VILNIUS UNIVERISTY

FACULTY OF MEDICINE

INSTITUTE OF DENTISTRY

Armita Mahinrad

V course, II group

Master‘s Thesis

Complications and Techniques of Local Anesthesia in Oral and Maxillofacial Surgery

Scientific Supervisor: Dr. Assist. Alina Čebatariūnienė

Vilnius

2023

Abstract

Pain is an unpleasant psychological and sensory experience arising from actual or potential tissue damage and is frequently related to dental treatment. Local anesthesia is an effective and safe way of managing pain; however, it can cause adverse effects that clinicians must be aware of. The following master's thesis focuses on the most common complications and techniques of local anesthesia in dental, oral, and maxillofacial surgery. These complications include hematoma, edema, trismus, paresthesia, facial blanching, facial nerve paralysis, ophthalmologic complications, infection, needle fracture, and tissue necrosis. The most common maxillary, mandibular, and supplemental injection techniques used in oral and maxillofacial surgery are overviewed in this literature review. The thesis also briefly concentrates on the significance of a thorough evaluation of the patient's medical history to recognize all the potential risk factors before the local anesthesia injection. The importance of proper knowledge of anatomy and materials; as well as the correct choice of the local anesthetic formulation and technique according to the preoperative evaluation of the patient and the procedure has been explained. Although most of these complications are rare, the performance of proper guidelines by the clinician can significantly reduce the incidence of various adverse effects. Lastly, the importance of preventive measurements and management of complications associated with administering local anesthesia are described in this paper.

Keywords: local anesthesia; complications; dental; dental anesthesia; techniques for dental anesthesia; maxillofacial surgery.

Table of Contents

Introduction

Local anesthesia is the most significant pain management method in oral and maxillofacial surgery. Local anesthesia is defined as a temporary block of the nerve impulse, preventing the nerve from carrying impulses to the brain, without any effect on consciousness. Effective and safe local anesthesia not only allows the achievement of high-quality treatment but in addition, reduces patients' anxiety during dental procedures (1). Furthermore, painless surgery under local anesthesia is essential due to the release of endogenous catecholamines as a consequence of excessive pain during dental treatment, which can alter the hemodynamic status such as increased blood pressure, heart rate, and dysrhythmias (2).

The choices of local anesthetic and injection techniques determine the success rate of local anesthesia to a considerable degree. Local anesthetics in oral and maxillofacial surgery can be mostly separated into amides and esters. However, esters have been progressively abandoned in dental therapy because of their allergenicity. The fundamental principle for developing local anesthetics is that drugs need to be effective and non-toxic. Currently, in the majority of countries or regions, standard local anesthetics used in oral and maxillofacial surgery are part of the amide group (Articaine, Dibucaine, Bupivacaine, Lidocaine, Mepivacaine, Prilocaine) and are injected mostly through a block or infiltration anesthesia. Moreover, the operators' technique level, the patient's subjective psychology, and the anatomical variation of maxillofacial structure also have a significant effect on local anesthesia in dental practice (1).

However, even though local anesthetics are considered safe and efficient drugs, they have risks that practitioners must be aware of. Recognizing and understanding the risks involved with local anesthesia reduces the chances of the occurrence of adverse events and essentially results in improved patient care (3). Nonetheless, even the most experienced practitioner can face complications. Unfortunately, there are not many published guidelines for clinicians which concentrate on the prevention and management of the possible adverse effects of local anesthesia in dentistry, and a very limited number of scientific articles and reports focusing on the complications of local anesthetic injections in dentistry, oral, and maxillofacial surgery fields (4).

This literature review will mainly focus on the most commonly used local anesthetic techniques in dentistry, oral, and maxillofacial surgery; as well as possible complications associated with local anesthesia.

Complications related to local anesthetics can be evaluated locally and systemically. Common systemic reactions because of local anesthesia are described as psychogenic reactions, methemoglobinemia, systemic toxicity, and allergy. Common local complications related to local anesthesia are needle fracture, prolongation of anesthesia, pain at injection, various sensory disorders, lack of effect, hematoma, gingival lesions, soft tissue injury, trismus, infection, edema, and ophthalmologic complications (5).

Firstly, the literature review will focus on a selection of the local anesthesia in dentistry and the main local anesthesia techniques which are used in oral and maxillofacial surgery and later, on complications that are associated with them such as edema, hematoma, trismus, facial blanching, facial nerve paralysis, paresthesia, ocular complications, infection after anesthetic injection, needle fracture, and tissue necrosis.

Objectives

The purpose of this literature review is to accomplish the following objectives:

- To find out the criteria for the selection of local anesthetics,
- To describe the main local anesthesia techniques,
- To analyze the association between local anesthesia techniques and possible complications in oral and maxillofacial surgery,
- To describe preventive measurements, clinical manifestation, and management of each possible complication.

Methodology

The four electronic databases were selected for the literature review including PubMed, ClinicalKey, ScienceDirect, and ResearchGate. Only studies published in English between 2010 and 2023 were selected for the analysis. Next, the research was conducted, using relevant keywords such as “local anesthesia, complications, dental, dental anesthesia,

techniques for dental anesthesia, maxillofacial surgery, etc.". Lastly, 45 references were selected in this literature review.

Structure

The thesis consists of an introduction, following the main objectives and methodology. In the main part of the master's thesis, the selection of local anesthesia according to the time for which pain management is required, postoperative pain control necessity, and the need for hemostasis have been discussed. Furthermore, the most frequently used maxillary, mandibular, and supplemental injection techniques have been described. The local anesthesia complications such as hematoma, edema, trismus, paresthesia, facial blanching, facial nerve paralysis, ophthalmologic complications, infection, needle fracture, and tissue necrosis are discussed in detail including their preventive measurements and management. Additionally, five clinical case figures will be included in the literature review. Lastly, a summary of reviewed studies has been concluded.

Selection of Local Anesthesia

Several factors need to be considered when selecting an appropriate local anesthetic. Firstly, the time for which pain control (pulpal and/or soft tissue) is necessary, needs to be considered; secondly, the necessity for posttreatment pain control needs to be taken into account; thirdly, the need for hemostasis; and lastly, any existent contraindications of the selected local anesthetic. Because of the many available combinations of injectable local anesthetics, the selection of an ideal drug sometimes becomes difficult for any given patient. Most of the time, dentists use one local anesthetic formulation in dental practices for all procedures, regardless of their duration. For instance, the dentist may select the use of 2% lidocaine with epinephrine 1:100,000 for procedures lasting 5 to 10 minutes and for procedures requiring 90 minutes of treatment. Even though the duration of pulpal anesthesia is accomplishable with this drug in ideal conditions and may provide pain-free treatment in both situations, the patient who requires only 10 minutes of pulpal anesthesia will be unnecessarily anesthetized for an additional 3 to 5 hours. In contrast, the patient requiring 90 minutes of pulpal anesthesia may have pain close to the end of the procedure (6).

A second consideration choosing a local anesthetic selection is the need for postoperative pain control. A long-duration local anesthetic can be administered if postoperative pain is considered to be a factor. For instance, for nontraumatic procedures, in which a shorter duration of soft tissue anesthesia is required, 3% mepivacaine can be used. When postoperative pain control needs to be taken into consideration, 0.5% bupivacaine is recommended, to be able to anesthetize the soft tissues for 8 to 12 hours. For patients with a potential risk of self-inflicted soft tissue injury, a short-duration anesthetic must be considered. These patients include physically or mentally disabled patients, younger children, >85 years old patients, and patients with type 1 diabetes, unable to miss a meal. For these patients, 3% mepivacaine is suggested for use in short procedures; nevertheless, if a more profound and/or longer duration of pulpal anesthesia is required, the use of a local anesthetic containing a vasoconstrictor is essential (6).

The third factor in the selection of a local anesthetic is the requirement for hemostasis during the procedure. Epinephrine is significantly efficient at reducing blood loss during dental surgical procedures. Therefore, anesthetic solutions with an epinephrine concentration of 1:50,000 or 1:100,000 are suggested (6).

