

Endodontics: A peep into the past and the future

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The author paints a picture of a half-century of endodontic practice: when diagnosis and treatment were done without benefit of an x-ray machine, when preparing an anesthetic solution was cumbersome and time consuming, when pulp was "killed" with arsenic but at times refused to die, when the 40-year-reign of the focal infection theory eliminated the teaching of endodontics at some schools or else limited treatment to anterior teeth at others. Today, the scope of endodontics has been broadened to include surgical endodontics, hemisection, intentional replantation of teeth, and endodontic implants. And the future looks promising for transplantation of natural teeth when subjected to tissue culture and for implantation of acrylic and ceramic teeth.

Endodontics as we know it today is of very recent development. In fact, its evolution is within the memory of most dental practitioners. There was a time, within the life-span of many of today's dentists, when endodontics was not practiced by a large number of dentists; nor was it taught at some dental schools. I hope that I may be excused if I make a few personal remarks and lead you to an appreciation of endodontics by way of the back door, the period when I first began to practice dentistry 50 years ago.

It will surprise some of you, and it may astound others, when I tell you that in 1923, when I graduated, many dentists practiced without an x-ray machine. In fact, in 1946, 27 years ago, it was estimated by the Ritter Company that 25 per cent of all dentists did not have x-ray machines. I shall have more to say about this later.

ANESTHESIA FOR PULPECTOMY

Arsenic was still used by many dentists for destroying the pulp before removing it. Some older patients, even today, are under the impression that the pulp has to be "killed" before it can be removed. The arsenic trioxide paste was

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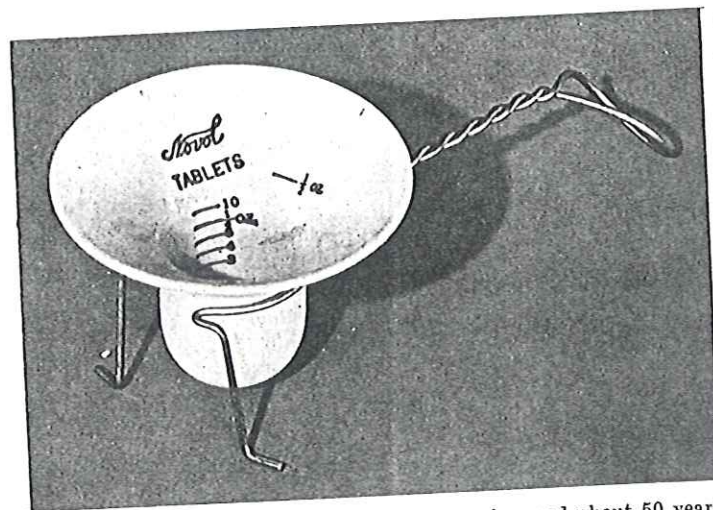


Fig. 1. Porcelain cup for dissolving tablets of Novocain, used about 50 years ago by most dentists in preparing an anesthetic solution for injection.

sealed in contact with an exposed pulp, or over a thin layer of dentin still covering the pulp, and left in situ for 3 or 4 days, or as long as a week, during which time the pulp was gradually destroyed—not entirely without pain in some cases. And, in a few cases where leakage around the temporary filling occurred, there was destruction and sloughing of the gingiva and the attachment apparatus with eventual loosening and loss of the tooth.

Pulps were also removed under pressure anesthesia. By this method, a pellet of Novocain was placed over the exposed pulp, a piece of unvulcanized rubber was placed over the pellet, and a flat-faced plugger or other instrument was forced against the rubber to jam the Novocain against and into the pulp. As the pellet dissolved, the pulp became anesthetized. A heroic method? Yes, it was heroic, but it worked—better than half the time. One wonders whether the nerves in the pulp became paralyzed from the trauma inflicted when it did work.

This method, however, was an improvement and not nearly so heroic as that used prior to the advent of Novocain, when a hickory peg sharpened to a point was thrust into the exposed pulp to macerate it quickly so that it could not conduct sensation.

Injection into the mucosa for pulp removal was not a popular method, because the method of preparing the Novocain solution was so cumbersome. This consisted of placing a Novocain tablet in a porcelain cup available especially for the purpose, adding the required amount of water, boiling the contents over a flame, and letting the solution cool before aspirating it into a syringe. Although a patent was issued for the Cook syringe in 1917, it was not used to any extent in the 1920's. A patent was reissued in 1927, and the breech-loading type of syringe first became popular in the 1930's.

