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Regional anesthesia for maxillofacial surgery in developing countries

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Regional anesthesia in the maxillofacial region is safer and more efficient than general anesthesia when its indications are carefully considered. In addition, the majority of medical institutions in developing countries are not well equipped for proper anesthesia and elective surgery. In this review, we describe regional anesthesia and cutaneous nerve divisions in the maxillofacial region. In addition, we summarize detailed regional anesthetic techniques adapted for representative cleft lip cases in developing countries.

Keywords: Cheiloplasty; Developing countries; Maxillofacial surgery; Regional anesthesia.

INTRODUCTION

Regional anesthesia is a type of local anesthesia and is aimed at anesthetizing a large part of the body such as an entire leg or arm compared to a smaller area such as a tooth or specific region of skin. Like local anesthesia, regional anesthesia is produced by any technique that causes an absence of sensation, local insensitivity to pain, and loss of local senses in a specific part of the body, and is performed by injection of anesthetic drugs either near a cluster of nerves or near the exit points of nerves from the bony skeleton [1,2]. Regional anesthesia is safer than general anesthesia in many situations, and can be used for relief of surgical or non-surgical pain and distress. In this review, local or regional anesthesia was categorized as conduction anesthesia, which is a comprehensive term that encompasses many forms of local anesthesia and differs from the meaning of general anesthesia.

There are several types of regional anesthesia. Two of the most frequently performed types of regional anesthesia are spinal and epidural anesthesia, which are produced by precise injections made in specific areas of the back. Peripheral nerve block is another common type of regional anesthesia used to numb a desired area of an extremity, such as the arm, leg or facial region, and is produced with injections made with great exactness near a cluster of nerves [3]. Two of the most frequently used types of peripheral nerve blocks are the femoral nerve block, which is produced by an injection in the leg region, and brachial plexus block, which is produced by injection in the arm and shoulder region. Spinal and epidural anesthesia, sciatic and popliteal nerve block, and paravertebral nerve block are all different types of peripheral nerve block and are used in a variety of

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different surgical procedures such as gastrointestinal, hepatic, gynecologic, ophthalmologic, orthopedic, and thoracic surgery, as well as vascular procedures and urologic procedures including radical prostatectomy, nephrectomy, and other procedures involving the kidneys, prostate, or bladder [4]. Indeed, it was previously common for anesthesiologists to use regional anesthesia for a wide variety of surgical procedures.

Local anesthesia is used during many facial plastic or maxillofacial surgeries. In addition, regional anesthesia produced with a regional nerve block using lidocaine or bupivacaine is frequently and easily administered for procedures on facial structures. Most parts of the skin of the forehead can be anesthetized by infiltration of the supraorbital nerve, which exits the frontal bone at a point several centimeters above the pupil. Likewise, the infraorbital nerve exits the maxillary bone at a point several centimeters just below the pupil, and can be targeted with an infraorbital nerve block to anesthetize the cheek, nasal sidewall, a portion of the nasal tip, one half of the upper lip, and vestibular mucosa related to the upper teeth. Lastly, the mental nerve exits the mandible approximately 1-2 cm above the lower bony rim in the region of the canine and premolar teeth and is frequently blocked to anesthetize the corresponding half of the lower lip, lower teeth related to the mucosa and skin, and lower cheek skin [5,6].

The majority of hospitals in developing countries are not well equipped and lack the appropriate infrastructure needed for general anesthesia. This lack of sufficient medical infrastructure has been proposed as a reason why many surgeons are hesitant to perform charitable operations in extremely poor areas. On the other hand, during our own previous charitable efforts in developing countries, we have observed that some patients from rural parts of developing countries are unwilling to undergo regional anesthesia. In this review, in order to better understand the anatomical and technical approaches to maxillofacial regional anesthesia, we summarize our experiences and discuss the peripheral nerves of the face.

ANATOMICAL CONSIDERATIONS FOR MAXILLOFACIAL REGIONAL ANESTHESIA

Sensory and motor innervations to the maxillofacial region are distinct and easily separated, and thus sensory block can be achieved without motor nerve paralysis. With respect to classification of maxillofacial skin innervation, it is important to consider the following cranial nerves: trigeminal, facial, glossopharyngeal, and hypoglossal. In addition, several branches of the cervical plexus such as the cervical dorsi rami are also important for sensory innervation of the back side of the neck and face [3,7].