A fourth factor in selecting a local anesthetic is the presence of any contraindications. Absolute contraindications require that the unfavorable drug not be administered to the patient in any circumstances. For instance, when a patient has a documented, and reproducible allergy to the local anesthetic agent. In cases of relative contraindication, it is recommended to avoid administering a questionable drug at the risk of an increased adverse reaction. An alternative drug that is not contraindicated needs to be taken into consideration. Nevertheless, if a suitable alternative is unavailable, the questionable drug may be used with the minimum dose to provide adequate pain management. Patient consent is needed before the administration of the anesthetic. Risks and benefits that correlate with the use of questionable drugs need to be considered (6).

Maxillary Anesthetic Techniques

In the upper jaw, the cortical plate of bone overlying the teeth is typically thin, allowing the use of infiltration anesthesia. Infiltration is the most prevalent dental injection and is

indicated when a single maxillary tooth is treated. In situations, where several maxillary teeth are being treated, nerve blocks such as the posterior superior alveolar nerve block and anterior superior alveolar nerve block may be administered. These techniques will be discussed further in more detail (7, 8).

Supraperiosteal Injection

The infiltration or supraperiosteal technique is performed to anesthetize teeth and the surrounding soft tissue adjacent to the injection site. The infiltration technique is the most frequently used technique for obtaining pulpal anesthesia. The most common complications associated with this technique include hematoma, trismus, allergic, and toxic reactions (8).

Infiltration anesthesia is typically indicated for pulpal anesthesia of the maxillary teeth when the treatment is restricted to one or two teeth. Likewise, it is suitable for soft tissue anesthesia for surgical procedures in a defined area. Contraindications with the use of infiltration technique include the presence of infection or acute inflammation in the injection area, as well as dense bone which may cover the teeth apices. Dense bone covering the teeth' apex is most likely to be present in the first permanent maxillary molars in children (6).

In this anesthesia method, the patient is requested to open his/her mouth partially and the syringe is kept parallel to the long axis of the tooth. The needle is injected in the mucobuccal fold above the apex of the tooth and advanced until it contacts the bone. Then withdrawn slightly, the solution is deposited approximately 1,0-1,5 ml. In the case of the palatal infiltration technique, the needle is inserted on the palatal side of the tooth, between the gingival margin and the median palatine raphe along the long axis of the tooth (8).

In order to avoid any possible complication associated with the infiltration technique, a small quantity of solution needs to be slowly injected to prevent ulceration or pain (8). As previously mentioned, the infiltration technique is favored and recommended for procedures limited to the treatment of one or two teeth (9). As a result, it is not recommended for larger areas because of multiple needle insertions and administration of larger amounts of anesthetic solution (6).

Anterior Superior Alveolar Nerve Block

The anterior superior alveolar (ASA) nerve block will anesthetize the periodontal ligament, periosteum, buccal soft tissue, alveolar bone, and teeth from the canine to the midline. The penetration depth is around 16 mm in the mucobuccal fold above the maxillary first premolar. Around 1.0 ml of anesthetic solution is slowly deposited. Crossover innervation must always be taken into account in case of insufficient anesthesia near the midline (10). This anesthetic technique is not so commonly used due to the potential injury to the patient's eye (6).

Indications for the ASA nerve block include procedures involving more than two maxillary anterior teeth and the buccal tissues overlying them. If there is any presence of inflammation or acute infection where the infiltration technique is contraindicated, an ASA nerve block may be used as an alternative. In cases, where a patient has a dense cortical bone and supraperiosteal anesthetic injection is unsuccessful. ASA nerve block can be considered as an alternative (6).

Posterior Superior Alveolar Nerve Block

The posterior superior alveolar (PSA) nerve block is a dental nerve block intended for profound anesthesia of the maxillary molars. Due to its frequent complications, complex technique, nonreliable landmarks, and variation in depth of insertion, the PSA nerve block is rarely performed in dentistry practice. Complications arising from the posterior superior alveolar nerve block include hematoma formation due to trauma to the pterygoid plexus of veins, trismus resulting from trauma to the lateral and medial pterygoid muscles, blurred vision, transient diplopia, and temporary blindness (11). Ghosh et al., have stated that ophthalmic complications following a posterior superior alveolar nerve block can be due to vascular causes or diffusion through bony channels (12). Additionally, a very rare complication of Bell's palsy can also develop due to improper placement of the needle into the inferior part of the parotid gland causing trauma of the cervicofacial division of the facial nerve (13). Consequently, many dentists prefer the infiltration technique for anesthetizing the maxillary molars rather than the posterior superior alveolar nerve block (11). Mostly in cases where inadequate anesthesia is achieved through the supraperiosteal technique, the posterior superior alveolar nerve block can be used to obtain more profound anesthesia of prolonged duration (2).

The posterior superior alveolar nerve block targets the posterior superior nerve in the infratemporal fossa. It is achieved by the deposition of the anesthetic agent along the posterior surface of the maxilla. The needle has to be advanced medially, superiorly, and posteriorly at a 45-degree angle to the maxillary occlusal plane in order to reach the infratemporal fossa (13).

The posterior superior alveolar nerve block is indicated for the dental procedure that involves the treatment of two or more maxillary molars. Additionally, when supraperiosteal injection is ineffective or is contraindicated due to inflammation or infection (6).

On the other hand, in patients with a high risk of hemorrhage as in the case of hemophiliacs, or patients taking drugs such as coumadin or clopidogrel that can increase bleeding, PSA nerve block is contraindicated. Supraperiosteal or periodontal ligament (PDL) injection may be used as an alternative to PSA nerve block (6).

Mandibular Anesthetic Techniques

The adult mandible represents a different situation compared to the maxilla. The cortical plate of bone overlying the mandibular teeth is typically pretty dense, disallowing the infiltration injection to be fully effective. Nerve block administration is considered the most common and standard anesthetic technique treating mandibular teeth, providing anesthesia to all eight teeth in the quadrant. The incisive nerve block may be performed when treating teeth anterior to the mental foramen such as incisors, canine, and premolars. Other techniques include the PDL injection, Gow-Gates mandibular nerve block, Akinosi– Vazirani (closed mouth) nerve block, and intraosseous (7).

Inferior Alveolar Nerve Block

The inferior alveolar nerve block (IANB) is one of the most widely used techniques in the dentistry field. Unfortunately, even when properly administrated it has the greatest percentage of failure. The IANB anesthetizes the inferior alveolar nerve (a branch of the mandibular division of the trigeminal nerve), incisive nerve, mental nerve, and commonly, however, not always the lingual nerve of the injected side. This block affects the sensation of all the teeth on one side of the mandible, which is anesthetized, the inferior portion of the bone of the ramus to the midline, periosteum of the mandible, and the lingual soft tissue, as

well as buccal soft tissues anterior to the mental foramen, anterior 2/3 of the tongue and in addition, the floor of the oral cavity (8).

In this technique, the patient is seated in a semi-supine or supine position. The index of the free hand is placed on the mucobuccal fold opposite to the premolar area. Then the clinician establishes the external oblique ridge and the anterior border of the ramus. The greatest depth of the anterior border of the ramus which is the coronoid notch is located retracting the soft tissues. The insertion point of the needle is about 6 to 10 mm above the occlusal plane and at 3/4 of the anterior-posterior distance from the coronoid notch to the pterygomandibular raphe. The syringe is advanced from across the lower premolar teeth of the opposite side's lower premolar teeth, parallel with the mandibular occlusal plane. A long dental needle is used; the needle is inserted about 25mm of the 35 mm into the tissue until the bone is contacted. After touching the bone, the needle is withdrawn slightly, aspiration is performed, and around 1.5 to 1.8 ml of solution is deposited over a minimum time of one minute (5).

There are various techniques for performing an inferior alveolar nerve block and they are as follows. First, the Halstead method, in which the nerve is blocked as it penetrates the mandibular foramen. The success rate of this technique is between 71% and 87%. However, in this technique, the solution is not deposited high enough to anesthetize the buccal nerve, and an additional injection may be required for the buccal nerve (14).