Solutions of cocaine for injection were also available to the dental profession in the 1920's in the form of a 2-ounce bottle surmounted by a rubber cap. The

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cap was pierced by the needle of the syringe, and a suitable amount was removed and injected into the tissues. When a patient reaction occurred, one could not tell whether it was from the cocaine or from contamination as a result of repeated injections and aspirations through the rubber cap.

CHEMICAL AIDS

Highly irritating caustic chemicals, such as 50 per cent sulfuric acid, phenolsulfonic acid, and 20 per cent hydrochloric acid, were used as adjuncts in enlarging root canals. A combination of pure metallic sodium and potassium was advocated for destroying pulp remnants, especially in cases of putrescent pulps, and also for enlarging root canals. The metals combined with the organic part of dentin and made the inorganic portion more friable to the use of reamers and files. The heat generated when the sodium and potassium combined with moisture in the root canal was often great enough to incinerate the fine instrument which was used to convey the metals into the canal. At times a flash of fire could be seen in such cases where the sodium and potassium came into contact with considerable moisture in the canal.

Sodium dioxide, also hot stuff, was used in root canals for the same purpose, but it was not nearly so dramatic as the sodium-potassium alloy and was therefore not quite so popular. In regard to sodium dioxide, *Merck's Index*¹ states: "In contact with organic matter or readily oxidizable substances ignition and explosion may take place." Fortunately, I am not aware that such an accident ever occurred.

Before a medicament was applied in the root canal, the canal was dried with cotton swabs which were rolled between thumb and fingers on a three-sided broach and then sterilized in a molten metal sterilizer. At a meeting of the American Association of Endodontists in the 1940's, a dentist from Cincinnati gave a clinic on rolling threads of cotton rapidly on a broach attached to a miniature lathe. One must bear in mind that the American Association of Endodontists was organized only 30 years ago—within the lifetime of most of today's dentists.

INTRACANAL MEDICAMENTS

Medicaments for sterilizing the root canal were not much better than those for enlarging the canal, since they were highly irritating, and some were caustic. They were chiefly formocresol, phenol, camphorated chlorphenol, Campho-Phenique (a solution of camphor and phenol in liquid petrolatum), Black's 1,2,3, (oil of cassia 1, phenol 2, oil of wintergreen 3), eugenol, and some proprietary preparations. Later, Howe's ammoniated silver nitrate solution was introduced. Its propensity for staining teeth dark gray or black did not deter dentists from using it, because it was supposed to detoxify the toxic products elaborated by microorganisms in the root canal.

The so-called "ionization" method was used empirically for sterilizing root canals, and some dentists even today place much faith in the power of electricity. It was, however, a convincing method for both the dentist and the patient. When properly used and checked by culture, it is still a satisfactory method.

Pulp mummification (a method of embalming the pulp tissue instead of removing the pulp) was in vogue. It has its counterpart today in a medication and cement containing paraformaldehyde. The exposed pulp was first destroyed by arsenic, and then an antiseptic paste containing paraformaldehyde was sealed with cement over the dead pulp tissue. Later on, eruptions unexpectedly occurred, requiring removal of the mummified pulp or extraction of the tooth.

ROOT CANAL FILLINGS

Root canals often were filled with cotton moistened with creosote, trieresol-formalin, or an essential oil such as Black's 1,2,3, or oil of cinnamon or cassia. In other cases canals were filled with gutta-percha and a paste to which thymol-iodide was frequently added, or with a cement. Silver cones did not make their appearance in this country until the 1930's. The Callahan-Johnston method of filling root canals was popular in the southern part of the country, where Johnston taught. By this method, the root canal was filled with pure ethyl alcohol, and the alcohol was gradually replaced by chloroform until the canal contained only pure chloroform. Gutta-percha cones were successively introduced into the canal until the milky solution was gradually converted into a solid filling. Excess chloroform which diffused or was forced through the apical foramen often caused pain for several days. However, accessory canals were often filled by this method.

Surgical endodontics as we know it today was hardly ever practiced by the general practitioner, although some of the operations, such as hemisection, were described in the previous century. If a resection was needed, the patient was generally referred to an oral surgeon, but more often than not the tooth was extracted.