The trigeminal nerve is the fifth and largest cranial nerve and supplies innervation to masticatory muscles and the principal sensory functions of the maxillofacial region including facial skin and the anterior half of the head; the mucous membranes of the nose, sinuses and mouth; the anterior two-thirds of the tongue; all of the teeth; the temporomandibular joint; orbital contents excluding the retina; and portions of the dura [7]. The ophthalmic nerve, the first main branch of the trigeminal nerve, enters the orbit through the superior orbital fissure and divides into three main sub-branches, namely, the frontal, nasociliary, and lacrimal nerves. The maxillary nerve, the second main branch of the trigeminal nerve, exits from the cranium through the foramen rotundum and crosses the pterygopalatine fossa anterior to the lateral pterygoid plate, and enters the orbit through the inferior orbital fissure. The relevant terminal cutaneous branches of the maxillary nerve are the infraorbital, zygomaticofacial, and zygomaticotemporal nerves. The mandibular nerve, the third main branch of the trigeminal nerve, exits the cranium through the foramen ovale accompanied by the motor root of the trigeminal nerve, crosses the pterygopalatine fossa posterior to the lateral pterygoid plate, and courses anterior to the neck of the mandible. The mandibular nerve divides into an anterior motor branch that contains a small amount of sensory nerve such as the buccal nerve, which supplies the skin and mucous membrane deep to the buccinators muscle, and a large posterior division consisting of three main branches comprising the auriculotemporal, inferior alveolar, and lingual nerves (Fig. 1).

The facial nerve transverses the parotid gland in front of the ear and divides into five main branches comprising the temporal, zygomatic, buccal, mandibular, and cervical nerves. These branches radiate out to supply the muscles of expression in the respective maxillofacial region. In addition, the glossopharyngeal nerve supplies sensation to the posterior third of the tongue, the pharynx, palatine tonsil, part of the soft palate, and the anterior surface of the epiglottis. The pharyngeal branch of the glossopharyngeal nerve forms a large part of the pharyngeal plexus which innervates the pharyngeal wall along with the glossopharyngeal nerve. The superior laryngeal and recurrent laryngeal nerves are two main branches of the vagus nerve. Lastly, the hypoglossal nerve provides motor innervation to the tongue [1,6,7].

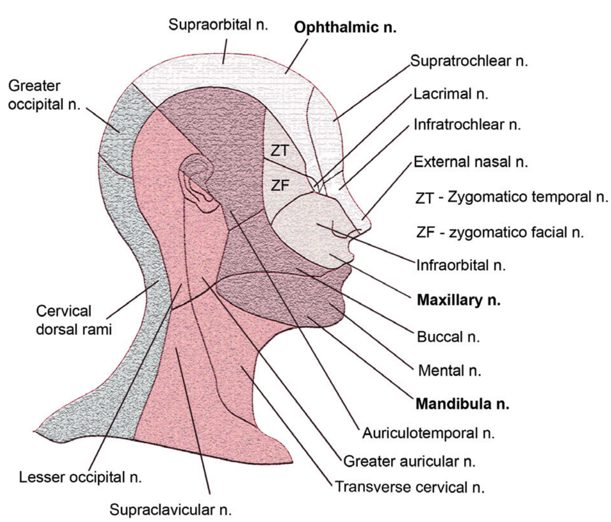

Fig. 1. Cutaneous nerve distribution of the maxillofacial region emphasizing trigeminal nerve divisions.

NERVE BLOCKS TO THE MAXILLOFACIAL REGION

In many developing countries, the majority of dermatologic pathology and traumatic wounds in the maxillofacial region can be repaired under regional anesthesia (Fig. 2). Indeed, block anesthesia in the facial region either alone or in combination with general anesthesia can benefit patients in a range of clinical situations such as postoperative pain control, anesthetic technique, awake intubation, and chronic pain management. The specific requirements for regional anesthesia vary according to the location, size, and depth of the pathologic lesion or trauma.

Direct local infiltration of an anesthetic is somewhat uncomfortable, and has many disadvantages such as the requirement for multiple injections, tissue distortion, and hindering margin identification. Nevertheless, intraoral nerve blocks are routinely used by dentists to achieve safe and effective regional anesthesia in the anterior portion of the face [8]. Unlike local anesthesia, regional anesthesia has many specific benefits beyond avoiding the risks and side effects of general anesthesia. One of the

