TEXTBOOK OF
Operative Dentistry

BAUM / PHILLIPS / LUND

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PREFACE

From the days of G. V. Black until the turn of the mid-century, Operative Dentistry existed as a pillar of strength whose teachings were subject only to minor modifications and whose foundation was unquestioned and considered permanently secure. As taught in the dental schools, Operative Dentistry followed a traditional pattern because it instructed the student in the undisputed treatment of hard tissue of the mouth.

After World War II this era passed, and as the years go by more variations and changes have crept into dental practice and into Operative Dentistry teaching programs. As new materials that the practitioner can use in his regimen of treatment become available, many concepts previously embraced and revered are no longer sacrosanct.

As a case in point, one can observe a modification in retentive features to include the creation of microscopic porosity in enamel by acid etching. Other changes have been brought about by the influence of science and industry. The miniature precision ball bearing, for example, made direct-drive air turbine handpieces possible, thereby eliminating the need for gears in an angle handpiece. Ultrahigh speeds became possible and in conjunction with diamond and carbide rotary cutting instruments caused tooth reduction to take on entirely different proportions. Instead of undermining the dentin to split off and remove enamel, the dentist could now simply grind through it. Box forms became a matter of intent rather than slots inadvertently left from the process of splitting away overlying enamel plates.

Refinements in impression materials, ceramics, and miniature pins, along with a myriad of other materials and techniques, have expanded the horizons of Operative Dentistry and changed its method of teaching. Sloppy techniques and operating habits could easily result from an "easier methodology," so dental educators, as they take a progressive approach must do so without sacrificing the teaching needs for excellence in operative skills. In a sense it is more necessary for the dentist to be well trained in the use and control of his instruments than the general surgeon. In Operative Dentistry, unlike soft tissue surgery, any unintentional blemish or cut into hard tooth substance will not heal. Recognizing that students must develop these skills, the authors have not sacrificed basic principles. For example, Chapter 6 deals quite extensively with how to hold and effectively use hand instruments.

In presenting the subject matter the authors have endeavored to accomplish two things: (1) to acquaint the reader with the physical properties and working nature of the materials involved and (2) to explain the procedures of the operations at hand. The various procedures are coordinated with the nature and properties of the materials involved.

The authors have taken the liberty of expanding the coverage of material ordinarily taught in Operative Dentistry. Because of the increased demands of the public for the salvage of broken-down teeth, the operative dentist must be prepared to render a restorative service to the endodontically treated tooth and to be competent in the placement of metal-ceramic crowns (Chapters 19 and 20).

Insofar as possible, techniques and procedures are clinical treatment. Although the book is valuable in teaching the pre-clinical courses in Operative Dentistry, it is not intended to serve as a laboratory manual or as a voluminous treatment of all the techniques used in restorative procedures. Rather the focus is a concise presentation of the methodologies used in Operative Dentistry. It will be noted that the chapters are inclined toward a "how to do" approach to treatment. They are virtually devoid of research data itself to support a point of view, even though the concepts presented are consistent with modern research findings. The chapters, in fact, are not followed by any bibliographic references. It was felt that the lecturers and preceptors in Operative Dentistry of the various schools would prefer to augment the text with their own laboratory manuals and their own references for student study. It is hoped that the student in using this text will find it helpful to him in achieving his goal as he prepares to render professional dental service to the hard tissues of the oral cavity.

Many of the materials that appear throughout the text are illustrated by using specific brand names. It is readily admitted that there are a variety of products from different manufacturers that will provide equal results.

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CONTENTS

1

PREVENTION OF DENTAL DISEASE

Maintenance of the body in a state of health is a goal to be sought by any practitioner of the healing arts, and the dentist is no exception. It is a careful and wise dentist who protects the oral health of his patients rather than serving only as a repairman for damaged teeth.