Second, the Akinosi technique, in which a higher level of injection is performed and anesthetizes the inferior alveolar nerve, the buccal nerve, and the lingual nerve, by a single injection. This technique is very advantageous in patients with limited jaw opening, especially in patients with trismus from infection, or in anxious patients who would not open their mouth to allow the use of the standard Halstead technique. According to research, the success rate of the Akinosi technique is 96% (14).

Thirdly, in the Gow-Gates technique, external landmarks are used that direct the needle to a higher puncture point, therefore guaranteeing a sufficient height for the deposition of the solution above the lingula. The success rate of the Gow-Gates technique is reported to be 98% (14).

As I previously mentioned, even though IANB is commonly used, it can still have some complications, such as muscle trismus, hematoma, allergic reactions, infection, needle

breakage, numbness of the auricle or ear lobe, and facial nerve paralysis if the needle is inserted too low. Additionally, paresthesia, dysesthesia, and paralysis of the lingual nerve have also been reported. Infrequently occurring complications involve ophthalmologic complications, extraocular muscle paralysis, ptosis, diplopia, necrosis of the skin over the chin, and abducens nerve palsy. I will discuss some of the main complications caused by IANB including their prevention and management in more detail (15).

Supplemental Injection Techniques

Intraligament Injection Technique - Periodontal Ligament Injection

Intraligamentary anesthesia (ILA) is frequently used as it is effective and easy to carry out. Therefore, it is favored in treatment procedures involving the mandible. On the other hand, the PDL injection is primarily used when conventional anesthesia is not fully efficient, when only a short duration of anesthetic is required, and when a patient wants to avoid numbness of the lip and tongue associated with mandibular block injections. The anesthetic solution is injected manually using pressure syringes or by a computer-controlled device into the periodontal tissue of the tooth (16).

In this technique, the dentist inserts the tip of the needle into the periodontal ligament between the alveolar bone and the root surface. The needle is inserted at an angle of 30-40 degrees concerning the long axis of the tooth. The anesthetic solution should therefore reach a subgingival depth of approximately 2 to 3 mm. Single-rooted teeth should be anesthetized with two injections, and for multi-rooted teeth, one injection per root is needed to achieve efficient anesthesia (17).

A correctly performed ILA implies various advantages: the onset of action is immediate; the mean duration of 30–45 minutes allows the performance of most routine dental treatments; the total amount of anesthetic solution (including vasoconstrictor) and the injection pain are both significantly reduced compared to inferior alveolar nerve block (16). Restrictions such as eating, speaking, and drinking do not imply to patients following the intraligament injection after dental treatment. Meanwhile, this technique prevents postoperative burn or bite injuries that result from prolonged sensitivity loss after major or potent anesthetic techniques like posterior superior nerve block and inferior alveolar nerve block (17). Additionally, the localized anesthetic effect of intraligament anesthesia enables the treatment in different areas;

for instance, right and left mandibular molars in the same appointment. Considering the fact that the onset of the anesthetic effect is achieved almost instantly after administration, there is no latent period between the anesthesia and treatment, like in the case of the inferior alveolar nerve block. Moreover, in contrast to the inferior alveolar nerve block, there is no risk of nerve injuries by intraligamentary injections (18). Due to these characteristics, intraligamentary anesthesia is more favorable, particularly in the treatment of multimorbid "high-risk patients", such as patients with anticoagulation or cardiovascular disease (19).

Nevertheless, despite all the advantages of ILA, there are still some contraindications that must be considered. For instance, Rahn et al. discovered a potentially high incidence of bacteremia of 61% in patients treated with intraligament anesthesia. They could considerably reduce this rate with a preoperative chlorhexidine mouthwash for 30 seconds. Nonetheless, intraligament anesthesia still presents as a hazardous approach for immunosuppressed patients and patients with the risk of Endocarditis. Furthermore, in patients with profound marginal periodontitis or teeth with a sclerotic periodontal gap, the benefits of intaligament injection technique are reduced, and inferior alveolar nerve block as an alternative technique is recommended (19).

To summarize, ILA can be considered as effective as inferior alveolar nerve block and supraperiosteal anesthesia. Various research has demonstrated the feasibility of intraligament anesthesia for most dental routine treatments, while in addition, the patients benefit from the advantages mentioned above of this anesthetic technique (16).

Buccal Nerve Block

The buccal nerve block is the nerve block commonly performed after the inferior alveolar nerve block for specific procedures, such as the extraction of mandibular molar teeth. The long buccal nerve is a branch of the mandibular nerve which supplies sensory information to areas of the face and mouth, specifically the cheeks and the gum areas near the second and third molars. In dental practice, it is indicated for procedures involving the mucosa adjacent to the posterior molar teeth, such as the placement of a rubber dam clamp and extraction of the wisdom teeth. In addition, administration of anesthesia to the buccal nerve can help patients undergo a pain-free dental visit when treatment needs to be done on their teeth (6).

The site of injection is distal and buccal to the wisdom tooth, with the needle penetrating 1-2 mm as the nerve lies directly below the mucosa. The buccal nerve block can be painful except if it is given after the inferior alveolar nerve block. Considering this is most frequently the case, a 25-long needle is recommended. However, a short needle may be used as well. A few drops of anesthetic need to be deposited just before contact to avoid patient pain (6).

Complications reported in the literature following the administration of the buccal nerve block include hematoma formation, which is clinically observed as a bluish discoloration and swelling of the tissues at the injection site. Moreover, blood can exit the needle injection site into the buccal vestibule. To manage and treat that, a clinician must apply pressure with a sterile gauze directly to the area where it bleeds for at least three minutes (6).

Local Anesthesia Complications

Hematoma

Hematoma is one of the less prevalent complications which occur following local anesthesia (20). Hematoma formation as an adverse effect of local anesthesia is the consequence of venous or arterial laceration; intra-arterial blood pressure elevates, causing effusion of blood into the neighboring soft tissues. Therefore, if there is a high pressure while injecting, it may be a warning to inject against the bloodstream. The hematoma's size is dependent on the compactness and density of the affected tissue; once a vein rupture is involved, a hematoma does not necessarily occur (21, 5). A hematoma developing as a consequence of the rupture of an artery typically enhances rapidly in size until treatment is performed, due to considerably greater blood pressure within the artery. Comparatively, in the areas of the hard palate where the density of the tissue is much greater, the hematoma develops very infrequently (22).

From the anatomical perspective, various nerve effects cause hematoma in particular regions such as mental nerve block located at the chin area, buccal nerve block, palatal injections within the mouth, anterior superior alveolar nerve block below the lower eyelid, and posterior superior alveolar nerve block extraoral in the lower buccal region of the mandible, intraoral distal to the maxillary tuberosity (5). In addition, the posterior superior alveolar nerve block and inferior alveolar nerve block are recognized as being associated with a higher incidence

of positive aspiration in comparison to all infiltration and block anesthesia techniques in oral surgery (20).

Clinically, hematomas that are formed after the inferior alveolar nerve block are usually only visible intraorally, whereas the hematomas after the posterior superior alveolar nerve block are visible extraorally (Figure 1) (22, 6).

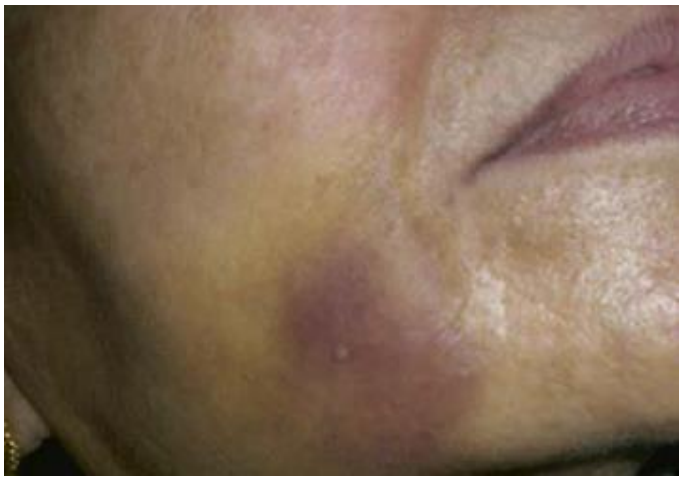


Figure 1. Hematoma developed extraorally after posterior superior alveolar nerve block. Adapted from (6).

