

THE DIAGNOSIS AND TREATMENT OF CONDITIONS RESULTING FROM DISEASED DENTAL PULPS.

By Edgar D. Coolidge, D. D. S., Chicago, Ill.

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THE conditions to be considered for pulp treatment begin with the vital healthy pulp which is removed to allow the tooth or root to be used for some mechanical anchorage of operative or prosthetic construction. While the importance of the vitality of the pulp is recognized today as never before, the time has not yet come when all patients can be given the best treatment when they present for dental service, without an occasional vital pulp removal. Such cases should be handled with the greatest care to protect the periapical tissue from injury and to leave the root in such a condition that no future disturbance will occur from unclean materials used or imperfect results. Whatever may be expected of the profession of dentistry in the treatment of the pulp will certainly be looked for in cases having the most favorable history; and unless the best methods of operating at the present time in such cases do not produce a very high percentage of success, we must change those methods or discontinue removing vital pulps of teeth for any purpose whatsoever.

In examining the radiographic records of root-canal fillings inserted in the past, we are able to get a fairly accurate perspective of the status of these operations as a basis upon which to build our future work. When examining radiographs of root-canal fillings inserted in the past, we must take into consideration

that there was scarcely ever any use made of the radiograph to assist the dentist to fill the canals completely, and, therefore, a very large percentage of all fillings are imperfect or poor fillings. Another factor of great importance to be considered is that less attention was paid to the necessity of surgical cleanliness than is paid at the present time, and consequently a much larger percentage of abscesses would result from such operations than from similar operations carried on under aseptic conditions. Dr. Arthur D. Black (1) reports radiographic examinations of over 1,500 fillings, which he separates into two classes, showing good fillings in large and small canals, and poor fillings in large and small canals. Of the good root fillings in large and small canals about 9 per cent showed abscessed conditions about the apices, while poor root fillings in large and small canals showed about 63 per cent abscessed conditions. This statement is encouraging to the careful operator. If in the past, without the advantages of equipment and methods of operating now used, it was possible to produce over 90 per cent of success where good root-canal fillings were inserted, it looks as if a reasonable conclusion might be made that by making all good fillings under aseptic conditions, the difficulties of this problem would be to a very large extent solved.

THE DISEASES OF THE DENTAL PULP.

The diseases of the vital dental pulp as recognized today are hyperemia and inflammation. "Hyperemia of the pulp consists essentially in the expansion of the blood vessels, principally the arteries, during any sudden abnormal blood pressure." (2) The recognition of this condition is important from the standpoint of preventive treatment, for usually, by prompt attention to the tooth, further development of the disease can be avoided and the tooth pulp restored to normal condition. The step from hyperemia to normal or to further and more serious disease—namely, inflammation—is very slight. It is very difficult to determine at just what point hyperemia becomes an inflammatory condition. Dr. G. V. Black stated (2) in his work upon this subject that "the result of inflammation of the pulp in the tooth of an adult is practically always the death of the pulp." It is important to recognize and correct this condition to prevent further progress of this disease. When the pulp is inflamed and the prognosis is very unfavorable, it is far better service to the patient to remove the pulp under aseptic conditions and completely fill the canal with gutta-percha than to leave the pulp to die and become infected before treatment is begun. Here, again, is important preventive dentistry, and the result should justify such a treatment.

DEAD PULPS.

The dead pulps which present for treatment may be infected or not infected. Where the pulp is dead without infection, the treatment involved is as simple as the one removed by anesthesia. The difficulty in this case is to be sure there is no infection present, and it is usually safe to assume that all dead pulps may be infected. When the pulp becomes infected, the dentin also becomes infected and the problem of overcoming that difficulty has never been satisfac-

torily solved. Much of the infected dentin in the canal can be removed by the process of curetting and filing while preparing the canal for filling, and certain antiseptics should be used to overcome as much of the infection in the dentin as possible. After careful mechanical and therapeutic treatment, the apical foramen should be sealed and the canal filled completely with a well condensed filling of gutta-percha, which should place the tooth in a reasonably safe condition for the future. However, the presence of collateral branches and multiple foramina, which are often found, contribute to the uncertainty of the future health of the investing membrane, and the tooth containing an infected pulp can never be considered as safe after treatment as one that has never been infected but had its pulp removed while vital.

