ANAEROBIC INFECTIONS IN DENTAL PRACTICE

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INTRODUCTION

Odontogenic infections are one of the most frequently encountered infections afflicting humans throughout the world. The prevalence of dental caries and periodontal disease in India is approximately 60-65% [Ramchandran K et al] and 65-100% respectively [Kanal M, et al].

MICROBIOTA OF ODONTOGENIC INFECTIONS

The obligate anaerobic bacteria make up the bulk of the mouth's flora. The predominant bacteria are anaerobic Streptococcus, Bacteroides, and Fusobacterium. Odontogenic infections usually arise as a result of normal endogenous flora. The anaerobic bacteria seen in odontogenic infections are not usually considered to be pathogenic themselves. A more invasive bacterium, such as Streptococcus, serve as the initiators of the infection, preparing the local environment for anaerobic bacterial invasion. The anaerobes become predominant, since the reduction-oxidation potential favors anaerobic growth. Alone or in combination with Fusobacterium, Peptococcus, or Peptostreptococcus, B. melaninogenicus is the most commonly isolated anaerobic bacterium. Saini et al compared the normal aerobic and anaerobic bacterial oral flora with flora from deep seated dental caries, gingivitis and adult periodontitis. The ratio of aerobes and facultative anaerobe to anaerobes was 0.90, 0.72, 0.56 and 1.78 in cases of dental caries, gingivitis, periodontitis and normal gingiva respectively http://www.ijmm.org/ viewimage.asp?img=IndianJMedMicrobiol_2003_21_2_111_7986_1.jpgdepicting that aerobes and facultative anaerobes were more in normal gingiva while anaerobes predominated in orodental infections. Ninety seven percent of orodental infections were polymicrobial as compared to 28% in controls. Streptococcus mutans and anaerobic lactobacilli were common in dental caries, Actinomyces and Peptostreptococcus spp. in gingivitis, Actinobacillus actinomycetemcomitans and Porphyromonas gingivalis in periodontitis.

Studies over years have shown that obligate anaerobes predominated in infected root canals and made up as much as 90% or more of the microbiota (Möller et al). Dental canals with necrotic pulp tissues (primary infected canals) present a polymicrobial flora characterized by a wide variety of combinations of bacteria, averaging 4-7 species per canal. These bacteria are predominantly anaerobic and gram-negative cocci (Gomes BPFA, Drucker D.B, Lilley J.D. J. Dent 1996; Gomes B.P., Pinheiro E.T., Gade-Neto C.R., Sousa E.L., Ferraz C.C., Zaia A.A., Teixeira F.B., Souza-Filho F.J. 2004; Sundqvist G., Johansson E., Sjögren U. 1989; Sundqvist G. 1992; Sundqvist G.1992; Sato T., Hoshino E., Uematsu H., Noda T. 1993]. Peptostreptococcus spp was the most predominantly isolated microbial genera, followed by Streptococcus spp (14.2%), Porphyromonas spp (12.2%), E. faecalis (9.6%), Staphylococcus salivarius (8.6%), Prevotella spp (8.1%), Lactobacillus spp (7.1%), Actinomyces spp (7.1%), Candida albicans (4.1%), Fusobacterium spp (3.6%) Veillonella spp (2.5%), Eubacterium spp (2.5%), Bacillus spp (2.0%), and Escherichial coli (1.6%) were other types of bacteria recovered. Facultative anaerobes, especially E. faecalis, were the microorganisms most commonly isolated from secondary infections. [E. Ercan, et al]

By adopting more exacting anaerobic techniques in studies, the flora associated with lesions in necrotic pulps in human deciduous teeth has been shown to consist mainly of obligate anaerobe suggesting that the environment of the lesions is anaerobic and favours the growth of obligate anaerobesThe obligate anaerobic strains, belonging to Peptostreptococcus (25 percent), Propionihacterium (19 percent), Eubacterium (17 percent) and Fusobacterium (13 percent), accounted for major parts of the bacterial flora of the lesions of human deciduous teeth. Bifidohacteriurn (2 percent), Lactobacillus (1 percent), Actinomyces (1 percent) and Veillonella (0.7 per cent) were minor parts of the flora in agreement with the study by Ando and Hoshino' .[Ando N, Hoshino E. 1990.] on bacteria of endodontic lesions of permanent teeth in adults using similar procedures. Asaccharolytic obligate anaerobes mostly assigned to Eubacterium, Fusohacterium and Peptostreptococcus. occupied 57 per cent of the isolates in the present study. This indicates that asaccharolytic bacteria, such as peptide- and/or amino acid-degrading bacteria, may have advan-

tages over saccharolytic bacteria in necrotic pulps of deciduous teeth. possibly because of a limited availability of fermentable carbohydrate in this situation. Thus, the environment of the necrotic pulps of deciduous teeth may favour the growth of asaccharolytic bacteria, as suggested previously by Sundqvist.[Sundqvist G.1992]. Asaccharolytic bacteria are also predominant in periodontal pockets (73 per cent), [Hoshino E, Uematsu H, Sato T. 1993; Uematsu H, Sato T, Hoshino E. 1992] suggesting that the nutritional conditions in necrotic pulps may be in some ways similar to those in periodontal pockets. In contrast, saccharolytic bacteria have been reported to compose the majority (75-95 per cent) in the flora of dental plaque and in dentinal lesion. [T., Hoshino E., Uematsu H., Noda T. 1993].