He, the dentist, occupies a rather unique position as a therapist because of the nature of the biologic substances with which he works. Unlike his medical colleagues, he deals primarily with tissue that is hard and has no ability to repair itself. Unlike the physician, whose therapy consists largely of applying a potion, prescribing a drug, or utilizing medications, the dentist's aids are drills, instruments, and filling materials. Unlike the physician, whose surgical procedures upon soft tissues depend on normal healing processes, the dentist has little expectation that a tooth will regrow its missing part following decay removal. Any effective therapeutic measure the dentist initiates must replace the missing part in metal, plastic, or ceramic material. Unlike the physician (orthopedic surgeon), who also deals with hard bony substances, the dentist cannot cover up the teeth he treats with soft tissues and skin to protect them from a hostile environment.

In performing his health service, the operative dentist (1) prevents or arrests the disease process and (2) restores the missing part. Frequently both objectives are met by the placement of a simple filling (restoration). Often, however, the disease process can be arrested *without* restoring the tooth. In analyzing the dental problem one must differentiate between these two objectives! It is perhaps in relation to the former, the control of disease-causing factors, that the preventive aspects in dental care take on their greatest significance. It does no good to place fine restorations in an environment that will destroy them in a short period of time. Only by simultaneous acts of prevention and restoration can a true health service be rendered.

CONTROL MEASURES

Dental diseases, like other diseases of the body, are congenital, degenerative, or infectious in nature. Although congenital and degenerative factors require some concern, major attention along preventive lines must be given to infectious processes and action from microbial agents.

By definition, an infectious disease is the invasion of the body by pathogenic organisms. Although not an invasion of the body in the classic

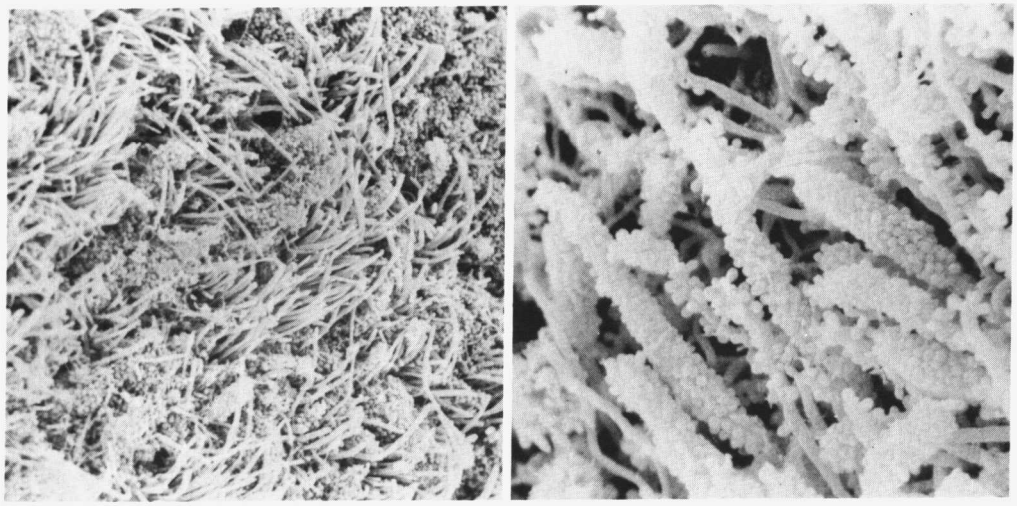

Figure 1–1 Scanning electron microscopic pictures of dental plaque. (Courtesy of Dr. Sheila Jones, Apex 5:93–98, 1971)

sense, a quasi-infectious process takes place when colonies of organisms attach themselves to the teeth (Fig. 1–1). As they grow, these organisms subject the tooth to decalcifying actions, with subsequent destruction and cavitation. Attachments of these microbial growths to the teeth are known as "plaque." Although it can be removed and tooth surfaces cleansed, plaque will soon re-form with new growth, and the destructive process will continue.

It is not the intention of this chapter to discuss the etiology of dental caries or theories of plaque formation. This will be left to other disciplines, where the matter is dealt with in greater detail.