FOCAL INFECTION THEORY

The milieu for practicing endodontics 50 years ago was not very favorable. The dental profession had not yet recovered from the blow delivered by a physician in 1910. At that time Dr. William Hunter² gave a lecture in Montreal which rocked the foundations of the medical and dental professions. Dr. Hunter was not a dentist; yet what he said about dentistry at the time made front-page headlines. He accused the dental profession of contributing to ill health by the kind of dentistry practiced at the time, naming a long list of diseases which he attributed to oral sepsis from crowns, bridges, dentures, and dentistry in general. Dr. Hunter's attack on the dental profession was based primarily on emotional rather than scientific grounds. As a physician rather than a dentist, and as a resident of a country other than the United States, he certainly did not have much opportunity to observe and to judge American dentistry. Nevertheless, he vigorously attacked the American dental profession for contributing to, or causing, ill health of patients. Let me give you a few examples of what he said: "No one has probably had more reason than I have had to admire the sheer ingenuity and mechanical skill constantly displayed by the dental surgeon. And no one has had more reason to appreciate the ghastly tragedies of oral sepsis which his misplaced ingenuity so often carries in its train. 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 to which there is no parallel in the whole realm of medicine or surgery. The whole constitutes a perfect gold trap of sepsis." "I speak from experience. The worst cases of anemia, gastritis, colitis of all kinds and degrees, of obscure fever of unknown origin, of purpura, of nervous disturbances of all kinds ranging from mental depression to actual lesions of the cord, of chronic rheumatic affections, of kidney disease, are those which owe their origin to, or are gravely complicated by, the oral sepsis produced in private patients by these gold traps of sepsis." "The medical ill effects of this septic surgery are to be seen every day in those who are the victims of this gilded dentistry—in their dirty-gray, sallow, pale, wax-like complexions, and in their chronic dyspepsias, intestinal disorders, ill health, anemias and nervous ('neurotic') complaints from which they suffer. In no class of patients and in no country are these, in my observation, more common than among Americans and in America, the original home of this class of work."

The reaction to Dr. Hunter's indictment of the dental profession was the indiscriminate removal of teeth. I must digress here to point out that Hunter did not base his accusations on x-ray diagnosis, because the dental x-ray machine as we know it today was not yet available. In fact, according to Raper,³ there were fewer than a dozen x-ray coils in use by dentists in the entire United States. These were devices generally made by physicists and assembled from parts somewhat in the manner of early hi-fi sets of a decade or so ago.

In 1895 it took from 15 to 20 minutes' exposure time to obtain a radiograph of the teeth. It required just as much exposure time in 1910 when Hunter gave his talk, because the art had not progressed to any extent in the intervening years. There was some improvement in developing time, however, compared to the original time of a half-hour or more for developing a sensitized plate of film.

The first dental x-ray unit was adapted from a medical unit and was sold by the Victor X-ray Company in 1913, 3 years after Hunter's lecture. A regular x-ray machine as we know it today was not available to the dental profession until a year after the advent of the Coolidge tube in 1918.

In the 1920's there were "dental x-ray studios," often operated by a technician in the employ of a dentist. This was a convenience for dentists who did not have an x-ray machine and, as stated earlier in this article, about one fourth of the dental profession did not have x-ray machines.

Now let us return again to Hunter and observe the reaction of the medical and dental professions to his talk. Some members of the medical profession subconsciously seized upon Hunter's diatribe as a means of shifting the responsibility to the dental profession for those diseases and illnesses for which there was no available cure. It was easier to order the removal of teeth in the hope that the patient would be benefited than to determine the cause and develop a remedy. The result was wholesale extraction of teeth. In fact, some urged not only simple extraction but surgical removal. Burns⁴ stated: "No dead or devitalized teeth should ever be merely pulled. In every instance involving a dead tooth for whatever reason removal has been decided upon, surgical removal should be the method of choice."

FOCAL INFECTION THEORY REJECTED

One of those who sat astride the bandwagon advocating extraction of root-treated teeth was E. C. Rosenow of the Mayo Clinic. He injected rabbits with massive doses of microorganisms isolated from extracted teeth of patients with arthritis and claimed to have produced similar disease in a high percentage of cases in the animals. Later, in an assessment of Rosenow's experiments, Snyder⁵ stated: "Unfortunately the majority of bacteriologists have been unable to duplicate Rosenow's bacteriological and experimental results." He cited the experimental work of Menzer,⁶ Bull,⁷ and Swift and Kinsella,⁸ the latter being unable to find more than 8.3 per cent of positive blood cultures instead of the 75 per cent claimed by Rosenow following injection of alpha streptococci from rheumatic patients.

Not only teeth but tonsils, prostates, appendices, ovaries, and other expendable organs were sacrificed on the altar of the focal infection theory. With regard to tonsils, a physician⁹ stated: "During the short course of only one year, more than a million tonsillectomies were performed. . . . And now our present era is concerned with the general extraction of teeth. The term focal infection was formulated and already influences every medical thought and activity. The patient fears his own teeth, the physician points to the teeth and condemns them, and the dentist extracts the teeth on the least indication, all visualizing an imaginary enemy."

