Republic of Iraq
Ministry of Higher Education
And scientific Research
University of Baghdad
College of Dentistry

Comparison between inferior alveolar nerve block and infiltration techniques in extraction of mandibular posterior non vital teeth

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of oral surgery
in Partial Fulfillment for the Bachelor of Dental Surgery

By:
Hussain Bassam Farman
Hussain Azad Mossa

Supervised by:
Dr. Mohamed Abd Alrazaq

B.D.S, MSC, PHD OMFS

April, 2022

Certification of the Supervisor

I certify that this project entitled "Comparison between inferior alveolar nerve block and infiltration in extraction of mandibular posterior teeth" was prepared by the fifth-year students Hussain Bassam Farman and Hussain Azad Mossa under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Dr. mohammed

Date

Dedication

Acknowledgement

First of all, I want to thank God for helping me to complete this research. Thanks to Prof. **Dr. Raghad Abdulrazaq,** dean of collage of dentistry, university of Baghdad for his continuous support for the students.

Deep appreciation and respectful regards to **Dr. Sahar Shakir,** head of oral and maxillofacial surgery department, collage of dentistry, university of Baghdad, for facilitating the commencement of this project and providing all the support at his disposal.

My sincere thanks to, ***Dr. Mohamed Abd Alrazaq*** for his continued support and encouragement.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Local anesthesia plays an essential part in dentistry and anesthetic drugs are the most regularly used drugs in either medicine **(Awad *et al*., 2020)** and dentistry **(Kaufman *et al*., 2005).** Inferior alveolar nerve block (IANB) technique is still the most common anesthetic technique used for the posterior teeth in the mandible **(Foster *et al*., 2007; Shabazfar *et al*., 2014**). When successfully administered, it provides sufficient anesthesia in a wide zone of the posterior mandible to perform surgery and restorations. **(Davis *et al*., 1996; Kämmerer *et al*., 2011; Awad and Mourad, 2020.**). However, it has a somewhat high failure rate of 7 to 75% (**Hinkely *et al*., 1991; Steinkruger *et al*., 2004)**. Furthermore, it has major complications, as systemic toxicity from iatrogenic intravascular injections, bleeding from injury to neighboring blood vessels, prolonged mandibular anesthesia, also transient or even permanent paresthesia of the inferior alveolar and lingual nerves **(SF.M, 2004; Hussein, 2015).** To evade IANB drawbacks, researchers used alternative techniques like periodontal ligament injection anesthesia (PDL). Correlated to IANB, PDL is adequate for single tooth anesthesia **(Shabazfar *et al*., 2014)** has no risk for nerve damage, and less painful injection. However, PDL damages the periodontal tissue, causes root resorption, and severe bacteremia up to 100% **(Awad, *et al*., 2020)**. local infiltration anesthesia is another simple alternative with less complications, which has proven to be successful in surgical and restorative work in both the maxilla as well as in the anterior part of mandible, but not been used frequently in the posterior mandible due to the dense bone at this region **(Awad *et al*., 2020)**. On the other hand, recent studies indicated that 4% articaine could achieve successful anesthesia even in the posterior mandible (**Corbett and Kanaa, 2008).**

Aim of the Study

The current study aimed to: -

1- evaluate the success of infiltration technique versus inferior alveolar nerve block technique (IANB) anesthesia during extraction of posterior non-vital teeth in the mandible.

2- compare the time, pain and frequency of repeated injection between the two anesthetic techniques.

Review of Literature

1.1. Development of the Mandibular Jaw

The first pharyngeal arch forms two processes that eventually fuse at the mandibular symphysis to form the mandible. At birth, the mandibular symphysis is composed of fibrocartilage. Within one year of life, the symphysis fuses and a subtle ridge remains at midline on the anterior surface of the body (**Lipski *et al*., 2013; Breeland *et al*., 2021**).

1.2. Structure of the Mandible

The mandible is consisted of the following parts: the body, two rami, the codyloid and the coronoid processes **(Breeland *et al*., 2021)**.

1.2.1. Body of the mandible

The body is the anterior portion of the mandible and is bound by two surfaces and two borders. The body ends and the rami begin on either side at the angle of the mandible, also known as the gonial angle **(Breeland *et al*., 2021)**.

External surface: The external surface contains the mandibular symphysis at midline, detected as a subtle ridge in the adult. The inferior portion of the ridge divides and encloses a midline depression called the mental protuberance. The edges of the mental protuberance are elevated, forming the mental tubercle. Laterally to the ridge and below the incisive teeth is a depression known as the incisive fossa. Below the second premolar is the mental foramen, in which the mental nerve and vessels exit. The oblique line courses posteriorly from the mental tubercle to the anterior border of the ramus **(Breeland *et al*., 2021)**.

Internal surface: The internal surface contains the median ridge at midline and mental spines, which are just lateral to the ridge. The mylohyoid line begins at midline and courses superiorly and posterior to the alveolar border **(Breeland *et al*., 2021)**.

The Alveolar border: The alveolar border, which is the superior border, contains the hollow cavities in which the lower sixteen teeth reside. **(Breeland *et al*., 2021)**

The Inferior border: The inferior border creates the lower jawline and contains a small groove in which the facial artery passes through **(Breeland et al., 2021)**.

1.2.2. Ramus

The ramus contributes to the lateral portion of the mandible on either side. The coronoid process and condyloid process are located at the superior aspect of the ramus. The coronoid process is anterior and the condyloid process is posterior; the two are separated by the mandibular notch. The ramus is bound by two surfaces and four borders and contains two processes **(Breeland *et al*., 2021).**

Lateral surface:The lateral surface contains a portion of the oblique line, which began on the external surface of the body. This surface also provides the origin for the masseter muscle **(Breeland *et al*., 2021)**.

Medial surface: The medial surface contains the mandibular foramen through which the inferior alveolar nerve and inferior alveolar artery enter and subsequent course the mandibular canal. At the anterosuperior aspect of the mandibular foramen is a sharp process called the lingula of the mandible. At the posteroinferior aspect of the mandibular foramen is the mylohyoid groove, against which the mylohyoid vessels run **(Breeland *et al*., 2021)**.

Superior border: The superior border which gives rise to the coronoid and condyloid processes **(Breeland *et al*., 2021)**.

Inferior border: The inferior border is continuous with the inferior border of the mandibular body and contributes to the jawline **(Breeland *et al*., 2021)**.

Posterior border: The posterior border is continuous with the inferior border of the ramus and is deep to the parotid gland. This border is used in conjunction with the inferior border of the mandibular body to determine the gonial angle **(Breeland *et al*., 2021)**.

Anterior border: The anterior border is continuous with the oblique line of the external surface of the body **(Breeland *et al*., 2021)**.

1.2.3. Coronoid Process

The coronoid process is located at the superior aspect of the ramus. Its anterior border is continuous with that of the ramus, and its posterior border creates the anterior boundary of the mandibular notch. The temporalis muscle and masseter insert on its lateral surface **(Breeland *et al*., 2021)**.

1.2.4. Condyloid Process

The condyloid process is also located at the superior aspect of the ramus and is divided into two parts, the neck and the condyle. The neck is the thinner portion of the condyloid process that projects from the ramus. The condyle is the most superior portion and contributes to the temporomandibular junction by articulating with the articular disk **(Breeland *et al*., 2021)**.

1.3. The Blood Supply and Lymphatics

Blood supply to the mandible is via small periosteal and endosteal vessels. The periosteal vessels arise mainly from the inferior alveolar artery and supply the ramus of the mandible. The endosteal vessels arise from the peri-mandibular branches of the maxillary artery, facial artery, external carotid artery, and superficial temporal artery; these supply the body of the mandible (**Saka *et al*., 2002**). The mandibular teeth are supplied by dental branches from the inferior alveolar artery. Lymphatic drainage of the mandible and mandibular teeth are primarily via the submandibular lymph nodes; however, the mandibular symphysis region drains into the submental lymph node, which subsequently drains into the submandibular nodes.