Infectious processes and the relative success achieved in preventing them are dependent upon the pathogenic power of the organism against the resistance of the host (patient). With regard to the host's resistance, one should keep in mind that the tooth is a viable living structure, not a hard piece of inert material. It is a composite structure, consisting of mineral salts blended with organic material. Moreover, in a healthy systemic state small amounts of fluid pass from the pulps of the teeth outward through the dentin, gradually seeping through the enamel into the saliva. Thus the tooth must be looked upon, and treated, as a dynamic substance, not a static, inert material.

Caries Prevention

It should be borne in mind that normal healthy enamel and dentin are largely dependent upon good nutrition during the long formative years of early childhood when the tooth is being developed. Nutrition, therefore, as a means of developing host resistance is especially important during the formative years, but it should also be considered in the overall healthy maintenance of the oral tissues throughout life.

Eating proper foods for proper health is only a small part of the role the patient must play in maintaining good teeth and a healthy mouth. His cooperation and assistance are very important in reducing the effect of the

micro-organisms in the mouth, organisms that contribute toward caries. A combined effort on the part of the patient and the dentist can arrest, delay, and eliminate many of the carious processes that result in destruction of hard tooth substance. Briefly, the roles of the two might be summarized as follows:

PATIENT	DENTIST
1. Elimination of foods that serve as nutrients for the micro-organisms, particularly foods ingested between normal meals.	1. Periodic cleansing of the teeth.
2. Removal of microbial organisms from the teeth (removal of plaque by brushing, flossing, and so on)	2. Occasional application of fluoride to the teeth, when indicated.
3. Stimulation of circulation of gingival tissues.	3. Use of sealants on caries-susceptible areas, especially in pits and fissures, when indicated.
4. Use of fluoride-containing dentifrice to make the enamel surface more resistant to caries.	4. Educating, motivating, and assisting the patient in his role of maintenance and care.
5. Maintenance of good health with the aid of proper nutrition, and so on.	

Dental Examination and Preliminary Treatment

It is apparent from the preceding lists that the dentist's role is not as time consuming as the patient's and that an effective "caries prevention" program is not possible without the patient's cooperation. The wise dentist, therefore, will study his patient to determine whether an active disease process is in progress. Examples of patients with rampant caries are shown in Figures 1–2 and 1–3.

Despite the apparent complexity of dental care, the dentist can usually render an effective patient service if he uses common sense and judge-

Figure 1–2 Decalcification of gingival enamel. Rapidly advancing caries in a mouth with poor oral hygiene. (Courtesy of Dr. David Krutchkoff)

Figure 1–3 Deep carious lesion that has destroyed much of the dentin and enamel on the facial surface of this lower right first molar. (Courtesy of Dr. Eugene Givens)

ment in the application of knowledge already at his disposal. He can determine if the carious process is progressing at a rapid rate by the following observations:

A. ***Examination of the Patient with Rampant Caries***

1. The dentin within a cavity will be soft to probing — the result of rapid dissolution and removal of the mineral salts.
2. Enamel surfaces may be covered with diffuse patches of white chalky enamel, showing an attack over a broad front (Fig. 1–4).
3. Dentin within the cavity will be only slightly discolored. Because its surface is being lost at such a rapid rate, it has little opportunity to be stained by coffee, berry juices, and other foods (Fig. 1–5).
4. Teeth in the mouth only a short time (maxillary bicuspid of a child only 13 or 14 years of age) will show evidence of carious lesions.

