Review Article

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Anesthetic efficacy of Gow-Gates versus inferior alveolar nerve block for irreversible pulpitis: a systematic quantitative review

Ifrah Sarfaraz[1], Selma Pascoal[2], José Paulo Macedo[1,4], Abel Salgado[1,4], Dil Rasheed[3], Jorge Pereira[1,4]

[1]University Fernando Pessoa, Faculty of Health Sciences, Porto, Portugal
[2]University Institute of Health Sciences, IUCS-CESPU, Gandra PRD, Portugal
[3]Bahria University Medical and Dental College, Karachi, Pakistan
[4]CU Oral Surgery, Oral Medicine and Oral Implantology, UFP, Porto, Portugal

This review aimed to assess and compare the outcomes of the anesthetic efficacy of inferior alveolar nerve block (IANB) and Gow-Gates mandibular nerve block (GGMNB) in patients with symptomatic irreversible pulpitis. A descriptive systematic review of quantitative research was conducted wherein the “Preferred Reporting Items for Systematic Reviews (PRISMA)” was adopted, and the Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome (PICO) criteria were used to structure the research question. A literature search was performed using PubMed/Medline, Cochrane Library, Google Scholar, and Ovid. Selection criteria were applied for populations over nine years of age, of either sex, with irreversible pulpitis, and articles published in English regarding conventional IANB or IANB and Gow-Gates techniques between 2009 and 2019. Prospective randomized clinical trials or randomized controlled trials were included in the review, in which anesthetic efficacy or success was measured. After screening, four articles were included. Three studies were randomized clinical trials, and two were randomized controlled trials. The validity and reliability of the individual studies were examined. There was evidence of the higher efficacy of the GGMNB technique than that of the IANB technique. However, both techniques can be mastered through training.

Keywords: Anesthetic Efficacy; Anesthetic Success; Gow-Gates; Inferior Alveolar Nerve Block; Irreversible Pulpitis; Mandibular Posterior Teeth.

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INTRODUCTION

Local anesthetics are a class of drugs used to block transmission and peripheral nerve function [1]. Dental anesthesia has been practiced in dentistry since the 19th century to reduce or minimize the discomfort related to intrusive dental procedures [2]. Dentistry and pain are typically associated with the mindset of patients, particularly extractions or symptomatic teeth that require endodontic treatment. Thus, dentists need to identify a good anesthetic before the procedure that focuses solely on the treatment, without interfering with the patients' gestures [3].

The main difference in the predicted length of medical anesthesia is determined by the fact that dentists usually utilize different anesthesia methods (Table 1). Clinicians have consistently sought an anesthetic alternative that can increase success rates well above 100 percent in the posterior mandible, in particular [4–9].

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Corresponding Author: Jorge Pereira, PhD, CU Oral Surgery, Oral Medicine and Oral Implantology, UFP, Rua Carlos da Maia, 296; 4200-150 Portugal
Tel: +351 225074630 / +351 936390808 E-mail: jpereira@ufp.edu.pt
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Table 1. Local anesthesia solutions available for use in clinical dentistry [4,5,6]

Duration	Solution	Trade name	Infiltration (pulpal)	Nerve block (pulpal)	Soft tissue duration	Mgs per cartridge
Short duration plain	Lidocaine HCL 2%	Xylocaine	5 m	Not indicated	2 h	26
	Mepivacaine HCl 3%	Carbocaine, Isocaine, Polocaine, Scandanest	20-30 m	45-65 m	2-3 h	54
	Prilocaine HCl 4%	Citanest Plain	10-15 m	45-65 m	3-4 h	72
Normal duration with vasoconstrictor	Articaine HCl 4% w/ epi 1:100,000	Sepotocaine, Articadent, Zorcaine	60-75 m	Up to 120 m	3-5 h	68
	Articaine HCl 4% w/ epi 1:200,000	Sepotocaine, Articadent	60-75 m	Up to 120 m	3-5 h	68
	Llidocaine HCL 2% w/ epi 1:50,000	Lidocaine, Xylocaine, Lignospan Standard, Octocaine 50	55-65 m	80-90 m	3-5 h	36
	Llidocaine HCL 2% w/ epi 1:100,000	Lidocaine, Xylocaine, Lignospan Standard, Octocaine 100	55-65 m	80-90 m	3-5 h	36
	Mepivicaine HCl 2% w/ levo 1:20,000	Carbocaine, Isocaine 2%, Polocaine, Scandanest 2%	40-60 m	60-90 m	3-5 h	36
	Prilocaine HCl 4% w/ epi 1:200,000	Citanest Forte	35-45 m	50-70 m	3-6 h	72
Long duration	Bupivacaine HCl 0.5% w/ epi 1:200,000	Marcaine, Vivacaine, Bupivacaine	Up to 7 h	Up to 7 h	Up to 12 h	9

epi, epinephrine; levo, levonordefrin.

