Guideline on Pediatric Restorative Dentistry

Originating Committee
Clinical Affairs Committee – Restorative Dentistry Subcommittee

Review Council
Council on Clinical Affairs

Adopted
1991

Revised
1998, 2001, 2004

Purpose

The American Academy of Pediatric Dentistry (AAPD) presents this guideline to assist the practitioner in the restorative care of infants, children, and adolescents. The objectives of restorative treatment are to repair or limit the damage from dental caries, protect and preserve the tooth structure, rees tablish adequate function, restore esthetics (where applicable), and provide ease in maintaining good oral hygiene. Pulp vitality should be maintained whenever possible.

Methods

The AAPD convened a consensus conference on pediatric restorative dentistry in April, 2002. Consensus statements resulted from the expert literature review and science-based position papers presented.[1] Results of the conference, literature review, MEDLINE search, and expert opinion were used to revise these guidelines.

Background

Restorative treatment shall be based upon the results of an appropriate clinical examination and ideally be part of a comprehensive treatment plan. The treatment plan shall take into consideration:

1. the developmental status of the dentition;
2. a caries-risk assessment[2,3];
3. the patient's oral hygiene;
4. anticipated parental compliance and likelihood of timely recall;
5. the patient's ability to cooperate for treatment.

The restorative treatment plan must be prepared in conjunction with an individually tailored preventive program.

Caries risk is greater for children who are poor, rural, or minority or who have limited access to care.[4] Factors for high caries risk include decayed/missing/filled surfaces greater than the child's age, numerous white spot lesions, high levels of *Streptococcus mutans*, low socioeconomic status, high caries rate in siblings/parents, diet high in sugar, and presence of dental appliances.[5] Studies have reported that maxillary primary anterior caries has a direct relationship with caries in primary molars.[6-11] Caries in the primary dentition is highly predictive of caries occurring in the permanent dentition.[5]

Restoration of primary teeth differs significantly from restoration of permanent teeth, due in part to the differences in tooth morphology. The mesiodistal diameter of a primary molar crown is greater than the cervicoocclusal dimension. The buccal and lingual surfaces converge toward the occlusal. The enamel cap is thinner and is more consistent (about 1 mm throughout). The cervical enamel rods slope occlusally, ending abruptly at the cervix instead of being oriented gingivally, gradually becoming thinner as in permanent teeth.

The pulp chambers of primary teeth are proportionately larger and closer to the surface. Primary teeth contact areas are broad and flattened rather than being a small distinct circular contact point, as in permanent teeth. Shorter clinical crown heights of primary teeth also affect the ability of these teeth to adequately support and retain intracoronal restorations.

Young permanent teeth also exhibit characteristics that need to be considered in restorative procedures, such as large pulp chambers and contact areas that are proximal to primary teeth.

Tooth restoration should include the removal of caries or improperly developed tooth structure to establish appropriate outline, resistance, retention, and convenience form compatible with the restorative material to be utilized. Dentin conditioning and bonding should be performed appropriately for the restorative technique. Rubber-dam isolation should be utilized when possible during the preparation and placement of restorative materials.

As with all guidelines, it is expected that there will be exceptions to the recommendations based upon individual clinical findings. For example, stainless steel crowns (SSCs) are recommended for teeth having received pulp therapy. With a conservative access and sound lateral walls in a tooth that would exfoliate in less than 2 years, an amalgam or resin could be appropriate. Likewise, a conservative Class II restoration for a primary tooth could be expanded to include more surface area when the tooth is expected to exfoliate within 1 to 2 years.

Recommendations

Dentin/enamel adhesives

Dentin/enamel adhesives allow bonding of resin-based composites and compomers to primary and permanent teeth. Enamel bonding was discussed in the 1950s with the use of phosphoric acid to condition enamel for resin restorations.[12] Adhesives have been developed with reported dentin bond strengths exceeding that of enamel.[13-15] In vitro studies have shown that enamel and dentin bond strength is similar for primary and permanent teeth.[9-22] Clinical studies evaluating dentin adhesives have utilized both permanent and primary teeth.[23-29] The clinical success of adhesives allows for more conservative preparation when using composite restorative materials.

