Oral Microbiome Toxins and Systemic Diseases

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This article describes the genesis of oral microbe toxicology, how it impacts health, and how microbial imbalances may lead to immune depletion, autoimmune expression and cancer. The oral microbial ecosystem, better known as the oral microbiome, is particularly important and vital to maintaining both oral and overall health in the body. Salivary flow and biofilms on the teeth and soft tissue maintain microbial equilibrium within the oral cavity and protect pathogens from manifesting and growing. Disturbing the homeostasis of the oral cavity can stir pathogen activity and lead to both oral and systemic disease. Recently, scientists have recognized that oral infection, such as periodontitis, jaw ostitis, non-vital teeth such as root canal-treated teeth, and dental cavitations, may affect the course and pathogenesis of a number of systemic diseases.[1, 2, 3, 4] The spread of pathogenic oral microorganisms and their toxins have been implicated in cardiovascular diseases, and numerous neurological and immunological disorders. The interaction between oral and systemic health are bidirectional and complex, involving many biochemical and circulatory pathways.

The number of microbial cells within a human body exceeds the total number of human cells in the body by nearly 10 times.[5, 6] Most of these organisms live in the intestine, but more than 700 bacterial species have been detected in the oral cavity.[7] The number of bacteria can exceed a thousand billion when the mouth is not sufficiently cleaned. The oral cavity is comprised of many surfaces, each coated with a plethora of bacteria, the proverbial bacterial biofilm. Within the oral cavity, there are two types of surfaces where bacteria can colonize: the hard surfaces of the teeth and jawbone and the soft tissue of the oral mucosa.[8] The teeth, gingival sulcus, tongue, cheeks, hard and soft palates, and

tonsils each provide enriching environments in which microbial communities can flourish.[9]

Different types of microorganisms prefer distinct niches according to varying surface structures and functions.[10] Each niche provides the optimal conditions and nutrients for its populating microbes.[11] Periodontal disease and non-vital teeth, such as root canal-treated teeth, have been established as a source of oral pathogens associated with certain systemic diseases including cancer.[12, 13] Studies have also demonstrated that oral bacteria and fungi chronically infect the dentinal tubules and lateral canals of non-vital teeth following a root canal procedure.[14] Some microbes that dwell in the mouth readily migrate from the oral cavity, passing with saliva and food into the gastrointestinal tract, or spread into the respiratory mucus membrane system. Oral microbes constitute a "pathogenic reservoir" from which systemic infection and systemic diseases can occur. Dental infections, including gingivitis, periodontitis, dental caries and odontogenic infections, result in numerous dental visits each year. They can range in severity from a mild buccal space infection to a severe life-threatening multi-space infection.

Bacterial toxins and certain species of oral yeast and fungi in the gum or non-vital teeth all produce toxins at sites of active infection.[15] These toxins include volatile sulfur compounds, such as hydrogen sulfide (H_2S) and methyl-mercaptan (CH_3SH) produced from the breakdown of the amino acids cysteine and methionine, respectively, as well as polyamines such as putrescine and cadaverine produced from the breakdown of the amino acids lysine and arginine, respectively. Numerous studies have demonstrated the ability of low micromolar H_2S, a known neurotoxin, to inhibit the activity of several vital human enzymes including the Na+/K+-ATPase, cytochrome a3 oxidase, and carbonic anhydrase. When these important metabolic enzymes are depleted, it can lead to compromised immunity and general ill health.

Over 75 different species of oral bacteria have been found to produce significant amounts of hydrogen sulfide. At least 21 different species have been shown to produce

methyl mercaptan from degradation of the amino acids cysteine and methionine, respectively.[16] Fungal toxins, such as gliotoxin, are thiol-reactive molecules and are damaging to a number of critical metabolic enzymes. Toxin-producing bacteria may also cause cancer by converting ethanol into its carcinogenic derivative, acetaldehyde, to levels capable of inducing DNA damage, mutagenesis, and secondary hyperproliferation of the epithelium. Many oral bacterial and fungal toxins are proven carcinogenic and enter the systemic circulation where they can potentiate carcinogenesis.[17, 18] Some of these oral microbes produce toxic nitrosamines that are associated with cancer.

Nitrosation is the process of converting organic compounds into nitroso derivatives, such as nitrosamines. Nitrosamines are a class of chemical compounds first described in the chemical literature over 100 years ago, but which did not receive much attention until 1956. That year, two British researchers, John Barnes and Peter Magee, reported that dimethylnitrosamine produced liver tumors in rats. They proposed that microbial carcinogenesis may also involve nitrosation in which microbial cells catalyze the formation of N-nitroso compounds from the precursor's nitrite and amines, amides, or other nitrosatable compounds. It is now known that several species of oral bacteria encompass strains capable of catalyzing nitrosation.[19] Additionally, certain yeasts and fungi that exist in the mouth are nitrosating organisms. Nitrosamine from oral bacteria, yeast, and fungi appears to be a participant in certain carcinomas, not only of the esophagus, but also of other mucosal areas such as the oral cavity.[20] Studies continue to emerge linking the toxins of pathogenic oral microorganisms to certain types of cancer.[21, 22, 23]

