full thickness mucoperiosteal flap was reflected to provide adequate access for visualization, instrumentation and to minimize surgical trauma.
Hemisection of the mesial root and crown was done with a vertical cut method faciolingually toward the bifurcation area (Fig. 8) with a long shank, tapered fissure carbide bur using guide prep as the starting point. Once the separation was complete, the mesial half was extracted using a straight elevator (Figs 9, 11 and 12). The socket was curetted and thoroughly irrigated along with root planning of distal root (Fig. 10). Odontoplasty was done to remove the developmental ridges and mesial aspect of distal root was contoured in such a way so as to facilitate oral hygiene measures, flap was reapproximated and sutured back into its position, the distal half of the tooth was ground out of occlusion which allowed the surgical site to heal with no occlusal stresses. Patient was then recalled for follow-up after 3 weeks and prosthetic phase was performed.

**Prosthodontic Phase**

After the complete healing of the extraction socket, tooth preparation was done in relation to 35 and distal root of 36 to receive a porcelain fused to metal restoration and the final impression was made using putty reline technique and master cast was obtained. A premolar-shaped ridge lap pontic was designed for esthetic reasons. Coping trial was done and fabrication of fixed partial denture (FPD) was completed (Fig. 13). Final prosthesis was cemented using glass ionomer cement type I (Fuji GC) (Figs 14 and 15) and postoperative instructions were given to maintain the
hygiene of that area. Occlusion was checked, radiographs were taken and patient was recalled for follow-up after 3 months.

DISCUSSION
The case discussed above had multiple factors that raised questions on the prognosis of tooth #36 and in addition as tooth #35 had to undergo prosthetic rehabilitation. Performing a hemisection procedure was considered as an appropriate treatment option as tooth #36 that could be offered to the patient.

Hemisection of multirooted teeth may be a viable treatment option when widespread periapical lesion and bone loss reaching furcation has occurred at one root and
the other root is healthy. Bühler stated that hemisection should be considered before every molar extraction, because it provides a good, absolute and biologic cost saving alternative with good long-term success.10,11 Before selecting a tooth for hemisection, patient’s oral hygiene status, caries index and medical status should be considered. Also, the accessibility of root furcation for ease of operation as well as good bone support for the remaining roots should be assessed. The furcation region is carefully smoothed, to allow proper cleansing, and thus to prevent accumulation of plaque.12

It is important to consider the following factors before deciding to undertake any of the resection procedures:

• Advanced bone loss around one root with acceptable level of bone around the remaining roots.
• Angulation and position of the tooth in the arch. A molar that is buccally, lingually, mesially or distally tilted, cannot be resected.
• Divergence of the roots—teeth with divergent roots are easier to resect. Closely approximated or fused roots are poor candidates.
• Length and curvature of roots—long and straight roots are more favorable for resection than short, conical roots.
• Feasibility of endodontics and restorative dentistry in the root/roots to be retained.12

By performing hemisection procedure, distal root and crown portion of 36 was preserved, secondly it was conservative approach toward tooth #37 by saving it from undergoing unnecessary tooth reduction for use as an abutment.

CONCLUSION

Hemisection is a conservative approach to remove the diseased part and to leave the healthy part of tooth instead of its extraction. It also provides good crown root ratio and protects the adjacent tooth from being used as an abutment. If the case selection is ideal, the prognosis depends upon the success of all endodontic, periodontal and prosthetic treatment.

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Management of Internal Root Resorption with Mineral Trioxide Aggregate as Obturating Material

Abhinav Kishore, Sakshi Singhal, Anuraag Gurtu, Rashmi Bansal, Anurag Singhal, Sumit Mohan

ABSTRACT

Endodontic treatment of teeth with internal root resorption represents a clinical challenge. Internal resorption is a rare condition in permanent teeth that poses procedural difficulties for treatment. It is a dental complication caused by dental trauma, surgical procedures, excessive pressure or irritation from bleaching agents that can lead to loss of tooth. A correct diagnosis and an understanding of the etiology and dynamics of the processes involved in tooth resorption is critical for effective management. This paper presents a case having non perforating resorptive defect in the middle 1/3rd of the root of a left maxillary central incisor which was treated nonsurgically with white mineral trioxide aggregate (MTA).

Keywords: Diastema, Internal root resorption, Mineral trioxide aggregate, Obturation, Odontoclast cells.

