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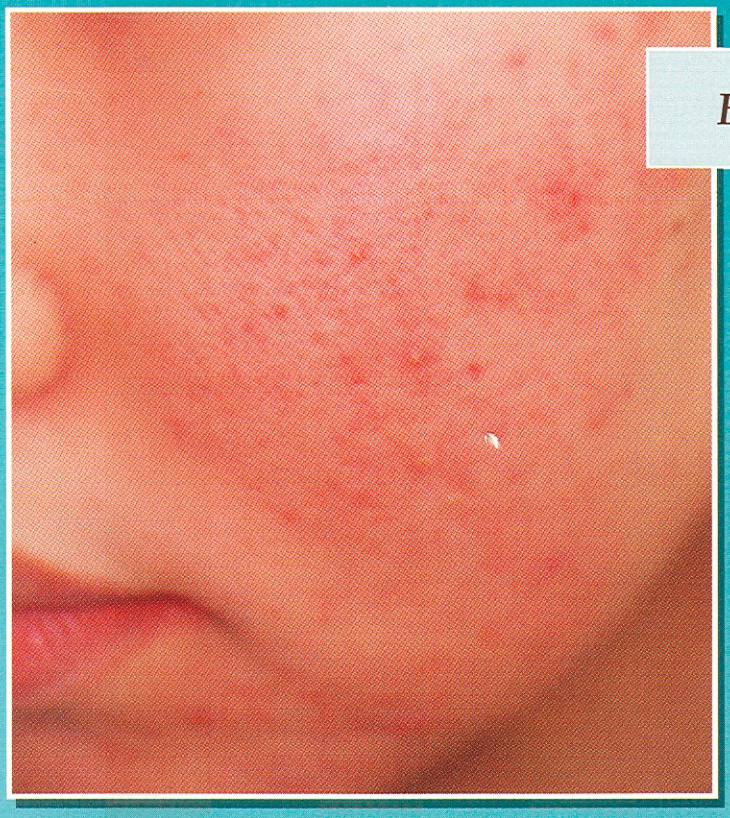

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Local Anesthetic Blocks for Cosmetic Surgery

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Local Anesthetic Blocks of the Head and Neck for Cosmetic Facial Surgery, I: A Review of Basic Sensory Neuroanatomy

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Minimally invasive cosmetic procedures for the face are gaining in popularity. Many procedures being performed do not warrant general or intravenous anesthesia but do call for pain control beyond that of topical anesthesia. Nonablative skin resurfacing, lip implants, and treatments with some of the new injectable fillers are examples of procedures that require or are enhanced by local anesthetic blocks. Although most physicians receive formal training in local anesthesia, both novice and seasoned cosmetic surgeons can benefit from a review of basic sensory neuroanatomy and techniques in administering local anesthetics. This article, the first in a 5-part series, reviews the history of local anesthetics and basic sensory neuroanatomy of the head and neck. Being familiar with this material can help cosmetic surgeons effectively use local anesthetic blocks, thus enhancing patient treatment and outcomes.

Proficiency in local anesthesia techniques is integral to a successful cosmetic surgery practice. From the standpoint of patient care, it is important to ensure painless treatment with predictable outcomes. Rushing through a procedure because of inadequate pain control is a bad experience for both the surgeon and the patient, and can affect surgical outcomes. Providing adequate pain control for patients also has an impact on the growth and marketing of a practice because a physician who performs in a gentle, painless manner gets many word-of-mouth referrals. A cosmetic surgeon who fails to use adequate pain control techniques will lose patients.

Although some patients request topical or injectable anesthetics for small-needle procedures that involve the injection of botulinum toxin type A or fillers, many patients "grin and bear it." Bovine dermal collagen plus 0.3% lidocaine (Zyplast®) contains lidocaine and the injection area is rendered insensate during treatment. The new hyaluronic acid fillers (Restylane® and Perlane®) and calcium hydroxylapatite filler (Radiance™ FN), however, contain no local anesthetics. In addition, Perlane requires a 27-gauge needle and Radiance FN requires a 26-gauge needle to accommodate viscosity and particle-size variations. One advantage of these new fillers containing no local anesthetics is that no overcorrection is necessary; however, the disadvantage is that there is no inherent local anesthesia effect. Many new nonablative resurfacing techniques now being developed do not require general or intravenous anesthesia, but they frequently call for pain control beyond that of topical anesthetics. As these new procedures and fillers become available, the author predicts that more cosmetic surgeons will be refining their local anesthesia techniques, as augmentative pain control will be required. Once mastered, local anesthesia techniques can assist cosmetic surgeons far beyond the scope of injectable anesthetics. Local anesthetics can be used for lesion removal, implant placement, laser procedures, and a host of other uses to obtund pain associated with cosmetic procedures of the head and neck.

