

Failure rate of inferior alveolar nerve block among dental students and interns

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ABSTRACT

الأهداف: لمعرفة نسبة فشل التخدير الناحي لعصب الفك السفلي السنخي (IANB) المطبق من قبل أطباء الامتياز وطلاب كلية طب الأسنان وكيفية معالجتهم لها وأسباب فشل الاستعمال عن مستوى معرفة الأطباء لطرق IANB المختلفة.

الطريقة: في يناير 2011م تم توزيع استبيان مكون من 3 صفحات ويحتوي على 13 سؤالاً على 350 فرداً بشكل عشوائي من طلاب السنة الثالثة إلى الخامسة وطلاب الامتياز في كلية طب الأسنان، الجامعة الملك سعود، الرياض، المملكة العربية السعودية. تضمن الاستبيان الاستعمال عن (العمر والجنس والمستوى الأكاديمي) كما تضمن أسئلة عن نسبة فشل IANB وأسبابه وكيفية معالجة المشارك للمشكلة، ومدى معرفته بطرق التخدير الناحي والطرق الأخرى الداعمة لها والمضاعفات الناتجة عنها.

النتائج: من بين 250 الاستبيانات الموزعة، أعيدت 238 (معدل الاستجابة 68%). شهد معظم (85.7%) من المستطلعين فشل IANB مرة أو مرتين. عزى معظم المشاركين نسبة الفشل (66.45%) إلى اختلاف المعالم التشريحية بين الأفراد. كانت طريقة الحقن داخل الرباط أكثر الطرق البديلة استخداماً بنسبة (57.1%). ذكر حوالي نصف المشاركين وقد كانوا من طلاب السنة الثالثة 42.8% أنهم لم يجربوا طريقة أخرى للتخدير أعرب (45.8%) من المشاركين عن امتلاكهم للمعرفة مع افتقارهم للتدريب الكافي، فيما أشار (44.9%) من المشاركين عن افتقارهم للمعرفة بالإضافة للتدريب الكافي.

الخلاصة: لخفض معدلات فشل IANB للطلاب والمتدربين الأسنان، ومعرفة المعالم، واختلاف تشريحي وتدريبهم في بدائل IANB. ويجب تعزيز تقنيات Gow-Gates and Akinosi سواء من الناحية النظرية والإكلينيكية في المناهج الأسنان

Objectives: To report the failure rate of inferior alveolar nerve block (IANB) among dental students and interns, causes of failure, investigate awareness of different IANB techniques, and to report IANB-associated complications.

Methods: A 3-page questionnaire containing 13 questions was distributed to a random sample of 350 third to fifth years students and interns at the College of Dentistry, King Saud University, Riyadh, Saudi Arabia on January 2011. It included demographic questions (age, gender, and academic level) and questions on IANB failure frequency and reasons, actions taken to overcome the failure, and awareness of different anesthetic techniques, supplementary techniques, and complications.

Results: Of the 250 distributed questionnaires, 238 were returned (68% response rate). Most (85.7%) of surveyed sample had experienced IANB failure once or twice. The participants attributed the failures most commonly (66.45%) to anatomical variations. The most common alternative technique used was intraligamentary injection (57.1%), although 42.8% of the sample never attempted any alternatives. Large portion of the samples stated that they either lacked both knowledge of and training for other techniques (44.9%), or that they had knowledge of them but not enough training to perform them (45.8%).

Conclusion: To decrease IANB failure rates for dental students and interns, knowledge of landmarks, anatomical variation and their training in alternatives to IANB, such as the Gow-Gates and Akinosi techniques, both theoretically and clinically in the dental curriculum should be enhanced.

*Saudi Med J 2016; Vol. 37 (1): 84-89
doi: 10.15537/smj.2016.1.13278*

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Received 17th August 2015. Accepted 5th November 2015.