INTRODUCTION

Internal resorption is a pathological lesion related to pulpal inflammation and bacterial invasion. It is a resorptive defect of the internal aspect of the root following necrosis of odontoblasts as a result of inflammation. It is caused due to transformation of normal pulp tissue into granulomatous tissue with giant cells, which resorb dentin. Odontoclast multinuclear cells are responsible for the resorption, which can grow to perforate the root if untreated. The predisposing factors to internal root resorption are trauma, pulpitis, pulpotomy, cracked tooth, tooth transplantation, restorative procedures, invagination, orthodontic treatment and even a herpes zoster viral infection.

Clinically, the condition is usually asymptomatic and detected by routine radiographic examination which reveals a round-to-oval radiolucent enlargement of the pulp space with margins smooth and clearly defined with distortion of the original root canal outline. Pain or discomfort may be the chief complaint if the granulation tissue has been exposed to oral fluids. The granulation tissue can clinically manifest itself as a ‘pink spot’ in cases in which crown dentin destruction is severe. To arrest the odontoclastic activity, endodontic treatment is required. But biomechanical preparation alone cannot remove the odontoclastic cells from the round oval resorptive area, so copious irrigation with 5.25% of sodium hypochlorite is necessary. Thermoplasticized gutta percha technique is advised for obturation of such defects. However, gutta percha does not bond to tooth structure, cannot prevent odontoclastic activity and do not provide strength to the tooth structure. A new biomaterial mineral trioxide aggregate (MTA) can be used for obturation of such defects. It has both bioactive and biomineralization properties, so it bonds to the dentin by formation of hydroxyapatite crystals and its alkaline nature can restrict the activity of odontoclast cells. So it can provide strength, seals the canal better and prevents tooth resorption. The treatment of internal resorption should be initiated as soon as possible to prevent further loss of hard-tissue or an eventual root perforation.

The purpose of this paper is to present a case report on the management of left maxillary central incisor with internal resorption in middle-third using MTA as an obturating material further the esthetic treatment was also given by providing all ceramic crown.

CASE REPORT

A 38-year-old female patient, reported to the Department of Conservative Dentistry and Endodontics with chief complaint of unesthetic prosthesis irt 21 (Fig. 1A). Patient was asymptomatic with noncontributing medical history. She gave history of trauma 6 years ago.

Clinical examination revealed a faulty prosthesis wrt 21 with short clinical crown height and presence of spacing wrt 11, 12 and 21, 22. Tooth 21 was tender on percussion. Radiographic examination revealed an oval radiolucent area within the canal in the middle-third suggestive of internal resorption (Fig. 1B).

After the removal of prosthesis (Fig. 2), cold test was done in 11 and 21. Tooth 21 was nonvital and 11 was vital.

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The case was diagnosed as chronic apical periodontitis with internal resorption wrt 21. Endodontic treatment using MTA as the obturating material was planned. An informed oral and written consent was obtained from the patient.

As the crown height was short rubber dam placement was done with the help of wedge. A conventional access cavity was prepared with #2 round bur, beginning from the center of the lingual surface of anatomic crown. The bur was used to penetrate through the enamel and slightly into the dentin (approximately 1 mm). The bur was directed perpendicular to the lingual surface as the external outline opening was created. Then the angle of bur was changed parallel to the long axis of the root. A lingual shoulder was removed to gain access to the lingual wall of the root canal. 30# K-file was placed in the canal and the working length was taken using an apex locator (apex ID) and further confirmed by a periapical radiograph (Fig. 3).

Biomechanical preparation was done with step back technique with apical preparation upto size 50 and step back upto size 70 with K-file. Throughout the procedure, the canal was irrigated by normal saline and 5.25% sodium hypochlorite alternatively.

Calcium hydroxide intracanal medicament (Cal-Excel) was placed for 2 weeks and the access opening was sealed with a temporary dressing (cavit). After 2 weeks, the dressing was removed and the canal was irrigated and dried with paper points. Mineral trioxide aggregate was manipulated according to manufacturer’s instructions and carried into the canal using MTA carrier.

Mineral trioxide aggregate was condensed into the canal by hand condensation using finger pluggers (2 and 3 number). After confirming the placement of MTA at apical third by direct digital radiography, the resorptive area and rest of canal were obturated by MTA (Fig. 4). Then, a moist cotton pellet was placed in the root canal orifice and the chamber was sealed by temporary dressing (cavit). After 72 hours, patient was recalled and postendodontic restoration was completed with composite.

