CALLS TO ACTION

It is hard to believe that it has been more than seven years since the Office of the Surgeon General issued its national call to action to promote dental health. The call to action proposed five separate initiatives:

1. Change perceptions of oral health by the public, policymakers, and health providers.
2. Overcome barriers by replicating effective programs and proven efforts.
3. Build the science base and accelerate science transfer.
4. Increase the oral health workforce diversity, capacity, and flexibility.
5. Increase collaboration between the private sector and the public sector.

The American Dental Association has responded in many ways, including convening an access to dental care summit in 2009. This summit had representatives from a wide variety of groups interested in oral health and the delivery of dental care. The common goal was to identify a number of solutions for providing access to care for vulnerable populations. One of the suggested solutions included motivating private practitioners to provide care to lower-income patients at reduced fees through such programs as Medicaid, which would involve an increased collaboration with non-dentists. A second suggestion was the increased use of auxiliary help in the provision of care.

It was also strongly suggested that a means be found to alleviate some of the educational debt burden of recent dental school graduates. It was felt that this debt forces many graduates to make career choices that are based on economics rather than on locating where oral health services are most needed.

The ADA has also promoted a number of public information programs such as ***Give Kids a Smile***. These types of programs keep the oral health message in the public eye with the impetus of increased awareness resulting in increased action.

The Massachusetts Dental Society has also responded with its own ***Call to ACTION***, a plan for improving the oral health of Massachusetts residents by the year 2013. The plan has three basic goals:

1. Educating the public about the correlation between oral health and systemic health.
2. Improving access to care by such means as increasing participation in MassHealth, creating new dental auxiliary positions, increasing the capacity of community health centers, finding a means to help with loan repayment and tuition reimbursement, involving dental schools in community service programs, and increasing the involvement of retired dentists in providing care to the underserved.
3. Advocating for prevention programs.

New programs and change take time. It is gratifying that an effort is being made to improve the public perception of how our profession is addressing the problem of providing care to the underserved. It is also gratifying that we are moving in the direction where programs are going from the planning stages to actually providing continuous care. ■

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Arthur I. Schwartz

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GOT STOCK? THE LONG AND SHORT OF CAPITAL GAINS

If you buy or sell shares of stock, you need to be familiar with the rules that govern the way capital gains are taxed. That's because the amount you owe in tax can depend on a number of factors, including the length of time you hold the shares and the federal income tax bracket you're in. Here are the basics.

Basis and Holding Period

"Basis" refers to your investment in the shares of stock you hold. Generally, your basis is the amount you paid for the stock, plus any commissions you paid to purchase the shares. (Note, however, that special rules apply if you received the stock as a gift or as part of an inheritance.) If you sell a share of stock and the sales price—less any commission—is more than your basis, you have a gain; if the amount you receive is less than your basis, you have a loss.

Your holding period is generally the length of time that you hold a share of stock before you sell or exchange it. If you hold a share of stock for a year or less before selling it, any gain you have is short-term capital gain. If you sell a share of stock after holding it for more than a year, any gain is long-term capital gain. Your holding period typically starts on the trade date the share is purchased, and ends on the trade date it's sold.

Short-term Capital Gain

Short-term capital gain is treated as ordinary income, just like interest on your savings account or wages from your employer. It's added in with all of your other income, and the amount of federal income tax you owe depends on the federal marginal income tax bracket you're in. For example, if you're in the top tax bracket in 2010, you'll pay tax on ordinary income at a maximum rate of 35 percent.

Long-term Capital Gain

If you sell shares of stock that you've held for more than a year, any gain is long-term capital gain, and special maximum tax rates apply. If you're in the 10 or 15 percent marginal income tax bracket in 2010, you'll pay no federal income tax on long-term capital gains (a "0 percent tax rate" applies). So, for single individuals with taxable income of $34,000 or less ($68,000 for married individuals filing jointly), long-term capital gains are free from federal income tax in 2010.

For those who aren't in the lowest federal income tax brackets (i.e., those in the 25, 28, 33, and 35 percent brackets), a 15 percent maximum tax rate generally applies to long-term capital gains. There are limited cases, however, when individuals in the higher tax brackets can still benefit from the 0 percent tax rate. For example, a retired couple with taxable income of $60,000 would be in the 15 percent marginal income tax bracket in 2010 if they were to file jointly (the bracket covers married couples with taxable income less than or equal to $68,000). The couple sells stock, resulting in a long-term capital gain of $40,000. This increases their taxable income to $100,000, placing them in the 25 percent marginal income tax bracket. In this situation, they would pay no federal tax on the first $8,000 of long-term capital gain, and the maximum 15 percent rate would apply to the remaining $32,000 in gain.

Offsetting Gains with Losses

Any capital losses that you may have realized during the year can offset some or all of your capital gain. If your losses offset all capital gains, any excess capital loss can be applied against up to $3,000 of ordinary income ($1,500 for married individuals who file separately), and any unused capital loss can be carried forward to future years.

Big Exception: Retirement Plans, IRAs

All of this assumes your stock is not being held in a tax-advantaged retirement account like a 401(k) plan or IRA. Special tax rules apply to investments, including stock, held within these plans. If you sell shares of stock within one of these plans, there's no immediate tax consequence. Instead, you'll generally pay federal income tax when you take withdrawals from the plan, and any income will be considered ordinary income—even if the earnings are attributable to capital gains. (Certain Roth retirement plans and Roth IRAs provide for tax-free treatment of qualified withdrawals.)

Uncertainty in 2011

The special federal income tax rates that currently apply to long-term capital gains expire at the end of 2010. Absent new legislation, in 2011, individuals in the 15 percent tax bracket (under current law the 10 percent bracket disappears in 2011) will pay tax on long-term capital gain at a rate of 10 percent. For everyone else, a 20 percent rate will generally apply. Special rules (and slightly lower rates) will apply for qualifying property held five years or more.

Small Business Stock

Special rules apply to qualified small business stock. Generally, a portion of any gain realized upon the sale of qualified small business stock held for more than five years can be excluded from income. The portion of the gain that is not excluded from income is generally taxed at a maximum rate of 28 percent. For additional information, see IRS Publication 550. ■

GEORGE GONSER
Mr. Gonser is CEO of MDSIS–Spring Insurance Group.

OPTIONS ARE GOOD IN THE HEALTH INSURANCE MARKETPLACE

One of the main challenges of the Massachusetts and national health care reform efforts is to control costs. The Massachusetts effort has, for the most part, been a rousing success. Nearly 98 percent of Massachusetts residents are covered by a qualified insurance plan. The costs of these plans, however, have risen more than 100 percent since 2000. It is a noble cause to get as many people covered as possible, but if the costs are not brought under control, will people be able to afford health insurance at all? This is the paramount issue.

So what are some of the ways to cut these costs? Well, if you think the answer is merely capping the insurance premium increases, as we have seen happening here in Massachusetts, that is not enough. Carriers will buckle under the weight of artificial caps, and fewer health plans will provide coverage in the state if that is the long-term solution. Is the answer to just cut provider contracts? This has dangerous repercussions in providing proper and top-notch care and having the requisite funds to spur innovation and research. Additionally, the role of the consumer in his or her own health care management needs to be considered. What if there was a plan that offered a solution? One local carrier thinks it may have the answer.

Blue Cross Blue Shield of Massachusetts is marketing a plan called Blue Options that integrates a unique approach to the health insurance marketplace. (At MDSIS–Spring, we are an equal opportunity proponent of the local carrier community. We work with all the carriers and have had excellent relationships with them for many years. We are the first to criticize and the first to give praise when it is due, with no restrictions.) Blue Options is not a new product to the market; it is actually in its third iteration. In a nutshell, the Blue Options product is designed to engage subscribers in the decision-making and cost-sharing aspects of insurance based on cost and quality measures. The plan is designed around a tiered network of primary care and acute care hospitals that allows members to choose where they receive care. The catch is that the cost sharing is higher for providers deemed to be high-cost or low-quality.

There are three tiers that make up the quality/cost matrix: Enhanced Benefit Tier (met quality benchmark, low-cost benchmark), Standard Benefit Tier (met quality benchmark, moderate-cost benchmark), and Basic Benefit Tier (scored below quality benchmark, moderate-cost benchmark). The plan places the providers and acute care hospitals into one of the three tiers based on how they score on cost and nationally accepted quality measures. The subscribers make their choice and, according to the tier at which the selected provider is rated, will pay based on that tier rating. For example, subscribers electing to utilize a provider in the Basic Benefit Tier will have larger out-of-pocket expenses than if they use a provider in the Enhanced Benefit Tier. Simply put, utilizing a higher-quality, lower-cost provider (Enhanced Benefit Tier) will cost subscribers less.

There are three important ramifications concerning the adoption of this product—consumer interaction, streamlining of the provider contract, and payment design and premium cost savings. For consumer interaction, this product continues the move toward a more consumer-driven health plan where consumers are more actively engaged in managing and directing their care and its cost. The product creates a more balanced provider contracting approach that puts the onus on the providers to strive for a higher-quality, competitively priced product and service model. Finally, the cost of such a plan is about 10 percent less than a $1,000-deductible plan, so it is being priced competitively.

All three segments of the market (provider, consumer, and insurance carrier) are being targeted with this progressive product model. With the contracting being done on an annual basis, lower-end providers can make improvements that can move them into higher tiers in the future. Consumers will have to make decisions on their current portfolio of providers: Should they continue to pay for providers who are in a more expensive tier that will cost them more, or should they switch to providers in a tier that will save them money? Finally, will the insurance carriers price the product aggressively enough to make the change worthwhile? While the product has seen average adoption thus far, the challenges with premium increases and health care reform should make this product one to watch and investigate going forward. ■

Developing Treatment Algorithms for Restoration or Replacement of the Compromised Tooth

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Introduction

The introduction of newer therapeutic modalities, surgical and restorative techniques, and restorative materials has dramatically expanded available treatment options regarding the compromised tooth. While a potential boon for clinicians and patients alike, such expansion places greater demands on the diagnostic and treatment-planning capabilities of the clinician. The challenge is not in mastering available surgical and restorative treatment techniques, but rather in determining when to apply each treatment modality and how to utilize the chosen therapeutic approach to its maximum benefit for the patient.

Treatment decisions should always be made in consideration of the health of the patient, the appropriateness of the therapy, the informed desires of the patient, and the costs of the therapy. Therapeutic costs to be assessed are not only financial, but also biologic, esthetic, therapeutic, temporal, and psychological. In addition, the prognosis of each therapeutic option over time must be considered.

When faced with a single compromised tooth, treatment options include restoration of the tooth, in conjunction with endodontic, orthodontic, and/or periodontal therapies where necessary; tooth removal and replacement with an implant-supported single crown; or tooth removal and replacement with a three-unit fixed partial denture. It is imperative that selection of a specific treatment approach is not grounded in the clinician's less-than-thorough understanding of the advantages, disadvantages, and potentials of each treatment option. A clinician's lack of understanding or experience with a given treatment approach, or failure to master delivery of such therapy, is a poor excuse for selecting one therapeutic option over another. Rather, treatment outcome expectations, the various risks of each therapeutic option, and the prognosis of each treatment approach should be carefully considered and weighed in the decision-making process.

The challenge is how best to quantify the tooth survival rates of recommended procedures and therapies. While excellent documentation is present regarding success and failure rates of specific therapies, the literature is woefully inadequate in assessing treatment outcomes for other modalities. Many articles poorly define patient selection, overall patient dental health, criteria for success, and other confounding factors. In addition, a number of published reports utilize materials that are no longer employed on a day-to-day basis. Finally, there is a paucity of literature comparing various treatment approaches in the same patients or clinical practices. As a result, while the goal is to render the decision-making process as scientific as possible, a number of "soft" factors influence this process, including clinician bias and perspective. It is for this reason that clinical dentistry is still a unique combination of art and science.

Diagnostic Requirements

A thorough examination and diagnosis must always be carried out, and a comprehensive interdisciplinary treatment plan must be formulated prior to initiation of any active therapy. Such an examination always begins with an open discussion with the individual patient, so as to assess the patient's needs and desires. Failure to ensure such open avenues of discussion increases the risk of patient dissatisfaction, along with poor treatment outcomes. Thorough data collection is a must. Examination of hard and soft tissues, use of models with face-bow mountings, and analysis of the patient's occlusion in conjunction with a high-quality full series of radiographs provide baseline data needed for decision making and treatment recommendations. Three-dimensional imaging is often required. Such imaging provides especially important information when assessing the bone support on the palatal root of a maxillary molar, the precise extent of an endodontic lesion that is present, the assessment of available bone if tooth extraction and implant placement are contemplated, and assurance of the absence of other pathologies that may either influence the course of therapy or pose significant health risks to the patient.

All potential etiologies must be identified and assessed prior to formulating a comprehensive treatment plan, including systemic factors, periodontal status, the presence or absence of parafunction, carious lesions, endodontic lesions, and trauma, among others.

As the available treatment options and "ideal" treatment plan are being formulated for presentation to the patient, it is important that both the predictability and expected treatment outcome of each therapeutic approach be honestly and openly assessed and discussed. Such an assessment allows the patient to choose the treatment option for which he or she is best suited physically, financially, and psychologically.

Teeth that can be predictably restored to health through reasonable means should always be maintained, if such retention is advantageous to the final treatment plan and addresses the patient's desires and wishes. Once again, lack of understanding about the predictably attainable results following periodontal and/or endodontic therapy, as well as the expected long-term prognoses of various approaches, often results in formulation of treatment plans that do a disservice to the patient.

It is inappropriate to remove all teeth that show any degree of compromise and replace them with implant-supported prosthetics. However, it is equally inexcusable to fail to understand and incorporate regenerative and implant therapies into available treatment armamentaria when addressing a patient's unique situation.

The success rates of procedures that have statistical track records can be presented to the patient to help him or her weigh the pros and cons of each option. Such data can also be used to support the treatment decisions of the dentist. Unfortunately, the success rate of a particular procedure performed by the practitioner in question, which is of greatest value, is often unavailable statistically. Usually, the dentist can only state that his or her success with this particular procedure is based on the number of times it has been performed successfully. This history of success and/or failure often shapes the treatment plan.

Assessing the Individual Tooth

Prior to making a determination as to the advantages or disadvantages of retaining a given tooth, there are a number of parameters that must be appropriately assessed.

Periodontal Considerations

The periodontal status of the tooth in question is an absolute indication or contraindication to an attempt at long-term maintenance through periodontal and restorative therapies. There is no question that pocket depths in excess of 4 mm are not maintainable by either the patient or the dental professional. Therefore, except in instances where teeth are being maintained in older or medically compromised patients, pocket elimination must be a feasible treatment outcome in order to consider restoration and retention of a given tooth. Such pocket elimination may proceed through periodontal resective therapy, periodontal regenerative therapy, or a combination of the two.

Pocket elimination also includes resolution of any furcation involvements that are present. Performing extensive restorative therapy on a furcated tooth because it demonstrates "only" a Class I furcation involvement is ill advised. It is well established that such areas will continue to break down, due to the "cul de sac" that will continue to trap plaque despite the best professional and patient plaque-control measures. There is no argument in the literature over whether or not furcation involvements progress. The only points to be considered are how quickly a given furcation involvement will progress, such progression upon the impact of the planned therapy, and the influence of overriding patient concerns (e.g., age, health, etc.).

A stable band of attached keratinized tissue, and hence an intact fiber barrier system, must be present to help provide adequate defense against the added plaque accumulation and potential periodontal compromise inherent in placement of restorative margins at the gingival crest or intrasulcularly. If such a band of attached keratinized tissue cannot be established due to various anatomic or psychological considerations on the part of the patient, then the tooth is ill suited for restoration and retention.

If a stable periodontal milieu may be established for reception of restorative dentistry, without unduly compromising the support of the tooth in question, the argument for retaining the tooth is greatly enhanced. However, should the tooth in question demonstrate extensive periodontal attachment loss, or should performance of necessary preprosthetic crown-lengthening osseous surgery significantly alter the crown-to-root ratio of the tooth, the tooth may be a poor candidate for retention.

A minimum of 3–4 mm of healthy tooth structure must be available crestal to the alveolar bone crest to allow both redevelopment of an appropriate attachment apparatus and establishment of the necessary ferrule in the preparation design. If the restorative-margin tooth interface is deep subgingivally, patient home care is compromised, and the resultant increased plaque accumulation may reinitiate not only the periodontal inflammatory process, but also recurrent caries at the aforementioned interface.

Endodontic Considerations

In addition to determining whether or not endodontic therapy can be carried out on a given tooth, care must be taken to assess the expected residual tooth structure following such endodontic intervention, and the ability of this residual tooth structure to withstand load application over time.

Natural tooth contours may result in a thin isthmus of tooth structure following endodontic therapy. Areas of specific concern are two-rooted maxillary first bicuspids and the furcal aspect of the mesial root of a lower molar. Teeth with the highest endodontic failure rates are mandibular first premolars, followed by maxillary laterals, maxillary first and second premolars, the mandibular second premolar, and maxillary and first molars.[1]

While root canal systems are generally predictable in morphology, complicating or unique attributes set many teeth apart. Zillich and Dawson describe mandibular first premolars as either easy or exceedingly difficult to treat.[2] This par-

ticular tooth will present with a second or third canal 23 percent of the time. In addition, these canals may divide at any point within the root. Maxillary premolars exhibit variations similar to mandibular premolars, often making them difficult to successfully treat.

Sjögren reports 8- to 10-year success rates of 96 percent in teeth with vital pulps, and 86 percent if the pulp is necrotic, following endodontic therapy.[3] The manner in which the tooth is obturated affects success; however, endodontic success does not always equate to restorative success. The factors confounding endodontic therapy make restorative options more challenging. Placement of a post in a maxillary or mandibular first premolar that falls in the 23 percent complex root canal configuration category may be impossible or result in a compromised prognosis, due to the mechanics of preparing the internal aspect of an irregular cavity with walls of varying thickness using a rotary instrument.

The absolute and relative contraindications to retention of a given tooth are listed in Table 1. If tooth extraction and implant placement are to be contemplated, it is important to realize that such a treatment choice does not preclude the need for appropriate diagnosis and assessment before carrying out therapy.