A large group of dentists who grew up during this period insisted that all pulpless teeth be removed regardless of whether the bone structure appeared normal or not, regardless of whether the teeth had been treated endodontally or not. They were known as "hundred percenters."

A few courageous voices were raised against the holocaust of wanton extraction. C. N. Johnson,¹⁰ who later became editor of the *Journal of the American Dental Association*, raised his voice in defense of root canal treatment. He wrote: "To sum up, pulpless teeth may be retained whenever they are amenable to successful treatment. Most pulpless teeth are amenable, and therefore most pulpless teeth may be retained."

The tide, however, did not begin to turn until about 20 or more years later. In the 1930's an editorial appeared in the *Dental Cosmos* which rejected the claims of Hunter and the focal infection theory and defended retention of pulpless teeth. To quote from the editorial¹¹: "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. Now let us turn from the destructive policy, the path of least resistance, to the constructive, even though it be beset with more difficulties, it certainly offers more possibilities of making the masticatory apparatus a useful and helpful organ rather than a crippled and constant menace to the welfare of the patient."

It took another 10 years or more before some dental schools had the focal infection theory in focus. A number of schools had blue-penciled endodontics from their curricula and, while they taught the diseases of the pulp, they did

not teach endodontic practice except in a desultory way. Treatment was limited to anterior teeth in the belief that it was too difficult to eliminate infection from posterior teeth.

In fact, in 1940, there appeared a book entitled *Death and Dentistry* by M. H. Fischer.¹² Let me quote two passages from the book. "There is but one future for the dead tooth—its extraction." "The following types of 'restorations' are wrong in principle and all destined for limbo: (1) full crowns, (2) pegged teeth, (3) swinging bridges, (4) fixed bridges, (5) jacket crowns, (6) half crowns."

RETURN TO ENDODONTIC TREATMENT

The pendulum swung slowly in the other direction, away from extraction and toward conservation, so that by the 1950's endodontic treatment had begun to be accepted by the medical profession and by a number of hard-nosed skeptics in the dental profession who had been opposed to it. In fact, even some "hundred percenters" recanted and began to treat anterior teeth.

It is not difficult to understand why there was so much opposition in recent years to approval of endodontics as a specialty of dentistry. It had to overcome opposition stretching through four decades. It was inevitable, however, that the much-maligned practice of endodontics would take its rightful place beside the other specialties of dentistry. Meanwhile, many advances have been made in endodontic practice through the years.

It may be difficult today to visualize a period in dental practice when radiographic diagnosis was not available. One had to do a lot of guessing as to whether or not an area of rarefaction was present, what the size and outline of the area was, what the length of the tooth was, whether the canal was patent or blocked, whether the canal was underfilled or overfilled, etc. We are still groping in the dark to some extent, but we can enjoy the blessings of radiographic diagnosis, which has not only taken much of the guesswork out of endodontic practice but has also simplified treatment and made endodontics a more exact science and art.

Biomechanical, rather than mechanical, instrumentation is practiced, with respect for the periapical tissues. Instrumentation is now simplified because of the availability of standardized instruments. Irrigation of the root canal serves several purposes not appreciated in the past when this modality was not practiced. An effort is made to use mild but effective medicaments today, instead of highly irritating agents. EDTA has replaced the acids, and tissue-tolerant medicaments have replaced some of the destructive, caustic agents of former times.

BACTERIOLOGIC CONTROL AND OBTURATION

One of the beneficial effects of the focal infection era was the reintroduction of emphasis on the need for bacteriologic control to determine whether microorganisms had been eliminated before obturation of the canal. This procedure gave credence to the scientific aspect of endodontic treatment and was accepted by the dental profession, just as a negative Kahn or Klein test is accepted by

the medical profession and absolves a patient from lues. It is my observation that, as time has gone on and both generalists and endodontists have become busier, short cuts have been taken in endodontic treatment. The elimination of culturing by some endodontists is endangering the success of treatment with detriment to the patient.¹³

Finally, methods of obturating root canals have been improved, so that the door to infection is closed to microorganisms. On the basis of clinical evaluation, the understanding today is that slight underfilling within 1 mm. or so of the apex is desirable and that overfilling is undesirable. While in some cases overfilling is well tolerated, in most cases overfilled material acts as an irritant to the periapical tissue.

