Review Article

Narrative review of ultrasound-guided interventions as diagnostic and therapeutic tool in orofacial pain

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Background and Objective: Orofacial pain refers to any type of pain in the area bounded by the eyes and the lower mandible including the oral cavity. It is very challenging to diagnose these conditions. Ultrasound-guided interventions help in diagnosis and treatment of these conditions. We describe a narrative review of all related interventions.

Methods: The data was collected from databases (PubMed, EMBASE, Scopus, ISI Web of Knowledge, Cochrane library) using keywords "orofacial pain", "ultrasound intervention", "nerve block", "headache" and "new modalities" and 250 articles were identified and approximately 80 relevant English full text articles were included in this narrative review

Key Content and Findings: Orofacial pain is classified into 6 categories as per International Classification on Orofacial Pain (ICOP). The treatment options have been discussed in overview. Ultrasound interventions namely atlanto-axial and atlanto-occipital joint injection, greater, lesser and least occipital nerve block, infra-orbital nerve block and Stellate ganglion block are being elaborately described in this review. Various approaches of the blocks have reviewed and safest method under ultrasound guidance has been discussed in detail.

Conclusions: Several, diagnostic, and therapeutic indications of nerve blocks have emerged for management of orofacial pain. The use of ultrasound has improved the safety and efficacy of blocks.

Keywords: Ultrasound interventions; orofacial pain; headache; nerve block; idiopathic facial pain

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Introduction

Description of pain in the area bounded by the eyes and lower mandible including the oral cavity is defined as an orofacial pain (Indian Association of Orofacial Pain) (1). Recently, International Classification on Orofacial Pain (ICOP) has been proposed to ameliorate the clinical management and research through comprehensive refined diagnostic criteria (2). In width, six broad categories have been set out with multi-level subcategories.

It is estimated that a vast proportion of all orofacial pains are constituted by dental aches and disorders of temporomandibular joint (3-5). Management of a complex orofacial pains ordinarily requires a collaborative tack of a dentist and a pain physician and is often challenging. The clinician needs to have solid knowledge of the pain conditions that arise from these structures for proper diagnosis and a multidisciplinary approach of management is strongly recommended (6). Contrariwise, advanced imaging modalities for diagnosis and handling of orofacial pains has revolutionized patient care.

The utility of ultrasonography (US) in performing target specific nerve blocks has metamorphosed pain management as they provide radiation free environment

Table 1 Search strategy summary

Ideas	Specification
Date of search	28th October, 2021
Databases and other sources searched	PubMed, Embase, Ovid Medline, Cochrane, Scopus, ISI Web of knowledge
Search terms used	("nerve block"[MeSH Terms] OR ("nerve"[All Fields] AND "block"[All Fields]) OR "nerve block"[All Fields] OR ("nerve"[All Fields] AND "blocks"[All Fields]) OR "nerve blocks"[All Fields]) AND ("orofacial pain"[MeSH Terms] OR ("orofacial pain "[All Fields] AND "headache"[All Fields] AND "ultrasound interventions"[All Fields]) OR "orofacial pain syndromes"[All Fields] OR ("oral pain"[All Fields] AND "facial pain"[All Fields]) OR "orofacial pain disorders"[All Fields])("ultrasound"[All Fields] OR "interventions"[All Fields] OR "us-guided"[All Fields] OR "interventions"[All Fields] OR "interventions"[MeSH Terms] OR "ultrasound-guided"[All Fields] OR "procedures"[All Fields] OR "intervention"[All Fields] OR "interventional"[All Fields] OR "ultrasound intervention"[All Fields] OR "us-guided "[All Fields] OR "us-guided interventions"[All Fields]) AND ("orofacial pain"[MeSH Terms] OR ("orofacial "[All Fields] AND "joint"[All Fields] AND "headache"[All Fields]) OR "orofacial pain"[All Fields] OR ("facial pain"[All Fields] AND "syndromes"[All Fields]) OR "orofacial pain"[All Fields])
Time frame	2000–2022
Inclusion and exclusion criteria	Clinical trials, research studies, case reports, case series, systematic reviews were included. Studies that irrelevant to the current topic, or did not have the focused question, keywords were excluded
Selection process	Two authors MT, SN independently searched indexed databases using MeSH terms and screened the titles and abstracts of the identified studies. Disagreements were solved through mutual discussion between authors and in case of a lack of consensus through discussion involving a third author (SS)

