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A Comparison of The Analgesic Effect of Ultrasound Guided Glossopharyngeal Nerve Block Versus Blind Technique in Post Tonsillectomy Pain Relieve in Children

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Abstract

This research aims to assess the efficacy of two glossopharyngeal nerve block (GNB) techniques for managing postoperative pain in children aged 3–7 years undergoing tonsillectomy. The study compares an ultrasound-guided peristyloid approach with a blind intraoral technique. Effective postoperative pain management is essential to prevent complications such as dehydration, infection, and secondary hemorrhage, thereby enhancing recovery and improving the convalescence period. Poor pain control can delay hospital discharge and interfere with the child's return to normal activities, making optimized analgesic approaches crucial. Key outcomes include comparing postoperative FLACC pain scores at 0, 2, 4, & 6 hours, both at rest & during swallowing. The study also assesses the time to the 1st request for analgesics, total analgesic consumption, procedural difficulty, and time required for execution. Additionally, surgeon and parent satisfaction levels are analyzed, contributing to a holistic evaluation of each technique's overall impact. Initial findings indicate that the ultrasound-guided GNB offers superior pain control compared to the blind intraoral method, with fewer side effects such as accidental vascular injury or nerve damage. The ultrasound-guided approach ensures precise anesthetic delivery, reducing potential complications and enhancing patient safety. However, challenges such as procedural complexity, the need for specialized training, and the availability of ultrasound equipment must be considered. Further large-scale studies with long-term follow-ups are essential to validate these findings, confirm safety profiles, and determine the most effective and practical technique for managing post-tonsillectomy pain in children, ultimately improving clinical outcomes.

Key words: *GNB; Ultrasound; Tonsillectomy.*

Introduction

Following surgery analgesia in pediatric cases after tonsillectomy is a critical issue. Effective pain relief following surgery is crucial following tonsillectomy, as pain can hinder swallowing, increase the risk of infection and dehydration, and subsequently cause hemorrhage, while also potentially obstructing rapid recovery & smooth convalescence. The pain reaches its peak intensity immediately post-operation and throughout the initial twenty-four hours. Elevated pain following surgery can postpone hospital discharge, hinder the return to school, & impact the kid's nutrition (1).

This study aimed at reducing pain following surgery after tonsillectomy in kids aged three to seven years of age.

Pain

Pain is probably the most prevalent clinical medicine complaint; comprehending its pathogenesis is essential for accurate interpretation in cases. It is beneficial to distinguish between the concepts of nociception and pain. Nociception denotes the identification of harmful stimuli by nociceptors, succeeded by the transmission & transduction of sensory neural data from the periphery to the brain. In contrast, pain denotes the outcome of processing by upper centers of the brain; it involves the genuine painful sensory & emotional produced by nerve impulses. Pain reports aren't only a direct result of nociception; they consist of interaction with several inputs (affective dimensions, attention, autonomic factors, immunological variables, & others) & are more fully appreciated from the perspective of a neuromatrix. (2).

Cellular Level

When chemical, thermal, or mechanical stimuli attain a harmful intensity indicative of injury, they are sensed by nociceptors, a particular group of peripheral nerve fibers located in the joints, skin, bone, muscle, & viscera. (3).

Organ Systems Involved

Nociceptors are located in the skin, viscera, bone, joints, & muscle; however, they are absent in the central nervous system, which explains the feasibility of awake craniotomy being non-painful for the case (4).

It is essential to recognize that the specific sensory modalities associated with nociception vary according to the tissue kind. (5).

Function of pain

The neural mechanisms for nociception & pain function automatically to reduce damage to tissue from environmental factors. It is essential to acknowledge that there are multiple operational classifications of the behavior of pain. Withdrawal, as a basic reflex activity, is mostly associated with acute injury pain; spinal reflexes trigger these responses upon activation of nociceptors. Nevertheless, more intricate behaviors are closely associated with brain pain circuits. For example, arm motions triggered in anticipation of a painful visual input need the synthesis of reflexive actions with advanced sensory, spatial, and temporal data. (6).

