27. A New Dental Caries Treatment System developed in Japan

By Takao Fusayama, M. J. A.*

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Abstract: A revolutionally tooth saving restorative system for dental caries was developed in Japan by using a caries detector and a chemically adhesive composite resin. It surprised dentists in the world causing much resistance and controversy because it was too revolutional. But, the 12 years routine use by many dental schools and clinicians in Japan has confirmed its usefulness and the supporters and followers of the system are now day by day increasing in the other continents too. This article illustrates the technical essence of the system. The conical cavity after complete removal of the infected dentin guided by the caries detector is immediately filled with the chemically adhesive composite resin after etching the whole cavity wall without any lining. It is painless without anesthesia and best saving teeth.

Key words: Carious detector; chemically adhesive composite; total etching; painless restoration; outer carious dentin; inner carious dentin.

Introduction. A new system of dental caries treatment and restoration, least sacrificing the dental tissue, was developed in Japan in 1970s and internationally presented in 1980 by the book entitled “New Concepts in Operative Dentistry”. As usual for a revolutional innovation, this system faced a tremendous resistance of dental researchers and clinicians in the world because it was too revolutional.

In Japan, however, it was routinely used by many dental schools and clinicians successfully, being adopted by the social and national health services. The practical usefulness has thus been perfectly confirmed through the past 12 years. Not only in Japan, the supporters recently began to appear also in the United States and Europe day by day increasing.

After the initial development, the materials, equipment and technique for this system were further improved in details. This paper illustrates the technical essence of the latest system.

The most conservative cavity preparation. Our 20 years research effort revealed that the carious softened dentin consists of two layers. The outer carious dentin is an irreversibly deteriorated, infected, unremineralizable and senseless dead tissue to be removed, while the inner carious dentin is a reversibly denatured, uninfected, remineralizable and sensitive living tissue to be preserved (Fig. 1). The pain on cavity preparation so far experienced by patients was revealed to be simply because dentists cut this inner layer which should not be removed. We then developed the caries detector, 0.5% basic fuchsin or 1.0% Acid Red 52 (Food Red 106) solution in propylene glycol, which stains only the outer layer to be removed (Fig. 2). For the ideal restoration removing only the stainable infected dentin, an adhesive restorative material not requiring the mechanical retention was keenly demanded.

* Emeritus Professor, Tokyo Medical and Dental University.
In response to the author’s suggestion, the world first chemically adhesive composite resin (Clearfil) was developed by a Japanese manufacturer (Kuraray Co., Osaka, Japan). After complete removal of the senseless infected dentin guided by the caries detector, no sensitive uninfected dentin is reduced for retaining this material because it is chemically adhesive. It is therefore painless without anesthesia. For best saving teeth, anesthesia had better be avoided because it allows overreduction into the important living dentin, although it is exceptionally used for cavities in which precise selective cutting of the stained tissue by vision is difficult.

**Application of the caries detector.** A drop of the detector is applied in a cavity and spray-washed after 10 seconds. Only the outer carious dentin is left stained red and so removed. Because the depth of penetration of the detector is limited, the detection and reduction is repeated until the cavity wall is no more stainable. The high speed diamond bur is used for removing the decayed or undermined enamel, while the low speed round steel bur is used to remove the infected dentin carefully distinguishing the stained tissue.

In acute or moderate decays, only the stainable tissue is removed using the
detector from the beginning in order to prevent overcutting into the unstainable softened tissue. In chronic decays with heavy natural discoloration, the discolored senseless tissue is first removed as much as possible and then the residual outer carious dentin detected by the detector is removed together with the heavy natural discoloration.

![Diagram]

Fig. 3. The caries detector can guide pulp diagnosis clearly and objectively without depending on ambiguous subjective symptoms. When the detector-stainable infected dentin is completely removed, no, small or wide pulp exposure indicates respectively direct filling, pulp capping or endodontic therapy.