The formation of hematoma can be prevented by aspirating before injecting the anesthetic solution. In order to avoid damaging the walls of the blood vessels, even more, the number of needle penetrations into tissues needs to be minimized. Using a short needle for the posterior superior alveolar nerve block can as well decrease the risk of hematoma formation. In the event of instant swelling after injection, localized pressure must be applied for at least 2 minutes to stop the hemorrhage (5).

Hematoma infrequently may lead to any significant problems. However, there is a bruise resulting intraorally, and typically nothing is visible extraorally. Possible complications may include pain and trismus (22). The patient must be informed about the possible soreness and limitations in the movement. The clinician needs to advise the patient to take analgesics such as aspirin or another nonsteroidal anti-inflammatory drug in case soreness develops. Both discoloration and swelling usually disappear in 10 to 15 days. Ice packs should be applied for the first 24 hours after surgery following intermittent hot moist packs that need to be used to resolve the condition, as well as massage therapy with an application of heparin cream. It is

very important to inform the patient that heat application needs to be postponed to at least 4 to 6 hours after the incident. Application of heat produces vasodilation which may promote an increase in the size of the hematoma if applied too early. In cases of large hematoma, antibiotics should be prescribed to prevent the development and progression of wound infection (5, 6).

Edema

Swelling of tissues can result from trauma during injection, hemorrhage, infection, allergy, and injection of irritating solutions (4).

Edema due to local anesthesia complications results in dysfunction of the region and pain. Angioneurotic edema produced by a topical anesthetic in an allergic patient, even though being particularly rare, can compromise the airway. Edema of the larynx, pharynx, or tongue may develop and is a potentially endangering and life-threatening condition that requires immediate management (6).

In order to prevent complications such as edema, clinicians must use an atraumatic injection technique when administering the local anesthetic, proper care needs to be taken of the local anesthetic armamentarium. A complete medical evaluation of the patient before any drug administration needs to be taken (6).

The management of edema is dependent on the causing factor. The treatment of allergy-induced edema consists of intramuscular epinephrine injection and, moreover, administration of corticosteroids and antihistamines, and consultation with an allergist to identify the exact cause of the edema. The management of trauma-induced edema should be as a hematoma. For the management of edema produced by infection, antibiotics must be prescribed (4, 6).

Trismus

One of the most common complications of local anesthesia is trismus, in other words, limited mouth opening (23). Trismus is described as a painful event with an inability to open the mouth normally (5). It is indicated that normal jaw opening is greater than 30 to 40 mm. In trismus cases, a mouth opening is defined as less than 40 mm; others have described it as an opening of 15 to 30 mm, or even less than 20mm (24).

Trismus is caused by a variety of factors such as several injections in the same area in a short time, trauma to muscles (either the temporal muscle or the lateral pterygoid muscle) which cause fibrosis and hematoma formation, or intramuscular injections inside the muscle, fracture of the needle in the muscles during insertion to styloid process, imprecise and inaccurate positioning of the needle when performing maxillary posterior injections or the inferior nerve block, inflammation of the masseter and other masticatory muscles, a low-grade infection, and an excessive amount of local anesthetic solution injected into a bounded region which leads to expansion of tissues (5).

The most common muscle to be the cause of trismus is the medial pterygoid, which may be penetrated while performing an inferior alveolar nerve block (14). In the acute phase, pain from hemorrhage causes muscle contraction and limitation of motion (5). Trismus progression to chronic hypomobility and fibrous ankylosis may be prevented by the early initiation of treatment involving heat therapy – which involves placement of a moist or hot towel at the site for about 20 minutes every hour and progressively opening and closing the mouth as means of physiotherapy (23). The jaws must be stressed, however, when treating this condition, it is essential to avoid rapid motion or the use of significant forces. Force and rapid motion may exacerbate the injury and increase the reflex that causes muscle contractions; therefore, subsequent stretching of connective tissue is difficult or even impossible. The main purpose of therapy is to gradually and gently get the jaw functioning early to avoid fibrosis, which would make the condition complicated to reverse. Passive motion applied several times per day is considerably more effective than static stretching in decreasing inflammation and pain (14). Soft diet, analgesics, anti-inflammatory drugs, antibiotics prescription, and muscle relaxants are also indicated as an early initiation therapy (23). Antibiotic therapy is needed in cases when trismus is caused by an infection. Typically, trismus resolves in 6 weeks, ranging from 4 to 20 weeks (5).

A practitioner needs to be aware of the muscles and anatomical landmarks: palpation of bony anterior ramus for temporalis muscle, pterygomandibular fold for pterygoid muscle, and appropriate angulation of the needle and bone contact before injecting are useful approaches in the prevention of trismus as a result of local anesthesia (5). In patients with a history of trismus, the Akinosi-Vazirani technique can be applied as an alternative to the conventional

IANB technique. In the Akinosi-Vazirani technique, the patient's mouth remains closed, and the practitioner aims to inject the local anesthetic solution into the pterygomandibular space. The technique is indicated for all forms of dentistry performed in the mandibular arch, but it is especially favorable when the patient has a history of IANB failure as a consequence of anatomical variations or accessory innervation. Dentists can improve their performance skills by incorporating alternative anesthetic techniques which enhance dentists' ability to provide successful local anesthesia regularly for all procedures in mandibular teeth (25).

Paresthesia

Another possible complication of local anesthetic administration is 'paresthesia', described as a neuropathy with altered sensations and persistent anesthesia beyond the expected duration of anesthesia. No treatment is still available to overcome this condition (26). Furthermore, the definition of paresthesia must include dysesthesia and hyperesthesia, in which the patient experiences both numbness and pain. Trauma to any nerve may result in paresthesia. Paresthesia is not a rare complication of oral surgical procedures and mandibular dental implants. However, the prevalence of paresthesia related to local anesthetic administration is quite low (7). Paresthesia or neuralgia complication is mostly temporary, however, may also be permanent if the anesthetic solution is injected directly into the nerve. This mainly involves mandibular nerve following the inferior alveolar nerve block or lingual nerve. The nerve may be injured during injection by direct injury, or the intraneural blood supply may get damaged by the needle, resulting in a hematoma, or the medial pterygoid muscle may get traumatized by the needle, causing trismus (5). Clinical reactions of patients can be varied and profuse, including sensations of numbness, tingling, itching, and swelling. Associated oral dysfunction, such as drooling, tongue biting, loss of taste, and speech impediment, may be observed. Direct trauma to the lingual nerve following the inferior alveolar nerve block technique is considered to be the most prevalent etiology of paresthesia. A "zap" or "electric shock" is experienced by the patient in the course of the injection (7, 27).

Pogrel has reported that the prevalence of paresthesia after inferior alveolar nerve block is as low as 1:850,000 and as high as 1:20,000. Others have stated the prevalence to be in the range of 0.15% to 0.54% for temporary paresthesia and a range of 0.0001% to 0.01% for permanent paresthesia (3).

According to Pogrel and Thamby, a higher occurrence rate of paresthesia with the lingual nerve (79%) than with the inferior alveolar nerve (21%) was recorded. The investigators estimated that since the mouth is open wide and the lingual nerve is more taut; it makes the nerve more immobile in the tissue and therefore unable to be deflected by the needle (3).

Several authors have stated that paresthesia can also result after local anesthesia in non-surgical dentistry. The mechanism underlying non-surgical paresthesia is unknown. Various hypotheses have been proposed to describe and explain the relationship between paresthesia and local anesthetics: firstly, penetration of the needle which causes direct trauma; secondly, nerve compression caused by perineural edema after the injection; thirdly, hemorrhagic damage; and lastly, neurotoxicity of the local anesthetics (26).

The intensity of oral paresthesia is related to the length of the altered sensations; although in the majority of the cases, a nerve, affected abnormally by a local anesthetic, spontaneously recovers in an 8-week period, and in some instances, this unfavorable event could be prolonged and persist for 6–18 months or even make the nerve incapable to recover completely (26).

Van Eaden, Pedlar, and Meechan described a small number of patients in which prolonged paresthesia lasted more than 18 months after inferior alveolar nerve block injection with articaine (26).