Table 1. Local Factors Influencing When to Perform Crown-Lengthening Osseous Surgery (CLS)

Factor	Perform CLS and Keep Tooth	Remove Tooth
Can make tooth periodontally stable?*	Yes	No^
Can treat the tooth endodontically?	Yes	No^
Will compromise adjacent support?	No	Yes^
Will induce secondary occlusal trauma?	No	Yes~
Requires periodontal, endodontic, and restorative therapies?	No	Yes~
Presence of parafunction?	No	Yes~
Esthetic compromise following therapy?	No	Yes~
Large number of visits required?	No	Yes~
Complex therapy required?	No	Yes~
Excellent long-term prognosis?	Yes	No^
Patient wants to keep tooth?	Yes	No~

* Denotes probing depths ≤ 3 mm; no furcation involvements; adequate attached keratinized tissue
^ Absolute indication for tooth removal
~ Relative indication for therapy

Implant Receptor Site Considerations

A number of site-specific factors must be considered if tooth removal and implant placement are to be entertained. The position, quantity, and quality of the available bone are of paramount importance. A malpositioned tooth may result in an extraction socket whose position precludes ideal implant positioning without either regenerative therapy at the time of tooth extraction, followed by subsequent implant placement or concomitant regenerative therapy at the time of tooth removal and implant insertion.

The assessment of bone quantity must be carried out in a three-dimensional manner. An assessment limited to evaluating the length of the implant that may be placed and whether or not the implant will be inserted wholly within an intact extraction socket, is inadequate. A patient with a thin, highly scalloped biotype, or one who has undergone buccal orthodontic tooth movement or has caused hard- and soft-tissue recession through aggressive brushing, will demonstrate a thin, highly labile buccal alveolar bony plate following tooth removal. Placement of an implant in such a situation without concomitant regenerative therapy to protect and increase the bulk of the buccal bone will leave the patient with a situation of high bone resorption upon application of functional load. Any implant placed must be housed in adequate bone to withstand functional forces buccally and lingually/palatally, over time.

Assessing Cost-Benefit Ratios

A risk/reward benefits analysis must be undertaken to help determine the most reasonable approach to a given situation. The development of an appropriate treatment algorithm mandates recognition and evaluation of all applicable cost-benefit ratios. These cost-benefit ratios are biologic, esthetic, financial, temporal, psychological, and therapeutic in nature. Appropriate assessment must also take into consideration not only the present but also the future status of the treatment delivered.

Biologic Considerations

Biologic costs impact both the tooth under direct consideration and adjacent teeth. The tooth being assessed may pay a biologic price in terms of loss of tooth structure following preparation with or without endodontic intervention; loss of supporting bone following preprosthetic periodontal therapy, when necessary; or development of furcation involvements following preprosthetic crown-lengthening osseous surgery.

Case Study I

A patient presents with a subgingival fracture on the buccal aspect of a mandibular first molar. (See Figure 1.) This tooth has already undergone orthodontic therapy. Radiographic examination demonstrates the short residual root trunk present between the root fracture and the entrance to the buccal furcation. (See Figure 2.) Due to the short distance between the subgingival margin of the buccal fracture and the entrance to the furcation (approximately 1.3 mm), performance of the necessary crown-lengthening osseous surgery would result in development of a significant buccal furcation involvement, as well as a compromised prognosis for the tooth following completion of therapy.

Removal of such a tooth and its replacement by an implant with concomitant regenerative therapy may appear at first to be an overly aggressive treatment approach. The argument might be made that the patient would be better served by placing a crown on the tooth and "trying to hold on to it for as long as possible," especially as endodontic therapy had been performed some years before.

Such a treatment option is not in the best interest of the patient unless patient health precludes more comprehensive care, or patient age leads the clinician to think that the tooth will not have to function for much longer. Post-and-core buildup and a full-coverage restoration without periodontal surgical therapy entails significant expense, and will result in a milieu that institutes a periodontal inflammatory lesion almost immediately upon completion of tooth restoration. At best, the disease process will proceed slowly. At worst, the tooth will become significantly compromised and periodontally untreatable in the near future.

Performance of crown-lengthening osseous surgery prior to post-and-core buildup and full-coverage restoration of the tooth will also entail additional expense and will not provide a periodontal milieu conducive to placement of restorative dentistry without the initiation of an inflammatory periodontal lesion.

Conservative therapy is removal of the tooth and placement of an implant and subsequent restoration, so as to provide a healthy, functional situation for the patient.

The biologic costs to the adjacent teeth must also be considered. If crown-lengthening osseous surgery performed around a given tooth will unduly compromise the periodontal support of the adjacent teeth, such therapy is not indicated. Performing treatment that compromises healthy teeth is inadvisable when predictable therapeutic modalities such as tooth extraction and implant placement exist. Figure 3 demonstrates a mandibular first molar with recurrent subgingival caries on its distal aspect. The position of the caries is such that crown-lengthening osseous surgery can be safely performed without unduly compromising the supporting bone of either the first molar or the mesial aspect of the second molar. In contrast, Figure 4 is a radiograph of a mandibular first molar that demonstrates recurrent subgingival caries on its distal aspect, which represents a much greater compromise than that encountered in Figure 3. Due to the extension of the caries along the distal root, appropriate crown-lengthening osseous surgery would involve removal of significant osseous support and attachment apparatus from the mesial aspect of the second molar, as well as a possible inability to attain the necessary 4 mm of biologic width between the recurrent caries and the entrance to the buccal furcation of the first molar.

Case Study II

A patient presents with recurrent caries around a crown on a maxillary second bicuspid. (See Figure 5.) The caries appears on the interproximal surface of the second bicuspid. If the caries had been

Figure 1. A patient presents with a buccal subgingival fracture of a mandibular first molar.

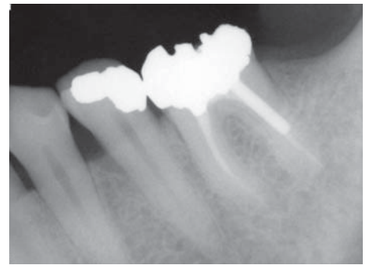


Figure 2. Radiographic examination demonstrates a short residual root trunk between the fracture and the entrance to the buccal furcation. Performance of crown-lengthening osseous surgery would result in a significant buccal furcation involvement on the first molar.

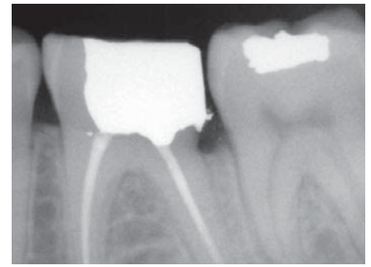


Figure 3. A patient presents with recurrent subgingival caries on the distal aspect of the mandibular first molar. The position of the caries renders this tooth an excellent candidate for crown-lengthening osseous surgery.

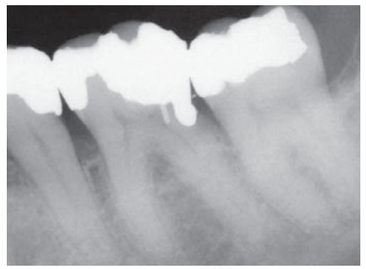


Figure 4. A patient presents with recurrent subgingival caries on the distal aspect of the mandibular first molar. Crown-lengthening osseous surgery would necessitate removal of significant bone support from the mesial aspect of the mandibular second molar and may compromise the entrance to the buccal furcation of the mandibular first molar. The first molar should be removed and replaced.

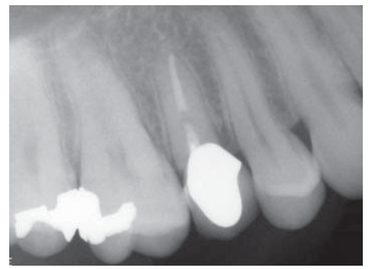


Figure 5. A patient presents with recurrent caries on the distal aspect of the maxillary second bicuspid. Crown-lengthening osseous surgery would result in significant compromise of the bone support on the mesial aspect of the first molar and invasion of the mesial furcation of the first molar.

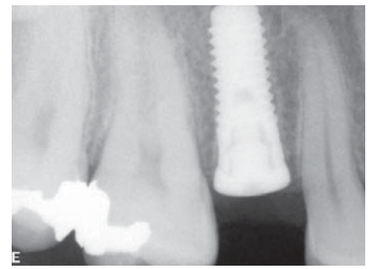


Figure 6. The tooth is removed and replaced with an implant.

located on the buccal or palatal aspects of the tooth, crown-lengthening osseous surgery could safely be performed without affecting the support of the adjacent teeth. Unfortunately, performance of the necessary crown-lengthening osseous surgery would significantly compromise the mesial support and result in development of a mesial furcation involvement, of the adjacent first molar. As a result, it is more prudent to remove the tooth and place an implant at the time of tooth removal. (See Figure 6.)

Esthetic Considerations

The effects of crown-lengthening osseous surgery on the patient's esthetics must be assessed. While palatal caries on a maxillary anterior tooth may be safely exposed for restoration, the same procedure performed interproximally or buccally often results in an unacceptable esthetic treatment outcome. In such situations, other treatment options should be explored. While supereruption of the tooth prior to crown-lengthening osseous surgery could be considered, such an approach is not ideal, as the supererupted, crown-lengthened, and restored incisor would present with a poor crown-to-root ratio and thus a limited prognosis after the patient had been subjected to extensive and expensive therapies.

Financial Considerations

The financial ramifications of each treatment approach play a significant role in selection of a given therapeutic modality. In order to better assess this consideration, a questionnaire was sent to 100 periodontists in urban and suburban areas throughout the United States in 2008. The periodontists were asked, in consultation with their restorative partners, to provide information regarding the costs of various therapies. Only 87 periodontists sent back the requested information, so 13 additional periodontists were individually contacted and asked to provide the same information. (See Table 2.)

The average cost of restoration of a natural tooth was 1.3X. If crown-lengthening osseous surgery was required, an additional cost of 1.1X was added, for a total cost of 2.4X. If endodontic therapy was necessary, an additional fee of 0.9X to 1.3X was added, for a total fee of 3.3X to 3.7X. Finally, if a core buildup was carried out after endodontic therapy, an additional 0.6X of cost was added, for a total fee of 3.9X to 4.3X.

Table 2. Relative Fees for Various Therapies

Therapy	Fee
Endodontic—Single Root	0.9X
Endodontic—Multiple Roots	1.3X
Core Buildup—Natural Tooth	0.6X
Crown—Natural Tooth	1.3X
Pontic	1.4X
Crown-Lengthening Periodontal Surgery	1.1X
Regenerative Periodontal Surgery	1.9X
Orthodontic Supereruption	2.8X
Extraction	0.3X
Three-Unit Fixed Bridge	4.3X
Implant	2.1X
Implant Abutment (stock) and Crown	2.2X
Implant Abutment (custom) and Crown	2.7X
Regenerative Therapy at Tooth Extraction	0.7–1.4X
Sinus Augmentation	2.5X
Osteotome Sinus Lift	0.9X
Osteotome Sinus Lift at Time of Implant Placement	N/C

The average cost of tooth extraction, implant placement, and restoration with a stock abutment and single crown was 4.6X. If regenerative therapy was necessary in conjunction with implant placement, an additional fee of 0.7X to 1.4X was added, for a total fee of 5.3X to 6.0X.

Considering only the financial ramifications of therapy, it becomes obvious that if a tooth may be restored in a healthy manner necessitating either crown-lengthening osseous surgery or endodontic therapy and post-and-core buildup, it is prudent to do so. However, if crown-lengthening periodontal surgery, endodontic therapy, post-and-core buildup, and full-coverage restoration are required on a given tooth, and the tooth could instead be replaced with an implant, abutment, and crown without performing extensive regenerative therapy, it is more logical financially to follow the implant course of treatment. Naturally, financial considerations do not stand alone in determining the appropriate therapeutic approach.

Temporal Considerations

Temporal requirements must also be considered. If tooth retention mandates an excessive number of visits to perform the necessary periodontal therapy, endodontic therapy, and subsequent restoration, the patient may be better served through tooth extraction and implant placement at the time of tooth removal. Following healing, two restorative visits will usually be required. However, implant reconstructive therapy will only be viewed in such a manner if all treating clinicians understand the potentials of various therapeutic approaches.

The ability to extract a tooth, debride the socket, and successfully place an implant at the time of tooth removal, with or without immediate temporization, has been well established throughout the literature. Numerous articles have elucidated various treatment algorithms for implant placement at the time of tooth removal.[4] The literature conclusively demonstrates that the predictability of osseointegration if implants are placed at the time of tooth extraction or are placed into intact bone following healing are interchangeable when considering implant placement at the time of extraction of single-rooted teeth.

Implant placement at the time of multirooted tooth extraction has traditionally been viewed as a compromised treatment approach due to the technical difficulties in ideally positioning the implant, and the unpredictability in effecting appropriate regeneration of bone in the residual extraction socket surrounding the implant. However, two recent publications documenting more than 650 cases demonstrate the long-term predictability of implant placement at the time of extraction of maxillary or mandibular molars with performance of concomitant regenerative therapy.[5,6]

Immediate implant placement at the time of tooth extraction should not be viewed as a compromise, but rather, as another therapeutic alternative to be considered when developing appropriate viable treatment algorithms.

Immediate implant placement at the time of tooth extraction may also shorten the time required to perform therapy. Utilization of such a treatment approach will often result in a significantly shorter course of therapy than crown-lengthening osseous therapy, endodontic therapy after appropriate healing has been carried out, and post-and-core buildup and restoration of the tooth in question.

Psychological Considerations

Patient demands and desires may lead to selection of one treatment approach over the other. If a patient is psychologically unable to deal with the thought of losing his or her tooth, or is afraid of having an implant placed, extraordinary efforts may be made in an attempt to save the tooth in question. Patient desires may also mandate tooth extraction and replacement with an implant. A patient who is ill suited for complex multidisciplinary care, or one who states that he or she does not wish to maintain a given tooth and subject it to extensive therapy "unless the result is guaranteed," is a poor candidate for performance of crown-lengthening osseous surgery, endodontic therapy, and tooth restoration.

Complexity of Care

Complexity of care is an important consideration. A tooth for which performance of appropriate endodontic therapy would be difficult if not impossible is ill suited for retention. In addition, if the complexity of surgical and/or restorative therapy required increases the chances of immediate or long-term failure, then tooth retention is not advised.

Figure 7. Implants are in place in the positions of the first and second premolars. A mesiobuccal root amputation has been performed on the first molar. Crown-lengthening osseous surgery has been performed on the second molar.

Figure 8. The castings are in place on the model. Note the straight emergence profile of the casting out of the gingiva in the area of the mesiobuccal root amputation on the maxillary first molar.

Implant utilization does not eliminate all concerns regarding complexity of care and the required clinical skills to perform appropriate therapy. Surgical access, site compromises, or difficulty in restoration following osseointegration of the implant is each a serious contraindication to tooth removal and implant placement.

Predictability of Care

The long-term predictability of therapy is paramount when selecting a treatment approach. There is a paucity of literature comparing long-term success rates of teeth restored with single crowns—with or without prior endodontic intervention—and single implant-supported crowns. A comparison of studies purporting to evaluate one or the other of the treatment modalities is difficult. Significant advances in endodontic techniques and restorative materials render many of the older studies of no use in carrying out such a comparison. In addition, the advent of rough-surfaced implants and various implant designs and restorative options invalidates the inclusion of older studies when comparing long-term success rates of different treatment approaches. Available literature assessing success rates of teeth restored with single crowns—with or without prior endodontic therapy and utilizing newer restorative materials—reports success rates in the range of 94 percent.[7] Implant success and survival rates for rough-surface implants restored with single crowns have been consistently reported in excess of 95 percent over five to 10 years.[8]

The Cost of Retreatment

The commitment necessary upon retreatment must also be carefully weighed. Failure of a natural tooth restored with a single crown may be due to crown fracture, recurrent caries, root fracture, development of an endodontic lesion, or progressive periodontal disease. The dangers of root fractures following endodontic therapy that results in inadequate tooth structure to withstand functional forces over time have already been reviewed. Most of the complications listed above would result in significant retreatment or tooth removal and replacement.

In contrast, complications around osseointegrated rough-surface implants restored with cemented single crowns usually take the form of porcelain fracture or soft-tissue inflammation. The inflammation is easily treated through debridement and/or mucogingival therapy. Depending on the method that had been employed to attach the crown to the implant, treatment may require either removal of the crown and application of new porcelain or replacement of the crown. Either need is less involved and less traumatic to the patient than tooth removal and replacement. Naturally, a third treatment option is tooth removal and placement of a three-unit fixed-partial denture. An in-depth discussion of this option, as compared to implant placement and restoration for replacement of a single missing tooth, has been explored in detail and will not be discussed here.[9]

Case Study III

A patient presents with extensive periodontal destruction in the maxillary left posterior sextant. The maxillary first and second premolars were hopeless. A Class III buccal-to-mesial furcation in-

Figure 9. Eleven years postoperatively, the second molar has already been replaced by an abutment and crown. Recurrent caries is now noted around the retained roots of the first molar.

Figure 10. A patient presents with deep, recurrent caries on the maxillary first and second premolars and maxillary second molar.

Figure 11. Following extraction of the first and second premolars and second molar, implants were placed and restored in both premolars and the first molar position.

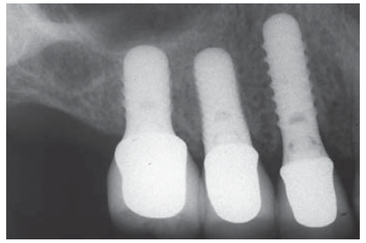


Figure 12. A radiograph taken eight years posttherapy demonstrates stability of the peri-implant crestal bone.

volvement was noted on the maxillary first molar. The maxillary premolars were extracted and implants were placed with concomitant regenerative therapy. Crown-lengthening osseous surgery was performed on the first and second molars, in conjunction with a mesiobuccal root resection on the maxillary first molar. Examination of the master cast demonstrates implant positions, as well as the contour attained on the maxillary first molar following root resection and appropriate odontoplasty. (See Figure 7.) Castings were fabricated on the implants and natural teeth, ensuring that a straight emergence profile of the casting from the gingival was present in the area of root resection. (See Figure 8.) Five years later, the second molar decayed and had to be removed. At the time of tooth extraction, it was replaced by an implant, which was subsequently restored with a single crown.

