



The Selection of Contemporary Restorative Materials: Anecdote vs. Evidence-Based?

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Abstract

The contemporary practitioner is faced with a bewildering number of options from which to choose when selecting restorative materials. There are not only many different types of materials available, but also numerous options for any given group of materials. For example, many manufacturers offer their customers three or even four different dentin bonding agents. The sheer number of available products is in itself overwhelming. When coupled with aggressive marketing strategies, misinformation supplied by paid clinicians at many seminars and lectures, and infomercials disguised as scientific articles in many of the trade journals, it is little wonder that the average ethical practitioner is frustrated when attempting to make rational choices.

Clinicians use information gleaned from a variety of sources to make these difficult decisions. This article will attempt to evaluate the validity of these sources and will provide a philosophical matrix to assist the practitioner in making rational decisions relative to materials selection.

One of the parameters that is frequently used to differentiate materials from one another is in vitro data related to their physical properties. It is imperative clinicians understand that differences between material in terms of physical properties are very poor predictors of clinical performance.¹⁻³ Substantial improvements in physical properties do not necessarily translate into improvements of clinical performance. For example, existing hybrid composite resin materials have adequate compressive strength. A new material with three times that compressive strength will not perform better clinically, because existing materials already exceed the critical threshold for this parameter.

It is very fashionable today to demand that dental professionals practice “evidence-based” dentistry. While this principle is clearly important, it is also critical to understand that very little of what oral health care providers do clinically has a solid, unam-



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biguous evidence base supporting it. The epitome of “evidence-based” is a meta-analysis of prospective randomized controlled clinical trials. Very few properly constructed clinical trials have been conducted, which precludes the existence of acceptable meta-analyses. Thus, accessing an “evidence-base” is neither simple nor straightforward.

However, “evidence” does exist and is available. It does require that knowledgeable “experts” gather and synthesize information from a variety of sources, and then disseminate that information in a responsible manner to practicing dentists. This process specifies significant professional and ethical responsibilities for both the “expert” and the practitioner who is the consumer of the information.⁴ Both the expert and the consumer must recognize the potential for selective bias when referencing studies to support a specific material or technique.⁵ Both must also be responsible for critically evaluating the scientific validity of referenced studies.

Sources of Information

There are numerous potential sources from which a clinician can gain information that contributes to the evidence-base supporting or refuting use of a material or technique. It is important that practitioners understand that the power or validity of the information varies considerably with the source. At the top of the list are prospective clinical trials published in peer-reviewed journals.⁶ These studies are evaluated by an editor-in-chief, a section editor, and then by two or more “experts” in the discipline. These experts have a reasonable, but not automatic, chance at identifying deficiencies in the experimental method or statistical analysis. As a result, many articles describing many deficient studies are rejected and do not become part of the recorded literature. However, many studies that have significant deficiencies do get published. Frequently, the

conclusions reached in these articles are not supported by the data. Often these inaccurate conclusions are quoted by other authors, and the misconceptions are perpetuated. The intelligent clinician must understand that just because something is in the literature, it doesn’t necessarily mean it is correct.

Thus, the contemporary clinician, by necessity, must be a critical consumer of the literature, and indeed of any information received from all sources.

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In this regard, it is important to realize that practitioners in the real world have multiple roles to play. They must manage a significant small business, supervise a diverse staff of auxiliaries, keep up with changes in materials and techniques, and also maintain a semblance of a normal life. It is difficult, if not impossible, for the average practitioner to juggle all of these responsibilities, and thus, it is unrealistic to expect them to keep up with the peer-reviewed literature on a meaningful basis. This places increased responsibility on “experts” to supply factual, well-supported information to clinicians.

A lower level of validity is assigned to in vitro laboratory studies. As mentioned earlier, studies evaluating basic physical properties of materials are not particularly useful in predicting clinical performance. (Personal communication,

Dr. J. Robert Kelly, American Academy of Restorative Dentistry, 2002.) In vitro laboratory studies evaluating parameters such as marginal integrity, bond strengths, etc. can provide important information and evidence, but these should eventually be supported by corroborating clinical evidence.