To correct the gingival finish line, gingivectomy was performed using diode laser (Fig. 5). Tooth preparation for all ceramic crown was done. Rubber base impression was taken and die was prepared. All ceramic crowns were fabricated (Figs 6A and B).

The resulting crown with all the requisite translucency and shade matching with the adjacent central incisor (Fig. 7).
Management of Internal Root Resorption with Mineral Trioxide Aggregate as Obturating Material

DISCUSSION

Internal (inflammatory) root resorption can be characterized both as a well-known and poorly known disease entity destroying the dental hard-tissue. Internal inflammatory root resorption is an insidious pathologic process, initiated within the pulp space and associated with loss of dentin. It is an oval-shaped enlargement of the root canal space, usually asymptomatic and detectable by radiographs. It can be either transient or progressive...
Internal resorption only occurs when the predentin adjacent to the site of chronic inflammation is lost as a result of trauma or other unknown etiologic factors. Trauma is the most common etiological factor (43%), followed by carious lesions (25%). The condition might go unnoticed until the lesion has advanced significantly, resulting in a perforation or symptoms of acute or chronic apical periodontitis after the entire pulp has undergone necrosis and the pulp space has become infected. Hence, root canal treatment must be initiated as soon as possible once an inflammatory resorptive lesion is detected to prevent further hard-tissue loss and eventual root perforation.

In the present case report, left maxillary central incisor with internal resorption in the middle third of the root, was detected during routine radiographic examination. The treatment was planned, considering the patient’s age, periodontal status, resorption location, absence of perforations, and resistance of remaining root hard-tissue. A nonsurgical endodontic treatment along with reinforcement by bioactive MTA was considered.

The shape of the resorption defect usually makes it inaccessible for direct mechanical instrumentation. So, 5.25% of sodium hypochlorite was used for irrigation of root canal and to remove vital tissue. Calcium hydroxide as an intracanal medicament was used to control the bleeding, maximizes the effect of disinfection procedures, maintains alkalinity, and necrotizes residual pulp tissue. Before obturation with MTA remnants of calcium hydroxide were removed, so that it will not affect the bonding of dentin with MTA.

According to Culbreath et al (2000), the treatment for internal resorption can include several materials, such as gutta percha, zinc oxide eugenol and amalgam alloy. However, these materials do not provide strength to the tooth structure and may be responsible for considerable
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Tooth discoloration. Mineral trioxide aggregate is a new material that has bioactive and biomineralizing properties. Because of these characteristics, MTA might become a viable alternative treatment option as compared to gutta percha-based materials and sealers. Mineral trioxide aggregate exhibits superior sealability against bacterial microleakage, while demonstrating antibacterial and bioinductive properties that can improve treatment outcomes. Furthermore, the material is sterile, radiopaque, resistant to moisture, and nonshrinking and stimulate mechanisms responsible for the biomineralization.

Biomineralization property of MTA forms hydroxyapatite crystals that helps in bonding with dentin to provide mechanical strength and also has the alkaline nature to restrict the activity of odontoclastic cells responsible for internal resorption. After endodontic treatment, the periodontal treatment for crown lengthening with lasers was done and then esthetic correction was done by placement of all ceramic crown and closure of diastemas.

When determining the prognosis of an endodontically treated tooth with internal root resorption, the need for radiographic control every 5 months for at least 2 years should be considered. Such fact is due to the possibility of the area involved by the resorption to present a lateral canal, which would allow the continuity of the resorption process and compromise the treatment.

CONCLUSION

On the basis of the review of literature and clinical and radiographic outcomes hereby presented, it can be said that teeth with large internal root resorption should be treated in an attempt to salvage the tooth. The early diagnosis and treatment are very important in order to stop the resorptive process. It is imperative to initiate endodontic treatment as soon as possible to arrest the progression of the resorptive process and to prevent further weakening of tooth structure. Success in management of a case of internal resorption depends on early detection, appropriate treatment planning, removal of inflammatory pulp tissue, reinforcement of weaker tooth structure, and a three-dimensional obturation. Mineral trioxide aggregate can be used successfully for obturation of such defects.

REFERENCES