Commentary

Minimally Invasive Periodontal Therapy: Will Periodontal Therapy Remain a Technologic Laggard?

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Minimally invasive therapeutic approaches have become the standard of care for many medical procedures. In contrast, the use of minimally invasive techniques in non-surgical and surgical periodontal therapy has not progressed to the same extent. This commentary explores some of the technologic forces that influence the acceptance of minimally invasive therapeutic modalities. There is adequate science to support the development and clinical use of minimally invasive periodontal treatment but the technology to perform minimally invasive procedures is not currently available. Potential explanations for what seems to be a growing technologic lag are explored.
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KEY WORDS

Dental scaling; economics; oral hygiene; periodontitis; practice management; root planing.

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The standard surgical and non-surgical methods used to treat chronic periodontitis have remained essentially unchanged for decades.[1-3] Most periodontitis is treated using blind non-surgical approaches that depend on tactile sensations to discover and remove subgingival accretions. Evidence exists that blind non-surgical therapy can be useful in shallow-to-moderately deep periodontal pockets when performed by skilled clinicians who are provided unlimited treatment time on anesthetized patients.[4-6] Evidence also exists that deeper pockets often require surgical treatment to correct underlying bony defects.[7]

Non-surgical periodontal therapy seems increasingly popular. This is likely based on numerous factors. These may include a paucity of evidence on how much deposit can be left on the tooth surface and still stabilize the inflammatory lesion; lack of appropriate records and consistency of follow-up; and the positive economic consequences of not referring the patient. This last point may be associated with the perceived costs and side effects of periodontal surgery. In addition, many patients and practitioners believe that there are simpler ways to treat periodontitis, such as lasers and medicated trays, which are easier, less uncomfortable, and can be accomplished by a general dentist.

It is our opinion that much of the non-surgical periodontal treatment currently performed is inadequate to arrest or reverse the disease process. Because chronic periodontitis tends to progress slowly, it is often difficult to accurately evaluate the results of periodontal therapy in the short term and this may result in inadequate treatment. It is also our observation that many sites that could benefit from more advanced care are not referred for the needed care. Perceptions remain common among patients and non-periodontists that periodontal surgery can result in long-term thermal sensitivity, compromised esthetics, or impaired functional outcomes.

This commentary explores how new technology-based therapeutics enter clinical practice and become

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accepted. We will contrast recent technology-based surgical advances in medicine with those in periodontics. We will also comment on our observations on the need for the periodontal community to actively promote newer and less-invasive techniques to serve our patients better and to preserve the specialty of periodontics. Many of our comments are based on observations and opinions that are not fully supported by quality scientific studies. For this reason, we are presenting this as a commentary rather than a true scientific review. Despite this drawback, we believe that an analysis of periodontal minimally invasive procedures is timely.

HOW NEW TECHNOLOGIES ACHIEVE CRITICAL MASS IN THE HEALTHCARE MARKETPLACE

New technologies are logically incorporated into clinical practice when they provide improvements compared to older technologies. The likelihoods of improved therapeutic outcomes or lower costs (including capitalization and use costs) are common determinants that motivate the widespread adoption of new technologies into clinical practice. Occasionally, the need for improved technologies is obvious to clinicians; other times it is not. It should be no surprise that when a need for better technology is widely appreciated by clinicians, manufacturers and suppliers are more motivated to develop technologies to satisfy that need. However, the need for many new technologies may not be obvious to most full-time clinicians, perhaps because they are busy treating patients. This means that technology developers need to plan for and capitalize not only the costs of developing a new technology, but also must capitalize to cover the major expenses associated with convincing the practitioner community that a new technology is worth adopting.

