Teaching Alternatives to the Standard Inferior Alveolar Nerve Block in Dental Education: Outcomes in Clinical Practice

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Abstract: Surveys were sent to Harvard School of Dental Medicine students and graduates from the classes of 2000 through 2006 to determine their current primary means of achieving mandibular anesthesia. Orthodontists and orthodontic residents were excluded. All subjects received clinical training in the conventional inferior alveolar nerve block and two alternative techniques (the Akinosi mandibular block and the Gow-Gates mandibular block) during their predoctoral dental education. This study tests the hypothesis that students and graduates who received training in the conventional inferior alveolar nerve block, the Akinosi mandibular block, and the Gow-Gates mandibular block will report more frequent current utilization of alternatives to the conventional inferior alveolar nerve block than clinicians trained in the conventional technique only. At the 95 percent confidence level, we estimated that between 3.7 percent and 16.1 percent (mean=8.5 percent) of clinicians trained in using the Gow-Gates technique use this injection technique primarily, and between 35.4 percent and 56.3 percent (mean=47.5 percent) of those trained in the Gow-Gates method never use this technique. At the same confidence level, between 0.0 percent and 3.8 percent (mean=0.0 percent) of clinicians trained in using the Akinosi technique use this injection clinical technique primarily, and between 62.2 percent and 81.1 percent (mean=72.3 percent) of those trained in the Akinosi method never use this technique. No control group that was completely untrained in the Gow-Gates or Akinosi techniques was available for comparison. However, we presume that zero percent of clinicians who have not been trained in a given technique will use the technique in clinical practice. The confidence interval for the Gow-Gates method excludes this value, while the confidence interval for the Akinosi technique includes zero percent. We conclude that, in the study population, formal clinical training in the Gow-Gates and Akinosi injection techniques lead to a small but significant increase in current primary utilization of the Gow-Gates technique. No significant increase in current primary utilization of the Akinosi technique was found.

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In late November 1884, William S. Halsted and Richard J. Hall first achieved neuroregional anesthesia in the mandible by injecting a solution of cocaine in the vicinity of the mandibular foramen.[1] Since that revolutionary injection, dentists have possessed the remarkable ability to deliver invasive dental treatment in a pain-free manner and relieve suffering for patients. Today, pain management is central to the success of any dentist. Indeed, many patients choose their provider based on perceived ability to deliver painless dentistry.

To achieve mandibular anesthesia, most dentists in the United States use an injection technique targeting the mandibular sulcus, similar to the technique described by Jorgensen and Hayden in 1967.[2] This injection remains a proven method for delivering local anesthesia in a safe manner with minimal discomfort to the patient, and it usually represents one of the first clinical skills students learn in dental school. However, there are several disadvantages associated with the standard inferior alveolar (IA) nerve block. One limitation of the Jorgensen technique is that it relies on the presence and identification of anatomical landmarks such as teeth, the pterygomandibular raphe, and the retromolar pad. Malamed identifies the inferior alveolar nerve block as the injection with the highest clinical failure rate, which he reports to be 15 to 20 percent when properly administered.[3] This high failure rate is often attributed to a high degree of variation in the morphology of the mandibular ramus and the location of the mandibular foramen, but improper technique is the most common reason for failure.[4] Specifically, inadequate mouth opening allows the IA nerve to remain in a relaxed state and fails to bring the nerve into close approximation with the medial wall of the ramus. Improper anterior, posterior, or inferior placement of the needle also commonly leads to failure. Because the target for the

conventional IA block is very near the neurovascular bundle, this technique also has a high frequency of positive aspiration, and intravascular injection can occur.[5] Furthermore, the standard block often fails to anesthetize branches of cranial nerve V_3 that originate proximal to the injection site and provide accessory innervation to the mandibular teeth. The relatively distal location of the injection also leads to lack of anesthesia of soft tissues posterior to the mental foramen.

