Radiology of Non-Spinal Pain Procedures
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Understanding radiology has always been integral to any interventional procedure. With advances in technology and its applications the breadth and depth of imaging has dramatically increased over the past few years. Therefore, it behooves the interventionalist to have a basic awareness of the various imaging modalities including their strengths and weaknesses, as well as the underlying radiological anatomy, especially in cross section. This knowledge can be helpful in understanding the imaging of the indications for a given procedure, choosing a guidance modality, and for evaluation of the patient who has had a possible complication.

1.1 Plain Film Radiographs and Fluoroscopy

This is the most common and usually the initial type of imaging performed. It is helpful to have more than one view of a particular object. These are generated by X-rays directly creating an image based on the various densities of the underlying structures that the X-rays have passed through. There are five basic densities:

- Air – black on radiography
- Fat – black on radiography
- Bone – white on radiography
- Metal – bright white on radiography
- Soft tissues and water – spectrum of gray on radiography

Contrast can be used for angiography, arthrography, genitourinary, and for alimentary tract imaging. Fluoroscopy is continuous or real-time imaging using X-ray radiography. Its strengths include that it is fast, readily available, is able to perform complex angulations, and that the imaging is in real time. Weaknesses include limited tissue contrast, inability to directly visualize targeted soft-tissue structures, radiation exposure and potential allergic reactions when iodinated contrast is used.

1.2 Computed Tomography

Computed tomography (CT) is widely available in almost all hospitals. It is rapidly performed, has a large field of view, and is not operator dependent. It uses X-rays detectors to generate values called a Hounsfield unit corresponding to shades of gray, black or white. This is then used to create a cross-sectional image through a computer algorithm. Iodinated contrast can be utilized to detect enhancement and thereby improving the diagnostic sensitivity of CT. Two- (2D) and three-dimensional (3D) reconstruction is now available on many modern spiral CT scanners. Its strengths include the following: fast, less motion-sensitive compared to MRI; readily available; cross-sectional capability with better soft-tissue contrast than plain films or fluoroscopy; allows one to visualize vessels and sometimes nerves, enhancing the safety of some image guided procedures; it is helpful in situations with anatomic variation (i.e., pathology) or obese patients for guidance.

However, it has the following weaknesses: it is more expensive than plain films or ultrasound; the radiation dose is higher than plain films; there is a potential for allergic reactions if using iodinated contrast; it is slower than fluoroscopy when used for image guidance; multiple needle insertions and repositionings may be required resulting in longer procedure times; complex angulation is not available for image guidance.
1.3 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is widely available in most hospitals and in many outpatient imaging centers. It has excellent soft-tissue contrast, multiplanar imaging, but is more expensive and has long scan times (issues with patient claustrophobia and motion artifact). Images are formed by exposing the patient to a strong magnetic field while radio waves are transmitted into the patient. The hydrogen protons absorb the energy of the radio waves and resonate to varying degrees. Once the radio wave energy is discontinued the hydrogen protons relax. The radio waves that are generated by this relaxation or decay are detected by a receiver coil. The number and location of the protons can thus be detected by assigning digital values to this information. A cross-sectional image is thus created.

*T1-weighted images* are obtained receiving the information early during the proton relaxation process when fat gives a white signal, water a dark signal. Anatomic resolution is better than T2-weighted imaging.

*T2-weighted images* are obtained late during the proton relaxation process when water and fat give a bright signal. This gives better contrast than T1-weighted images and is excellent for identifying pathology.

*Proton density or spin density weighted images* are intermediate between T1 and T2 weighted images. It is useful in musculoskeletal imaging due to its ability to distinguish between marrow, hyaline cartilage, fibrocartilage (present within menisci) and yet still identify fluid.

*Gadolinium contrast* demonstrates enhancement on T1-weighted images to identify pathology. The contrast is of much lower volume and has a better safety profile than the iodinated contrast used in CT.

*Fat saturation or suppression* is routinely used in T2-weighted or proton density-weighted images as well as T1-weighted images post gadolinium enhancement to remove fat signal. This is done to improve the sensitivity of the study to underlying pathology. Both fat and pathology are bright after enhancement or on T2-weighted or proton density-weighted imaging. Therefore, the bright fat signal is subtracted out to better reveal the underlying pathology. Short tau inversion recovery (STIR) is another commonly used technique to remove fat signal.

*Magnetic resonance angiography* (MRA) may be useful for imaging vessels.