1.4. The trigeminal nerve

The trigeminal nerve is the largest of the cranial nerves. It originates from the brainstem at the midlateral surface of the pons, near its upper border, by a smaller motor and a larger sensory root. The afferent fibres transmit information from the face, oral and nasal cavities, and most of the scalp. Most of these fibres have their cell bodies located in the trigeminal ganglion or Gasserian ganglion **(Rodella *et al*., 2012).** With the exception of periodontal ligament mechanoreceptors, the cell bodies of the neurons involved in proprioception and the stretch receptors are located in the mesencephalic nucleus. In addition, the trigeminal nerve also contains visceral efferent fibres for lacrimal, salivary and nasal mucosa glands; these fibres come from facial and glossopharyngeal nerves and run into the trigeminal nerve after an anastomosis with a branch of the facial or glossopharyngeal nerves **(Rodella *et al*., 2012)**. Somatic efferent fibres of the trigeminal nerve innervate the masticatory muscles. They originate from the motor nucleus of the trigeminal nerve located in the pons **(Rodella *et al*., 2012)**. The trigeminal nerve gives three branches distal to the trigeminal ganglion (Figure 1.1)

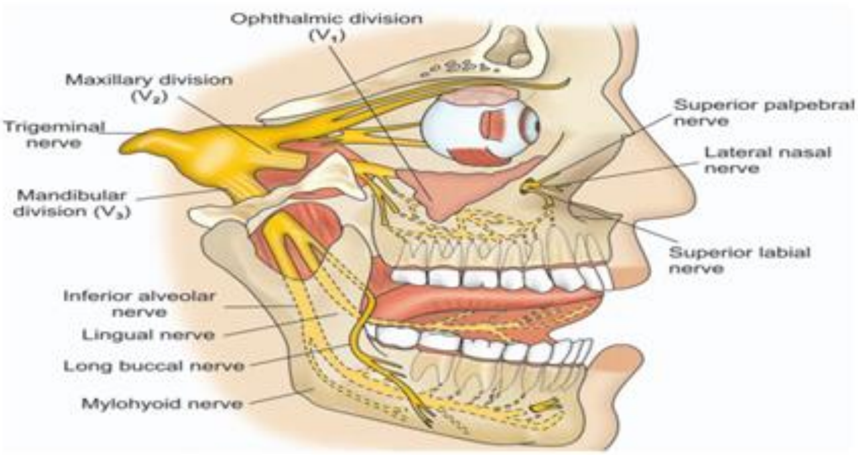

Figure 1.1: The Trigeminal Nerve and Its Branches (Chitre, 2016).

The upper branch of the trigeminal nerve is the ophthalmic nerve (V1). It passes forward in the lateral wall of the cavernous sinus and gains access to the orbit via the superior orbital fissure. The ophthalmic nerve gives branches to supply sensation to the eyeball, conjunctiva, lacrimal glands, nasal mucosa, skin of the nose, eyelid and forehead **(Rodella *et al*., 2012)**. The middle branch is the maxillary nerve (V2). Maxillary division exits the middle cranial fossa through the foramen rotundum and enters into the pterygopalatine fossa here it gives off several branches for the dura, the maxillary teeth and associated gingiva, the maxillary sinus, the upper lip, the lateral surface of the nose, the lower eyelid and conjunctiva, the skin of the cheek and of the side of the forehead, the nasal cavity and the mucosa of the hard and soft palate **(Rodella *et al*., 2012)**. The lower branch is the mandibular nerve (V3). Unlike the ophthalmic and maxillary divisions, which contain only afferent fibres, the mandibular division contains both afferent and efferent fibres. It runs from the trigeminal ganglion through the foramen ovale down towards the mandible in the region of the infratemporal fossa giving off several branches. The main trunk divides into the nervus spinosus, a recurrent meningeal branch and the medial pterygoid nerve. Then, it divides into a small anterior and a large posterior trunk; the masseteric nerve, the deep temporal nerve, the long buccal nerve and the lateral pterygoid nerve originate from the former; from the posterior division (as seen in Figure 1.2) the auriculotemporal nerve, the lingual nerve and the inferior alveolar nerve originate. The inferior alveolar nerve gives off the mylohyoid nerve before it enters the mandible through the mandibular foramen on the medial surface of the mandibular ramus and gives two terminal branches: the mental nerve and the incisive nerve **(Rodella *et al*., 2012)**.

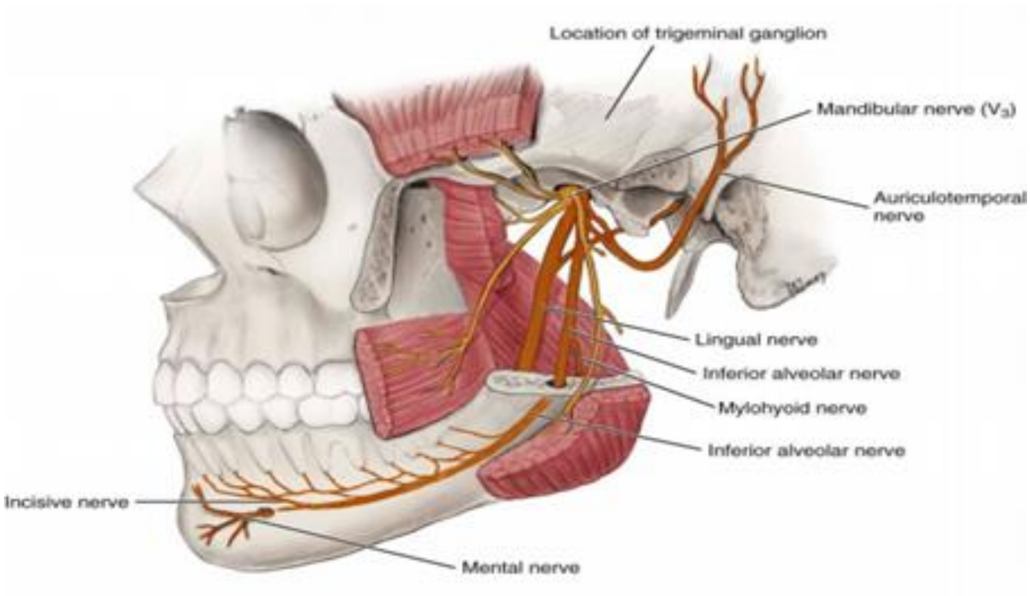

Figure 1.2: The pathway of the posterior trunk of the mandibular nerve of the trigeminal nerve is highlighted (Fehrenbach and Herring. 2007)

1.5. Local Anesthesia

Local anesthesia (LA) is a reversible blockade of nerve conduction in a circumscribed area that produces loss of sensation. Today's anesthetics are safe, effective, and can be administered with negligible soft-tissue irritation and minimal concerns for allergic reactions (**Ogle and Mahjoubi, 2012)**. Pain has been a faithful companion of human beings and is a result of most of dental procedures and illness therefore a good control of dental pain is inevitable and feasible. The administration of local anesthetics has come to be the standard of care of dental profession. The choice of using a local0 anesthetic depends on time of the surgical procedure, patient's medical history, and the interaction between local anesthetics and patient usual medications. Dentists should be experts in dental-anesthetic techniques and in pharmacology of local anesthetics, since they are the most used medications in odontology (**Hernández-Cortez *et al*., 2020).** In 1884, cocaine was discovered to have local anesthetic properties and soon became widely used in many types of surgery (**Ring, 2007**). The first registered dental anesthesia in history was in 1885 of the alveolar inferior nervous, applied by the medical surgeon William Stewart Halsted. The injected drug was a combination of cocaine and epinephrine. In 1905, 2% procaine with epinephrine 1:50,000 was introduced, giving a quick access to dentists worldwide. Procaine, propoxycaine, and tetracaine were the most used LAs until the middle 1940s (**Hernández-Cortez *et al*., 2020)**. The improvements in agents and techniques for local anesthesia are possibly the most important advances in dental science to have occurred in the past 100 years **(Hawkins and Moore, 2002)**. As in other types of neural blockade, the choice of anesthetic agent, amount, type, and concentration of vasoconstrictor is based on many factors, such as physical status, age and weight of the patient, duration of the procedure, and need for hemostasis (**Giovannitti *et al*., 2013)**.