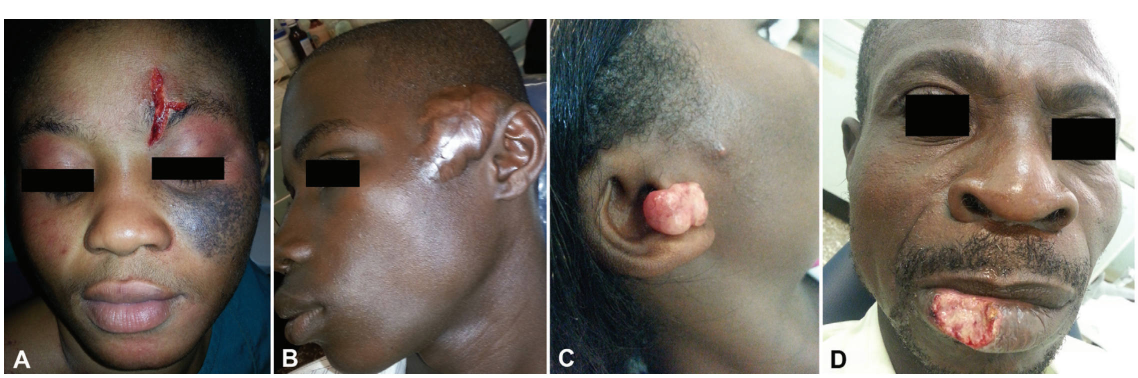

Fig. 2. Representative clinical cases for repair or excision operation under regional anesthesia. Facial trauma (A), unknown hard mass near the tempora region (B), fast growing soft mass on the meatus of the ear (C), and a deep biting wound on the lower lip (D).

primary benefits is the elimination of both intraoperative and postoperative pain. Indeed, postoperative pain control can be extended for many hours using long-acting local anesthetic agents. Furthermore, with respect to the extremities, this benefit can be prolonged for several days by using epidural analgesia or continuous regional analgesia delivered by a continuous infusion of local anesthetic through a catheter placed alongside a nerve [9]. In this way, opioids or morphine-like drugs can be avoided, as well as their side effects such as nausea, vomiting, and sedation, all of which can shorten the patient's duration in the recovery room and reduce the risk of unplanned admission to the hospital.

Regional anesthesia induces good muscle relaxation and reduces intraoperative bleeding through variable vasoconstriction effects, resulting in improved operating conditions. This can reduce surgery duration as well as the risk of requiring a blood transfusion. For example, epidural and spinal anesthesia decreases the risk of blood clot formation in the lower extremities during surgery. In addition, studies in which general anesthesia was compared with regional anesthesia in patients who received both forms of anesthesia have consistently demonstrated patient preference for and improved satisfaction with regional anesthesia. Additional benefits of regional anesthesia include analgesia without the risk of respiratory depression induced by opiate analgesia, the ability to administer with minimal equipment, and low risk of complications.

Regional anesthesia is safer compared to any type of local anesthesia or general anesthesia, and significant complications associated with regional anesthesia are extremely rare. Advances in medical knowledge, the availability of new and safer medications and techniques, as well as technological advances in the monitoring of patients during and after the surgery have all contributed to the decreased risks associated with regional anesthesia. Thus, while no technique is completely risk free, the complications and side effects associated with regional anesthesia tend to be minor in nature, consisting mainly of tenderness and/or bruising at the injection site. Occasionally, a nerve block may be followed by numbness and tingling in the distribution of the blocked nerve(s) for a limited time following the nerve block.

With respect to maxillofacial regional anesthesia, it is important to consider anesthetic time in order to avoid evoking any pain in the patient. If a procedure will last more than 2 hours, some local anesthetic agents must be added to the block injection site, and additional methods for pain control such as analgesics will be beneficial to prevent any pain felt by the patient. To this end, placing an intravenous line is recommended for regional or block anesthesia, and may also be considered for maxillofacial procedures. Indeed, due to the specific anatomy of the maxillofacial region, analgesics can be delivered by intravenous infusion or by intramuscular injection during maxillofacial procedures. Blocking is also more effective under conscious or deep sedation. To prevent pain initially, a topical anesthetic may be applied to the skin before insertion of the block needle by first cleaning the skin with a sterile solution followed by injection of a small skin wheal of local anesthetic. Overall, detailed considerations of operation time and pain control are very important, because pain is more difficult to control once it has been reported by the patient.