B. ***Examination of the Patient with Slow Caries Activity***

1. The cavities will be dark brown or black in color (see Fig. 1–5). Repeatedly subjected to food stains (e.g., coffee, berries), the dentin absorbs the stains, and its darkness becomes proportional to the long months of exposure. Carious dentin therefore is not identified by its color; it is identified by its texture.
2. The dentin is more dense to probing with a sharp pointed instrument. This is a result of the slow rate of decalcification, as contrasted to rapid decalcification in the acute stage.
3. Fragile crusts of enamel overlying the cavity are more likely to be broken off, whereas intact enamel is more evident in the rapidly developing lesion. Prolonged wear and chewing forces tend to break off the enamel edges, as seen in Figure 1–6.
4. Soft chalky patches of whitish enamel are virtually missing in the

Figure 1–4 Decalcification of gingival enamel. Calcium salts have leached out of the enamel because of the carious activity. Note penetration into dentin of the lower cuspid. (Courtesy of Dr. Ellen Eisenberg)

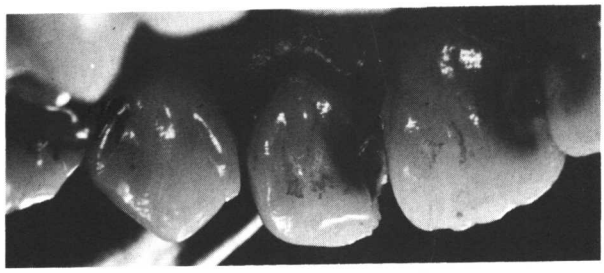

Figure 1–5 Lingual view of two carious lesions. The lesion of the lateral incisor shows more discoloration than the central because it has progressed at a slower rate. The lesion on the central forms a cul-de-sac, which naturally retains debris and microbe activity, whereas the corner on the lateral incisor is missing, allowing a degree of free cleansing. (Courtesy of Dr. Eugene Givens)

older lesion, owing to staining and remineralization of the decalcified areas.

C. ***Initial Treatment of the Caries-Susceptible Patient.*** Most patients fall within these two extremes, tending to have either rapid or retarded caries activity. Depending upon relative activity of the carious process, one or more of the following treatments should be considered:
   1. The soft, diseased dentin should be excavated from the lesions to remove as many microbial agents as possible along with their by-products and other debris.
   2. Open cavities within the diseased teeth should be filled with cement dressings to keep out saliva, bacteria, and food particles (such a lesion might be compared to a wound that is cleansed, disinfected, and bandaged (see Chapter 8).
   3. Overall microbial activity within the mouth should be reduced by:
      a. modifying the dietary regimen to reduce nutritional components for the microbial colonies (elimination of food and drink rich in carbohydrates) and
      b. frequent cleansing by brushing and flossing to remove the plaque and microbial colonies from the tooth surfaces.
   4. Fluorides should be employed to increase the resistance of enamel to dissolution. This can be accomplished by the application of fluoride in the office, by the home use of aqueous solutions and dentifrices, and by the possible incorporation of fluoride into the drinking water.

Within a few weeks these procedures should provide obvious evidence of caries arrest and control. Nevertheless, the patient should be kept under observation for a period of several months to assure that the disease has been brought under control. As soon as it has been determined that the acute stage of the disease has passed, permanent restorations (e.g., amalgam, gold, composites) can be placed within the teeth without fear of caries reoccurring adjacent to them.

While some rapidly advancing and deep lesions need to be treated with

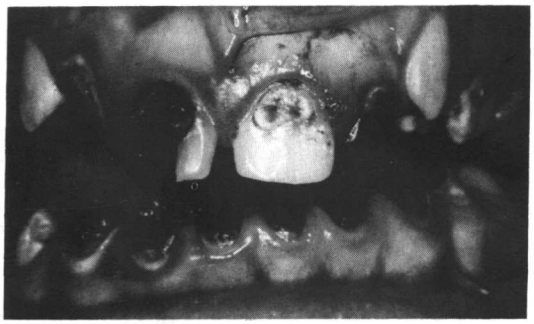

Figure 1–6 Mouth of a 13 year old boy. Although all the enamel is missing, the underlying black dentin is hard, firm, and insensitive to probing. (Courtesy of Dr. Douglas Foerth)

a temporary sedative cement, most cavities can be restored at the convenience of the dentist on an appointment basis, and it can be anticipated that the disease will not progress unduly fast.