In the 1970s two alternatives to the standard IA nerve block were introduced. In 1973, George A.E. Gow-Gates described a novel approach to mandibular anesthesia in which the anesthetic solution is injected just anterior to the head of the mandibular condyle at maximal opening. Gow-Gates developed this technique in 1947, after becoming dissatisfied with the reliability of the conventional mandibular block.[5] The Gow-Gates method of delivering anesthesia provides several decided advantages. Most importantly, Gow-Gates used the technique clinically for thirty years and reported a 99 percent success rate.[6] Watson and Gow-Gates reported that this mandibular block technique consistently yields a higher percentage of clinically excellent anesthesia than do conventional techniques.[7] Malamed later independently reported a 95 percent success rate using the Gow-Gates technique.[8] Because of the relatively proximal location of the injection, the Gow-Gates technique blocks virtually the entire distribution of the mandibular nerve. This technique also rarely results in positive aspiration and is independent of the anatomy of the inferior portion of the ramus, the mandibular foramen, and the lingula. A recognized disadvantage of the Gow-Gates technique is slower onset of anesthesia, which can take from five to seven minutes.[8]

A third technique for mandibular anesthesia was introduced by Akinosi in 1977.[9] The Akinosi mandibular block is administered while the patient is in a closed-mouth position. The needle is positioned at the level of the maxillary marginal gingiva, parallel to the maxillary occlusal plane. The syringe is advanced posteriorly, and the needle penetrates approximately 2.5 cm to 3 cm into the soft tissues in the embrasure between the mandibular ramus and the maxillary tuberosity.[9] Like the Gow-Gates technique, the Akinosi block delivers anesthetic more proximally than the conventional block, leading to a larger area of anesthesia and a reduced chance that accessory innervation will cause failure. The Akinosi technique, like the Gow-Gates injection, blocks the long buccal nerve, obviating the need for a separate injection. This technique boasts success rates similar to those achieved with the Gow-Gates method. Akinosi reported a 93 percent first injection success rate.[9] Additionally, the Akinosi block utilizes a closed-mouth approach, affording a clear advantage when trismus frustrates administration of the injection. Rapid induction of anesthesia represents another advantage of the Akinosi technique. When administered correctly, positive tongue and lip signs are present in forty seconds.[9]

The advantages associated with the Gow-Gates and Akinosi techniques make them attractive to dental professionals who want to minimize patient discomfort and anxiety. Despite the advantages, most dentists have not embraced these techniques. Some clinicians may avoid the techniques out of fear of increasing the pain associated with the injection, which is the part of dental procedures most anxiety-provoking for the patient. However, multiple randomized controlled clinical trials have found no significant differences in pain on injection among the three techniques (standard inferior alveolar nerve block, Gow-Gates mandibular block, and Akinosi mandibular block).[10,11] One clinical trial found that the Akinosi technique was subjectively most acceptable to the patient.[12] Perceived increased risk represents another reason clinicians may reject the alternative techniques. Indeed, some authors fervently oppose the widespread use of the Akinosi and Gow-Gates techniques.[13] Isolated cases of temporary paralysis of cranial nerves III, IV, and VI following the Gow-Gates mandibular block have been reported.[14,15] This type of complication may result from omission of careful aspiration and failure to inject the anesthetic solution within the target area.[14] According to Malamed, the solution should not be deposited unless bone (the lateral aspect of the neck of the condyle) is sounded with the needle when administering a Gow-Gates block.[8] Malamed described the use of extraoral landmarks to administer the Gow-Gates mandibular block as a simple procedure and attributed the high success rates achieved with the Gow-Gates technique to the constancy of these landmarks.[8]

Our review of the literature reveals no studies, prospective or retrospective, that suggest that the Akinosi and Gow-Gates techniques are associated with higher complication rates or more severe complications. In fact, Malamed reported a decreased incidence of trismus with the Gow-Gates technique upon evaluation of 4,275 cases.[8] Nonetheless, alternatives to the conventional inferior alveolar nerve block remain, for the most part, absent from formal

predoctoral dental training in the United States. Thus, most dental professionals do not utilize the Gow-Gates and Akinosi techniques. This study tests the hypothesis that students and graduates who received training in the conventional inferior alveolar nerve block, the Akinosi mandibular block, and the Gow-Gates mandibular block will report more frequent current utilization of alternatives to the conventional inferior alveolar nerve block than clinicians trained in the conventional technique only.

Materials and Methods

One-page surveys were sent to all Harvard School of Dental Medicine (HSDM) students and graduates from the classes of 2000 through 2006. All responses were anonymous, and subjects were informed that completion of the survey constitutes consent to participate. The HSDM Committee on Human Studies reviewed the survey and approved this study with exempt status (Human Studies Docket Number M11456-101).

A total of 212 surveys were mailed. Subjects were asked to classify their gender, professional status, and year of graduation and identify their current primary means of achieving mandibular anesthesia: standard IA block, Gow-Gates mandibular block, Akinosi mandibular block, or another technique. Subjects also reported which of the three injection techniques they used for their very first injection in dental school. For each injection technique, subjects identified the approximate number of injections they provide per week and estimated their success rates. Finally, subjects reported their protocol for management of failure to achieve profound anesthesia. Subjects that indicated use of only the standard IA nerve block were additionally asked to state their reasons for not using alternative techniques.