Six years later—11 years after the initial surgical therapy was carried out—the patient presents with significant recurrent decay on the retained roots of the maxillary first molar. (See Figure 9.) This tooth will now have to be extracted and replaced with an implant. While five and 11 years, respectively, fall within accepted timeframes for assessing treatment success, the patient was not well served by this therapeutic approach. As significant reconstructive and implant therapy was already being carried out, and as the patient demonstrated a relatively high caries rate, it would have been more logical to extract the premolars and molars, place four implants with concomitant regeneration, and restore them with individual abutments and crowns.

The financial costs of multiple procedures performed on a tooth may appear excessive if the prognosis or expected outcome of treatment deteriorates. In addition, each therapy represents an inconvenience to the patient, possible discomfort, and a healing period. Should multiple procedures be chosen to accomplish a goal if an approach requiring fewer visits would afford the same treatment outcome expectations and prognosis of the therapy? Training has traditionally advocated preservation of a given tooth as the optimal therapy to offer to a patient. However, hidden unknowns such as an undetected crack in the tooth, damage to the root wall during post preparation, an exposed furcation due to a necessary crown-lengthening procedure, a root system that has unrealized complexities, or an endodontic fill that is "only clinically acceptable" all conspire to yield a result whose unpredictable prognosis cannot be calculated.

Case Study IV

A patient presents with significant caries on the maxillary first and second premolars and the maxillary second molar. (See Figure 10.) The maxillary first molar is missing. Due to a combination of the extension of caries subgingivally, and caries having destroyed much of the bulk of the tooth mesially and distally, it was decided that it was more prudent to extract the three teeth and place implants in the positions of the first and second premolars and the first molar. No opposing mandibular tooth was present in the second molar position. Subsequent to attainment of osseointegration, the implants were restored with abutments and crowns. (See Figure 11.) Radiographic examination eight years after therapy had been performed demonstrates stability of the peri-implant crestal bone. (See Figure 12.)

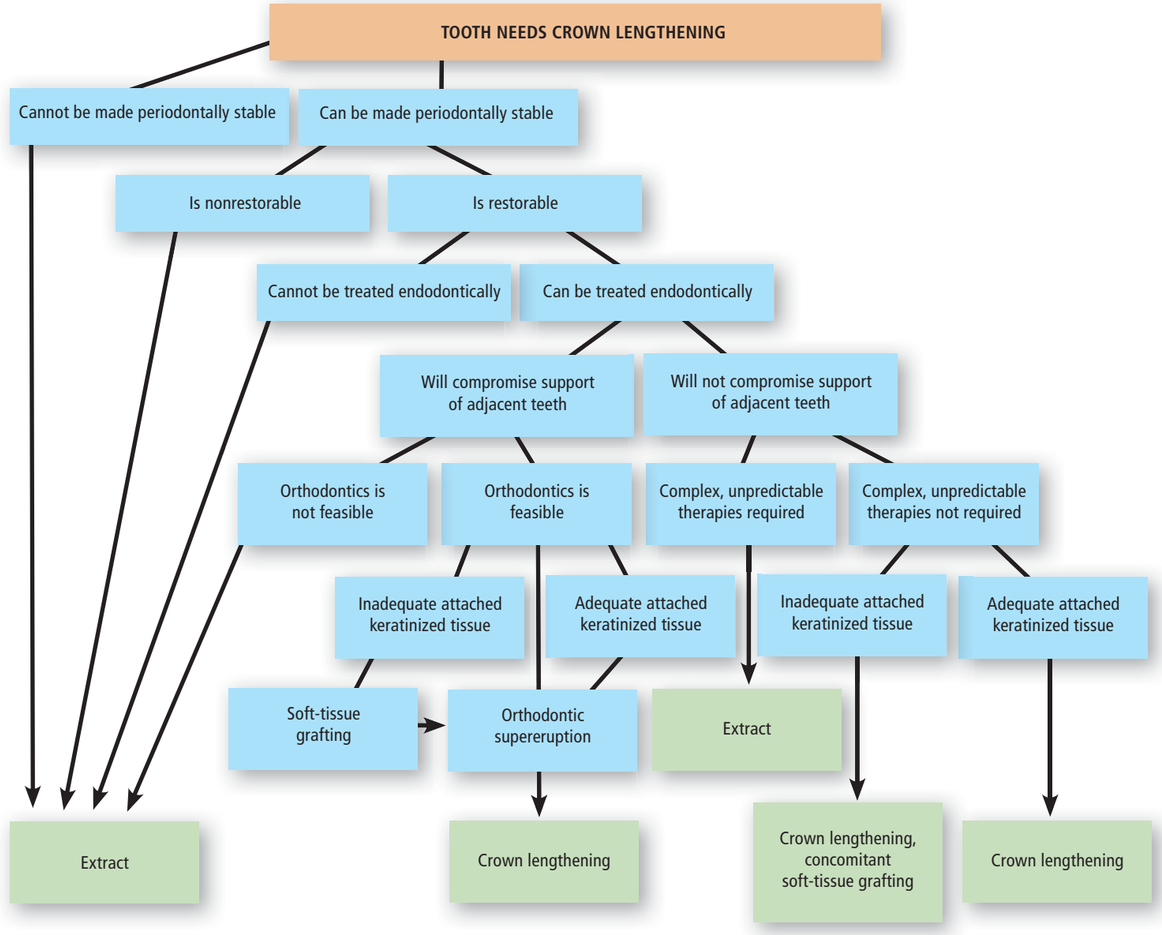
Single-tooth replacement with osseointegrated implants and crown restorations has proven to be a highly predictable treatment modality. Numerous longitudinal and retrospective studies demonstrate survival rates at least equal to other methods of tooth replacement, over time.[8,10-12] Jivraj and Chee state that "decisions to salvage questionable teeth should be weighed against the predictability of implant therapy and the efficacy of long-term outcomes."[13]

Does this mean that all decayed teeth, or teeth requiring endodontic therapy, should be extracted and replaced by implants? It does not. Such a treatment approach is unjustifiable. There is no doubt that crown-lengthening therapy, followed by appropriate restorative intervention, is highly predictable. However, such treatment should not be blindly performed without appropriately assessing other available therapeutic modalities. (See Table 1.)

Conclusion

A number of treatment options afford themselves to the clinician when faced with a compromised tooth. However, prior to determining which treatment approach to pursue, whether it be tooth retention with periodontal and/or endodontic therapy, or tooth removal with implant placement and restoration, the indications, contraindications, potentials, and risks of each treatment approach must be assessed. (See Table 3.) The final decision should be based on what is in the best interest of the patient, and not be determined by the clinician's diagnostic or clinical limitations. ■

Table 3. A Tooth Requiring Crown Lengthening



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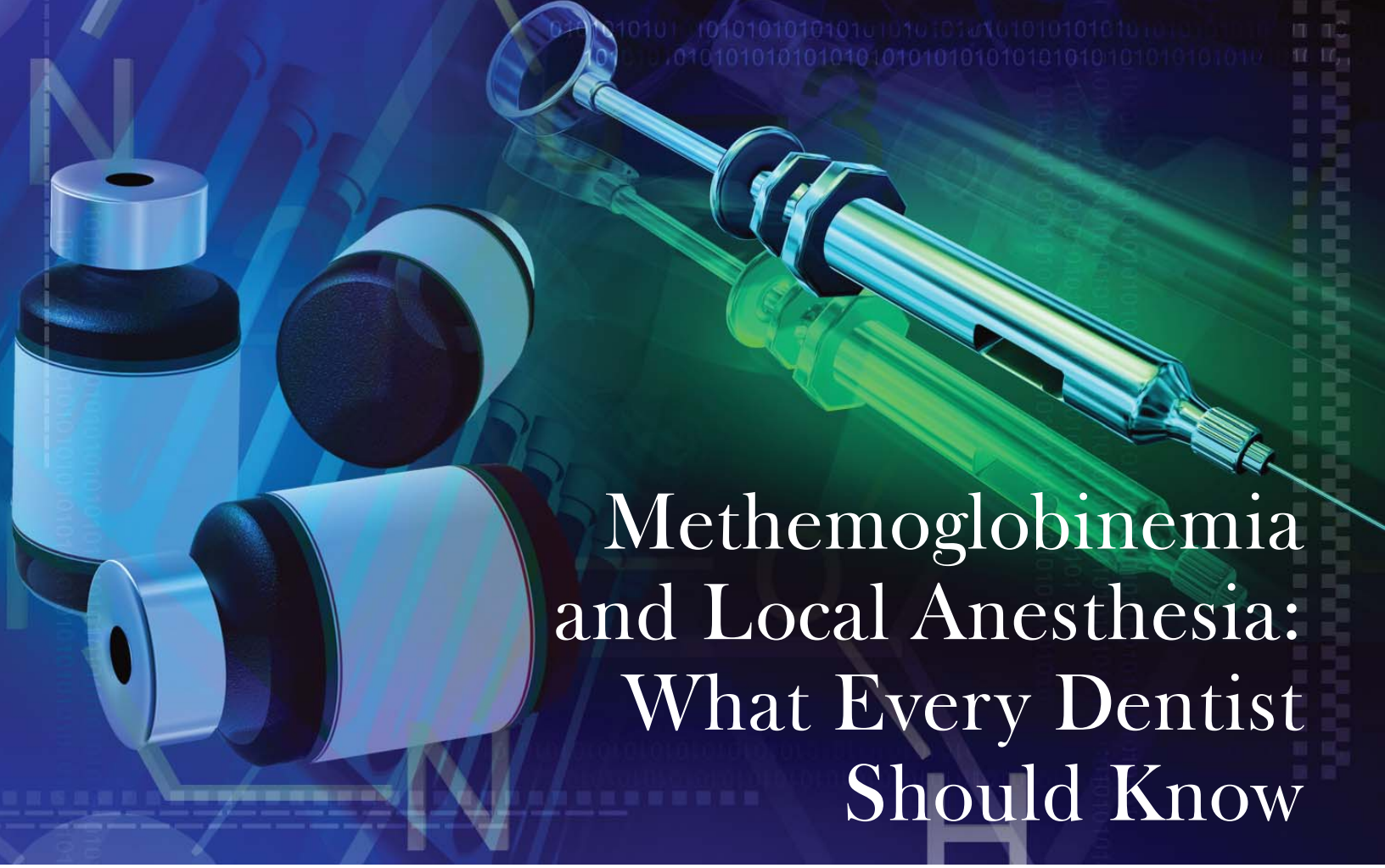

Methemoglobinemia and Local Anesthesia: What Every Dentist Should Know

GREG TENTINDO
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Methemoglobinemia is a rare but serious complication of local anesthetic administration in dentistry. An elevated methemoglobin level in the blood reduces its ability to carry oxygen, resulting in cyanosis. Thus, it has the potential to result in significant morbidity and mortality in susceptible patients. Specific local anesthetics used routinely in dentistry, most notably prilocaine and benzocaine, have a propensity to cause methemoglobinemia. It is crucial to patient care for a dentist not only to understand the risk factors for methemoglobinemia, but also to be able to diagnose and subsequently treat the condition. This article will cover the etiology, diagnosis, and management of methemoglobinemia arising from local anesthesia in dentistry.

Under normal physiologic function, 97% to 99% of the iron in the hemoglobin moiety is reduced and in its ferrous (Fe^{2+}) state. This allows adequate loading and unloading of oxygen. However, hemoglobin is inherently unstable and the iron atoms within are continuously being oxidized to its ferric (Fe^{3+}) state. This form of hemoglobin is called methemoglobin, and it more tightly binds oxygen, hindering its release to the tissues of the body.[1] Methemoglobinemia is defined as an abnormal elevation of methemoglobin levels in the blood. The human body contains multiple mechanisms to combat the oxidation of hemoglobin and keep levels of methemoglobin to a minimum (1% to 3%). The most important of these reductive mechanisms uses NADH generated from the Embden-Meyerof-Parnas glycolytic pathway as an electron donor to reduce the oxidized ferric iron to the more favorable ferrous state. Methemoglobinemia will occur when the production of methemoglobin exceeds the reductive capacity of this mechanism. This situation may arise after exposure to various toxic substances or drugs, such as local anesthetics. A hereditary deficiency in the enzyme NADH methemoglobin reductase used in this system is the cause of congenital methemoglobinemia. People who are homozygous for such a de-

ficiency exhibit methemoglobin levels of 10% to 50% under normal physiological conditions.[2]

Acquired methemoglobinemia generally results from exposure to a drug that provides a sufficient oxidative stress to overwhelm the endogenous reductive pathways. Local anesthetics used in dentistry are among the drugs that have the potential to do this. More than 90% of reported cases of methemoglobinemia involved the use of either benzocaine or prilocaine.[3] Other local anesthetics that have been implicated in causing methemoglobinemia are lidocaine and articaine, but to a much lesser extent. These cases are typically seen in patients with underlying congenital methemoglobinemia.

Local anesthetics are indirect oxidizers, meaning they induce methemoglobin formation after metabolic modification in vivo. For amide local anesthetics, this involves hydrolysis of the amide to the corresponding amine. This amine is then metabolized to a species that directly oxidizes hemoglobin. The major determining factor in the ability of amides to form methemoglobin is the nature of the amine liberated after hydrolysis. In the case of prilocaine, the metabolism of ortho-toluidine is responsible for the oxidation of hemoglobin. When prilocaine is used for peripheral nerve blocks, methemoglobin values anywhere from 0.9% to 15.4% at three hours may be present with administration of 300 to 400 mg.[4]

Benzocaine-related methemoglobinemia is not as well understood. It is thought that benzoic esters are hydrolyzed by a mechanism similar to anilides. Cases of methemoglobinemia have been reported with as little as a single one-second spray of 20% solution on mucous membranes. However, others have failed to develop symptoms with doses higher than 200 mg/kg, leading investigators to conclude that only some patients are susceptible.[4] When administering prilocaine, benzocaine, or any other local anesthetic, it is imperative to follow the manufacturer's recommendations on dosing. The dosage recommendation for prilocaine, for a healthy adult, is 8 mg/kg up to a maximum of 600 mg or 8 cartridges.[5] Guay[4] and others recommend that the clinical use of benzocaine should be abandoned, especially in unmetered spray preparations, and many institutions have taken the drug off of their formularies due to the fact that it is impossible to predict which individuals will be susceptible to developing methemoglobinemia after benzocaine exposure. If benzocaine spray is used, extreme caution should be taken to avoid inhalation of the spray.

The clinical signs and symptoms of methemoglobinemia will vary with blood levels of methemoglobin. The hallmark sign of methemoglobinemia is unexplainable cyanosis with decreased SpO_2, which is unresponsive to oxygen administration.[5] Patients will appear lethargic

and suffer from respiratory distress. Signs of cyanosis will appear in nail beds and mucous membranes. Venous blood may appear chocolate brown and will not become redder when exposed to oxygen.[1] Clinical signs of cyanosis will initially be observed as blood levels of methemoglobin reach 10% to 20%. With higher blood levels (35% to 40%), dizziness, fatigue, exertional dyspnea, and tachycardia are observed.[6] At around 50% concentration, lethargy and stupor usually appear, and concentrations above 70% can be lethal.

The absolute concentration of methemoglobin is not the only determinant of symptomatology; it also depends on the rates of formation and elimination. Levels of methemoglobin acutely acquired will produce more severe symptoms than levels caused by hereditary defects or maintained chronically. This is because people who are hereditarily compromised develop compensatory mechanisms, such as erythrocytosis and increased 2,3-diphosphoglyceric acid, which are lacking in an otherwise healthy subject. The clinical manifestations of acquired methemoglobinemia tend to be more severe than those produced by a subsequent degree of anemia. This can be explained by the fact that methemoglobin increases the affinity of the unaltered hemoglobin for oxygen, in addition to decreasing the available oxygen-carrying capacity. These effects can be attributed to an intermediary form of hemoglobin in which one or more of the iron moieties are in the ferric state.[2]

Arterial blood gas analysis in the hospital setting and pulse oximetry in the dental clinic may be useful in the diagnosis of methemoglobinemia. Multiple wavelength co-oximetry may confirm the diagnosis of methemoglobinemia. Multiple wavelength co-oximeters use eight wavelengths of light to measure the absorption of blood. They can determine amounts of oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, and methemoglobin. Conventional pulse oximeters measure ultraviolet absorption at only two wavelengths and can therefore only differentiate between oxyhemoglobin and deoxyhemoglobin. They are diagnostically unreliable because abnormal values are only suggestive of methemoglobinemia. The pulse oximeters often reveal falsely low oxygen saturation in patients with low levels of methemoglobinemia, while often revealing falsely high values of oxygen saturation in patients with high levels of methemoglobin. Arterial blood gas analysis is often misleading because normal PaO_2 concentrations are often found on analysis.[7]

The presence of certain concurrent diseases or medications may predispose patients to methemoglobinemia or may greatly increase the clinical effects. These conditions include anemia, acidosis, cardiopulmonary disorders, liver impairment, renal impairment, G6PD deficiencies, extremes of age, and, possibly most important, underlying congenital methemoglobinemia.[8] The presence of other oxidizing agents, such as paracetamol or fentanyl, may also increase a patient's risk of developing methemoglobinemia. The symptomatology of methemoglobinemia is associated with impaired oxygen delivery to the tissues. For this reason,

conditions like chronic obstructive pulmonary disease (COPD), pneumonia, and congestive heart failure can greatly increase the clinical effects of methemoglobinemia.

Following a diagnosis of methemoglobinemia, a dentist should be prepared to manage the situation. For the majority of patients with mild elevations in methemoglobin levels, no therapy is indicated. The patient's natural enzymes will reduce the levels following elimination of the offending drug. Nonetheless, even small elevations in the blood should be taken seriously because they suggest that further oxidative stress may elevate the levels to a dangerous point. Patients should be examined for negative effects resulting from decreased oxygen delivery and supplemental oxygen immediately delivered, although the patient may be unresponsive to it. Immediate treatment should be provided for patients with obvious changes in mental status or ischemic chest pain.[2] Methylene blue, which is a heterocyclic aromatic chemical compound with the ability to reduce the iron moiety within hemoglobin, is the antidote to acute methemoglobinemia and is administered to patients at a rate of 1.0–2.0 mg/kg intravenously every 60 minutes as required up to a total dose of 7 mg/kg.[4] This treatment will not be effective for patients with G6PD deficiency, because it may possibly induce hemolysis. If methylene blue treatment is ineffective, the cause of the oxidant stress may not have been identified.

