Restoration of primary anterior teeth: review of the literature

Jacob K. Lee, DDS, FRCD(C)
Dr. Lee is a pediatric dentist in private practice, San Clemente, Calif.
Correspond with Dr. Lee at leeway99@hotmail.com

Abstract

This paper reviews the published data on restorations of primary anterior teeth. The discussion includes Class III restorations, Class V restorations, various forms of full coronal restorations, atraumatic restorative technique (ART) and recommendations for future research.(*Pediatr Dent.* 2002;24:506-510)

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Over the years, there have been numerous articles published regarding the restoration of primary anterior teeth. They have announced various novel techniques of restoring carious lesions in the incisors. These techniques have been demonstrated in case reports, and the procedures have been illustrated in a step-by-step diagrammatic fashion. However, very little data exist on the longevity of these restorations in a clinical setting. Once a technique has been reported, very little clinical treatment outcomes have been assessed to determine whether these techniques are indeed successful. Many of the reports of successful outcomes remain anecdotal.

Class III restorations

Class III composite restorations have been utilized to restore mild to moderate interproximal carious lesions in primary anterior teeth.[1] However, due to the morphology of the pulp, dentin, and enamel, the primary incisors have enjoyed less retention of restorative material compared to the permanent teeth.[2] The pulp chambers of the primary incisors are comparatively much larger than the permanent teeth. Thus, the enamel and the dentin are much thinner. Consequentially, the pulp is much closer to the outer layers of the primary tooth. The depth of cavity preparation becomes very shallow, which may result in insufficient amount of restorative material, predisposing to the loss of restoration.[3] Although clinical data on restoring Class III carious lesions are minimal, the knowledge gained in the research of tooth adhesive systems has facilitated the procedure.

For many years, resins were assumed to be toxic to the pulp.[4,5] Moreover, it was believed that acid etching would result in pulpal necrosis. Thus, composites were considered unsafe and unpredictable. After numerous studies of direct placement of acid on the pulp tissue and total etching of the enamel-dentin preparation, it was concluded that composite resin exhibited only minimal toxicity, and the true cause of damage to the pulp was microleakage.[6-8] It is not the material itself, but the bacteria invading the interface of the restoration and gaining access to the pulp that causes pulpal inflammation and, occasionally, pulp death.

There has not been a lot of research on dentin and enamel bonding to primary teeth. Therefore, clinicians extrapolated the results observed in permanent teeth to primary teeth. Recently, more information is emerging, describing differences between the primary teeth and permanent teeth. Bonding techniques for primary teeth in turn have been altered to address the differences.

Dentin of the primary teeth is less mineralized, despite the presence of a gradient of mineralization.[9] Nör et al, discovered the dentin surface in the primary teeth to be more reactive to acid etching than permanent teeth, and the reported lower bond strengths found in primary teeth were attributed to a thicker hybrid layer that is not completely penetrated by the bonding agent.[10] They recommended that a shorter etching time for primary dentin be used to reproduce the hybrid layer seen in etched permanent dentin. In utilizing the total-etch technique, and with an etching time of 15 seconds, de Araujo et al, observed through SEM the formation of a resin-reinforced hybrid layer in primary teeth.[11]

Skaleric et al, reported the enamel of primary teeth to have more organic matter and less mineral salts.[12] They have a lower degree of microcrystal arrangement primarily attributed to the difference in time allotted for mineralization–1 year in the primary incisor and 7 to 8 years in the permanent incisor. Moreover, the prismless layer of primary teeth

does not respond well to acid etching. Corniff and Hamby recommended that a diamond bur be used to remove the enamel's prismless layer before acid etching.[13] To increase surface area, mechanical locks or slots were placed to prevent dislodgement of restorations. These dovetails were placed on the labial as well as the lingual surfaces.[14] Piyapinyo and White described an in vitro study of modifying the classic Class III cavity preparation by incorporating 0.3 mm deep labial reduction to simulate a veneer-like preparation.[2] Results showed that the modified technique exhibited greater bond strength than the conventional Class III restoration. Therefore, a larger surface area for bonding improves retention of the restoration to the tooth substrate. More data needs to be gathered to test this technique.