MRI’s strengths include: highest soft-tissue contrast of any imaging modality; multiplanar imaging is readily available; no ionizing radiation is used; infinite obliquities are available for guidance if MR guidance is available. Its weaknesses include: more expensive than CT; long imaging times; less available for guidance; limited to use in patients with ferromagnetic cerebral aneurysm clipping, implanted electrical devices (pacemakers, ICDs, spinal cord stimulators), metal foreign bodies in and around the eyes, and recent coronary stenting.

1.4 Ultrasound

Ultrasound is widely available in almost all hospitals. It is relatively inexpensive compared to CT or MRI. In addition, real-time imaging is possible. It uses high frequency sound waves transmitted into a patient by a transducer, which are then reflected back and detected intermittently by the same transducer. The information is converted into digital data and processed by a computer to generate a cross-sectional ultrasound image.

Sound waves can be deflected, reflected, or absorbed in a given structure when there is a difference in acoustic impedance (amount of sound energy that can be transmitted) between two adjacent differing structures. Sound waves that are reflected back to the transducer are utilized for image formation where water is anechoic (dark), soft-tissue organs are echoic (gray), margins between adjacent structures are hyperechoic (white) and air is very bright (white), which may not allow use of ultrasound to image. Doppler ultrasound imaging allows one to identify and characterize vascular structures in the field of view.

The major strengths of ultrasound imaging include the following: less expensive than CT or MRI; easily available; no radiation exposure; real-time imaging capability; allows direct visualization of blood vessels and nerves that enhances the safety for guidance; allows complex angulation and multiplanar imaging; portable; expanding role in musculoskeletal application, complimentary to MRI in tendon and nerve evaluations. However, it also has the following weaknesses: operator dependency; requires high technical
skill; small field of view; limited in evaluating thorax and bones; limited use in obese patients.

1.5 Nuclear Medicine

Nuclear medicine is widely available in almost all hospitals; however, it has limited applications in the context of pain interventions. It uses an intravenously injected or orally ingested radiopharmaceutical which is then distributed throughout the body based on its uptake (usually metabolically based). Uptake appears as a relative increase or decrease depending on the type of pathology. Nuclear medicine’s strength is its sensitivity in evaluating physiology such as inflammatory processes. Its weakness is its lack of anatomic definition and its lack of specificity. Often it must be combined with other modalities to be clinically relevant.

1.6 Book Overview

The purpose of this book is to introduce the interventionalist to the possible applications of radiology both for guidance and diagnoses of indications/contraindications and complications. An introduction to relevant cross-sectional anatomy for each procedure is included, as well as a subsection on anatomic structures to be avoided during a given image-guided procedure.

The chapter is divided into sections of interventions: head and neck, thorax, abdomen, pelvis, and upper and lower extremities.

In the extremity section, however, cross-sectional anatomy was not emphasized since most of the relevant structures are relatively superficial. Clinical presentation was included for a given procedure only if it was usually performed for a clinical pain syndrome and not if the procedure was performed for regional anesthesia.

Contraindications are not specifically listed for every procedure because it is understood that infection and coagulopathy is a contraindication for every procedure and that infection can be imaged radiologically at every location of the site of injection. On the other hand, coagulopathy is not an entity that can be imaged radiologically.

Complications are specifically listed for each procedure only if they are specific to a particular procedure. Complications that can occur for any procedure include: bleeding/hematoma; infection; ischemia/infarction (which can be caused by intravascular injection, vessel thrombosis, embolus, dissection, and spasm); local anesthetic toxicity/allergy; disulfiram reaction (if alcohol is used); nerve damage/neuritis (pain, hypoesthesia, dysesthesia, abnormal sensory or motor function, etc.); reactivation of herpes zoster; tendon rupture if tendon is directly injected; sloughing of skin or mucosa.

** Signifies that the entity may be imaged. It is understood that an entity may represent a clinical syndrome but that its underlying pathology may actually be imaged [cervical radiculopathy** may be imaged via imaging of cervical spondylosis or disc herniation (herniated nucleus pulposus/HNP)]

Disclaimer: This book is not intended to be a procedural manual on how to perform the injection. The book is not intended to entail any type of clinical decision-making process involved in deciding when to perform the injection. In fact, it is often inappropriate to perform the injection but rather preferable to refer the patient for definitive treatment surgically. In addition, conservative measures (rest, anti-inflammatory medications (NSAIDs), physical therapy, ergonomic adjustments, etc.) should be instituted before injections are attempted. Furthermore, it is not a manual on how to perform the diagnostic workup. Many of these diagnoses are made on the basis of patient history and physical examination, and radiology is in fact not necessary. Radiology may only be necessary to confirm the diagnosis if the patient does not respond to initial treatment. Moreover, radiology may not necessarily comprise a first-line diagnostic modality. For instance, EMG or arthroscopy may be better suited as an initial technique in confirming or excluding pathology.
Below we examine the strengths and weaknesses of the various imaging modalities used for diagnosis in the head and neck.