1.5.1. Theories of L.A. Action.

Many theories have been promulgated over the years to explain the mechanism of action (MOA) of LA, including the acetylcholine, calcium (Ca) displacement, and surface charge theories. Two other theories, the membrane expansion theory and the specific receptor theory are given credence today. The specific receptor theory is more widely held **(Malamed, 2014).**

1.5.1.1. The Membrane Expansion Theory

This theory suggests that local anesthetics are absorbed into the membrane, increasing fluidity and causing expansion. This expanded membrane closes sodium channels, preventing depolarization **(Day and Skarda, 1991).**

1.5.1.2. The Specific Receptor Theory

The most favored today, proposes that local anesthetics act by binding to specific receptors on the sodium channel **(Malamed, 2014).** It suggests that the dissociation of local anesthetic alters electrical forces across the membrane. The degree of blockade depends on the amount of ionized local anesthetic action at specific receptors at or near the sodium channel, preventing sodium influx **(Day and Skarda, 1991).** Once the local anesthesia agent gets gained access to receptors, permeability to sodium ions is reduced or eliminated; and nerve conduction is interrupted (**Chitre, 2010).**

1.5.2. Pharmacology of L.A

1.5.2.1. Chemical Structure

Modern local anesthetics are typically differentiated based on their chemical structure, specifically the linkage (an amide versus an ester linkage) between common elements of the compound. The majority of commonly used dental local anesthetics fall into the amide category (lidocaine, mepivacaine, bupivacaine, prilocaine), though there are some amide-type local anesthetics that also contain an additional ester linkage(articaine). It is rare in dentistry that estertypeanaesthetics are used for local anesthesia purposes, though these types of anaesthetics are used more commonly for topicalization (such as benzocaine and tetracaine hydrochloride) prior to injection to reduce discomfort associated with mucosal needle puncture (**Decloux and Ouanounou, 2021).**

1.5.2.2. Mechanism of Action

Local anaesthetics all act in the same manner (**Decloux and Ouanounou, 2021)**. The nerve membrane is the site at which local anesthetics exert their pharmacologic actions (**Malamed, 2014**). Local anesthetics block nerve conduction by preventing the increase in membrane permeability to sodium ions. Local anesthetics reversibly block transmission. Two current theories of the exact mechanism of action are the membrane expansion and specific receptor theories (**Day and Skarda, 1991).**

1.5.2.3. Onset of Action

The onset of action of local anesthetics is the period from local anesthetic deposition near the nerve trunk to profound conduction block, is determined by several factors. The negative log of the acid dissociation constant (pKa) is the primary factor that determines the onset of action.

The pKa of a local anesthetic determines the amount of drug that exists in an ionized (acidic) form at any given pH. The lower pKa levels increases tissue penetration and shortens onset of action due to more lipid-soluble unionized (base) particles. In contrast the higher pH level optimizesthe dissociation of these base molecules and shortens the onset of action. This theory explains why local anesthetics often do not work in infected tissue. The infected tissue tends to be a more acidic environment and reduces the pH of the tissue, consequently reducing the number of unionized local anesthetic particles, causing a delay in the onset of action, or ineffective anesthesia. Anesthetics that have a high degree of lipid solubility and are in the base unionized form will readily cross the nerve membrane and attach to the sodium receptors, resulting in a rapid onset of action. Anesthetics that have a low degree of lipid solubility and are cationic and ionized will penetrate the nerve membrane slowly and produce a slower onset of action.The administration site also influences the onset of action. The onset of a nerve block is faster in an area with smaller diameters of nerve trunks, and the onset is prolonged in areas with increased tissue or nerve sheath size **(Nathe, 2016)**.

1.5.2.4. Duration of Anesthesia

The duration of local anesthetics is influenced by the following:

• Protein binding: longer acting local anesthetics such as bupivacaine are more firmly bound to the receptor sites than shorter acting local anesthetics such as lidocaine. Increased protein binding allows the cations (RNH+) to bind/cling more firmly so duration is increased **(Nathe, 2016)**.

• Vascularity of the injection site: vascularity increases absorption of the anesthetic, allowing the drug to leave the injected area faster, decreasing potency as well as duration.

• Presence or absence of a vasoconstrictor drug: added vasoconstrictors to a local anesthetic decrease the vasodilatory properties of local anesthetics by constricting the surrounding blood vessels at the site of administration, increasing the duration of the anesthetic **(Nathe, 2016)**.

1.5.2.5. Absorption of Local Anesthetic

The rate of systemic absorption of local anesthetics is dependent upon the total dose and concentration of the drug administered, the route of administration, the vascularity of the tissues at the administration site, and the presenceor absence of a vasoconstrictor in the anesthetic solution. All local anesthetics are vasodilators and produce a pharmacologic effect on blood vessels, varying slightly from type to type **(Malamed, 2004)**. The importance of these vasodilating properties are the increase in the rate of absorption of local anesthetics and the decrease in the rate of action. Higher blood levels of the drug increase the chance of the patient developing an overdose. The local anesthetic molecules diffuse out of the sodium channels and are carried into the bloodstream. To reduce the rate of absorption, vasoconstrictors are added to local anesthetics to decrease the vasodilating properties of the local anesthetic by constricting the blood vessels and reducing the blood supply to the area of injection. The vasoconstrictor will reduce rapid systemic absorption, which reduces systemic toxicity and increases the duration of the anesthetic. Of equal importance is the site where the anesthetic is injected. If the anesthetic is inadvertently injected intravascularly, it will be absorbed into the bloodstream rapidly, significantly increasing the possibility of an overdose **(Nathe, 2016)**.

1.5.2.6. Distribution of local anesthetic

After absorption of the local anesthetics into the bloodstream,they are distributed throughout the body to all tissues. High vascular organs such as the brain, heart, liver, kidneys, and lungs have higher concentrations of anesthetics **(Malamed, 2004)**. Local anesthetics easily cross the blood-brain barrier, because nerves are predominantly susceptible to localanesthetics. The toxicity of local anesthetics is directly related to the amount of accumulation in the tissues **(Nathe, 2016)**.

1.5.3. Local Anesthesia agent

Ideal characteristic of local anesthesia must have the following characteristics **(Bonanthaya *et al*, 2021):**

1-It should be nonirritating and non-allergic.

2-It should not cause structural changes to nerve and have low systemic toxicity.

3-Its onset of action should be short and should be stable in solution.

4-It should be effective as both injectable and topical application.

5-Its action should be long enough to allow the procedure to be completed.

1.5.3.1. Classification of local anesthetic agents: based on chemical structure (Bonanthaya *et al*, 2021).

Table 1.1 The Chemical Structure of Local Anesthetic Agents

Chemical structure	Example
Esters of benzoic acid	Cocaine, Benzocaine, Butacaine, Piperocaine, Tetracain
Esters of para amino benzoic acid	Procaine, Chloroprocaine, Propoxycain
Amide	Articaine, Bupivicaine, Lidocaine,Dibucaine,

	Mepivacaine, Prilocain
Quinolone derivative	Centbucridin

1.5.3.2. Classifcation of local anesthetic agents: based on duration of Action (Bonanthaya *et al*, 2021)

Table 1.2 Duration of Action of Local Anesthetic Agents	
Duration of action	Example
Ultra short acting Pulpal anesthesia: less than 10 min Soft-tissue anesthesia: 30–45 mi	Chloroprocaine, Procain
Short acting Pulpal anesthesia: 5–10 min Soft-tissue anesthesia: 60–120 mi	Lidocaine, Prilocain
Medium acting Pulpal anesthesia: 45–90 min Soft-tissue anesthesia: 120–240 mi	Mepivacine, Articain
Long acting Pulpal anesthesia: 90–180 min Soft-tissue anesthesia: 240–540 mi	Bupivicaine, Etidocain

1.5.3.3. Selection of Local Anesthetic Agents

There are two main classifications of local anesthetic agents: esters and amides. Esters are metabolized in the plasma by plasma cholinesterase, and most amides are metabolized in the liver, the exception being articaine which is metabolized in the blood similar to esters. Because there is a greater propensity of patients who are hypersensitive to injectable esters, all injectable local anesthetics manufactured for dentistry today are in the amide group **(Logothetis, 2016)**.