Results

Of the 212 surveys mailed, ten were returned due to incorrect addresses, leaving 202 potential subjects. Eight of the graduates with inaccurate addresses on file are female; two are male. Of the 202 potential subjects, 117 graduates and students returned surveys. Twenty-three potential subjects indicated a professional status of orthodontist or orthodontic resident and were excluded from the study, leaving a final response of ninety-four subjects. Forty-five percent of the subjects were dental students, and an additional 12 percent were general dentists. No surveys were returned from oral surgeons or prosthodontists. Table 1 identifies demographic characteristics of subjects.

Academic records indicate that all survey recipients received formal clinical training in the standard IA nerve block, the Gow-Gates technique, and the Akinosi technique during their predoctoral education at HSDM, although only 81 percent of subjects reported formal training in all of these techniques as part of their predoctoral education. Fourteen percent of respondents reported training in the Gow-Gates technique, the Akinosi technique, or both during postdoctoral education.

Seventy-two subjects (76.6 percent) reported using the standard IA block for their very first injection in dental school. The corresponding figures for the Gow-Gates and Akinosi techniques were fourteen (14.9 percent) and seven (7.5 percent), respectively. Eighty subjects (85.1 percent) reported using the standard IA block as their current primary injection technique, while eight (8.5 percent) subjects reported using the Gow-Gates technique primarily. Of the eight individuals who primarily use the Gow-Gates tech-

Table 1. Demographic characteristics of subjects

Characteristic	Number of Surveys Mailed	Number of Potential Subjects*	Subjects
Male	106 (50%)	90 (50%)	47 (50%)
Female	106 (50%)	89 (50%)	44 (47%)
Gender unidentified			3 (3%)
Dental student			42 (45%)
General dentist			11 (12%)
Endodontic resident			3 (3%)
Endodontist			4 (4%)
Periodontic resident			9 (10%)
Periodontist			3 (3%)
Pediatric resident			4 (4%)
Pediatric dentist			2 (2%)
Oral surgery resident			9 (10%)
Oral surgeon			0 (0%)
Prosthodontics resident			2 (2%)
Prosthodontist			0 (0%)
Other specialty			4 (4%)
Specialty unidentified			1 (1%)

*Excluding orthodontists and orthodontic residents.

nique, five (63 percent) were dental students, one (13 percent) was an oral surgery resident, one (13 percent) was an endodontist, and one (13 percent) did not identify professional status. Interestingly, five (63 percent) of these eight individuals reported that they used the Gow-Gates technique under supervision for their very first injection in dental school. Characteristics of the eight individuals who primarily use the Gow-Gates technique are summarized in Table 2. No respondents reported using the Akinosi technique as a primary means of achieving mandibular anesthesia.

To examine the relationship between injection technique and professional status, we created cross-tabulations for each alternative technique (Tables 3 and 4). The percentage of clinicians within each professional category that never use the Akinosi technique was 100 percent for most specialties. Oral surgery residents reported the lowest frequency (33 percent) of never using the Akinosi technique, followed by periodontics residents (56 percent) and dental students (69 percent). For the Gow-Gates mandibular block, only the pediatric dentists and

Table 2. Characteristics of individuals who primarily use the Gow-Gates technique

Characteristic	Frequency	Percentage
Male	4	50.0%
Female	3	37.5%
Gender unidentified	1	12.5%
HSDM Class of 2002	1	12.5%
HSDM Class of 2003	1	12.5%
HSDM Class of 2004	1	12.5%
HSDM Class of 2005 (fourth-year dental students)	2	25.0%
HSDM Class of 2006 (third-year dental students)	3	37.5%
Very first injection in dental school was Gow-Gates	5	62.5%
Very first injection in dental school was standard IAN block	3	37.5%

Table 3. Cross-tabulation of professional status and never use Akinosi technique

	Number of Subjects Who Never Use Akinosi	Percentage of All Subjects Who Never Use Akinosi	Percentage of Peers (Same Professional Status)
Dental student	29	42.65%	69.05%
General dentist	10	14.71%	90.91%
Endodontic resident	3	4.41%	100.00%
Endodontist	3	4.41%	75.00%
Periodontic resident	5	7.35%	55.56%
Periodontist	3	4.41%	100.00%
Pediatric resident	4	5.88%	100.00%
Pediatric dentist	2	2.94%	100.00%
Oral surgery resident	3	4.41%	33.33%
Prosthodontic resident	2	2.94%	100.00%
Other	4	5.88%	100.00%
Total	68	100.00%	