If a nerve is injured as a consequence of dental local anesthesia, the first treatment should be the management of pain. In order to reduce local anesthesia-dependent nerve injury, a high concentration of anesthetic agent for inferior alveolar nerve blocks needs to be avoided (use 2% lidocaine as standard), and iterative injections also be prevented. In addition, the use of a low daily dose of multivitamin B in order to regain nerve function and healing has been recommended (5).

Facial Blanching

Most of the incidence of facial blanching in the literature is reported during the inferior alveolar nerve block injection technique (Figure 2). Systematic vasospasm and accidental arterial penetration are accepted as the theory of this phenomenon. Facial blanching occurs

almost immediately after the administration of the local anesthetic solution. Blanching of the skin is reported as a transient complication and disappears within five to ten minutes. The most common areas where blanching of the facial skin is observed after local anesthetic injection are lips, midface area, and lateral nose. Symptoms might include discomfort in the eye area and pain which may be a cause of sudden contraction of blood vessels (28, 29).

Figure 2. Facial blanching after administration of inferior alveolar nerve block. Adapted from (28).

To reduce complications, the anesthetic solution must be injected into the mandibular foramen region and not into other anatomical areas such as blood vessels. Consequently, knowledge of anatomy and the location of the mandibular foramen are essential for the possible prevention of this adverse effect. Nevertheless, good knowledge of the anatomical location of the mandibular foramen may not necessarily minimize complications and ensure success considering that the size and shape of the mandible as well as the location of the mandibular foramen vary among different individuals. Nonetheless, being aware of the atomical location of the mandibular foramen and understanding the anatomical structure of the mandible is crucial for inferior alveolar nerve block (28).

Furthermore, facial blanching after an inferior alveolar nerve block also may be due to an anesthetic injection into the area of the maxillary artery, affecting the infraorbital artery (28).

Every artery in the oral cavity is at risk of intra-arterial injection. The proximal segment of the maxillary artery is infiltrated in Gow-Gates injection. In addition, greater palatine artery injection was reported in some cases to be the cause of palatal and facial blanching (29).

With the choice of local anesthetic techniques in less vascular areas, the potential risk of facial blanching can be decreased. However, dentists must be familiar with this complication in order to avoid unnecessary treatments (29).

Facial Nerve Paralysis

The facial nerve gives motor innervations to the muscles of facial expression. The nerve exits the skull from the stylomastoid foramen and after exiting the foramen, it enters the parotid gland, divides, and leaves the parotid as five major branches. In cases when the local anesthetic is injected close to the "deep lobe" of the parotid, facial nerve paralysis can occur. Facial paralysis can occur if, when administering a local anesthetic for the inferior alveolar nerve block, the needle goes posteriorly and the anesthetic solution is injected within the substance of the parotid; therefore this will paralyze the muscles of facial expression, resulting in unilateral Bell palsy (14). According to the literature, Bell palsy has a prevalence of 10 to 40 per 100000 (30). Symptoms of facial nerve palsy include the deviation of the mouth to the affected side (Figure 3) and the individual is incapable of closing the eye on the affected side (Figure 4) (14, 31). Blinking and winking become impossible. Nevertheless, the cornea maintains its innervation; therefore, if it is irritated, the corneal reflex is still intact, and tears lubricate the eye (7). The paralysis typically lasts a few hours, based on the type of anesthetic used (14). Transient facial nerve paralysis is mostly always evitable by following the protocol with the IANB and Vazirani–Akinosi nerve block. When the tip of the needle contacts the bone (the medial aspect of the ramus) before the deposition of the anesthetic solution, substantially, it prevents the possibility of anesthetic solution being deposited into the parotid gland during an interior alveolar nerve block (7).

There is no treatment to reverse the impact of local anesthesia other than waiting until the anesthetic effect fades out. If paralysis of facial muscles occurs, the patient must be reassured that it is temporary, and the effect of local anesthesia will disappear in a few hours. In patients who wear contact lenses, lenses should be removed because they may cause damage

to the cornea. An eye patch must be placed on the affected eye to maintain eye moisture (14). Ask the patient to cover his/her eyes with a clean cloth to prevent dust from entering the eye. The clinician must ask the patient to stay in the clinic for three hours in order to monitor his/ her condition (32). Even though the effect is considered transient, the authors have seen cases in which the palsy lasted for a week (14).

Figure 3. Deviation of the mouth to the affected side. Adapted from (31).

Figure 4. Inability to close the eye on the affected side. Adapted from (31).

Ophthalmologic Complications

In accordance with the literature, adverse phenomena particularly affecting vision have a prevalence rate of 1 in 1000 and therefore are rather rare. However, among ocular complications, ptosis, mydriasis, diplopia, amaurosis, and loss of accommodations have been reported (33).

Such complications most frequently occur after posterior superior alveolar nerve block or inferior alveolar nerve block (33). The most common ophthalmologic complications include diplopia (dual vision), ptosis, ophthalmoplegia (paralysis or weakening of eye muscles), and mydriasis (dilatation of the pupil). On exceedingly rare occasions, amaurosis (partial/total blindness) can be observed (5).

The systemic review on ophthalmologic complications following dental local anesthesia, with 66 reports and 89 cases carried out by Alamanos et al., found that the Gow-Gates technique for mandibular block anesthesia is only connected with diplopia. Additionally, it was stated that vision impairment is more related to inferior alveolar nerve blocks than to posterior superior alveolar nerve blocks. The latter technique has infrequently been reported as a cause of amaurosis (33).

Duration of Complications

Most of the complications are temporary and disappear on interruption of the anesthetic effects (5). For instance, in the review by Alamatos et al., 92% of the complications stated in the literature, such as external ocular muscle palsies, were transient; therefore, current evidence supports the theory that diplopia will resolve and is temporary. On the other hand, in four out of six patients with permanent complications (8%) vision impairment (permanent damage of the optic pathway) developed and the other two resulted in an isolated fixed pupil (iridoplegia) that clinically manifested as anisocoria. External ophthalmoplegia appears to be a short-term condition, while internal ophthalmoplegia may not fully resolve. In 25% of the patients, the time for the resolution of a temporary complication was more than 6 hours (33).

Symptoms

The symptoms experienced by patients during ophthalmologic complications are double vision, reduced sensation on the lateral aspect of the lower eyelids, vision blurriness, dropping of the upper and lower eyelids, squinting, short-term dizziness, loss of vision, and difficulties with reading as a result of paralysis of accommodation (34).

Pathway of Anesthetic Solution

Clinicians have only occasionally been able to precisely describe and explain the spreading route of the anesthetic solution. Some authors have proposed the abducens nerve as the etiology of diplopia (33).

Perforation of the vascular wall or intraarterial injection would provoke the sympathetic fibers to run alongside the internal maxillary artery until reaching the orbit. The intravenous injection may reach the cavernous sinus through the pterygoid plexus and anesthetize the abducens, trochlear, or oculomotor nerves (5).

Horner's syndrome may arise after IANB anesthesia due to the penetration of the local anesthetic through the prevertebral and lateral pharyngeal spaces, resulting in a barrier of the stellate ganglion (5).

Area of Anesthetic Injection

Complications after an anesthetic injection were experienced by 42 patients in the mandible and 46 patients in the maxilla. In this review by Alamanos et al., none of the reported blocks demonstrated to be more susceptible to ocular complications (33).

Type of Anesthetic Drug

Some authors have concluded that articaine may cause ocular complications more often in comparison with other anesthetics due to its improved tissue diffusion properties; based on the limited evidence available for this type of anesthetic, this suggestion can be neither substantiated nor refuted. By far the most frequently reported ocular complications in the literature are those that occur after the use of lidocaine (33, 34).

In order to limit the potential complications, multiple aspirations while injecting, visualization of the regional anatomy, and aspiration on at least two planes before administration of local anesthetic are carried out (5).

Types of Complications

Ophthalmoplegia

In the study conducted by Alamanos et al., ophthalmoplegia was the most prevalent condition (68 patients). Based on the affected muscles, ophthalmoplegia can be classified as "total" or partial" and as "internal" or "external" (33).