Mechanism of pain

Numerous mediators of inflammation, as previously detailed in this article, secrete a "soupof inflammatory mediators" near the injury site to activate nociceptors. Afferent nociceptors emanating from the periphery are responsible for transmitting noxious signals to projection neurons that are in the spinal cord dorsal horn. The cells that make up the dorsal horn are called laminae, and they are arranged in layers that are physiologically distinct from one another. Depending on the synapse type in the laminae created by the nociceptive fiber, a certain group of projection neurons will transmit information to the somatosensory cortex through the thalamus, giving information related to the spatial

characteristics & intensity of the painful stimulus. (7).

Related Testing to Estimate Pain

The complex, multifaceted, and subjective characteristics of pain render clinical measurement quite problematic. In recent decades, numerous validated measures have been developed to facilitate study on the processes of pain & the consequences of measurement. In the setting of acute pain management during surgical operations or acute mental disorders, the numeric rating scale (NRS) & visual analogue scale are the most commonly utilized methods for evaluating pain severity. Multidimensional instruments, like the Brief Pain Inventory & McGill Pain Questionnaire, were created for chronic pain assessment. These tools are primarily utilized in research settings, while novel experimental pain assessment methods, such as neuroimaging for objective evaluation, are being suggested. (8).

Clinical Significance of Pain

The attributes of pain of case provide insights into its pathophysiology. A short explanation of pain is therapeutically advantageous for pain management as both a symptom & a potential indicator of the causal disease.

Acute pain: The stimulation of nociceptive transducers at the location of local tissue injury provides this pain type. The environment of local injury may additionally modify the properties of central nociceptors, connections, & the autonomic nervous system. (9).

Chronic pain: Chronic pain is often associated with illnesses like arthritis, DM, & tumor proliferation, which exacerbate chronic tissue inflammation or modify the characteristics of peripheral nerves (neuropathic). Due to the persistent nature of chronic pain, it is anticipated that external factors like emotions, stress, & environmental conditions could cumulatively interact with the injured tissue and increase the severity and pain interval. (10).

Somatic pain: This type of pain can be either acute or chronic & is triggered by nociceptors in the superficial or deep tissues. Cutaneous somatic pain, such as that from skin laceration, is characterized as sharp or searing and is precisely localized. Somatic pain originating from deep tissues, including tendons, joints, and bones, is characterized by a throbbing or aching sensation & is less localized. (2).

Visceral pain: This pain primarily originates from the viscera as well as structures of deep somatic, such as that from the GIT. Visceral pain that lacks precise localization is transmitted by C fibers from deep tissues to the spinal cord. (11).

Neuropathic: This chronic pain frequently results from injury to nerve fibers, causing heightened spontaneous firing or changes in their neurotransmitter or conduction characteristics. (12).

Allodynia: Pain produced by a normally benign stimulus is termed allodynia. Although the mechanism remains incompletely elucidated, it is hypothesized to result from 1) skin sensitization, resulting in a lowered threshold of dormant nociceptors, or 2) injury to peripheral neurons causing structural alterations that prompt touch-sensitive fibers to reconfigure & establish synapses in regions of the spinal cord typically associated with pain transmission. (2).

Hyperalgesia: Arises when harmful stimuli elicit an amplified pain reaction. Analogous mechanisms to those suggested for allodynia, wherein cases exhibit pain amplification or hyperalgesia, alongside an extended duration of pain persistence. (13).