1.5.4. Indication of Local Anesthesia

it is desirable to keep the patient in the state of consciousness while insensibility to pain is produced in the teeth and the supporting structures. In general, local anesthesia is used to render the teeth and supporting structures insensitive to painful procedures. Specifically, it is used for the following:

Oral Surgery

1. To make needle insertion painless.
2. Extraction of teeth and fractured roots.
3. Odontectomy.
4. Treatment of alveolalgia.
5. Alveolectomy.
6. Apicoectomy.
7. Incision and drainage of localised abscesses.
8. Removal of cysts, residual infection areas, hypertrophic tissues and neoplastic growths, ranula and salivary calculi.
9. In the treatment of tic douloureux by producing prolonged anesthesia with a combination of a local anesthetic agent and alcohol injection, for blocking the involved nerve.

10. A therapeutic test to localise the source of vague pain about the face **(Chitre, 2016)**.

1.5.5. Contraindication of Local Anesthesia

These can be divided into two groups: (1) Absolute contraindications, and (2) Relative contraindications

1.Absolute Contraindications

a.History of Allergy to Local Anesthetic Agents

Local anesthetic agents belonging to the same chemical group should not be used. However, local anesthetic agents in the different chemical group can be used. In case, a patient gives history of allergy to an amide local anesthetic agent, an ester local anesthetic agent can be used **(Chitre, 2016)**.

b.Documented Allergy to Other Constituents of the Solution Such as Bisulfites and Preservatives.

History of allergy to any of the constituents of the local anesthetic solution. Bisulfites, in the form of Sodium-bisulfite and sodium-metabisulfite are used as anti-oxidants or as preservatives to the vasoconstrictor in the local anesthetic solutions. Other general preservatives present in the local anesthetic solution include thymol, methylparaben, and chlorbutol. The solution containing the constituent should be avoided. An alternate solution should be used, if possible **(Chitre, 2016)**. An alternative to local anesthetics such as diphenhydramine, opioids, or general anesthesia can be used **(Eggleston *et al.*, 1996)**.

2. Relative Contraindications

a. Fear and apprehension: Where the patient is uncooperative or refuses for regional analgesia.

b. Presence of acute inflammation or suppurative infection at the site of insertion of the needle: There are increased chances of dissemination of infection with the passage of the needle from the abscess area to the deeper tissues.

c. Infants or small children: These patients lack reasoning and understanding.

d. Mentally retarded patients: These patients are unable to cooperate.

e. Restricted mouth opening: When the patient cannot open his mouth sufficiently, in situations, such as (i) trismus, or (ii) partial or complete ankylosis of temporomandibular joint.

f. Patients with significant medical disease: cardiovascular disease, hepatic dysfunction, renal dysfunction, and clinical hyperthyroidism.

• Patients with significant cardiovascular disease: All local anesthetic solutions containing high concentrations of vasoconstrictor, such as epinephrine, so it should be avoided. Local anesthetic agents containing higher dilution of epinephrine, such as 1:100000 or 1:200000, or 3% mepivacaine or 4% prilocaine can be used (for nerve blocks).

• Patients with significant hepatic dysfunction: All local anesthetic agentsbelonging to amide group undergo biotransformation in liver (fixed function oxidases). These agents are best avoided, if not, should be used judiciously.

• Patients with significant renal dysfunction: All amides and esters should be avoided; however, these can be used judiciously.

• Patients with clinical hyperthyroidism: High concentrations of vasoconstrictor, so it should be avoided. Local anesthetic agents containing higher dilutions of epinephrine such as 1:100 000 or 1:200 000, or 3% mepivacaine or 4% prilocaine (nerve blocks) can be used.

g. Major surgical procedure (**Chitre, 2016**).

1.5.6. Advantages of local anesthesia

The advantages of local anesthesia according to **Chitre (2016)** are:

1. Patient remains awake and cooperative.
2. Little distortion of normal physiology; therefore, can be used in poor risk patients.
3. Low incidence of morbidity.
4. Patient can leave hospital unescorted.
5. Additional trained personnel not required.
6. Technique not difficult to master.
7. Percentage of failure is small.
8. No additional expense to the patient.

1.5.7. Disadantage of local anesthesia

No true disadvantage to the use of local analgesia; when the patient is mentally prepared and when there are no contraindications. In every instance, when satisfactory anesthesia can be achieved and the patient is cooperative, local analgesia is the method of choice **(Chitre, 2016)**.

1.6. Lidocaine

Lidocaine is the most commonly used dental local anesthetic and has become the gold standard against which all other dental local anesthetics are compared. Lidocaine 2% combined with a vasoconstrictor in a 1:100,000 concentration provides reliable and profound pulpal anesthesia for approximately 60 minutes with a duration of soft tissue anesthesia ranging from 3 to 5 hours. Lidocaine is also supplied as a 2% solution with 1:50,000 epinephrine **(Giovannitti *et al.*, 2013)**. Lidocaine hydrochloride is the first amino amide type of localanesthetic, and has been in use for more than 60 years (**Ogle and Mahjoubi, 2012)**. Lidocaine hydrochloride has limited allergenicity with fewer than 20 reports of allergic reactions in the literature in the past 50 years **(Hawkins and Moore, 2002)**. As a local anesthetic, its characterized by a rapid onset of action and intermediate duration of efficacy, making it suitable for infiltration and nerve block anesthesia, and the "perfect" local anesthetic for dentistry. The maximum recommended dose of lidocaine with epinephrine is 3.2 mg/lb or 7 mg/kg of body weight for adult patients, and should not exceed 500 mg in total **(Logothetis, Demetra D, 2016)**. The dose of lidocaine without epinephrine is 2 mg/lb or 4.4 mg/kg, not to exceed 300 mg in total **(Logothetis, Demetra D, 2016)**. Adverse drug reactions (ADRs) are rare when lidocaine is used as a local anesthetic and is administered correctly **(Ogle and Mahjoubi, 2012).** The 2% lidocaine with 1:100,000 epinephrine formulation is considered the gold standard when evaluating the efficacy and safety of newer anesthetics (**Ogle and Mahjoubi, 2012).** Lidocaine is used as topical anesthetic in 2% or 5% gel, 2% solution, 4% or 5% solution, 5% ointment, or 10% spray. The onset of action is approximately 1 to 2 minutes and duration of action is approximately 15 minutes (Table 1.3). It is effective on alveolar mucus, but not on the palatal mucous membrane **(Lee, 2016)**.

Table 1.3 Composition and Properties of Lidocaine	
Chemical Formula	2-Diethylamino-2′,6-acetoxylidide hydrochloride
Classification.	Amide
Excretion	Via the kidneys; less than 10% unchanged, more than 80% various metabolic
Onset of Action	Rapid (3 to 5 minutes)
pKa	7.9
pH of Vasoconstrictor-	≈3

Containing Solution	
Anesthetic Half-Life	1.6 hours (≈90 minutes)
Effective Dental Concentration.	2%

1.7. Methods of Local Anesthetic Administration

There are three major different types of methods for LA administration:

– Local infiltration

– Field block

– Nerve block

In local infiltration, deposition of the local anesthetic solution is in the area of the surgery to anesthetize the small terminal nerve endings. Field block involves the deposition of anesthetic solution near the large terminal nerve branches to prevent the passage of impulses from teeth to the central nervous system. In nerve block, local anesthesia is deposited away from the site of surgery, but close to the main nerve trunk. Different techniques for mandibular nerve block anesthesia have been published, including the mental/incisive nerve block **(Bonanthaya *et al*., 2021)**.

1.8. Techniques of Local Anesthesia of the Mandible

1.8.1. Inferior Alveolar Nerve Block (Also Known as Mandibular Nerve Block)

This is the single most important nerve block; whose technique needs to be mastered. With this, we can anesthetize the whole of the mandibular soft and hard tissues, including the cheek, and many procedures in this region can be carried out. For injection on the right side of the patient and for a right-handed operator**,** the surgeon should be on the right side and in front of the patient. The patient is asked to open the mouth wide. With the left hand, the operator palpates the posterior buccal sulcus, runs the index finger posteriorly to feel the external oblique ridge and the anterior border of the coronoid process. As the finger proceeds upwards, palpate the coronoid process up and down to determine the deepest point on its anterior border which is the coronoid notch (Figure 1. 3) **(Bonanthaya *et al*., 2021)**. This is a very important landmark because it determines the vertical height at which the needle should be inserted, the reason being the mandibular foramen on the medial aspect of the ramus where we want the needle to reach is in direct line with the coronoid notch. Once the coronoid notch is palpated with the pulp of the index finger, the finger is rotated such that the nail faces medially **(Bonanthaya *et al*., 2021)**.