with real time visualization of structures to be blocked including joint space, nerve, blood vessels and drug administration (6,7). We present the following article in accordance with the Narrative Review reporting checklist (available at https://joma.amegroups.com/article/view/10.21037/joma-22-19/rc).

Objective

Various approaches have been described for ultrasound-guided procedures, like in plane and out of plane approach for cervical medial branch block (7-9). The purpose of this review is to describe and illustrate the basic ultrasound guided approaches used for pain handling in common orofacial pain with better efficacy and safety profile (10).

Methods

The data was collected from all indexed journals from the year 2000 to 2022, with keywords of ultrasound interventions, orofacial pain, various approaches (*Table 1*).

Comprehensive US-guided interventions for orofacial pains

Interventional US for orofacial pain should be performed using a coherent approach to aid patient well-being. The patient position is personalized to block specification to achieve ideal ergonomics. A high-frequency (9–15 MHz) linear array transducer is used for imaging. In-general, relevant anatomy is identified and colour doppler is employed to confirm vascular structures. The pertinent block anatomy, US technique and frequent indications are individually described methodically (*Table 2*).

Orofacial pains presentation similar to primary headache

Atlanto-axial (AA) and atlanto-occipital (AO) block

AA-AO joint pain often has a variable presentation. They frequently present with an occipital headache. Establishing a diagnosis requires an intraarticular injection of AA/AO joint which is usually therapeutic. Conventionally, fluoroscopic guidance has been the standard of care (11-13).

Table 2 Overview of classification of orofacial pain

Serial No.	Classification	Treatment	Other interventions available
1	OFP related to dentoalveolar structures	Conservative treatment	–
2	Myofascial orofacial pain	Conservative treatment	Trigger point injections with LA and steroid
3	Temporomandibular joint pain	Conservative treatment	Surgical correction
4	OFP attributed to lesion or disease of cranial nerve:	Gasserian ganglion block	RFA of Gasserion ganglion
	Trigeminal neuralgia	Infraorbital nerve block	Cryoneurolysis of infraorbital nerve
	Glossopharyngeal neuralgia	Glossopharyngeal nerve block	Surgical correction of styloid process
5	OFP resembling presentation of primary headaches:		
	Cluster headache	Sphenopalatine ganglion block	Cryoneurolysis of GON and LON
	Occipital headache	Greater and lesser occipital nerve block	–
		Third occipital nerve block	–
	Cervicogenic headache	Atlanto-occipital block	RFA of cervical medial branch
		Cervical medial branch block	–
6	Idiopathic orofacial pain	Stellate ganglion block	–
		Sphenopalatine ganglion block	RFA of sphenopalatine ganglion

OFP, orofacial pain; LA, local anesthetics; RFA, radiofrequency ablation; GON, greater occipital nerve; LON, lesser occipital nerve.

It is however limited by lack of visualization of the vertebral artery (VA) and the dural sleeve thereby possessing an inadvertent threat.

Early, ultrasound approaches for AA/AO injections proclaimed feasibility (13,14). More technically reliable approaches evaluating various patient positions, needle trajectory and different US views have since been described (14,15).

Technique

AA joint injection

Patient is asked to lay in a prone position with a pillow placed underneath the chest to allow for slight head flexion. A high-frequency ultrasound transducer is placed over the occiput. Scanning cranio-caudally, the probe is then aligned in the midline over the cervical spinous processes to identify the first bifid spinous process; that of C2. Probe is then slid laterally to view the AA joint (C1-C2). VA is viewed further laterally and is confirmed by applying color doppler. An in-plane approach is then utilized to place the needle in joint space under vision.