Clinical experience and research have shown that local dental anesthesia is not always as successful as needed [2,10–15]. It was also reported that there are no 100% achievements in terms of mandibular block efficacy rates. Research and clinical experience have shown that the success rate of local anesthesia in the maxilla is far better than that of the mandible. This is likely due to the density and thickness of the cortical layer of the jaws. In the maxilla, the most effective method is buccal infiltration anesthesia close to the level of the apices of the teeth. Meanwhile, in the mandible, local anesthesia is performed primarily by injecting a volume of local anesthetic along the mandibular nerve before it reaches the mandible. Due to anatomical variations in the location of the second branch of the trigeminal nerve with respect to the mandibular ramus, the effectiveness of local anesthesia is not always 100% [2,10–16].

Scientists and physicians worldwide have identified inferior alveolar nerve block (IANB) as the most widely employed anesthetic technique for decades [2].

The following reasons have been associated with the failure of IANB:

Patient anxiety and fear are often the main causes of failure of anesthesia. From a neurophysiological viewpoint, a person may experience intense or perceived discomfort even if nerve conduction is interrupted [17–19].

The plexus of the nerves innervates the mandibular soft and hard tissues. Even if the IAN is blocked, this plexus may still permit some sensation. In 10%–20% of cases, the mylohyoid nerve provides mandibular molars with associated innervation [20].

Several new formulations have been introduced; however, IANB failure remains unchanged. No significant differences were observed between the groups [21].

During anesthesia, pulp inflammation and abscesses are the major problems for dental professionals [22]. Research has shown variation in the impulse production of nerve fibers attributable to inflammation in rabbits. Some studies have also suggested variations in the presence of inflammation in peripheral sensory fibers [23–25]. Nevertheless, the question still arises as to how the entire conduction of sensory fibers can be influenced by an inflamed pulp. Wallace reported that the whole neuron cell membrane is impaired by activation of the tissue's resting membrane potential once the tissue becomes inflamed [26].

In 1884, the first neuroregional anesthesia in the jawbone was induced by infusion of a cocaine solution into the mandibular foramen by Halsted and Hall [27]. Different techniques for anesthetizing the mandibular nerves have been considered due to the problems and deficiencies associated with IANB. [28] Conventional IANB was described by Malamed SF, GGMNB, Vazirani/Akinosi block (closed mouth block), and Fischer 1.2.3 IANB.

Conventional IANB is the most widely employed method for local anesthesia in mandibular surgery. In some instances, even the most experienced clinician fails to achieve this nerve block. Unfortunately, the rate of failure to achieve this block was fairly high (15% to 20%). The failure rate of conventional IANB was estimated by certain authors to be approximately 20% to 25% [29].

In this procedure, the vertical line delineation is not very precise between two-thirds and three-quarters of the length between the posterior boundary and coronoid notch provides a substantial margin for error [30]. It has been difficult to identify and implement this clinically by beginners, which could lead to failure to identify the location of initial needle entry as well as anatomical landmarks identified by Malamed [31,32].

Delayed induction of anesthesia is a recognized downside of the Gow-Gates (GG) method. The GG technique was declared by Malamed [32] to have a latency of 5 to 7 min. The latency of the central incisor was reached within 10 to 12 min, according to Levy [33]. The latency can range from 8 to 45 min, according to Agren and Danielsson [34]. This technique is mainly indicated in patients undergoing dental procedures in whom IANB does not provide adequate analgesia owing to anatomical variation or accessory nerve supply. This approach provides a true mandibular nerve block as it blocks the trunk of the nerve before it divides into its three main terminal branches. The incidence of intravascular injection is also less common with this approach. A disadvantage of this approach is the undesired anesthesia of the lower lip and temporal region. [32]. This blocks the IAN and its branches and the lingual, mylohyoid, auriculotemporal, and buccal nerves [17]. In this approach, anatomic landmarks include the following [17,32]: corner of the mouth; the intertragic notch; and the distolingual cusp of the second maxillary molar tooth. The nociceptor is triggered by pH variations or mild temperature in the inflamed pulp, as their function varies through inflammatory mediators (kinins and prostaglandins). The consequence of pain is the detection and distribution of A-delta and C-fibers [35]. Therefore, pain is substantially higher during irreversible pulpitis.