"Cavities" are not always the result of the carious process. The dentist, in his efforts to protect the patient and prevent additional damage, may discover that a patient's eroded lesions are the result of some obscure cause, such as regurgitated acids from the stomach. Likewise, dissolution of enamel and dentin can occur as a result of dietary habits that permit citrus fruits to have prolonged surface contact with teeth or as a result of abrasive action from incorrect tooth brushing habits.

Dental deterioration may also follow a debilitating disease or a severe emotional disturbance that has had a systemic effect upon the body in general and upon the teeth in particular (Fig. 1–7). Pregnancy in some women often appears to be associated with rampant carious activity. Hormonal changes and other systemic factors combine to modify the oral environment and to lower the ability of the tooth to resist carious activity. When normal systemic activity is restored, the natural tooth defenses become effective again, and the accelerated carious activity is reduced.

The clinician will observe that a time lag of perhaps 6 to 12 months is noted between the onset of systemic change and subsequent manifestations in the teeth. For example, a middle-aged person undergoing a period of extreme emotional stress in January, during which his health suffers, may not manifest unusual carious activity until October or November of that same year. Similarly, when the period of emotional stress ends and physical health is again restored, several months will pass before the rampant carious activity subsides. During this period of time the treatment should be palliative and involve only the use of temporary restorative materials.

Destructive habit patterns, if present, should be identified and terminated. Although many and varied, the most common habit is the frequent bathing of the teeth with saliva containing nutrient sugar solutions, which serve as food for the microbial colonies. Sucking mints or Life Savers and prolonged sipping of soft drinks or sweetened coffee are but a few of the ways in which nutrients can be supplied to the plaque. Often a smoker endeavoring to "break the habit" resorts to a diversionary habit such as gum chewing or "coke" sipping, which supplies nutrients to the pathogenic organisms (Fig. 1–8). Improper tooth brushing and flossing habits will severely abrade the teeth, while sucking on lemons produces a dissolution

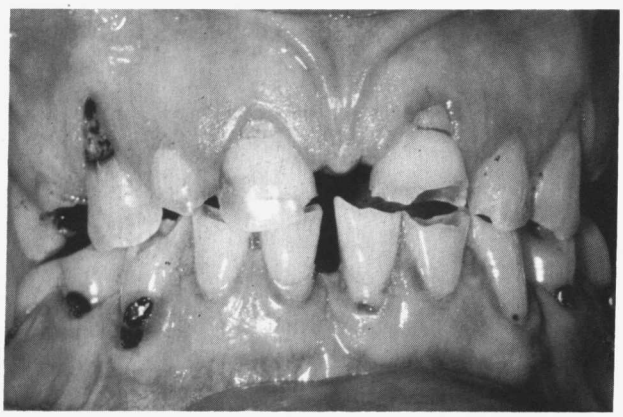

Figure 1–7 Hard tissue pathology of this adult patient is the major area of concern. Restoring the worn anteriors to function and acceptable esthetics is a real challenge. (Courtesy of Captain Richard B. McCoy, U.S.N.)

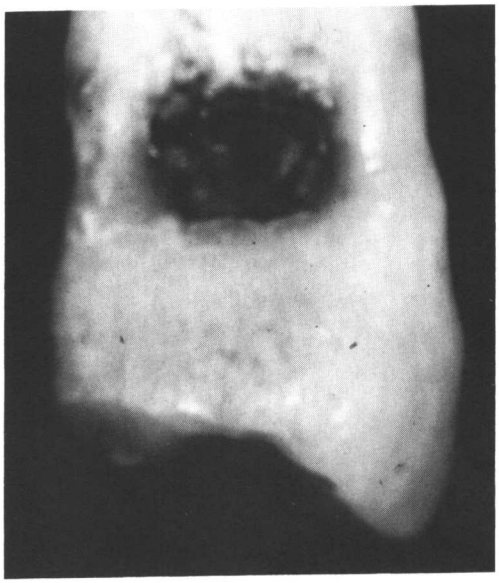

Figure 1–8 Despite the presence of root caries, this premolar was lost because of periodontal disease.

of the enamel by the citric acid. Bruxism (clenching or gnashing the teeth) can also be a destructive habit.