Periodontal Disease and Systemic Disease

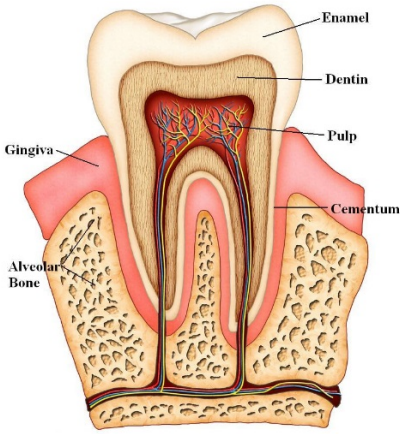
Periodontal disease is a destructive inflammatory disease of the supporting tissues of the teeth and is caused either by specific microorganisms or by a group of specific microorganisms, resulting in progressive destruction of periodontal ligament and

alveolar bone with periodontal pocket formation, gingival recession, or both.[24] Periodontal disease is associated with an increased production of reactive oxygen species which, if not buffered sufficiently, cause damage to cells and tissues.[25]

The spread of oral microorganisms and their toxins have been implicated in cardiovascular disease including heart attack, stroke, high blood pressure, and atherosclerosis, arthritis, implant infections, brain abscesses, hematological infections, and pre-term, low birth weight infants. In particular, a link between periodontal disease and many systemic illnesses such as heart disease, diabetes and stroke has been well documented.[26, 27, 28, 29, 30] To date, at least 16 systemic diseases including cancer have been linked to periodontitis. These systemic diseases are associated with periodontal disease because they generally contribute to either a decreased host resistance to infections or dysfunction in the connective tissue of the gums, increasing patient susceptibility to inflammation-induced destruction.[31] However, it is important to note that not long ago the idea of periodontal disease causing systemic disorders was considered heresy. Keep this in mind when later reading about the controversy of non-vital, or root canal-treated teeth causing systemic disease.

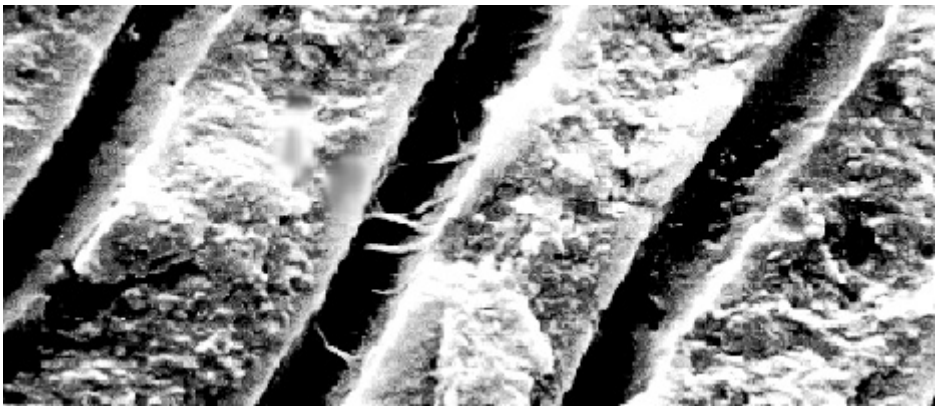
A 2007 study uncovered a strong correlation of advanced gum disease in men to a 63% higher incidence of pancreatic cancer.[32] A year later, another research study confirmed that cancer risk increases when gum disease is present, and that even the presence of moderate gum disease contributed to an overall 14% increased risk of cancer.[33] A Swedish study linked periodontal disease to an increased prevalence of breast cancer. Researchers of that study stated that the chronic periodontal disease indicated by missing molars seemed to associate statistically with breast cancer.[34] That study puts forward the idea that the risk of a woman developing breast cancer could be amplified by chronic gum disease. The study analyzed and evaluated over 3000 women between the ages of 30 and 40 years over a 16-year period. Among the women studied, those who reported that they had suffered from chronic gum disease or had lost teeth due to

periodontal disease were found to be more than two times as likely to be diagnosed with breast cancer as compared to those who had healthy gums.



Root Canal Treatments and their Potential Health Consequences

A tooth is basically comprised of 3 layers--the enamel, the dentin and the pulp. Dentin accounts for about 90% of the tooth. Located between the exterior enamel and the interior pulp, dentin is a hydrated nano-composite of hydroxyapatite mineral crystallites distributed in a scaffold of collagen fibrils, with fluid and non-collagenous proteins. When looked at under a microscope, dentin has a very specific structure. Dentin consists of microscopic channels, called dentinal tubules, which radiate outward through the dentin from the pulp to the exterior cementum or enamel border. The centers of these tubules are filled with living protoplasm. The protoplasm in these tubules has no blood supply so it depends on the blood vessels in the pulp for its nourishment or sustenance. The inner part of the tooth, or pulp, contains blood vessels, nerves, and connective tissue. Inside the pulp, there is a cavity within the center of the tooth known as the root canal. The term endodontic refers to the inner part that consists of the pulp chamber, or the coronal part of the tooth, the main canal(s), and the more intricate anatomical branches that may connect the root canals to each other or to the surface of the root. The tooth's nerve lies within the root canal. If the pulp becomes infected, the dentin tubules can harbor hundreds of millions of bacteria.