An important factor in evaluating the relative validity of an in vitro study is the mode of testing. Most clinical failures that are not a result of recurrent caries are mechanical failures due to fatigue of either the restorative material or the tooth/restoration complex. Load-to-failure studies do not test either teeth or materials in the manner in which they fail, and thus have minimal validity and provide little valuable information to clinicians. Fatigue studies come much closer to mimicking intraoral conditions. Such studies are clearly more difficult to carry out, but have considerably more predictive value. These studies also must be carefully scrutinized to ascertain that meaningful forces were used, and that additional procedures such as thermocycling, etc. were carried out.

Another type of article that is frequently cited as “evidence” is a review article. These articles can be of considerable value in terms of quickly learning what is known about a given material at a specific point. However, often review articles suffer from an inherent bias that may be held by the author(s), and the reader should be aware of such deficiencies. Case studies and case reports may describe a new technique or reveal useful clinical tips, but are considered relatively light on the evidence scale.

The alternative sources of information have relative levels of validity. Trade journals and tabloids generally publish biased infomercials, often with full-page advertisements for the material described in the article appearing within the body of the article.

Newsletters can provide information on handling characteristics of a product, packaging details, accuracy of shades, etc., but generally have minimal scientific validity. The Internet is a source of information, but unfortunately, bad information seems to be more readily available than good information. One site that has proven invaluable in the past few years is the U.S. Air Force Dental Investigation Service, (<http://www.brooks.af.mil/dis/>).⁷ This is a free, unbiased site that provides excellent information on new products in a timely manner.

The Role of Postdoctoral Continuing Dental Education

Most clinicians obtain a majority of their information on new products by attending various types of continuing education programs. These include dental society meetings, university-sponsored courses, study clubs, private institutional programs, symposia, and a host of electronic alternatives. The truth is, these courses and programs vary widely in their validity and content. Again, the clinician must be a critical consumer of continuing dental education, and must hold presenters responsible for providing scientific documentation to support their statements. Lecturers must properly disclose financial relations related to any of the products they are recommending. The increasing tendency for local societies to request funding from manufacturers and suppliers for their scientific meetings has the potential to reduce the program to infomercial status due to speaker bias.

One benefit of mandatory continuing dental education is the fact that previously isolated practitioners get to communicate with each other. Never underestimate information that is received from respected colleagues. In this regard, the optimum continuing education program is an ongoing study club where practitioners with a specific

interest get together on a regular basis for a prolonged period. Peer learning in these situations can be very powerful. Critical evaluation of one's own successes and failures is also a valuable tool.

Finally, some materials have simply passed the test of time, and even though they have never been the subject of valid clinical trials, they are considered to be "acceptable" because they have a long history of use. Zinc phosphate cement is a classic example. There have

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been many in vitro laboratory studies published related to zinc phosphate cement, but almost no valid clinical trials. Yet, it has been used successfully for more than 100 years, and is considered the gold standard to which all other cements are compared.⁸

Technique Sensitivity of Dental Materials

One critical factor in deciding whether or not to use a specific material is its relative level of "technique sensitivity."⁹ A material can be described as technique-sensitive when different clinicians achieve significantly different results when using it. Silver amalgam is a material with very low technique sensitivity because clinically acceptable results can be achieved by almost all operators.¹⁰ Placing composite resin restorations in posterior teeth can be

described as technique-sensitive due to inherent difficulties in isolation, selection and manipulation of bonding agents, and factors related to controlling polymerization shrinkage stresses. Because of these variables, different clinicians achieve very different results with the resulting restoration. Cast gold is also a technique-sensitive material.¹¹ Clinical trials of cast gold have demonstrated equivocal results.¹²⁻¹⁶ The difference in the results of these trials is likely a result of variability in the ability of the operators.

A rule of thumb that should be considered when selecting materials is that materials that are considered technique-sensitive should only be used where there is a well-defined advantage to be derived from using them. For example, glass ionomer cement is considered by some authorities to be more technique-sensitive than zinc phosphate cement. The primary advantage of glass ionomer is fluoride release that **might** provide some protection against recurrent caries. It would be rational to use glass ionomer cement to cement castings in a patient who is caries-prone, but probably not rational to use it in a patient who is relatively resistant to dental caries. Thus, another useful principle to be considered when selecting a dental material is that unless there are specific indications for a specific product, the least technique-sensitive material should be utilized.