Tooth destruction may occur with or without the influence of infectious microbial activity. Occasionally, clinical insight and knowledge from other disciplines is necessary for even the most experienced diagnostician to determine the causes of tooth destruction in some stubborn cases.

A logical question comes to mind, "Is not a tooth with a rapidly developing cavity more painful than a tooth with a slowly developing one?" The answer is "No." Rate of dissolution bears no relationship to pain. A rapidly developing cavity is no more painful than a slowly developing one; indeed, most carious lesions develop asymptomatically, with the development of little or no pain.

Identification of problem areas requiring patient cooperation is only a small part of the problem. Of far greater importance are the human factors that require the patient to exercise self-discipline, to be diligent in plaque removal, and to be careful with his diet. Forgetting to cleanse the mouth after eating is a major problem, as a majority of patients tend to be apathetic or negligent. The dentist must be aware of motivating influences and, insofar as possible, stimulate the patient to be thorough and consistent in the two most important areas, namely, food intake and plaque removal.

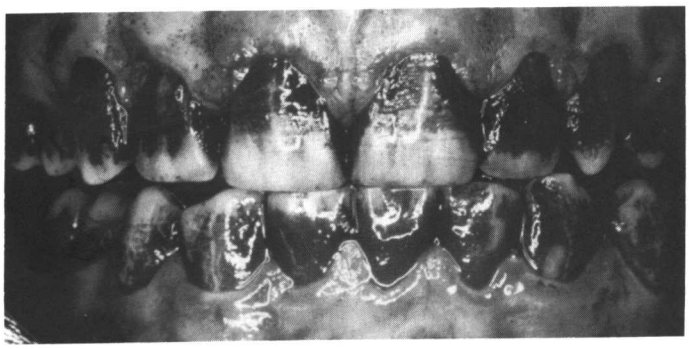

Figure 1–9 Plaque stained with disclosing tablets.

Chewable disclosing tablets are also helpful in identifying areas of plaque that have not yet been removed. These tablets stain the plaque a deep red color and provide the patient with a stimulus toward more fastidious brushing habits (Fig. 1–9). Inspection for plaque is recommended before each appointment. If the patient has not been diligent in his efforts to remove plaque, it must be called to his attention and new efforts made to correct this problem.

It is not within the scope of this chapter to describe the training regimen that should be followed or the instructional procedures to be given for flossing and brushing, use of toothpicks, bridge cleaners, and so on.

PIT AND FISSURE SEALANTS

A technique of filling and sealing grooves in the occlusal surface with a resin is proposed as a means of preventing caries. This resin must be thin enough to allow it to penetrate into the grooves and fissures if sealing is to take place. Resins are available for such a purpose. To use this material the teeth must be isolated and dry, and this suggests it is best to use the rubber dam. The teeth must be given a thorough prophylaxis, preferably with a nonfluoridated paste and then rinsed and dried. The acid etch technique is employed as discussed in Chapter 10, following which the area is rinsed and dried. Then the groove sealant is applied by carefully observing the manufacturer's instructions. When completed, there should be a hard resin surface in the grooves with some lateral excess.

This procedure raises some specific questions, including the following: Will a sharp explorer accurately detect occlusal caries, for even at its sharpest, an explorer will measure 80 micrometers at the tip? Is it reasonable to cover a groove with a sealant if caries might be present? How long will the material last? Although some clinical studies are encouraging to date, long-term observations will supply the answers to these and other questions.

The use of a groove sealant may have value for children or adolescents. In the usual adult practice in which patients are under periodic surveillance, pit and fissure sealants will be of very limited value.