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Profound local anesthesia is administered in preparation for many dental procedures.¹ The practice was pioneered by Halsted and Hall, who, in 1884, introduced the technique of injecting a cocaine solution into the region of the mandibular foramen.² Today, the inferior alveolar nerve block (IANB) is commonly used to induce local anesthesia for various applications throughout modern dentistry.³ However, IANB failure rates can be substantial, reaching 15-20%,⁴ and often cannot be overcome with a repeat IANB injection.⁵ Inferior alveolar nerve block failure has been attributed to technical errors, pathological processes (namely, trismus), infection, inflammation, previous surgery and psychological causes, such as fear, anxiety and apprehension.³ Poor technique has been reported to be the most common reason for failure of conventional IANB.^{4,6} Specifically, poor technique may be related to inadequate mouth opening, incorrect needle placement (too anterior or posterior), or failure to give enough time for the anesthesia to work.⁶ Malamed⁵ has recommended waiting 3-5 minutes after the injection before starting the procedure. The standard IANB procedure (**Figure 1A**) is a direct technique wherein the practitioner places his or her thumb intra-orally at the deepest concavity of the anterior ascending ramus. The point of injection is located midway between the midpoint of the thumb nail and the pterygomandibular raphe. The needle is advanced 15-25 mm parallel to the occlusal plane of the contralateral premolars until it reaches the proper bony end point injection site.¹ In a 2014 review, Khalil⁷ discussed alternative techniques for overcoming conventional IANB failure. The Gow-Gates technique (also known as the high mandibular block)⁸ and the Vazirani-Akinosi closed-mouth technique,⁹ for example, have been available for more than 40 years. Additionally, some have suggested that anesthesia quality can be improved by injecting anesthetic solution into intraligamentary and intra-osseous areas.¹⁰ The Gow-Gates technique⁸ (**Figure 1B**), which was introduced in 1973 is credited with several advantages, such as use of only a single injection, minimal positive aspiration rate, low risk of complications, higher success with anatomical

variations, minimal pain, and stable landmarks.¹¹ Notably, in a study of 4,275 cases, Malamed¹² observed a decreased incidence of trismus with the Gow-Gates technique, relative to conventional IANB, upon evaluation of 4,275 cases.¹² The Akinosi⁹ closed-mouth technique (**Figure 1C**), which was introduced in 1960¹³ has also been advocated for overcoming IANB failure. It is simpler than the Gow-Gates technique and does not depend on bony contact. Both the Gow-Gates technique and the Vazirani-Akinosi technique involve anesthetizing the inferior alveolar nerve, lingual nerve, and long buccal nerve with a single injection.¹ In a 2010 study, Aggarwal et al¹⁴ observed a significantly better success rate for mandibular molar anesthesia with the Gow-Gates technique (52%) than with conventional IANB (36%), with an intermediate success rate (41%) for the Vazirani-Akinosi technique, and a relatively poor success rate (27%) for infiltrations. Remarkably, Jung et al¹⁰ found that buccal-plus-lingual infiltrations could provide satisfactory anesthesia in 32-67% of patients if lidocaine was used, and in 57-92% of patients if articaine was used, even without the use of standard IANB. Although the mentioned alternative techniques are well-established, Johnson et al¹⁵ found that nearly half (47.5%) of Harvard dental students alumni (classes 2000-2006) not only had never used an alternative technique, but further stated that they felt no need for an alternatives. The aims of this study were 1) to assess IANB failure rate among dental students and interns, and how it was overcome, 2) to report the causes of failure, 3) to investigate the awareness of alternative techniques, and 4) to assess IANB-related complications.

Methods. A 13-item, 3-page questionnaire was distributed randomly to 350 (230 male and 120 female) students (third year to fifth year), and interns at the College of Dentistry, King Saud University, Riyadh, Saudi Arabia in January 2011. Subjects were excluded if they returned the questionnaire that were not completely answered, had double answers, or were first or second year students. The questionnaires were anonymous and treated according to principles of the Helsinki Declaration.