Adhesive systems currently follow either a "total-etch" or a "self-etch" technique. Both types include simplified "one-bottle" systems. Total etch technique requires 3 steps. It involves use of an etchant to prepare the enamel while opening the dentinal tubules, removing the smear layer, and decalcifying the dentin. After rinsing the etchant, a primer is applied that penetrates the dentin, preparing it for the bonding agent. The enamel can be dried before placing the primer, but the dentin should remain moist. A bonding agent then is applied to the primed dentin. The simplified adhesive system combines the primer and the adhesive in "one bottle." The self-etch technique initially required 2 steps: a self-etching primer and an adhesive resin. "One bottle" products are currently available, incorporating the etchant, primer, and bond together.

Because the adhesive systems require multiple steps, errors in any step can affect clinical success. Attention to proper technique for the specific adhesive system is critical to success.[30-32]

Recommendations:

"The dental literature supports the use of tooth bonding adhesives, when used according to the manufacturer's instruction unique for each product, as being effective in primary and permanent teeth in enhancing retention, minimizing microleakage, and reducing sensitivity."[33]

Pit and fissure sealants

Sealant has been described as a material introduced into the occlusal pits and fissures of caries-susceptible teeth, forming a micromechanically-bonded, protective layer cutting access of caries-producing bacteria from their source of nutrients.[34]

Pit and fissure caries account for approximately 80% of all caries in young patients. Sealants reduce the risk of caries in those susceptible pits and fissures. A tooth's caries risk should be determined, and any primary or permanent tooth judged at risk would benefit from sealant application. Sealant placement on teeth with the highest risk will give the greatest benefit.[35] High-risk pits and fissures should be sealed as soon as possible. Low-risk pits and fissures may not require sealants. Caries risk, however, may increase due to changes in patient habits, oral microflora, or physical condition, and unsealed teeth subsequently might benefit from sealant application.

With appropriate diagnosis and monitoring, sealants can be placed on teeth exhibiting incipient pit and fissure caries.[36] Studies have shown arrested caries and elimination of viable organisms under sealants or restorations with sealed margins.[37-39] Surveys have shown that pediatric dentists often incorporate enameloplasty into the sealant technique.[40] In vitro studies have shown enameloplasty may enhance retention of sealants.[41-44] Short-term clinical studies show enameloplasty as equal to but not better than sealant placement without enameloplasty.[45,46]

Isolation is a key factor in a sealant's clinical success. Contamination with saliva results in decreased bond strength of the sealant to enamel. In vitro and in vivo studies report that use of a bonding agent will improve the bond strength and minimize microleakage.[47-53] Fluoride application immediately prior to etching for sealant placement does not appear to affect bond strength adversely.[54,55]

Sealants must be retained on the tooth and should be monitored to be most effective. Studies have shown glass ionomer sealant to have a poor retention rate.[56,57] Numerous studies have reported the retention rate of resin-based sealants.[58-64] Studies incorporating recall and maintenance have reported sealant success levels of 80% to 90% after 10 or more years.[65,66]

Recommendations:

1. "Bonded resin sealants, placed by appropriately trained dental personnel, are safe, effective, and underused in preventing pit and fissure caries on at-risk surfaces. Effectiveness is increased with good technique and appropriate follow up and resealing as necessary.
2. Sealant benefit is increased by placement on surfaces judged to be at high risk or surfaces that already exhibit incipient carious lesions. Placing sealants over minimal enamel caries has been shown to be effective at inhibiting lesion progression. Appropriate follow up care, as with all dental treatment, is recommended.
3. Presently, the best evaluation of risk is done by an experienced clinician using indicators of tooth morphology, clinical diagnostics, past caries history, past fluoride history, and present oral hygiene.
4. Caries risk, and therefore potential sealant benefit, may exist in any tooth with a pit or fissure, at any age, including primary teeth of children and permanent teeth of children and adults.
5. Sealant placement methods should include careful cleaning of the pits and fissures without removal of any appreciable enamel. Some circumstances may indicate use of a minimal enameloplasty technique.
6. A low-viscosity, hydrophilic material bonding layer as part of or under the actual sealant has been shown to enhance long-term retention and effectiveness.
7. Glass ionomer materials have been shown to be ineffective as pit and fissure sealants, but could be used as transitional sealants."[27]