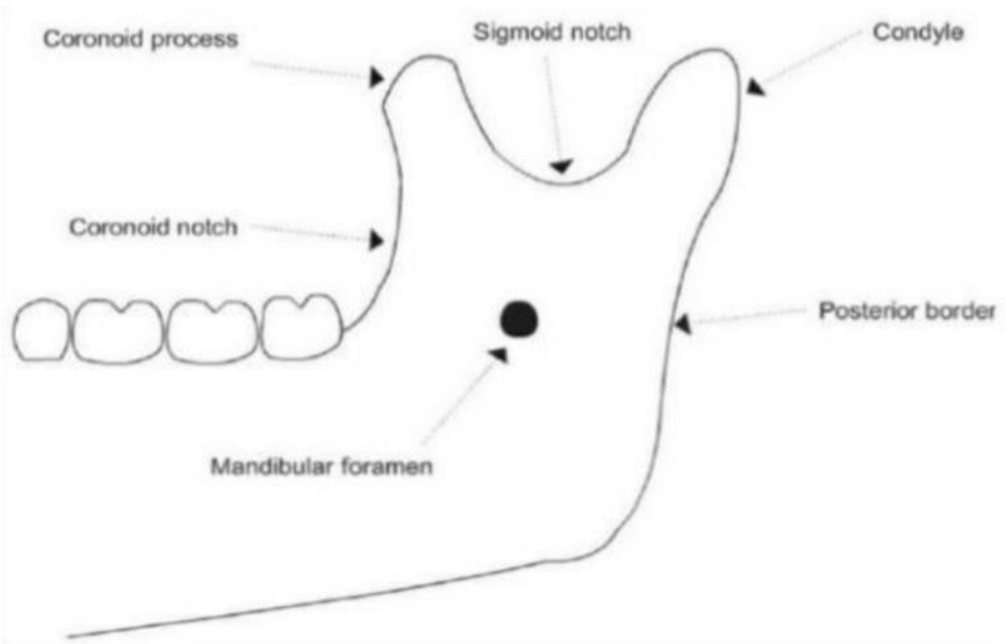

Figure 1.3: The Anatomical Land Marks in IANB (Khalil, 2014)

At the same time, the finger retracts the soft tissue. The syringe is aspirated and 1 ml of the solution is deposited. This will anesthetize the inferior alveolar nerve as it enters the mandible. Now, the needle with the syringe is swung on to the corner of the mouth (pterygo mandibular rather) on the same side **(**Figure 1.4**)**, i.e., right, and is slowly withdrawn after about half the length is inserted and 0.5–0.8 ml of the solution is deposited here.

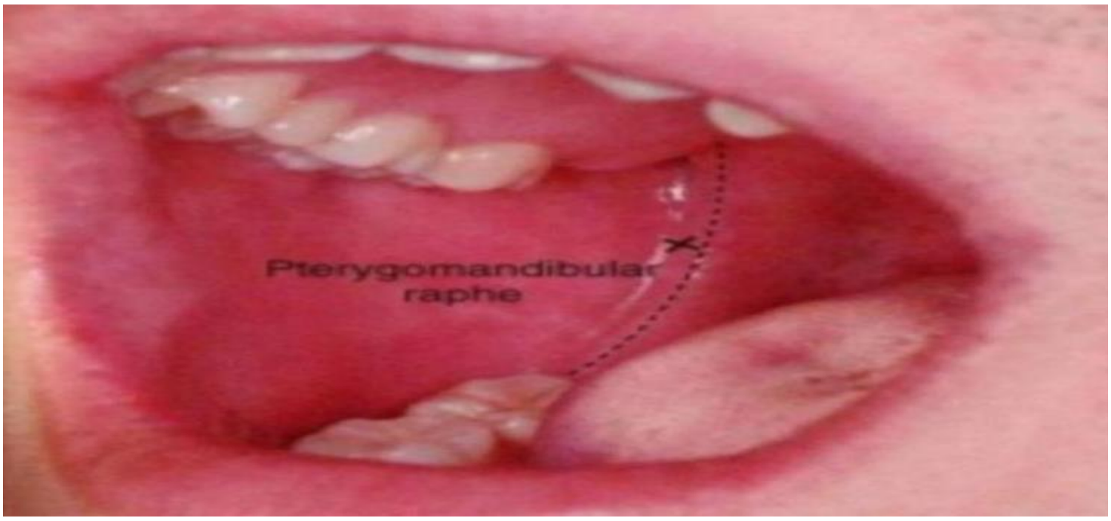

Figure 1.4: The Injection Site in IANB (Malamed, 2013)

This will take care of the lingual nerve, which is anteromedial to the inferior alveolar nerve. Now the needle is withdrawn completely out of the soft tissue and is reinserted into the cheek, posterior to the last molar teeth at the level of the occlusal plane of the mandibular teeth for a short distance. After aspiration, the remaining 0.5 ml of the solution is deposited to anesthetize the long buccal nerve **(Bonanthaya *et al*., 2021)**. For the left-sided block, the surgeon is slightly behind the patient on the right side with the left hand coming around). This classical Mandibular Nerve block of inferior alveolar nerve with lingual & long buccal is done together if the mandibular molars and their adjoining soft tissues need to be anaesthetized. The reason being the pulp and the periodontium of these teeth are supplied by the inferior alveolar nerve. The lingual gingiva is supplied by the lingual nerve and the buccal gingiva by the long buccal nerve **(Bonanthaya *et al*., 2021)**.

1.8.1.1. Failure of IANB

The most common causes for failure to obtain adequate inferior alveolar local anesthesia in these patients are:

1-positioning the tip of the needle too far medially resulting in inadequate anesthesia.

2-positioning the tip of the needle too far inferiorly-resulting in anesthesia of only the lingual nerve **(Bennett, 1978).**

1.8.1.2. Area anesthesized in IANB

Mandibular teeth to the midline, body of the mandible, inferior portion of the ramus, buccal mucoperiosteum, mucous membrane anterior to the mental foramen, anterior two thirds of the tongue and floor of the oral cavity, lingual soft tissues and periosteum **(Malamed, 2013)**.

1.8.1.3. Nerves anesthesized in IANB

Inferior alveolar, a branch of the posterior division of the mandibular division of the trigeminal nerve (V), Incisive, Mental, Lingual Nerves (Figure 1.5) (**Malamed, 2013)**.

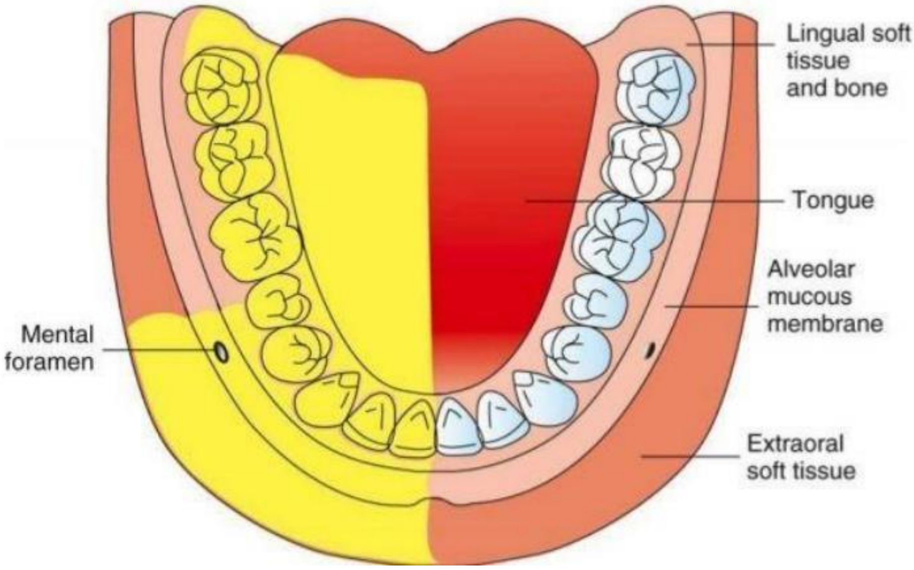

Figure 1.5: Area Anesthetized by IANB (Malamed 2013)

1.8.2. Infiltration Anesthesia

The reason that infiltration techniques may not be the first choice in the adult mandible is because practitioners tend to think that the thick cortical plate prevents diffusion of solution into the cancellous bone and, therefore, to the nerves supplying the pulps of the teeth. There are holes in the body of the mandible however, and these could permit diffusion of solution into the cancellous space. Such holes include the mental foramen and multiple minor perforations, especially in the lingual aspect of the anterior mandible and the retromolar ridge. Infiltration may be used in the mandible either to supplement other methods, such as regional block anesthesia, or as a primary technique **(Meechan, 2010)**.

