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Basic Concepts of Endodontics*

I. B. Bender, D.D.S., Philadelphia, Pennsylvania

[Editor's Note: *The author was graduated from the School of Dentistry, University of Pennsylvania in 1930, where at the present time he is Assistant Professor in Oral Medicine. He is also Senior Attending Dental Physician at the Albert Einstein Medical Center (Eastern Division) and Instructor in Oral Surgery, Graduate School of Medicine, University of Pennsylvania.*

Dr. Bender has been awarded numerous grants for research to study the problem of post-extraction bacteremia and its relationship to heart disease. He is the author of over thirty articles dealing with problems in oral medicine. He is a member of the honorary society of Sigma Xi, American Association of Bacteriologists, American Association of Endodontists, New York Academy of Science, I.A.D.R., and A.A.A.S.]

The recent greater interest that has manifested itself in the field of endodontics could be attributed to:

(1) a better understanding of the focal phenomenon; (2) a greater appreciation of the basic concepts in endodontics; (3) the application of antibiotics in the sterilization of the root canal.



Dr. Bender

The problem of focal infection has been extensively reviewed by Easlick and his associates and Grossman. The term *focal infection* denotes a secondary

or metastatic lesion derived from a primary focus of infection. It should be

stressed that a primary infectious lesion must be present before a secondary focus of infection can develop, e.g., subacute bacterial endocarditis. Briefly, the following factors must be present before a secondary or metastatic lesion can develop: (1) a primary lesion; (2) bacteria must be present in the primary lesion; (3) trauma must be introduced to disseminate the bacteria into the circulation; (4) the trauma must be great enough to produce hemorrhage so that the organisms can gain entry into the circulation; (5) a secondary or a distant lesion must be present so that the bacteria can localize themselves, as in a diseased heart valve, damaged kidney or other body tissues that have developed lesions through various organic diseases.

If any of the above factors are not present, it is inconceivable that a secondary focus can develop. While it is true that some of the bacteria may get through on a diapedetic basis, the defense

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mechanism of the body, namely the phagocytes, would destroy the organisms quickly and prevent the dissemination of the bacteria. Bacteria can only break through the defense barrier of the body if there is a heavy influx of organisms and this can only occur if hemorrhage has taken place.

A tooth with an area of rarefaction that has been properly treated, showing evidence of repair with normal reossification, should not be considered as a primary focus of infection.

The basic fundamental concepts of endodontics should be reviewed so that a greater degree of success could be achieved by the profession at large. It is by understanding these problems, not the mastering of new technics, that we will improve our results.

The concept in treatment requires the following three basic fundamentals: (1) surgically clean technic with the use of the rubber dam; (2) mechanical cleansing, and (3) mechanical seal of the root canal.

The rubber dam is used to preserve a surgically clean technic and is expedient to facilitate the operation with more speed. The term *surgically clean* is suggested instead of *aseptic technic* because it is more descriptive of the procedures as used in root canal therapy. In the true sense of the word, the procedures as used are not aseptic. In an aseptic technic, gauze masks and rubber gloves would have to be used. Such a technic is advocated by Nygaard Ostby of Norway. The term *surgically clean technic* is more in keeping with the armamentarium utilized in practice by most endodontists.

The rubber dam not only helps to maintain a surgically clean field but also aids in the prevention of accidental dropping of small instruments in the mouth, particularly when working in the molar area. This is attested by the fact that bronchoscopists are occasionally called upon to remove root canal instruments that have lodged in the bronchi. All instruments that enter the root canal should be sterile especially in dealing with cases of vital pulp extirpation.

The second basic fundamental in treatment requires debridement and enlargement of the root canal. This serves three purposes: (1) it cleanses the canal of any organic tissue; (2) more antibiotic or germicide can be sealed within the canal; and (3) a larger canal can more easily be filled.