The questionnaire included demographics questions (age, gender, and academic level). The main section of the questionnaire included questions on frequency of IANB failure, reasons for those failures in the participant's opinion, actions taken by the participant to overcome the failure, awareness of other block injection techniques, and supplementary techniques,

Disclosure. Authors have no conflict of interest, and the work was not supported or funded by any drug company. The research was funded by the College of Dentistry Research Center Ethics Committee, King Saud University, Riyadh, Kingdom of Saudi Arabia (Registration Number IR 0095).

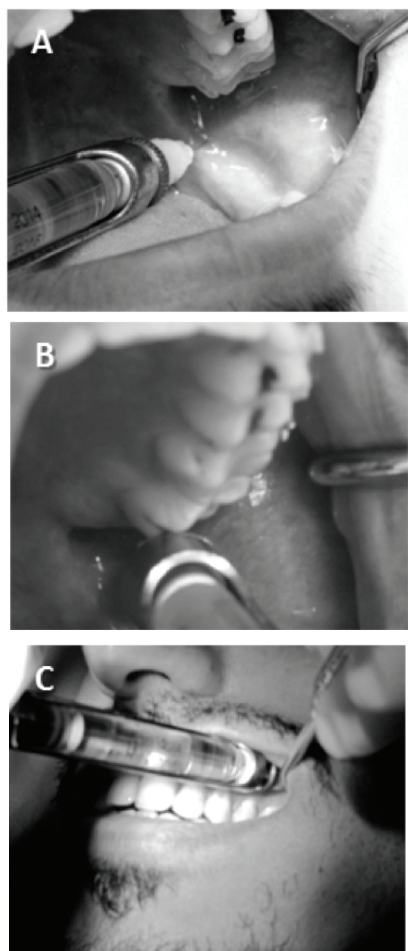


Figure 1 - Delivery of anesthesia by: A) standard inferior alveolar nerve block; B) Gow-Gates alternative technique; and C) Vazirani-Akinosi alternative technique.

and complications encountered. A statistician was consulted to determine the sample number and in the designing of the questionnaire. Data were analyzed with SPSS software version 17 (SPSS Inc., Chicago, IL, USA). Demographic and questionnaire response data were subjected to descriptive analysis, cross tab analysis, and Chi-square tests with a significance criterion of $p=0.05$.

Results. Of 350 disseminated questionnaires, 238 were returned, including 140 from male students (58.8%) and 98 from female students (41.2%), providing an overall response rate of 68%. In terms of academic level, 23.9% (n=57) of the 238 respondents were third year students, 21% (n=50) were fourth year students, 29% (n=69) were fifth year students, and 26% (n=62) were interns. All students involved in the study indicated that they had used the standard IANB technique. As reported in Table 1, more than a third of the study participants, reported that they had experienced IANB failure “sometimes”, and a similar portion reported that they had experienced it “rarely”, with smaller portions reporting having experienced it “never”, “often”, and “very often”. The experience with IANB failure did not differ across gender groups. There was an inverse trend between academic level and frequency of failure experienced, with the least experienced respondents (third year students) having the largest portion of respondents who indicated that they had never experienced failure and no respondents who reported having experienced it very often;

Table 1 - Summary of responses by academic level to the question “How often have you experienced IANB failure in the clinic?” among 238 students.