1.8.2.1. Infiltration as a Supplementary Technique in the Mandible

Investigators have suggested that the infiltration anesthetic technique that is used as a supplementary method in adults can overcome anesthetic failure that is caused by accessory nerve supply **(Meechan, 2011)**.

1.8.2.2. Infiltration as a Primary Technique in the Mandible

Mandibular infiltration techniques for the permanent dentition as a primary technique:

1. Anterior Mandible

The infiltration anesthetic technique conceptually is appealing in the anterior mandible because other techniques have particular disadvantages in this area **(Meechan, 2011)**. In this region the cortex is quite thin and might provide little resistance to infiltration **(Meechan, 2010)**.

2. Molar Region

For pediatric patients age 7 to 12 years, single buccal infiltration of 4% articaine with 1:100,000 epinephrine effectively provided adequate palatal or lingual local anesthesia for primary molar extraction **(Rathi *et al*., 2019)**.

Table 1.4 Advantages of infiltration anesthesia compared to regional block
❖ Technically simple
❖ More comfortable for patients
❖ Provides hemostasis where it is needed
❖ Counters collateral supply in many cases
❖ Avoids damage to nerve trunks
❖ Less chance of intravascular injection
❖ Safer in patients with bleeding diatheses
❖ Reduced chances of needle stick injury
❖ Preinjection topical masks needle penetration discomfort

Materials and Methods

2.1. Study sample

This study was conducted in the maxilofacial department in the college of dentistry, university of Baghdad, Baghdad, Iraq.

Patients were classified into two groups to be given either inferior alveolar nerve block (IANB) or infiltration anesthesia for mandibular premolars and molars teeth for extraction.

After a detailed medical, family and dental history is taken from the patients. Then the inclusion and exclusion was established.

Inclusion criteria were as follow:

1-Healthy patients.

2-Older than 18 years.

3-Patients have a tooth in the posterior mandible needs extraction under local anesthesia.

Exclusion criteria:

1-Allergy to local anesthesia

2-Pregnant patients

3-Patients taking medications affecting pain sensation as (analgesics, antidepressants, narcotics and sedatives).

4-Patients having active pathology at the site of injection.

5-Patient with cardio vascular diseases.

2.1.1. Patient Grouping

The patients were divided arbitrary into two groups of 20 subjects each as seen in Table 2.1:

Table 2.1 patient grouping

Group A	Inferior alveolar nerve block	16 patients (20 teeth)
Group B	Infiltration technique	20 patients (20 teeth)

Group A, IANB technique was administered using a 1.8-mL cartridge of 2% lidocaine with 1:100,000 epinephrine. The cartridge was given for inferior alveolar nerve and for lingual nerve block.

Group B, the infiltration technique was performed. Two injections using needle and dental syringe were given for the targeted tooth; buccally targeting the soft and hard tissues, the second injection was in the lingual side for lingual soft and hard tissues.

2.2. Materials and Instruments

The materials and the instruments used in the current study were:

1-Basic diagnostic and surgical extraction kits.

Figure 2.1: Basic diagnostic and surgical extraction kits

2-sterile dental gauze.

3-Lidocaine 2% with 1:100,000 epinephrine local anesthesia as seen(Figure2.1).

Figure 2.2: The Local Anesthetic Solution

• Stop Watch

2.3. methods

2.3.1. Inferior Alveolar Nerve Block technique

After the determination and diagnosis of the accused tooth. The L.A was injected in IANB technique (pterygomandibular raphe) anesthetizing the inferioralveolar nerve, the lingual nerve and the long buccal nerve. Lidocaine 2% with 1:100,000 epinephrine was used as the local anesthetic agent in group A (Figure 2.3).

Figure 2.3: Inferior Alveolar Nerve Block Technique

The timer was started at the time of injecting the anesthesia. The initial onset of anesthesia was obtained by checking the lower lip numbness by patient report and gentle touching of cotton along the lip, when the patient reported numbness i.e. (loss of cotton light touch on the skin) and starting of the surgical procedure, the time was recorded.

2.3.2. Infiltration technique

For group B, The L.A was injected in the infiltration technique in the muco-buccal and the muco-lingual folds for the accused tooth as seen in (Figure 2.4). Lidocaine 2% with 1:100,000 epinephrine was used as the local anesthetic agent. Same method of time recording as group A was performed for collecting the onset time.

Figure 2.4: Infiltration Technique

2.4. Data collection

After the administration of local anesthesia for both techniques, the following parameters were tested:

1-Onset of the procedure: it was tested with a stop watch by measuring the time between the injection and the starting of the extraction procedure.

2-Frequcy of the repeated injection (if needed): if the patient is still feeling pain, we may need to repeat the technique used as follow: Giving (1) if the technique was used once, and (2) if it was used twice.

3-Postoperative pain sensation: each patient was asked after the procedure if he felt pain during the procedure as: Giving (yes) if the patient felt pain and (no) if he did not feel pain.

4-Extraction completion: if the technique was used twice or less and either elevators or dental forceps completed the extraction, the anesthetic technique considered successful as: (yes) and (no) if we needed another anesthetic technique.

Figure 2.5: Extraction completion of lower third molar

After the extraction procedure is completed, general post-operative motivation and instruction are given to the patient.

2.5. Statistics

Data were analyzed by using the statistics software SPSS (Statistical Package for Social Sciences) version 25. For independent testing of IANB vs. Infiltration technique, Shaoiro-Wilk test were used. Pearson's chi square test used for the two applied anesthetic techniques vs onset of anesthetic action. All the tested used were at a level of significance of 0.05.

Results

3.1 Demographic data

This study included 36 patients: 15 males and 21 females (42% vs 58%) respectively as shown in Figure 3.1. There were 40 total extracted teeth, 16 (40%) of them were permanent premolars (2^{nd} premolar) and 24 (60%) were permanent molars (1^{st} 2^{nd} 3^{rd} molars) as shown in Figure 3.2.