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History of Local Anesthetics

One of the most notable advancements in the past century was the discovery of local anesthesia. Prior to the advent of local anesthetics, patients literally "bit the bullet" and had no options for dealing with pain. Inebriation was a common practice, but ethanol offered little analgesia.

Cocaine was the first local anesthetic to be widely used in surgical applications. In the 19th century it was reported that the Indians of the Peruvian highlands chewed the leaves of the coca plant (*Erythroxylon coca*) for its stimulating and exhilatory effects.[1-3] It was also observed that these Indians had numbness in the areas around the lips. In 1859, Albert Niemann, a German chemist, was given credit for being the first to extract the isolate cocaine from the coca plant in a purified form.[4] When Niemann tasted the substance, his tongue became numb. This led to one of the most humane discoveries in all of medicine and surgery. More than 2 decades later, renowned psychoanalyst Sigmund Freud began treating patients with cocaine for its physiologic and psychologic effects. A colleague treated for morphine dependence subsequently developed cocaine dependence.[4]

While he was a resident at the University of Vienna Ophthalmologic Clinic, ophthalmologist Carl Koller demonstrated the topical anesthetic activity of cocaine on the cornea in animal models and on himself. In 1894, Koller used cocaine for local anesthesia in an operation for glaucoma.[2-5]

William Halsted was a prominent American surgeon who investigated the principles of nerve block using cocaine. In November 1884, Halsted performed infraorbital and inferior alveolar nerve block (mandibular dental block) and demonstrated various other regional anesthetic techniques.[4] Halsted's self-experimentation with cocaine left him addicted. He spent 2 years resolving his addiction and regaining his eminent position in surgery and teaching.[4]

Early dentists dissolved cocaine hydrochloride pills in water and drew this mixture into a syringe to perform nerve infiltrations and blocks. The extreme vasoconstrictive effects of cocaine often caused tissue necrosis, but nonetheless provided profound local anesthesia that revolutionized dentistry and medicine forever. Many proprietary preparations of that time contained cocaine (Figure 1).

By the early 1900s, cocaine's adverse effects had become well recognized. The potential deleterious reactions to the drug included profound cardiac stimulation (cocaine blocks the neuronal uptake of norepinephrine in the peripheral nervous system), central nervous system stimulation, and mood-altering effects.[6,7] These adverse events have proven lethal in sensitive individuals. Coupled with severe physical and psychological dependence, the effects proved to be significant drawbacks to the use of cocaine for local anesthesia.

In 1904, Alfred Einhorn, searching for a safer and less toxic local anesthetic, synthesized procaine (Novocain).[4,8] Novocain was the gold standard of topical anesthetics for almost 40 years when Nils Lofgren synthesized lidocaine, the first amide group of local anesthetics.[4] Lidocaine provided advantages over the ester group (procaine), including greater potency, less potential for allergic reactions, and a more rapid onset of anesthesia.[1,2,9,10]

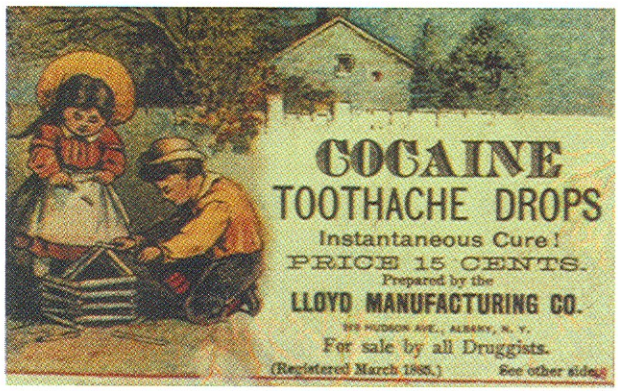

Figure 1. A sign indicating the use of cocaine in early dentistry.