AO joint injection (14)

In a slight head flexed-prone position, the probe is placed longitudinally below the mastoid process. The transducer is then moved medially till C1 transverse process is visualized. A color doppler is then utilized to confirm the VA. A more medial displacement leads to disappearance of the VA from the view as it runs anterior to spinal cord. Further medially the AO joint is then visualized usually corresponding to the midpoint of occipital protuberance and mastoid process. Targeting the joint, the needle is inserted in-plane.

Greater occipital nerve block (GON)

GON block has found significant utility in pain medicine as it is supported by evidence in mitigating various orofacial pains such as occipital neuralgia, cervicogenic headache, cluster headache and migraine (16).

GON has been conventionally targeted just medial to the pulsation of the occipital artery at the level of the superior nuchal line. It is however limited by significant variability and multiple branching (17). A more consistent site is where it curves around the obliquus capitis inferior muscle (OCIM) and is an important landmark for visualizing the GON at the C2/C1 level under US guidance (18).

Technique (16)

Position of the patient may vary as per clinician preference. However, a lateral decubitus position may offer greater operator and patient comfort whilst preserving hemodynamics. Keeping the patient head in neutral position and the cervical spine in anteflexion is advised.

A linear high frequency probe is placed over the occipital protuberance. Scanning caudad the bifid spinous process of C2 is recognized. The probe is then moved laterally to visualize the OCIM. The muscle appears hypoechoic, posterior to the lamina of the axis and deep to the semispinalis capitis muscle (SsCM). GON is observed as an oval-shaped hypoechoic structure interposed between OCIM and SsCM. A color doppler is advised to obviate the VA which lies anterior to OCIM and more lateral. An in-plane needling from lateral to medial direction is preferred. Hydrodissection of the intermuscular plane may be desired to expose the nerve.

Third occipital nerve (TON) block and cervical medial branch block

The cervical zygapophysial joints are burdened by the axial load on the cervical spine and undergo constant wear and tear, many-a-time triggering pain. The articular branches of the medial branch from the cervical dorsal rami provide the innervation. Additionally, pain generating nociceptive elements on the facet joint, and capsule has been described (19).

These diarthrodial joints predominantly have a dual innervation from the medial branch above and below its location. The C3-C7 spinal nerves give rise to their respective dorsal rami. The medial branch of C3 has a distinct anatomy. A deeper division supplies the C3-C4 zygapophysial joint. The superficial component of the C3 medial branch is denoted as the TON. It provides articular branches to the C2-C3 zygapophysial joint and subsequently becomes cutaneous to supply suboccipital region.

Blocks performed are diagnostic and generally therapeutic. Failure to achieve analgesia should prompt a repeat confirmatory block at a different instance in time to minimize the false positives (20).

Technique

Cervical medial branch block

Procedure is routinely executed in a prone position which facilitates performance of bilateral injection. A suitable transducer is stationed in the sagittal plane over the cervical spinous processes. The desired cervical level is ascertained. Moving the probe laterally, firstly, the lamina and then the facet joint is identified. The typical sono-image of the facet column is described as the 'saw sign'. The medial branch can be appreciated as a hyperechoic structure at the deepest point between the articulations. Specific medial branch is then targeted using in-plane needling. The C7 medial branch demonstrates anatomical variation to other medial branches and is located caudad to the C6/C7 facet joint but cranial to superior edge of posterior tubercle of C7 transverse process (21) (*Figure 1*).

TON block

In the lateral position, a high frequency linear probe is placed longitudinally over the mastoid parallel to the spine. Probe is then aligned to view the C1-C2 transverse process. A pulsatile VA is located deep in the interstice. Advancing the probe in posterior and caudad direction, the articulation of the arch of atlas and the articular pillar of C2 is noted and centralized. A rotatory movement aids recognition of TON as an oval hypoechoic structure with hyperechoic spots (22,23). Needling is carefully accomplished in the short axis, depositing the drug alongside the nerve.