"Tech-push" is a term that describes products that are developed, tested, and marketed before the widespread perception of need in the user community.[8] The development and marketing of onabotulinumtoxin A¶ is a good example of a successful tech-push endeavor. This is because, before the marketing of this muscle paralytic, few conceived of using such an approach to esthetic improvement. Tech-push technology contrasts to "market-pull" technology (sometimes termed "tech-pull"), where a clinical need is evident in advance and products are developed to satisfy the need. A good example of a market-pull technology is the Salk polio vaccine, which was developed in response to a polio epidemic. The demand for this vaccine far outstripped available supplies as soon as it became available.[9]

Dental digital radiography is a good example of the typical pattern of acceptance of improved technology by mainstream dentistry. Despite digital radiography's clear advantages and despite intensive marketing (tech-push) for over a decade, by late 2006, only 25% of private dental practices were estimated to have adapted this technology (reflecting limited market-pull).[10] History has shown that the evolution of worthy new dental technologies from tech-push to market-pull tends to be slow-paced at best.

One reason for such slow transformations may be because many traditional dental procedures seem successful to most practitioners and patients based on short-term observations. A related reason is that patients and some practitioners often do not detect the negative outcomes of suboptimal care over longer terms. A complementary explanation may be that cost-control decisions tend to be the purview of individual practitioners rather than made by institutions, such as hospitals and insurance carriers. A fourth rationale may be that the simple human inclination is to view change with ambivalence or even fear. Regardless of why, dentistry's history of slow transformation of tech-push technologies with high potential for patient benefit to mainstream practice is a negative feedback loop that retards clinical innovation. This is because the longer it takes for tech-push to convert to market-pull, the more expensive and more risky it is for product developers.

ADVANCES IN NON-SURGICAL PERIODONTAL THERAPY

Minimally invasive, non-surgical periodontal therapy, typically blind scaling and root planing (SRP), often shows commendable results in studies in which average post-treatment measurements, expressed as a patient mean, are compared to pretreatment data.[1,2,6,11] Comparative results seem even more compelling when changes are stratified to emphasize improvements at more seriously diseased sites.[5,12] However, such studies are typically performed in controlled clinical environments in which the clinicians are highly experienced and have unlimited time to treat each tooth. These conditions rarely exist in the real-life clinical world. Furthermore, much of this therapy is performed by clinicians who may not possess exceptional skills and who are frequently allowed only limited time in which to perform therapy. Unexceptional clinical skills and limited therapeutic intervals can limit the effectiveness of tooth-borne accretion removal, which in turn can lead to reinfection and eventual progression of periodontal destruction.[13-15]

Despite the limitations of SRP and the availability of advanced minimally invasive technology, almost all general dentists and periodontists persist in using techniques for non-surgical therapy that have

¶ Botox, Allergan, Irvine, CA.

remained essentially unchanged for decades. This is in contrast to our medical colleagues, who routinely use minimally invasive technology to achieve better results with less morbidity. Decreases in post-surgical complication rates and lowered hospitalization costs rapidly transformed such tech-push technologies into overwhelming market-pull products in which incremental improvements synergistically encourage additional refinement and ever-increasing adoption of these technologies. Of note is that these transformations occurred fairly rapidly, notwithstanding the fact that most relevant medical specialists had no prior clinical experience with these devices.

Why has dentistry not embraced SRP performed using advanced and minimally invasive technology? Several years ago, a periodontal endoscope[#] was introduced and is still used extensively by a small number of periodontists, dentists, and dental hygienists. Unfortunately, this first-generation device is difficult to use and can be challenging to maintain. It was also moderately expensive and required the clinician first to visualize the site, debride it blindly in a second step, and then reassess in a third step. At best, even in the hands of highly skilled users, this approach was cumbersome and had a steep learning curve.