Magnified (5000X) Longitudinal Dentinal Tubules
Where Bacteria and Fungus become Trapped

If the pulp becomes infected or diseased, the tooth must either be extracted or treated. The treatment is termed a root canal treatment or endodontic treatment. Actually, there are several reasons a dentist or endodontist will perform a root canal treatment, such as to treat tooth decay that invades the pulp, to repair a cracked or broken tooth or abscessed tooth, to address tooth trauma that results in the exposure of the nerve, or to treat a tooth that is slowly dying due to aging or past trauma.

Hence, a dentist or endodontist can attempt to structurally "save" the tooth by drilling into the canal and scraping out the infected pulp. Then, the endodontist will fill and seal the narrow opening. Root canal fillings are selected that will exactly fit into the freshly prepared canals. Usually a rubber-like material called gutta-percha is used to fill the canal space. It is a thermoplastic material, which is heated and then compressed into and against the walls of the root canals to seal them. Together with adhesive cement called a sealer, the gutta-percha fills the prepared canal space. Once the pulp, along with the nerves contained in it, is removed, the tooth itself can no longer feel pain, or so some dentists claim. A temporary or permanent filling material will then be placed to seal the access hole that was made to treat the canals. If the tooth lacks sufficient structure to hold a restoration (filling) in place, the dentist or endodontist may place a post (either metal or a very strong plastic) in one of the canals inside the tooth to help

retain it. The tooth then becomes non-vital or dead, meaning that the nerves, blood vessels, and other structures that made it vital have been destroyed.

This is the only area of medicine where a dead organ (a tooth is an organ) is left in the body intentionally. Structurally, yes, it has been “saved.” However, a root canal-treated tooth is weaker structurally than a healthy tooth and may crack or decay further. An alternative to an endodontic or root canal treatment is simply to take out the infection by removing the tooth.

More than 15 million root canal treatments are performed in the U.S. every year. It is a growing part of the medical industry, generating hundreds of millions of dollars annually. However, controversy over their safety has existed ever since the 1920s - when Dr. Weston Price first published information on the potential dangers of endodontic procedures.[35] Dr. Price discovered that root canals had within them bacteria capable of producing many diseases.

Dr. Price was concerned about the pathological bacteria found in nearly all root canal teeth of that time. He was able to transfer diseases harbored by humans from their extracted root canal teeth into rabbits by inserting a fragment of a root canal root under the skin in the belly area of a test rabbit. He found that root canal fragments from a person who had suffered a heart attack, when implanted into a rabbit, would cause a heart attack in the rabbit within a few weeks. Transference of heart disease could be accomplished 100 percent of the time. Some diseases transferred only 88 percent of the time, but the handwriting was on the wall. Which is more important? The life of the tooth or the life of the patient? This is still the primary question facing us today.

Dr. Price spent 25 years performing research on pulpless and endodontically-treated teeth, which supported the theory of “focal-infection,” which held that certain systemic diseases had their genesis in infected endodontically-treated teeth. The focal infection

theory contends that microorganisms, or their toxins, arising from a focus of circumscribed infection, such as the gums or a dead tooth, could disseminate systemically, resulting in the initiation or exacerbation of systemic illness or the damage of a distant tissue site. Certainly, Dr. Price was ahead of his time in his observations and deductions. In the 1930s and 40s, Price's research fell victim to the Canadian Dental Association, and others in the endodontic community who criticized his focal-infection theory and called it "radical." It was not until recent decades, in part due to research in systemic diseases associated with periodontal disease, that focal-infection theory has been given credibility and its due further research.[36, 37, 38, 39, 40, 41, 42]

Despite the controversy surrounding endodontic treatment, its goal is to completely remove bacteria and their byproducts and pulpal remnants from infected root canals, and to completely seal the disinfected root canals. However, it is not possible to completely sterilize a dead or non-vital tooth. Although most endodontists assure patients that each root canal-treated tooth is cleaned out and "sterilized" completely before the filling material is placed, this is physically impossible. Even if the pulp chamber could be thoroughly sanitized, bacteria and their metabolic waste cannot be removed from the extensive, tiny dentinal tubules and lateral canals that surround the pulp. Instead, sealing the tooth provides these pathogens with a dark, moist, anaerobic environment in which they thrive. Within this anaerobic environment, bacterial and fungus multiply and may become more virulent. While the top and much of the tooth's interior are sealed, the tooth is not completely blocked off from the rest of the body. There is an escape route through the vessels that extend into the tip of the tooth's root into the jawbone. From there, microbes and their toxins are released from the dead tooth into the bone, where they may then enter the general circulation.[43] In other words, though the tooth is sealed at the top, what's in the tooth is free to escape through the roots and enter the circulatory system, including any pathogens remaining within the tooth and, more importantly, their metabolic waste. From such an infection, the jawbone then may become infected and develop osteonecrosis. This is termed periapical periodontitis (also called apical periodontitis, or periradicular periodontitis) and is

characterized as an acute or chronic inflammatory lesion around the apex of a tooth root which is caused by bacterial invasion of the tooth's pulp.