In summary, it is the responsibility of the operative dentist to: (1) employ all preventive measures at his disposal to insure the integrity of sound tooth substance and (2) to restore permanently only those teeth whose lesions rest in an environment that will not be readily subject to recurrence of disease after the teeth have been restored.

OPERATIVE PROCEDURES

Lest one blame only the patient for prevalence of tooth decay and its recurrence around existing restorations, the operative dentist should also direct his attention to restorative procedures, per se, which play a very important role in this regard. Far too often, the dentist uses poor judgment in evaluating the defect and in designing its restoration. Designs should be made that obviously take into account the size and shape of the lesion. In addition, however, consideration should be given to congenital defects of the crown, the texture of the enamel at the edges of the lesions, the age of

the patient, a prognosis of the patient's ability to care for his mouth, as well as chewing and wear patterns of the tooth in question.

Many years ago before the advent of the dental engine, soft carious dentin was removed by a dental instrument, the excavator, which scooped out the soft material of the lesion. Without the aid of local anesthetics, dentists were not expected to cut into sound dentin to anchor a restoration or to terminate the edges of a cavity in sound enamel. It was to be expected that such restorations could be dislodged by chewing forces or subjected to subsequent caries around their edges. It was not until about 1875 that Dr. G. V. Black proposed a rational regimen for "extension for prevention" principles, which made restorations more permanent because they were engineered and designed scientifically. The advent of belt-driven rotary handpieces and electric engines to power them made this new science a practicable modality. In brief, these principles are based on the rule that potentially carious areas should be included within the cavity design, without sacrificing mechanical anchorage for the restoration. Although designs of cavity preparation have changed somewhat in recent years, no significant deviation from these scientific principles has occurred.

The late Dr. Howard R. Raper, who introduced the bite-wing x-ray to the dental profession in 1925, concisely described the role a dentist plays in the prevention of dental disease.*

> In the battle for the control of caries there is no substitute, as yet, for the service dentists have to offer. Fractional prevention is certainly not a satisfactory substitute. What does the patient gain if, in a certain tooth otherwise destined to have three cavities, there develop only two? It takes only one cavity to destroy a tooth — unless a dentist comes to the rescue and arrests or cures the disease by filling the tooth.
>
> Take my own personal case for example. Why do I, at the age of 70 odd, still have 26 of my own natural teeth? [Dr. Raper at 88 years still had 26 of his natural teeth.] Is it because I have used any particular brand of medicated toothpaste? No, I have used all kinds of toothpastes and powders, no one kind to the exclusion of others.
>
> Is it because I have always brushed my teeth immediately after eating? No, I have not found it possible to follow this recommended routine.
>
> Is it because I have always consumed a perfectly balanced diet? No, my diet throughout my life has not been one of which dieticians would wholly approve. It has not been either especially good or especially bad.
>
> Is it because I have resisted the impulse to eat sweets? No, I cannot recall ever refusing a piece of candy and demanding a carrot stick.
>
> Is it because I have employed some especially effective brushing technic or a toothbrush guaranteed to "reach the inaccessible areas?" No, my brushing technic has been fair, but nothing to brag about; and I have used all kinds of toothbrushes — including some with bristles so stiff I had to learn to discriminate against them.
>
> Is it because I drank fluoridated water? No, I have not always had that advantage.
>
> Ah then, you say, it must be because I was blessed with very good teeth by nature. Again the answer is no. It is true that, until recently, I have enjoyed a rather high degree of immunity to periodontal disease; but, looking at the other side of the coin, my susceptibility to caries has been somewhat higher than average.
>
> So I repeat the question: Why do I at my ripe old age still have 26 functionally good teeth? The answer is so simple. It is because, and only because, dentists have saved them for me, by filling the cavities and scaling away the calculus. Had I been denied this service, I would today have no teeth.

*Paul Barton, *The Prevention of Toothache: One Man [Raper] and His Campaign.* Bulletin, Indiana University, School of Dentistry, 50th Anniversary Edition, Spring Issue, 1975.