PERIAPICAL TISSUE INVOLVEMENT.

It is difficult to know just when the periapical tissue is first involved with the diseased pulp. Many teeth have infected pulps without any evident involvement of the periapical tissue. The determination of such involvement is based on the evidence found in the radiograph except in cases where swellings or fistula or some visible evidence of periapical involvement occurs. The conditions involving the periapical tissue are abscesses, acute and chronic. The acute abscess does not as a rule involve a sufficient amount of tissue destruction to make the prognosis of the condition unfavorable. Usually after the evacuation of the pus and the removal of the cause—namely, the infection in the root canal—the condition will yield to treatment. The chronic abscess is of long standing, and there is always more or less tissue involvement in the periapical region. The radiograph shows a difference in the density, which appears as a darkened area in the negative. These darkened areas vary in extent from small

lines and shadows to large hollow cavities in the alveolar process, and contain pus or granuloma or are cyst cavities. Some of these absorptions include the peridental membrane and its attachment to the cementum, leaving a portion of the cementum denuded. The extent of the cementum denuded, which of course becomes infected and soaked with the pus in the cavity, has a great deal to do with the prognosis of the case. There may be absorptions of the root itself, leaving a roughened surface not only infected but such as would become a mechanical irritant in the tissue.

METHOD OF DIAGNOSIS.

In a complete examination and diagnosis of a case it is well to record all the information obtainable regarding both the local and general conditions of the patient. The first examination should be made by observation of missing teeth, crowns, bridges, large fillings under which it is considered doubtful if a normal condition of the pulp exists, and by recording the same. By transillumination or examination with the mouth lamp all teeth not reflecting a normal color should be recorded. While these methods of examination will detect almost every tooth under suspicion, the examination is not complete. By percussion and palpitation, by tapping tooth after tooth with an instrument, and by feeling along the buccal and labial surface of the alveolar process on the gum directly over the root, any inflammation of the peridental membrane or swelling or soreness may usually be detected, and also the dullness of sound of the pulpless tooth may often be detected by percussion and thus recorded. By either faradic or galvanic current the condition of the pulp can be determined to a certain extent, and at least the vital pulps of normal condition can be distinguished from the dead pulps, and a further record of the teeth under suspicion can be made. In the vitality test by the electric current

one should first establish as near as possible the normal amount of current required to produce irritation and response, and pass from tooth to tooth, recording as doubtful such teeth as do not respond to the same amount of current. Where crowns or very large metal fillings are present, the electric current is not reliable, since the conductivity of metals is so rapid that irritation would be produced thru the peridental membrane and the same response would be evident as with vital pulp. The irritation point of the inflamed pulp will be lower, and of the pulp undergoing supuration it will be higher, while dead pulps will not respond at all. Absolute dependence cannot be placed on any of the above mentioned methods of diagnosis, but by a careful application of all these methods one should arrive at a fairly accurate distinction between the vital and dead pulps and record other irregularities of pulp conditions suspected.

The record of irregularities of occlusion and alignment of the teeth should be included at this time as well as the general condition of the teeth as to their susceptibility to and the presence of decay. It should also include a record of the condition of the gingiva and gums and of the depth of detachments of the peridental membrane in the subgingival space—that is, the depth of all pockets usually spoken of as pyorrhea pockets—since the prognosis of the case is dependent upon every condition present within the oral cavity. When this record is complete, there is much valuable data upon which to base the recommendation for treatment after the diagnosis.