Referred pain: Referred pain manifests when pain is experienced in a region distinct from the source of the unpleasant stimulus, shown by sensations in the shoulders, neck, & back after a myocardial infarction. A consensus on the underlying mechanics of referred pain is lacking, with multiple explanations proposed. The pain that one has can be classified as either visceral, which originates from an organ, or somatic, which originates from deep tissues like joints or muscles. According to Ruch's convergent-projection theory, which was published in 1961, somatic fibers & afferent visceral sensory

pain fibers converge in the same spinal dorsal root ganglia segments. This causes the central nervous system to falsely perceive pain as coming from the body wall. (14).

pain following surgery in tonsillectomy

Following surgery, pain is a significant issue in both kids and adults having tonsillectomy. Safe and efficient anesthesia following surgery not only alleviates pain & related morbidity but also promotes early oral intake & sufficient hydration. Hultcrantz et al. found that the median recovery duration was approximately ten days for adults & seven days for kids, with pain peaking around three to five days post-surgery. Swedish research indicates that approximately thirteen thousand tonsillectomies are conducted annually in Sweden, with twenty-six percent of these cases seeking medical assistance for pain following surgery. In the United States, almost five hundred thousand cases younger than fifteen undergo tonsillectomy annually, with pain following the procedure persisting for one week in nearly half of these cases. Acute pain can induce physical pain, anxiety, & behavioral issues, whereas effective acute pain treatment can facilitate functional recovery & enhance long-term functional results. (15).

Management of post-tonsillectomy pain in kids

Despite the intense pain kids suffer from post-tonsillectomy, inadequate pain management is prevalent. The research revealed that a greater forty percent of kids had reduced doses of pain medication on the following surgery day, while sixty percent received diminished doses on day two following surgery. Caregivers commonly have difficulties in alleviating their child's suffering, often consulting primary care doctors or emergency clinics for assistance. The American Academy of Otolaryngology-Head & Neck Surgery has advised that healthcare providers educate cases and careers on the management of post-tonsillectomy discomfort throughout the preoperative education phase..."(16).

Pharmacologic management of post-tonsillectomy pain in children

Acetaminophen

Acetaminophen is perhaps the most commonly prescribed painkiller following tonsillectomy; nonetheless, many consider it insufficient alone, leading to its widespread consumption in conjunction with other drugs. Side effects are often modest; nevertheless, a significant dosage might result in severe liver damage and potentially fatality. In 2011, the Food and Drug Administration limited prescription combination drugs to a maximum paracetamol dosage of 325 milligrams and demanded the inclusion of a boxed warning to indicate the risk of serious liver harm. Intravenous administration during surgery has been studied to enhance perioperative analgesia and diminish opioid consumption, yielding diverse, however generally unsatisfactory, outcomes. The American Academy of Otolaryngology-Head & Neck Surgery advises administering paracetamol at a dosage of ten to fifteen milligrams. Per kilogram per dose every four to six hours, with the maximum dosage not exceeding the lesser of seventy-five milligrams/(kgd) or four thousand milligrams. (17).

Non-steroidal anti-inflammatory drugs (NSAIDs)

Previously rejected by numerous otolaryngologists, non-steroidal anti-inflammatory drugs (notably ibuprofen) have gained widespread acceptance as safe. The current Clinical Practice Guideline from the American Academy of Otolaryngology-Head & Neck Surgery designates ibuprofen as "safe & effective" & provides a "strong recommendation" for its utilization. Concerns with NSAID use in this setting predominantly stem from the potential for COX-1 inhibition to enhance the risk of postoperative hemorrhage due to its anti-platelet actions. An increasing amount of evidence substantiates the safety of ibuprofen following tonsillectomy. (18).

Opioids

Humans have utilized opioid analgesics for millennia. Opium is cited multiple times for diverse

applications in the writings of Hippocrates. Historically, codeine, an opium derivative, was a cornerstone of analgesic protocols in pediatric post-tonsillectomy care. Nonetheless, doubt regarding its effectiveness prompted clinical research in 2000, which revealed no analgesic advantage of acetaminophen/codeine compared to acetaminophen only, accompanied by much poorer oral intake, probably due to nausea & other gastrointestinal adverse effects associated with codeine. (19).