Resin-modified glass-ionomer cements have also been shown to be an effective restorative material for Class III restorations.[15] In circumstances where isolation of the tooth to be restored is difficult, particularly with very young children, glass ionomer cement or resin-modified glass ionomer cement is the restorative material of choice. Lack of isolation will cause resin-based composite restorations to fail, whereas glass ionomer cement can still set in the presence of water. A success rate of 100% has been reported in the literature where Class III resin-modified restorations had been placed and maintained intraorally for almost 4 1/2 years.[15]

Class V restorations

Resin-based composite is an ideal restorative material for Class V restorations. Composites maintain color, provide excellent esthetics and can be bonded to tooth structure with currently available adhesives used in conjunction with the enamel acid-etch technique. Although resin-based composite is the material of choice, adequate isolation is necessary for success of the restoration. Due to the young age of some children treated and associated behavior management difficulty, it is sometimes impossible to isolate teeth for the placement of composite restorations. In these cases, glass ionomer cement or resin-modified glass ionomer cement would be indicated. These glass ionomer cements can set in the presence of moisture. Croll et al, reported a 98% success rate with Class V resin-modified glass ionomer cement restorations placed in primary teeth with an average duration of 4.2 years at the time of his report.[15]

Full coronal coverage of incisors

Stainless steel crowns

Preformed stainless steel crowns (SSCs) are considered to be the most durable and reliable for restoring severely carious or fractured primary incisors. Croll described SSCs to be easy to place, fracture proof, wear resistant, and attached firmly to the tooth until exfoliation.[16] The main disadvantage is the unsightly, silver metallic appearance. As the population becomes more conscious of esthetics, these SSCs have become less desirable. Croll reported that some parents did not mind the appearance of the SSCs; however, others preferred to have the incisors extracted if the SSCs were the only restorative option.

Facial cut-out stainless steel crowns

One enhancement in appearance is the placement of a resin or composite material in a labial fenestration of SSC.[17-19] Although this technique is a dramatic improvement over the plain metallic appearance of stainless steel, the procedure is time consuming and metal margins can still be seen.[20] Clinicians still have to contend with hemorrhage control during application of composite facings. No clinical data of this procedure is published.

Resin-veneered stainless steel crowns

Recently, resin-veneered SSCs have been introduced. In these crowns, the composite resins and thermoplastics are "bonded" to the metal. Waggoner and Cohen, in 1995, tested 4 brands of veneered SSCs, Kinder Krowns, Whiter Biter Crown II, NuSmile, and Cheng Crowns.[21] They found that veneers on the Whiter Biter II exhibited the greatest shear force and retention compared to the other brands. They believed that in Whiter Biter Crown II, the plasticity of the veneer material on the crown allows the material to flex under force. Moreover, the meshwork was spot welded to the crown. Then, the veneer material was poured onto the mesh, mechanically retained via finger-like projections incorporated into the meshwork.

Baker et al, tested the shear bond strength of the same 4 brands of resin-veneered crown that Waggoner and Cohen tested.[22] It is interesting to note that, unlike Waggoner and Cohen's study, Baker et al, found that the Whiter Biter Crown II group exhibited the least amount of shear bond strength. The difference in the data may be due to the fact that Baker's study soaked the crowns for 90 days prior to thermocycling. Water sorption may have influenced the bond strength of certain resin veneers.

Al-Shalan et al, studied repairing the fractured labial veneers in vitro.[23] Of the 5 bonding agents used, that is, Multipurpose Adhesive bond (3M Dental Products), Ellman adhesive (Ellman Int.), Ceramic Adhesive system (Ceramco, Inc.), All-Bond adhesive system (Bisco Dental Products), and Caulk Adhesive system (Dentsply Int., Inc.), the highest rebond strength was achieved with the Caulk system. It is interesting to note that there was no statistically significant difference between the group that received mechanical preparation with diamond vs the unprepared group.