Were the technical failings or ergonomic shortcomings of this first-generation periodontal endoscope largely to blame for its relative obscurity, or did other issues predominate? We believe that in addition to the first-generation device's ergonomic and mechanical shortcomings, some of our periodontal colleagues may have been uncomfortable with the obvious need to educate referring dentists that the capabilities of this new non-surgical technology might necessitate changing traditional referral protocols. Additionally, there may have been an entrenched resistance to change on the part of practicing periodontists. Unfortunately, there is no good analogy in medicine that might help answer this question. This is because the widespread adoption of increasingly less-invasive approaches by physicians may be at least partly explained by the fact that medical and surgical care is often reimbursed by third-party payers who demand that doctors learn and adopt improved or less expensive technologies that might otherwise not succeed. As much as we are loathe to acknowledge that treatment mandates from third-party payers may produce patient benefits, this is a plausible explanation in light of how little market-pull exists in dentistry for similar advanced technologies. However, we prefer to believe that the first-generation periodontal endoscope would have been more successful had it been easier to use, more reliable, and had additional studies been done to demonstrate its efficacy. Regardless of why this device did not catch on in a big way, it seems that dental inventors and suppliers are hesitant to invest in a second-generation endoscope because of the high costs associated with tech-push for a device for which we believe there ought to be significant market-pull.

As responsible periodontists, these are important concerns now that enhanced versions of periodontal endoscopes are technically feasible. We believe that the ideal device would be an endoscope that allowed for direct visualization of root surfaces during debridement. Such devices could be used to visualize root surfaces and remove any residual calculus in a single step rather than visualization followed by the separate step of accretion removal. We believe that such a device would allow effective debridement of root surfaces at probing depths well beyond depths where blind SRP is reliable. A combination endoscope/scaler might also improve operator ergonomics and work pace substantially compared with the first-generation device. Most important, widespread use would likely lead to improved clinical outcomes and decrease the need for periodontal surgeries.

There is little doubt that second-generation periodontal endoscopes would remain somewhat expensive and would continue to have a moderately steep learning curve. However, we believe that such obstacles may offer advantages to clinical periodontists because inexpensive and effective therapies easily used in general practice equate to a diminished need for specialists. What informed and ethical general practitioner would not offer his or her patients an improved minimally invasive solution to dilemmas that cannot be addressed in the general practitioner's office? Nevertheless, despite our hopes for the introduction and acceptance of improved technology for minimally invasive treatment, we fear that a lack of market-pull will limit the likelihood that a dental supplier will develop and field such a device.

It is worth noting that these same marketplace difficulties exist for other dental devices, such as lasers and medication-filled trays marketed for periodontal therapy. These devices are currently tech-push and may have significant clinical value but have not reached widespread market-pull acceptance. Perhaps this is because claims for many of these devices are supported by only limited research.[16,17] In likely contrast, Cobb[13] documents a large body of scientific evidence that SRP has definable therapeutic benefits. Therefore, it is logical to expect that that an endoscopic device that facilitates better root planing will substantially improve non-surgical outcomes. Investigations using the first-generation endoscope device strongly suggest that this is true.[18-21] Although comparisons of non-surgical minimally invasive treatment with traditional blind non-surgical treatment have not yet been published, two articles reported no signs of

Perioscopy, Oakland, CA.

pocket inflammation both in vivo and histologically following non-surgical minimally invasive treatment.[19,20] Because inflammation is seminal to chronic periodontitis, a lack of inflammation is a plausible predictor of periodontal health following this minimally invasive therapy. Unfortunately, unless someone is willing to incur the substantial financial risk of developing and marketing a second-generation periodontal endoscope, we fear this technology will founder and the studies needed to "prove" the technology will not be performed.

ADVANCES IN SURGICAL PERIODONTAL THERAPY

An important goal of periodontal therapy is reducing inflammation. Where probing depths are deep, this goal is often not achieved using blind (non-surgical) methods. There is evidence that deeper sites are more likely to progress than shallower sites.[22] These are sites where periodontal surgery will most likely benefit the patients and often result in the regeneration of supporting tissue and the long-term retention of teeth. We believe that patients with deeper pockets are generally best served by referral to periodontal specialists. Unfortunately, the transitioning of patients from general practice to a periodontal practice is where this classic disease management paradigm often breaks down. Instead, SRP is often performed in the general practitioner's office and the patient is subsequently "maintained" by frequent prophylaxes. Professional periodontal maintenance and meticulous self-care will often suffice to maintain health at sites that have responded well to SRP.[23] However, areas with deeper residual probing depths and unresolved inflammation caused by incomplete debridement often progress over time.[7]