The mechanical cleansing of the root canal by means of reamers and files is the most important fundamental step in achieving success in endodontics. The enlargement not only serves for good debridement but also removes the organic tissue upon which bacteria could multiply. Besides removing the superficial layers of infected dentine, it also removes the chemical breakdown products or protein degradation which can act as an irritant like bacteria. The chemical irritation can produce an area of rarefaction at the apex just the same as bacterial irritation. It has been demonstrated in many cases exhibiting areas of rarefaction, cultures taken from canals of such teeth are sterile in 20% of the cases.

Menkin has shown that inflammatory reactions take place just as readily from chemical as from bacterial irritations. Areas of rarefaction in the apical region can be produced by bacterial, chemical or mechanical irritants. Bone and the surrounding periapical tissue cannot distinguish the nature of the irritant and its reaction to the injury is the same. Therefore, the philosophy of treatment requires not only removal of bacteria but also chemical irritants without traumatizing the apical tissue.

Areas of rarefaction are often observed in teeth having silicate restorations even though there is no exposure or underlying decay. In these instances, the pulp has degenerated from massive pulpal hemorrhage and many times the cultures are negative. The areas of rarefaction are due to the chemical irritation from the degradation of the pulp tissue and/or from the silicate cement. A similar observation can be seen in cases giving a history of a blow or fall. In these we see a tooth that has no caries or previous filling. The blow was sufficient to interfere with

the blood circulation of the pulp and an area developed that is usually detected by routine x-ray examination. These are examples of chemical irritation producing areas of rarefaction. Seldom do they develop acute flare-ups as is usually observed in cases of bacterial irritation. If there is an acute flare-up with infection, the infection may have occurred through the hematogenous route.

In these cases the debridement or the mechanical cleansing of the root canal would be sufficient to produce repair, since the etiological factor has been removed. In such cases, sterilization by antibiotics or germicides is not necessary. Whether sterilization is or is not necessary can be determined by taking a preoperative culture. We have observed in a series of over 800 cases of various diagnoses that cultures are preoperatively negative in about 40 per cent of the cases. This checks well with the findings of Ostrander and Crowley. In a study on a small number of cases (36), the mere mechanical cleansing and enlargement had rendered 20 per cent of the cases sterile that were preoperatively positive. Cases that are preoperatively negative are filled at the second visit provided there is no pain or excessive seepage of intercellular fluid.

As a result of these findings one questions the unusual importance attached to the role of sterilization. It is important, however, to bear in mind that sterilization will aid in the elimination of organisms in the positive cases much faster. Also, that many of these negative cases may be false negatives. The use of a sterilizing agent can prevent complications of infection such as pain and swelling. Pain may also ensue mechanical instrumentation of reaming, filling or overfilling, particularly in cases of vital pulp extirpation.

In order to prevent pain as a result of mechanical instrumentation, the operator should confine his instruments within the root canal. This is best obtained by determining the length of the root canal preoperatively. X-rays do not always give the true length of the tooth.

The true length is best determined in the following manner: place a root canal silver point on the tooth to be operated upon by tacking with sticky wax on the labial surface of tooth. An x-ray is taken and measurements are compared on film with the known true length of silver point. If measurements are the same, then the x-ray reveals the true length of the tooth. If the silver point is shorter on x-ray then it is foreshortened; if it is longer, the picture is elongated. The percentage of foreshortening or elongation can then be determined. Another method is that of direct proportions expressed in the following manner:

$$\frac{TLS - TLT}{FLS - FLT}$$

TL — true length
 FL — false length
 S — silver point
 T — tooth

The true length of silver point is to the false length of silver point, as measured on x-ray, as true length of tooth (expressed as x) is to the false length of tooth, as measured on x-ray. Then by solving for x the true length of tooth can be determined. A hypothetical example is illustrated in the following manner: suppose the length of silver point when measured is 20 mm. When measured on x-ray the silver point is 22 mm. That means there is a ten per cent elongation. Therefore, if the tooth measures 25 mm. on the x-ray, its true length is 22.5 mm. Or by the formula of direct proportions it can be ex-

pressed as $\frac{20}{22} = \frac{x}{25}$ by cross multiplication

$x = 22.7$ mm. Either method can be used. This procedure is recommended for all single-rooted teeth. As a matter of caution, one millimeter is subtracted because the apical opening is not always at the extreme tip of the tooth. Many apical openings are on the side of lingual aspect of the root end. In this manner all instruments entering the root canal are predetermined as to their length by

placing rubber dam stops at the determined length.