Table 4. Cross-tabulation of professional status and never use Gow-Gates technique

	Number of Subjects Who Never Use Gow-Gates	Percentage of All Subjects Who Never Use Gow-Gates	Percentage of Peers (Same Professional Status)
Dental student	18	41.86%	42.86%
General dentist	8	18.60%	72.73%
Endodontic resident	1	2.33%	33.33%
Endodontist	0	0.00%	0.00%
Periodontic resident	3	6.98%	33.33%
Periodontist	2	4.65%	66.67%
Pediatric resident	2	4.65%	50.00%
Pediatric dentist	2	4.65%	100.00%
Oral surgery resident	3	6.98%	33.33%
Prosthodontic resident	2	4.65%	100.00%
Other	2	4.65%	50.00%
Total	43	100.00%	

prosthodontic residents had 100 percent of subjects report never using the technique. The percentage of clinicians that never use the Gow-Gates mandibular block ranged from 0 percent to 100 percent among the professional status categories, with no endodontists reporting never using the technique.

To estimate the proportions of respondents who never use the Gow-Gates and who at least occasionally use the Gow-Gates, respectively, we calculated an exact binomial 95 percent confidence interval. The same calculations were made for the Akinosi technique. All analyses were conducted in Stata 6.0 (Stata Corp., College Station, TX). At the 95 percent confidence level, we estimated that between 3.7 percent and 16.1 percent (mean=8.5 percent) of clinicians trained in using the Gow-Gates technique use this injection technique primarily, and between 35.4 percent and 56.3 percent (mean=47.5 percent) of those trained in the Gow-Gates method never use this technique. At the same confidence level, between 0.0 percent and 3.8 percent (mean=0.0 percent) of clinicians who received training in the Akinosi technique use this injection technique primarily, and between 62.2 percent and 81.1 percent (mean=72.3 percent) of those trained in the Akinosi method never use this technique. Theoretically, zero percent of those who have not been trained in a given technique will use the technique in clinical practice. The confidence interval for the Gow-Gates method excludes this value, while the confidence interval for the Akinosi technique includes zero percent.

Forty-six respondents (49 percent) estimated a success rate of greater than 90 percent with the conventional IA nerve block, compared to twenty-nine respondents (31 percent) with the Gow-Gates technique and nine respondents (10 percent) with the Akinosi technique. Estimated success rates for the three injection techniques are shown in Figure 1. Only one subject (1 percent) reported never using the conventional IA nerve block, compared to sixty-six subjects (70 percent) for the Akinosi technique and forty-two subjects (45 percent) for the Gow-Gates technique. The reported number of injections per week for the alternative techniques diminished sharply at the one to ten injections per week category, whereas a significant number of respondents reported ten to twenty, twenty to thirty, or greater than thirty injections per week using the conventional IA nerve block. The estimated numbers of injections per week for the three injection techniques are shown in Figure 2.