External Ophthalmoplegia

The external type of ophthalmoplegia is a prerequisite for diplopia and is a symptom of underlying pathology. The study conducted that; diplopia had been reported for almost 50% of patients in the review. Diplopia manifests in different patterns as vertical, horizontal, and combined, depending on the affected cranial nerves (CNs III, IV, and VI). The most commonly reported type of ophthalmoplegia was the palsy of CN VI (N. abducens), giving rise to impaired abduction and consecutive esotropia (convergent strabismus) (33).

Internal Ophthalmoplegia

Internal ophthalmoplegia leads to either impaired direct and consensual light reflexes or blurred vision (loss of accommodation). Nonetheless, blurred vision is merely an ocular symptom and can be resulted from a broad spectrum of pathologic conditions; for instance, in the case of an ectopic anesthetic effect, blurred vision may result from cycloplegia (paresis of the ciliary muscle) (33).

Horner Syndrome

This syndrome mostly occurs with the characteristic signs of miosis, ptosis, and enophthalmos; nevertheless, in the rare case of remote denervation of the stellate ganglion (sympathectomy), further complications may arise; for instance, the feeling of "suffocation", hoarseness of the voice, and profuse flushing of the ipsilateral side of the neck and as well as the upper extremities (33).

Amaurosis

Visual impairment was established in 20 reports (22%), however, only in four patients this condition remained permanent; complete permanent blindness had not been recorded or mentioned in the reviewed data (33).

Globe Penetration

Direct mechanical trauma to the globe during anesthetic administration is typically described as globe penetration. Nevertheless, in the study review by Alamanos et al., it was a rare condition and only occurred during the administration of an infraorbital block (33).

Prevention of Complications

It is mostly accepted that intravascular injections are the possible causes of ocular complications related to intraoral anesthesia. Therefore, all local anesthetic injections must be accompanied by aspiration before actual injection to prevent ocular complications. If a considerable amount of anesthetic is about to be injected, it must be administered slowly and with frequent aspirations (35, 36).

Management of Complications

In case of eye complications, the first and most essential step is to comfort and reassure the patient. Each complication must be evaluated individually. In cases, when the clinician is not certain about the complication and the underlying cause, a patient needs to be referred to an ophthalmologist. The impaired eye must be covered with gauze until the symptoms are reduced or disappeared. A patient must be accompanied home considering that monocular vision disallows the patient from precisely estimating distances. A patient must be referred to an ophthalmologist for further evaluation if the symptoms last more than 6 hours. In case of any eye symptoms, a dentist needs to take into consideration the anxiety of the patient and the treatment should be postponed (37, 38).

In order to limit the potential complications, multiple aspirations while injecting, visualization of the regional anatomy, and aspiration on at least two planes before administration of local anesthetic are carried out and are highly recommended (4). Present

evidence shows that every complication must be managed symptomatically and individually evaluated. In specific cases, further consultation with the specialist is needed (33).

Infection

Due to the usage of glass cartridges and disposable needles, infection complications became significantly rare after the administration of local anesthetic. Infection may spread to tissues by the needle penetration through an infected tissue, due to the needle being contaminated before an operation or improperly prepared local anesthetic diluted solutions. Nevertheless, a latent viral infection may be reactivated as a result of the trauma of the procedure which may be accountable for neural sheath inflammation (5, 6).

In order to prevent any complications associated with infection after injection of the local anesthetic, a clinician must always use sterile disposable needles, avoid any contamination of the sterile needle with non-sterile objects, multiple injections are also not favorable, cartridges must be one-time used, and stored aseptically after every patient (5). Prior to the insertion of the anesthetic, the penetration area must be cleaned with a topical antiseptic (4). The function of the topical antiseptic is to produce a transient reduction in the bacterial population at the injection site, therefore decreasing any risk of postinjection infection. An applicator stick with the topical antiseptic is applied at the area of injection for 15 to 30 seconds. Topical antiseptics containing alcohol are better to be avoided because the alcohol may induce tissue irritation. In cases where a topical antiseptic is not available, a sterile gauze wipe can be used to properly prepare the tissues before injection. However, prior to intraoral injection, the application of a topical antiseptic is still considered an optional step in tissue preparation (5). In addition, antiseptic mouthwash solutions like chlorhexidine must be as well taken into account for all regional techniques. Infected areas should not be injected through local anesthesia (4).

In the presence of infection, it is essential to increase the pH of the anesthetic agent during injection of local anesthetic in order to enhance effectiveness since the infected tissue is more acidic. This process is termed anesthetic buffering and leads to patient comfort during injection, lowers postinjection tissue injury, and results in rapid onset of anesthesia. However,

clinician always needs to consider the risk of transportation of bacteria from the infected area into the adjacent healthy tissues, especially, when it is deposited under pressure (5).

Infection is very rarely recognized instantly. Patients typically experience dysfunction and postoperative pain one day or more following the treatment. The recommended infection treatment is antibiotics such as penicillin V 500 mg every 6 hours for 7–10 days; heat, drainage, physiotherapy, and analgesics are additionally advised (4, 6).

Needle Fracture

From the time stainless steel, non-reusable needles were introduced into the dental field; needle breakage became an exceedingly rare complication of dental anesthetic injections. The most common technique in which broken dental needles were reported is inferior alveolar nerve blocks and posterior superior nerve blocks. Long dental needles are most probably to be broken during the injection. However, since the long needle is unlikely to be injected to its full length into soft tissue; in most cases, some segments of the needle would remain visible in the patient's mouth. Retrieval of the fragment can be easily performed with a hemostat. Additional causes of needle fractures include unexpected sudden movement by the patient while the needle is still inserted in tissue, intentional bending of the needle by the clinician before injection, and persuasive forceful contact with bone (6, 39).

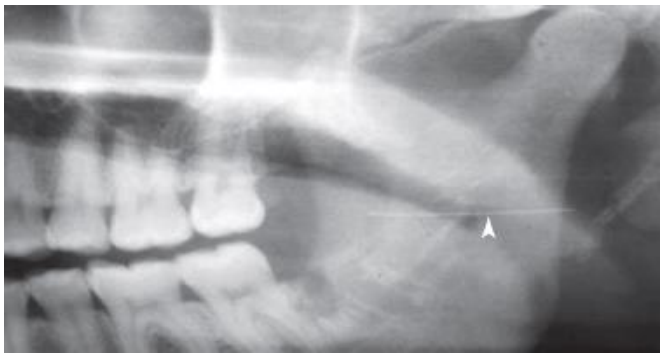
During the local anesthetic injection, where the needle has been inserted and the soft tissue has hollowed under pressure from the syringe, the broken needle fragment will not be visible when withdrawing the syringe from the patient's mouth. Needle breakage by itself is not a major problem as long as the needle may be withdrawn non-surgically; however, needle fragment remains in the soft tissue and need to be always removed either surgically or non-surgically, because it can present a potential risk of causing serious damage to the tissues. Even though needle fragment migration rarely occurs; nevertheless, it is possible in some cases as it is demonstrated in the sequence of panoramic x-rays at three-month intervals (Figure 5) (7, 6).

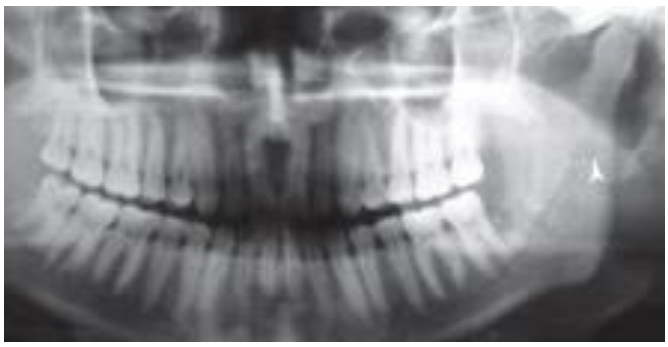
Prevention of Needle Fracture

There are several risk factors that can reduce the chances of needle breakage when they are avoided. Firstly, dentists must avoid the usage of short needles for inferior alveolar nerve blocks in larger children and adults. Secondly, prevent the usage of 30-gauge needles for inferior alveolar nerve block in children and adults. Thirdly, when injecting a local anesthetic into soft tissue, bending the needle must be avoided. Fourthly, dentists must avoid inserting a needle into soft tissue to its hub, unless it is necessary for the successful injection. Lastly, we must be particularly cautious when performing local anesthesia on anxious-phobic adults and younger children (6).