After a root canal treatment, bacteria and fungi remain within the tooth, growing and multiplying. Because microbes can change their form and function in response to a changed microenvironment within the tubules, they can continue living in spite of the altered oxygen and food supply. This phenomenon was confirmed in a study demonstrating that anaerobic bacteria were able to survive and maintain an infectious disease in periapical lesions of non-vital teeth.[44] Microbes of the dead tooth begin to produce various toxic chemicals, which have been shown to be harmful and especially toxic to specific organs or organ systems.[45] Additionally, carefully conducted electron microscopy studies have further confirmed that root canal-treated teeth contain pathologic bacteria.[46, 47]

In one study of pathogenic organisms cultured from root canal-treated teeth, researchers found that *Peptostreptococcus* was the most prevalent species followed by *Streptococcus*, *Porphyromonas gingivalis*, and *Enterococcus faecalis*. *Enterococcus faecalis* was a prevalent species in the failed root canals evaluated.[48] In another study, using DNA testing technology, researchers identified multiple pathological bacteria found within root canal-treated teeth, the bone adjacent to the teeth, and in extraction sites where healing has not taken place.[49] They found bacterial contamination in 100 percent of the samples tested and identified 42 different species of anaerobic bacteria in 43 root canal samples. A few of the types of pathogenic bacteria they found included: *Capnocytophaga ochracea, Fusobacterium nucleatum*, *Gemella morbillorum, Leptotrichia buccalis* and *Porphyromonas gingivalis.* Hence, root canal-treated teeth are contaminated with pathogenic bacteria that are detrimental to the immune system and can participate in the progression of degenerative diseases and cancer.

Laboratory Testing

Dental DNA is a laboratory that dentists can use to document microbial DNA in surgically curetted osteonecrotic material. The lab reports that they have never had a sample that did not show evidence of at least three species of anaerobic microbes, and that they find most samples usually contain more. For more information, see the Dental DNA website: http://www.dentaldna.us/

Bacterial population shifts occur over time with anaerobic organisms ultimately dominating the bacterial mix.[50, 51, 52, 53, 54] The pathogenicity of bacteria and fungi in the root canal-treated tooth depends on several factors, including:

- the redox potential, or the amount of oxygen in the local environment
- access to and availability of nutrients
- any existing microbial interactions
- the presence of mercury from dental mercury amalgams
- the integrity and strength of the host's defense system

The redox potential in the necrotic root canal is very low, which favors the dominance of anaerobic bacteria. Mercury from amalgams may potentiate pathogenicity and lower immunity. The presence of an immune system disorder such as cancer can also cause an ecological shift in the microbe environment. Hence, mercury fillings together with anaerobic bacteria create a very toxic oral environment that can influence overall immune health and lead to systemic diseases.

Dr. Robert Jones, a researcher at the Institute for Cancer Sciences at the University of Glasgow, researched the relationship between root canal treatments and breast cancer. His 5-year study involving over 300 women with breast cancer found that 93 percent

had undergone root canal treatments. Dr. Jones also found that in the majority of the cases, the cancer tumors were located on the same side of the body as the root canal or other oral pathology.[55] Dr. Thomas Rau, a Swiss physician and researcher, has observed the same association in breast cancer patients. Dr. Rau examined the records of 150 women who had been admitted to his clinic for breast cancer. He found that 147 of them (98.5%) had one or more root canal treatments and the other three had cavitation problems.[56]

However, even with ongoing validation that oral bacteria can elicit systemic diseases, the American Association of Endodontists states, “There is no valid, scientific evidence linking root canal-treated teeth and disease elsewhere in the body.”[57] Illogically, what they are saying is that gum infections can cause systemic diseases, but tooth infections cannot. So, many dentists and patients face a perplexity between “saving” a compromised tooth through endodontic treatment (and the potential of failure and systemic infection) or opting for extraction.

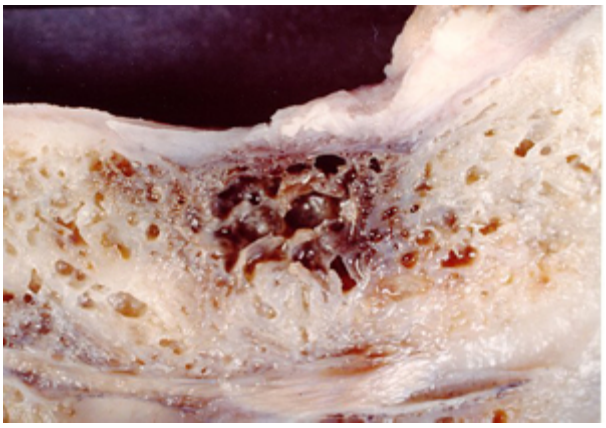
Cavitations and Osteonecrosis of the Jaw

Cavitations, unlike dental cavities, are areas of unhealed bone that are often the result of a tooth extraction. In other words, a cavity is a hole in a tooth, whereas a cavitation is a hole in the jawbone. Cavitations have many scientific names such as cavitational osteitis, chronic jaw osteitis, ischemic osteonecrosis of the jaw, chronic non-superative osteomyelitis, and more. This is primarily necrosis (dead tissue) in the bone marrow, a result of impaired blood flow (ischemia). Unlike most tooth cavities, bone cavitations cannot be detected by using regular dental X-rays; thus, many cavitations are missed. The use of cone-beam computer tomography (CBCT) has greatly assisted with identifying cavitations.