**CT** (American College of Radiology) is sensitive for benign and malignant paranasal sinus pathology. It is also excellent for lymphadenopathy and evaluating bone invasion from malignancy. It has proven to be superior for the work-up of distant metastasis. CTA should be used for carotid and vertebral dissection, while PET/CT is the most sensitive in the work-up for cancer.

**MRI** (American College of Radiology) demonstrates superior soft tissue contrast in the head and neck while capable of distinguishing between neoplastic, inflammatory, and obstructive processes in nasal cavity tumors. It is sensitive for trigeminal neuralgia (neurovascular compression for cranial nerve V root entry zone). The migraine phenomenon may be demonstrated in the brain. It is more sensitive for infection than CT, including herpes zoster ophthalmicus. Moreover, it is superior to CT in evaluating the tongue/oral cavity, palate and intracranial extension from the skull base, as well as for detecting malignant perineural and intracranial invasion. MRA can demonstrate carotid and vertebral artery dissection (mimics cluster headache).

**Angiography** is useful in the evaluation of carotid and vertebral dissection if CTA or MRA is inconclusive. Pseudoaneurysm can be detected as a complication.

**PET** (American head and Neck Society; Coleman): PET/CT is used for the work-up of suspected malignancy with negative CT or MRI. FDG identifies a primary cancer in 20–40% of patients who present with metastatic disease in the neck with an unknown primary tumor. PET and CT have similar accuracy in the initial staging of nodal disease. PET is more accurate than CT or MRI in detecting recurrent tumor (study of choice for follow-up). It is sensitive for staging neck cancer, unknown primary, distant metastasis, and response to therapy. However, it is limited by tumor size to less than 3–4 mm. Moreover, it may provide false positive results in inflammation, muscular activity, and healing bone. A thorough understanding of artifacts is required.

**Ultrasound** is useful in characterizing palpable masses (thyroglossal duct cysts, branchial cysts, cystic hygromas, salivary gland tumors, abscesses, carotid body tumors, vascular tumors, and thyroid masses). It is also capable of characterizing vascularity in real-time and in duplex mode.

### 2.1 Sphenopalatine Nerve Block

#### 2.1.1 Anatomy

The sphenopalatine ganglion is the largest collection of neurons exterior to the cranium in the head. The ganglion is positioned within the pterygopalatine fossa. It has a complex of nerves attaching to it (Fig. 2.1). The ganglion hangs from V2 via the pterygopalatine nerves. The vidian nerves (composed of greater and lesser petrosal nerves) project posteriorly, which travel through the pterygoid canal. The vidian nerve contains sympathetic fibers from the superior cervical ganglion, which pass through the sphenopalatine ganglion into the lacrimal gland and nasal/palatine mucosa.

The greater and lesser palatine nerves extend inferi orly from the ganglion. The superior posterior lateral nasal and pharyngeal nerves also emanate from the ganglion.
The parasympathetic innervation arises in the superior salivatory nucleus. It then courses through the facial nerve to constitute the greater petrosal nerve. The greater petrosal nerve combines with the deep petrosal nerve to become the vidian nerve. The vidian nerve terminates in the sphenopalatine ganglion and then postganglionic fibers supply nasal mucosa and V2 on route to the lacrimal gland.

The pterygopalatine fossa is a small cavity through which many important structures are associated. V2 travels through the foramen rotundum which is located at the upper, medial, and posterior portion of the fossa. The vidian nerve courses through the pterygoid canal at the lower lateral and posterior portion of the fossa. The maxillary artery is contained within the fossa.

The ganglion is separated from the nasal cavity by a thin layer of lateral nasal mucosa at the posterior aspect of the middle turbinate (sphenopalatine foramen). The ganglion communicates to the oral cavity via the greater palatine canal, which contains the greater and lesser palatine nerves. The ganglion communicates to the cranial cavity through the pterygoid canal, foramen rotundum, and foramen lacerum.

The roof of the pterygopalatine fossa is the sphenoid sinus, the outer border is the infratemporal fossa, the inner border is the palatine bone, and the anterior border is the maxillary sinus.