Management of Needle Fracture

In cases of needle fracture, the patient needs to be referred to the oral and maxillofacial specialist for evaluation and potential retrieval of the broken fragment. The conventional approach involves finding the location of the needle fragment by performing a computed tomographic scanning and panoramic X-ray. When the location of the retained fragment is determined, a surgeon removes the broken needle fragment with the patient being under general anesthesia (6).





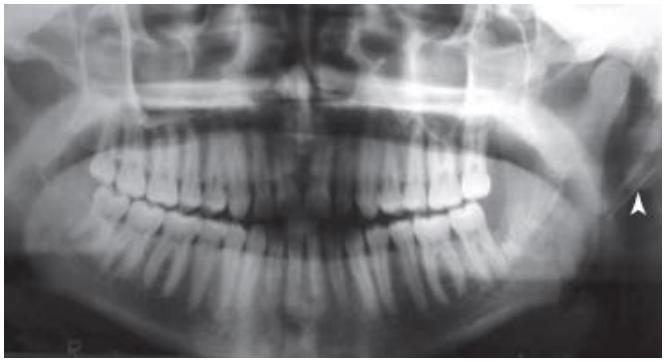


Figure 5. Needle fragments migration as demonstrated in the series of panoramic x-rays taken at 3-month intervals. Adapted from (6).

Tissue Necrosis

Soft tissue necrosis occurring at the site where the anesthetic injection was performed is termed Anesthetic Necrosis. The most common site of injection which can be affected by tissue necrosis is the hard palate. This occurs due to the underlying bone being in close proximity to the palatal mucosa, therefore resulting in traumatic needle penetration and pressurized deposition of the anesthetic solution. The palate has a rich blood supply through the lesser and greater palatal arteries which participate in wound recovery and maintain metabolism by providing oxygen and nutrients. The necrosis is most frequently seen as a consequence of ischemia in the localized region of the injection site. The most prevalent cause is the result of faulty and incorrect injection techniques. According to the literature, the greater palatine nerve block is considered the most common injection technique resulting in tissue necrosis. The differential diagnosis of the necrotic lesion can be herpes simplex, aphthous stomatitis, neoplastic lesion, or mucormycosis (40, 41).

Localized ischemia is caused primarily as a result of following aspects such as excess of anesthetic solution deposited in the tissue firmly bound to the bone as it is evident in the palate. In particular cases, the presence of epinephrine in the local anesthetic agent is considered to be the cause of secondary necrosis and ischemia. In addition, the presence of vasoconstrictor decreases the supply of oxygen to the injected site, therefore, enhancing the build-up of acidic by-products (42).

A palatal necrotic ulcer caused by local anesthesia may occur due to deposition of pressure during the injection of the anesthetic solution, faulty injection technique which is followed by

traumatic needle penetration, excessive and rapid deposition of the anesthetic solution, or blanching at the anesthetic site, presence of epinephrine, and relatively inadequate blood supply. Trauma induced either by the local anesthetic solution or insertion of the needle can result in swelling and burning of the tissues which may reactivate latent viruses like herpes virus and give rise to vasculopathy of small or large arteries provoking ischemia. Chronic necrosis destroys the palatal bone to leave a bony sequester, ultimately resulting in the perforation of the palate (43, 42).

Clinical features of anesthetic necrosis include deep ulcerations, well-circumscribed ulceration areas, delayed healing, and seldomly observed bone sequestration at the site of necrosis. Symptoms are usually seen several days after administration of the local anesthetic (44).

Treatment and Prevention of Anesthetic Necrosis

Treatment of such lesions typically consists of patient reassurance and conservative management. In the presence of ulceration, topical anesthetic gel without Epinephrin can be prescribed to relieve pain. Following conservative treatment, most of the lesions heal spontaneously within 3-4 weeks. Antibiotics are prescribed only if the lesion is secondarily infected. In cases, where underlying bone is involved or the ulcer does not heal, surgical intervention will be needed. In order to prevent or reduce complications associated with post-anesthetic necrosis, a clinician must choose the proper injection technique, have proper knowledge of anatomy, and carefully deposit the local anesthesia. Topical anesthetics need to be strictly used according to the manufacturer's instructions limiting the application time to 1-2 minutes to minimize toxicity and optimize efficiency and use anesthetic solutions that do not contain epinephrin or have lower epinephrin concentration, especially for minor surgical procedures such as simple tooth extractions. Longer application of topical anesthetic may lead to desquamation of epithelial tissue. For instance, 3% mepivacaine without vasoconstrictor may be used as an alternative anesthetic solution which leads to efficient palatal anesthetic without causing soft-tissue necrosis (44, 42, 43, 45).

Conclusion

Although local anesthesia remains the primary pain management medication in dentistry, the practitioner must consider the risk of complications associated with each local anesthetic administration technique in oral and maxillofacial surgery. In order to prevent some unfavorable complications of local anesthesia, the complete and detailed medical history of the patient must be regularly monitored. In this literature review, the importance of the correct choice of anesthetic solution was presented following their selection criteria. Main local anesthetic techniques used in dentistry, oral, and maxillofacial surgery were described, highlighting the significance of proper guidelines which could greatly minimize the occurrence of various complications associated with those techniques. Proper knowledge of anatomy and materials, accompanied by aseptic and atraumatic injection techniques is essential for the clinician. The importance of modification of the injection technique according to the patient's anatomy, accompanied by proper adherence to the injection protocol was emphasized in this paper. The association between local anesthetic techniques and potential complications in oral and maxillofacial surgery was represented. The importance of preventive measurements and management of adverse effects of local anesthesia were as well discussed in the paper. Unfortunately, there are not many published guidelines for clinicians that focus on the prevention and management of those complications. Moreover, it needs to be noted that there is a lack of high-quality reviews and research available on this subject matter. Finally, some relevant information such as the type of needle, materials used, dosage, and type of anesthetic solution was often not stated in the articles.

Abbreviations

ASA- Anterior Superior Alveolar

PSA- Posterior Superior Alveolar

IANB- Inferior Alveolar Nerve Block

ILA- Intraligamentary Anesthesia

PDL- Periodontal Ligament

References

1. Wang YH, Wang DR, Liu JY, Pan J. Local anesthesia in oral and maxillofacial surgery: A review of current opinion. Journal of Dental Sciences. 2021 Oct 1;16(4):1055–65.

2. John RR. Local Anesthesia in Oral and Maxillofacial Surgery. In: Bonanthaya K, Panneerselvam E, Manuel S, Kumar VV, Rai A, editors. Oral and Maxillofacial Surgery for the Clinician [Internet]. Singapore: Springer Nature; 2021 [cited 2022 Nov 18]. p. 61–77.

3. David R. Cummings DDS, Yamashita DDS. Complications of Local Anesthesia Used in Oral and Maxillofacial Surgery - ClinicalKey [Internet]. [cited 2022 Nov 18].

4. Ho JPTF, van Riet TCT, Afrian Y, Sem KTHCJ, Spijker R, de Lange J, et al. Adverse effects following dental local anesthesia: a literature review. J Dent Anesth Pain Med. 2021 Dec;21(6):507–25.

5. Yalcin BK, Yalcin BK. Complications Associated with Local Anesthesia in Oral and Maxillofacial Surgery [Internet]. Topics in Local Anesthetics. IntechOpen; 2019 [cited 2022 Nov 16].

6. Stanley F. Malamed. Handbook of Local Anesthesia. 7th edition. Elsevier; 2020.

7. Brendan T. Finucane, Ban C.H. Tsui. Complications of Regional Anesthesia - Principles of Safe Practice in Local and Regional Anesthesia. Third Edition. Springer;

8. Ghavimi MA, Kananizadeh Y, Ghoreishizadeh SH and A, Ghavimi MA, Kananizadeh Y, Ghoreishizadeh SH and A. Overview of Local Anesthesia Techniques [Internet]. A Textbook of Advanced Oral and Maxillofacial Surgery Volume 2. IntechOpen; 2015 [cited 2022 Nov 16].