If one attempts to instrumentate or fill beyond the apex, especially in cases of vital extirpation, complications of pain may ensue. In a number of instances an area of rarefaction or slight apical thickening can be observed after treatment. This is an example of mechanical irritation. In most cases this thickening resolves itself; in a few, resection or extraction has to be resorted to.

All instruments to be used are measured by determining the length with the use of a small piece of rubber dam as a stopper. A smooth broach of fine or medium size is introduced to explore and determine the patency of the canal. A measured barbed broach that fits loosely is introduced to remove organic tissue. The barbs on the broach are at 45 degree angles and if a large broach is introduced into the canal it could gain entry because the barbs can be compressed. However, on removal, the barbs would be caught against the walls of the canal in a reverse angle and therefore the instrument might break. The instrument should be free in the canal to prevent the complication of breakage. It should be inserted and withdrawn a little at a time to make sure that the instrument can negotiate the canal without binding.

Reaming and filing of the canal are best obtained by starting with the smallest number reamer that would fit the canal. A corresponding file number is then introduced and the canal is planed, using a downward stroke for the upper and an upward stroke for the lower teeth, in four directions, mesial, distal, lingual and labial surfaces. The next larger number instrument is then introduced and the procedure is repeated with reamer and file. The reamer is used to make room for the file. The reamer can either be used with a twirling motion or a half turn with a pull stroke. After two sizes of instruments are used the barbed broach is introduced to loosen the dental shavings that might pack in the canal. Proceed with the next size and again repeat procedure of enlarging with reamer,

planing with file and loosening the debris with barbed broach. No matter how wide the canal is at the start, it should be made wider to make certain that all the organic debris and tissue are removed. Do not skip sizes of instruments, follow the numbers in sequence, otherwise a ledge is created which is difficult to eliminate.

Irrigation with chlorinated soda and peroxide or superoxol 30 per cent is recommended in septic or discolored canals. In cases of vital extirpation, the canals can be irrigated with sterile saline or peroxide solution.

The mechanical enlargement of the canals not only serves to eliminate the debris but also reduces the length of the accessory canals, thus increasing the probability of sealing the canals. At this point the canal is dried with paper points and great care should be exercised not to force these points against any vital tissue. Mechanical irritation of the apical tissue should be kept to a minimum by measuring the paper points.

A combination of antibiotics suspension and fungicide is then sealed in the root canal. The mixture of antibiotics and fungicide is prepared in the following manner: 200 mg. each of streptomycin (chloride), chloramphenicol (chloromycetin) and sodium caprylate are placed in a sterile mortar. These powders are well triturated for 10-15 minutes. To this is added a commercially available 1 ml aqueous suspension of 300,000 units of procaine penicillin G. The entire mass is triturated again with a sterile pestle until a homogeneous mass is obtained. The suspension is then transferred with a small sterile spatula to a sterile discharged procaine carpule from which one of the rubber plungers has been removed. The paste is tapped or vibrated into the carpule. The rubber plunger is then replaced and the carpule is inserted into a standard procaine syringe. A blunt needle, such as used in discharging hydrocolloid, is attached to the syringe. The antibiotic paste is applied to the root canal by ejecting into the canal. Replace stilette in needle after use. Reamers or files are then used to bring the mate-

rial into intimate contact with the walls of the canal. In order to exercise a germicidal action, the suspension must be brought in contact with the organism. A blunt paper point is then placed in the canal to further compress the medication against the walls of the canal. This is sealed with gutta percha and cement and the patient is dismissed for seven days. This combination of antibiotics and fungicide has been proved to be stable and effective for local use for at least one year at room temperature.