The general remarks and history of the case should be recorded. Pathological conditions, if present or recent, should be recorded as: enlarged joints, painful joints or muscle pains, local inflammations of the eyes, nose, throat, or tonsils, such general conditions as anemia, nervousness or fatigue, and organic

disturbances, such as appendicitis, gastric ulcer, gall bladder trouble, or any other condition that might arise from or be affected by local infections in the oral cavity. In many cases even a blood count should be made and blood pressure recorded. Often patients suffering from conditions arising from focal infections have had a complete physical examination, and the physician will usually gladly cooperate with the dentist, and a better perspective of the case can be obtained by such consultation and exchange of examination records.

A complete radiographic record of the mouth is an indispensable asset before the diagnosis is complete. Many of the conditions recorded from the examination thus far will be verified by radiograph. Record of all root-canal fillings can be made showing those which are in a condition to be accepted without treatment and those which must be replaced. Periapical conditions should be recorded as shown by the radiograph. Teeth over which occur darkened areas, rarified areas, and small absorptions may be considered for treatment, and those showing large absorptions, denuded areas of cementum, and large absorptions involving alveolar process and supporting tissue should be considered as beyond treatment in most cases. Many times a darkened area will be found on a radiograph negative directly over the apex of a root involving the periapical tissue. Should the vitality tests indicate a vital pulp, such an area should not be considered as direct evidence of a pathological condition. As a check upon such opposing evidence, it is advisable further to investigate the condition by making a thermal test or by repeating the first tests or in some instances even by resorting to drilling into the tooth to determine the exact condition present. The recognition of such areas depends upon the amount of absorption found by radiograph, as absorption follows the infection which develops within the root-canal

in the decomposed pulp tissue. *The dead and infected pulp may be a decided menace to the health of a patient before the area of absorption appears to attract the attention of the diagnostician, and therefore, the radiograph should not be relied upon entirely to locate such conditions nor should the involvement of the periapical tissue be determined entirely by the same means.* The histology of the cementum shows that, when suppurative conditions exist, reattachment of the periodontal membrane cannot be expected, and it is not good practice to carry such cases along under treatment for an indefinite period. There are some cases which show definite absorbed areas which extend into the alveolar process without destroying much of the attachment of the tissue to the cementum. Where there is any evidence that the amount of cementum denuded is small, treatment may be given, and gratifying results will usually follow. However, the case should be kept under close observation for an indefinite period.

THE PROGNOSIS.

The prognosis of the case should be based upon the summing up of all conditions recorded together with a consideration of the mechanical requirements for reconstructing and restoring the organs of mastication for safety to health, comfort, and usefulness of function.

The general condition of the patient's health has much to do with the prognosis as well as the local condition of each tooth. More radical treatment should be employed where systemic disturbances are present than where such conditions do not exist. The mental attitude of the patient toward dental operations and the physical ability for endurance of prolonged treatment must be considered as another great factor in the prognosis. The duration of a diseased condition is of some importance, as there is more or less complication attending conditions of long standing and the prognosis of a case

is more favorable when taken early. One should consider the accessibility of the tooth to the operation of treatment and filling of the root and to the operation of root resection where indicated. Resection of the root of single-rooted teeth, and occasionally of one root of a multi-rooted tooth, may be considered where absorptions exist which denudes an amount of the cementum that would make the prognosis of the condition unfavorable without such treatment. A consideration of the value and importance of every tooth individually and to the whole masticatory apparatus as a unit should be given before entering upon a long and costly treatment; and such diseased teeth as can be removed without affecting the value and comfort of the mechanical substitute to replace them, the operator should remove rather than prolong the treatment of the entire case.

THE TREATMENT.