2.1.1 Function

It is a parasympathetic terminal ganglion. Preganglionic parasympathetic fibers from the greater petrosal nerve (of the facial nerve CNVII) via the vidian nerve synapse at the ganglion. Postganglionic sympathetic axons arrive via the vidian nerve from the deep petrosal nerve and pass through the ganglion without synapsing.

The postganglionic parasympathetic axons exit via the greater and lesser palatine nerves, nasopalatine nerve, sphenopalatine nerves, and zygomatic nerves.

It provides secretomotor innervation to the mucous glands of the palate, nasal cavity, lacrimal gland, and the mucosa of the nasopharynx posterior to the auditory tube.

2.1.2 Injection Site

There are various approaches that are used including: a lateral approach (discussed below only) including suprazygomatic and infrazygomatic arch approach, intranasal topical application to the back of the nasal pharynx along the middle turbinate, and the greater palatine foramen approach.

2.1.2.1 What Does the Needle Traverse?

The needle traverses the structures within the infratemporal fossa (infrazygomatic masticator space) prior to entering the pterygopalatine fossa as its final destination (applies to the infrazygomatic approach). The path is just superior to the coronoid process of the mandible. Alternatively, a transnasal or transoral approach (using the pterygopalatine canal to enter the sphenopalatine foramen) can be used. The structures
traversed within the infratemporal fossa (within the infrazygomatic masticator space) include (Figs. 2.5–2.6):

- Superficial layer of the deep cervical fascia
- Masseter muscle
- Temporalis muscle/tendon
- Lateral pterygoid muscle
- Pterygoid venous plexus (Harnsberger et al. 2006a)
  - Located both medial and lateral to the lateral pterygoid [http://www.emory.edu/ANATOMY/Anatomy Manual/fossae.html]
- Retromaxillary fat pad (Buccal space)
- Internal maxillary artery (Harnsberger et al. 2006b)
  - Travels anteromedially within the masticator space lateral to the pterygoid muscle to end up within the pterygopalatine fossa
- Pterygopalatine fossa (Harnsberger et al. 2006c)
  - Communicates with the masticator space via the pterygomaxillary fissure between the maxilla and lateral pterygoid plate

2.1.2.2 Which Structures the Needle Should Avoid

**Pterygoid venous plexus**: This is a prominent venous plexus medial and lateral to the surface of the lateral pterygoid muscle. It may be difficult to avoid; however, it is a venous structure and therefore under low pressure for potential hematoma formation.

**Maxillary artery**: The artery travels from its origin within the parotid gland through the masticator space anteromedially on the lateral aspect of the lateral pterygoid (usually) to terminate in the pterygomaxillary fissure as the sphenopalatine artery. It may be difficult to purposefully avoid puncture unless a blunt-tipped needle is used in the infrazygomatic approach.

**Inferior orbital fissure**: If the needle is advanced too far the orbital structures including the globe can be punctured.

2.1.2.3 Imaging/Radiology

CT and fluoroscopic approaches can be combined (Vallejo et al. 2007) (Figs. 2.2–2.6).
2.1.3 Indications

The following are common indications for intervention in the head and neck:

- Sphenopalatine neuralgia – Sluder’s (sphenopalatine) neuralgia is pain of the eyes and nose, with radiation to the ear. The greater superficial petrosal nerve (GSPN) is most likely the pathway along which this pain radiates to the ear. It is crucial to exclude benign and malignant sinus disease before making the diagnosis of (idiopathic) sphenopalatine neuralgia (Weissman 1997).
- Paranasal sinus infection** – Causing irritation of the sphenopalatine ganglia (SPG) – disputed.
- Intranasal deformities** – deviated septum, septal spurs and prominent turbinates.
- Vasomotor syndrome.

Fig. 2.4 Reconstructed CT image showing the needle inside the pterygopalatine fossa (Vallejo et al. 2007)

Fig. 2.5 CT at the level of the needle tract for a sphenopalatine block. Needle path is delineated and pertinent anatomic structures are labeled. A mass (M) is noted within the right pharyngeal mucosal space encasing the internal carotid artery (arrowhead) (Gupta et al. 2007a)
2.1 Sphenopalatine Nerve Block

**Trigeminal neuralgia.**

* Head and neck cancer – cancer of the tongue and floor of the mouth (intranasal approach) (Varghese et al. 2002).

* Lethal midline granuloma (intranasal approach) (Saade and Paige 1996).