Glass ionomer cements

Glass ionomers have been used as restorative cements, cavity liner/base, and luting cement. Glass ionomer cements are the product of an acid-base reaction between a glass powder and a water-soluble polymer. The initial glass ionomer materials were difficult to handle, exhibited poor wear resistance, and were brittle. Advancements in glass ionomer formula led to better properties, including the formation of resin-modified glass ionomers. These products showed improvement in handling characteristics, decreased setting time, increased strength, and improved wear resistance.[67-69] Glass ionomers have several properties that make them favorable to use in children:

1. chemical bonding to both enamel and dentin;
2. thermal expansion similar to that of tooth structure;
3. biocompatibility;
4. uptake and release of fluoride;
5. decreased moisture sensitivity when compared to resins.

Glass ionomers are hydrophilic and tolerate a moist, not wet, environment, whereas resins and adhesives are affected adversely by water. Because of their ability to adhere, seal, and protect, glass ionomers often are used as dentin replacement materials.[70-72] Glass ionomer has a coefficient of thermal expansion similar to dentin.

Resin-modified glass ionomers have improved wear resistance compared to the original glass ionomers and are appropriate restorative materials for primary teeth.[73-79] Resins should be considered first for permanent teeth, as they provide better esthetics and wear resistance than glass ionomers. Glass ionomer and the resin "sandwich technique" was developed on the basis of the best physical properties of each.[80] A glass ionomer is used as dentin replacement for its ability to seal and adhere while covered with a surface resin because of its better wear resistance and esthetics.

Fluoride is released from glass ionomer and taken up by the surrounding enamel and dentin, resulting in a tooth that is less susceptible to acid challenge.[81-84] Studies have shown that fluoride release can occur for at least 5 years.[85,86] Glass ionomers can act as a reservoir of fluoride, as uptake can occur from dentifrices, mouthrinses, and topical fluoride applications.[87,88] This fluoride protection can be useful in patients at high risk for caries, which has led to the use of glass ionomers as a luting cement for SSCs, space maintainers, and orthodontic bands.[89,90]

Another application of glass ionomer cements where fluoride release has advantages is for the alternative (atraumatic) restorative technique (ART).[91] ART utilizes hand or rotary instruments for the removal of carious tooth structure, with the placement of glass ionomer to restore the tooth. ART was developed for caries treatment in children where resources were not available to provide traditional care.[92] Studies examining ART's effectiveness generally report on the restoration's retention.[93,94] ART may be used to restore and prevent dental caries in young patients, uncooperative patients, patients with special health care needs, and situations where traditional cavity preparation and placement of traditional dental restorations is not feasible.

Recommendations:

"Glass ionomers cements can be recommended as:

1. luting cements;
2. cavity base and liner;
3. Class I, II, III, and V restorations in primary teeth;
4. Class III and V restorations in permanent teeth in high risk patients or teeth that cannot be isolated;
5. caries control:
   a. high-risk patients;
   b. restoration repair;
   c. ART."[95]

Resin-based composites

Resin-based composite is an esthetic restorative material used for posterior and anterior teeth. There are a variety of resin products on the market, with each having different physical properties and handling characteristics based upon their composition. "Resin-based composites are classified according to their filler size, because filler size affects polishability/esthetics, polymerization depth, polymerization shrinkage, and physical properties."[96] Microfilled resins have filler sizes less than 0.1 micron. Minifilled particle sizes range from 0.1 to 1 microns. Midsize resin particles range from 1 to 10 microns. Macrofilled particles range from 10 to 100 microns. The smaller filler particle size allows greater polishability and esthetics, while larger size provides strength. Hybrid resins combine a mixture of particle sizes for improved strength while retaining esthetics. Flowable resins have a lower volumetric filler percentage than hybrid resins. Highly-filled, small particle resins have been shown to have better wear characteristics.[97-99]