Response	Academic level				Total
	Third year	Fourth year	Fifth year	Intern	
<i>Distribution of replies given by respondents in each academic level</i>					
					Study cohort
Very often	0 (0.0)	2 (4.0)	4 (5.8)	5 (8.1)	11 (4.6)
Often	4 (7.1)	5 (10.0)	6 (8.7)	7 (11.3)	22 (9.2)
Sometimes	13 (23.2)	15 (30.0)	28 (40.6)	27 (43.5)	83 (34.9)
Rarely	16 (28.6)	19 (38.0)	29 (42.0)	23 (37.1)	87 (36.6)
Never	24 (42.1)	9 (18.0)	2 (2.9)	0 (0.0)	35 (14.7)
Total responses	57 (100.0)	50 (100.0)	69 (100.0)	62 (100.0)	238 (100.0)
<i>Portions of each reply from each academic level</i>					
					Those with reply
Very often	0 (0.0)	2 (18.2)	4 (36.4)	5 (45.5)	11 (100.0)
Often	4 (18.2)	5 (22.7)	6 (27.3)	7 (31.8)	22 (100.0)
Sometimes	13 (15.7)	15 (18.1)	28 (33.7)	27 (32.5)	83 (100.0)
Rarely	16 (18.4)	19 (21.8)	29 (33.3)	23 (26.4)	87 (100.0)
Never	24 (68.6)	9 (26.5)	2 (5.9)	0 (0)	35 (100.0)
Total in academic category	57 (23.9)	50 (21.1)	69 (29.1)	62 (26.2)	238 (100.0)

IANB - inferior alveolar nerve block

conversely, the most experienced respondents (interns) had the largest portion that reported having experienced failure very often, and no individuals who had never experienced failure (Table 1).

The portions of respondents taking particular courses of action in the face of IANB failure are shown in Figure 2. Notably, 42.8% (102/238) of the respondents (mainly third year students) indicated that they had never tried any different techniques, even when they faced with IANB failure. According to the subjects' self-report questionnaire responses, 47% had performed a single repeat IANB injection (2 total injections) to overcome a failure, 32.5% had performed 2 repeat injections (3 total injections), and 20.5% had performed 3 or more repeat injections (4 or more total injections) to overcome a failure. There was an inverse relationship between education level and number of attempts with the same technique ($p < 0.001$), but no effect of gender.

As reported in Table 2, IANB failure was attributed by far most often to anatomical variation, followed by improper technique, and very few respondents attributed failure to a faulty local anesthetic solution. The distributions of causes attributed differed significantly by academic level ($p = 0.003$, Chi-Square test; Table 2),

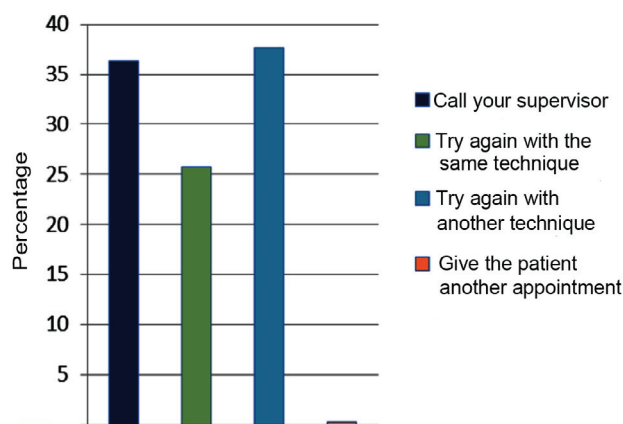


Figure 2 - Replies to the question: What do you usually do when you have an inferior alveolar nerve block failure?

but not gender. The present cohort indicated that the most common supplementary technique used when IANB failed was intraligamentary injection (57.1%), followed by intrapulpal injection (29.1%), and intraosseous injection (13.8%). Approximately, 20% of the respondents (49/238) did not know the most probable cause of failure, were mostly being from third year students (n=57). Regarding awareness of different techniques, 55.9% of the cohort (133/238) reported familiarity with infiltration, 30.7% familiarity with indirect technique (73/238), 10.3% familiarity with the Gow-Gates technique, and only 2.9% reported familiarity with the Vazirani-Akinosi technique. Only 9.2% (22/238) of the respondents mentioned that they had enough knowledge and training of IANB-alternative techniques. Meanwhile, 45.8% (109/238) indicated that they had enough knowledge, but lacked of training in alternative technique, and 44.9% (107/238) indicated that they lacked both knowledge and training. Of the 136 respondents who had administered an alternative technique after IANB failure, 55.9% (76/136) used an infiltration technique, and 30.9% (42/136) used an indirect technique; only 10.3% (14/136) used the Gow-Gates and only 2.9% used the Vazirani-Akinosi technique. Pre-IANB aspiration was considered mandatory by only 23.9% (57/238) of the participants, who reported using it consistently.