* Migraine (Fig. 2.7) and cluster headaches – imaging is useful in excluding structural lesions that can mimic cluster headache (i.e., herpes zoster, sinusitis, subarachnoid hemorrhage, trigeminal neuralgia, meningiomas of the cavernous sinus, arteriovenous malformations, pituitary adenomas, nasopharyngeal carcinoma, etc) (Sargeant 2007; Mendizabal 2005).

* Atypical facial pain

* Herpes zoster ophthalmicus (Fig. 2.8)

**2.1.4 Contraindications**

Contraindications may include invasion of the pterygopalatine space (contraindication for percutaneous approach, but not for intranasal approach) (Fig. 2.9) (Varghese and Koshy 2001).

![Fig. 2.6 Axial cross-sectional anatomy at the level of the upper maxillary antrum. Anatomic structures are shown on the left side of the diagram; spaces are shown on the right side. CN cranial nerve (Gupta et al. 2007a)](image)

![Fig. 2.7 WM increased T2 signal in migraine headache (Fazekas et al. 1992)](image)
2.1.5 Complications

The six main complications include: (1) Infection**; (2) epistaxis** (this can be imaged angiographically if there is an associated pseudoaneurysm); (3) hematoma – large venous plexus overlying the pterygopalatine fossa or the maxillary artery is punctured** (Figs. 2.10–2.11); (4) hypesthesia, dysesthesia or numbness of the palate, maxilla, or the posterior pharynx; (5) blindness due to needle advancement into the inferior orbital fissure; (6) Parotid gland injury.

2.2 Maxillary and Mandibular Nerve Block

2.2.1 Maxillary Nerve Block

(Fig. 2.12)

2.2.1.1 Anatomy

The maxillary nerve (V2) originates from the trigeminal ganglion, crosses the cavernous sinus, and exits the foramen rotundum to leave the cranium. It traverses the pterygopalatine fossa and approaches the orbit through the inferior orbital fissure. It then traverses the infraorbital groove and canal at the floor of the orbit. Finally, it enters the face through the infraorbital foramen where it is known as the infraorbital nerve.
2.2 Maxillary and Mandibular Nerve Block

Fig. 2.10 (a, b) CT-directed fine-needle biopsy. (a) Contrast-enhanced axial CT image shows a focal soft-tissue mass within the masticator space (arrow). Gas surrounding the lesion is related to a postsurgical defect that communicates with the oral cavity. (b) Axial nonenhanced CT image shows the tip of a 22-gauge Chiba needle within the anterior aspect of the soft-tissue abnormality (curved arrow). The region was sampled twice.

Fig. 2.11 Histologic analysis showed only inflammatory changes. (a, b) Pseudoaneurysm of the buccal branch of the distal internal maxillary artery. (a) Selective right external carotid arteriogram, lateral projection, shows mild irregularity of the distal internal maxillary artery and focal dilatation of the distal buccal branch (arrow). (b) Delayed image from same injection shows filling of a 5-mm pseudoaneurysm (arrow) (Walker et al. 1996)

2.2.1.2 Function

The maxillary nerve is purely sensory. It supplies sensation to the skin and mucosa between the palpebral fissure and the mouth, including the upper lip, nose, nasal cavity, sinuses, dura mater, temporal and lateral zygomatic region, and maxillary teeth.
2.2.1.3 Injection Site

The classic approach for the maxillary block is a lateral approach anterior to the coronoid process of the mandible through the mandibular notch. This block is usually performed using external anatomical landmarks and by eliciting paresthesia (Fig. 2.12).

2.2.1.4 Cross-Sectional Anatomy

What Does the Needle Traverse? Maxillary Nerve

The needle traverses the structures within the infratemporal fossa (infrazygomatic masticator space) prior to entering the pterygopalatine fossa as its final destination (applies to the infrazygomatic approach). The path is just superior to the coronoid process of the mandible (Figs. 2.13–2.14).

A suprazygomatic approach has also been described with the pterygopalatine fossa as the final destination (Fig. 2.15).

Alternatively, a transnasal or transoral approach is used; however, this is predominately performed by oral surgeons (using either the pterygopalatine canal to enter the sphenopalatine foramen or around the maxillary tuberosity).

The structures traversed within the infratemporal fossa (within the infrazygomatic masticator space) include:

- Superficial layer of the deep cervical fascia
- Masseter muscle

Fig. 2.12 A patient with the needle on the maxillary nerve entering through the mandibular notch (Waldman 2001a)

Fig. 2.13 Transverse section of the head and face at the level of the mandibular notch showing needle placement on the mandibular nerve, on the lateral pterygoid plate, and on the maxillary nerve. After the pterygoid plate is touched, the needle is slightly withdrawn and pushed posterior until it slips off the pterygoid plate (Raj et al.)