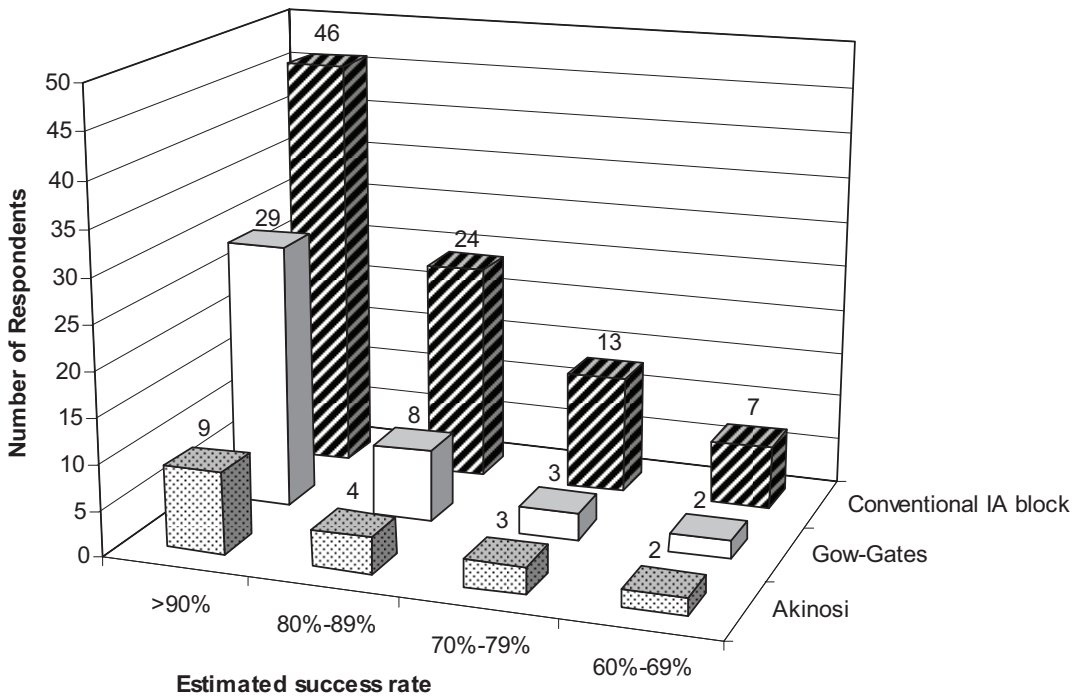

Figure 1. Estimated success rates with the conventional inferior alveolar nerve block, the Gow-Gates technique, and the Akinosi technique

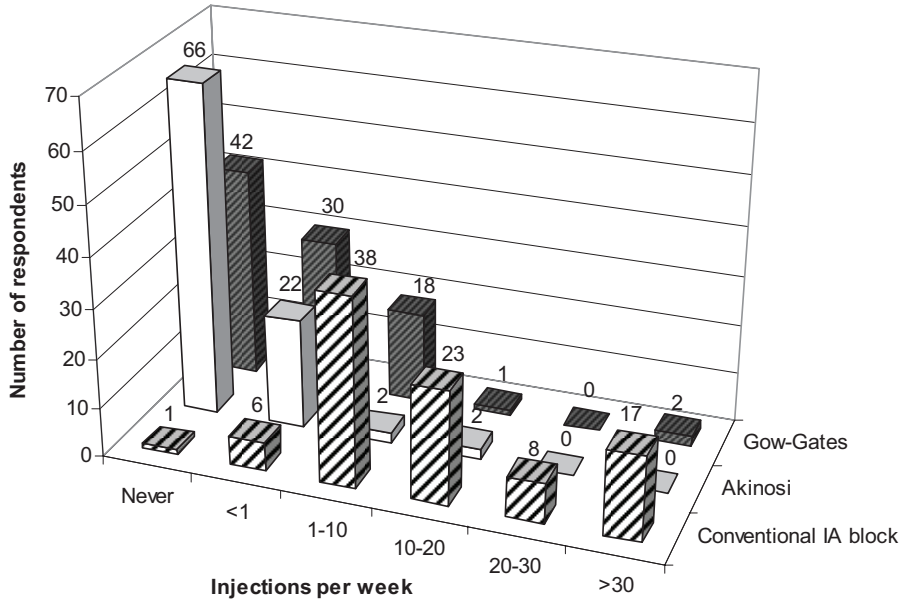

Figure 2. Estimated number of injections per week with the conventional inferior alveolar nerve block, the Gow-Gates technique, and the Akinosi technique

The most common protocol reported for management of failure to achieve profound anesthesia was "give another carpule of local anesthesia using the same technique" (70 percent). This response was reported at a much higher frequency than the second most commonly reported protocol, "change to Gow-Gates and give another carpule of local anesthesia" (14 percent). The reported protocols for management of failure to achieve profound anesthesia are summarized in Table 5.

Finally, subjects who indicated that they use only the standard inferior alveolar nerve block were asked to state their reasons for never using an alternative injection technique. Responses are summarized in Table 6. Some subjects provided multiple reasons. The most frequently reported reasons for not using alternative techniques were "most comfortable giving the standard injection" (31 percent) and "no need for alternative due to success with the standard injection" (30 percent).

Discussion

A major limitation of this study is that all subjects received training in all three injection techniques of interest: the standard inferior alveolar nerve block, the Gow-Gates mandibular block, and the Akinosi mandibular block. Ideally, a comparison group would have been available in which the dental professionals received training in only the standard injection. Such a study design would allow hypothesis testing using a χ^2 test. Because it was not practical to locate enough dental professionals completely unfamiliar with any alternative mandibular injection technique, we analyzed our data by calculating the 95 percent confidence intervals for the Gow-Gates and Akinosi techniques.