Corticosteroids:

In recent years, corticosteroids have undergone a transformation in their application during pediatric tonsillectomy, akin to that of NSAIDs. The potential negative impacts of corticosteroids on wound healing have rendered their use throughout or following tonsillectomy contentious. Czarnetzki et al. identified an elevated risk of hemorrhage following a solitary intraoperative administration of dexamethasone. Nonetheless, that discovery hasn't been corroborated in additional investigations involving many meta-analyses. A meta-analysis revealed a greater frequency of surgical intervention for hemorrhage (three percent versus 1.5 percent); however, it didn't identify a rise in the overall hemorrhage rate. This finding wasn't observed when considering only findings with minimal bias risk, and no dose-response relation has been established. (20).

Tonsillectomy

Anatomy and Physiology

The palatine tonsils constitute a part of Waldeyer's ring of lymphoid tissue. Additional components comprise adenoids, tubal tonsils, and lingual tonsils. The lymphoid tissue is delineated from adjacent musculature by a fibrous capsule originating from the pharyngobasilar fascia. The area among the capsule and muscle is referred to as the peritonsillar space. The tonsils are situated among the palatoglossus and palatopharyngeal muscles, which constitute both the front & back pillars, respectively. The superior constrictor muscle is positioned laterally to the tonsil. Directly behind these muscles lies the glossopharyngeal nerve, which is vulnerable to damage during tonsillectomy. Temporary edema surrounding this nerve may result in taste disturbances & transferred ear pain. (21).

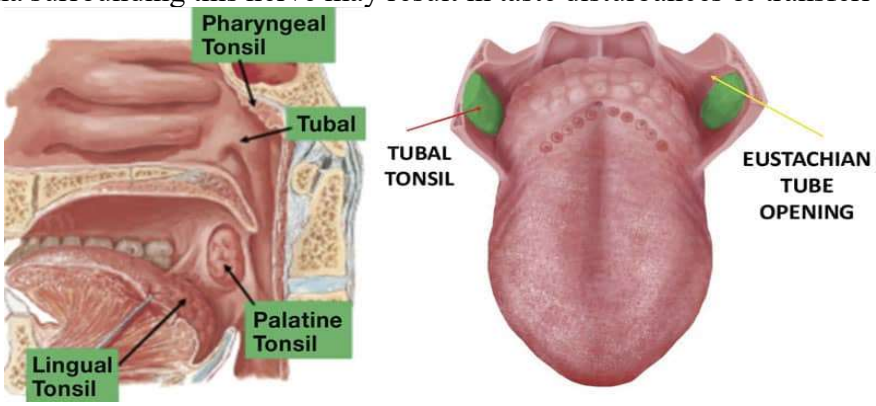


Figure (1): Anatomy of tonsils (22).

Epidemiology

Tonsillectomy, while less frequently conducted than in the past, is one of the most prevalent surgical operations among pediatric cases in the United States. Annually, around 530,000 tonsillectomies are conducted in kids and teens in the United States due to recurring throat infections or sleep-disordered breathing. (23).

Pathophysiology

The tonsils consist of three tissue masses: the pharyngeal (adenoid) tonsil, the lingual tonsil, and the palatine or facial tonsil. The tonsils consist of lymphoid tissue enveloped by respiratory epithelium,

which is invaginated, resulting in the formation of crypts. (24).

Indications

The primary indications for tonsillectomy are sleep-disordered breathing (SDB) & recurrent tonsillitis. Sleep-disordered breathing refers to the repeated partial or total obstruction of the upper airway throughout sleep, leading to disturbances in normal ventilation & sleep cycles. Diagnosis can be established through patient history & physical examination. Symptoms of sleep-disordered breathing involve hyperactivity, diurnal fatigue, and hostility. Signs of sleep-disordered breathing involve pronounced snoring, observed breathing disorders, restless sleep, growth impairment, poor academic performance, and nocturnal enuresis. Kids with sleep-disordered breathing exhibit significantly greater rates of antibiotic consumption, a forty percent rise in hospital visits, and a 215% rise in healthcare utilization due to heightened upper respiratory infections relative to kids without SDB. Tonsillar and adenoid hypertrophy are the predominant causes of sleep-disordered breathing. The size of the tonsils does not consistently correspond with the severity of sleep-disordered breathing, & polysomnography can further assess cases exhibiting signs and symptoms of SDB in the absence of tonsillar hypertrophy. (25,26).