Cavitations may develop into extensive osteonecrosis of the jaw (ONJ). In most cases, ONJ can take years to develop. Ischemic ONJ is due to poor perfusion of oxygen in the bone matrix. Highly toxic bacteria are associated with ONJ and weaken overall health, often without any obvious pain in the jaw area. However, sometimes pain, even severe pain, does develop.

Although the term cavitation is not commonly used in conventional dentistry today, it was initially described in 1915 by Dr. G.V. Black, who is considered the “father of operative dentistry.” He described a progressive disease process in the jawbone, which killed bone cells and produced a large cavitation area or areas. He was intrigued by the unique ability of this disease to produce extensive jawbone destruction without causing redness in the gingiva, jaw swelling, or an elevation in the patient's body temperature. Essentially, this disease process is a progressive impairment which produces small blockages (infarctions) of the tiny blood vessels in the jawbones, thus resulting in osteonecrosis or areas of dead bone. He described a cavitation as bone necrosis, or “chronic osteitis,” resulting in hollowed-out lesions found at the sites of old extractions. The bone was usually softened initially by the progressive cellular death of cancellous bone, until an actual hole resulted. He even went on to describe the appropriate way to treat such lesions, which was essentially a surgical debridement.

During the next 60 years, Black’s findings were either ignored, forgotten, or not properly accepted. They were never integrated into dentistry nor taught in any U.S. dental institutions. In the 1970s, however, cavitations were “re-discovered” and correlations with previously unexplained pain syndromes were suggested.



Cross section of the jawbone showing a hollow area with necrotic (dead) tissue

Specialists have recognized cavitations as a possible cause of chronic facial pain and termed them neuralgia-inducing cavitational osteonecrosis (NICO). Often, NICO is an overlooked factor in trigeminal neuralgia, as well as other kinds of facial pain like trigeminal neuralgia.[58] Bouquot and McMahon reported that a patient with NICO might have experienced pulpal, periodontal or sinus infections, undergone tooth extractions, endodontic procedures or periodontal surgeries, experienced blows to the facial region, received vasoconstrictors during procedures involving administration of local anesthetics, or a combination of these.[59]

Most of the scientific inquiry into jawbone osteonecrosis was done regarding its relationship with pain: facial neuralgias, atypical facial pain, trigeminal neuralgia, migraine, and pain referred to distant sites. Several surgeons, starting with Dr. E. J. Ratner in 1976, have reported high rates of relief from neuralgic pain when ischemic jawbone sites are identified and treated. The first step, as Ratner recommended, is to confirm the connection between the site and the pain with local anesthetic. After that, the sites would be opened surgically and curetted of the necrotic contents. Reliable relief of neuralgias has been reported, although it sometimes would take repeated surgical treatments to reach that result.

If we can find evidence for ischemic bone lesions so often, and many of them are not painful, why should we be concerned? The reason is – they are toxic. They universally harbor anaerobic microbes: bacteria, fungi, and viruses. While these microbes may or may not be culturable, they can be identified by their DNA. Moreover, the waste products these microbes leave behind have also been shown to contain several toxic compounds. Cytokine ratios are altered in ischemically damaged jawbone. Some wonder if these jawbone lesions, affected as they are by microbes, microbial waste products, and altered physiology, are not a hidden source of systemic stress and immune disease.

Cavitation Causes and ONJ

There are several pathways by which a jawbone cavitation can arise due to technical errors and/or failure to thoroughly remove any underlying infection around the extracted tooth. When a tooth is extracted, the socket and jawbone around it are typically cracked or fractured, which reduces the blood supply to the traumatized bone and creates the perfect environment for a cavitation to develop. Additionally, when dentists extract dead teeth, or teeth that have infected pulp, infected roots and remnants of the periodontal ligament, as well as other infectious material, is sometimes left behind. The blood produced during the extraction will clot in the socket, which gradually closes, sealing in bacteria which then can multiply and start a cavitation infection.

Tooth Extraction

There really is no such thing as a simple tooth extraction. This is because a certain undetermined percentage of the population will experience ischemic bone healing of routine dental extractions due to their underlying hypercoagulation states, an immune compromise, or toxic oral microbiome. The biggest risk for complications after having a tooth extracted is infection. The more teeth that are involved, the greater the risk.

These are some strategies that biological dentists have devised to mitigate the risk of causing cavitations:

- Minimize the use of vasoconstrictors, even for surgery. This avoids the transient ischemia that can be so damaging to osteocyte viability. “Where there is more bleeding, more bone will follow.”