Product Packaging

A final consideration that is used when selecting a product is the packaging of the product. In situations where multiple products have similar utility, one product may be selected because the clinician prefers the packaging of that product. Many practitioners prefer a uni-dose approach and thus may select one brand of composite resin over another because it is available in uni-dose and the other isn't. Some dental



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cements are supplied with a dispenser that extrudes equal amounts of base/catalyst, which simplifies the mixing procedure and permits dispensing variable amounts of cement so that simultaneous cementation of multiple casting is possible if desired. Some cements are supplied in a precapsulated auto-mix form which may be preferred by some dentists. Similarly, a clinician may well select an impression material because it is available with an auto-mix system.

The preceding discussion described the basic information base that may be utilized to select restorative materials. The following examples will illustrate a thought process used for the selection of dental cements and composite resins.

Dental Cements and Luting Agents

There are many different dental cements available to the clinician. Literally, hundreds of articles have been written on this subject and countless studies have been described in the literature. A relatively small number of studies have been properly conducted clinical trials, so the clinician must synthesize information from various sources when considering product choices.

Laboratory studies related to apparently important physical properties provide little illumination to the clinician. There are differences between available cements in terms of compressive strength, diametral tensile strength, adhesion to the tooth structure, solubility, film thickness, etc., but there is no evidence of improvements in any of these physical properties results in improved clinical performance.¹⁷⁻²¹

Clinical studies have been conducted comparing solubility and post-cementation sensitivity with different cements.²²⁻²⁵ While differences in solubility are apparent, it does not seem that they are clinically significant with restorations possessing acceptable fit, nor does it appear that the improve-

ments in solubility can compensate for poor fit. It also appears that the post-cementation sensitivity anecdotally reported with both zinc phosphate cement and glass ionomer cement is operator-related and can be prevented with proper technique.²⁶⁻³²

Thus, it seems that the major determining factors in selecting a dental cement are a history of successful use and relative differences in technique-sensitivity. Both zinc phosphate and resin-modified glass ionomer cements

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have a long history of successful clinical use, are relatively easy to manipulate, and lack significant technique sensitivity. Conventional glass ionomer cements have certainly been used successfully, but are considered by some to be more technique-sensitive than zinc phosphate or resin-modified glass ionomers. It seems reasonable to recommend that metal restorations, including cast gold and porcelain-fused-to-metal crowns be cemented with either zinc phosphate or resin-modified glass ionomer cement. The choice between these two groups of materials can essentially be based on operator preference. In that regard, contemporary dispensing systems have made the resin-modified glass ionomer materials very easy to use and hence they have become extremely popular.

Resin cements are generally more technique-sensitive than conventional cements and resin-modified glass ionomer cements. Important variables with these cements include maintenance of a dry field, working times, ultimate

film thickness, flow of the cement and removal of excess cement. These cements should be utilized only in specific clinical situations where the benefits accruing from use of the cement warrant the risk entailed. These situations include the cementation of Maryland fixed-partial dentures, etchable all-ceramic crowns, ceramic or composite inlays and onlays, and laminate veneers.

Composite Resin Restorative Materials

Composite resin restorative materials have been available for close to 50 years. These materials, when bonded to tooth structure with the appropriate adhesives, have made the concept of minimally invasive dentistry a reality. The literature related to composite resins is voluminous, as they have been extensively evaluated in both laboratory and clinical studies. Studies comparing physical properties of composite resin materials do little to assist the clinician in making an appropriate selection. However, such studies have determined that micro-filled composite materials have a low elastic modulus. This limits their use in stress-bearing situations (posterior teeth, Class IV restorations), but makes them the material of choice for the restoration of abfraction lesions. Many believe such lesions are at least in part caused by tooth flexure, and a low modulus material seems to perform better than a more rigid material in those situations.³³⁻⁴¹

Studies evaluating flowable composites have demonstrated that these materials have generally poor physical properties and excessive polymerization shrinkage. The physical properties and shrinkage vary considerably from material to material, and the differences are related to the wide range of filler content of these products. This combination of poor strength and wear resistance, coupled with high shrinkage would seem to restrict the use of flowables. The primary

use for a flowable composite resin would be as a lining material with posterior composite restorations.

Clinical trials with posterior composite resin materials have established that materials with a high filler content using small filler particles will perform well in small to intermediate cavity preparations. Wear of such materials ranges from six to 15 microns per year and most modern hybrid composite resins demonstrate substantially equivalent performance. Trends in recent years have tended toward the development of hybrid composites that are highly filled (> 75 percent) with filler particles that are getting smaller and smaller.