SURGICAL ENDODONTICS

Advances have also been made in the area of surgical endodontics. The scope of endodontics has been greatly enlarged in recent years, so that surgical endodontics does not mean just root resection but also includes hemisection, radisectomy, and endodontic implants. In addition, significant progress is being made in intentional replantation, transplantation, and implantation of teeth. Endodontally treated roots are also serving as support for "full dentures," now known as overlay dentures.

In cases of posterior teeth which cannot be treated routinely because of blockage, dilaceration, or partial calcification of the root canals, especially in lower molars where resection might result in paresthesia, intentional replantation can be done without hazarding a difficult operation followed by a long, drawn-out period of paresthesia. Such teeth have been followed for nearly 20 years without showing any evidence of resorption and are functioning as if they had not been replanted. While intentional replantation is no panacea, it will nevertheless rescue 75 per cent of teeth that would otherwise be extracted.

Until recently, a transplanted tooth was looked upon as a temporary expedient because of tissue or organ rejection. Most transplanted teeth are held in by ankylosis and are exfoliated within 2 or 3 years, similar to a traumatically avulsed tooth. Today it is possible to suppress or eliminate the immunologic factor by tissue culture and to transplant the tooth either in the same socket at a later time or in a newly created socket, without evidence of rejection following.

Research studies are also being carried out in primates in the area of implantation of both acrylic and ceramic teeth. The latter, because of control of pore size in calcium aluminate and pyrolite teeth, appears to offer much promise, but only time will judge its value in the human patient.

The overlay denture, which is also a parameter of endodontic treatment, depends for its support on roots that have been endodontically treated and filled. By means of a male or female attachment, retention is provided for a "full denture." The endodontally supported overlay denture not only gives greater stability for the denture but also provides better proprioceptive discrimination as compared to the conventional complete denture, according to Loiselle and associates.¹⁴

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What of the future of endodontics? The future must emphasize the need for preventive endodontics. By preventive endodontics is meant prevention of pulp disease. Ideally, this would eliminate the need for endodontic treatment, except in the case of problems resulting from traumatic injury. Pragmatically, this means preservation of the natural dentition by all means possible, from protection of the crown to conservation of the root. The lines of defense in preventive endodontics may be listed as follows:

1. Crown protection

- (a) Fluoridation of community water supply
- (b) Topical application of fluoride to the teeth
- (c) Restriction of cariogenic foods
- (d) Home oral hygiene to remove plaque
- (e) Periodic prophylaxis and examination
- (f) Incipient caries detection and restoration
- (g) Silver amalgam containing a fluoride (?)
- (h) Mouth guard to prevent trauma, when indicated
- (i) Thermosetting resin for sealing pits and fissures (?)

2. Pulp protection (without exposure)

- (a) Knowledge of anatomy to prevent exposure
- (b) Coolant during cavity preparation
- (c) Cavity varnish or lining
- (d) Indirect pulp capping
- (e) Cement base in shallow cavity
- (f) Zinc oxide-eugenol base in deep cavity

3. Pulp conservation (with exposure)

- (a) Direct pulp capping
- (b) Pulpotomy

4. Root conservation

- (a) Intentional pulp extirpation (pulp exposure or resorption)
- (b) Pulpotomy (trauma or infection)
- (c) Root canal therapy
- (d) Root resection
- (e) Replantation (when avulsed)
- (f) Intentional replantation
- (g) Transplantation
- (h) Hemisection or radisectomy
- (i) Endodontic implant

In addition, more teeth will be saved when there is a better appreciation of iatrogenic endodontics by the dental profession. Let me briefly point out a few areas where preventive endodontics can play an important role. In cases where a deep carious lesion is present, cavity preparation should be done under the rubber dam so as not to contaminate the pulp with saliva. In addition, this gives one a better view of the field of operation. An uncontaminated pulp has a better chance of survival, even if exposed.

Instrument fracture during biomechanical preparation of the root canal can be prevented to a great extent if reamers and files up to size 30 are used only

twice and those above that number are used a maximum of three times. To identify the number of times an instrument has been used, different-colored rubber stoppers are attached to the instruments. This is not to say that in treating a difficult molar two or three instruments of the same size might become useless before the apical foramen is attained.

The vitality of pulps in teeth with fractured roots can be maintained if the teeth are splinted for 2 or 3 months so that the coronal fracture is immobilized. Repair of the fractured segments will occur, much as a callus in bone, with occasionally a deposition of cementum on the fractured surfaces.

Let *prevention* be our watchword now and in the future.

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