Conclusion

In general, the administration of local anesthesia is extremely safe and effective as long as proper administrative techniques and doses of local anesthetics are observed. Acquired methemoglobinemia remains a rare but potentially serious complication in susceptible patients when specific local anesthetics are used. ■

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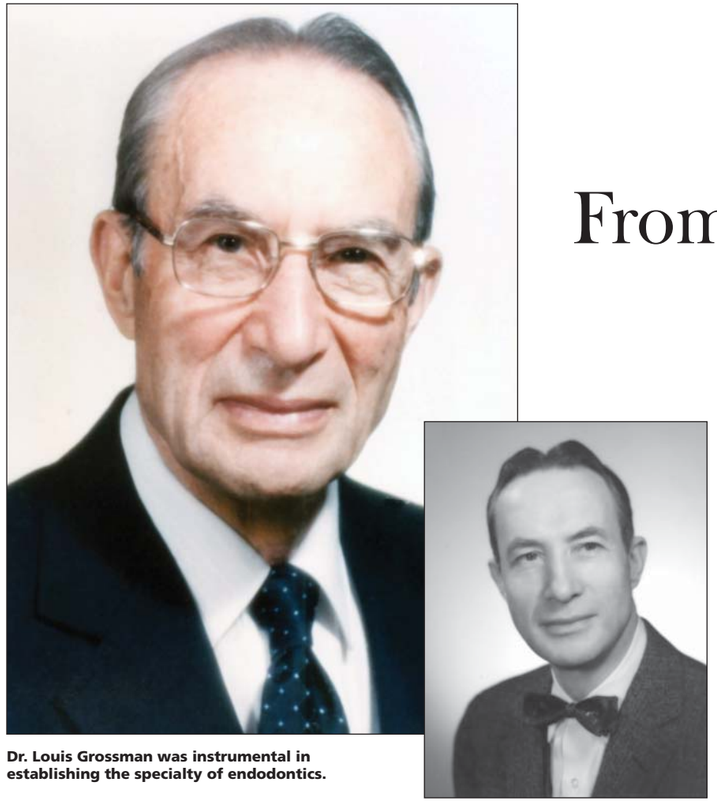
A Century of Endodontics: From Philadelphia to Boston



Photos courtesy of the University of Pennsylvania Archives

Dr. Louis Grossman was instrumental in establishing the specialty of endodontics.

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Dr. Millstein is the historian of the Massachusetts Dental Society, as well as an endodontist with a practice in Cambridge.

Louis Irwin Grossman was born in a small Ukrainian village near Odessa in 1901. A few years later, his family immigrated to Philadelphia. As a prodigious student, he graduated from the South Philadelphia High School in 1919[1] and recalled working from 6 to 10 p.m. during those years at the local newspaper. It was there that he learned the love of the written word and even considered a future as a journalist. However, he had been accepted at the University of Pennsylvania School of Dentistry (now known as the School of Dental Medicine) for the class of 1923.

Before the school year began, he visited the Thomas W. Evans Museum and Dental Institute on 4001 Spruce Street in Philadelphia. By chance, he noticed the well-known professor of Materia Medica and Therapeutics, Dr. Hermann Prinz, whose accent and linguistic proficiency caught Grossman's ear. Dr. Prinz would become a father figure to Dr. Grossman, urging him after graduation in 1923 to undertake further study at the University of Rostock Dental School, which was situated in a small town on the Baltic Sea, where German was the language of instruction. Dr. Grossman earned his DMD from Rostock in 1928.[2] His thesis surveyed the various techniques of endodontic practice taught at the dental schools in the United States.[3]

Penn's Dr. Joseph T. L. Appleton also took an interest in this ambitious young graduate, guiding and encouraging Dr. Grossman in his research efforts in bacteriology. Through Drs. Prinz and Appleton, Dr. Grossman met other prominent men in the dental profession. Now he would add his journalistic skills to this newfound wealth of knowledge and become a scientific exponent and writer for the fledgling specialty known as endodontia.[2]

Over the next 40 years, Dr. Grossman meticulously researched all phases of root canal therapy. With his knowledge of bacteriology, he was able to successfully help discredit the "focal infection theory" set in motion in 1910 by British physician William Hunter. By 1950, Dr. Grossman and others eventually put an end to the needless extraction of millions of teeth.

By the 1950s, with funding from the National Institute of Dental Research, multidisciplinary investigations into the basic sciences of bacteriology, pathology, pharmacology, and immunology contributed to a better understanding of the infected pulp and periapical pathology. Clinical observation based on considerable experience also led to a fuller understanding of problems related to failure of previously successful cases. Endodontics became the accepted treatment and the preservation of the dentition a priority for the dental profession.[4]

Dr. Grossman published voluminously and lectured endlessly on the topic both here and abroad, and in 1940 he wrote the first of 11 editions of *Root Canal Therapy* (later retitled *Endodontic Practice*), published by Lea & Febiger of Philadelphia. These seminal contributions occurred within Penn's Department of Oral Medicine, chaired by Lester Burket, DDS, who would go on to become dean of the Penn School of Dental Medicine. Beginning in 1953, Dr. Grossman oversaw a series of six International Conferences on Endodontics given every five years at Penn. The University Press published these as bound transactions of the events.[5] In 1964, Dr. Grossman initiated a postgraduate department of endodontics at Penn. Upon his mandatory retirement in 1968, the university established its first Department of Endodontics and the Louis I. Grossman Professorship in Endodontics. Former associate Seymour Oliet, DDS, occupied the first chair.[6] Penn later honored Dr. Grossman with a Doctor of Science degree in 1978.

The Future of Root Canal Therapy

Realizing the need for a group of like-minded clinicians to set the stage for the future of root canal therapy, Dr. Grossman organized the Philadelphia Study Club in 1939. Two of the earliest members included his previous dental students, Drs. Israel Boris Bender and Samuel Seltzer.[7] This success was followed with a call for a national organization and was encouraged by both Dr. William J. Gies, founder of the International Association of Dental Research, and Dr. L. Pierce Anthony, editor of the *Journal of the American Dental Association (JADA)*.

When notified that W. Clyde Davis, DDS, a dentist from Lincoln, Nebraska, was also interested in a similar organization, Dr. Grossman invited him to serve on an organizing committee of the American Root Therapy Association. The gathering would coincide with the Chicago Dental Society meeting, and an announcement would be placed in *JADA*. Nineteen dentists from various sections of the country met at the Palmer House Hotel in Chicago on January 23, 1943, for the purpose of organizing a society for the study of root canal therapy. After a spirited discussion, they voted to name it the American Association of Endodontists (AAE).[8]

Twenty-one years later, endodontics was accepted by the American Dental Association as a recognized specialty. The American Board of Endodontics was incorporated in 1956, was recognized and approved by the Council on Dental Education in 1957, and gave its first examinations in 1965.[9] The board became a reality due to the work of Dr. George Stewart, Dr. Grossman's former associate at Penn, and Dr. Jacob Freedland of North Carolina.[10]

As the pioneering moment in endodontic history began to wane with its acceptance as a specialty, the founders began to prepare for the next generation of postdoctoral students, educators, and researchers. These early leaders convened for a Workshop on Advanced Education in Endodontics given at the Forsyth Dental Center in Boston in October 1966. Two of the organizers were Drs. Louis Grossman and Ralph Sommer.

As president-elect of the American Dental Association, Dr. F. Darl Ostrander of the University of Michigan was instrumental in the passage of the specialty status for endodontics. Along with Dr. Sommer, he was a seminal figure in endodontic education. In his paper, "The Past, Present, and Future of the Practice of Endodontics," Dr. Ostrander noted: "It is abundantly clear that the future of endodontics depends on expanded and greatly improved teaching at all levels of dental education and research in endodontics and related areas. If these goals can be accomplished, it seems logical to expect that the techniques required for therapy will become simplified. This condition should allow the general practitioner to treat successfully a larger number of endodontic cases and should make possible greatly expanded care by the endodontic specialist."[11]

The Boston Legacy

Back in 1878, the Pennsylvania College of Dental Surgery, a proprietary school, morphed into the Dental Department at the University of Pennsylvania.[12] Seventy years later, a hospital-based dental school dedicated solely to graduate den-

Photo courtesy of the University of Pennsylvania Archives

The Thomas W. Evans Museum and Dental Institute was completed in 1915 and would become home to the University of Pennsylvania School of Dentistry.

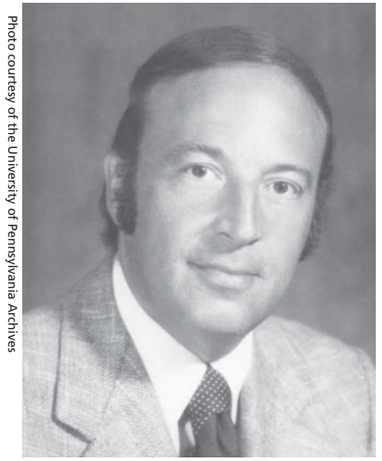
tistry was in the process of crystallizing in Boston. The venture would be grounded on a sound biological rationale with close cooperation between dental medicine and total health. It was led by Henry M. Goldman, DMD, a 1935 graduate of Harvard Dental School who returned from the service in 1945, where he had served as the first chief of the dental pathology section at the Armed Forces Institute of Pathology for the United States Army.[13]

Harvard Dental School transformed itself into the Harvard School of Dental Medicine in 1942. The university envisioned a small group of dental scientists with an additional degree (MD or PhD), who would train the students to become future educators and researchers. It used the Johns Hopkins Medical School model from 1883 as its working standard.[14] Dr. Goldman, not having advanced degrees, did not find a place in this new paradigm. However, a prominent physician, Dr. Jacob Fine from the Beth Israel Hospital staff, invited him to use its small dental clinic as a teaching facility.

During 1946, Dr. Goldman began his association with the faculty of the University of Pennsylvania by joining Drs. Lester Burket, LeRoy Ennis, and E. Howell Smith on the Ivory Cross expedition to Holland. The purpose of this venture was to bring new dental knowledge to countries that had suffered under the Nazi regime. Dr. Goldman had known Dr. Burket, an oral pathologist, during the mid- to late 1930s while Dr. Burket was acquiring his medical degree from Yale University. The trip introduced the young Harvard graduate to both the international education and the worldwide travel that would become essential components in establishing the future school.[13]

As the Beth Israel dental clinic grew, Dr. Goldman took a number of yearlong residents in periodontics. One of the earliest was Dr. David Walter Cohen, a recent graduate of the Penn dental school. Dr. Cohen returned to Penn in 1951, was named head of the first Department of Periodontics in 1956, and was named dean in 1972. Through the efforts of Dean Burket, the Beth Israel Hospital program established official links with the Penn dental school by creating a unique two-year postgraduate program in periodontology with Dr. Goldman as its director. The didactic year was spent at the Penn Graduate School of Medicine and the clinical year at the Reisman Clinic at Beth Israel.[13] Under this format, Dr. Goldman's students earned certificates of distinction from a major university and became eligible to earn a master's degree and potential diplomate status from the American Board of Periodontists.

Photo courtesy of the University of Pennsylvania Archives



Dr. David Walter Cohen

Dr. Herbert Schilder

On the advice of Dr. Philip Shupack, a classmate who trained in periodontics at Beth Israel, Herbert Schilder, DDS, a young graduate of New York University Dental School who was serving a two-year Army commitment in Aberdeen, Maryland, called upon Dr. Goldman at the Beth Israel clinic in 1955. Dr. Goldman advised and directed the aspiring endodontist to seek additional training at the University of Pennsylvania with Dr. Grossman and then to return to Beth Israel. Even though Dr. Grossman had not yet formed an official postdoctoral program, he invited Dr. Schilder to attend his short courses while still in the military.[15]

Dr. Cohen, who was also a lecturer in periodontics at Temple Dental School beginning in 1953, was familiar with the one-year residency program in endodontics at that school. The Department of Endodontics at Temple had been established in 1948 by Dr. Morton Amsterdam and a fellow Penn dental school graduate. With the 1954 death of Tufts endodontist Dr. Bernard Berg, Dr. Goldman needed a new clinician. At a continuing education course, Drs. Cohen and Schilder discussed the latter's future as a root canal therapist. Since there was no official postdoctoral program at Penn, Dr. Cohen called Dr. Amsterdam, who, after interviewing Dr. Schilder, offered him the endodontic residency at Temple. Dr. Schilder would also have the opportunity to complement his education with Dr. Grossman through Penn's yearlong short courses. Dr. Amsterdam impressed upon Dr. Schilder the need to attend and actively participate in the yearly meetings. The latter planned to return to Boston, where his wife had attended Wellesley College.[16]

Upon completion of Dr. Schilder's year in Philadelphia in 1956, Dr. Goldman secured office space at 53 Bay State Road in Boston so that Dr. Schilder could open a private practice. Dr. Goldman also offered him a teaching position at the Reisman Clinic at Beth Israel. The nucleus for the future Boston University School of Graduate Dentistry was now in place.

As a role model, Dr. Goldman urged his staff to publish, lecture here and abroad, and teach. The purpose was to develop a more advanced institution that would benefit the profession. As Dr. Schilder became more experienced, he became an advocate of specialty education within the AAE, where he served as president in 1985, as well as in the ADA, where he held the office of first vice president in 1990. Unlike Dr. Goldman, who was known for publishing numerous texts (many with Dr. Cohen), Dr. Schilder, out of deference to Dr. Grossman, never wrote a textbook on endodontics.

By 1958, Dr. Schilder was head of the endodontic section of the department of stomatology at Boston University School of Medicine and accepted his first postdoctoral student, Dr. Cyril Gaum, in 1960.[17] In 1963, Dr. Schilder became a founder, associate professor, and chair of the Department of Endodontics at the School of Graduate Dentistry at Boston University.

Dr. Bernard Berg's earlier work with chloropercha had piqued Dr. Schilder's curiosity.[18] Over the next several years, Dr. Schilder gradually developed a warm gutta-percha technique employing Kerr sealer and vertical compaction to obturate the root canal system; this technique influenced the profession and changed the face of modern endodontics. The triad of cleaning, shaping, and filling took on new meaning.[19] Schilder eventually retired from teaching in April 2003.

In a tribute to Dr. Schilder upon his death in 2006, Dr. Joseph Williams wrote of his teacher, partner, and longtime friend: "He was 'The Professor' to hundreds of graduate students and thousands of dentists around the country and the world. . . . Herb Schilder changed the stature of modern endodontics for the better. Patient care, results of treatment, education of practitioners, and understanding of the specialty have all benefited from his influence. Herb's genius was his ability to articulate very complicated concepts and techniques into easily understood vernacular."[20]

In 1999, Jeffrey W. Hutter, a graduate of the Penn dental school, assumed the mantle as the first Herbert Schilder Chair in Endodontics at Boston University. Dr. Hutter spent his professional career in the Navy, culminating as chair and director of postdoctoral endodontics at the Naval Dental School in Bethesda, Maryland. In 2008, he became dean and the first Spencer N. Frankl Professor in Dental Medicine at Boston University's Goldman School of Dental Medicine. During 2009, Dr. Hutter appointed George Huang, DDS, MSD, DSc, a Taiwan native and former student of Dr. Schilder, as the second Herbert Schilder Chair in Endodontics.[21]

Summary

While Dr. Grossman was in Rostock with a letter of introduction from Dr. Prinz, he visited several distinguished dentists in Berlin. One was the aged Dr. Otto Walkoff, who, with the help of a physicist while in Wurzberg, was the first dentist to capture the image of a tooth soon after the discovery of radiology by Roentgen in 1895. At his home, Dr. Walkoff passed the X-ray tube head that had taken the historic film to Dr. Grossman, who then held this treasured artifact in his hands.[2] This transfer of culture from Germany to the United States marked the beginning of modern endodontics. Similarly, when Dr. Goldman gave Dr. Schilder his backing by sending him to study under Dr. Grossman at the University of Pennsylvania, the progress of endodontic excellence moved forward, ensuring a Century of Endodontics. ■

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The Henry M. Goldman School of Dental Medicine building at 100 East Newton Street in Boston

Going... Going... Going... Gone Green

Making Your Dental Practice Environmentally Friendly

This compendium was collected and compiled as a joint project of the Council on Dental Practice and the Standing Committee on the New Dentist

Mary C. DeMello, DMD

Ryan M. Clancy, DMD

The concept of "going green" is certainly a popular topic in the world today. Despite terms like compact fluorescent lightbulbs (CFLs), energy efficient, and carbon footprint becoming more familiar to us, there is still a lot of ambiguity around what all this means, particularly as it relates to the practice of dentistry. Even so, the entire health care industry is going through a paradigm shift toward eco-friendly delivery of care.

In putting together this compendium, we found a tremendous amount of information on "green dentistry." Our goal is to educate members at both ends of the spectrum. We selected introductory articles for the neophytes, and included links for those who have a genuine interest but already understand the basics. The information has been condensed into summaries, tables, and lists of relevant information.

The MDS Web site (***www.massdental.org/green***) contains this and much more information with links to resources that will assist you. Visit the Web site often because we will update it with new information as it becomes available.

Annual Environmental Impact of Dentistry

- 680 million disposable plastic barriers
- 1.7 billion sterilization pouches
- 28 million liters of fixer
- 4.8 million lead foils
- 3.7 tons of amalgam waste
- 9 billion gallons of water (water vacuum systems) or 360 gallons of water/day/office

Visit www.massdental.org/green for a list of resources and information on going green.

A Room-by-Room Guide for Creating a Greener Dental Practice

By Dr. Jason and Rebecca McMillan

Americans are becoming more and more concerned about the environment. This includes your patients, who may be seeking to align themselves with dentists who show a commitment to improving the health of both their patients and the environment. Businesses that have incorporated sustainable features cite numerous benefits, including: recognition by their patients and community as an environmental leader; a strengthened bottom line through operating efficiencies; improved employee health and morale; a marketing edge over the competition; and opportunities to further increase productivity and reduce costs.

This article from Henry Schein Dental focuses on each room/area of a typical dental office and suggests big and small steps that dentists can take to reduce their carbon footprint and start the process of "going green." For instance, in the front office, communicate with doctors and patients via email and send digital X-rays. In the operatories, invest in digital radiography and save space, eliminate the need for film processing and hazardous waste disposal. And in the lab/sterilization room, utilize cassettes for instrument processing and reduce the use of sterilization bags.

To read the full article, visit ***www.massdental.org/green***.