9. Ciancio SG, Marberger AD, Ayoub F, Garlapo DA, Pantera EA, Pantera CT, et al. Comparison of 3 intranasal mists for anesthetizing maxillary teeth in adults: A randomized, double-masked, multicenter phase 3 clinical trial. J Am Dent Assoc. 2016 May;147(5):339-347.e1.

10. Reed K, Malamed S, Fonner A. Local Anesthesia Part 2: Technical Considerations. Anesthesia progress. 2012 Oct 1;59:127–37.

11. Thangavelu K, Kumar NS, Kannan R, Kumar JA. Simple and safe posterior superior alveolar nerve block. Anesth Essays Res. 2012;6(1):74–7.

12. Ghosh A, Vaibhav N, Raut R, Venkatesh A. Ophthalmic Complication Following Posterior Superior Alveolar Nerve Block for Tooth Extraction! A Rare Occurrence. Journal of Maxillofacial & Oral Surgery. 2015 Sep;14(3):862.

13. Singh K. Hematoma - A Complication of Posterior Superior Alveolar Nerve Block. J Dent Probl Solut. 2015 Mar 11;015–6.

14. Ogle OE, Mahjoubi G. Local Anesthesia: Agents, Techniques, and Complications. Dental Clinics of North America. 2012 Jan 1;56(1):133–48.

15. Rathee M, Brizuela M. Inferior Alveolar Nerve Block [Internet]. StatPearls [Internet]. StatPearls Publishing; 2022 [cited 2022 Nov 18].

16. Dalla Torre D, Burtscher D. Intraligamentary anaesthesia as a possible anaesthetic option in oral implantology: a retrospective analysis. International Journal of Oral and Maxillofacial Surgery. 2020 Jun 1;49(6):811–5.

17. Dr. Krishna Swaroop Achanta, Dr. Chithranjali Ravichandran. When Is Intraligamentary Injection Technique Used? [Internet]. 2022 [cited 2022 Nov 18].

18. Kämmerer PW, Schiegnitz E, von Haussen T, Shabazfar N, Kämmerer P, Willershausen B, et al. Clinical efficacy of a computerised device (STA™) and a pressure syringe (VarioJect INTRA™) for intraligamentary anaesthesia. Eur J Dent Educ. 2015 Feb;19(1):16–22.

19. Kämmerer PW, Adubae A, Buttchereit I, Thiem DGE, Daubländer M, Frerich B. Prospective clinical study comparing intraligamentary anesthesia and inferior alveolar nerve block for extraction of posterior mandibular teeth. Clin Oral Investig. 2018 Apr;22(3):1469–75.

20. Biočić J, Brajdić D, Perić B, Đanić P, Salarić I, Macan D. A Large Cheek Hematoma as a Complication of Local Anesthesia: Case Report. Acta Stomatol Croat. 2018 Jun;52(2):156–9.

21. Baiju A, Krishnakumar K, Panayappan L. ANAESTHESIA COMPLICATIONS: AN OVERVIEW [Internet]. 2018 [cited 2022 Nov 23].

22. Dr. Chetan. Hematoma – Complication of Local Anesthesia – Cause, Problems and Prevention [Internet]. [cited 2022 Nov 18].

23. Dr. Hayder A. Top 8 Complications of Local Anesthesia [Internet]. Bondistry. 2016 [cited 2022 Nov 18].

24. Santiago-Rosado LM, Lewison CS. Trismus. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 [cited 2022 Nov 18].

25. Haas DA. Alternative mandibular nerve block techniques: a review of the Gow-Gates and Akinosi-Vazirani closed-mouth mandibular nerve block techniques. J Am Dent Assoc. 2011 Sep;142 Suppl 3:8S-12S.

26. Piccinni C, Gissi DB, Gabusi A, Montebugnoli L, Poluzzi E. Paraesthesia after Local Anaesthetics: An Analysis of Reports to the FDA Adverse Event Reporting System. Basic & Clinical Pharmacology & Toxicology. 2015;117(1):52–6.

27. Garisto GA, Gaffen AS, Lawrence HP, Tenenbaum HC, Haas DA. Occurrence of paresthesia after dental local anesthetic administration in the United States. J Am Dent Assoc. 2010 Jul;141(7):836–44.

28. Kang SH, Won YJ. Facial blanching after inferior alveolar nerve block anesthesia: an unusual complication. Journal of Dental Anesthesia and Pain Medicine. 2017 Dec 1;17:317.

29. Rahpeyma A, Khajehahmadi S. Facial Blanching after Local Anesthesia Injection: Clinico-anatomical Correlation—Review of Literature. J Cutan Aesthet Surg. 2020;13(1):1–4.

30. Walker NR, Mistry RK, Mazzoni T. Facial Nerve Palsy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 [cited 2023 Apr 12].

31. Tzermpos FH, Cocos A, Kleftogiannis M, Zarakas M, Iatrou I. Transient Delayed Facial Nerve Palsy After Inferior Alveolar Nerve Block Anesthesia. Anesth Prog. 2012;59(1):22–7.

32. Mistry RK, Hohman MH, Al-Sayed AA. Facial Nerve Trauma. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 [cited 2023 Mar 6].

33. Alamanos C, Raab P, Gamulescu A, Behr M. Ophthalmologic complications after administration of local anesthesia in dentistry: a systematic review. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2016 Mar 1;121(3):e39–50.

34. Steenen SA, Dubois L, Saeed P, de Lange J. Ophthalmologic complications after intraoral local anesthesia: case report and review of literature. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology. 2012 Jun 1;113(6):e1–5.

35. Aoun G, Zarazir R, Hajj R, Fadi A, Frei E. Ophthalmic Complications of Locoregional Anesthesia in Dentistry. 2021 Jun 5;2.

36. Boynes SG, Echeverria Z, Abdulwahab M. Ocular Complications Associated with Local Anesthesia Administration in Dentistry. Dental Clinics of North America. 2010 Oct;54(4):677–86.

37. Costea C, Cucu A, Earar N, Dimitriu G, Dancă C, Chihaia, et al. OCULAR COMPLICATIONS DUE TO INTRAORAL LOCAL ANESTHESIA: A CASE REPORT. Romanian Journal of Oral Rehabilitation. 2017 Apr 1;9.

38. Ravi P, Gopi G, Shanmugasundaram S, Raja K. Ocular complications with dental local anaesthesia - A systematic review of literature and case report. The Journal of the Dental Association of South Africa = Die Tydskrif van die Tandheelkundige Vereniging van Suid-Afrika. 2015 Jan 1;70:354–7.

39. Malamed SF, Reed K, Poorsattar S. Needle breakage: incidence and prevention. Dent Clin North Am. 2010 Oct;54(4):745–56.

40. Sharma. Palatal ulceration: A local anesthetic complication [Internet]. [cited 2022 Dec 30].

41. Palatal Necrotic Ulcer Following Local Anesthesia: A Rare Complication. JODH [Internet]. 2020 May 12 [cited 2023 Jan 19];4(2).

42. Gargi V, Mohan RPS, Kamarthi N, Gupta S. Palatal Perforation: A Rare Complication of Postanesthetic Necrosis. Contemp Clin Dent. 2017;8(3):501–5.

43. Kao A, Taleb B. Palatal necrosis: a rare complication of local anesthetic in dentistry. PAMJ - Clinical Medicine [Internet]. 2021 Jan 5 [cited 2022 Dec 29];5(2).

44. Gupta R, Garg M, Pawah S, Gupta A. Postanesthetic ulceration of palate: A rare complication. Natl J Maxillofac Surg. 2016;7(1):86–8.

45. Chaurasia A, Airan M, Mall S, Gupta S, Sharma H, Mohini A. Postanaesthetic Aseptic Palatal Necrosis - A Case Report. Ann Maxillofac Surg. 2021;11(1):173–5.