Preparation

Anesthesia is administered in a consistent manner, irrespective of the procedure utilized. The case is placed in a supine position & has undergone oral intubation. Most surgeons favor oral RAE endotracheal tubes. The tube is secured at the midline using tape. The bed is subsequently rotated forty-five to 180 degrees to enable the surgeon to either sit or stand at the head of the bed, followed by the placement of a shoulder roll. A McIvor or Crowe-Davis mouth gag keeps the case's mouth in an open position. (27).

Postoperative Details

Administer liquid acetaminophen (Tylenol) with or without codeine for analgesia. The reluctance of parents to administer analgesics correlates with kids' refusal to eat, leading to weight loss, dehydration, & localized infection. Sutters et al. performed an investigation comparing scheduled following surgery opioid analgesia (acetaminophen and hydrocodone 167 milligrams/2.5 milligrams per five milliliters orally every four hours for three days) with as-needed opioid analgesia in children aged between the ages of six and fifteen following outpatient tonsillectomy. Kids in the scheduled-dose group had more analgesia than those in the PRN group (p-value less than 0.0001). Participants in the pro-re-nata group had elevated pain intensity levels (p-value equal to 0.017). The pain intensity scores were significantly elevated in the morning relative to the evening (p-value less than 0.0001). (28).

Complications

Common presentations

Hemorrhage

Hemorrhaging is a prevalent manifestation observed in general practice and emergency departments following tonsillectomy. Secondary post-tonsillectomy hemorrhages, characterized as hemorrhaging that transpires twenty-four hours or more following the procedure, are estimated to occur in around two to five percent of cases following tonsillectomy. The prevalence escalates with age and is more prevalent when the surgical indication is recurrent tonsillitis. While most occurrences are self-resolving and inconsequential, one group needs surgical or medical intervention. In some cases, hemorrhaging can be disastrous. Cases are advised to visit the emergency department in the event of bleeding; at present, many continue to consult their local physician. (29).

Pain

Post-tonsillectomy, moderate to severe pain is anticipated and is the most prevalent presentation to

general practitioners. Pain may be unilateral or bilateral and correlates with otalgia in fifty percent of patients. Otalgia usually elicits significant anxiety in patients & is commonly a basis for presentation with general practitioners. Pain may manifest unilaterally or bilaterally and can endure for a duration of up to five days. Pain may vary and often intensifies approximately four to five days following an initial enhancement. This aligns with peak wound inflammation. (30).

Fever

Fever occurring within the initial twenty-four to forty-eight hours following tonsillectomy isn't unusual. The rationale for this remains inadequately comprehended; still, hypotheses involve temporary bacteremia, an anesthetic drug, and an inflammatory reaction to tissue damage. Anand et al. identified no correlation among fever & positive throat and/or blood cultures obtained from the tonsillectomy sites. Literature indicates that fever may manifest in up to fifty percent of individuals within the first one to two days following tonsillectomy. A transitory fever that rapidly normalizes should not be managed with antibiotics. Persistent fever may signify an illness, warranting consideration of drugs. (31).

Oral intake

Merely fifty-five percent of kids will resume regular eating patterns by the conclusion of the 1st week post-tonsillectomy. A standard diet is frequently recommended upon discharge. Hall and Brodsky have indicated a pattern of reduced nausea & enhanced parental assessment of the kid's recovery when dietary restrictions were absent. Two previous investigations indicated that individuals consuming a regular diet following tonsillectomy had fewer subsequent hemorrhages compared to those on restricted diets. If kids are having difficulty eating & drinking, & dehydration is a concern, oral rehydration ice blocks are recommended. Any refusal of oral intake, involving analgesics or despite their administration, must be directed to the hospital where the procedure has been conducted for continued therapy. (32).