Resin-based composites allow the practitioner to be conservative in tooth preparation. In pits and fissures, the carious tooth structure can be removed and restored while avoiding the extension for prevention removal of healthy tooth structure. Historically, this technique of restoration with preventive sealing of the remaining tooth has been described as a preventive resin restoration.[100]

Resins require significantly longer time for placement and are more technique sensitive than amalgams. In cases where isolation or patient cooperation is compromised, resin-based composite may not be the restorative material of choice.

Recommendations:

"Indications:

The dental literature supports the use of highly-filled, resin-based composites in:

1. small pit-and-fissure caries where conservative preventive resin restorations are indicated in both primary and permanent dentition;
2. occlusal surface caries extending into dentin;
3. Class II restorations in primary teeth that do not extend beyond the proximal line angles;
4. Class II restorations in permanent teeth that extend approximately one third to one half the buccolingual intercuspal width of the tooth;
5. Class III, IV, V restorations in primary and permanent teeth;

6. strip crowns in the primary and permanent dentition.

Contraindications:

The dental literature recommends that resin-based composites not be used in the following situations:

1. where a tooth cannot be isolated to obtain moisture control;
2. in individuals needing large multiple surface restorations in the posterior primary dentition;
3. in high-risk patients who have multiple caries and/or tooth demineralization and who exhibit poor oral hygiene and compliance with daily oral hygiene, and when maintenance is considered unlikely."[101]

Amalgam restorations

Dental amalgam has been used for restoring teeth since the 1880s. Amalgam's properties, such as ease of manipulation, durability, relatively low cost, and reduced technique sensitivity compared to other restorative materials, have contributed to its popularity. Esthetics and improved tooth color restorative materials, however, have led to a decrease in its use.

The durability of amalgam restorations has been shown in numerous studies, either as subject itself[102-104]or as a control.[105-108] Studies of defective restorations have indicated that operator error plays a significant role the restoration's durability.[108-110] For example, in Class II restorations where the proximal box is large and the intercuspal isthmus is narrow, the restoration is stressed and can result in fracture. In primary teeth, studies have shown that 3-surface mesial-occlusal-distal (MOD) restorations can be placed but that SSCs are more durable.[111,112] In primary molars, the patient's age can affect the restoration's longevity.[102-104,113] In children age 4 or younger, SSCs had a success rate twice that of amalgams.[104]

The decision to use amalgam should be based upon the needs of each individual patient. Amalgam restorations often require removal of healthy tooth structure to achieve adequate resistance and retention. Glass ionomer or resin restorative materials might be a better choice for conservative restorations, thereby retaining healthier tooth structure. SSCs are recommended for pulpotomized primary teeth. Yet, a Class I amalgam could be appropriate if enamel walls can withstand occlusal forces and the tooth is expected to exfoliate within 2 years.[114] SSCs may be the better choice in patients with poor parental compliance and questionable long-term follow-up.[115]

Recommendations:

"Dental amalgam can be recommended for:

1. Class I restorations in primary and permanent teeth;
2. Two-surface class II restorations in primary molars where the preparation does not extend beyond the proximal line angles;
3. Class II restorations in permanent molars and premolars;
4. Class V restorations in primary and permanent posterior teeth."[116]

Stainless steel crown restorations

Stainless steel crowns are prefabricated crown forms that are adapted to individual teeth and cemented with a biocompatible luting agent. "The SSC is extremely durable, relatively inexpensive, subject to minimal technique sensitivity during placement, and offers the advantage of full coronal coverage."[117]

Stainless steel crowns have been indicated for the restoration of primary and permanent teeth with caries, cervical decalcification, and/or developmental defects (eg, hypoplasia, hypocalcification), when failure of other available restorative materials is likely (eg, interproximal caries extending beyond line angles, patients with bruxism), following pulpotomy or pulpectomy, for restoring a primary tooth that is to be used as an abutment for a space maintainer, or for the intermediate restoration of fractured teeth.

