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ENDODONTICS

COLLEAGUES FOR EXCELLENCE

Are your patients wondering if their arthritis or other ailments might improve if they have their endodontically treated teeth extracted? Are they asking about the focal infection theory? Some dentists are reporting an increase in these types of questions.

The American Association of Endodontists has prepared the material in this newsletter to help you review the history and facts about the focal infection theory and understand what patients need to know in order to alleviate their concerns about the safety of root canal therapy. Also included as an insert are abstracts of key articles on focal infection and endodontic treatment.

Root Canal Therapy Safe and Effective

FOCAL INFECTION GHOST RISES FROM THE GRAVE

You probably remember encountering the focal infection theory in dental school as a historical note in textbooks, lectures and seminars. As applied to root canals in the early part of this century (1910-1940), the theory stated that pulpless and endodontically treated teeth might leak bacteria or their toxins into the body causing arthritis and diseases of the kidney, heart, nervous, gastrointestinal, endocrine and other systems.

Back in the early 1900s, the majority of medical and dental professionals accepted the theory as fact. Keep in mind that dentistry at that time was a mechanical art. It was not as scientifically nor as biologically based as it is today. As a result, the theory had a disastrous effect on the medical and dental care provided to patients, resulting in the needless extraction of millions of pulpless and endodontically treated teeth in a misguided attempt to

cure a multitude of diseases. The theory also brought about millions of tonsillectomies, since tonsils were considered to be foci of infection as well.

In the decades since the theory was conceived, extensive and meticulous scientific investigations proved that root canal therapy is a safe and effective means for saving teeth and that endodontically treated teeth do not serve as foci for infection in other parts of the body.

THE HISTORY OF FOCAL INFECTION

1890-1909

The Rise of the Theory

The focal infection theory originated in 1890, when Dr. W.D. Miller discovered that gangrenous pulps could act as centers of infection causing alveolar abscesses. In 1904, Dr. Frank Billings defined a focus of infection as a "circumscribed area of tissue infected with pathogenic organisms."

A student of Dr. Billings's, Dr. E.C. Rosenow, reported in 1909 that streptococci present in diseased organs could establish an infection in a distant organ after traveling through the bloodstream. Therefore, Rosenow may be credited with defining focal infection as a localized or generalized infection caused by the dissemination of bacteria or their toxic products from a distant focus of infection.

DEFINITIONS

INFECTION	Invasion and proliferation of bacteria—or other pathogenic microorganisms—in body tissues and the reaction of the tissues to their presence.
FOCUS OF INFECTION	A localized area of infection.
FOCAL INFECTION	A secondary infection initiated in another site by bacteria that have traveled through the bloodstream from a focus of infection.
BACTEREMIA	The presence of bacteria in the bloodstream.

1910

In 1910, British physician Dr. William Hunter presented a lecture on focal infection to the faculty of McGill University in Montreal. His presentation, "The Role of Sepsis and Antisepsis in Medicine," condemned the way dentistry was practiced in the United States, where restoration was empha-

Focal Infection Thought to Account for American Malaise

sized over extraction. He stated that "gold fillings, gold caps, gold bridges, gold crowns, fixed dentures, built in, on, and around diseased teeth form a veritable mausoleum of gold over a mass of sepsis." He indicated that the infection trapped under poorly fabricated restorations led to Americans'

"dirty gray, sallow, pale, wax-like complexions, and...chronic dyspepsias, intestinal disorders, ill health, anemias, and nervous ('neurotic') complaints...." Dr. Hunter was actually referring to the infection found around and under poorly fabricated restorations, not pulpless teeth.

1910-1930

"Hundred Percenters" Extract Teeth to Cure Disease

Dr. Hunter's remarks were readily accepted by some physicians as a means of explaining away any disease for which they had no cure. It was easy to inform a patient that a tooth was causing the illness and had to be removed. It was also psychologically satisfying to both the patient and the physician to believe that disease could be treated so simply. Dentists, too, jumped on Hunter's bandwagon.