- Curette the socket with a bur to remove all remnants of the periodontal ligament. The ligament is a barrier that normally prevents the root surface from getting involved with the bone replacement cycle, so it may block the bone remodeling system from fully accessing the socket.

- Perforate or decorticate the lamina dura with a bur. This gives the marrow cells, macrophages and stem cells better access to the organizing blood clot in the socket. It follows the concept that micro-injuries to bone stimulate better healing, too.

Causes of Ischemic Osteonecrosis of the Jaw

Numerous local anesthetic solutions contain vasoconstrictors (particularly epinephrine). Vasoconstrictors are applied in order to restrict or reduce the blood supply to bone, teeth or gingival tissue, thus prolonging the anesthetic effect and minimizing bleeding. The application of vasoconstrictors with anesthetics may increase the occurrence of cavitational lesions in this region.

One of the primary factors in cavitation formation seems to be that the initial extraction does not include the thorough removal of the periodontal ligament from the socket after the tooth is removed. Unfortunately, this inadequate socket cleaning is the routine procedure with most extractions. Cavitation formation after tooth extraction is the rule and not the exception; yet, the condition is still largely unknown to most of dentistry and

underestimated by those who are aware of it. A cavitation can be expected to form when the socket lining separating the tooth from the bone is not thoroughly removed. A thorough removal of the ligament requires that a portion of the bony socket be removed as well.

Additionally, when the periodontal ligament is not thoroughly removed from the socket after the extraction, the surrounding bone receives no biological signal that the tooth is gone. The continued presence of any portion of the ligament gives the biological message to the surrounding jawbone that all is well, and no new bone growth is needed. Bone cells are not going to start new growth and then migrate through a barrier naturally designed to limit such growth. The jawbone determines that if the ligament is still there, the tooth must be there as well.

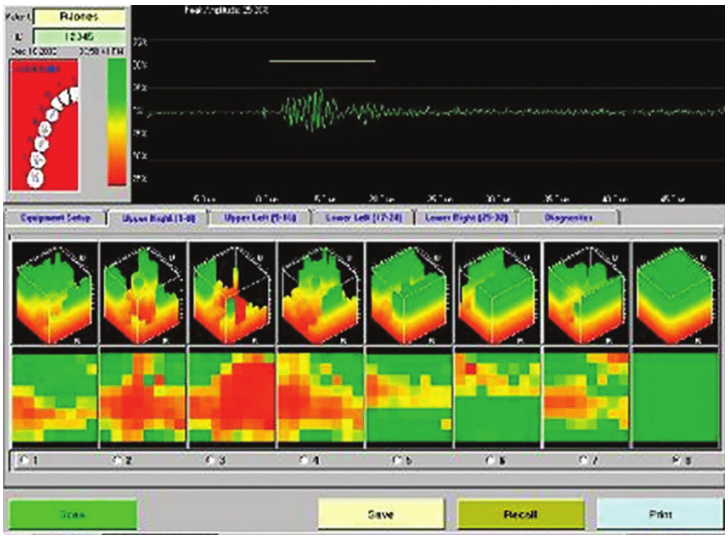
Another frequent cause of ischemic osteonecrosis is failed or improper endodontic treatment. Again, the treated root canals may become loaded with anaerobic bacteria or chemically toxic material used for the canal filling. The pathogenic bacteria reach the bone, eventually causing infection and loss of bone density. Since there is no longer a blood supply to the endodontically treated non-vital tooth, the body cannot fight the toxins and the underlying bone can degenerate into necrotic bone and fibrous marrow.

Cavitation and Periapical Periodontitis Diagnosis

Diagnosing cavitations and periapical periodontitis is an elusive process because they do not always readily appear on X-rays. Sometimes, cavitations show up only as very subtle differentiations in the texture pattern of the bone. If the dentist is not specifically looking for a cavitation or investigating a root canal-treated tooth for periapical periodontitis, then the X-ray may appear normal. This is because X-rays are not the optimal imaging technique for identifying and diagnosing cavitations, periapical periodontitis, or ONJ. A cone-beam computerized tomography (CBCT) of the jaw is a

more definitive 3-dimensional X-ray that can determine the presence and severity of a cavitation, ONJ, or periapical periodontitis from an existing root canal-treated tooth. Currently, CBCT is considered by some to be the highest standard of diagnostic care.[60, 61, 62, 63, 64] Unfortunately, rarely is CBCT performed to evaluate the stability of existing root canal-treated teeth, or to look for cavitations in extraction sites. People who have had root canals, however, should make sure to undergo CBCT imaging of that jaw area where the procedure was performed. Usually, most cities have a few oral surgeons that utilize CBCT. CBCT is also a helpful diagnostic aid to determine the severity of apical periodontitis causing jawbone necrosis. Signs and symptoms may occur before the development of clinically detectable osteonecrosis and include pain, tooth mobility, mucosal swelling, erythema, ulceration, or paresthesia of the associated branch of the trigeminal nerve.[65]

Until the company went out of business in 2005, there was a through-transmission ultrasound system available, called the Cavitat. The system was based on the fact that dead bone, with its disconnected trabecular structure, could not conduct sound the way intact bone does. A signal generated between a sending and a receiving contact, held on either side of the alveolar process, would be converted to a three-dimensional image of a volume of jawbone. Damaged bone was rendered in red, while normal bone is seen as green. Some very useful clinical and research work was done with this instrument, and its absence has negatively impacted further work in this area.