REGEIONAL ANESTHESIA FOR CLEFT LIP PROCEDURES

Cleft lip is a common craniofacial deformity and the prevalence of cleft lip with or without an associated cleft palate is 0.1 % in the general population [4,10]. Although cleft lip surgery, cheiloplasty, is usually performed during infancy or childhood, it tends to be performed later in many developing countries due to a number of difficult circumstances (Fig. 3). For example, most of the medical institutions in Africa are severely underfunded and understaffed. Reliable electricity is unusual, and many anesthesia drugs and muscle relaxants are not readily available. Some facilities lack running water, the majority of hospitals have no oxygen, and many of the operating

Fig. 3. Representative cases of cleft lip repair in adult patients under regional anesthesia. Cleft microlip (A), unilateral incomplete cleft lip with nostril distortion (B), unilateral incomplete cleft lip only (C), and unilateral complete cleft lip with nasal deviation (D).

rooms are small and cramped with poor lighting and no recovery room. Furthermore, drugs, needles, syringes and gloves are in short supply, as are endotracheal tubes, laryngoscopes, facemasks, and other specific equipment needed to anesthetize patients. In addition, monitoring equipment is limited, many wards are understaffed, postoperative nursing care ranges from adequate to nonexistent, and laboratory testing is often unreliable. Thus, in most of countries of West and Middle Africa, reliance on regional anesthesia is not only common, but a part of the medical culture.

Hodges and Hodges [10] developed an appropriate anesthesia protocol for safe cleft lip and palate surgery in remote centers with only basic facilities in Uganda. They suggested that patients aged more than 10 years could undergo cheiloplasty under sedation with diazepam 0.05-0.1 mg/kg using 1% Lidocaine with 1:200,000 epinephrine infiltration into the lips, gums, and nose. Prabhu KP et al. [11] reported the superiority of infraorbital nerve block over peri-incisional infiltration in terms of both efficacy and duration of effective analgesia using 0.125% bupivacaine with 1:200,000 epinephrine. Ahuja et al. [12] demonstrated the superiority of bilateral infraorbital nerve block over ‘sham blocks’ administered at the conclusion of surgery in 20 infants undergoing cleft lip repair. Meyer et al [13]. demonstrated the efficacy of bilateral infraorbital nerve block in 51 children undergoing cleft lip repair, and concluded that it decreased the risk of respiratory depression and facilitated immediate and comfortable awakening. Rajamani et al.

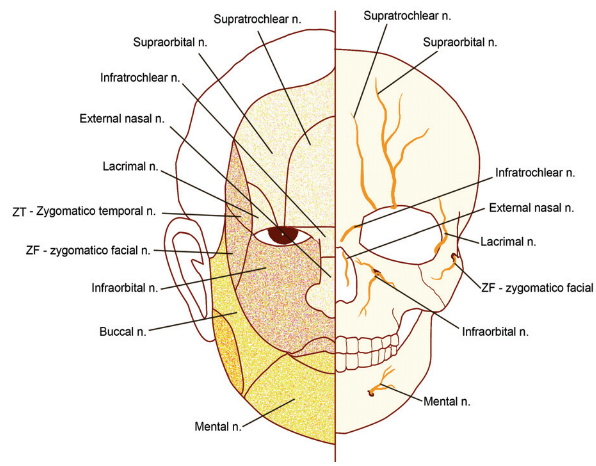

Fig. 4. Frontal view of the cutaneous nerve distribution on the skin surface (right) and on the skeletal level (left) focusing on the infraorbital nerve.

[5] demonstrated the superiority of bilateral infraorbital nerve block over fentanyl in terms of shorter time to awakening, better postoperative pain relief, and earlier time to feeding, while another study showed that there was no significant difference in pain score between patients administered fentanyl intravenously and those who received bilateral infraorbital nerve blocks with 0.25% bupivacaine [14]. Together, these studies make it clear that regional nerve block of the infraorbital and maxillary nerve is essential for performing cleft lip and palate surgery.

1. Infraorbital nerve block

The second division of the trigeminal nerve, the maxillary nerve, exits the skull from the foramen rotundum, and eventually enters the face through the

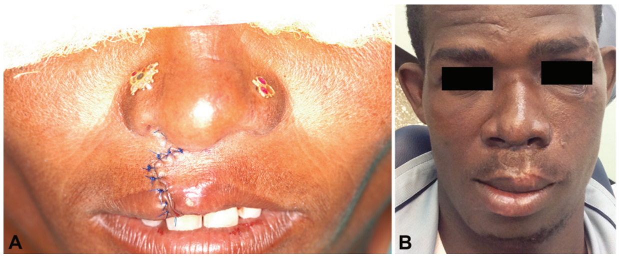

Fig. 5. Clinical appearance of a cheiloplasty performed with only regional anesthesia immediately after surgery (A) and after six months (B).

infraorbital canal, where it ends as the infraorbital nerve after giving off numerous branches [15]. The infraorbital nerve supplies sensory innervation to the skin and mucosa of the upper lip, lower eyelid, and to the side of the nose in a normal lip (Fig. 4). In patients with a cleft lip, the infraorbital nerve supplies the lateral part of the cleft lip whereas the opposite infraorbital nerve supplies the medial part of the cleft lip. Regional block of the infraorbital nerve is often used for maxillofacial regional anesthesia, having several advantages over local infiltration such as requiring a lower amount of medication and not causing tissue distortion [16]. Thus, infraorbital nerve block is a convenient alternative for situations such as facial lacerations in which tissue distortion is unacceptable (Fig. 5).