90% of isolates from periodontal pockets of adults with advanced periodontitis were obligate anaerobes suggesting that the environment in periodontal pockets was anaerobic favoring the growth of obligate anaerobes [Eubacterium (predominant, 54%), wollinella (9%), peptostreptococcus (6%), fusobacterium (5%), bacteroides (2%). [Uematsu, H.; Hoshino, E. 1992]

Overwhelming majority of the microorganism isolated from both shallow and deep layers of carious dentin has been found to be obligate anaerobes predominantly propionibacterium, eubacterium, arachnia, lactobacillus, bifidobacterium and Actinomyces. [Hoshino E. 1985].

Various studies in India and other countries have showed an isolation rate of anaerobes in periodontitis ranging from 42 to 100 % [VanWinkelhoff AJ et al. 2002; Salari MH and Kadkhoda Z. 2004; Saini et al 2003]. The varying recovery rates of isolation can be due to varying criteria of patient selection, culture method employed, geographical differences and the molecular techniques used for identification. The prevalence of anaerobes increases with the severity of disease and probing depth due to decreased oxygen tension in untreated human periodontal pockets, which is conducive to proliferation of anaerobes.

In a recent study from India, 86.7% positive cultures of aerobic and anaerobic microorganisms were yielded from the root canal samples of clinically symptomatic non vital teeth having periapical lesions (26/30 cases). Of these, 16.67% showed each of purely anaerobic and purely aerobic growth and 55.33% had mixed growth of anaerobic and aerobic isolates reflecting the polymicrobial nature of root canal infections. 49.27% of total isolates were obligate anaerobes, majority of which were gram-positive cocci (Peptococcus and Peptostreptococcus), followed by gram positive bacilli (Lactobacilli, Bifidobacterium, Propionobacterium and Eubacterium) and gram-negative bacilli, (Bacteroides and Fusobacterium). Isolated aerobes included Diphtheroids, Staphylococci, Streptococci, E.coli, K pneumoniae, P.aeruginosa and Candida albicans.[Rani, A and Chopra, A. 2006]

Daniluk T et have investigated the microbiota of supragingival plaques and abscess and reported that there were more aerobic (33/53; 62.3%) than anaerobic bacteria (20/53; 37.7%) in supragingival plaques while anaerobes were isolated more frequently than aerobes from the abscess. In adult patients with periodontal disease, Gram-positive anaerobes, including Peptostreptococcus, were the predominant bacteria in the subgingival plaque while in the supragingival plaque, Gram-positive aerobic cocci (Streptococcus and Staphylococcus) were predominant. [Daniluk T, Tokajuk G, Cylwik-Rokicka D, Rozkiewicz D, Zaremba ML, Stokowska W. 2006]

The bacteria associated with periodontal diseases are predominantly gram-negative anaerobic bacteria and may include A. actinomycetemcomitans, P. gingivalis, P. intermedia, B. forsythus, C. rectus, E. nodatum, P. micros, S. intermedius and Treponema species. It has been observed that between 3-12 weeks after the beginning of supragingival plaque formation, a distinctive subgingival microflora predominantly made up of gram-negative, anaerobic bacteria becomes established. Not all organisms in plaque are equally capable of causing destructive periodontal disease but the species must be able to attach to one of several surfaces including the tooth in order to establish in a periodontal site, a species. Bacterial adhesion is a specific mechanism and studies have shown that there is a diversity of receptors on tooth surfaces, epithelial or other host cells and other bacteria. Bacterial interactions play important roles in species survival as some interspecies relationships are favourable by allowing growth or facilitating attachment of, another species while other relationships are competitively antagonistic. It has been shown that bacterial counts associated with disease are up to 10(5) times higher than those associated with health.[Lovegrove JM. 2004]

Manifestations of anaerobic infection

In the vast majority of patients these infections are minor and resolve either by spontaneous drainage through the gingival tissues of the tooth or by extraction of the offending tooth. Unfortunately, these minor tooth-related infections occasionally become serious and life-threatening. Aggressive surgical and medical care is necessary to prevent disastrous results.