The mandible has a nonporous and dense cortical outer layer, and therefore usually requires a nerve block to be used at a site away from the teeth being treated [17]. The anesthetic failure rate is eight times higher in irreversible pulpitis than that in normal pulpitis. Mechanical allodynia occurs in 57.2% of patients with irreversible pulpitis. The diagnosis of the root canal with irreversible pulpitis teeth in comparison to teeth with healthy and necrotic pulp was significantly more severe when compared to that in mechanical allodynia, which decreased the physical pain threshold [36].

Multiple studies have been conducted, mainly in the last decade, which showed varying results in the anesthetic efficacy of GG and IANB procedures in patients presenting with irreversible pulpitis. Therefore, the main goal of this systematic review of quantitative research was to extract the available data and provide valid evidence regarding the use of GG and IANB procedures in patients presenting with irreversible pulpitis. All trials regarding the utilization of these techniques in dentistry that met the inclusion criteria were analyzed.

METHODS

1. Methodology of review

The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" was adopted for the current review [37,38].

2. Formulation of research question and keywords selection

A PICO [patient population (P), intervention (I), comparison (C), and outcomes (O)] approach was used to structure and respond to the research question. It was found that higher precision can be achieved through the use of PICO templates, and the relevance of search results can also be improved [39].

PICO criteria for the research question was: "Does the GG technique (I) have a better anesthetic efficacy (O) compared to that of IANB (C) for patients with irreversible pulpitis (P)"? According to this research question, the following keywords and Medical Subject Headings (MeSH) were used for the search: inferior alveolar nerve block, mandibular block, anesthetic success, anesthetic efficacy, GG, pulpitis, irreversible pulpitis, acute pulpitis, and mandibular posterior teeth. Both spellings of "anaesthesia" and "anesthesia" and were searched separately.

3. Search strategy

The literature search was performed on PubMed, Cochrane Library, and Ovid Medline. The keywords and MeSH terms were searched individually and combined with Boolean operators (AND, OR, and NOT) to identify the need for this review. There was no systematic review found specifically on this question, which provided further justification for us to perform this review. The search for the selection of studies was carried out from December 1 to 7, 2019.

4. Eligibility criteria

The following selection criteria were applied:

- Population: Patients older than 9 years of either sex with irreversible pulpitis.
- Language: Articles published worldwide in English regarding conventional IANB, IANB, and GGMNB.
- Timeline: Articles published between 2009 and 2019.
- Study characteristics: Prospective, randomized clinical trials, or randomized controlled trials were included.
- Outcome: Articles where anesthetic efficacy or success rate was evaluated.
- Exclusion criteria: Animal studies, books, case-control, case reports and case series, cross-sectional studies, cohort studies, commentaries and conference papers, gray literature, meta-analysis, policy and guidelines, review articles, and unpublished data.

5. Study selection process

A total of six studies from Cochrane, 16 studies from PubMed/Medline, two from Ovid, and 87 studies from Google Scholar were primarily identified. After removal of the duplicates (n = 111), preliminary screening of titles and abstracts was performed, and 104 studies were excluded because they did not meet the eligibility criteria. The excluded studies were systematic reviews, meta-analyses, case series, case reports, animal studies, cross-sectional studies, unpublished and gray literature, and clinical guidelines and comparative studies on techniques other than GGMNB and IANB, articles on premedication effects, and anesthesia dosage. Seven