Other problems exist with these preveneered crowns. Crimping these crowns can fracture the veneers, and the crowns are expensive. It is unknown what effect heat sterilization has on the bond strength of these materials. Manufacturers recommend cold sterilization of these crowns. Wickhersham et al, has shown that preveneered Kinder Krowns and Nu Smile SSCs can undergo heat sterilization without deleterious effect on their bond strength

or color.[24] They noted that the only significant decrease in fracture resistance was demonstrated in the Kinder Krowns group that had undergone cold sterilization in 2% gluteraldehyde, which was the method advocated by its manufacturer. Armed with such information, hopefully the dental manufacturers will continue to test their products to recommend appropriate handling techniques.[16,25]

Roberts et al, examined the durability of 38 Whiter Biter II preveneered stainless steel crowns placed during general anesthesia. On the crown age average of 21 months, 6 (8%) crowns showed partial loss of facial veneer, and 9 (24%) crowns showed complete loss of the resin facing.[26] Failures occurred most commonly at resin-resin and resin-metal interface. Statistically, a larger overjet of the incisors increased the likelihood of resin veneer failure. Although most parents of the study were satisfied with the crowns, they expressed concern over the large size, color, and visualization of some metal.

More recently, a resin-veneered crown—Dura Crown (Success Essentials Space Maintenance Laboratory, Chatsworth, Calif)—was introduced. This crown has the labial gingival margin crimped and resin adapted to the gingival edge of the anterior aspect of the crown. At this time, no data is available to indicate more favorable outcomes than other veneered SSCs.

Some have recommended chairside veneering of composite resin to anterior SSCs.[27,28] Although the adaptability of the crown to the tooth has been largely improved, the main disadvantage with this procedure is the longer chair time. Investigators reported placement of 80 such crowns in one year. They highlighted that this technique was an overwhelming success with the parents and patients. Long-term clinical data remains to be seen.

Cementation of stainless steel crowns

The luting cements for SSCs have undergone tremendous improvements. Traditionally zinc phosphate, polycarboxylate, and reinforced zinc oxide eugenol have been used to cement the SSCs to seal the crown margins. However, newer materials with superior physical properties of adhering to tooth structure and releasing fluoride are now available. Shiflett and White determined that dentin bonding agent, resin-modified glass ionomer, adhesive composite resin cement, and glass-ionomer cement significantly reduced microleakage compared to the traditional cements.[29] This could enhance the clinical efficacy of all forms of SSCs.

Polycarbonate crowns

Polycarbonate crowns are heat-molded acrylic resin used to restore anterior primary teeth.[18] Although more esthetic than the SSCs, the polycarbonate crowns do not resist strong abrasive forces, leading to occasional fracture or dislodgement.[30] They have merely paved the way for the development of strip crowns. No long-term studies of polycarbonate crowns are available.

Strip crowns

Composite crowns (strip crowns) using celluloid crown forms are a popular method of restoring primary anterior teeth.[31] These composite crowns provide superior esthetics than other forms of anterior coronal coverage. Because it is a popular procedure, the expectation is that there would be a plethora of clinical data on its clinical efficacy. Although the technique has been well described, surprisingly, very little clinical data exists on the longevity of these crowns.[31-33] The procedure is very technique sensitive, and any lapses in patient selection, moisture and hemorrhage control, tooth preparation, adhesive application and resin composite placement can lead to failure.[34] The difficulty in application is reflected in a study that only 21% of general dentists surveyed perform strip crowns compared to 73% of pediatric dentists.[35]

Because the composite crown relies on dentin and enamel adhesion for retention, if a lot of tooth structure is absent, the longevity of the crown is jeopardized. Over time, various techniques have been advocated to overcome the loss of a crown. Some have incorporated mini pins.[36] Others have used "short posts" in pulpectomized primary anterior teeth for additional retention. Judd et al, tested retention of strip crowns on 92 teeth that have received pulpectomy.[37] Composite core-post was constructed to reinforce the remaining crown dentin. Although they encountered recurrent caries and severe bruxism, they showed no failures of retention of the short posts in a 1-year period.

