Abstract

Introduction: The parotid gland is the largest salivary gland and parotid cancer accounts for 5% of the incidence rate of all head and neck tumors and 80% the salivary gland tumors. Benign tumors account for 80–85% and malignant tumors account for 15–20%. About 25% of untreated parotid pleomorphic adenoma shows malignant degeneration after a long history of disease, especially in multiple pleomorphic adenoma, but Warthin's tumors are rarely malignant, with a rate of less than 1%.

Objectives: This review aim to assess the role of magnetic resonance imaging and diffusion weighted MR Imaging in diagnosis and characterization of parotid gland tumors.

Data Sources: Medline databases (PubMed, Medscape, Science Direct. EMF-Portal) and all materials available in the Internet till 2018.

Study Selection: This search presented 70 articles. The articles studied the role of MRI and diffusion weighted image in parotid tumors and to purify the most recent studies in this field.

Data Extraction: If the studies did not fulfill the inclusion criteria, they were excluded. Study quality assessment included whether ethical approval was gained, eligibility criteria specified, appropriate controls, and adequate information and defined assessment measures.

Data Synthesis: Comparisons were made by structured review with the results tabulated.

Conclusion: The combination of conventional MR imaging with advanced multiparametric MR assessment can enable accurate characterization of parotid gland tumors non – invasively.

Key words: MRI, Diffusion weighted image , Parotid tumores

INTRODUCTION

Parotid gland tumors account for approximately 3-6% of all head and neck tumors, with an annual estimated global incidence of 0.4-13.5 per 100,000 persons About 80% of parotid tumors are benign the most common being pleomorphic adenomas and 20% are malignant ***(Tianz et al., 2010).***

It is important to determine whether parotid gland tumors are benign or malignant and to assess its extent and relationship to adjacent structures preoperatively, because this information will strongly influence the choice of surgical procedure. Local excision or superficial parotidectomy is performed for benign tumors, whereas total parotidectomy, with or without facial nerve removal, block dissection of lymph nodes and bony resections is performed for malignant tumors ***(Yabuuchi et al., 2003).***

Clinical examination findings have limitations in differentiation of benign and malignant parotid neoplasm. Only a few clinical symptoms, such as facial nerve palsy, skin ulceration, fast-growing masses, otalgia (related to posterior auricular nerve involvement) and cervical adenopathies, allow the diagnosis of malignancy. However, unfortunately most parotid tumors present as slow-growing, painless masses whether benign or malignant. SO the differentiation between them is not possible by clinical examination only ***(Thoeny, 2007).***

Although the histopathology diagnosis is considered the gold standard tool in evaluation of parotid gland tumors, obtaining histopathological diagnosis before surgery is challenging. Even in the most experienced hands, it is arduous to perform a biopsy of parotid gland tumors as sampling frequently has to occur deep to normal mucosa, where the tumors may occur and it carries an inherent risk of tumors dissemination. Even if a successful biopsy, due to the complex histopathological features of the parotid gland, a definitive diagnosis may still not be achieved. Even in the best case scenario where a histopathologic diagnosis has been achieved, there are other features of the tumor which are critical in treatment planning and can only be ascertained with medical imaging ***(Tie et al., 2014).***

Ultrasound (US) is accepted as the first imaging method for the assessment of the parotid glands. Benign neoplasms are usually hypoechoic, well-defined, homogenous structure but many benign tumor e.g. plemorphic adenomas are irregular shape. Whereas malignant neoplasm of the parotid gland may have irregular shapes, irregular borders, blurred margins, and a hypoechoic inhomogeneous structure or may have a benign appearance. However, US appearances of benign and malignant parotid gland lesions may overlap and non-specific. Furthermore, US, it is often difficult to study the deep parotid lobe because of the acoustic shadow of the mandible, and it is not possible to visualize the facial nerve, retropharyngeal and deep neck adenopathies and the intracranial or skull base extent of the mass ***(Tartaglione et al., 2015).***

CT is the second selected imaging modality for the diagnosis and staging of parotid tumors. It has high accuracies for detecting and staging such cancers. CT like US, as the imaging features of benign and malignant parotid gland lesions are often nonspecific and overlapping. Furthermore, CT has exposure to radiation as a side effect ***(Yuli et al., 2013).***