Soon, poorly fabricated restorations were not the only culprits being blamed for American malaise. Pulpless and endodontically treated teeth began to come under fire as well—even teeth that showed no signs of infection. Also, Dr. Weston Price, another proponent of

the focal infection theory, began a 25-year study on pulpless and endodontically treated teeth.

As a result of this expansion of the theory, some dentists and physicians, appropriately called "hundred percenters," recommended the extraction of any and all pulpless or endodontically treated teeth. In fact, surgical removal of the teeth, rather than just simple extraction, was also advocated to remove the supposed focus of infection from the surrounding periodontal ligament. After extraction, the dentist was instructed to scrape the socket aggressively with a bur or instrument to remove the infected bone immediately lining the alveolus—a procedure that is

no longer encouraged in modern dentistry.

In the ensuing years, the dental literature was replete with case histories reporting cures of various illnesses following the extraction of teeth. Although these reports were empirical and without appropriate follow-up, they wrongfully justified the continued extraction of teeth. In time, however, the cures attributed to the extraction of teeth proved to be short lived and were considered psychological—the extraction serving as a surgical placebo. In most cases, the illnesses returned to the patients, who then faced the additional burden of living with mutilated dentitions.

1930-1939

Studies Disprove Extraction "Cures" and Find No Correlation of Illness to Endodontically Treated Teeth

An editorial rejecting the application of the focal infection theory in dentistry appeared in *Dental Cosmos* in 1930. The article stated that "the policy of indiscriminate extraction of all teeth in which the pulps are involved has been practiced sufficiently long to convince the most rabid hundred percenter that it is irrational and does not meet the demands of either medical or dental requirements, and much less those of the patient." The editorial called for a return to "constructive" rather than "destructive policy" because "the constructive...certainly offers more

possibilities of making the masticatory apparatus a useful and helpful organ rather than a crippled and constant menace to the patient."

Population studies conducted in the 1930s found absolutely no correlation between the presence of endodontically treated teeth and the frequency of illness in patients who participated in the studies. In 1938, in the *Annals of Internal Medicine*, physicians R.L. Cecil and D.M. Angevine reported an important follow-up study of 156 patients with rheumatoid arthritis who had teeth or tonsils removed because

they were considered foci of infection. Of the 52 patients who had teeth extracted, 47 did not get any better and three became more ill. This study is of particular interest in light of the fact that Cecil had been a strong advocate of the focal infection theory and had earlier reported improvement in his arthritis patients who chose to have alleged foci of infection removed. Upon reviewing the results of the follow-up study, however, Cecil called for a reassessment of the focal infection theory and suggested that the further removal of suspected foci of infection be halted.

1940-

PRESENT

Advances in Science Prove Original Focal Infection Research Methods Flawed

A number of noted dental researchers evaluating the studies conducted by Rosenow and Price have determined that the scientific methods used at that time were flawed in three major areas: (1) the experiments were not properly controlled, (2) the doses of bacteria

injected into the experimental animals were too massive, and (3) the supposed infected pulpless teeth were actually contaminated with bacteria during extraction procedures.

Additional research conducted during the past three decades has

verified these flaws. As a result of these clinical and scientific studies, the medical and dental professions have concluded that there is no relationship between pulpless or endodontically treated teeth and any of the so-called "degenerative" diseases.

CURRENT THINKING ON FOCAL INFECTION

While it is a shame that the focal infection theory resulted in the needless extraction of millions of pulpless and endodontically treated teeth, the theory did have some positive repercussions for medicine and dentistry. The theory

encouraged much research in the basic sciences—including microbiology and immunology. This extensive research helped lead the science of dentistry to its current scientific and biological basis for root canal treatment.

Successful Root Canal Treatment

The role that bacteria play in the development of pulpitis and subsequent periradicular periodontitis has been well established. As a result, one major goal of endodontic therapy is the elimination of bacteria—and the tissue substrate that supports their growth—from the root canal system.

Working in an aseptic environment—rubber dam, sterile instruments, etc.—the practitioner accomplishes bacterial elimination by thorough cleaning, shaping and obturation of the root canal system in three dimensions.