After using the foregoing combination in over 1000 cases, we have not experienced any pain or untoward reactions. One case, however, did manifest a sensitivity reaction in a patient known to be sensitive to penicillin. For those patients and dentists that are penicillin sensitive, the following formula is recommended: one gram of streptomycin, one gram of chloramphenicol and 500 mg. sodium caprylate added to two ml of propylene glycol. This is prepared and used in the same manner as described above.

While many may raise the point that the combination of antibiotics does not have a tremendous advantage over the standard germicides, it does have one particular advantage. It kills the organisms without irritating normal or inflammatory tissue. If we are going to exercise care not to injure the tissue either mechanically or chemically, then the antibiotic does have an advantage over the standard germicide in that there is no chemical injury.

Erich's dream of killing the organism without injuring the tissue cell has finally come to fruition. Not to take advantage of such a drug is to deny the philosophy of accepted procedure of tissue sterilization.

Another advantage that antibiotics have is their penetrability. It has been shown that penicillin and streptomycin will penetrate fibrin while sulfonamides or other drugs will not. Recently Turkenkopf has shown marked diffusibility of the polyantibiotic mixture of Grossman when sealed within the confines of the root canal.

Our clinical investigations show that there is a more rapid sterilization of the infected root canals with antibiotic therapy than with standard germicides. With the use of the antibiotics we are able to start treatment of acute conditions at the first sitting and seal the canal. It has been our experience that within four to eight hours the acute symptoms subside. This we were not able to do with the use of germicides, namely cresatin, azochloramide, monochlorophenol or beechwood creosote. Treatment usually required the establishment of drainage by allowing the root canal to be opened. After the acute swelling would subside, then a germicide was sealed, thereby losing time. In many instances, even then, flare-ups would occur and drainage had to be reestablished all over again. By then both the dentist and the patient became disgusted with the result and the tooth was subjected to the treatment of tincture of cold steel, namely extraction.

Even though if it is conceded that the antibiotics do not sterilize more rapidly than the germicides, although we think that they do, they still have the advantage of not injuring the vital tissue cells. It is for this reason that we feel that healing manifests itself more rapidly. It is our clinical impression that healing takes place more rapidly because there aren't as many destroyed cells that have to be removed before healing takes place. Also because of the antimicrobial activity in the presence of fibrous tissue, the organisms that are present in the periapical tissue are readily destroyed and thus healing takes place rapidly.

Cases manifesting large areas of rarefaction in molar and anterior teeth have exhibited signs of complete reossification with restoration of a normal lamina dura in a matter of a few months with the use of antibiotics. In many instances signs of repair would manifest themselves at the end of the first or second treatment. With the use of standard germicides, signs of healing would not manifest themselves until months after treatment. On

(Continued on page 24)

BASIC CONCEPTS OF ENDODONTICS

(Continued from page 9)

many occasions, the areas would appear larger after treatment was completed. This was looked upon as a normal finding. A series of check-up x-rays would reveal slow progressive filling in of bone. It was not unusual to find complete repair 18 months to two years later.

We have observed that large areas of rarefaction repair just as rapidly or even more quickly under antibiotic therapy than apical curettage or resection. Seldom do we resort to apical surgery, unless the case must be finished in one sitting. Our criteria of apical surgery is that after conservative treatment, if the area does not show a reduction in size within two weeks or one month, surgery is performed.

If the tooth does not manifest any pain or discomfort and is ready to be filled, if a culture is negative, the canal is mechanically sealed with a root canal cement followed by a hard core of gutta percha or silver point.

At the present time, there is considerable controversy as to the relative merits of the use of the culture technic. Our opinion is that it is the only laboratory test that endodontists have at their command to determine whether sterility has been accomplished or if a particular technic is sterile. It is the only method that we have that can measure the comparative effectiveness of various medicaments.