Mechanism of Action of Local Anesthetics

Local anesthetics block the sensation of pain by interfering with the propagation of impulses along peripheral nerve fibers without significantly altering normal resting membrane potential.[11] Local anesthetics depolarize the nerve membranes and prevent achievement of a threshold potential. A propagated action potential fails to develop and a conduction blockade is achieved. This occurs by the interference of nerve transmission by blocking the influx of sodium through the excitable nerve membrane.[12]

Sensory Anatomy of the Head and Neck

The main sensory innervation of the face is derived from cranial nerve V (the trigeminal nerve) and the upper cervical nerves (Figure 2).

The Trigeminal Nerve

The trigeminal nerve is the fifth of the 12 cranial nerves. Its 3 branches originate at the semilunar ganglion (gasserian ganglion) located in a cavity (Meckel's cavity) near the apex of the petrous part of the temporal bone. These 3 large nerves—the ophthalmic, maxillary, and mandibular—proceed from the ganglion to supply sensory innervation to the face (Figure 3).

Often referred to as "the great sensory nerve of the head and neck," the trigeminal nerve is named for its 3 major sensory branches. The ophthalmic nerve (V1), maxillary nerve (V2), and mandibular nerve (V3) are literally *3 twins* (trigeminal), carrying sensory information of light, touch, temperature, pain, and proprioception from the face and scalp to the brainstem. The commonly

continued on page 519

continued from page 516

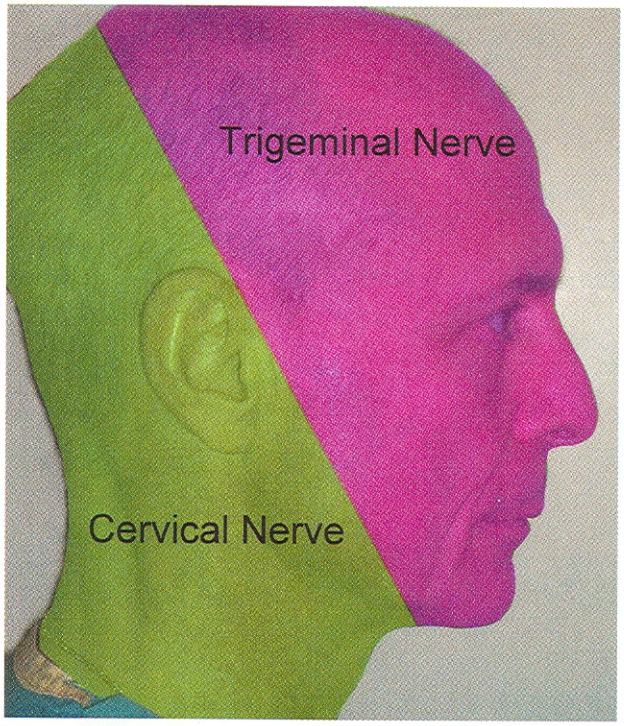

Figure 2. The sensory innervation of the head and neck is derived from the trigeminal and upper cervical nerves.

used terms V1, V2, and V3 are shorthand notation for cranial nerve V, branches 1, 2, and 3, respectively. In addition to nerves carrying incoming sensory information, certain branches of the trigeminal nerve also contain nerve motor components. (The ophthalmic and maxillary nerves consist exclusively of sensory fibers; the mandibular nerve is joined outside the cranium by the motor root.) These outgoing motor components include branchial motor nerves (nerves innervating muscles derived embryologically from the branchial arches) as well as "hitchhiking" visceral motor nerves (nerves innervating viscera, including smooth muscle and glands). The trigeminal nerve exits the trigeminal ganglion and carries sensory information to the mid-lateral aspect of the pons at the brainstem.[13]

The ophthalmic nerve (V1) leaves the semilunar ganglion through the superior orbital fissure. The maxillary nerve (V2) leaves the semilunar ganglion through the foramen rotundum at the skull base, and the mandibular nerve (V3) leaves the semilunar ganglion through the foramen ovale at the skull base[13] (Figure 3, inset). The remainder of this article discusses the sensory components of this nerve system as they relate to local anesthetic blocking techniques for cosmetic procedures for the face.