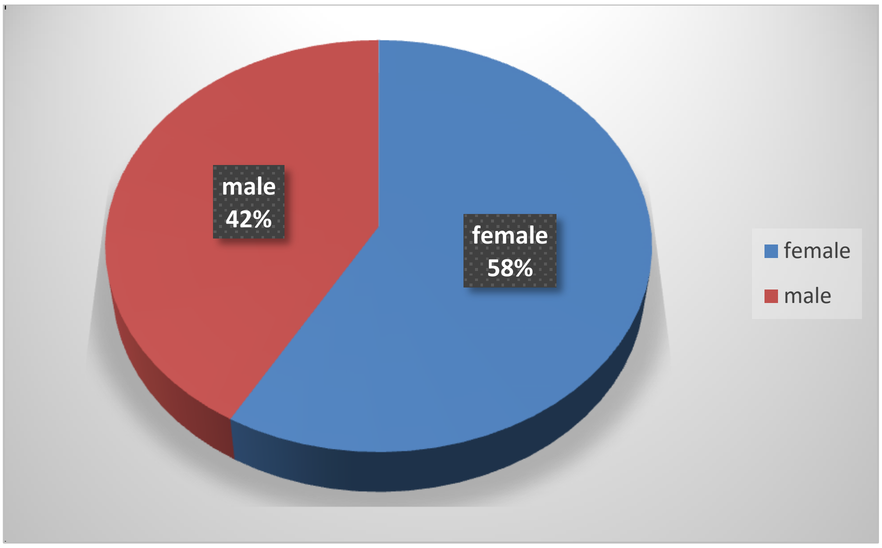

Figure 3.1: A pie chart illustrating the gender distribution

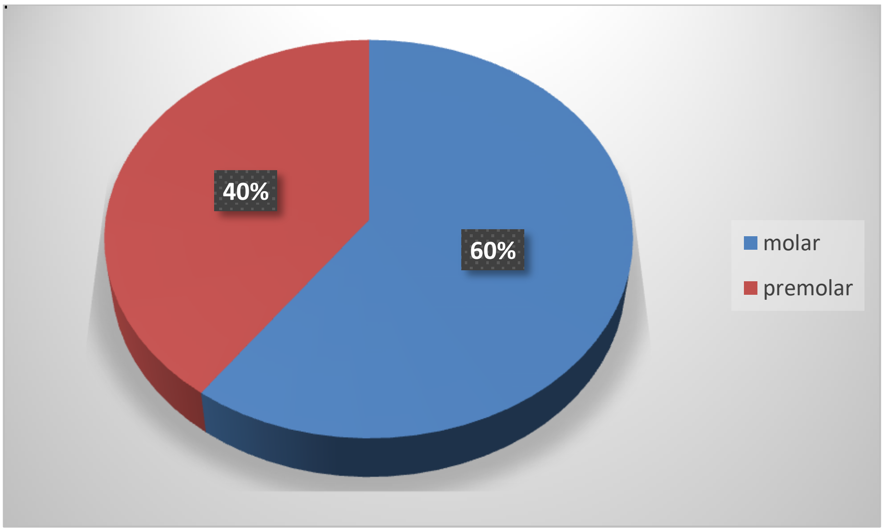

Figure 3.2: A pie chart illustrating the different teeth being extracted

3.2 Descriptive statistics and technique difference regarding the onset of the procedure

The mean values, SD, mean difference and t-test statistical analysis results regarding the onset of the procedure are represented in Table 3.1.

In Table 3.1 IANB technique showed higher mean values for the onset of the procedure (7.43) compared with infiltration technique (3.63) with a significant difference between the two techniques (p= 0.000).

Table 3.1 Descriptive statistics and technique difference regarding the onset of the procedure

Technique	Descriptive statistics (Min.)				Technique difference		
	N	Mean	S.D.	S.E.	Mean difference	t-test	p-value
Block	20	7.431	2.641	0.591	3.800	5.113	0.000 (HS)
Infiltration	20	3.631	2.018	0.451			

N: number, S.D.: standard deviation, S.E.: standard error

3.3 Frequency of repeating injection in both techniques

Table 3.2 shows the result of Frequency of repeating injection in both techniques. Significantly higher Frequency of repeating injection was recorded in infiltration technique (13) compared with IANB (5)(p = 0.011).

Table 3.2 Frequency of repeating injection in both techniques

Repeat	Once	Twice	Total
Block	15 (75%)	5 (25%)	20 (100%)
Infiltration	7 (35%)	13 (65%)	20 (100%)

p-value= 0.011 (S)

3.4 Number and Percentage of Frequency of pain sensation in both techniques

Table 3.3 shows the result of Frequency of pain sensation in both techniques. There was no significant difference between the two techniques (p=0.507).

Table 3.3 Number and Percentage of Frequency of pain sensation in both techniques

Pain	Present	Absent	Total
Block	12 (60%)	8 (40%)	20 (100%)
Infiltration	14 (70%)	6 (30%)	20 (100%)

p-value= 0.507 (NS)

3.5 Frequency of extraction completion in both techniques

Table 3.4 shows the result of Frequency of extraction completion in both techniques. IANB showed a significantly higher frequencies of extraction completion (19) than infiltration technique (13)(p=0.018).

Table 3.4 Frequency of extraction completion in both techniques

Completion	Yes	No	Total
Block	19 (95%)	1 (5%)	20 (100%)
Infiltration	13 (65%)	7 (35%)	20 (100%)

p-value= 0.018 (S)

Discussion

In recent study, local infiltration technique against IANB technique was investigated using a 1.8 ml of 2% lidocaine with 1:100,000 epinephrine for extraction of posterior teeth in the mandible. For this study, twenty non–vital posterior teeth were extracted in each technique, and the following topics is discussed:

1-Onset of anesthesia was measured in minutes showed that there was a highly significant difference in the onset of anesthesia between the two methods. The onset of anesthesia was faster in the infiltration technique which could be due to proximity of the nerve endings to the site of injection in infiltration technique. This was in accordance with Jung and colleagues **(Jung *et al*, 2008)**. However, **(Thiem *et al*, 2018)** reported that both techniques produced similar results. This could be due to using pressure syringe when injecting the anesthetic solution in infiltration technique.

2-For the Frequency of repeating injection, the result was significantly higher in infiltration technique than IANB technique. Due to the thickness of the cortical bone in this location **(Vassend O, 1993; Fagade *et al*., 2005)**. Similar result was reported by **Thiem *et al***. in 2018.

3-Frequency of extraction completion showed that IANB was significantly higher than infiltration technique. This could also be explained by the thick cortical bone in this area. However, Similar studies were not found therefore no comparison can be established.

Conclusion

1-The Onset of the procedure after infiltration anesthesia was quicker than IANB.

2-Frequency of the repeated injection was higher in infiltration anesthesia compared to IANB.

3- Extraction completion was higher in IANB compared with infiltration anesthesia

Although the onset of procedure after anesthesia was quicker in infiltration technique. The other two parameters (Frequency of repeating injection and frequency of extraction completion) were in favor of IANB, hence, we can consider that IANB technique is better than infiltration.

Reference

(A)

Aggarwal V, Singla M, Kabi D. Comparative evaluation ofanesthetic effcacy of GowGates mandibular conduction anesthesia, Vazirani-Akinosi technique, buccal-plus-lingual infltrations, and conventional inferior alveolar nerve anesthesiain patients with irreversible pulpitis. Oral Surg Oral Med OralPathol Oral Radiol Endod. 2010;109:303–8.

Akinosi JO. A new approach to the mandibular nerve block.Br J Oral Surg Oral Med Oral Pathol Oral Radiol Endod.1977;15:83.

Awad, Sally, and Samah I. Mourad. "Extraction of mandibular posterior teeth: Comparison between standard inferior alveolar nerve block and local infiltration anesthesia." Egyptian Dental Journal 66.1-January (Oral Surgery) (2020): 107-112.

(B)

Breeland, G., Aktar, A. and Patel, B.C. Anatomy, head and neck, mandible. In StatPearls [Internet]. StatPearls Publishing, 2021.

Bonanthaya, K., Panneerselvam E, et al., eds. Oral and Maxillofacial Surgery for the Clinician. Springer Singapore, 2021.

Becker, D.E. and Reed, K.L. Essentials of local anesthetic pharmacology. Anesthesia progress, 2006, 53(3), pp.98-109.

Boronat Lopez A, Penarrocha Diago M. Failure of locoregionalanesthesia in dental practice. Review of the literature. Med OralPatol Oral Cir Bucal. 2006;11:510-3.

Bennett RC: Monheim's local anesthesia and pain control indental practice. 6th Ed. St. Louis, C.V. Mosby Co. pp. 97-109,1978.

Bataineh AB, Alwarafi MA. Patient’s pain perception during mandibular molar extraction with articaine: a comparison study between infiltration and inferior alveolar nerve block. Clin Oral Investig. (2016) Nov; 20(8):2241- 2250.

Reference

(C)

Choi EH, Seo JY, Jung BY, Park W. Diplopia after inferior alveolar nerve block anesthesia: report of 2 cases and literature review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. (2009); 107(6):e21–e24.

Corbett IP, Kanaa MD, Whitworth JM, Meechan JG. Articaine infiltration for anesthesia of mandibular first molars. J Endod. (2008); 34(5):514–518.

Chitre, A. P. *Manual of Local Anaesthesia in Dentistry*. JP Medical Ltd, 2016.

(D)

Day, T.K. and Skarda, R.T. The pharmacology of local anesthetics. Veterinary Clinics of North America: Equine Practice, 1991, 7(3), pp.489-500.

Decloux, D. and Ouanounou, A., 2021. Local anaesthesia in dentistry: a review. International Dental Journal, 2021.

Davis MJ, Vogel LD. Local anesthetic safety in pediatric patients. N Y State Dent J. (1996); 62(2):32–35.

(E)

Eggleston, Steven T., and Lori W. Lush. "Understanding allergic reactions to local anesthetics." *Annals of Pharmacotherapy* 30.7-8 (1996): 851-857.