Research has also shown that the use of appropriate bactericidal irrigating solutions during the cleaning and shaping phase of treatment will help eliminate bacteria and bacterial substrate from the root canal and dentinal tubules. In addition, the use of gutta-percha along with sealer and modern obturating techniques after appropriate cleaning and shaping substantially decreases the likelihood that the canal filling will shrink, thus deterring reinfection of the root canal. If endodontic therapy is appropriately per-

The Key to Success...

*...in endodontic therapy
is thorough cleaning,
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dimensions.*

formed, clinical symptoms should disappear, and radiographic and histologic healing of the periradicular area should occur.

With the help of advances in science and technology, dentists today can achieve well over 90% success in treating pulpal pathosis without extracting teeth.

WHEN INFECTION DOES SPREAD FROM AN INFECTED ROOT CANAL

Sometimes, bacteria from infected pulp tissue do spread to other tissues. That is how acute periradicular abscesses are formed. If large numbers of bacteria from infected pulp tissue gain entry into the periradicular tissue and the patient's immune system is not able to combat the invasion, the patient will present with signs and symptoms of an acute periradicular abscess.

Clinically, these patients present with swelling and mild to severe pain. Depending on the relationship of the apices of the involved tooth to the muscular attachments, the swelling may be localized to the vestibule or extend into a fascial space. In addition, the

patient may exhibit systemic manifestations such as fever, chills, lymphadenopathy, headache and nausea. Since reaction to the infection occurs very quickly, the involved tooth may or may not show radiographic evidence of pathosis—a widened periodontal ligament space or radiolucency. However, in most cases, the tooth will elicit a positive response to percussion, and the periradicular area will be tender to palpation.

Treatment involves root canal therapy to remove the source of the infection. In some cases, incision and drainage may precede the root canal therapy. In addition, antibiotic therapy

may be indicated if the patient has a compromised host resistance, the presence of systemic symptoms—fever, lymphadenopathy, etc.—or fascial space involvement.

In the case of the acute periradicular abscess, infection from the root canal spreads to immediately adjacent structures in the periapex and then to immediately adjacent fascial spaces of the head and neck, resulting in cellulitis and systemic signs and symptoms of infection. This is not an example of focal infection, where bacteria travel through the circulatory system and establish infection at a site distant from the focus of infection.

INFECTIVE ENDOCARDITIS

Practitioners are well aware of the relationship between bacteremias caused by dental procedures—especially extraction and periodontal treatment—and the risk of infective endocarditis in patients with damaged heart valves. This classic example of focal infection is in no way related to the focal infection theory as proposed in 1910, because the bacteremia occurs at the time of the dental procedure, not from the mere presence of pulpless or endodontically treated teeth.

Endocarditis is a serious disease. During dental procedures known to

cause bacteremia, susceptible patients are prescribed antibiotics according to current American Heart Association guidelines. The antibiotics help rid the circulation of the bacteria known to establish residence on the damaged heart valve.

Classic studies have shown a direct correlation between the incidence of bacteremia and the amount of trauma generated during a dental procedure. Because extraction is far more traumatic than root canal treatment, the chance of a bacteremia from extraction is much greater than the chance from root canal

treatment. Studies have shown that root canal therapy results in a bacteremia only if the root canal is instrumented beyond the apex. When the instruments are confined to the root canal space, bacteremias do not occur.

With this in mind, it is no wonder that root canal therapy, instead of extraction, should be the treatment of choice whenever possible for patients susceptible to infective endocarditis, for patients who are medically compromised or immunosuppressed, and for those who have a history of radiation therapy to the jaws.

CONCERN FOR YOUR PATIENTS

The members of the American Association of Endodontists are concerned that misinformed individuals are returning to the research of Price, Rosenow and others—research conducted during the first few decades of this century—and attempting to resurrect the focal infection theory based on these outdated studies. As educated providers of dental care, we

must work to prevent a return to the mentality of the “hundred percenters.” We owe it to our patients to address their concerns and to explain that this research has been considered and disproved many times. We owe it to them to provide the best possible treatment and, whenever possible, to help them preserve their natural dentitions. ■

If you would like more information on the focal infection theory, call your local endodontist or contact the American Association of Endodontists, 211 East Chicago Avenue, Suite 1100, Chicago, IL 60611-2691, Phone: 312/266-7255, Fax: 312/266-9867.