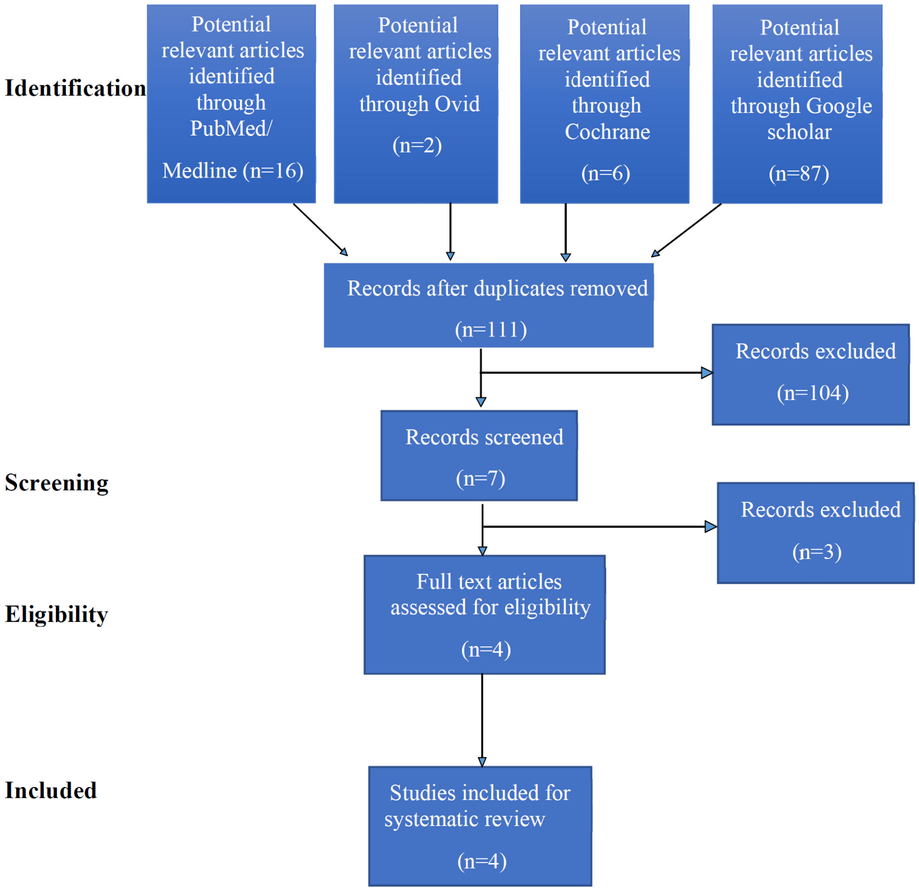

Fig. 1. Flow-chart of the study selection process.

articles were selected for full-text reading. Of these seven studies, three studies were further excluded because the focus question was not answered and they focused mainly on third molar impaction. Ultimately, four articles were included in the analysis. A flow chart of the study selection process is shown in Fig. 1.

6. Quality assessment tool

The "Cochrane Risk of Bias Tool for Randomized Controlled Trials" was used to assess the quality of the included studies. If all criteria were met (low for every domain) then the study was labeled as "good." If one criterion was not met (high risk for any domain), then the study was labeled as fair and if two or more criteria were not met (high risk or unclear in more than two domains), then the study was labeled as poor [40].

RESULTS

After retaining articles following scanning of titles, abstracts, and full texts, four studies were successfully identified and included in the systematic review as Study 1, Aggarwal et al. (2010) [35]; Study 2, Ghoddusi J et al. (2018) [41]; Study 3, Saatchi M et al. (2018) [42]; and Study 4, Sharma R et al. (2018) [43]. These studies were categorized as randomized clinical trials. The studies included patients with irreversible pulpitis. The list and a summary description of all the four studies, including their characteristics viz-a-viz quality analysis, are listed in Tables 2 and 3 and Figs. 2 and 3.

1. Characteristics of the included studies

The characteristics of the studies included in this review are in Table 2. One study (Study 2) compared

Table 2. Characteristics of included studies

Item	Study			
	1	2	3	4
Author	Aggarwal, et al. [35]	Ghoddusi J, et al. [41]	Saatchi M, et al. [42]	Sharma R, et al. [43]
Year of publication	2010	2018	2018	2018
Methods / Study design	Double-blinded, prospective randomized controlled trial	A parallelgrouped, randomized, double-blind clinical trial	A randomized clinical trial, prospective study	A randomized clinical study
No. of groups	4	2	3	4
Sample size	102 subjects, assigned into four groups: Gp#1 = 27, Gp#2 = 26, Gp#3 = 25 & Gp#4 = 24	80 subjects, assigned into two groups: Gp#1 = 40 & Gp#2 = 40	150 subjects, assigned into three groups: Gp#1 = 50, Gp#2 = 50 & Gp#3 = 50	120 subjects, assigned into two groups: Gp#1 = 30, Gp#2 = 30, Gp#3 = 30 & Gp#4 = 30
Age range	21-32 years	18-50 years	More than 18 years	Average age 30 year
Gender	Both male & female	Not mentioned	Both male & female	Both male & female
Intervention	GGMNB, VA, BL and IANB techniques	GGMNB and IANB techniques	GGMNB, IANB and GGMNB+IAN B techniques	GGMNB, VA and IANB with buccal infiltration and conventional IANB techniques
Outcome assessment scale	The pain was assessed byusing "Heft-Parker visual analog scale". The anesthetic success was noted as "none" or "weak/mild" pain	The pain was assessed by using "Visual analog scale". VAS score 1-3 was labelled as mild pain, 4-6 as moderate, 7-9 as severe pain and 0 as no pain	The pain was assessed by using "HP-VAS". The anesthesia success was described as the HP-VAS scores "0" without pain or with mild pain "1-54 mm"	The pain was assessed by using "Heft-Parker visual analog scale". The pain scale was classified into four categories that "0" for no pain, "1-54 mm" as "faint, weak, or mild pain", "55-114 mm" as "moderate pain" and "114 mm" as "strong, intense and maximum possible pain"
Anesthetic efficacy (GGMNB vs IANB)	52% vs 36%	50% vs 42.5%	40% vs 44%	66.7% vs 46.7%