Ophthalmic Nerve (V1)

The ophthalmic nerve, or first division of the trigeminal, is a sensory nerve. It supplies branches to the cornea, ciliary body, and iris; to the lacrimal gland and conjunctiva; to part of the mucous membrane of the nasal cavity; and to the skin of the eyelids, eyebrow, forehead, and upper lateral nose (Figure 3, V1). It is the smallest of the 3 divisions of the trigeminal and divides into 3 branches, the frontal, nasociliary, and lacrimal.[13] The frontal nerve divides into the supraorbital and supratrochlear nerves, providing sensation to the forehead and anterior scalp. The nasociliary nerve divides into 4 branches, two of which supply sensory innervation to the face. These 2 branches are the infratrochlear nerve, which supplies sensation to the skin of the medial eyelids and side of the nose, and the ethmoidal nerve, which gives off a terminal branch called the external (or dorsal) nasal nerve and innervates the skin of the nasal dorsum and tip. The lacrimal nerve also innervates the skin of the upper eyelid.

Maxillary Nerve (V2)

The maxillary nerve, or second division of the trigeminal, is a sensory nerve that crosses the pterygopalatine fossa, then traverses the orbit in the infraorbital groove and canal in the floor of the orbit, and emerges on the face at the infraorbital foramen as the infraorbital nerve.[13] At its termination, the nerve divides into branches that spread out on the side of the nose, the lower eyelid, and the upper lip, joining with filaments of the facial nerve.[13] Terminal branches of the maxillary nerve include the zygomatic, zygomaticotemporal, and zygomaticofacial nerves.

The zygomatic nerve arises in the pterygopalatine fossa, enters the orbit by the inferior orbital fissure, and divides at the back of that cavity into 2 terminal branches, the zygomaticotemporal and zygomaticofacial nerves.

The zygomaticotemporal branch runs along the lateral wall of the orbit in a groove in the zygomatic bone, then passes through a foramen in the zygomatic bone, and enters the temporal fossa. It ascends between the bone and substance of the temporalis muscle and pierces the temporal fascia approximately 2.5 cm above the zygomatic arch, where it is distributed to the skin of the side of the forehead (Figure 3, V2).[13]

The zygomaticofacial branch passes along the inferior lateral angle of the orbit, emerges on the face through a foramen in the zygomatic bone, and perforates the orbicularis oculi muscle. It supplies sensation to the skin on the prominence of the cheek (Figure 3, V2).

As the maxillary nerve traverses the orbital floor and exits the infraorbital foramen, it branches into a plexus of nerves, which has 3 terminal branches. The inferior palpebral branches ascend behind the orbicularis oculi muscle and supply sensation to the skin and conjunctiva of the lower eyelid (Figure 3, V2). The lateral nasal branches (rami nasales externi) supply sensation to the skin on the side of the nose (Figure 3, V2). The superior