Apical periodontitis, an inflammatory process around the apex of a tooth root, is primarily a sequel to microbial infection of the pulp space. [Baumgartner, J. C.1991]

Dental caries and periodontal disease i.e. gingivitis and periodontitis are the

most common chronic oral diseases world-wide. Dental caries is an infectious microbial disease that results in localised dissolution and destruction of the calcified tissues of the teeth.[Ross PW]

Endodontic infections are symptomatic or asymptomatic inflammatory diseases caused by microbial infection of the root canal system. The bacterial flora of the root canal has been studied over many years. The micro-organisms associated with endodontic infections comprises of a complex mixture of bacterial species. Endodontic infections are for the most part endogenous infections that arise from the normal oral microbiota under predisposing conditions (pulp necrosis or pulp removal for treatment). In advanced stages of the infectious process, bacterial organizations resembling biofilms can be observed adhered to the dentinal root canal walls

Periodontitis can be defined as "an apical extension of gingival inflammation to involve the tissues supporting the tooth, including periodontal ligament and bone". The most common is chronic periodontitis and is the major cause of tooth loss in the adult population and along with dental caries, is the most frequent oral health problem in the world. The disease is mediated by the microflora forming the plaque biofilm on the tooth surface. These diseases are usually associated with microbial infection due to accumulation of a plaque biofilm and calculus. The adherent microbes evoke release of a number of inflammatory mediators in the underlying soft tissue ultimately resulting in the destruction of host tissue. Human periodontitis is associated with a widely diverse aerobic and anaerobic bacteria in subgingival and supragingival plaques of adult patients with periodontal disease and complex subgingival microbiota encompassing both Gram-positive and Gram-negative bacteria, facultative and anaerobic organisms, and possibly yeasts. At least nearly 500 bacterial strains have been recovered from the subgingival crevice, a particularly well-studied microbial niche. Most of these strains are thought to be commensals and a smaller number, potential opportunistic pathogens.

Rupf et al (2000) examined the profiles of periodontal pathogens in pulpal and periodontal diseases affecting the same tooth by PCR. It was speculated that periodontal pathogens often accompany endodontic infections and supported the idea that the periodontic endodontic interrelationships should be considered as critical pathways which might contribute to refractory courses of endodontic or periodontal diseases.

Gomes et al have demonstrated complex interplay of species particularly gram negative anaerobes resulting in characteristic clinical pictures such as presence or history of pain, tenderness to percussion and swelling which cannot be achieved by individual species alone. It was also shown that the microbiota of primary infected canals with apical periodontitis differs in number and in species from the secondary infected canals. The root canal microflora of untreated teeth with apical periodontitis was found to be mixed, comprising mostly anaerobic gram-negative and gram-positive microorganisms with more than 3 species per canal while facultative anaerobic and gram-positive bacteria predominated in canals with failed endodontic treatment, harboring 1-2 species per canal. [B. P. F. A Gomes 2004]. The type of microbial flora in the root-filled tooth with persistent apical periodontitis has very different characteristics. These infections are characterized by one or just a few species, predominantly Gram-positive micro-organisms particularly Enterococcus faecalis with an equal distribution of facultative and obligate anaerobes. A recent study has also shown positive correlation between the concentration of endotoxin in the root canal and the presence of endodontic signs and symptoms. [Rogerio C Jacinto, 2005]

Chavez de Paz LE has reviewed the nature of persisting endodontic infections subsequent to endodontic therapy which depends not on the robustness of the organisms in the infected site, but on their capability of adapting their physiology to the new environmental conditions set by the treatment by adhering on the surface to form polymicrobial biofilm communities on root canal walls [Chavez de Paz LE. 2007] Molecular methods have been largely used for profiling bacterial communities in diverse environments Nocker A, 2007], and aid in inclusion of as-yet-uncultivated bacteria in the analysis [Siqueira JF, Jr, Rôças IN, Rosado AS. 2005].

Various studies have demonstrated that composition of the endodontic microbiota differs consistently between individuals suffering from the same disease.[Machado de Oliveira JC, Siqueira JF, Jr, Rôças IN, Baumgartner JC, Xia T, Peixoto RS, et al. 2007; Siqueira JF, Jr, Rôças IN, Rosado AS. 2004; Rôças IN, Siqueira JF, Jr, Aboim MC, Rosado AS. 2004] suggesting that disease severity, based on intensity of signs and symptoms, or response to treatment may be related to the bacterial community composition. Therefore, the microbiota associated with the same endodontic disease significantly differs in species richness and abundance between individuals living in different geographic locations (Siqueira JF, Jr, Rocas IN, Debelian GJ, Carmo FL, Paiva SS, Alves FR, et al. Profiling of root canal bacterial communities associated with chronic apical periodontitis from Brazilian and Norwegian subjects. J Endod. 2008;34:1457-61) and Siqueira et al have contemplated the use of same treatment protocols, especially systemic antibiotic therapy, for all individuals, suggesting further research on application of sophisticated technology to identify community patterns related to geog-

raphy and establish whether or not treatment protocols should be customized accordingly.[Siqueira JF Jr, Rôças IN. 2009 Aug 10;1.]