Infraorbital nerve block can be achieved using either an intraoral or extraoral approach. The intraoral approach has been described to be at least as effective in producing upper lip anesthesia as extraoral block, but is also associated with a greater number of complications. Ocular penetration after infraorbital nerve block has also been reported in a patient with an absent palate [6]. For extraoral block, the infraorbital nerve is easily blocked as it emerges from the infraorbital foramina, which is either palpable or can be estimated from other palpable landmarks.

Eipe et al. [16] reported that the infraorbital nerve can be blocked by an extraoral approach with 10ml of local anesthetic solution containing equal volumes of 2% lidocaine with 1:200,000 adrenaline and 0.5% bupivacaine. According to their study, the point of entry is the intersection of a vertical line through the pupil of the eye and a horizontal line through the ala of the nose. From this point, a 23-gauge needle can be directed medially and cephalad until the infraorbital foramina is reached. The needle is then withdrawn slightly and 2 ml is injected. Through the same point of the skin entry, but directed medially, toward the ala, an additional 1 ml is injected. In neonates, the landmark is the midpoint of the line joining the angle of the mouth to the midpoint of the palpebral fissure. In adults, the landmark is the midpoint of the line joining the supraorbital ridge and the mental foramen. The last 2 ml is injected caudally and medially toward the lip. The same procedure is repeated on the opposite side with the remaining 5 ml of anesthetic solution, and the adequacy of anesthesia is ascertained after 5 minutes. After marking the skin, the surgeon infiltrates the edges with 5 ml of solution for hemostasis [16]. This technique does not anesthetize the nasal septum, the floor of the nose, or the premaxilla, and thus may not be suitable for wide clefts involving or requiring mobilization of tissue from any these areas. Thus, bilateral complete clefts with prolabium involvement may also be difficult to anesthetize using this approach. Furthermore, in revision surgeries, block of scarred tissue can be difficult due to primary cheiloplasty having distorted the innervation of the cleft lip.

Cheiloplasty or even cleft palate surgery in young children less than ten years old can be performed under regional anesthesia alone, although airway obstruction and respiratory complications should be carefully checked throughout the surgical procedure. As described above, avoiding morphine and other opioid agents in postoperative analgesia is beneficial for maintaining the patient's airway.

2. Maxillary nerve block

Although infraorbital nerve block is effective in most cleft patients, it does not provide effective analgesia in cases of associated cleft palate repair or to the cleft alveolus region. Specifically, the maxillary nerve provides sensory innervations of the anterior and posterior palate, the upper dental arch, the maxillary sinus, and the posterior nasal cavity. Maxillary nerve block through the infrazygomatic approach permits anesthesia of the entire palatine territory, but this nerve block is associated with several potential complications such as orbital puncture, intracranial injection, maxillary artery puncture, or posterior pharyngeal wall injury [17]. On the contrary, in the suprazygomatic approach, the puncture site is at the frontozygomatic angle, at the junction of the upper edge of the zygomatic arch and the frontal process. In the suprazygomatic approach, the needle is inserted perpendicular to the skin, and advanced to reach the greater wing of the sphenoid at a depth of approximately 20 mm, then withdrawn a few millimeters and redirected toward the nasolabial fold at a direction of 20 degrees forward and 10 degrees downward. The progression in the pterygopalatine fossa is 35 to 45 mm, and the anesthetic solution is injected after a negative aspiration test. Real-time ultrasound guidance can also be used to visualize the spread of local anesthetic solution in the pterygomandibular fossa [18].

CONCLUSION

Regional anesthesia, or 'nerve block,' is a form of anesthesia in which a specific part of the body is anesthetized. In general, regional anesthesia is ideal when the area of interest is innervated by a single superficial nerve. Unlike the upper and lower extremities, regional nerve block in the maxillofacial region has many advantages and benefits. Especially in the poor environment of developing countries, regional block can be used to facilitate safer and more efficient procedures.

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