Orofacial pain attributed to disease or lesion of cranial nerve and branches

Infra-orbital nerve block

A vast majority of neuropathic pain over the face is attributed to infraorbital division of the maxillary nerve (second division of the trigeminal nerve) (24). The nerve provides cutaneous innervation to lower eyelid, lateral side of the nose and the upper lip through its sensory branches, namely the inferior palpebral, the lateral nasal, and the superior labial (18,24,25).

Traditionally, infraorbital nerve block has been performed using anatomical landmarks with varying success (18). Utilization of US has demonstrated higher accuracy with considerable safety (26).

Infraorbital nerve block establishes to be an eminent tool in the arsenal of every pain physician.

Technique

In supine position, US probe is placed horizontally just beside the nose and slid laterally to locate a depression of the infraorbital foramen as exhibited by a disruption in the hyperechoic line. In the foramen, nerve is located and its

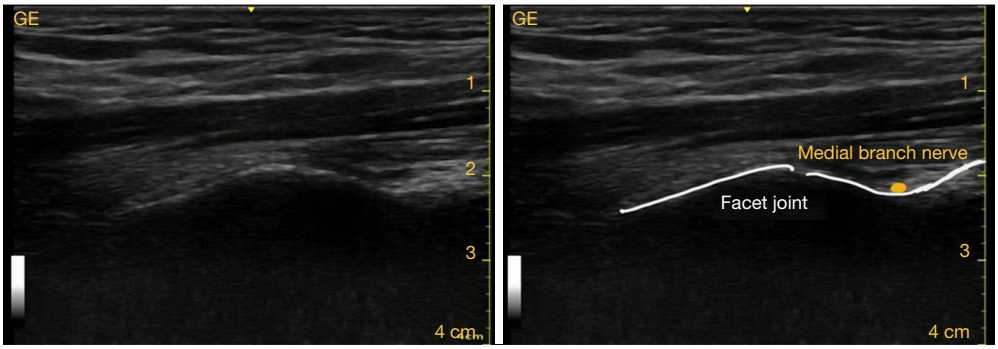

Figure 1 Cervical medial branch block. Orange dot: medial branch nerve; white outline: facet joint.

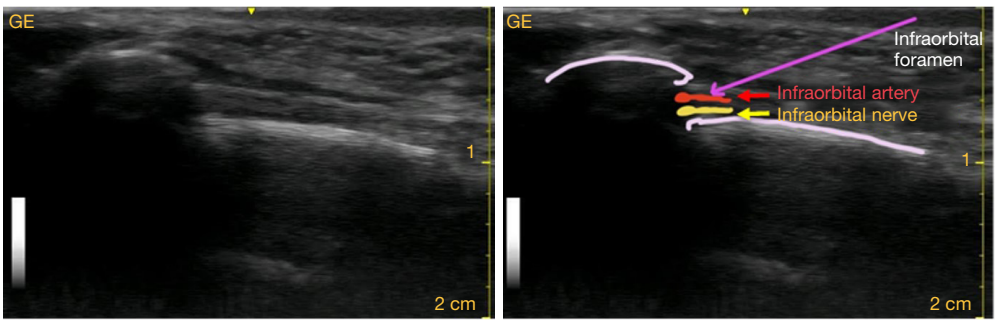

Figure 2 Infraorbital nerve block. Above red line is skin and subcutaneous fat, below yellow line is maxilla bony prominence. Red arrow: infraorbital artery; yellow arrow: infraorbital nerve; purple arrow: infraorbital foramen.

relation to infraorbital artery is verified using color doppler. Needle is then guided in-plane to approximate the nerve and the drug is deposited (*Figure 2*).

Idiopathic orofacial pain

Stellate ganglion block (SGB)

Stellate ganglion is a sympathetic ganglion formed by the fusion of the inferior cervical and first thoracic ganglion. SGB is routinely used in complex regional pain syndrome (CRPS) and peripheral vascular disease, for diagnosis and management of sympathetically mediated pain (27).