Recently a nano-filled composite resin material (Filtek Supreme Plus, 3-M/ESPE, St. Paul, Minn.) was introduced into the North American market. This material has a high filler content of very small filler particles. The material polishes very easily, resulting in excellent esthetics, and it is expected to display excellent wear resistance. It has a slightly lower elastic modulus than traditional hybrid composites, and this raises two important questions. Is the modulus low enough to recommend use of the material in abfraction lesions? Will the lower elastic modulus have a negative effect on clinical performance for posterior restorations? Laboratory studies cannot provide answers to these questions. It is simply not known what the threshold is, positive and negative, relative to the elastic modulus. The answers can only come from data generated in clinical trials.

Because modern hybrid composites display equivalent performance, choice of materials is based on operator preference. Factors that might be important in this regard include handling characteristics, availability of shades, packaging or even price. With these materials, manipulation is far more critical than material selection. Critical manipulative variables include obtaining adequate

Table 1

Matrix for introduction of new materials

- Wait for independent clinical evidence.
- Ask the “experts.”
- Understand the materials or system.
- Practice with the material prior to using it with patients.
- Proceed with caution.

isolation, proper etching of the enamel and dentin hybridization, incremental placement of the composite material, and proper finishing techniques. Techniques to reduce or minimize stress at the bonded dentin surface should be considered. These include use of a thin liner (0.5 mm.) of flowable composite, use of a resin-modified glass ionomer liner, use of a soft-start polymerization technique, and incremental build-up or sectioning techniques to reduce the “c-factor” effect inherent with certain cavity preparations.

Summary

In summary, materials selection in restorative dentistry has become increasingly complex. Clearly, it is desirable that “evidence-based” dentistry is practiced, but clear, unambiguous evidence is not available for many materials. There is evidence available for most materials, but it must be synthesized from data from a variety of sources. It is likely unreasonable to expect the average practitioner to keep up with the peer-reviewed literature, so “experts” play a significant role in this regard. “Experts” have a responsibility to disclose financial affiliations and to present factual, unbiased presentations backed by what scientific evidence is available. Dentists have a responsibility to be critical consumers of continuing dental education, and are encouraged to get involved in a study club activity.

Ultimately, the responsibility for

proper materials selection rests with the clinician. Practitioners must have the discipline to decline use of a material until there is clinical evidence to demonstrate its utility. For example, the new nano-composite material described above may well prove to be an improvement over traditional hybrids. However, there is a possibility that clinical performance could be inferior to that of hybrids. Because the hybrid materials have performed well for some period of time, clinicians would be wise to wait until at least short-term clinical data is available to support use of the new material.

The following “matrix” is included (see **Table 1**) to assist the practitioner in making choices related to newly introduced dental materials:

■ Wait for independent clinical evidence before using a new product. Sharer’s criteria for all-ceramic restorations seem applicable to most materials.⁴² He suggests that materials be tested for a minimum of three years, optimally five years, and have a success rate of 95 percent or better at these time frames. If the supplier cannot provide the evidence, be disinclined to try the product.

■ Ask “experts” in the discipline what their opinions and experiences are with the product. They have often had experiences with the product for substantial time periods prior to formal commercial instruction to the profession.



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■ Before using the product, make certain you understand its composition, indications and contraindications and any critical manipulative variables. For example, many all-ceramic crowns require specific tooth preparation and cervical margin designs, as well as specific cementation protocols. Failure rates may be excessively high if these specific details are not followed.

■ Practice with material on extracted teeth prior to using it in a patient. Many materials have specific handling characteristics that should be known before using them in vivo.

■ Proceed with caution. Try the material in a few situations where it might clearly be indicated and critically evaluate the short-term results. Then try it in a situation where one might be “pushing the envelope” slightly, and again evaluate the results. When satisfied with these results, incorporate the material as indicated into the practice.

The choice of dental material to be used in any specific clinical situation will depend upon the complex interaction of a number of factors. The clinician must be responsible for understanding the nature of materials available, and must communicate the available choices to the patient so that informed consent may be given. Finally, the clinician must understand the critical manipulative variables with any specific material so that optimum performance of that material will result.

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