The caries detector clearly indicating the depth of the infected dentin allows also clear pulp diagnosis (Fig. 3). When the pulp is not exposed by complete removal of the stainable tissue, the cavity can be immediately restored regardless of any subjective pulp symptoms, because the pulp is surely not infected and the pulpitis is only reversible. When the pulp is slightly exposed, the exposure is capped with a Ca(OH)₂ cement which is superficially disinfective and promotes the dentin bridge formation, because the infection is only superficial. When the pulp is largely exposed, it must be endodontically treated regardless of presence or absence of subjective symptoms, because the pulp is surely infected. Neither the X-ray opacity nor the electric resistance can give such a definite guidance because they are dependent on the degree of demineralization which has no direct relation to the depth of infection.

The cavity design. When the decayed enamel and the infected outer carious dentin is completely removed resulting in a conical cavity, cavity preparation is also simultaneously over (Fig. 4). Most principles established by G. V. Black are no more directive. The retention form is not necessary. Slender residual dental structures and sometimes even extensive free enamels can be preserved because the chemically adhering composite resin supports them. The extension for prevention is not necessary in the smooth surfaces because the tight chemical adhesion eliminates the marginal weakness to caries recurrence. The posterior proximal cavity is often prepared from buccal inserting round burs through the interdental space without sacrificing the marginal ridge.

The optimum inclination of the marginal cavity wall is 60 to 80° because slight inclination increases the bond strength to the etched enamel. The long bevel is not recommended because it makes the cavosurface angle indistinct increasing the chance to leave the excess resin feather which later peels retaining filth. It increases also the prevalence of marginal fracture under occlusion.
optimal marginal inclination of 60 to 80° is usually automatically obtained on caries removal. But additional cut of the marginal enamel wall forming the round bevel is necessary to get the optimal marginal inclination when a shallow decay is spreading in enamel. This is the only modification of a cavity after complete caries removal.

The simplest and surest pulp protection. Neither the etching acid nor the composite resin chemically irritates the pulp. The bacterial irritation can be prevented by complete removal of the stainable infected dentin. The essential factor of postoperative sensitivity is separation from the floor dentin which causes volume or pressure change when the restoration is subjected to mechanical or thermal stress. This change can also drive irritants or bacteria into the tubules when the margin is leaky.

To prevent such a separation, both enamel and dentin walls are totally etched with the phosphoric acid jelly etchant and the cavity is filled with selected chemically adhesive composites, Clearfil family (Kuraray Co., Osaka, Japan). The bonding agent penetrates the etch-opened dentinal tubules forming tags adhering to the tubule walls as well as the etched porosity of the intertubular dentin surface forming the resin-impregnated dentin layer (Fig. 5). This penetration contributes to retention as well as to pulp protection by the tight seal of tubule apertures. The subsequently developed chemically adhesive composite, Scotch Bond with P-10 (3M Co., St. Paul, Minn.), was also recently proved to be similarly effective when used in our system.

A cement lining widely covering the dentin wall is prohibited because it is a profitless and baleful labor increase. Namely it weakens the retention of restoration, the dentinal tubule aperture seal and the gingival marginal seal. When the marginal deterioration reaches the lining cement, the secondary caries easily penetrates deep dissolving the cement. Dentists must know that the composite tightly adhering to the etched dentin is the most pulp protecting liner better than any cements.

When the pulp is slightly exposed, however, the exposure had better be capped for preventing the packed composite from being driven into the pulp (not for preventing the chemical irritation). A spot lining with a quick setting
Ca(OH)$_2$ cement is recommended. The area of lining must be minimized in order to leave maximal dentin exposed for etching and adhesion.