BL, buccal-plus-lingual infiltrations; GGMNB, Gow-Gates mandibular nerve block; Gp, group; IANB, inferior alveolar nerve block; VA, Vazirani-Akinosi.

Table 3. Quality assessment of the included studies

Study No.	Author	Year	Bias arising from the randomization process	Bias caused by deviations from intended interventions	Bias caused by missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall bias
1	Aggarwal, et al. [35]	2010	+	?	+	+	+	?
2	Ghoddusi J, et al. [41]	2018	+	-	+	+	+	-
3	Saatchi M, et al. [42]	2018	+	+	+	+	+	+
4	Sharma R, et al. [43]	2018	+	-	+	-	+	-

Legend: +, Low risk of bias; ?, Some concerns; -, High risk of bias.

GGMNB and IANB techniques, one study compared GGMNB, Vazirani-Akinosi (VA), buccal-plus-lingual infiltrations (BL), and IANB techniques (Study 1), one study compared GGMNB, IANB, and GGMNB + IANB techniques (Study 3), and one study compared GGMNB, VA, and IANB with buccal infiltration and conventional

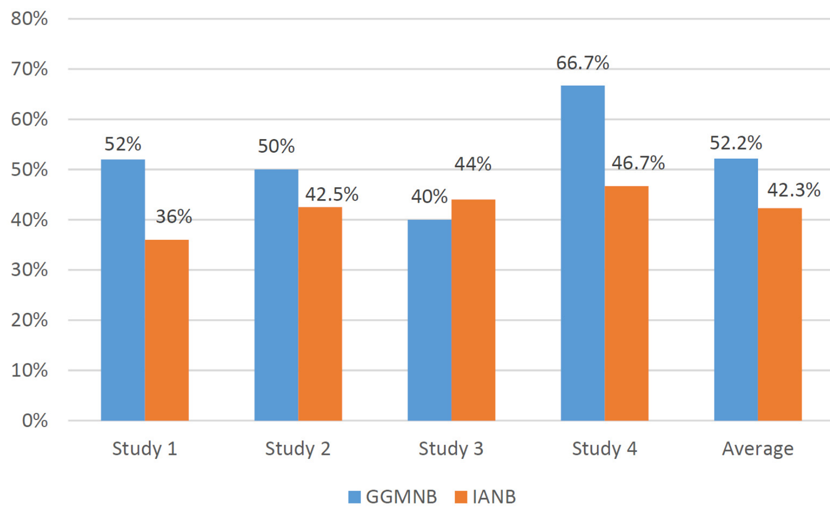

Fig. 2. Anesthetic efficacy of Gow-Gates (GGMNB) and inferior alveolar nerve block (IANB) in included studies.

Fig. 3. Risk of bias in included studies.

IANB techniques (Study 4). The total number of randomized subjects was 452. Three studies included both male and female patients, and one study did not specify the sexes. The age range of the three included studies (Studies 1 and 2) was 18 to 50 years; whereas, in study 3, the upper limit of age was not mentioned, and in study 4, the average age of the participants was 30 years. All included studies in the current review were published between 2010 and 2018. Of the four studies, three studies (Studies 1, 2, and 4) showed that GGMNB has higher anesthetic efficacy than that of IANB, and only one study (Study 3) showed an insignificant difference between the anesthetic efficacy of GGMNB and IANB.