Why is referral such a roadblock? We believe that referrals may be delayed or withheld because of patient or practitioner concerns that the periodontist may prescribe surgery that may lead to negative post-surgical consequences. This fear arises because traditional periodontal surgeries often entail extensive elevation of soft tissue flaps. Extensive tissue reflections can lead to morbidities that confirm the fears of patients and general practitioners. These include increased thermal sensitivity; functional difficulties, such as interproximal food impaction; and compromised esthetic outcomes. As a result, patients with unresolved therapeutic needs are sometimes denied treatment options that would help them retain comfortable, esthetic, and functional dentitions while reducing oral inflammation that may lead to improved systemic health.

One of the ways to diminish these negative outcomes while increasing the efficacy of therapy is minimally invasive periodontal surgery. As noted previously, in medicine, many classic surgical approaches have been abandoned in favor of minimally invasive procedures. Minimally invasive surgery (MIS) facilitates decreased tissue manipulation that lessens overall trauma to surgical sites. MIS permits faster healing with decreased short- and long-term morbidity.[24] A minimally invasive procedure for periodontal regeneration termed "minimally invasive surgery" was discussed in numerous articles from 1995 until 2005.[25-28] More recent, a procedure termed "minimally invasive surgery technique" (MIST) has been described.[29-31] Although differing in some aspects, both MIS and MIST procedures have produced outcomes that are equal to or better than results reported for traditional regenerative periodontal surgeries. In general, the results have included significant improvement in probing depths, with virtually all post-surgical probing depths <4 mm; significant improvements in attachment levels; and with the MIS procedure, no detectable recession. These procedures are performed with small incisions and are often limited only to the facial or lingual aspect.

The MIS approach for periodontal regeneration eliminates most of the concerns of patients and general practitioners regarding the likelihood of untoward side effects following periodontal surgeries. Thermal sensitivity after MIS is rare because incisions are limited to the anatomic area of interest and are not extended to adjacent healthy teeth. Postoperative gingival recession is minimal or non-existent.[27,28] Moreover, it has been reported that there is no tendency for deeper probing depths to reoccur over 6 or more years postoperatively.[32]

Future devices for performing minimally invasive periodontal surgical procedures need to be easier to use. Better devices to assist in visualizing small surgical fields, better devices to prepare surgical sites, and better instruments to aid in the placement of regenerative materials are all needed. Such advanced technologies, now ubiquitous across medical-surgical disciplines, benefit from continuous, market-pull–driven improvements every year. This is in contrast to periodontal practice where currently available MIS instruments are suboptimal modifications of instruments designed for large-field surgeries. Therefore, it seems to us that for invasive periodontal surgical techniques to advance in parallel to advances in medicine, our specialty needs to embrace the possibility of new technology. Otherwise, periodontics as a specialty faces the ever-increasing risk of becoming superfluous.

CONCLUSIONS

Both authors acknowledge potential conflicts of interest related to the observations and suggestions in this commentary. Both of us have worked in minimally

invasive periodontal therapy for many years and have had relationships with dental and medical instrument manufacturers. Some of our colleagues may dismiss our opinions on this basis. However, our interests in the concepts outlined in this commentary are based on the improved therapeutic results we have observed when minimally invasive techniques are used. This is in large part because we have long been concerned by the substantial therapeutic void that exists in the periodontal care continuum between traditional, blind SRP and conventional large-field periodontal surgeries. Additionally, it has been our observation that endoscope-assisted minimally invasive root planing and minimally invasive regenerative surgery yield consistently better results with less patient morbidity than traditional treatment techniques. The likelihood that the therapeutic improvements discussed in this commentary might benefit our specialty is a happy corollary to what is our primary desire, namely to have available the best possible technologies to benefit our patients.

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