Because the 95 percent confidence interval for the Gow-Gates method excludes zero percent, we reject the null hypothesis that students and graduates who received training in the conventional inferior alveolar nerve block, the Akinosi mandibular block, and the Gow-Gates mandibular block will report equivalent current utilization of alternatives to the conventional inferior alveolar nerve block compared to clinicians trained in the conventional technique only. The 95 percent confidence interval for the Akinosi method does include zero percent, indicating no significant increase in current utilization compared to clinicians trained in the conventional IA nerve block alone. We fail to reject the

null hypothesis for the Akinosi technique.

Despite the reported advantages of the Gow-Gates and Akinosi techniques, the findings from this study indicated that only a small percentage of clinicians trained in these injection techniques choose to use them as their primary means of establishing mandibular anesthesia and a large percentage completely abandoned these techniques.

Several factors account for the widespread lack of enthusiasm for alternatives to the standard IA block. Predoctoral programs that include the Gow-Gates and Akinosi techniques in the dental curriculum usually de-emphasize these alternatives due to lack of familiarity among the majority of the faculty. Students tend to view the alternative injections as heroic measures to consider if the standard block fails, and they feel an aversion toward using alternative injections for fear of criticism from their instructors.

Few clinicians are willing to stray from the conventional inferior alveolar nerve block they learned in dental school. As dentists gain clinical experience, they learn to manage IA nerve block failures, usually by additional injections (see Table 6). Some clinicians switch to the Akinosi or Gow-Gates block in the event of standard IA block failure. Many dentists repeat the conventional injection after repositioning the needle. In either case, the dentist must revisit the injection, which is the portion of the procedure that patients commonly report as anxiety-provoking. The significantly higher success rates of the Akinosi and Gow-Gates techniques can potentially reduce anxiety for many patients by reducing the need for additional injections.

Norms within professional groups seem to represent another factor influencing the use of alternative injection techniques. For example, 100 percent of endodontists who responded to the survey indicated that they use the Gow-Gates technique at least occasionally, and 67 percent of endodontic residents indicated the same. Endodontists possibly feel they need alternative injection techniques to achieve adequate anesthesia for their patients.

Table 5. Reported protocol for failure to achieve profound anesthesia

Response	Frequency	Percentage
Give another carpule of anesthesia, same technique.	66	70.21%
Change to standard IAN block and give another carpule.	2	2.13%
Change to Akinosi and give another carpule.	1	1.06%
Change to Gow-Gates and give another carpule.	13	13.83%
Change to different type of local anesthetic.	4	4.26%
Change type of local anesthetic and change technique.	1	1.06%
Other	7	7.45%

Table 6. Reasons for using only the standard inferior alveolar nerve block

Reason	Percentage
Most comfortable giving the standard injection.	31%
No need for alternative due to success with standard injection.	30%
Not adequately trained in alternatives/faculty not familiar with alternatives.	10%
Least painful/least invasive/least risk to the patient.	7%
Standard injection results in fastest onset of anesthesia.	4%

Conclusions

Current instruction in the Akinosi and Gow-Gates mandibular block techniques in predoctoral dental education does not generally translate into widespread and routine use of these techniques in clinical practice. Possibly, lack of reinforcement following the initial training leads to disuse of the alternative techniques.

Dental schools could dramatically increase the number of graduates using the Gow-Gates and Akinosi techniques through a few simple and inexpensive changes. The first barrier to the use of these alternative injections techniques is lack of familiarity among the faculty. Providing instructors with a seminar to refresh their skills in the Akinosi and Gow-Gates blocks could diminish this phenomenon. Additionally, requiring students to pass an examination that tests for competency would ensure that all students have the skills necessary to properly administer the injections. Having these skills, students could then assess all three injection techniques and select the one that consistently provides excellent clinical anesthesia. Finally, dental schools should ensure that students fully understand the reported advantages and disadvantages to the alternative injection techniques.

If dental educators accept the reported advantages to the Gow-Gates and Akinosi injection techniques, then conferring these skills on dental students

seems a worthwhile endeavor. Indeed, if students do not learn the alternative techniques during their predoctoral education, they are unlikely to ever learn the skills unless they choose to specialize in endodontics or oral surgery. However, dental schools are faced with the difficult challenge of bringing students to a level of clinical competency in only four years. The addition of any content to the curriculum, especially content not essential to reaching an acceptable level of competency, is appropriately met with skepticism and resistance. In our view, inclusion of alternatives to the conventional IA nerve block in predoctoral education can be accomplished efficiently, and the benefits of such training to clinicians and their patients justify the additional expenditure of resources.

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