In high caries-risk children, aggressive treatment of primary teeth with SSCs is better over time than multisurface intracoronal restorations. Review of the literature comparing SSCs and Class II amalgams concluded that, for multisurface restorations in primary teeth, SSCs are superior to amalgams.[118] SSCs have a reported success rate greater than that of amalgams in children under age 4.[104]

The use of SSCs also should be considered in patients with increased caries risk whose cooperation is affected by age, behavior, or medical history. These patients often receive treatment under sedation or general anesthesia. For patients whose developmental or medical problems will not improve with age, SSCs are likely to last longer and possibly decrease the frequency for sedation or general anesthesia with its increased costs and its inherent risks.

SSCs can be indicated to restore anterior teeth in cases where multiple surfaces are carious, where there is incisal edge involvement, following pulp therapy, when hypoplasia is present, and when there is poor moisture control.[119] When esthetics is a concern, the facing can be removed and replaced with a resin-based composite (open-faced technique). Several brands of primary SSCs are available with preformed tooth-colored veneers. These veneered SSCs can be more difficult to adapt and are subject to fracture or loss of the facing.

Recommendations:

1. "Children at high risk exhibiting anterior tooth caries and/ or molar caries may be treated with SSCs to protect the remaining at-risk tooth surfaces.
2. Children with extensive decay, large lesions, or multiple-surface lesions in primary molars should be treated with SSCs.
3. Strong consideration should be given to the use of SSCs in children who require general anesthesia."[117]

Labial resin or porcelain veneer restorations

A resin or porcelain veneer restoration is a thin layer of restorative material bonded over the facial or buccal surface of a tooth. Veneer restorations are considered conservative in that minimal, if any, tooth preparation is required. Porcelain veneers usually are placed on permanent teeth.

Recommendations:
Veneers may be indicated for the restoration of anterior teeth with fractures, developmental defects, intrinsic discoloration, and/or other esthetic conditions.[120]

Full-cast or porcelain-fused-to-metal crown restorations

A cast or porcelain-fused-to-metal crown is a fixed restoration that employs metal formed to a desired anatomic shape or a metal substructure onto which a ceramic porcelain veneer is fused. The crown is cemented with a biocompatible luting cement.

Recommendations:
Full-cast metal crowns or porcelain-fused-to-metal crown restorations may be utilized for:

1. teeth having developmental defects, extensive carious or traumatic loss of structure, or endodontic treatment;
2. as an abutment for fixed prostheses; or
3. for restoration of single-tooth implants.[121-123]

Fixed prosthetic restorations for missing teeth

A fixed prosthetic restoration replaces 1 or more missing teeth in the primary, transitional, or permanent dentition. This restoration attaches to natural teeth, tooth roots, or implants and is not removable by the patient. Growth must be considered when using fixed restorations in the developing dentition.

Recommendations:
Fixed prosthetic restorations to replace 1 or more missing teeth may be indicated to:

1. establish esthetics;
2. maintain arch space or integrity in the developing dentition;
3. prevent or correct harmful habits; or
4. improve function.[124-126]

Removable prosthetic appliances

A removable prosthetic appliance is indicated for the replacement of 1 or more teeth in the dental arch to restore masticatory efficiency, prevent or correct harmful habits or speech abnormalities, maintain arch space in the developing dentition, or obturate congenital or acquired defects of the orofacial structures.

Recommendations:
Removable prosthetic appliances may be indicated in the primary, mixed, or permanent dentition when teeth are missing. Removable prosthetic appliances may be utilized to:

1. maintain space;
2. obturate congenital or acquired defects;
3. establish esthetics or occlusal function; or
4. facilitate infant speech development or feeding.[127-129]

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