It is true that, because numerous new dentin adhesives have been introduced in recent years, the material used in the fabrication of strip crowns have constantly undergone modifications. Nevertheless, as evidenced by lack of long-term clinical information, clinicians appear to be informed with "how-to" aspects, rather than longitudinal scientific data.

Artglass crowns

Artglass (Kulzer) is a current material advocated for restoring anterior primary teeth. It contains bifunctional and new multifunctional methacrylates forming a cross-linked, three-dimensional polymer.[38] Although it is 75% filled compared to the conventional 85% filled composite resin, the unique filler materials of microglass and silica are purported to provide greater durability and esthetics than composite strip crowns. They are available in one shade and in 6 sizes for primary central, lateral and cuspid teeth.

Updyke studied 95 Artglass crowns that he placed in a 2-year period.[39] Of 95 crowns, 79 received Alfa (representing clinically ideal), 11 received Bravo (representing clinically acceptable), and 5 received Charlie (representing clinically unacceptable) ratings. The vast majority of the failures were due to bond failures. The difficulty in interpreting this data is the absence of an independent observer and the fact that the dentin adhesive was changed to a different product during the study. Nevertheless, this study

format illustrates how a clinician can initiate a pilot study in evaluating his or her own procedures to establish a more substantive investigation.

Atraumatic restorative treatment

Atraumatic restorative treatment (ART) involves removal of carious lesions by hand instruments followed by restoring the cavities with a fluoride-releasing restorative material.[40] This technique has been lauded as limiting the progression of carious lesions where access to dental care is limited. However, there is little available data on the success of ART for managing caries of primary anterior teeth in clinical setting.

Maintenance

Long-term success of anterior restorations for primary teeth is not the mere means of removing carious lesions and restoring with esthetic materials. Maintenance of these restorations by the patients and their parents is critical to prevent failure. Caries in the primary anterior teeth are largely due to early childhood caries (ECC). Efforts to prevent caries in this population by educating parents and caregivers regarding the cariogenicity of nocturnal and at-will feeding practices have experienced limited success.[41] Education alone appears be inadequate. The parents must be motivated to alter their feeding behavior patterns.

Almeida et al reported that of the children with ECC who underwent dental treatment under general anesthesia, 79% had detectable carious lesions at subsequent hygiene visits, and 17% required retreatment under general anesthesia within 2 years following comprehensive dental rehabilitation.[42] The prognosis of the best professional treatment in the absence of knowledge on how other factors influence the long-term clinical performance of restorations remains guarded.

Clinicians need to have the appropriate information to sufficiently inform and motivate the parents/guardians to improve oral hygiene as well as understand the impact of a cariogenic diet.[43] Future caries susceptibility implies future failure of current restorations. Therefore, clinical trials should not be restricted to assessment of certain techniques, but include studies of peripheral factors that shape the clinical outcome of restorations as well.

Summary

Due to the lack of available clinical data, it is difficult to determine whether certain techniques of restoring carious primary anterior teeth are effective. Unfortunately, some anecdotes have become synonymous with scientific data. Objective clinical measurements of performance are much needed. McCoy et al, contend that, even in clinical trials, 1- or 2-year clinical results may not be sufficient to accurately predict 3-year results.[44] To complicate the matter, by the time the results are published, the materials used for the research may no longer be available, making the data outdated.

Thus, systematic outcome measures and data collection methods that can withstand the test of time are vital to ascertain which restorative techniques are indeed successful.[45] Clinicians need to be trained to undertake proper clinical trials, multi-center format studies need to be created to gain a sufficient sample size number, and adequate research funds need to be obtained to complete these investigations. Ultimately, the results must be published. Until that moment, the dental procedures continue to remain unstudied, and difficult to justify.[46]

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