HENRY SCHEIN®
DENTAL

Go Green Dentistry

By Kevin Henry

Are you thinking about "going green" in your dental practice and wondering if it will make any impact? This article from *Dental Practice Management News* answers the question; there are plenty of things that you can do that will make a difference.

Obviously, large solutions such as moving to digital radiography, creating a paperless practice, and building or retrofitting a green practice will make a big difference. But smaller changes help, too. Installing low-flow toilets in the bathroom and aerators in faucets help conserve water. In the office, turning off the computer or setting it to go into sleep or standby mode reduces electricity use by 70 percent. (Screen savers do not save energy.) Turning off the television in the reception area overnight does not save energy, but unplugging it does. Switching to compact fluorescent lightbulbs (CFLs) is expensive initially but will save energy costs over time.

To read the full article, please visit ***www.massdental.org/green***.

Green Facts

- By converting to digital X-rays, a typical dental office can prevent disposal of at least 200 liters of fixer and 17,200 lead foils in just five years.
- Digital patient charting saves as much as 10,000 sheets of paper a year in a typical dental office.
- More and more dentists are adopting green habits for their dental practices, such as using recycled and eco-friendly materials for construction. This includes floors made from sustainable woods, floor coverings that are biodegradable and naturally inhibit bacterial growth, and renewable energy sources and high-efficiency lighting. Some dentists are following guidelines from the internationally recognized certification system LEED (Leadership in Energy & Environmental Design) when designing their office spaces (see ***www.usgbc.org/leed*).**
- The estimated value of green construction starts in 2000 was $792 million. The projected value of green construction starts for 2010 is $60 billion (10 percent of all construction starts).
- It is estimated that every three years, the amount of plastic in the ocean doubles. In a Texas-sized part of the ocean known informally as the "Pacific Garbage Vortex," there's a bigger mass of plastic than plankton.
- According to the *Wall Street Journal*, Americans use 100 billion plastic shopping bags each year. Manufacturers make an estimated 200 million tons of plastic each year. Less than 3.5 percent is recycled, which means that every year we add 193 million tons of plastic to the world—permanently.
- It takes approximately 350 years for an aluminum can to decompose.

Visit www.massdental.org/green for a list of resources and information on going green.

It's Easy Being Green
Environmentally Friendly Practices Are Sprouting Everywhere

By Carol Bommhardt

This article from *AGD Impact* profiles four dentists who made the conscious decision to move toward a greener way of life and who believe that going green can and should be incorporated in every aspect of their lives, including their profession. One dentist opened the first LEED-certified dental office in the nation. LEED (Leadership in Energy and Environmental Design) is a third-party certification program and the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings. Another dentist, in addition to obtaining Gold certification for her LEED-certified office, gives her patients nonpetroleum-based lip balm and toothbrushes made from recycled yogurt cups.

Their advice to other dentists is to look at the four main areas for improvement—energy efficiency, water conservation, higher air quality, and waste reduction—and develop strategies to address these areas.

To read the full article, visit ***www.massdental.org/green***.

Back to Basics: Tips on Going Green

The American Dental Association offers these tips on implementing green practices in your dental offices:

Waste Reduction Tips

- Recycle the "Big Five": aluminum, glass, paper, plastic, and steel
- Reduce or reuse paper, including cardboard
- Send appointment reminders on recycled paper or through email or text message
- Print double-sided
- Recycle computer parts and electronics
- Pay practice bills online

Energy Conservation Tips

- Install programmable thermostats
- Install motion sensors and turn off power at night
- Replace incandescent bulbs with compact fluorescent lightbulbs (CFLs)
- Tune up your heating and cooling systems
- Purchase LED bulbs for exit signs
- Purchase smart power strips for electronics

Water Conservation Tips

- Check your practice for leaks every six months
- Incorporate waterless hand sanitizer
- Teach your patients to turn off water when they brush
- Review your water bill for spikes each month
- When you wash your hands, turn off the water while you lather

Pollution Prevention Tips

- Bike, walk, or carpool to work
- Use only low-toxic cleaning products
- Install an amalgam separator
- Use low or no-VOC (volatile organic compounds) paint products
- Utilize and encourage your patients to use public transportation
- Replace all aerosols with pump dispensers

The Do's and Don'ts of Green Infection Control

The Do's

- **Do** opt for reusables instead of disposables
- **Do** use alcohol hand sanitizers instead of hand washing
- **Do** use trigger/pump sprays instead of aerosols
- **Do** establish better inventory controls to eliminate discarding excess products past their expiration date
- **Do** ensure accurate mixing of chemicals and prepare amounts based on use-life and shelf-life
- **Do** switch from film X-rays to digital technology
- **Do** ensure sterilizers and cleaning units are full before running them to reduce the number of cycles run per day
- **Do** use products made from recycled materials
- **Do** use recyclable products

The Don'ts

- **Don't** use paper (e.g., biodegradable) instead of plastic surface barriers, since paper will allow moisture and microbes to penetrate
- **Don't** reuse standard sterilization wraps and pouches, since they were not designed to maintain sterility after more than one use
- **Don't** use woven cloth (e.g., denim) as sterilization wraps and then reuse it, since it is not a good microbial barrier
- **Don't** use a disinfectant that has a reduced concentration of an active ingredient unless there is evidence of its efficacy
- **Don't** shorten cleaner or sterilization cycles to save energy
- **Don't** reuse items sold as disposables

The Environmentally Responsible Dental Office:

A Guide to Pollution Prevention and Proper Waste Management in the Dental Office

By the Virginia Dental Association and the Virginia Department of Environmental Quality

The Virginia Dental Association and the Virginia Department of Environmental Quality developed this comprehensive guide to help dentists become better caretakers of the environment. Although its list of resources and references is specific to Virginia, it still provides an excellent refresher on the proper handling and disposal of mercury, amalgam, and other waste products, including X-ray fixer solution, developer, and cleaners. One section discusses the proper disposal of drugs and pharmaceutical chemicals.

The Green section of the manual lays out suggestions for green purchasing, recycling of general office waste, increasing energy efficiency, and water conservation. To read the full article, visit ***www.massdental.org/green***.

Infection Control Going Green: Oncoming Reality? Parts 1 and 2

By John A. Molinari, PhD

These two articles from *Dental Economics* discuss questions and issues dentists need to consider in making green infection control decisions.

For example:

- How much actual regulated infectious waste does your office generate?
- Are you correctly categorizing medical waste and infectious waste? If not, you may be paying for the disposal of medical waste that could be disposed of with your regular office trash.

Going green by going digital means eliminating the need to recycle lead foil and paying to dispose of spent fixer solution and developer. Manufacturers and distributors of infection control products are starting to offer green alternatives that work just as effectively.

To read the full articles, visit ***www.massdental.org/green***.

Ways to Go Green

- Put recycling bins in your office and recycle the "big five": aluminum, glass, paper, plastic, and steel
- Install water-saving toilets
- Use paint that does not include volatile organic compounds (VOCs)
- Use office furniture made from recycled or reclaimed wood
- Install energy-efficient appliances (washer, dryer, dishwasher)
- Go paperless—utilize a virtual office for patient charting, billing, and radiography
- Use LCD computer screens instead of CRT screens
- Recycle lead foil from X-rays
- Use less harmful (nontoxic) surface disinfectants to clean and sterilize
- Use biodegradable disposable cups instead of regular paper cups
- Send appointment reminders on recycled paper or via email or text message
- Use 100 percent recycled stationery
- Purchase organic or eco-friendly scrubs
- Recycle computer parts, other electronics, and batteries
- Drink tap water, not bottled water
- Get rid of all aerosol products
- Recycle or refill toner cartridges
- Learn how much energy and water you are using in your practice
- Replace windows with double-pane energy-efficient windows
- Change and recycle vacuum pump filter screens at least once a month or as directed by the manufacturer
- Post the steps you are taking to be a green dental office in your waiting room or patient rooms
- Install environmentally friendly cabinetry (no added urea-formaldehyde)
- Implement an instrument recycling program
- Stock recycled toilet paper, paper towels, and tissue
- Turn off and unplug computers, printers, copiers, and TVs at the end of the day
- Use dishware and mugs instead of paper or Styrofoam in the office kitchen
- Print and copy on both sides of stationery when possible
- Use compact fluorescent light bulbs (CFLs)

Just do something! Start with small steps that work on any budget and don't require a lot of effort.

Massachusetts Dental Society

Two Willow Street, Suite 200, Southborough, MA 01745-1027 • (508) 480-9797 • (508) 342-8747 in MA

Visit www.massdental.org/green for a list of resources and information on going green.

146th MDS House of Delegates

Changing of the guard: MDS President Dr. John Fisher (left) receives the presidential gavel from Immediate Past President Dr. David Samuels.

ADA First District Trustee Dr. Robert Faiella swears in the 2010–2011 MDS officers.

Speaker of the House Dr. Thomas Torrisi presided over his third Annual Session at the 2010 House of Delegates on Friday, May 14, 2010, at the Burlington Marriott. Six resolutions were passed by delegates, including a $20 dues increase and the formation of a committee to study the viability of the Boston Pilot Group—an offshoot of last year's redistricting discussions. (For a complete list of the resolutions, please visit ***www.massdental.org/hod*** or see the July-August 2010 issue of the MDS Connection.)

More than 160 delegates were in attendance as an almost entirely new slate of officers took the oath of office for the 2010–2011 governing year. John Fisher, DDS, a general dentist in Salem, was sworn in as MDS president; Charles Silvius, DDS, a general dentist in Revere and former secretary of the MDS, was elected president-elect; Paula Friedman, DDS, a general dentist in Boston, associate dean at the Boston University Henry M. Goldman School of Dental Medicine, and former chair of the MDS Council on Public Affairs, was elected vice president; Anthony Giamberardino, DMD, a general dentist in Medford and former assistant secretary of the MDS, stepped into the role of MDS secretary; Lisa Vouras, DMD, a general dentist in Reading and former trustee of the East Middlesex District, was elected assistant secretary; Michel Jusseaume, DDS, a general dentist in Westport and former assistant treasurer, was sworn in as treasurer; and Howard Zolot, DMD, a periodontist in North Andover and former trustee of the Merrimack Valley District, assumed the role of assistant treasurer.

Additionally, five new district trustees were inducted: Richard Marchand, DMD, a general dentist in Yarmouth Port (Cape Cod District); Tofigh Raayai, DMD, an orthodontist in Everett (East Middlesex District); Thomas Trowbridge, DDS, MD, an oral and maxillofacial surgeon in Lowell (Merrimack Valley District); John C. Owen, DMD, a general dentist in Needham (Metropolitan District); and David Lustbader, DMD, an oral and maxillofacial surgeon in Quincy (South Shore District). Four new Guest Board Members were also welcomed: Todd Belfbecker, DMD, a general dentist in Revere; Debbie Eisen, DMD, associate clinical professor of prosthodontics and operative dentistry at Tufts University School of Dental Medicine and a private practitioner in Swampscott; Geraldine C. Garcia-Rogers, DMD, a pediatric dentist in Winchester; and Abol Massih Tehrani, DMD, a prosthodontist in Haverhill.

As in past years, 50-Year members were honored at a luncheon for completing half a century of MDS membership. (See list at left.)

Twenty-two of the 50-Year MDS members attended a luncheon in their honor at the House of Delegates.

MDS 50-Year Members

Angelo L. Bilionis, DDS
Richard R. Brousseau, DMD
Gerald R. Carrier, DMD
Charles A. Dean, DDS
Paul F. DePaola, DDS
Milton M. Dines, DDS
Joel L. Dunsky, DDS
Robert A. Flashner, DMD
Stanley H. Frodyma, DDS
David R. Gelinas, DMD
Daniel B. Green, DDS
Richard A. Hallisey, DDS
Peter G. Kimball, DMD
Anthony J. Koury, DMD
Maria Krivoshlikoff, DMD
Marvin Lowy, DMD
Paul A. Marino, DDS
Robert W. Mattson, DMD
James T. McInerney, DMD
Edward M. Morin, DMD
Richard T. Murphy, DMD
Richard A. Nutile, DDS
John J. O'Connell Jr., DDS
James V. Picone, DDS
Philip E. Richardson, DDS
Cloyed L. Ross Jr., DMD
Martin Rutberg, DMD
James T. Ryan, DMD
Edward H. Seadale, DDS
Pramod M. Soparkar, DMD
Richard J. Sorbera, DDS
Paul Sowsy, DMD
Donald B. Stackhouse, DMD
Raymond Widican, DDS

Bacterial Microleakage and Post Space Timing for Two Endodontic Sealers: An In Vitro Study

SEYED MOHSEN JALALZADEH, DDS; AHMAD MAMAVI, DMD; HASAN ABEDI, DMD, MS; RASOUL YOUSEFI MASHOUF, PHD; AMIN MODARESI, DMD; VIRGINIA KARAPANOU, DMD, MS

Dr. Jalalzadeh is an assistant professor and Dr. Mamavi is a postgraduate student in the department of endodontics, and Drs. Abedi and Yousefi Mashouf are in the department of microbiology at the University of Medical Sciences in Hamadan, Iran. Dr. Modaresi is a dentist practicing privately in Hamadan. Dr. Karapanou is an associate professor in the department of endodontics at Tufts University School of Dental Medicine.

Abstract

Aim—The effects of immediate versus delayed post space preparation on the apical seal using resin and zinc oxide eugenol (ZOE) sealers were compared by a bacterial leakage model.

Methodology—Eighty-six premolars were randomly assigned to four experimental groups of 20 teeth. Three teeth were assigned to each control group, either positive (filled only with gutta-percha) or negative (not obturated but root surfaces completely covered). Obturation was achieved by gutta-percha with resin or gutta-percha with a ZOE sealer and lateral condensation technique. Post space was prepared either immediately or a week later, while the obturated teeth had been stored in 100 percent relative humidity at 37ºC. The teeth were inserted into plastic vials and suspended in glass bottles. All teeth were covered with cyanoacrylate and layers of nail varnish but the apical 3 mm and were sterilized using gamma rays. Phenol red lactose broth was inoculated into the vials. *Staphylococcus epidermidis* was introduced into the root canal access of the teeth. Turbidity of the broth in the vials (discoloration) was evaluated daily for a period of 70 days. The data was analyzed statistically with Pearson Chi Square and two ways with ANOVA at 45 days and 70 days.

Results—When the depth of time was considered, the mean time of leakage showed no differences between immediate and delayed preparation for resin AH26 versus ZOE Dorifil at 45 and 70 days (p = 0.37 and p = 0.217, respectively). In 45 days, considering the number of teeth with leakage, there was a significant difference between immediate preparation and delayed preparation in AH26 sealer groups (p = 0.028). No difference was present between immediate and delayed preparation groups for the ZOE sealer groups (p = 0.14).

Conclusion—According to the results of this study and despite type of sealer, immediate post space preparation did not achieve better sealing than delayed post space preparation. Resin AH26 showed the least leaking teeth in 45 days, but it made no difference in 70 days.

Introduction

Obturation of root canals in three dimensions to optimally seal the coronal and apical portion of endodontically treated teeth results in preventing apical and coronal microleakage,[1] the most common cause of failure after root canal therapy.[2,3] Various factors such as sealer material type, chemical and physical features of sealer, root canal shape, filling material characteristics, obturation technique, tooth contamination with moisture, and removal of the smear layer are associated with efficient root canal sealing.[4] Gutta-percha may be the main core material, but it is the use of a sealer that resists microleakage (leakage of bacteria) inside the tooth.[5] Another important factor that may adversely affect sealing sufficiency is the post space preparation. Posts retain the restoration of insufficient tooth structure.[6] Sealing ability may be affected as a result of gutta-percha removal techniques, the amount of root filling remaining, and the type of sealer, as well as the time of post space preparation; thus, immediate post space preparation is performed right after the obturation of the root canal system while the sealers have not set, and delayed post space preparation is performed a week later. A few studies have reported no microleakage differences between immediate and delayed post space preparations.[7,8] Others indicated that there is a significant difference of apical microleakage associated with immediate versus delayed preparations.[9,10]

Microleakage assessment is an in vitro evaluation of sealing ability accomplished using dye penetration, dye extraction, fluid filtration, or bacteria and toxin infiltration methods. Bacteria as leakage tracer provide more biologically significant and clinically relevant information.[11] Many researchers have evaluated the effect of immediate and delayed post space preparation on the sealing quality of endodontic materials using dye penetration or fluid filtration.[7–11] In our study, we used as our microleakage marker *Staphylococcus epidermidis*, nonmotile gram-positive cocci, approximately 0.5 to 1.5 mm, which can survive on a dry surface for long periods with adhesive properties to hydrophobic biopolymers and plastic. The two different sealers used in this experiment have different properties, and thus it is possible that their clinical use might affect the bacterial microleakage in the root canal system. AH26 is an epoxy resin-based sealer with greater bond strength and dentin adhesion when compared with many other sealers. Dorifil is a ZOE-based sealer with antiseptic properties but limited dentin adhesion. When the post space is to be prepared immediately after obturation or to be delayed, the question arises as to which sealer might be the appropriate material in preventing microleakage.

Materials and Methods

Eighty-six sound, single-canal premolar teeth were immersed in 2.5% sodium hypochlorite solution for one hour immediately following extraction, then cleansed and rinsed with normal saline and stored in 100 percent relative humidity until use. The coronal portion of the teeth was removed to create standardized root length of 16 mm. In this respect, the length of the root was the same in all teeth to take account of anatomic variations and to obtain standardized leakage measurements.

A #15 K file was used to verify patency of the canals and to determine working length, 1 mm short of the length that the tip of the 15 K file observed at the apex. The canals were instrumented to a size #30 K file using standardized step-back technique to a #45 K file. Gates Glidden #2 and #3 were used. Sodium hypochlorite 2.5% was used during instrumentation. At the end, canals were rinsed using normal saline and dried with paper cones. Post space was prepared with #3 Peezo reamer to maintain 5 mm of remaining filling. Peezo reamers result in lower adverse effects than other techniques for post space preparation.[1,14,17]

Four experimental groups of 20 teeth each were randomly assigned. Positive and negative control groups had three teeth each. The groups broke down as follows:

Group A: Immediate post space preparation of canals obturated with gutta-percha and resin (AH26) sealer.

Group B: Immediate post space preparation of canals obturated with gutta-percha and ZOE (Dorifil) sealer.