Cavitat

Oral Infection and Cavitation Treatment

Treatment for oral infections and cavitations depends upon each patient's unique situation. Cavitations should only be treated surgically if there is indication of a relation to pain or chronic health effects not resolved by other means. However, surgery (surgical curettage) is sometimes necessary to clean out an infected cavitational site and dead bone. The key to bone healing and regeneration is the removal of the necrotic tissue. If the necrotic tissue is not thoroughly removed, the necrosis may spread and cause further destruction to the bone, nerves, and blood vessels. This kills roots of the teeth in the process, for they are cut off from their blood supply. Once the necrotic tissue has been cleaned out, healing can then take place and new bone cells will fill in the cavitations. The next treatment step is a bone grafting procedure to fill the cleaned and disinfected cavitation area. Additional treatment options include the use of lasers and ozone treatments, as well as probiotics and other remedies and therapies to assist lymphatic drainage. The following are the most commonly employed cavitation treatments:

Surgical Curettage - The success of surgical curettage of painful lesions seems to follow the old adage that where more bleeding is provoked, bone will follow. Repeated procedures were required to reach the final result in many cases. Surgical curettage remains the standard for definitive treatment.

Anti-coagulation Therapy - Many of the anaerobic waste products of microbial metabolism are themselves pro-thrombotic and tend to perpetuate the ischemic problem. Some rate of relief of pain in long bones and jawbone neuralgias has been achieved with anti-coagulation therapy, counteracting the effects of the patients' endogenous hypercoagulation tendencies. It can provide relief in up to 40% of NICO cases, especially surgical failures. With this modality are proteolytic enzymes that may be taken orally to systemically reduce hypercoagulation.

Ozone Therapy - Ozone/oxygen mixture has been used successfully for the treatment of various diseases for more than a decade.

Ozone is the perfect substance for use in dental procedures. Its atraumatic, painless, noninvasive nature, and relative absence of discomfort and side effects increase the patient's acceptability and compliance - thus making it an ideal treatment choice for dentists. Its unique properties include immunostimulant, analgesic, antihypnotic, detoxicating, antimicrobial, bioenergetic and biosynthetic actions.

It disinfects the tissues treated and leaves no toxic residues. It also has the capacity to stimulate blood circulation and the immune response. Ozone can also provoke several healing mechanisms that result in the generation of new circulation.

Three fundamental forms of application to oral tissue are applied:

(1) ozonated water,

(2) ozonated olive oil, and

(3) oxygen/ozone gas injection.

Ozonated water and olive oil have the capacity to entrap and then release oxygen/ozone, an ideal delivery system. These forms of application are used singly or in combination to treat dental disease. Oxygen/ozone gas can also be injected in a dose-controlled manner into identified lesions, through a trephine (X-tip, Dentsply-Maillefeur).

Low Level Laser Therapy - With the advent of various advances in the field of laser dentistry, there has been a growing interest in the effects of low-level lasers on tissues. Since the 1960s, it has been broadly termed Low-Level Laser Therapy (LLLT) or photobiomodulation. When most dentists hear the word laser, they often think of a hard or soft tissue laser that is used to cut enamel or soft tissue. Low Level Lasers are another subset of laser therapy that is a virtually untapped commodity in dentistry, yet which would be a huge asset to a dental practice and its patients. LLLT can benefit almost every aspect of a dental practice, regardless of whether it is a general dental practice or a dental specialist. Stimulation of endorphins; reduction in the conduction of nerve fibers that carry pulpal pain (c-fibres); stimulation of fibroblasts, osteoblasts and odontoblasts; and increased circulation and lymphatic drainage can all aid in improving clinical outcomes and decrease the pain felt by a patient after dental appointments.

In any case of a dental infection, the laser can be applied to the submandibular lymph nodes to increase the lymphatic flow of the infected area, reduce the inflammatory cells and bring neutrophils to the infection site for faster healing.

Shock Wave Ultrasound - Shock wave therapy is based on the principles of ultrasonic lithotripsy and success in treating orthopedic neuralgias. Inducing micro-trauma by

treatment of ischemic jawbones with an extra-oral ultrasonic wand can induce new circulation and bone regrowth.

Antibiotics?

Truly, there is no clear guideline for use of antibiotics in dentistry. In most cases, they have been misused or overused. Therefore, antibiotic resistance is increasing. Additionally, many individuals have antibiotic allergies. The routine use of antibiotics before or after extractions or endodontics remains very questionable.