Uvula edema

Uvula edema frequently occurs post-tonsillectomy and may result from vigorous manipulation throughout the procedure or disruption of lymphatic or venous supply throughout tonsil dissection. This may lead to dysphagia or the sensation of an obstruction in the throat, a feeling that can cause concern for cases. Edema often cures spontaneously within several days; nevertheless, oral steroids may be necessary in severe cases. (33).

Halitosis

Halitosis frequently presents as a complaint to general practitioners following tonsillectomy and is among the primary symptoms resulting in unwarranted antibiotic prescriptions. Castellano et al. showed that halitosis affects almost seventy percent of cases and persists for an average duration of 5.2 days. Halitosis in isolation doesn't signify an infection, and cases along with their families must be assured that this condition is prevalent. Chewing gum may alleviate halitosis for cases who are concerned. (32).

Glossopharyngeal nerve block

The glossopharyngeal nerve descends from the jugular foramen, positioned postero-medial to the styloid process, along the posterior aspect of the stylopharyngeal muscle. It branches at the level of the middle constrictor to supply sensory impulses to the posterior 3rd of the tongue, the vallecula, the anterior surface of the epiglottis, the pharyngeal wall, and the tonsils. (34).

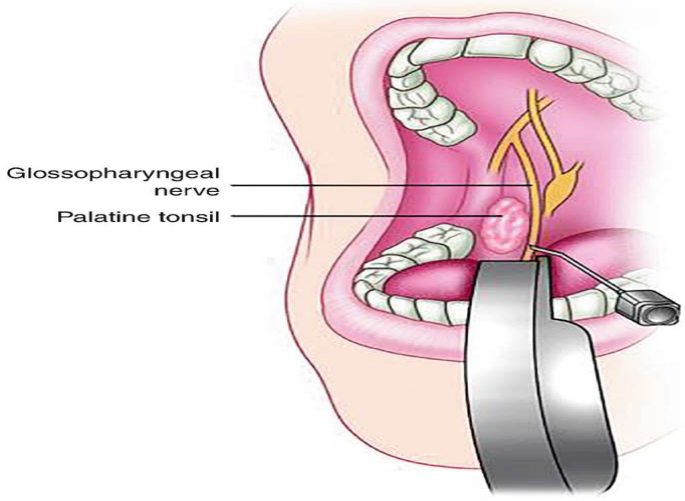


Figure (2): The glossopharyngeal nerve and tonsils (35).

Techniques of glossopharyngeal nerve block

The glossopharyngeal nerve arises from the posterolateral groove situated among the medullary olives and the pontine angle. It originally possessed three or four roots that subsequently merged into the neural stem. The stem traverses the jugular foramen & is encased in an independent nerve sheath prior to exiting the skull. The glossopharyngeal nerve traverses anterior to the internal jugular vein & internal carotid artery, then distributes to the mucosa of the palatine tonsil, pharynx, & posterior third of the tongue. (35).

Landmarks (36): The mastoid process, posterior and anterior tonsillar pillars, angle of the mandible, as well as maxillary premolar teeth.

Materials: Cartridge, local anesthetic solution.

Operator's position: Right GPNB: six o'clock position; left GPNB: the eight o'clock position, with the case's head at the twelve o'clock position.

Target area: Base of the tonsillar pillars in the submucosal plane.

Intraoral Glossopharyngeal Nerve Block (glossopharyngeal nerve block) - Each injection technique underscores the importance of aspiration prior to injection to prevent intravascular injection, which may lead to hematoma & ecchymosis. (37).

Anterior Tonsillar Pillar Method

22-gauge Quincke spinal needle implanted to a depth of half a centimeter at the anterior tonsillar pillar base (where the root of the tongue opposes the palatoglossal fold). Following negative aspiration, 5 cc of one percent plain lidocaine HCl was administered bilaterally via gradual injection. Authors noted that a volume of five milliliters of local anesthetic was utilized to achieve a superior laryngeal nerve block. Ninety-one percent of participants who got the block reported oropharyngeal discomfort lasting twenty-four hours or longer, while thirty-six percent had discomfort persisting for three days or more. Additionally, a significant antislavery effect was observed, persisting for eight hours or longer. According to Ramirez et al., clinical research involving a hundred individuals having upper gastrointestinal endoscopy demonstrated that glossopharyngeal nerve blocks with injection were superior to topical anesthetic. (38).