On the Horizon...

DNA Fingerprinting with PCR

Advances could lead to rapid and accurate identification of endodontic pathogens

It's all over the news. DNA fingerprinting is being used in more and more trials to help convict criminals who leave hair or other traces of cells at the scene. But did you know that if DNA fingerprinting had been around 80 years ago, it might have proved that bacteria found at distant foci did not originate from root filled teeth? Research being conducted today might have prevented the focal infection hysteria.

As you know, the genetic information found in your DNA is unique, and it is far more specific than the simple fingerprints traditionally used by police to identify criminals. Advances in molecular biology now allow researchers to take DNA from bacteria in one infection and compare it to the DNA from another infection to determine whether they are related.

Until recently, bacteria were primarily identified by culturing and gram staining samples of the living organisms. The polymerase chain reaction (PCR), a new technique in molecular biology for multiplying or amplifying the genetic code, has become the preferred method to facilitate genetic identification of specific bacteria. The PCR technique was initially used as a method for diagnosing genetic diseases and has

subsequently been used to identify viral infections, such as HIV.

There is a new DNA fingerprinting procedure, arbitrarily-primed PCR, that has been used to distinguish between isolates of the same species of bacteria. Specimens can be examined directly, without culturing, and only a few cells of a bacterium are necessary to yield an accurate identification. The procedure can also be applied to fixed—frozen or formalin—tissues. This process allows for rapid and exact identification of the organism in question. Recently, arbitrarily-primed PCR was used to characterize different strains in a tuberculosis outbreak.

What is perhaps one of the most promising aspects with regard to endodontics is the fact that PCR technology will enable researchers to correlate endodontic infections with their specific causative bacteria. This will allow scientists to correlate a cause and effect relationship between specific strains of an organism and disease. The misapplication of the focal infection theory to endodontically treated teeth might never have occurred at all if such sophisticated technology had been available then.

Comments? Did you enjoy this issue of *ENDODONTICS*? Did the information have a positive impact on your practice? Are there topics you

would like *ENDODONTICS* to cover in the future? We want to hear from you! Send your comments, questions and suggestions to:

ENDODONTICS

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ABSTRACTS

The following articles support the fact that modern root canal therapy can successfully treat infections of the tooth and surrounding tissues and that endodontically treated teeth do not contribute to focal infection.

1. Easlick KA. An evaluation of the effect of dental foci of infection on health.

JADA 42:615-686; 694-697, 1951.

This document reviews six general fields of systemic disease and their relationships to focal infection.

Focal infection concepts arose at the turn of the century; however, this was before current methods of scientific analysis were developed and perfected. The application of modern techniques to these concepts makes them topics of historical interest only.

In trying to diagnose focal infection, Ostrander and Crowley found that 38.6% of cases with periapical lesions could not be cultured. The relationship of pulp calcifications to bacteria demonstrated that their presence was physiological. Bacteria were also shown not to be indicators of infection as they were often present without any inflammation.

The success of conventional endodontic therapy was evaluated by radiography in 1927 by Coolidge, who reported a success rate of 97%. This contrasts

with the theory of focal infection and the link to teeth that was postulated before the development of radiography. Similarly, the role of oral bacteria in cardiac valvular disease through bacteremia, while being positive, can be prevented by the use of appropriate antibiotic regimens. A like finding to the relationship between oral bacteria and renal disease was found. While the bacteria in renal disease are primarily hemolytic streptococci, their origins are essentially from coliform populations.

In assessing ocular disease and uveitis, Guyton and Woods concluded that "...little or nothing is to be gained by the indiscriminate eradication of infections of the teeth, tonsils, sinuses and genito-urinary tract." Curtis summed up the relationship of the focal infection theory to disease succinctly by stating "...he falls back on the theory of focal infection when he does not know what else to try. Probably, focal infection is of little concern."