Group C: For one week, the teeth were stored in 100 percent relative humidity at 37ºC. Delayed post space preparation of canals obturated with gutta-percha and resin (AH26) sealer.

Group D: For one week, the teeth were stored in 100 percent relative humidity at 37ºC. Delayed post space preparation of canals obturated with gutta-percha and ZOE (Dorifil) sealer.

Positive control group: Teeth filled with gutta-percha without sealer.

Negative control group: Teeth had no gutta-percha and/or sealer. Post space was prepared in similar manner; however, the whole tooth, including the coronal and apical ends, was covered with cyanoacrylate and a layer of nail varnish.

Each tooth was placed into the opening of a plastic cap of a tube and the cap-tooth and cap-tube interfaces were sealed with cyanoacrylate and a layer of nail varnish. Root surfaces were also coated with two layers of nail varnish except for 3 mm around the apical portal. Root surfaces were completely coated in the negative control group. The teeth were sterilized using gamma rays. Lactose broth was added into each tube so that 2–3 mm of the apical root surface emerged into the broth. *S. epidermidis* was inoculated into the root canal at the coronal portion. The teeth were incubated at 37ºC, and the media inside of the canals were exchanged with fresh culture every 48 hours. The lactose broth in each tube was evaluated daily for up to 70 days until its red color turned to yellow, indicating bacterial leakage. All procedures were performed by one operator. The evaluations were performed independently and blindly in respect to the experimental group. The data were analyzed statistically after 45 days and 70 days with Pearson Chi Square and two ways with ANOVA.

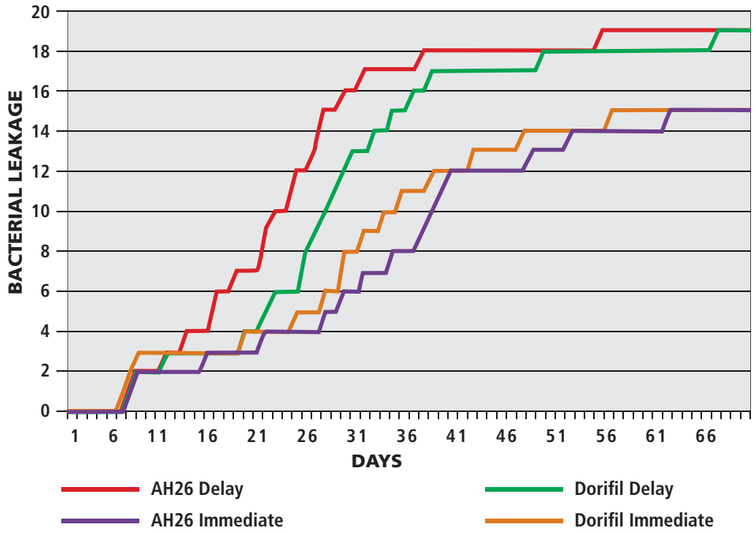
Results

All positive controls leaked within 24 hours; none of the negative controls leaked. When the depth of time was considered, the mean time of leakage showed no differences between immediate and delayed preparation for resin AH26 versus ZOE Dorifil at 45 and 70 days (p = 0.37 and p = 0.217, respectively). When the number of teeth with leakage was considered in 45 days, the Pearson Chi Square test confirmed no significant differences for resin versus ZOE sealer between the immediate preparation groups (p = 0.74), and again no differences when the delayed preparation groups were compared to each other (p = 0.5). (See Table 1.) In the assay at 45 days, a significant difference was noted for the immediate AH26 group versus the delayed AH26 group (p = 0.028). No difference was present between immediate and delayed preparation groups for the ZOE sealer group (p = 0.14). (See Table 2.) In the assay at 70 days, there were no significant differences between the four groups regardless of sealer type or post preparation time in amount of leakage (number of leaked teeth) or mean time of leakage (p values are 0.099 and 0.217, respectively).

Figure 1 shows that in the depth of time, development of leakage was similar for the same timing of post space preparation groups. At about three weeks, the delayed preparation groups (C and D) presented higher leakage more frequently than the immediate preparation groups (A and B).

The abundance of leakage showed significant differences at immediate versus delayed preparation for resin versus ZOE sealer at 45 days (p = 0.028 and p = 0.14, respectively) (see Table 2), but there were

Figure 1. Development of Bacterial Leakage in Four Groups



no significant differences in regard to the timing of the post space preparation (see Table 1).

Discussion

According to the results of this study, the immediate post space preparation groups presented less microleakage in 45 days, thus sealing better than the delayed post space preparation groups. This is in agreement with Fan et al. and Solano et al. studies showing significantly less leakage with immediate post space preparation after obturation.[6,12] It is possible that the longer setting time of sealers influenced microleakage. In immediate time of post space preparation, the sealer has not set completely, allowing accommodation of possible disturbances in the gutta-percha core during preparation of the post space, resulting in lower microleakage. Unset sealers are able to compensate for developing defects during post space preparation.[13,14] Leakage of the immediate preparation groups for both ZOE and resin sealers and of the delayed preparation groups for both sealers showed no differences after bacterial microleakage of 70 days. Statistical analysis showed no differences for resin and ZOE sealers when the immediate preparation group was compared with the delayed preparation group of any of the same kind of sealer. (See Tables 1 and 2.) Madison et al. and Abramovitz et al. also suggested that there were no differences between immediate and delayed post space preparation.[7,15]

It is interesting, though, that when the groups were evaluated in 45 days, the immediate preparation group with the resin AH26 sealer showed significantly less microleakage than the delayed group with AH26 sealer, which exhibited the worst leakage. As studies have reported, gutta-percha removal techniques affect sealing ability,[4] and it is likely that the mechanical action of the burs and the increased temperature produced while preparing for post space caused cracks of the set resin enough to compromise the good adhesion to the dentin walls and the greater tensile strength of the material. The Karapanou dye study also showed the least leakage for the immediate post space preparation and resin sealer but greater leakage for the delayed preparation group of the ZOE sealer.[13] Adanir et al. also found that resin-based sealers function adequately when compared with eugenol sealers.[16] In this bacteria study, the antimicrobial properties of the ZOE sealer possibly made the difference. At 70 days, the two sealers exhibited no significant differences. This suggests that, with time, the continued bacterial penetration during microleakage nullifies different materials used for sealing.

The study showed that at 45 days (evaluation time), the leakage increased in resin-delayed (20.78±8.48), ZOE-delayed (24.59±9.16), ZOE-immediate (25.23±11.92), and resin-immediate (27.17±11.85) groups with time.

However, after 21 days, a trend was prominent for increased rate of bacterial leakage for all groups. At that point, the group with immediate post space preparation and resin sealer produced the fewer leaking teeth, contrary to ZOE's antibacterial properties. For the delayed groups of both sealers, the trend showed to be stronger, as the teeth leaked more and faster, but in the depth of time, the immediate groups also exhibited a trend for higher leakage. (See Figure 1.) This can be possibly explained by the crumbling of the sealers in most teeth with the delayed preparation of the post space, by allowing the bacteria easy movement from the access cavity to the apical end through the cracks. After 45 days and to the end of our experiment (70 days), it is interesting that the advantage that the resin sealer exhibited for the first weeks was actually reversed. The antibacterial properties of ZOE versus resin probably made the difference not significant, as the time allowed the growth of bacteria to take place in the resin sealer teeth.

As a result of this in vitro study, clinicians should aim to permanently restore endodontically treated teeth by cementing the post and eliminating the post space within three weeks of obturation to ensure less microleakage. Although using various methodology and interferential factors make it infeasible to compare results, many studies agree that these are critical factors in the outcome of a successful obturation. The timing of a successful permanent restoration in the post space/buildup of the tooth and the timing of a post space preparation play an important role, as bacterial microleakage cannot be helped through different materials. Even though leakage was less in immediate groups regardless of the type of sealer, teeth leaked if left without any restorations.

Conclusion

Using bacterial leakage in vitro, immediate post space preparation achieves better sealing than delayed post space preparation, with slightly better results for the resin sealer when Peezo reamers are used for post preparation. There are no differences, however, between resin and ZOE sealers at 70 days of bacterial leakage.

Table 1. The Abundance of Bacterial Leakage in Regard to Timing of Post Space Preparation in 45-Day Assay

Post Preparation	Sealer	Total Sample	Leaked Number (percent)	*P* value
Immediate	Resin AH26	20	12 (60 percent)	0.74
	ZOE Dorifil	20	13 (65 percent)	
Delayed	Resin AH26	20	18 (90 percent)	0.5
	ZOE Dorofil	20	17 (85 percent)	

Table 2. The Abundance of Bacterial Leakage in Regard to Type of Sealer in 45-Day Assay

Sealer	Post Preparation	Total Sample	Leaked Number (percent)	*P* value
Resin AH26	Immediate	20	12 (60 percent)	0.028
	Delayed	20	18 (90 percent)	
ZOE Dorifil	Immediate	20	13 (65 percent)	0.14
	Delayed	20	17 (85 percent)	

This study demonstrates the importance of permanently restoring endodontically treated teeth at the earliest opportunity, preferably within three weeks. Dentists should consider a three-week period or less as the ideal interappointment time between endodontic treatment and follow-up restorative care, with a permanent buildup and sealing of the post space prepared for that purpose. ■

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DENTAL EROSION

Erosion of teeth is caused by chronic exposure to either acidic or calcium-chelating agents such as citric acid.[1] Depending on the cause of erosion, the pattern of tooth-structure loss is characterized by smooth concave facial and lingual surfaces of the maxillary anterior dentition and cup-shaped defects involving the occlusal and incisal surfaces of the anterior and posterior dentition.[2]

Affected tooth surfaces are often notable for a smooth "glazed" appearance, and an enamel "ledge" may be retained near the facial gingival margin.[3] Gastric fluids, either secondary to gastroesophageal reflux disease or in patients with eating disorders, are most commonly implicated in erosion. Referred to as perimolysis, this form of erosion typically affects the lingual surfaces of the maxillary dentition. Other causes of erosion include the consumption of acidic beverages such as soft drinks and sports drinks,[4-5] the use of acidic medicines such as chewable aspirin and vitamin C tablets, and the use of acidic mouthrinses.[6]

Figure 1. Dental erosion in a patient who reported consuming 30 cans of Coca-Cola each week.

Since enamel is reported to dissolve at a pH between 5.0 and 5.7,[7] the acidic pH used in mouthrinses to mask the bitter taste of pyrophosphates and prolong the shelf life has raised questions about the role such oral hygiene products play in erosion. (See Table 1.) While rinsing before brushing may enhance the loss of tooth structure, according to some authors,[6] the excessive use of mouthrinses is another factor to consider when evaluating a case of erosion. Most manufacturers recommend that mouthrinses be used for approximately 30 seconds twice per day; however, many patients do not adhere to such guidelines and exceed these recommendations.

When a clinical diagnosis of erosion is rendered, a thorough history should be taken to rule out potential dietary and systemic causes, including the frequency of use of acidic mouthrinses, in order to prevent further loss of tooth structure. ■

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Table 1. pH of Some Commonly Used Mouthrinses

Mouthrinse	pH
The Natural Dentist	3.1–4.0*
Tom's of Maine	3.0–4.5*
Peroxyl	3.0–6.0^
Phos-Flur	3.8–4.5^
Listerine	4.2*
Crest Pro Health	4.4^
Viadent	4.5~
Periogard	5.0–7.0^
Advanced Care Viadent	5.5–6.5~
Cepacol	5.5–6.5~
Scope	5.8^
Water (neutral)	7.0

* Company Web site
^ Direct correspondence with company
~ *Encyclopedia of Pharmaceutical Technology*, 2nd ed., Informa Healthcare, 2002

A 50-Year Journey from Begg to Straight Wire and Beyond: Is Orthodontics on the Correct Course Today?

VINCENT DEANGELIS, DMD

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Before embarking on this retrospective of the era of orthodontic biomechanics, a discussion of factors implicated in the etiology and pathogenesis of root resorption will provide insight into a central issue of this clinical perspective.

Root Resorption

Root resorption associated with orthodontic treatment has been recognized as a clinical problem since 1927, when Ketcham published his histological findings revealing this complication.[1] Since then, the specialty has considered root resorption to be a *sine qua non* of tooth movement. Several key factors have been implicated in this irreversible change that detracts from otherwise successful treatment, namely:

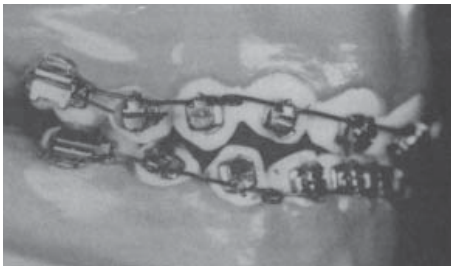
- Overall length of treatment
- Length of time in rectangular archwires that fully engage the Edgewise slot
- "Jiggling" and "round tripping" of teeth in the sagittal, vertical, and transversal planes
- Uncontrolled tipping, resulting in excessive compression of the periodontal ligament and alveolus
- Incisor root contact with the palatal cortical plate during intraslot torque

This pervasiveness was documented by Kaley, who made several revealing observations on posttreatment radiographs of 200 patients from his practice who were consecutively treated with a 0.022" x 028" Edgewise Straight-Wire Appliance for an average of 34 months.[2] More than 90 percent of the roots of the maxillary central incisors had been resorbed to some degree, ranging from blunting to more than one-fourth of their length. This percentage was nearly as high for maxillary lateral incisors. Maxillary incisors were four to five times more likely to exhibit severe resorption (more than one-fourth of the total root length) if their roots underwent labiolingual torque. The most significant measure associated with resorption in the maxillary arch was the approximation of maxillary incisor apices against the lingual or cortical plate. A patient was 20 times more likely to undergo severe root resorption of the maxillary incisors when the root apices were forced against the cortical plate. Also, the amount of resorption was directly proportional to the overall treatment time and the length of time with fully engaged rectangular archwires. Kaley's paper is one of many publications that address the incidence of resorption with the Edgewise appliance. Earlier, Goldson and Hendrickson published similar findings when they stated that all 42 patients they treated with the Begg Technique exhibited radiographic evidence of root resorption.[3] Orthodontic literature today is replete with these reports.

The Begg Technique

P. Raymond Begg of Adelaide, Australia, introduced a light archwire technique in 1956.[4] In his classic paper entitled "Differential Force in Orthodontic Treatment," Begg discussed principles of differential force used since 1938, after many years of experience with the Edgewise appliance. Concomitantly, Storey and Smith reported in the *Australian Dental Journal* that as forces were increased from 150 to 500 grams during distalization of canines, these teeth became anchorage units as molars moved mesially.[5]

Begg was intrigued and encouraged by the findings of Storey and Smith, since their histological and statistical evidence supported his clinical experiences. Storey and Smith presented the concept of undermining resorption, previously described by Sandstedt[6] and later confirmed by Schwarz[7] as their explanation for different rates of movement of canines and molars. Although



Figures 1a–1b. Severe uncontrolled tipping necessitating reversing the incisor root apices to their final position. Dehiscences and root resorption associated with these redundant root movements are inevitable. This round tripping can occur with any bracket configuration in the absence of careful biomechanical application.

undermining resorption was accepted as an integral part of the lightwire technique, little emphasis was placed on the dangerous potential for irreversible damage to the teeth and supporting structures during this pathologic process.

As the Begg Technique evolved and became more commonly accepted in the 1960s and 1970s, many clinicians became alarmed when they discovered that the undermining resorptive process led to irreversible changes. Moreover, the practice of overjet and overbite correction utilizing round wires through the classic first and second stages of the Begg treatment was followed by round tripping of root apices with torquing auxiliaries during the third stage of treatment. The direction of the movement of these apices was reversed to move them through newly deposited, and likely less resorbable, bone matrix. This process predictably produced unacceptable amounts of iatrogenic damage to the roots and supporting structures. A 1976 laminographic study by Dutch investigators Ten Hoeve and Mulié further illustrated the dangers of uncontrolled tipping and subsequent round tripping of teeth, as maxillary incisor root apices perforated the labial plate due to this excessive uncontrolled tipping.[8] (See Figures 1a–1b.)

Straight-wire Appliance

In the early 1970s, seemingly in reaction to disillusionment with both the light round wire techniques and the conventional Edgewise mechanisms, Andrews developed what he considered to be an improved Edgewise system. Andrews began gathering data for his Straight Wire Technique in the early 1960s, utilizing 120 untreated, perfectly normal occlusions. From these records, he derived the "six keys to normal [nonorthodontic] occlusion," which offered the basis for his treatment goals and technique.[9] Hence, Andrews developed his new concept that purportedly simplified treatment and obviated the need for first-, second-, and third-order bends due to his incorporation of torque, angulation, and varied thicknesses within the brackets.

The University of Illinois's Thurow, a disciple of Brodie and Downs, published a book entitled *Edgewise Orthodontics* in which he wrote that "an important consideration in torque action is the use of undersized wires."[10] Thurow stated that wires that fit the slot closely should never be used to torque individual teeth:

"When a wire with torque action is seated in a bracket, the twist of the wire will torque the adjacent teeth in an opposite direction. These adjacent teeth will not be permanently moved if the archwire is left in place long enough to become completely passive, but . . . will have been subjected to unnecessary back and forth torque action. Wires adjusted to torque individual teeth should be sufficiently undersized to allow the adjusted wire to rotate in the slot of the adjacent tooth with no torque action on that tooth. This precaution is more easily observed with a 0.022" slot than with a 0.018" bracket slot."

DeAngelis conjectured in the 1970s that vestibular bone fenestrations could result from the round tripping of buccal roots as incisal palatal root torque is accomplished with intraslot mechanics.[11,12] Twisting of the rectangular wire into the incisor bracket slots requires an opposite twisting of the archwire in the molar buccal attachments—Newton's third law that for every action there is an equal and opposite reaction in mechanics. Consequently, the molar roots must first move buccally as incisor roots are being moved palatally, inducing potential vestibular fenestrations until the archwire's torque forces have been fully expended. Subsequently, the molar roots return to the confines of the alveolus. However, the vestibular fenestrations can and probably do remain. (These controversial points will be discussed in greater length when describing the Amalgamated Technique later in this perspective.)