ANTIBIOTIC RESISTANCE

It is unnecessary to perform cultures for uncomplicated odontogenic infections in uncompromised patients. However, in compromised patients and in patients with severe fascial space infections, it is wise to get a specimen of pus for culture and antibiotic sensitivity testing. The specimen must be taken in an anaerobic method so that anaerobic culturing can be done. Aspiration with a large-bore needle through intact skin or mucosa is the preferred method.

Gaetti-Jardim *et al* determined susceptibility of the isolates from 58 endodontic infections. All isolates were sensitive to imipenem and 99.3% to amoxicillin/clavulanate association, while 16.1% showed resistance to amoxicillin and penicillin G, and 4.89% to cefoxitin. Resistance to metronidazole was just found in facultative anaerobes. Production of beta-lactamases was detected in 18.2% of the isolates and presented a correlation with resistance to beta-lactams.[Gaetti-Jardim Júnior E, Landucci LF, Lins SA, Vieira EM, de Oliveira SR. J Appl Oral Sci. 2007]

Rani and Chopra reported all isolates from root canals sensitive to cefotaxime and cefoparazone, 82.6% sensitive to tetracycline, 76.8% to cephalexin, 43.5% to amoxicillin and erythromycin, 34.8% to benzylpenicillin and 27.5% to metronidazole. [Rani, A and Chopra, A. 2006].

TREATMENT

The usual cause of odontogenic infections is necrosis of the pulp of the tooth, which is followed by bacterial invasion through the pulp chamber and into the deeper tissues. Necrosis of the pulp is the result of deep caries in the tooth, to which the pulp responds with a typical inflammatory reaction. Extraction of the tooth (or removal of the necrotic pulp by an endodontic procedure) results in resolution of the infection. The primary treatment of odontogenic infections has been surgical for centuries and will continue to be so. Extraction of the tooth, drainage of the abscess, and release of pressure are fundamental in the management of these infections. Blome et al have evaluated the root canal samples for the presence and numbers of specific species as well as for total bacterial load in teeth with chronic apical periodontitis using quantitative real-time polymerase chain reaction (PCR). Root canals with primary infections harboured a higher bacterial count and was reduced by at least 95% after chemomechanical root canal preparation. [Blome B, 2008].

Negative culture results have been considered as surrogate endpoints for long-term treatment outcome with low sensitivity of culturing techniques and inability to detect as-yet-uncultivated bacteria as a limitation to reliable use of this predictor. Quantitative molecular methods are more sensitive than culture to establish more reliable standards to predict outcome. [Siqueira JF Jr, Rôças IN. 2009 Aug 10;1. doi: 10.3402/jom.v1i0.2009.]. Also, rapid diagnosis of bacteria involved in abscesses/cellulitis as well as of antibiotic resistance genes will allow clinicians to manage infectious diseases proactively.

In an experimental study on monkeys, Fabricius et al determined the influence on the healing of the periapical tissues when selected bacterial strains and combinations thereof remain after root canal treatment and relationship to healing of the quality of the root filling. 175 root canals, previously infected with combinations of four or five bacterial strains and with radiographically verified apical periodontitis, were endodontically treated and followed up. After 2-2.5 yr, it was observed that when bacteria remained after the endodontic treatment, 79% of the root canals showed non-healed periapical lesions, compared with 28% where no bacteria were found. When no bacteria remained, healing occurred independently of the quality of the root filling in contrast to, when bacteria remained, there was a greater correlation with non-healing in poor-quality root fillings than in technically well-performed fillings, demonstrating the importance of obtaining a bacteria-free root canal system before permanent root filling in order to achieve optimal healing conditions for the periapical tissues.[Fabricius L, Dahlén G, Sundqvist G, Happonen RP, Möller AJ 2006]

Antibiotics are a necessary adjunctive therapy in many infections to limit the local and systemic spread of infection and hasten complete resolution. Since anaerobic infections are generally polymicrobial, where anaerobes are mixed with aerobic organisms, therapy should provide coverage of both types of pathogens. Treatment of anaerobic infection is complicated by the slow growth of these organisms and the growing resistance of anaerobic bacteria to antimicrobials. [Brook I. 2007]. The close relationship of microbes and the disease process should be understood to administer antimicrobial therapy. Penicillin or amoxicillin are generally effective against most of the aerobic & anaerobic bacteria recovered. The patient whose oral cavity may harbor penicillin resistant organisms should be considered for treatment with drugs effective against these organisms. These agents include amoxicillin-clavulanate, clindamycin or the combination of meteronidazole plus amoxicillin or a macrolide.

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