2. Grossman LI. Root Canal Therapy. 4th edition. Lea & Febiger,

Philadelphia, pp. 15-40, 1955.

The historical basis for the focal infection theory and the misconceptions of the pulpless tooth are addressed. Yet, the importance of this writing is probably that the historical lessons should not be forgotten. Fish and Maclean in 1936 elegantly observed that culturing bacteria from the pulp following extraction was a result of microbial contamination from the gingival sulcus, not from the pulp space. Once the gingival tissues were cauterized, the contamination of the pulp and root surface was eliminated. While circumventing the

blame to periodontally diseased teeth from endodontically diseased or pulpless teeth for systemic dissemination of bacteria, their report also negated the methodologies used in the bacteriologic studies prior to 1936. The bacteriologic studies of Price and Rosenow, which formed the foundation for focal infection enthusiasts, could no longer be used to "rationally" support the focal infection theory and the therapeutic wholesale extraction of teeth.

3. Grossman LI. Focal infection: Are oral foci of infection related to systemic disease?

Dent Clin N Amer, pp. 749-763, Nov. 1960.

Dr. Louis I. Grossman cites the invalidity of a number of the key bacteriologic studies prior to 1940 that were used to help establish the focal infection theory. The studies are invalid because the sample cultures, all taken from extracted roots of both vital and pulpless teeth and from tooth sockets taken immediately after extraction, were contaminated by gingival bacteria during extraction. Scientific studies by Fish and Maclean, Tunnicliff and Hammond, and Gunter and Appleton proved this finding which invalidated most of the reports on pulpless teeth as being foci of infection. With regard to the relationship of pulpless teeth and systemic disease such as diseases of the eye, arthritis, heart and blood disease, and gastrointestinal and renal disease, there is virtually no data to support a cause and effect scenario. Statistical studies in

the medical literature have demonstrated that the incidence of foci of infection in a particular disease group is virtually the same as in a control group, i.e. one without the respective disease. Unfortunately, incidences in which spontaneous remissions occur soon after the removal of a pulpless tooth or the inability to find a causative factor for a disease entity have led some frustrated practitioners to rely on the focal infection theory as a crutch to offer an explanation for their findings. Dr. Grossman points out that, except for sporadic cases of subacute bacterial endocarditis, which may be related to tooth extraction in individuals with already damaged heart valves, a relationship between oral bacteria and systemic disease has been difficult to establish.

4. Bender IB, Seltzer S, and Yermish M. The incidence of bacteremia in endodontic manipulation.

Oral Surg 13: 353-360, 1960.

This study was undertaken because of criticism of endodontic procedures relative to focal infection. The purpose of this study was to determine if endodontic procedures can produce a bacteremia. Fifty patients between 19 and 78 years of age who had not received antibiotics within one month were randomly selected for the study. Twenty-six teeth were instrumented within the root canal, and 24 were instrumented beyond the root canal. The rubber dam and aseptic technique were purposely not used in this study to increase the number of bacteria in the root canals from salivary contamination that might gain entry into the blood stream. The teeth were isolated with cotton rolls, and in each case the reamer or file was moved vigorously with a pumping motion for ten minutes. Blood samples (16 ml) were taken before, immediately after, and ten minutes after endodontic manipulation. Each of the blood samples was divided into four aliquots of four ml of blood and incubated at 37°C for two weeks. Paper points were used to sample the root canals and suspended in brain-heart infusion broth. The bacteria in a positive culture were identified.