Table 3 - Summary of responses by gender to the question “What is the most common complication you have observed after an IANB?” among 238 students.

Complication	Gender		Total with indicated response
	Male	Female	
Hematoma	17 (12.1)	11 (11.2)	28 (11.8)
Trismus	11 (7.9)	0 (0.0)	11 (4.6)
Facial paralysis	24 (7.10)	6 (6.1)	30 (14.2)
Other(s)	13 (9.3)	14 (14.3)	27 (11.3)
Never had any complications	75 (53.6)	67 (68.4)	142 (67.3)
All responses*	140 (100.0)	98 (100.0)	238 (100.0)

IANB - inferior alveolar nerve block

Table 2 - Summary of responses by academic level to the question “What is the most common cause of IANB failure in your opinion?” among 238 students.

Cause	Academic level				Total
	3 rd year (n=57)	4 th year (n=50)	5 th year (n=69)	Intern (n= 62)	
Wrong technique	30 (52.6)	19 (38.0)	16 (23.2)	12 (19.4)	77 (32.4)
Anatomical variation	27 (47.4)	30 (60.0)	52 (75.4)	49 (79.0)	158 (66.4)
Problem with solution	0 (0.0)	1 (2.0)	1 (1.4)	1 (1.6)	3 (1.3)

IANB - inferior alveolar nerve block

Meanwhile, 16% (38/238) of the respondents reported using it usually, 23.5% (56/238) reported using it sometimes, 18.9% (45/238) reported using it rarely, and 17.6% (42/238) reported never aspirating before administering an IANB. The respondents most often (46.7%) reported that IANB block failure was most common in endodontics, followed by surgery (27.6%) while the third most common is restorative (25.7%).

As reported in Table 3, the most common complications reported to have occurred after respondents had administered an IANB were facial paralysis, hematoma, and trismus. However, more than two-thirds indicated that they had never observed a complication after having administered an IANB (Table 3). A significant gender, but not academic-level, difference was observed, with males being more likely to indicate that they had observed complications ($p=0.001$, Chi-Square test). Facial paralysis after IANB was never observed by 178/238 respondents (84.8%), observed only once by 30/238 respondents (12.6%), and observed more than once by 6/238 respondents (2.6%). Males were more likely than females to report having observed facial paralysis after administering an IANB ($p=0.027$). A significant effect of academic level on the likelihood of having observed facial paralysis was found ($p=0.002$), with the fourth year group observing it most frequently and the third year group observing it least frequently.

Discussion. Although several studies have been conducted on IANB failure.^{5,6,16} The present response rate (68%) was good for a cross-sectional study employing distributed questionnaires.^{15,17,18} Our data indicated that approximately 14% of the students and interns (overall) observed IANB failure very often or often, which is consistent with some prior studies.^{1,3,6} In general, similar responses were provided by males and females, with the exception of the complication frequency data, which showed that males have more complications than females. Our finding that almost half (47%) of the participants in our study repeated the standard IANB injection to achieve profound anesthesia is consistent with the work of Malamed,¹ who recommend to repeat the conventional IANB to overcome IANB failure, and Johnson et al,¹⁵ who found that 70% of their respondents repeated a standard IANB injection. Only 20.5% of our surveyed sample (37.5% of third-year and 33.3% of fourth-year students) indicated that they were able to overcome IANB failures by repeating the conventional IANB until it worked. The reliance on repeat injection may

be due to the fact that they were not able to perform alternative techniques. The most common response to IANB failure by third and fourth year students was to ask their supervisors for help; no similar study could be found with which to compare this finding. The portion of our interns who never tried any alternative techniques (42.8%) was modestly greater than the portion reported by Johnson et al¹⁵ (30%).