Andrews seemed to overlook the issues detailed by Thurow and their potentially unfavorable biological sequelae. Moreover, the Straight Wire Technique would be required to treat the ubiquitous Class II malocclusion to the tooth positions derived from 120 nonorthodontic normal occlusions. Transformation of a Class II malocclusion with skeletal Class II components to a Class I dental occlusion with an underlying skeletal Class II pattern can lead to inadvertent excessive incisor root torque and cause undesirable proximation of the maxillary incisor apices against the palatal cortical bone. The pretorqued brackets of Andrews and the greater degree of pretorque in the Roth modification system[13] (employed by Kaley) likely lead to root resorption, particularly when the Class II skeletal pattern can not be fully resolved during treatment, and when dentoalveolar compensations are required.

The Tip-Edge Appliance

In 1989, Peter Kesling introduced the Tip-Edge Appliance, which is a modification of the Chun-Hoon and Fogel-Magill Combination Techniques.[14] Kesling attempted to combine the features that previously existed in the combination bracket into one slot. Tip-edge brackets, unlike the Begg brackets, partially control mesiodistal tipping of teeth by chamfering diagonally opposite corners of the conventional Edgewise slot. His actual mechanotherapy, however, is essentially the same as practiced with the classic Begg approach, in that overjet and overbite are fully resolved by incisor and canine uncontrolled tipping with round archwires by the end of the second stage of treatment.

This recipe continues to tip root apices excessively in one direction and then reverses their direction during the third treatment stage (torque), with undesirable full-slot engagement. Interestingly, the original Begg Technique employed the more biologically sound lower load deflection rate system of torque with an auxiliary. Moreover, the relative narrowness of the brackets and elastomeric modules used in this technique increase

the amount of friction, and require greater forces when sliding mechanics are the objective. Basically, frictional force is inversely proportional to the bracket width. Simply stated, in sliding mechanics, the narrower the bracket, the greater the resulting friction, requiring reliance upon larger forces for tooth movement.[10] The Tip-Edge Technique seemingly disregards the untoward biodestructive lessons of the past. (See Figures 1a–1b.)

The Speed Appliance

Continuing on this mechanotherapeutic journey, yet another attempt to improve upon the conventional Edgewise bracket was made by Hanson.[15] In September 1980, Hanson described the Speed System of orthodontic treatment, which incorporates a self-ligating mechanism ostensibly designed to reduce sliding mechanics friction and to enhance the three-dimensional control of tooth movement. The Speed bracket is relatively narrow and incorporates a spring-loaded mechanism. These features, compounded by the Speed system's reliance on torque with full-slot engagement, are likely to induce irreversible apical changes and bone fenestrations. Additional self-ligation bracket modifications of late include Smart Clip, Innovation, and Damon. Although these modifications in bracket form may lessen treatment chair time, they do nothing to improve treatment results or to address biological issues.

Damon Treatment

A contemporary technique by Damon advocates dental arch expansion, ostensibly to avoid extractions when a dental arch/tooth size disparity exists.[16] This concept is similar to the discarded Labio-Lingual Technique of the 1940s and 1950s. Both of these expansion methods ignore the functional matrix concepts taught by Van der Klauw and Moss, who emphasized the concept that facial bones and dental arch shapes are in "functional equilibrium" controlled by soft tissue, musculature, respiration, deglutition, and other oronasal-facial functions. Disturbing this equilibrium risks a rebounding effect (relapse).[17] Therefore, the wisdom of this practice is suspect. Moreover, adverse effects upon the periodontium, such as the creation of dehiscences and fenestrations owing to excessive widening of the dental arches, are likely.

The Amalgamated Technique

In 1976, DeAngelis introduced the biologically oriented, efficient, and cost-effective Amalgamated Technique, after 10 years of development.[11,12,18] After practicing both Begg and conventional Edgewise techniques for approximately eight years, and observing with dismay the irreversible root changes, as well as suspecting the likelihood of vestibular fenestrations with intraslot incisor root torque, DeAngelis developed the Amalgamated Technique in an effort to avert this damage. This biomechanical method of therapy combined the best principles of both the Edgewise and Begg concepts to produce physiologically efficient, controlled tooth movement in three planes and to achieve biologically sound results.

The appliance incorporates 5 mm-wide, 0.022" x 0.028" edgewise brackets, which are strategically positioned, angulated, and have zero torque slots. A series of light round archwires are utilized to achieve optimal overbite and overjet by controlled tipping, totally avoiding round tripping of root apices. Correction of overjet without displacement of apices in the opposite direction is a desirable and fundamental objective of sound orthodontic mechanotherapy, and it is achieved with the Amalgamated Technique. Simple accentuated and reverse curves of Spee incorporated in the maxillary and mandibular archwires, respectively, combined with judicious Class 2 elastic force, produce controlled labiolingual tipping by directing the center of rotation to the incisor apices. Movement of incisors is monitored until the proper sagittal and transversal inclinations are attained with round archwires. At this point, root uprighting at extraction sites is virtually achieved by seating the successive thicknesses of archwires into preangulated wide brackets with hand-tied wire ligatures.

Maxillary anterior teeth are tipped to their optimal angulation relative to the line Nasion-point A (ideal sagittal axial inclination). Thereafter, the incisors are translated—bodily moved—palatally with Warren spring auxiliaries fastened to a light rectangular archwire. Torque is attained with the Warren springs and never with full or even partial archwire/slot engagement. The later method for torque, according to Thurow,[10] was a bad idea in 1966 and continues to be a bad idea today. The lower load deflection rates afforded by Warren spring auxiliary torque, vis-à-vis full-slot archwire torque, provide biologically desirable light continuous forces. Additionally, the forces generated using Warren torquing auxiliaries are approximately 1/7 of the forces generated by torque within the slot. Conversely, forces generated by torque within the slot are seven times greater than the forces generated by torque utilizing auxiliaries. The high load deflection rate of intraslot torque is undesirable and should be avoided. (See Figure 2.)

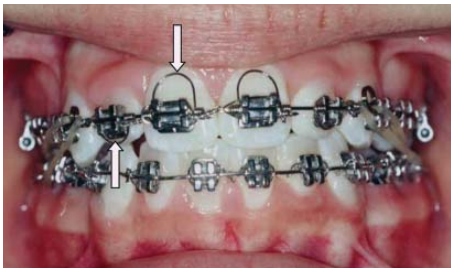


Figure 2. Warren spring auxiliaries torque the maxillary central and lateral incisors independently (central incisor palatal root torque with concomitant lateral incisor labial root torque). Intraslot torque is incapable of this independent action.

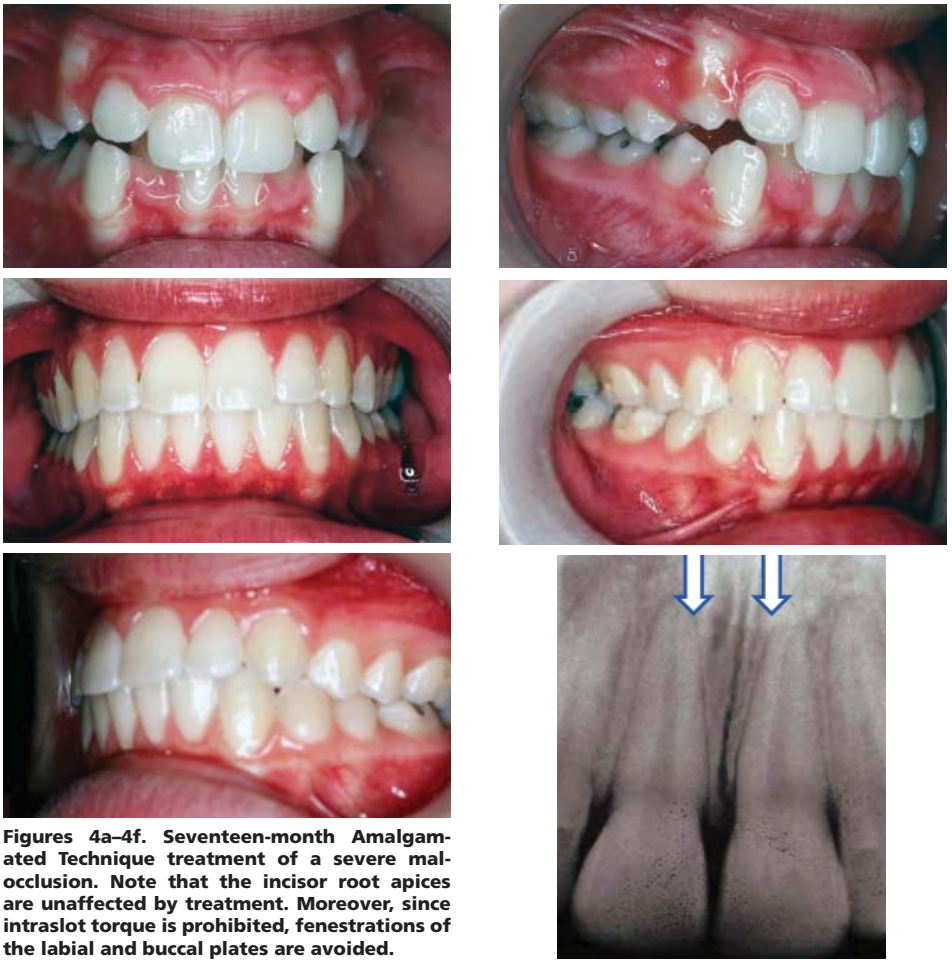
The 0.016" x 0.022" archwire/Warren spring combination is also advantageous, since the adjacent teeth do not un-

Figures 3a–3b. Severe root resorption associated with Straight-wire torque. Note that the mandibular incisor apices are not only severely resorbed, but also perforate the lingual plate.

dergo reverse torque. The 0.016" x 0.022" archwire in a 0.022" x 0.028" slot has 27.4 degrees of freedom.[19] Therefore, as the Warren spring exerts its torquing force, the archwire moves in the opposite direction; but since sufficient intrabracket tolerance exists, the archwire does not inadvertently torque the adjacent teeth, vis-à-vis intraslot torque. However, if this 0.016" x 0.022" archwire/Warren spring combination is used in a 0.018" x 0.025" slot, only 9.3 degrees of freedom are available, and the adjacent teeth are likely to undergo reverse torque by twisting the archwire in the opposite direction.

An important and revealing article by Wehrbein, Fuhrmann, and Diedrich affords a unique opportunity to assess histological tissue response to the Straight Wire appliance in a 19-year-old female who was killed in an automobile accident.[20] The histological findings included observations of vestibular fenestrations and extensive buccal root resorption of the maxillary molars. The authors stated that "pronounced resorptions with negligible reparative processes" were seen especially above the vestibular portions of the buccal roots, and in contrast, "the resorptions formerly extending into the dentine above the palatinal root were already covered with new cementum." In the periradicular region, the mesiobuccal and distobuccal roots of the molars penetrated the vestibular cortical tissue above the middle root section and projected "like a ship's bow into the soft tissue covering of the alveolar bone." The periosteum was "stretched like an awning over the severely resorbed root sections. No subperiosteal bone apposition could be seen in the fenestration area." The authors opined that the rectangular archwire/intraslot torque was likely responsible for these pathological findings.

Since the 19-year-old patient was in treatment for only 19 months at the time of her death, one can only speculate on the potential for further destruction during the full course of treatment. The earliest patients treated with the Straight Wire appliance are perhaps now between 30 and 50 years of age. Premature aging of the dentition could become more apparent over the next two decades, as the findings of Wehrbein et al. are extrapolated over the wider orthodontic patient population. (See Figures 3a-3b.) In an editorial comment, T. M. Graber, past editor of the *American Journal of Orthodontics and Dentofacial Orthopedics*, remarked regarding these findings: "In this era of great emphasis on controls, prospective studies and carefully selective criteria, anecdotal information does not mean much; however, there are exceptions. This is a unique case that has highly significant information from which we can extrapolate to our routine multibanded Edgewise therapy. Because we cannot see it does not mean it is not there; the tool seems to be controlling the practitioner."[20]



Figures 4a–4f. Seventeen-month Amalgamated Technique treatment of a severe malocclusion. Note that the incisor root apices are unaffected by treatment. Moreover, since intraslot torque is prohibited, fenestrations of the labial and buccal plates are avoided.

Conclusions and Recommendations

For all of the aforementioned reasons, and since overall treatment time is carefully limited to 18 to 24 months in most instances with the Amalgamated Technique, virtually no root resorption is evident radiographically, and fenestrations are unlikely, since intraslot torque is prohibited. (See Figures 4a–4f and 5a–5k.)

Kaare Reitan, a prominent histologist who extensively studied the tissue changes associated with orthodontic tooth movement, concluded that "bringing incisors into alignment by forcing a rectangular archwire into a bracket slot may be mechanically effective, but the force may be too excessive for the tissues to withstand."[21] Yet Donald Roth, an originator and avid proponent of today's universally accepted StraightWire Technique, surprisingly stated without deference to the biology of tooth movement that "it makes no difference how or how much teeth are moved as long as a .022" x .028" bracket slot is filled with a .022" x .028" archwire . . . whether the tooth is moved 2 mm or 8 mm, it should end up in the same position given time."[13] And D. R. Smith, another leading spokesperson for the Straight Wire appliance, has asserted in the publication *Clinical Impressions*: "Remember that it is better to build extra torque in the brackets. If you have exhausted the largest wires and still have inadequate torque, what can you do? You either have to add torque to the archwire or rebond the case with higher torque brackets."

As practitioners transition from accepting only the typical two-dimensional periapical X-ray, the panorex, and the cephalogram as their sole radiographic diagnostic tools, they begin to adopt 3-D technologies, such as Cone Beam computed tomography scans, for diagnosis, treatment planning, and particularly the analysis of treatment results. These rela-

Figures 5a–5k. Eighteen-month Amalgamated Technique extraction treatment of a severe malocclusion with no posttreatment sign of root resorption.

tively new applications, if utilized effectively, have the potential to enlighten the clinician on the pathologic consequences of faulty mechanics. As Reitan infers in his previous statement, the orthodontist treats human organisms, not mannequins.

In essence, the discerning clinician must consider the ramifications of force applied to teeth in all three planes. Forces must be light and continuous as anterior and posterior teeth are directed to their final positions, without superfluous movement of their root apices, utilizing both round and rectangular archwires within wide-bracket zero torque slots. The sequelae of excessive misdirected force on roots and paradental structures are pathologic and irreversible.

As Adlai Stevenson, U.S. Ambassador to the United Nations under President John F. Kennedy, said: "We can chart our future clearly and wisely only if we heed the path which has led us to the present." The clinician would do well to remember that in the absence of careful biologic consideration, innovations during the evolution of appliance design are worthless. Charles Burstone, an expert in orthodontic biomechanics, concluded that "the biological objectives in biomechanics must come first, for without them, there is no basis for appliance design." ■

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A Clinico-Pathologic Correlation

Figure 1. Preoperative appearance of the lesion showing buccal and lingual expansion of the maxilla.

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A 36-year-old female presented to the Oral and Maxillofacial Surgery Clinic at Tufts University School of Dental Medicine for evaluation of an expansile maxillary lesion. The patient was originally informed about a radiolucency in the area of the left maxilla, discovered on routine radiographs seven years ago, at which point the lesion was recommended for a biopsy. The patient refused any treatment for this lesion and has been followed radiographically by her general dentist for the past three years. More recently, the patient became aware of shifting of teeth, bony expansion of maxilla, and facial asymmetry, which brought her in for further evaluation. Her medical history is significant for hypothyroidism, for which she takes Levoxyl. The patient reported no known drug allergies and her social history was negative for tobacco or alcohol use.

On clinical examination, there was an obvious facial asymmetry with superior displacement of the left upper lip and nostril. Intraorally, there was significant expansion of the left maxillary alveolar ridge extending from the central incisor to the first molar region from the buccal and palatal aspects. The overlying mucosa was normal in appearance, with the exception of inflammation on the buccal aspect in the canine area. Anterior maxillary teeth were displaced by the lesion. There seemed to be erosion of the buccal cortex in the area of the left canine and premolar, which was soft to palpation. The lesion was completely asymptomatic with intact sensation in the distribution of the infraorbital nerve.

A panoramic radiograph revealed a well-defined, corticated, multilocular radiolucency in the anterior maxilla extending from the left central incisor to the second premolar. There was obvious displacement of the lateral incisor and canine. A contrast-enhanced computed tomography (CT) scan was obtained, which showed an expansile lesion of the left alveolar ridge with well-defined bony cortices and hypodense core with a thin sclerotic rim extending into the left maxillary sinus.

Differential Diagnosis

Ameloblastoma
Odontogenic myxoma
Ameloblastic fibroma
Central odontogenic fibroma
Keratocystic odontogenic tumor (KCOT)

Biopsy

Local anesthesia was achieved via left maxillary block through the greater palatine foramen with supplemental maxillary infiltration to aid in hemostasis. Once adequate anesthesia was obtained, a full thickness mucoperiosteal envelope flap was developed from the right maxillary central incisor to the left maxillary tuberosity. During flap elevation, the lesion was noted to have perforated through the bone in the canine and premolar area. There was noticeable attachment of the tumor to the overlying gingiva. Rongeur forceps were used to remove the thin buccal bone to gain access for removal of the lesion. The lesion was noted to have a spongy, gel-like consistency and was removed in pieces using dental curette. The bony defect was inspected for remaining fragments, and the exposed tooth root surfaces were scaled with periodontal scalers. The surgical site was irrigated with normal saline, and the flap was repositioned with 4-0 nylon sutures. The specimen was fixed in formalin and was sent for histopathologic evaluation by the Tufts Oral and Maxillofacial Pathology Department. The lesion was clinically suspicious for desmoplastic ameloblastoma or odontogenic myxoma.

Figure 2. The lesion after initial exposure showing perforation through the buccal cortex.

Figure 3. Bony defect after enucleation of the lesion showing obvious displacement of maxillary teeth and exposure of roots.

Histology

The hematoxylin- and eosin-stained sections showed a tumor composed of spindle and round cells in a random arrangement within a loose myxoid stroma. Cellular atypia was not a feature. Thin fibrils of collagen that focally became dense bands were noted within the myxomatous stroma. Odontogenic epithelial rests were not seen.