All preoperative blood samples and all blood samples taken ten minutes after manipulation produced no growth of bacteria. Six of 50 (12%) blood

samples taken immediately after manipulation were positive for the growth of bacteria. All six positive samples were associated with instrumentation beyond the root canal. Of those six positive blood cultures, three were associated with vital pulps and three were associated with non-vital pulps. The high incidence of streptococci in the root canals (41/50) and in the blood cultures (4/6) suggest salivary contamination consistent with the lack of asepsis. The lack of asepsis probably allowed the introduction of more bacteria. Despite the lack of asepsis, the incidence of bacteremia when instrumentation was confined to the root canal was 0/26 (zero) and with instrumentation beyond the apex the incidence of detectable bacteremia was 6/24 (25%). In a previous study the investigators found that the incidence of bacteremia following tooth extraction to be 84.9%. If the degree of trauma produced during tooth extraction was considered, mild trauma produced 68.7% and heavy trauma 93.4%.

For medically compromised patients such as those with a history of valvular heart disease, endodontic treatment should be the treatment of choice whenever possible.

Continued on reverse.

5. Davis MS, Joseph SW, and Bucher JF. Periapical and intracanal healing following incomplete root canal fillings in dogs. Oral Surg 31: 662-675, 1971.

The purpose of this study was to compare the reactions of the periapical tissues of dogs to hollow tubes in the form of widely prepared but underfilled root canals following vital pulp extirpation and to determine how healing would occur in this environment. Thirty-two root canals in a total of four dogs were completely cleaned up to a size #80, one millimeter short of the radiographic apex; they were subsequently filled with gutta-percha and sealer to various levels: to the working length, three millimeters short of the working length and grossly beyond the root apex. Three animals were sacrificed after 17 weeks and one was sacrificed after one year. The periapical tissue reactions were observed histologically. Fourteen canals were underfilled by three millimeters, nine were filled to within one millimeter of the radiographic apex, and nine

were grossly overfilled. Periapical healing was least successful in the over-filled canals. There was no significant histological difference between specimens observed at 17 weeks and those observed at one year. In some cases, the unfilled space in those canals filled three millimeters short of the radiographic apex became filled with viable tissue in the form of a complete and functional attachment apparatus which was continuous with the periodontium. This study demonstrates that properly cleaned root canals do not contain unhealthy or diseased periapical tissue and are not sites of focal infection. It further suggests that the body may tolerate quite well the presence of a hollow-tube in the form of an unfilled portion of a root canal.

6. Baumgartner JC, Hegggers JP, and Harrison JW. Incidence of bacteremias related to endodontic procedures: I. Nonsurgical endodontics. J Endod 2: 399-402, 1976.

Previous studies relating the incidence of bacteremias to endodontic manipulation either failed to use an aseptic technique or used inadequate microbiological techniques. The purpose of this study was to determine the incidence of bacteremias produced by various endodontic manipulations as used in modern endodontic therapy.

Blood samples were collected from 30 patients arranged into five groups of six patients each. Group A was instrumentation short of the apex in teeth with vital pulps. Group B was instrumentation beyond the apex in teeth with a nonvital pulp. Group C was instrumentation short of the apex in teeth with a nonvital pulp. Group D was obturation of the root canal system in teeth that had vital pulps at the beginning of treatment. Group E was obturation of the root canal system in teeth that had nonvital pulps at the beginning of treatment. Two 20 ml blood samples were collected from each patient. One sample was collected before treatment and the second sample within five minutes of the most traumatic part of the endodontic procedure being evaluated. Each sample was divided into four aliquots of 4.5 ml of blood. Two aliquots were injected into two bottles of prereduced tryptic soy broth with 0.05% sodium polyanethol sulfonate (SPS) for aerobic incubation and two aliquots were injected into brain-heart infusion broth with 0.02% SPS for anaerobic incubation. Paper points were used to collect samples from the root canals and placed

into both aerobic and anaerobic media for incubation. For anaerobic incubation the cultures were placed in an anaerobic atmosphere. The bacteria isolated from blood was compared to the bacteria isolated from the respective root canal.

The pulp cavities were positive for the growth of bacteria in 20 of 30 cases. All pretreatment blood samples were negative for the growth of bacteria. Only one blood sample in the 30 cases (3%) was positive for the growth of bacteria. The single positive blood sample was collected after instrumentation beyond the apex of a tooth with a nonvital pulp. The same species of bacteria was isolated from both the root canal and the blood sample. Within the group of six teeth that were overinstrumented, one in six (16.6%) was associated with a detectable bacteremia.