The so-called dentin bonding agents to be applied exclusively to dentin are recommended by chemists in the other continents but they are doubtful of their clinical usefulness because different treatment of enamel and dentin accurately distinguishing them in small clinical cavities is impossible. The so-called self-etching bonding agents incorporating acid in them are also recommended by some manufacturers but they may burn the gum papilla and the operator's fingers because they are sticky and highly wettable passing even through the tooth-rubber dam junction. Our system, etching enamel and dentin together and washing the acid away before application of the bonding agent, is the simplest and safest.

Placement of the adhesive composite resin. The time interval between etching, the bonding agent coating and the composite resin placing had better be minimized for maximal adhesion. This process is usually performed within a few minutes. Seepage after placement does not affect the adhesion if the cavity is washed, dried and coated again. The essential is to keep the cavity dry for a few seconds after etching till the bonding agent coating. Dry keeping for such a short time is very easy without rubber dam.

After the bonding agent coating, the cavity is immediately filled with either the self-cured or the light-cured composite resin. The self-cured is superior in the floor adhesion and the gingival marginal seal which are important for biological safety, because it polymerizes shrinking toward to the cavity walls warmed by the body temperature. So it must be used in deep or cervical cavities. In contrast, the light-cured polymerizes shrinking toward the top close to the light sauce and tends to separate from the floor or the gingival cavity margin. It is however slightly superior in the superficial hardness and color stability. So it is used in extensive shallow facial cavities or to laminate on the self-cured.

Development of superfine diamond points has considerably simplified the technique after placing. The restoration surface is simultaneously trimmed and finished with them because they cut efficiently and smoothly. The finished surface is polished with fine Silicone points or abrasive strips at the next visit. In anterior restoration, the glossy surface which has set against matrix must be removed by polish because it is apt to discolor regardless of the extreme smoothness. In posterior proximal restorations, however, the glossy surface must be preserved because the silica particles exposed by polish would abrade the contact point of the neighboring tooth. Discoloration is not a problem in this invisible area.

Discussion. The above described system sacrificing no more than the irreversibly deteriorated senseless tissue is an ideal restoration which is painless without anesthesia and kindest to teeth, to patients as well as to dentists. The adhesive composite thus used is now replacing not only cements or synthetic resin for anterior restoration but also amalgam for posterior restoration which requires to cut the important living tissue for mechanical retention and allows more prevalent marginal fracture and deep penetration of secondary caries along the cavity wall. The slogan for the progressive Japanese dentists is now Least Reduction, Least Pulp-removal and Least Extraction.

Because the system is technically simple, even the very initial test restorations, placed in 1977 by the operators who used this new material and technique for the first time, showed quite favorable results at 5 to 6 years (Fig. 6). Only
Seven Class III s  Two cervical erosions  One incisal fracture

Fig. 6. The initial adhesive composite resin, Clearfil F, placed in cavities with no mechanical retention by total etching with no lining, showed quite favorable results when examined after 5 to 6 years. Seven Class III restorations (left), two cervical erosion restorations (center) and one incisal fracture restoration (right).

One Class I  Two Class II s  One MOD

Fig. 7. The adhesive posterior composite resin, Clearfil Posterior, placed in occlusal cavities also showed quite favorable results after 6 to 7 years. One Class I restoration (left), two Class II restorations (center) and one MOD restoration (right).

one case out of 124 caused a pulp trouble due to the carelessly left infected dentin. After the initial development, the material and technique were further improved adding the posterior composite (Fig. 7). The usefulness of our system has been well confirmed by our routine use of more than 12 years with the material for anterior restoration and more than 8 years with the material for posterior restoration.

Conclusion. The new dental caries treatment system removing only the infected irreversibly deteriorated outer carious dentin and immediately restoring with the chemically adhesive composite resin after total etching of the cavity wall without lining is not only the simplest in technique but also the most tissue saving and pulp protective securing maximal longevity of teeth. It is painless without anesthesia. Switching from the traditional restorative system sacrificing a great deal of important dental tissue under anesthesia to this new tooth saving system is a duty for modern dentists who should save teeth in maximum for human welfare.

References