The moment treatment of a tooth is commenced, there is a certain responsibility that must be assumed by the operator. Where a healthy condition exists at the outset, his operations alone will be responsible for the health of the periapical tissue and to a large extent for the life of the tooth. Records of the past show the results of good operations and poor operations, and with the advantages of the present day over the past in the way of equipment, sterilization, and radiography, every conscientious operator should refuse to be satisfied with anything less than the most perfect result possible to be gained. One sometimes hears the statement made that the operator should not anticipate trouble in a tooth that has remained comfortable for years with an imperfect root filling. From such a hypothesis one might reason that, because a tooth has remained comfortable with an imperfect root filling, another will; hence, perfect root fillings are accidents, rather than

regular occurrences. *By such reasoning all progress would cease, and the root-canal situation would be a discredit to the profession.* Every operator must set as his standard only perfect root-canal fillings and not be satisfied with less than the very best result obtainable in every case.

PULP REMOVAL.

The safest method of pulp removal is by local anesthesia either by injection or by pressure. Pulp tissue removed by these methods need not be contaminated with irritating drugs, nor need the periapical tissue be injured from their effects. The use of arsenic trioxid should be discouraged. If arsenic were only used as an obtundent for making possible a painless exposure of the pulp, there would be very much less danger of injury to the periapical tissue. For this purpose it should never be left in a tooth over forty-eight hours and often only twenty-four hours. Drugs for use following pulp removal should be limited to the least irritating anodynes of the essential oils or their derivatives, preferably oil of cloves or eugenol. The root should be filled after pulp removal as soon as all the pulp tissue can be removed, the canal enlarged sufficiently to give access to the apical foramen, the canal dry, and no pericementitis present. This may be at the second sitting, or it may be necessary to extend the treatment over several sittings before the canal is ready for filling.

THE TREATMENT OF DEAD PULPS.

In the treatment of dead pulps the question of disinfection without injury to the periapical tissue is paramount. The mechanical cleaning and curettment during the process of enlargement is a very great factor in removing infectious organic matter and in scraping out the infected surface of the dentin surrounding the canal. Regardless of the condition of the periapical tissue, the process of disinfection is the same

and should be treated in the same manner. Highly irritating and caustic drugs should be used with the greatest of care, if used at all, and since results may be accomplished without their use, it is most advisable to resort to the less dangerous drugs. Formalin or any preparations containing it should never be allowed to come in contact with live tissue. Where the apical foramen of the canal is sealed by some substance which prevents contact of the drug with the periapical tissue, formalin may be used with a less degree of danger, but it should never be used for more than one treatment. Phenol is very destructive to the soft tissue, and if used at all, should be used with extreme care. After the canal has been thoroughly cleaned mechanically, there is less need of strong antiseptics. Beechwood creosote may be used without injury to the tissue and with entire satisfaction.

Chlorin has come into great use as an antiseptic and disinfectant for infected wounds. In the past the chlorin solutions proved too irritating to the tissue and too unstable in solution to be very widely used, but since the latter work of Dakin and Carrol and others on this subject we are given a solution that can be used to a considerable advantage in dentistry. The chlorin solutions were not found satisfactory for use in gangrenous root-canals until the advent of the solution called dichloramine-T. (4) This preparation is a yellow-white crystalline powder soluble in organic matter and oils but unstable in solution. It is recommended for use in a solution of chlorinated eucalyptol and paraffin oil or petrolatum. It yields chlorin slowly from the oily solution, and when sealed in a tooth for several days, will continually yield chlorin, which is recognized as one of the best antiseptics and disinfectants today. The action of this solution, which is toluene-sulphon-dichloramine, is based upon its high chlorin content linked to nitrogen. It does not precipi-

tate or coagulate albumen, but has a tendency to dry up the wound and produces a rapid and healthy granulation. This preparation has the highest recommendation by Dr. Herman Prinz for the treatment of gangrenous root-canals. It will be found to give satisfaction if used properly.

For several years chlorin liberated from a solution of sodium chloride by ionization has been recommended by Dr. M. L. Rhein and others. Dr. Prinz (3) states that "the process of electro-sterilization of infected root-canals as a means of establishing asepsis is an advanced step in dental therapeutics, and is deserving of earnest consideration by the clinical practitioner."