Glossopharyngeal nerve blocks

Intravenous midazolam Two to three minutes prior to the glossopharyngeal nerve block.22-gauge needle, thirty-two millimeters in length, utilizing a total of sixty milligrams of lidocaine (two percent solution)—thirty milligrams administered to each side. Medially retract the tongue with a needle

inserted submucosally at the base of the pillar, half a centimeter lateral to the tongue's base.The blockage has been confirmed with gag reflex stimulation after a latency of three minutes, following which the endoscopic surgery commenced."

Topical Anesthesia

The thirty milligrams of lidocaine spray was delivered in three successive periods of thirty seconds, each comprising ten sprays (ten milligrams for each dosage) of Xylocaine Pump Spray ten percent (Astra Zeneca).Midazolam was delivered and titrated two to three minutes later. (38).

Posterior Tonsillar Pillar Method

Injection of local anesthetic near the posterior tonsillar pillar base necessitates a broader mouth opening & tongue displacement for accessibility. (39).

Anterior Tonsillar Pillar Method

The tongue is positioned medially, resulting in reduced gag reflex, improved visibility, and greater tolerance compared to the posterior tonsillar method, which is universally endorsed as superior by others, involving Henthorn. Retraction creates a channel or groove down the floor of the mouth between the tongue and the teeth. The gutter terminates in a cul-de-sac located at the base of the anterior tonsillar pillar (palatoglossal arch).

Injection time

A 25-gauge spinal needle was placed 0.25 to 0.5 centimeters deep at the base of the palatoglossal arch, positioned immediately lateral to the base of the tongue. Aspirate; if air is aspirated, withdraw the device since it has been inserted too deeply; do not inject if blood is aspirated. Two milliliters between one and two percent lidocaine is administered (as an alternative to a cotton-tipped swab saturated with four percent lidocaine). (40).

Extraoral approach

The extraoral technique first utilized the styloid process as a reference point, resulting in low precision and significant adverse effects. Currently, many imaging modalities such as ultrasound, X-ray, & computed tomography (CT) are employed for positioning purposes. Ultrasound is an uncomplicated & highly effective placement method throughout perioperative analgesia. (41).

Complications of GPN block

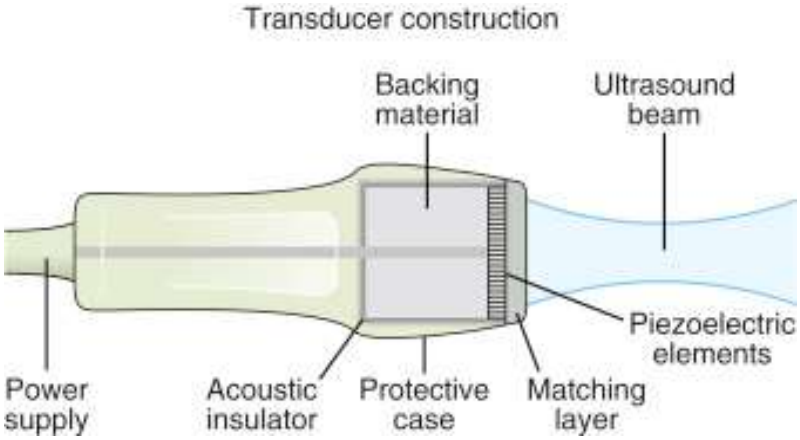
The complications of the glossopharyngeal nerve block are contingent upon the selected strategy for the block. Intraoral & ultrasound-guided techniques may result in hematoma or necessitate local anesthetic administration. Ultrasound-guided transstyloid techniques may induce dysphagia, but vagus nerve blockade might result in reflex tachycardia, bradycardia, vocal cord paralysis, & syncope. Unintentional obstruction of the carotid sinus nerve may result in hemodynamic variations. (36).