2. Quality assessment of included studies

The quality of the included studies was assessed using the "Cochrane Risk of Bias Tool for Randomized Controlled Trials (ROB)." The cardinal characteristics of the studies are presented in Table 3. Among the four included studies, one study (Study 3) was of "low" ROB, 2 studies (Study 2 and 4) showed "high" ROB, and one study (Study 1) showed "some concerns." The overall evaluation of the reviewed studies was "good" to "poor," Meanwhile, some studies had a high risk of bias, and some had an inappropriate methodology and a low reporting quality.

In Study 1, details regarding the concealment of allocation were not provided, which makes it liable to selection/allocation bias. The potential unknown covariate impact was not balanced among groups, which may have led to accidental bias on the outcome. The exclusion criteria were also not mentioned. A double-blinded study was mentioned; however, no details regarding the blinding were given in the article. Furthermore, it was unclear whether the patient and outcome assessor were blinded or the experimenter and patients were blinded, which may have led to detection bias of the results. The "Heft-Parker visual analog scale" was used to assess pain. The reliability and validity of the scale were not measured or mentioned. The overall quality of the study was graded as "poor" and better methodology is thus, required to address these possible biases. No registration of trial and funding source details was provided.

In Study 2, details were given regarding the concealment of allocation, which exempted it from selection/allocation bias. The potential unknown covariate impact was not balanced among groups, which may have led to accidental bias on the outcome. The exclusion criteria were mentioned. The study was double-blinded. Although the experimenter who carried out the intervention was not blinded. Additionally, the patient and outcome assessor were blinded, therefore, helping to decrease the risk of detection bias. The "Visual analog scale" was used to assess pain. The reliability and validity of the scale were not measured or mentioned. The overall quality of the study was graded as "good." Potential effect modifiers and side effects should have been addressed to overcome possible accidental biases. No funding source details were provided.

In Study 3, details were not given regarding the concealment of allocation, which makes it liable to selection/allocation bias. The potential unknown covariate impact was not balanced among groups, which may have led to accidental bias on the outcome. The study mentioned operator blinding. However, it is unclear whether the patient and outcome assessor were blinded, which may have led to detection bias in the results. The "Heft-Parker visual analog scale" was used to assess pain. The reliability and validity of the scale were not measured or mentioned. The overall quality of the study was graded as "fair" and better methodology is required to address the possible biases. No funding source details were provided.

In Study 4, details were not given regarding the concealment of allocation. Thus, making it liable to selection/allocation bias. The potential unknown covariate impact was not balanced among groups. This may have led to accidental bias in the outcome. The study did not mention details regarding blinding. Hence, it is unclear whether the experimenter, patient, outcome assessor, and data analyst were blinded or not. Therefore, this may have led to detection bias in the results. The "HP visual analog scale" was used to assess pain. The reliability and validity of the scale were not measured or mentioned. The overall quality of the study was graded as "poor". Therefore, a better methodology is required to address the possible biases. No funding source or trial registration details were provided.

DISCUSSION

The results of the four studies that were reviewed suggest that the anesthetic efficacy of the GG nerve block technique is superior to that of the IANB technique for irreversible pulpitis. However, the overall quality of the literature assessed was fair to poor. Three studies were randomized clinical trials, and two were randomized controlled trials. The randomized controlled trial studies were those of Aggarwal et al. (2010) [35] and Ghoddusi J et al. (2018) [41], and the randomized clinical trials were those of Saatchi et al. (2018) [42] and Sharma et al. (2018) [43]. The validity and reliability of the included studies were appropriate. This is due to the appropriate study design and accuracy of the study in the measurement of the efficacy of the selected anesthetic techniques. There is a lack of knowledge regarding the allocation, concealment, and blinding of the interventions. The details of the allocation were not mentioned by most researchers, thus, leading to ambiguous results.

The existing literature provides sufficient evidence to set the GG nerve block as a valid alternative to IANB. Policy guidelines for GG nerve block for irreversible pulpitis, however, should be developed to enable dentists to develop appropriate support strategies and training to use suitable anesthetic techniques. An exhaustive search of the literature, the explicit selection criteria used, and the validity of the evaluation of the included trials show thoroughness, and a systematic approach supported the conclusion that GG is superior to IANB for irreversible pulpitis.

Three studies used the "Heft-Parker Visual Analog Scale" for pain assessment and one study used the "Visual Analog Scale" for pain assessment. These tools are widely used to assess acute pain in a reliable, valid, sensitive, and appropriate way. Studies by Aggarwal et al. (2010) [35], Ghoddusi et al. (2018) [41], Saatchi et al. (2018) [42], and Sharma et al. (2018) [43] included patients over 18 years of age, making the outcome less generalizable to the pediatric population. Improving the quality of randomized controlled/clinical trials is also significant, particularly in the areas of blinding, allocation and concealment, failure, and intention-to-treat analysis.