From a clinical standpoint, particularly when one uses antibiotics, one or two sterilization treatments will give a negative culture in 98 per cent of the cases. So, that if a culture technic is not used, it is fairly safe that reinfection will not occur, especially if one is sure that the canal can be hermetically sealed at the apex. However, as Grossman states, not all of us can be certain that the canal is hermetically sealed. Therefore, there is a likelihood of reinfection in a small number of cases. This has been borne out by a number of cases that have demonstrated positive cultures upon re-treatment. In these instances, the areas of

rarefaction failed to heal or areas developed after treatment. Resterilization and refilling produced prompt healing.

The positive culture is more significant than the negative. A positive finding indicates that the canal has not been sterilized, while a negative culture does not necessarily mean that the canal is absolutely sterile. It is an indication that the number of bacteria are reduced to the point where the body can cope with the smaller number of organisms if they should be present. The positive culture is therefore more symbolic. It guides us as to when not to fill the canal.

An analogy can be drawn upon electrocardiographic findings. A negative electrocardiogram does not necessarily mean that a patient is free of coronary disease, especially if there is clinical evidence. A positive finding is a definite indication that cardiac disease is present. It only tells 50 per cent of the story. The same is true of the root canal culture.

While it is a fact that organisms can gain entry either by a leak in the seal or air contamination after a negative culture, it must be borne in mind that the mere presence of an organism does not constitute an infection. Dentine is very difficult to infect, especially when dry.

Clinicians who do not use the culture technic expose themselves to the criticism that they are not giving their patients maximum protection. The good results that they achieve without the use of the culture technic is based on the following facts: (1) by chance the canals are sterile to begin with; (2) with the use of antibiotics or germicides, sterilization has been accomplished in one or two treatments; and (3) they can mechanically seal the root canal.

In cases of history of rheumatic heart disease, cultures should be taken before and after sterilization treatment. In such cases, two successive negative cultures prior to filling are imperative. In routine cases, however, one negative culture is sufficient.

The canal can be filled if the tooth is clinically receptive, i.e., no pain or swelling and the culture is negative. If pain,

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swelling or marked exudate is present, under such conditions the canal should not be filled even though the culture may be negative. The clinical findings should be the guide corroborated by the laboratory findings as to when to fill the root canal.

Method of taking culture: The tooth is isolated under the rubber dam and the field of operation is swabbed with untinted tincture of metaphen followed by 70 per cent alcohol. This is dried by a blast of warm air and both solutions are reapplied and dried. The cement is removed from the tooth and the root canal exposed. The area is again sterilized twice and dried. A sterile barbed broach is used to remove the dressing from the root canal, if one is present. A fresh sterile point is inserted into the canal to cleanse the canal surface of any medicament and discarded. A paper point moistened with culture media is left in the canal at the apex for one minute. It is then transferred to a tube containing about 10 ml of brain heart infusion broth (Difco).

A strict aseptic technic should be followed in transferring the paper point to the tube containing the broth culture. The paper point should be suspended in the medium.

A more critical method of culturing is to seal the moistened paper point in the root canal for 48 hours. This would be a more accurate test of the bacteriologic condition of the canal. The usual one minute exposure may not pick up any organisms, whereas in 48 hours a more

critical sampling of the exudate is possible.

Cultures should be allowed to incubate for seven days at 37° C. This is especially so if antibiotics are used as a means of sterilization so that it may neutralize any bacteriostatic effect if any trace of the antibiotics was carried over by the paper point.

Recent studies by Dr. Seltzer and myself have demonstrated that there is a 13 per cent margin of error in our culture technic because there are no known inactivators for chloramphenicol.

The canal may be filled by any accepted method, either by overfilling with the resorbable paste as recommended by Castagnola or the method of Mygaard-Ostby, Grossman, Sommers, et al. No matter what the method may be, a hard core of gutta perchas or silver point should be used in conjunction with the cements.

In cases of vital pulp extirpation, the canals should be underfilled to 1-2 mm. irrespective of what method is used.

The eradication of the irritation, be it bacterial, chemical or mechanical, will produce repair with manifestation of bone regeneration as exemplified by the x-ray. If the irritation has not been eliminated, healing will not take place.

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