Fig. 2.14 Axial CT of head. An arrow indicates the needle tip located at the entrance of the pterygopalatine fossa (Okuda et al. 2000)
2.2 Maxillary and Mandibular Nerve Block

- Temporalis muscle/tendon
- Lateral pterygoid muscle
- Pterygoid venous plexus (Harnsberger et al. 2006a)
  - Located both medial and lateral to the lateral pterygoid
  [http://www.emory.edu/ANATOMY/AnatomyManual/fossae.html]
- Retromaxillary fat pad (Buccal space)
- Internal maxillary artery (Harnsberger et al. 2006b)
  - Travels anteromedially within the masticator space lateral to the pterygoid muscle to end up within the pterygopalatine fossa.
- Pterygopalatine fossa (Harnsberger et al. 2006c)
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Which Structures the Needle Should Avoid

*Pterygoid venous plexus*: This is a prominent venous plexus medial and lateral to the surface of the lateral pterygoid muscle. It may be difficult to avoid; however, it is a venous structure and therefore under low pressure for potential hematoma formation.

*Maxillary artery*: The artery travels from its origin within the parotid gland through the masticator space anteromedially on the lateral aspect of the lateral pterygoid (usually) to terminate in the pterygomaxillary fissure as the sphenopalatine artery. It may be difficult to purposefully avoid puncture unless a blunt tipped needle or meticulous aspiration is used in the infrrazygomatic approach.

A suprazygomatic approach may avoid the maxillary artery more successfully. This is because the maxillary artery is more ventrally positioned in the pterygopalatine fossa compared to the maxillary nerve. Also, with this approach, there is minimal distance between the point of entry of the needle and the pterygopalatine fossa (see Fig. 2.15).

*Emissary veins from the orbit.*

*CSF space*: The needle should not be advanced farther than 1.5 cm medially past the lateral pterygoid plate.

*Posterior aspect of the orbit/optic nerve*: Avoid by not advancing too cephalad or deeply in the pterygomaxillary fissure to allow entry of injectate into the infraorbital fissure.

*Pharynx*: If the needle is placed too posterior and air is aspirated (Raj et al.).

Strengths and Weaknesses of Each Image Guidance Modality

- **Fluoroscopy**
  - Fast
  - Easy
  - Allows complex angulation
  - May be slightly less accurate and reliable than CT

A reliable block can be difficult because fluoroscopy does not always show the relationship of the pterygopalatine fossa and foramen rotundum (Okuda et al. 2000).

- **CT with contrast**
  - Accurate
  - Safe
  - Vascular structures can be identified initially under contrast administration
  - Cancer may be avoided reliably compared to fluoroscopic guidance with lateral approach

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*Fig. 2.15* (a) Maxillary nerve block by the suprazygomatic route. A skin wheal is raised just above the superior edge of the zygomatic arch. (b) The needle is in the pterygopalatine fossa (Okuda et al. 2000)
Strengths and Weaknesses of Each Imaging Modality for Diagnosis (Indications/Contraindications and Complications)

(Please see beginning of Head and Neck section, Chapter 2, page 5 for listing of strengths and weakness of various imaging modalities)

2.2.2 Mandibular Nerve Block

2.2.2.1 Anatomy

The mandibular nerve (V₃) (see Fig. 2.16) is composed of sensory and motor roots. It originates from the trigeminal ganglion and exits through the foramen ovale.

2.2.2.2 Function

The mandibular nerve is a combined motor and sensory nerve that innervates:
- Mylohyoid muscle and digastric muscle
- Mucous membrane of the anterior two-thirds of the tongue
- The inside of the cheek (the buccal mucosa)
- Teeth and gums of the mandible
- Skin of the temporal region
- Auricula
- Lower lip and chin
- Muscles of mastication
- The muscles tensor tympani and tensor veli palatini

2.2.2.3 Injection Site

The classic technique involves external landmarks with or without fluoroscopy. The needle is placed through the mandibular notch and is directed posteriorly to the posterior margin of the lateral pterygoid plate (see Figs. 2.16 and 2.17).

Fig. 2.17 Transverse section of the head and face at the level of the mandibular notch showing needle placement on the mandibular nerve, on the lateral pterygoid plate, and on the maxillary nerve. After the pterygoid plate is touched, the needle is slightly withdrawn and pushed posterior until it slips off the pterygoid plate (Raj et al.)