Still, antibiotics are routinely prescribed for dental (odontogenic) infections, with penicillins being the first line of treatment for most odontogenic infections. They produce their effect by inhibiting cross-linking in the bacterial cell wall and are, thus, bactericidal. They have a fairly narrow antimicrobial spectrum. Amoxicillin, a semi-synthetic penicillin, is usually the most common antibiotic used by dentists, followed by penicillin V, metronidazole, and amoxicillin and clavulanate. If a patient with an early stage odontogenic infection does not respond to amoxicillin, there is a strong probability of the presence of resistant bacteria. Bacterial resistance to penicillins can be a result of the production of beta-lactamase by the bacteria. In penicillin-resistant cases, beta-lactamase-stable antibiotics are routinely prescribed. The American Heart Association considers amoxicillin to be the first choice for prophylaxis against endocarditis. If antibiotics are prescribed, it is now recommended that short courses are as effective as long courses - and that short courses avoid some (but not all) of the serious side effects. Prolonged courses of antibiotics destroy the commensal flora. In addition, longer durations of up to 21 days may result in the selection of resistant strains and a reduction in the ability of the oral flora to resist the colonization by harmful micro-organisms that are not normal residents, leading to superimposed infections by multi-resistant bacteria and yeasts.

Most antibiotics are “bactericidal” and as the antibiotics kill a bacterium, the bacterium “explodes” releasing fragments. The fragments are not eliminated immediately, for each piece is a lipopolysaccharide (LPS), also called an endotoxin. In other words, endotoxins are LPS constituents of the outer membrane of the cell wall of gram-negative bacteria. By way of contrast, exotoxins are the toxic chemicals that are released by pathogenic bacteria, and endotoxins are toxic entities (fragments of the original bacteria) that are the result of the bacterial explosion caused by the antibiotic.

Once in the circulation, the endotoxin prompts the release of endogenous mediators, such as tumor necrosis factor alpha (TNF-a), interleukin 1, interleukin 6, and other cytokines, from mononuclear phagocytes and other cells. These cytokines induce a cascade of secondary inflammatory mediators, eventually leading to endothelial damage and severe hemodynamic and metabolic derangements. Thus, endotoxins caused by antibiotics present a significant challenge to the immune system. For now, instead of facing one bacterium, it must process and eliminate countless endotoxins. With numerous types of bacteria to confront from each single root canal or cavitation, no one antibiotic can eliminate (kill) them all. Broad spectrum antibiotics cannot be used for this reason. Additionally, the detrimental effect of antibiotics on the gut microbiome (commensal flora) is devastating. Therefore, routine prescription of antibiotics for every extraction or endodontic procedure must be discouraged.

In summary, research has demonstrated that periodontal disease, virtually all root canal-treated teeth, and cavitations result in residual infections that release potentially toxic chemicals into the systemic circulation. These organisms and their toxins can cause systemic diseases of the heart, kidney, immune, nervous and endocrine systems.[66, 67, 68, 69, 70, 71,72] Many of the toxins released from the mouth are carcinogenic and have been demonstrated to increase the incidence of certain cancers. It takes a dentist well-versed in specialized procedures to identify and successfully treat these disorders. A second opinion or third opinion can help confirm or contest the true need for a root canal procedure. Unfortunately, too many dentists perform endodontic procedures for

the wrong reasons. Not all tooth pain and swelling occurs because the tooth root is infected. Swelling can also mean that gum tissue has abscessed. Periodontal infections can be healed without a root canal treatment. When it comes to serious pulp infection, instead of endodontic treatment, it may be best to opt for tooth extraction.

Those who have been told they need to have a root canal treatment, or those who have already had an endodontic treatment, should consider having an evaluation with an experienced biological (bioregulatory) dentist.[73] Biological dentists may be general dentists, periodontists, orthodontists, oral surgeons or pedodontists. In addition to training in their chosen specialty, they also have extensive training in both dental toxicology and specific healing modalities beyond those of western dentistry. A biological dentist is a dentist who practices dentistry while understanding that what happens to the teeth and gums may have an impact on the rest of the body. Biological dentists believe that prevention is the best cure; that tooth decay can be cured or prevented with proper nutrition; and that we should use all dental materials with a healthy degree of skepticism. Biological dentists believe that placing metal (mercury amalgams) and/or other foreign materials in the teeth and gums may have detrimental consequences. Specific modalities will vary from dentist to dentist, but all incorporate treatments for the betterment of the patient. Any protocol followed is designed from components that sustain life or improve the quality of life for individuals pursuing treatment. For the word “biological” refers to life. More broadly, practitioners performing endodontic procedures should be aware of the relationship between the outcome of endodontic treatment and systemic diseases.

Unfortunately, dentistry and most of medicine, particularly oncology, are completely divorced from each other. Oncologists would never think of oral toxicology from root canal-treated teeth or cavitations as co-causes of a cancerous terrain. Insurance companies also tend to view dentistry and medicine as inherently distinct practices. But as we learn more about how diseases that start in our mouths can ravage the rest of our bodies, this separation becomes increasingly hard to rationalize. There are few health-

related issues facing the world today that are more fundamental than the interface between the domains of dentistry and medicine.

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