Ultrasound guidance in regional anesthesia

The sound spectrum: Sound is a mechanical form of energy. A vibrating source generates sound. The sound spectrum is categorized into three segments: audible sound, which is detectable by the human ear, ranging from twenty hertz to twenty thousand hertz; infrasound; and ultrasound. (42).

Generation and detection of US waves

The piezoelectric phenomenon: The technique for generating high-frequency vibrations, demonstrated by certain crystalline materials, entails the reversible transformation of mechanical and electrical energy into one another. Piezo denotes pressure. When piezoelectric material crystals are subjected to compression or tension, an electric charge manifests on their surface. Mechanical energy will be converted into electrical energy. (43).



Transducer fabrication. Electrical current stimulates the piezoelectric components, producing sound waves. The matching layer reduces reverberations as sound waves propagate to the skin. The backing material attenuates crystal vibrations to inhibit unexpected, sustained sound wave propagation. An acoustic insulator, electrical shield, and casing isolate the piezoelectric elements from extraneous acoustic & electrical interference. (44).

US transducer: These are devices that convert one form of energy to another. It is composed of: a crystal element. Electric connections. Backing material. Transducer housing. Acoustic insulator.

Display modes

The amplitude (A) mode is limited to presenting one-dimensional information & so doesn't qualify as an image.

The bright (B) mode: Signals from returning echoes are represented as dots of variable intensities, and the aggregated information from several scan lines yields a two-dimensional representation of the cross-section traversed by the beam. (45).

The motion (M) mode: utilized to create an electronic record of a mobile object situated along the trajectory of the US beam. The M mode offers one-dimensional data along the beam path, which is very advantageous for assessing heart motion. (46).

The Doppler mode: The Doppler effect refers to the perceived discrepancy in frequency among the sound generated by a source and that detected by a receiver. The Doppler shift can be quantified to detect motion, identify the direction of movement, and calculate the velocity of a moving object. In clinical ultrasound, the Doppler mode is utilized for the assessment of blood flow and heart motion. (45).

Characteristics of needles in US nerve block

Needle visibility is an essential criterion for an effective and secure US-guided nerve block. The criteria for the needle utilized in nerve blocks include the needle's echogenicity, the picture quality produced by various ultrasound equipment, and the influence of varied insertion angles on image quality. (47).

Performing US-guided nerve block

Technique: The initial stage in a US-guided nerve block is to optimize all modifiable ultrasound parameters, such as penetration depth and frequency, according to the specific type of block to be executed. (48).

Type of needle: In adults, a 2.5-centimeter or five-centimeter, 22-gauge insulated needle is commonly utilized. A short-beveled needle, 22-25 gauge and thirty to fifty millimeters in length, is utilized in pediatric patients. (47).

Types of transducers: The two primary types of transducers that are utilized for nerve blocks are linear array & micro convex (curvilinear) transducers. The linear array transducer transmits high-frequency ultrasound beams in a linear configuration, producing rectangular-shaped scans. These transducers possess a broader footprint than microconvex probes & are more effective for imaging superficial structures (such as axillary nerve block & interscalene nerve block). (48).

Sono anatomy: Hyperechoic structures appear white on screen, while hypoechoic structures are dark or black. Tendons and fascia are hyperechoic, while myelinated axons are hypoechoic due to their fat content. Arteries and veins are anechoic or empty, appearing black on US. Doppler helps distinguish arterial and venous vessels. Muscles, fat, and bone are hyper- and hypoechoic, respectively. Local anesthetic is hypoechoic, resulting in the doughnut sign. Anisotropy occurs when US waves travel in one direction and are reflected in a different plane, causing hypoechoic structures to appear hypoechoic (49).

Needle insertion: Two needle insertion options are in-plane insertion, which inserts the needle longitudinally or parallel to the probe axis, and transverse insertion, which is perpendicular or tangential and called out-of-plane insertion. Longitudinal insertion allows for a visible needle length, but the distance to the target is longer. Transverse insertion reduces distance but may be difficult to visualize (50).

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