Diagnosis

Odontogenic myxoma

Discussion

Odontogenic tumors present in a variety of ways due to a wide range of biologic behaviors. Odontogenic myxoma is a benign neoplasm of odontogenic origin with locally aggressive and infiltrative behavior. The histogenesis of this lesion is uncertain, but it is thought to develop from the dental papilla. Metastasis to distant organs has not been shown.[1,2] The age distribution has a wide range of presentation from 1 to 73 years, with most occurring between the second and fourth decades of life. The female-to-male ratio is 1.5:1.[3] The location of this tumor is distributed throughout the jaws with predilection for the premolar and molar region. The presentation of this lesion outside the facial skeleton is very rare but can present in the long bones.[1,2]

Clinically, myxomas present as slow-growing expansions of maxilla or mandible. These neoplasms are generally asymptomatic with no neurosensory disturbances. Displacement of adjacent teeth is common, and these lesions can be associated with an unerupted tooth or a developmentally absent tooth.[1,2] Cortical perforation and extension of the maxillary tumors into the sinus are commonly noted. Gross pathological examination reveals an unencapsulated gray-white to tan-yellow mass with a rubbery, gelatinous texture.

Most odontogenic myxomas are discovered on routine periapical dental radiographs or panoramic radiographs. Additional imaging in the form of computerized tomography (CT) and magnetic resonance imaging (MRI) may be indicated on the clinical presentation of the lesion. Radiographically, odontogenic myxomas can present as unilocular or multilocular radiolucencies with a wide range of sizes. Kaffe et al. noted that 12.5 percent of myxomas were mixed radiolucent and radiopaque and 7.5 percent were radiopaque.[3] Multilocular lesions are described as having a "honeycomb" or "soap bubble" appearance with wispy trabeculae.[2] Tooth displacement is often noted and root resorption is infrequent. Only 5 percent of myxomas are associated with an unerupted tooth.[3] MacDonald-Jankowski et al. recommended that conventional radiographs and CT scans should be obtained for these lesions, as the radiographs are better at defining the lesion margins and the scans are more likely to show bony perforations and identify bony septa.[4]

The reported recurrence rate of odontogenic myxoma ranges from 10 to 33 percent, due to locally invasive behavior of this tumor.[5] Hence, the recommended treatment is a resection with 1.0–1.5 cm bony margins and one uninvolved anatomic barrier margin.[1] Enucleation is considered a palliative treatment and is an option for patients who prefer palliation or are at significant risk for general anesthetic.[1] Radiation therapy and chemotherapy have been attempted but showed no additional benefit.[2] In the present case, the lesion was enucleated with the patient being informed that additional treatment may be necessary based on histopathologic evaluation. The patient is now scheduled for resection of the lesion and reconstruction with an obturator.

Other odontogenic tumors, such as ameloblastoma, keratocystic odontogenic tumor, ameloblastic fibroma, and central odontogenic fibroma, should be considered in the differential diagnosis when the above clinical presentation is encountered.

Ameloblastoma is an odontogenic neoplasm, which presents in a variety of histological patterns. Its clinically aggressive behavior and frequency make it the most significant odontogenic neoplasm. Ameloblastoma can present as an intraosseus lesion, a peripheral lesion, or a combination of both. It is most frequently encountered in the third and fourth decades of life with only 10 percent of the cases in children. The lesion occurs commonly in the mandible, with 80 percent of cases presenting there. Similar to odontogenic myxoma, ameloblastoma can pre-

Figure 4. A panoramic radiograph showing radiolucency in the anterior left maxilla with displacement of the left lateral incisor and canine.

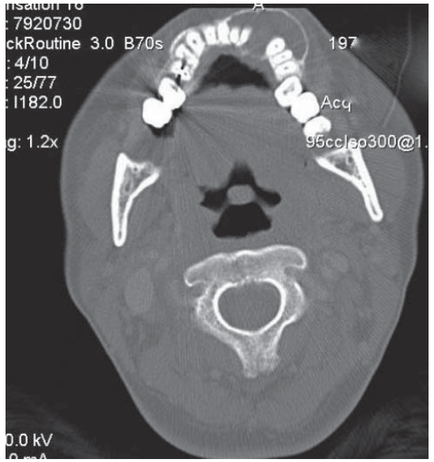

Figure 5. An axial cut of a non-contrast CT showing an expansile, well-defined hypodense lesion of the left maxilla.

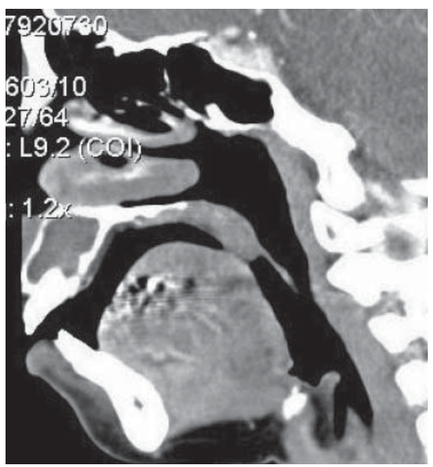

Figure 6. A sagittal cut of a contrast-enhanced CT displaying superior extension of the lesion with no soft-tissue involvement.

sent as a swelling and facial asymmetry. Frequently, the lesion is asymptomatic but can present with ulcerations of the overlying mucosa and pain. Radiographic evaluation most often reveals a multilocular "soap bubble" radiolucency, although it can present as a unilocular lesion as well. Histopathologic subtypes of ameloblastoma include follicular, acanthomatous, glandular cell, basal cell, plexiform, and desmoplastic.[6] Desmoplastic ameloblastoma was a high consideration in our case due to the gel-like consistency of the lesion. Histologically, desmoplastic ameloblastoma features dense, scar-like fibroblastic stroma, which can give it this kind of consistency and the radiographic appearance, and may be confused with a fibro-osseous lesion. The treatment of ameloblastoma is the same as that of odontogenic myxoma, with 1.0–1.5 cm bony resection and anatomic barrier margins of one uninvolved anatomic barrier.[1]

Central odontogenic fibroma is another lesion that can present as painless expansion of the bony cortices with displacement of roots. It is a rare lesion that is thought to be due to proliferation of mature odontogenic mesenchyme. Some pathologists consider these lesions as hyperplastic dental follicles and do not consider them as true neoplasms.[7] The age of presentation ranges from 4 to 80 years, with a mean of 40. About 45 percent of these lesions occur in the maxilla, with most located anterior to the first molar.[7] The gross examination of this tumor reveals a solid mass with a well-defined capsule.[1] Our specimen was definitely unencapsulated, making this diagnosis less likely. Radiographically, however, this lesion can present in almost identical fashion to an odontogenic myxoma as a well-defined, multilocular lesion with displacement of adjacent roots. Histologically, it is composed of stellate fibroblasts arranged in a whorled pattern and abundance of ground substance.[7] The treatment of this lesion is curative enucleation, as it does not display bony invasion and almost never recurs.

Another lesion considered in the differential diagnosis is ameloblastic fibroma. This is an uncommon tumor, which originates from the epithelial and mesynchymal tissues. Similar to the above case, these lesions present as asymptomatic expansion of the jaw bones; however, the age distribution is in a much younger group, with a mean age of 6 to 12 years compared to the above-mentioned lesions. Presentation of these lesions beyond age 25 is uncommon but can occur.[1,7] About 70 percent of the cases are located in the posterior mandible. The microscopic evaluation reveals narrow cords of odontogenic epithelium in a background of primitive mesenchymal stroma. These lesions can be treated with enucleation and curettage. Due to age distribution, this entity was not considered high on the differential diagnosis in this case.

Finally, keratocystic odontogenic tumor (KCOT) should also be considered as a possibility. Recently, this lesion has been reclassified as a neoplasm due to its potential for locally aggressive behavior. KCOT is thought to originate from either dental lamina rests or basal cells of the oral epithelium of the dental follicle.[8] These lesions occur most frequently in the second and third decades of life, with the mandible being the most frequent presentation site.[1,8] Clinically, these lesions present as expansile swelling in the jaws with or without pain. Radiographically, KCOT can be unilocular or multilocular with a "soap bubble" appearance. Histological evaluation reveals a characteristic corrugated, parakeratinized lining of the squamous epithelium with

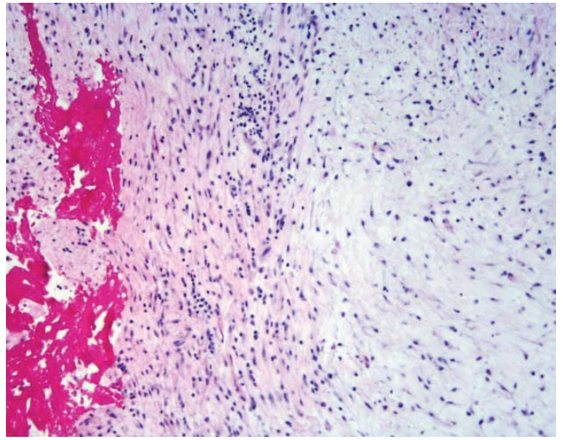

Figure 7. A low-power view showing the loose myxoid stroma common to odontogenic myxomas.

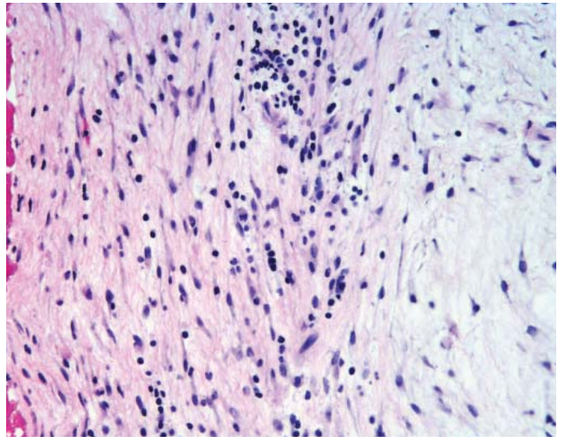

Figure 8. Medium-power view demonstrates the myxoid background containing a paucicellular mix of spindle and round cells.

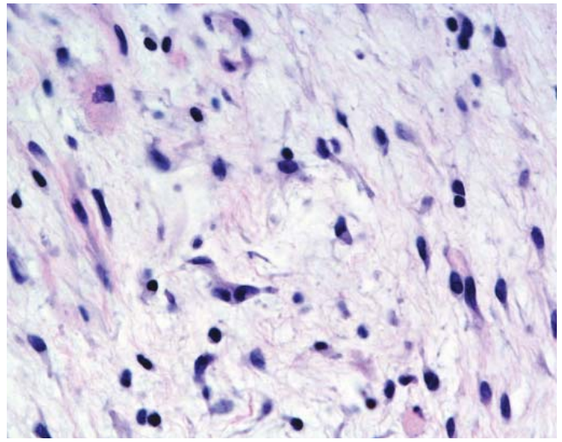

Figure 9. High-power view displays the round and spindle cells, characteristic of odontogenic myxoma, in a background of loose fibrous connective tissue.

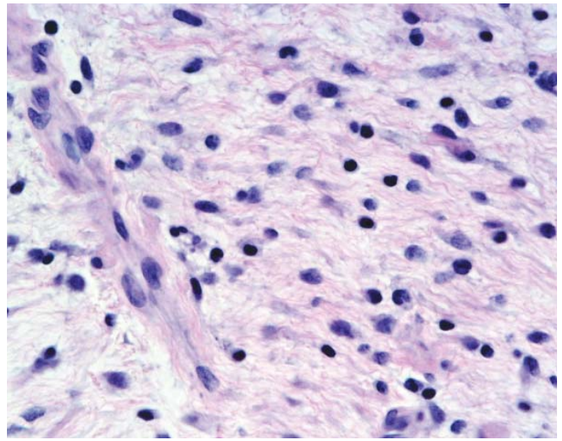

Figure 10. Odontogenic myxoma seen in a less myxoid area with small collagen fibrils and denser bands of mature collagen.

hyperchromatic palisaded basal cells.[1,8] These lesions often have small satellite cysts or odontogenic rests in the adjacent bone, which may account for high recurrence rates. The reported recurrence rates vary from 5 to 70 percent. The treatment of KCOT consists of enucleation and curettage with removal of satellite cells via peripheral ostectomy, application of Carnoy's solution, or cryosurgery.[1,8] Large lesions can be marsupialized prior to definitive removal. In the above case, the gross appearance of the removed lesion was not consistent with KCOT, but based on the radiographic and clinical presentation prior to enucleation, KCOT is a good addition to the differential diagnosis list.

Conclusion

Benign odontogenic neoplasms, such as odontogenic myxoma, usually present as expansile lesions of the jaws and can be completely asymptomatic. Many of these lesions are discovered incidentally on routine dental radiographs. Vigilant screening for these lesions will allow for early detection and prompt treatment. Patients diagnosed with odontogenic neoplasms should be encouraged to undergo early definitive treatment to prevent destruction of the surrounding tissues and loss of function due to potentially aggressive behavior. ■

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CLINICAL CASE STUDY

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MULTIDISCIPLINARY OCCLUSAL RESTORATION

FREQUENTLY, A CLINICIAN IS CONFRONTED WITH A COLLAPSED occlusion. Over the years, teeth have been lost for various reasons. Sometimes, it's as simple as a financial issue, in which case extraction is the only option for the patient. As people grow older, they still require a full dentition, which ensures the ability to develop a functional occlusion and, thereby, select foods that are nourishing rather than foods that will just satiate their present needs.

The patient was a 43-year-old female in sound health. Her chief complaint was that there was increased spacing of the anterior teeth, an inability to chew effectively, and pain in the right temporomandibular joint (TMJ), especially upon opening. Diagnosis was a collapsed occlusion with a decreased vertical dimension. Incisal guidance was minimal, if at all, because the anterior segment was weak, as can be seen in Figures 1a–1h.

Recommended treatment was multidisciplinary. Orthodontics was required to level and align the teeth, eliminate lower anterior crowding, close upper anterior spacing, achieve an ideal overjet and overbite, intrude a supraerupted molar to establish a suitable occlusal plane, and upright premolar and molar roots to create appropriate space for implant placement and restoration. Orthodontic treatment was required to procedurally stabilize the dentition. Occlusal equilibration was performed once the orthodontic banding was removed, and the patient was placed into removable retainers as the teeth came into occlusion. Further occlusal equilibration was performed. The maxillary second molar was retained in order to provide sufficient support for the dentition. An opposing implant added structural integrity to that area of the dentition. Periodontics was required to remove the frenum from the anterior teeth and to ultimately place three implants when the spacing and uprighting of the teeth had been accomplished by the orthodontist. Time of treatment was approximately two years. Final results are shown in Figures 2a–2f.

Ultimately, some of the vertical dimension was reconstituted. The dental arches were widened and tooth stability reinforced. The planes of occlusion—both left and right—were reestablished, and chewing capacity was enhanced. TMJ signs and symptoms were improved. Minimal crown and bridge was required, and an artificial increase in vertical dimension was unnecessary. In this way, the danger of a new occlusion was bypassed and the whole treatment was conservative with no removal of sound tooth structure other than with equilibration. The balanced occlusion can be seen in the posttreatment occlusograms. (See Figures 2g–2h.) These were made using Regisil 2X (Dentsply) in full-mouth triple trays. The patient closed tightly for one minute and the impression was removed after two minutes. It was then placed in a light box, and the densities of the occlusal impressions were recorded with a camera. The information was then fed into a microdensitometer wherein differences in thickness became visible. These differences were then used with a calibration grid to determine their thickness: White (0–50 microns), Orange (50–100 microns), Yellow (100–150 microns), Red (150–225 microns), Green (225–325 microns), Blue 325–450 microns), and Purple (450–650 microns).

This is a case that is multidisciplinary. Without an overall diagnosis and collaboration with the various dental specialists, success could not have been achieved. ■

Figures 1a–1h. Patient presented with a collapsed occlusion with a decreased vertical dimension.

Figures 2a–2h. After two years of multidisciplinary treatment, a balanced occlusion has been achieved.

Give Us Your Feedback on This Clinical Case Study

A Clinical Case Study is a written and visual assessment of a clinical case where the author presents before-and-after radiographs and/or photographs as a means to discuss the diagnosis, treatment plan, and actual treatment of a particular situation. The purpose of this study is to encourage JOURNAL readers to contribute a clinical response to the cases presented.

Please address your correspondence to Clinical Case Study, JOURNAL OF THE MASSACHUSETTS DENTAL SOCIETY, Two Willow Street, Suite 200, Southborough, MA 01745. Include your name, address, and phone number or email address so that we may contact you for follow-up. Responses may be published in a future issue of the JOURNAL.

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Open Wide—Memoir of the Dental Dame

MARGARET SEWARD
The Memoir Club Limited

As the well-known editor emeritus of the *British Dental Journal*, Dame Margaret Seward of Great Britain is particularly well equipped to present her autobiography, *Open Wide—Memoir of the Dental Dame*, which details her life and experiences. This 322-page illustrated volume is the unique autobiography of a dentist whose rise to exceptional heights, both professional and personal, makes for a story worth telling. History shows that dentistry originated and was practiced as a male-dominated profession that ultimately developed into an independent professional calling, all the while still coveting its male domination. The current progress and increasing number of women in dental leadership roles is a most welcome development that merits expansion and deserves total respect.

Open Wide is Dame Seward's faithful account of dentistry's advancements, as recalled by an empathetic dental leader who established a reputation as one of the expert contributors to the worlds of dentistry and public health. Among the many significant positions held by Dame Seward are: supervisor of the dental unit, Highlands Hospital in North London; editor of the *British Dental Journal*; editor of the *International Dental Journal* of the FDI World Dental Federation; president of the British Dental Association; and president of the General Dental Council. In 1999, Dr. Seward became the first—and still only—dentist appointed with the title Dame of the British Empire (DBE).

In addition to her achievements in her home country, Dame Seward has received honorary membership in the American Dental Association, and has received designations from the American College of Dentists, the American Association of Dental Schools (now the American Dental Education Association), the American Association of Women Dentists, and the American Academy of the History of Dentistry.

Recognitions notwithstanding, this autobiography stands out also for its many heartfelt accounts of Dame Seward's personal relationships with family, friends, colleagues, patients, and acquaintances. Readers may also enjoy the author's account of interactions with celebrities, the elite, the intelligentsia, and British royalty. Dame Seward possesses the ability to recall precise details of every period of her life, particularly her family life, which makes for an engaging and colorful read. It is refreshing to read her praise and acknowledgment of the support she has received from her husband, Professor Gordon Seward, who has also been decorated with the title Commander of the British Empire (CBE).

Dame Seward's friends and admirers agree that her retirement should never have been entertained, a conclusion with which this reviewer is in full accord. ■