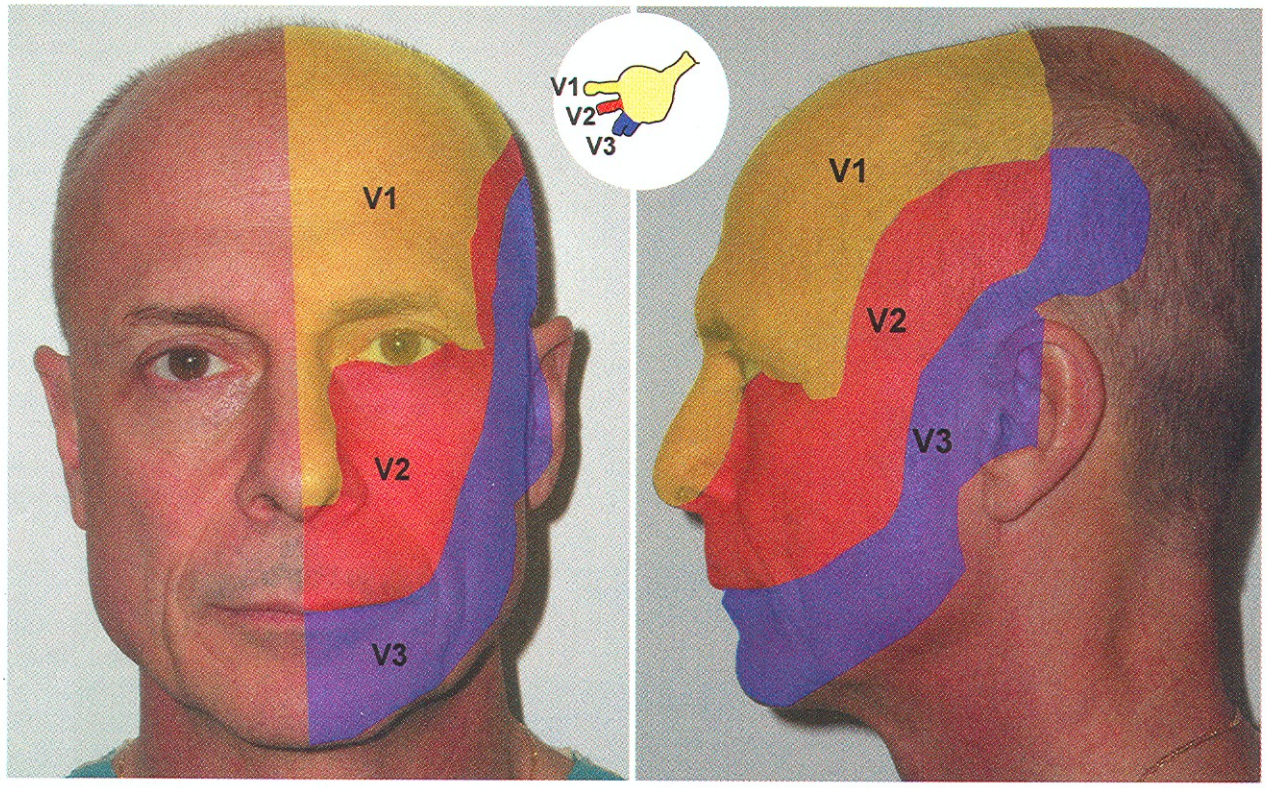

Figure 3. The main branches of the trigeminal nerve that supply sensation to the respective facial areas. The inset shows the trigeminal ganglion with the 3 main nerve branches.

labial branches are distributed to the skin of the upper lip, the mucous membrane of the mouth, and the labial glands (Figure 3, V2).[13]

Mandibular Nerve (V3)

The mandibular nerve supplies sensation to the teeth and gums of the mandible, the skin of the temporal region, part of the auricula, the lower lip, and the lower part of the face (Figure 3, V3). The mandibular nerve also supplies sensation to the muscles of mastication and the mucous membrane of the anterior two thirds of the tongue. It is the largest of the 3 divisions of the fifth cranial nerve and is made up of a motor and sensory root.[13]

There are 3 sensory branches of the mandibular nerve. The auriculotemporal nerve supplies sensation to the skin covering the front of the helix and tragus (Figure 3). The inferior alveolar nerve is the largest branch of the mandibular nerve. It descends with the inferior alveolar artery and exits the ramus of the mandible to the mandibular foramen. It then passes forward in the mandibular canal, beneath the teeth, and as far as the mental foramen, where it divides into 2 terminal branches, the incisive and mental nerves. The incisive nerve supplies sensation to the lower incisors. The mental nerve emerges at the mental foramen, and divides into 3 branches: one descends to the skin of the chin, and two ascend to the skin and mucous membrane of the lower lip.[13] The buccal nerve supplies sensation to the skin over the buccinator muscle.

Summary

Failure to provide adequate local anesthesia can negatively affect treatment outcomes and patient and physician satisfaction with cosmetic surgery procedures for the face. A firm understanding of basic sensory neuroanatomy of the head and neck can aid cosmetic surgeons in mastering techniques for the optimal delivery of local anesthetic blocks, ultimately enhancing patient treatment, satisfaction, and outcome.

Part 2 of this series will discuss specific local anesthetic blocks of the head and neck.

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continued on page 522

Sensory Neuroanatomy

continued from page 520

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