Small minorities of respondents in this study reported using the Gow-Gates technique (10.3%) or the Vazirani-Akinosi technique (2.9%). These findings are reasonably similar to those of Johnson et al's study.¹⁵ Harvard School of Dental Medicine study¹⁵ with a one-page survey in which only 14.9% of participants were using the Gow-Gates technique and only 7.5% were reported using the Vazirani-Akinosi technique. However, the most common subsequent course of action in cases of IANB failure differed between our study (infiltration, 55.9%) and Johnson et al's study¹⁵ (repeat standard IANB, 70.21%). Johnson et al¹⁵ stated that the Gow-Gates and Vazirani-Akinosi techniques are not taught as part of the Harvard dental curriculum and attributed the low familiarity of their respondents to this fact. The curriculum at our dental school is also lacking instruction in IANB alternatives. And it is our view that the low numbers of alternative technique users in this study are likely attributable to insufficient knowledge and training of alternative methods. The common attribution of IANB failure to anatomical variation in our cohort (namely, 75% of interns, fifth year students, and fourth year students) differs somewhat with the opinions of the participants of Haas³ and Malamed's⁵ studies, who considered it the second most common cause of IANB failure. It may be that the students and interns in our study had poorer knowledge of anatomical landmarks than the participants of these prior studies. Meanwhile, the relatively less common explanation of the failure being due to use of the wrong technique (only 19.4% of interns) is consistent with previous studies.^{3,5} Our finding that IANB failure was observed most commonly in endodontic treatments is likely due to the participants having encountered many endodontic patients who present with an active infection. The IANB has been shown to have a far better success rate in patients with uninflamed pulp than in patients with irreversible pulpitis.¹⁹ The post-IANB complications reported in this study, namely trismus, hematoma and transient facial paralysis, are consistent with those observed in previous studies.^{20,21} Other post-IANB complications documented in the literature include visual problems, motor problems (such as

palpebral ptosis), and diplopia.^{22,23} Although only 23.9% of the participants in our study reported that they always aspirate before administering an IANB, it is unclear how prevalent the practice is broadly speaking. Even lower rates of pre-IANB aspiration have been reported by Zenouz et al²³ (15.3%) and Nooh and Abdulla²⁰ (1.7%).

Finally, our data regarding the participants' self-reporting of their knowledge of and training with alternative techniques indicate clearly that both are lacking. The portion of students and interns in our study who felt they had both sufficient knowledge of and training in alternative techniques (9.3%) was far smaller than that reported by similar to the close to 90% figure reported by Johnson et al.¹⁵ This massive discrepancy is likely due to students at Harvard School of Dental Medicine students and graduates receiving far greater instruction related to alternative methods, including the Gow-Gates and Vazirani-Akinosi techniques.¹⁵

In conclusion, the results of the present study indicate that the dental curriculum at King Saud University is lacking in coverage of techniques that can be employed when an IANB fails or is contraindicated. To decrease the IANB failure rate, instruction related to anatomical landmarks, anatomical variation, and pre-IANB aspiration should also be enhanced.

Enhance education of alternatives to IANB, such as the Gow-Gates and Akinosi techniques, both theoretically and clinically, in the anesthesia courses of the dental curriculum; enhance knowledge of anatomical landmarks for IANB administration; train students how to select the most appropriate alternative technique; increase supervision and training of various techniques; and it should be emphasized that aspiration is mandatory before any anesthetic technique, including conventional IANB are some of the recommendations.

Acknowledgment. *We would also like to express our gratitude to Mr. Nassr Al Maflehi for his assistance in completing the statistical analysis. The authors thank the College of Dentistry Research Center and the Deanship of Scientific Research at King Saud University, Saudi Arabia for funding this research project. Our great appreciation is also extended to all students and interns who participated in this survey.*

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