Historically, SGB has been performed using landmark guidance by palpating the Chassaignac's tubercle (anterior tubercle of the transverse process of C6) (28,29). However, the safety of this approach has been questioned as tight vascular space surrounds the sympathetic chain, risking inadvertent vascular puncture. US guidance has now widely replaced other imaging modalities for performing blocks. It owes its superiority to visualization of soft tissues and less radiation exposure.

Literature supports the safety and effectiveness of SGB using US guidance (30,31).

Technique

Patient is placed in supine posture with head turned to the opposite side of the block.

The lower neck is scanned in short axis. Prevertebral fascia, longus colli muscle and chassaignac's tubercle are identified. Carotid artery, Inferior thyroid artery and VA are visualised and confirmed using color doppler. Needle is guided in plane to lie in the fascial plane beneath the prevertebral fascia and anterior to the sheath covering longus colli with intent to block the ganglion.

Care must be taken to avoid deposition of the injectate anterior to prevertebral fascia, which could cause hoarseness of voice due to involvement of vagus nerve or recurrent laryngeal nerve (*Figure 3*).

Peripheral neuromodulation

Direct stimulation of peripheral nerves induces decreased

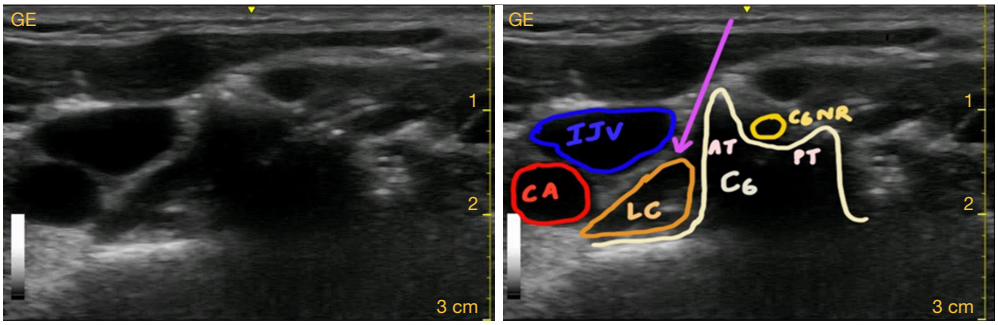

Figure 3 Stellate ganglion block. IJV, internal jugular vein (blue outline); CA, carotid artery (red outline); AT, anterior tubercle; PT, posterior tubercle; C6 NR, sixth cervical nerve root (yellow outline); LC, lateral cord (orange outline).

excitability, increased electrical threshold and transient slowing of conduction velocity (32). Improved outcomes have been demonstrated with neuromodulation in patient with occipital and trigeminal neuralgia (33-35). There is, however, an associated paraesthesia on stimulation which is mediated by Aβ fibres and is in accordance with the gate control theory of pain.

Stimulating electrodes are introduced through a needle beside the focused nerve under local anaesthesia. Initially temporary neurostimulation is applied. Subsequently, programmable, rechargeable generator is permanently implanted by creating a subcutaneous pocket, and permanent settings are done.

Complication

Performing nerve block in proximity of neuro-vascular structures demands expertise and can be technically challenging. Localised as well as systemic complications have been described. Central neuraxial spread of the drug and vascular injections can often lead to devastating outcomes. Use of advanced imaging such as US guidance is recommended to avert complications. Sterility must be emphasised to avoid infections. It is recommended to perform the above interventions in a controlled environment with availability of emergency drugs and equipment with advocated monitoring.

Conclusions

Several, diagnostic, and therapeutic indications of nerve blocks have emerged for management of orofacial pain. Ultrasound guidance has revamped operator performance and revolutionized patient care, making it a standard of care. Understanding relevant sono-anatomy will help pain physicians overcome the barriers and implement US guidance to in their clinical practice.

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Footnote

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