El-Kholey KE. Infiltration anesthesia for extraction of the mandibular molars. J Oral Maxillofac Surg. (2013); 71 (10):1658 e1651– 1655..

(F)

Reference

Fehrenbach MJ, Logothetis DD. Chapters: Anatomic Considerations. Mandibular Anesthesia. Editor: Logothetis DD,Local Anesthesia for the Dental Hygienist, ed 2, Elsevier, 2017.

Fehrenbach MJ, Herring SW. Illustrated anatomy of the head andneck, ed 5, Saunders/Elsevier, 2017.

Fehrenbach MJ, Herring SW: Anatomy of the head and neck, ed 3, St Louis, Saunders, 2007.

Foster W, Drum M, Reader A, Beck M. Anesthetic efficacy of buccal and lingual infiltrations of lidocaine following an inferior alveolar nerve block in mandibular posterior teeth. Anesth Prog. (2007); 54(4):163–169.

Fagade OO, Oginni FO. Intra-operative pain perception in tooth extraction—possible causes. Int Dent J. (2005); 55(4):242–246.

(G)

Giovannitti, J. A., Jr, Rosenberg, M. B., & Phero, J. C. Pharmacology of local anesthetics used in oral surgery. Oral and maxillofacial surgery clinics of North America, 2013, 25(3), 453–vi

(H)

Haas DA. Alternative mandibular nerve block techniques: areview of the Gow-Gates and Akinosi-Vazirani closed-mouthmandibular nerve block techniques. J Am Dent Assoc. 2011;142(Suppl 3): 8-12.

Hisham Khalil A basic review on the inferior alveolar nerveAnesth Essays Res. 2014 Jan-Apr; 8(1): 3–8.

Hussein R, Muhammad D, Omar O. Comparison between infiltration and inferior alveolar nerve block anesthesia in extraction of non-vital mandibular posterior teeth (prospective clinical study) 2014.

Reference

Hawkins, J. M., & Moore, P. A. . Local anesthesia: advances in agents and techniques. Dental Clinics of North America, 2002, 46(4), 719732.

Hernández-Cortez, E., Larios, C.G.S. and Flores-Carrillo, J.C.,. Local Anesthetics in Odontology. In Topics in Local Anesthetics. IntechOpen 2020.

Hinkley SA, Reader A, Beck M, Meyers WJ. An evaluation of 4% prilocaine with 1:200,000 epinephrine and 2% Mepivacaine with 1:20,000 levonordefrin compared with 2% lidocaine with:100, 000 epinephrine for inferior alveolar nerve block. Anesth Prog. (1991); 38(3):84–89.

Haas D. Alternative mandibular nerve block techniques.JAMA. 2011;142:8S

(J)

Jung IY, Kim JH, Kim ES, Lee CY, Lee SJ. An evaluation of buccal infiltrations and inferior alveolar nerve blocks in pulpal anesthesia for mandibular first molars. J Endod. (2008); 34(1):11–13.

John, R. R. Local Anesthesia in Oral and MaxillofacialSurgery. In *Oral and Maxillofacial Surgery for the Clinician* (pp.61-77). Springer, Singapore, 2021.

(K)

Kaufman E, Epstein JB, Naveh E, Gorsky M, Gross A, Cohen G. A survey of pain, pressure, and discomfort induced by commonly used oral local anesthesia injections. Anesth Prog. (2005);52(4):122–127.

Kämmerer PW, Palarie V, Daublander M, Bicer C, Shabazfar N, BrullmannD, Al-Nawas B. Comparison of 4% articaine with epinephrine (1:100,000) and without epinephrine in inferior alveolar block for tooth extraction: double-blind randomized clinical trial of anesthetic efficacy. Oral Surg Oral Med Oral Radiol. (2012);113(4):495–499.

(L)

Reference

Lipski M, Tomaszewska IM, Lipska W, Lis GJ, Tomaszewski KA. The mandible and its foramen: anatomy, anthropology, embryology and resulting clinical implications. Folia Morphol (Warsz). 2013 Nov;72(4):285-92. [PubMed]

Logothetis, Demetra D. *Local anesthesia for the dental hygienist*. Elsevier Health Sciences, 2016.

(M)

Meechan, John G. "Infiltration anesthesia in the mandible." *Dental Clinics* 54.4 (2010): 621-629.. "Infiltration anesthesia in the mandible." *Dental Clinics* 54.4 (2010): 621-629.

Meechan, J.G.,. The use of the mandibular infiltration anesthetic technique in adults. The Journal of the American Dental Association, 2011, 142, pp.19S-24S.

Malamed, S.F.,. Handbook of local anesthesia-e-book. Elsevier Health Sciences, 2014.

Malamed S: Handbook of local anesthesia,ed 5, St Louis, 2004, Mosby

Malamed SF. Handbook of local anesthesia, vol 4. Mosby, St. Louis.

Moore PA, Hersh EV. Local anesthetics: pharmacology and toxicity. Dental Clinics. 2010 Oct 1;54(4):587-99

Meechan, JG: Infiltration anesthesia in the mandible. Dent ClinN Am. 54, 2010, 621–629

Malamed, SF: The periodontal ligament (PDL) injection: analternative to inferior alveolar nerve block. Oral Surg. 53, 1982,117-121.

Reference

Malamed S. Handbook of local anesthesia, ed 6, St Louis, Mosby/Elsevier, 2013.

(N)

Nathe CN, "Local Anesthesia in Dental Hygiene Practice: An Introduction." *Local Anesthesia for the Dental Hygienist-E-Book* (2016): 2

(O)

Oulis, C.J., Vadiakas, G.P. and Vasilopoulou, A.,. The effectiveness of mandibular infiltration compared to mandibular block anesthesia in treating primary molars in children. Pediatric dentistry, 1996, 18, pp.301-305.

Ogle, O.E. and Mahjoubi, G.,. Local anesthesia: agents, techniques, and complications. Dental Clinics of North America, 2012, 56(1), pp.133-48.

(R)

Rathi, N.V., Khatri, A.A., Agrawal, A.G., Thosar, N.R. and Deolia, S.G.,. Anesthetic efficacy of buccal infiltration articaine versus lidocaine for extraction of primary molar teeth. *Anesthesia Progress*, 2019, *66*(1), pp.3-7.

Rodella, L.F., Buffoli, B., Labanca, M. and Rezzani, R.,. A review of the mandibular and maxillary nerve supplies and their clinical relevance. Archives of oral biology, 2012, 57(4), pp.323-334.

Ring M. E. (2007). The history of local anesthesia. Journal of the California Dental Association, 35(4), 275–282

(S)

Reference

Saka B, Wree A, Henkel KO, Anders L, Gundlach KK. Blood supply of the mandibular cortex: an experimental study in Göttingen minipigs with special reference to the condyle. J Craniomaxillofac Surg. 2002 Feb;30(1):41-5. [PubMed]

Shabazfar N, Daublander M, Al-Nawas B, Kämmerer PW. Periodontal intraligament injection as alternative to inferior alveolar nerve block—meta-analysis of the literature from 1979 to 2012. Clin Oral Investig. (2014); 18(2):351–358.

Steinkruger G, Nusstein J, Reader A, BeckM, Weaver J. The significance of needle bevel orientation in achieving a successful inferior alveolar nerve block. JAmDent Assoc. (2006); 137(12):1685–1691.

SF.M. Handbook of local anesthesia, vol 4, 4th edn. Esevier Mosby, St. Louis, 2004.

Sillanpaa M, Vuori V, Lehtinen R . The myelohyoid nerveand mandibular anesthesia. Int J Oral Maxillofac Surg , 1988, 17:206–207.

Sutton RN. The practical significance of mandibular accessory foramina. Aust Dent J 1994; 19:167-73.

(T)

Thiem DG, Schnaith F, Van Aken CM, Köntges A, Kumar VV, Al-Nawas B, Kämmerer PW. Extraction of mandibular premolars and molars: comparison between local infiltration via pressure syringe and inferior alveolar nerve block anesthesia. Clinical Oral Investigations. 2018 Apr;22(3):1523-30.

(V)

Vassend O. Anxiety, pain and discomfort associated with dental treatment. Behav Res Ther. (1993); 31(7):659–666.

(Z)

Zanco Journal of Medical Sciences. (2015); 18(3):822–825.