Part II of this study used the same materials and methods to examine surgical procedures. All seven (100%) blood samples collected after simple tooth extraction had positive blood cultures. Five of six (83.3%) blood samples were positive following flap reflection. Two of six (33.3%) blood samples were positive following apical curettage. Within the parameters of this study, it was concluded that modern nonsurgical endodontic treatment produces a remarkable low incidence of bacteremia. When root canal instrumentation was confined to the root canal, no bacteremia was detected.

7. Ehrmann EH. Focal infection: The endodontic point of view.

Oral Surg 44: 628-634, 1977.

This is a review article that utilized the literature available up to the time of publication to argue that there is no medical or economic evidence to support the extraction of pulpless teeth. The author correctly cites the increased incidence of bacteremias from extraction compared to the overzealous root canal treatment without regard to standard aseptic technique (outside the present

standard of care). The successful use of endodontic treatment rather than tooth extraction for patients who have had head and neck radiation therapy or who have hemophilia, leukemia and anemia illustrated that root canal treatment was preferable to extraction. The increased cost of restoration of missing teeth when teeth are needlessly extracted was also vividly presented.

8. Torabinejad M, Theofilopoulos AN, Kettering JD, Bakland LK. Quantitation of circulating immune complexes, immunoglobulins G and M, and C3 complement component in patients with large periapical lesions. Oral Surg 55: 186-190, 1983.

The formation of immune complexes is usually a protective mechanism for neutralization and the eventual elimination of antigens such as bacteria, bacterial components and denatured pulp tissues. Occasionally, immune complexes may cause tissue injury at the site of their formation or at a distant site. The objective of this study was to measure serum concentration levels of circulating immune complexes, IgG and IgM, and C3 complement component in patients with one to three, ten millimeters by ten millimeters or larger, periapical lesions of pulpal origin and compare them to serum levels in patients with no periapical lesions and in patients with rheumatoid arthritis. The Raji cell assay test was used to measure circulating immune complexes in all three groups, and radio-immunodiffusion was used to measure serum levels of IgG, IgM, and C3 complement. All results were statistically analyzed and indicated that there was no significant difference in the level of circulating immune complexes between the group with periapical lesions and the group without. As expected, the rheumatoid arthritis group had a significantly higher level of

circulating immune complexes than the other two groups. There was no significant difference in the levels of circulating IgG and IgM between all three groups while there was a significantly lower level of C3 complement component in the rheumatoid arthritis group than the other two groups. The lack of difference between levels of immune complexes in patients with periapical lesions and those without may indicate either an absence of detectable immune complexes in chronic periapical lesions or a rapid clearance of formed immune complexes by the phagocytic system of the host. The lack of significant difference in C3 levels between patients with lesions and those without indicate that immune complexes formed in chronic periapical lesions are confined to the lesions and do not enter into the systemic circulation or, if they do, the amount in the circulation is so minimal that it does not result in a detectable change in the level of the C3 complement component. The results of this study indicate that chronic periapical lesions cannot act as a focus to cause systemic diseases via immune complexes.

9. Benatti O, Valdrighi L, Biral RR, and Pupo J. A histological study of the effect of diameter enlargement of the apical portion of the root canal. J Endod 11:428-434, 1985.

This was a well controlled study involving 134 root canals performed in teeth of 13 mongrel dogs. All teeth were instrumented two millimeters beyond the radiographic apex and then filled one to three millimeters short of the foramen (as confirmed by radiographs) with Endomethasone sealer and a single cone of gutta-percha. The animals were sacrificed from three to 120 days, and all specimens were retrieved and processed for histological evaluation. Acute inflam-

mation was observed in all specimens at three days while cemental growth and repair was observed as early as 30 days. By 120 days inflammation was absent, and complete coverage and repair of the root canal filling was observed. The results illustrated that even with less than optimal conventional root canal treatment, inflammation will resolve, and repair of the apical foramen will occur after the root canal procedure.