In cases where there are absorptions about the apex of the root, there is frequently found to be considerable discharge or draining of liquid into the canal from the area. The discharge can be controlled by forcing tincture of iodine thru the foramen. Equal parts of beechwood creosote and tincture of iodine may be sealed into the canal in very moist dressings. No fear need be felt that the iodine will discolor the tooth, for experience will soon convince one that it does not and the result will be very gratifying.

BACTERIOLOGY.

In all infected cases the operator should verify his clinical judgment of having obtained asepsis, by taking a culture from the canal. A canal saturated with any antiseptic will not give a fair test. It is necessary to wash the canal out thoroughly with alcohol, followed by sterile water, absorb the water away, and then seal into the canal a dry bit of cotton or absorbent paper point very thoroughly to prevent any contamination from the outside. This should remain from 24 to 48 hours and then be removed carefully; a smear should be examined under the microscope and a culture made, to see if the canal is free from bacteria. It must be remembered that it is impos-

sible completely to sterilize all the dentin, but the inner exposed area can be freed from bacteria after mechanical cleaning and treatment and then the canal should be thoroly filled with gutta-percha.

FOLLOWING UP.

The case should be recorded with all the data concerning each tooth in regard to condition presenting, treatment used, method of filling, and radiographs. At intervals the patient should be sent for and radiographs made to show the progress of the recovery as well as to insure the patient against any further development of trouble at the root end. If operators will adopt some uniform method of recording and following up, it will be of inestimable value to the progress of this line of work.

The problems involved in the treatment and filling of root-canals are both mechanical and bacteriological. Perfect mechanical filling, after careful treatment with antiseptics which will not injure the periapical tissue, will show very gratifying results and I feel confident that the future will reveal a very large percentage of success in all cases so handled. The natural tooth is not to be compared with an artificial substitute for comfort and usefulness when it can be saved without jeopardizing the patient's health; and by following these cases along by means of radiograph for a few years and recording the condition about the root end, we shall soon be able to state with more clinical proof that such treatment is successful.

REFERENCE.

1. Journal of American Medical Association, October, 1918.
2. Special Dental Pathology.—Black.
3. Dental Materia Med. and Therapeutics.—Prinz.
4. American Journal of Clinical Medicine, September, 1918.

DISCUSSION.

John E. Nyman: Whether or not to allow a pulp to remain, is often a perplexing question, but if the continued

vitality of the pulp is dubious, it is wiser to devitalize and fill the canals under aseptic conditions.

Altho the radiographic examinations shown by the essayist are encouraging, it must be remembered that radiographic evidence is not final. I cannot help feeling that the conclusions drawn by the essayist are optimistic conjectures rather than certainties. Frequently, coincident with the destruction of the cancellous bone structure will proceed a sclerosis of the cortical region which gives sufficient radiopacity to conceal full evidence of an infected cavity behind. On the other hand, radiographs may seem to show but a partial root filling, where as opening up the canals shows them apparently filled to the apex. The explanation in some cases is that the foramen is located, not at the apex, but on the side of the root, as far as 2 mm. from the apex, and that this abnormal location, when on the labial, buccal or lingual side, is not betrayed in the radiograph.

Results obtained by the use of the faradic or galvanic current must be controlled by radiographic evidence, for occasionally we find, in teeth with multiple roots, that one root will be devitalized while the other is vital. I have found that viewing the film in front of a strong light, thru reversed opera glasses, brings out the infected areas more distinctly.

For pulp removal, I prefer regional and pressure anesthesia for immediate removal, and for gradual pulp extirpation the use of arsenic paste, in the manner advised by the essayist, followed by pressure anesthesia after counteracting any free arsenic trioxid that may be left. No useful drug should, I think, be condemned because careless or injudicious use makes it dangerous.

Diseased pulps give rise to our greatest problems. Whatever the evidence given by the radiograph, we may be sure that when opening the pulp chamber re-