Two studies recruited patients from emergency pain management that required immediate treatment to relieve pain. Saatchi et al. (2018) [42] and Sharma et al. (2018) [43] conducted a randomized control trial. Saatchi et al. (2018) [42] randomized the sample size into three groups. The first group of patients was administered two cartridges of lidocaine 1:80000 through the GG nerve block technique. The second group of patients was administered two cartridges of lidocaine 1:80000 using the IANB technique. Furthermore, the third group of patients was administered one cartridge of lidocaine 1:80000 using the GG nerve block technique and another cartridge of lidocaine 1:80000 was administered using the IANB technique. The results showed that a combination of different anesthetic techniques was more efficacious in anesthetizing the region. The author recruited patients aged 18 to 64 years. Therefore, the results might be reflected as the pain threshold varies from patient to patient. In addition, the author did not specify the medical conditions that were excluded because the efficacy of anesthesia is affected by different medical conditions and old-age-related problems such as bone loss, gum recession, and lesser blood supply to the pulp. The results should have been stratified among different age groups. One patient was found to be ineffective for lip numbness. Moreover, the affected tooth was not specified, which could be reflected as a bias. Sharma R et al. (2018) [43] randomized patients into groups 1 to 4, namely, GG block, Vazirani Akinosi closed mouth technique, IANB with buccal infiltration of 2% lidocaine with 1:80,000 epinephrine and IANB, respectively. The results showed that the GG technique had the highest success in anesthetizing the area, followed by the Vazirani Akinosi technique. Both techniques were used in both studies. However, one study showed a higher success of GG and the other showed a higher success of the combination of the two techniques. This could be due to age, pain threshold, and other systemic factors that were responsible for differences in anesthetic efficacy in both studies.

Aggarwal et al. (2010) [35] also compared four types of anesthetic techniques to determine the success of anesthesia. One group of patients was given an IANB with articaine 4% with 1:100,000 epinephrine, the second group was administered an anesthetic solution via the GG mandibular block anesthetic technique, the third group was given anesthetic solution via the Vazirani Akinosi closed-mouth technique, and the fourth group was administered buccal and lingual infiltrations with articaine 4% with 1:100,000 epinephrine. The study showed that IANB was more effective in reducing pain intensity 15 minutes after the injections, followed by buccal and lingual infiltrations. However, the study also showed that the highest success rate of the type of anesthesia during the whole treatment was with the Vazirani Akinosi technique, followed by the GG technique, and lastly the buccal and infiltration techniques. It is worth noting that GG was not very effective during the initial stages of pain reduction as compared to other techniques. However, it lasted until the completion of the procedure in comparison with other techniques. This is because articaine penetrates the bone, and the other two solutions were not specified.

On the other hand, Ghoddusi et al. (2018) [41] compared two techniques in terms of pain severity. The recruited patients had moderate to severe pain in the lower mandibular molar. The results showed that the GG nerve block technique reduced the pain in a greater number of teeth than that in the IANB technique. It is also worth noting that lip anesthesia was also effective with both techniques in patients with moderate to severe pain due to irreversible pulpitis. The study also found that during treatment, there was a need for supplementary buccal and lingual infiltration, which could be due to the severity of pulpitis pain. The importance of supplementary infiltration seemed to have a significant impact on reducing pain severity and was found to be statistically significant. The study also showed that anesthetized teeth responded to the pulp test, resulting in the vitality of the tooth.

There was a difference in the pain experienced in patients who receive either of these two mandibular nerve blocks (GG nerve block or IANB). There is evidence that the GG technique has higher efficacy than that of IANB. Each of the two techniques is equally easy to execute with training. Nevertheless, these techniques may require supplementary injections of infiltration during the treatment. Knowing how to perform the GG nerve block is important as this technique likely provides satisfactory anesthesia in patients than that in IANB. Knowing how to perform only one method to block the inferior alveolar nerve limits the ability of the dentist to provide consistently successful anesthesia; thus, making it more difficult for all patients to achieve the goal of pain-free dentistry. On the other hand, knowing how to perform the GG technique increases the likelihood that patients may be pain-free when undergoing mandibular dental procedures.

This review is unique and the first of its kind, as no descriptive systematic reviews were found comparing the anesthetic efficacy of GG nerve block and IANB. The process of extracting literature was rigorous and assessed against the inclusion criteria to reduce bias. This review highlights facts and provides sufficient evidence that the GG nerve block is a superior technique to IANB.

The GG technique for mandibular anesthesia has been in use since 1947 and was first published in 1973.

Comparative studies, by a variety of authors, have given credibility to the technique by showing that it is predictable, accurate, simple, and safe to use. The technique has a very high success rate, minimal toxic effects, and very low possible blood aspiration. Unlike the conventional IANB, and provided the mouth is fully opened, the GG technique allows for the deposition of the anesthetic solution in the relatively avascular region at the neck of the condyle. The needle pathway is substantiated by geometrical and mathematical analysis, which removes any doubt regarding the validity of the technique. Understanding how to administer GG provides clinicians with another method of achieving mandibular block anesthesia [17,32].

Inadvertent intravascular delivery of a local anesthetic is always possible. Delivery of local anesthetic inside the blood vessel results in systemic side effects and failure of anesthesia because not enough local anesthetic is available to act on the nerve. In the GG technique, the vascular areas located near the site of injection include the internal maxillary artery and pterygoid plexus of the vein. If the needle is placed at the recommended spot in contact with the neck of the condyle and then only the solution is deposited, the possibility of inadvertent intravascular injection can be drastically reduced [17,32].

According to the findings of Yu et al. (2017), the researchers found a lower rate of positive aspiration in the GG technique than that in the IANB technique [44]. Hence, the likelihood of vascular accidents is reduced. However, Barodiya et al. (2017) reported positive aspiration in the GG technique owing to puncturing of the internal maxillary or middle meningeal artery [45].

The rate of positive aspiration for the IANB technique was found to be 10 to 15%. Abbas Haghighat et al. (2015) in their clinical study of comparison of success rate and onset time of two different anesthesia techniques found that the onset of anesthesia depends on the closeness of approximation of the nerve-blocking drugs to the related nerve trunk [46].

Complications related to local anesthesia, such as persistent paresthesia and numbness due to nerve trauma and local hematoma formation triggered by the injury and bleeding of the vascular tissue, and trismus in the pterygomandibular area by intramuscular injection and needle fracture can occur [47-50]. Therefore, more effective anesthetic techniques, with fewer technical repetitions and less reinforcement, contribute to a lower risk of injury to important anatomical structures.

There is limited literature on this topic. Nevertheless, the word "irreversible pulpitis" is not widely used in the existing literature. The difficulty in researching the literature may have contributed to the inconsistent results and/or omission of significant studies. Articles written in English were one of the criteria that could once again be a potential limitation. The lack of full-text availability for other studies is another limitation.

In conclusion, the results of the four studies that were reviewed suggest that the anesthetic efficacy of the GG nerve block technique is superior to that of the IANB technique for irreversible pulpitis. Nonetheless, buccal lingual infiltration remains an important adjunctive method to regional blocks to reduce pain. In a nutshell, due to the vast blockage of the nerve system in the GG technique, this anesthetic technique is quite effective than infiltration. Nonetheless, the type of anesthesia, age of the patient, and systemic diseases do play a role and somehow affect the ability of pain to subside. However, the overall quality of the literature assessed was fair to poor.

The use of all techniques in practice does not necessarily follow, possibly because the alternative techniques are not familiar to the majority of dentists. Nevertheless, the challenge is worthwhile because the benefits are substantial.

AUTHOR ORCIDs

Ifrah Sarfaraz: https://orcid.org/0000-0002-1803-671X
Selma Pascoal: https://orcid.org/0000-0002-9665-7183
José Paulo Macedo: https://orcid.org/0000-0003-3653-7267
Abel Salgado: https://orcid.org/0000-0002-3534-2356
Dil Rasheed: https://orcid.org/0000-0002-5046-8408
Jorge Pereira: https://orcid.org/0000-0003-1420-8331

AUTHOR CONTRIBUTIONS

Ifrah Sarfaraz: Conceptualization, Data curation, Formal analysism, Investigation, Methodology, Software, Writing - original draft
Selma Pascoal: Conceptualization, Data curation, Investigation, Methodology, Supervision, Validation, Writing - review & editing
José Paulo Macedo: Data curation, Formal analysis, Methodology, Supervision
Abel Salgado: Data curation, Formal analysis, Methodology, Supervision, Writing - review & editing
Dil Rasheed: Conceptualization, Data curation, Formal analysis, Methodology
Jorge Pereira: Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Validation, Visualization, Writing - review & editing

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