Magnetic resonance imaging (MRI) is considered the most appropriate method for the preoperative evaluation of parotid gland tumors, owing to its superior soft tissue resolution. It provides excellent morphological and volumetric assessment, a precise definition of the relationship with adjacent structures and panoramic view of the cervical lymph nodes. Furthermore, MRI is the best in assessment of peri neural dissemination ***(Lucezewskil et al., 2013).***

Diffusion-weighted imaging (DWI) is an advanced MR imaging technique that relies upon the relative diffusivity of water protons within the tissue. This technique is based on the amount of random (Brownian) motion of water protons ***(Celebi et al., 2013).***

Diffusion weighted images can be assessed in two ways qualitatively, by visual assessment of signal intensity, and quantitatively, by measurement of the apparent diffusion coefficient (ADC). ADC value can theoretically be used to characterize tissues, as the degree of diffusion is correlated to cellular density and extracellular space volume. Malignant tumors are reported to have a high cellular density and low extracellular space volume, which is associated with impeded water proton diffusion and low ADC values. In contrast, various benign lesions are characterized by an increased amount of extracellular matrix with minimal increase of cellular density, which may result in higher ADCs. Therefore, DWI ADC used to improve diagnostic accuracy of convention MR imaging in differentiation between benign and malignant parotid gland tumors and add in differentiation the histological subtypes of parotid gland tumors ***(Vermoolen et al., 2012).***

AIM OF THE WORK

To assess the role of magnetic resonance imaging and diffusion weighted MR Imaging in diagnosis and characterization of parotid gland tumors.

Chapter 1

ANATOMY OF THE PAROTID GLAND

Surgical anatomy

The parotid gland is the largest of the paired major salivary glands. It is mainly present in front and below the ear lobule. It fills the gap between the ramus of mandible and the mastoid process. Superiorly, it extends up to the external acoustic meatus and inferiorly it reaches the upper part of carotid triangle. Posteriorly it overlaps sternocleidomastoid muscle and anteriorly it crosses the masseter ***(O'Rahilly, 2008)*** **(Fig 1).**

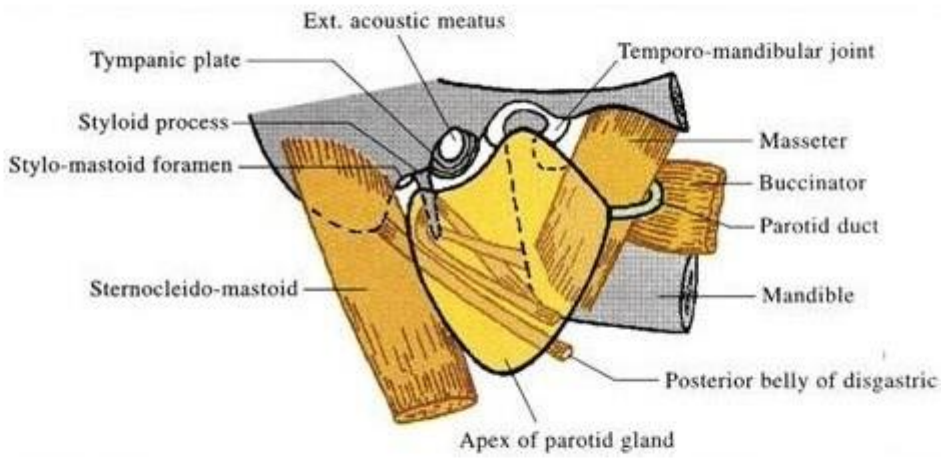

Figure (1): Diagrammatic view showing location of parotid gland ***(Thaaer, 2010).***

The parotid gland is irregular in shape, roughly a 3 sided inverted pyramid and weighs approx. 25gm. It has an apex, base, 3 borders and 3 surfaces. Its apex is directed below, overlapping posterior belly of digastric muscle and reaches carotid triangle. Structures emerging through apex are the cervical branch of facial nerve and anterior and posterior divisions of retromandibular vein. Its base is concave and directed upwards, is related to external acoustic meatus and posterior part of temporomandibular joint. Structures emerging through base (from anterior to posterior) are the temporal branch of facial nerve, superficial temporal vessels and Auricle temporal nerve ***(O'Rahilly, 2008) (*Fig 2)**

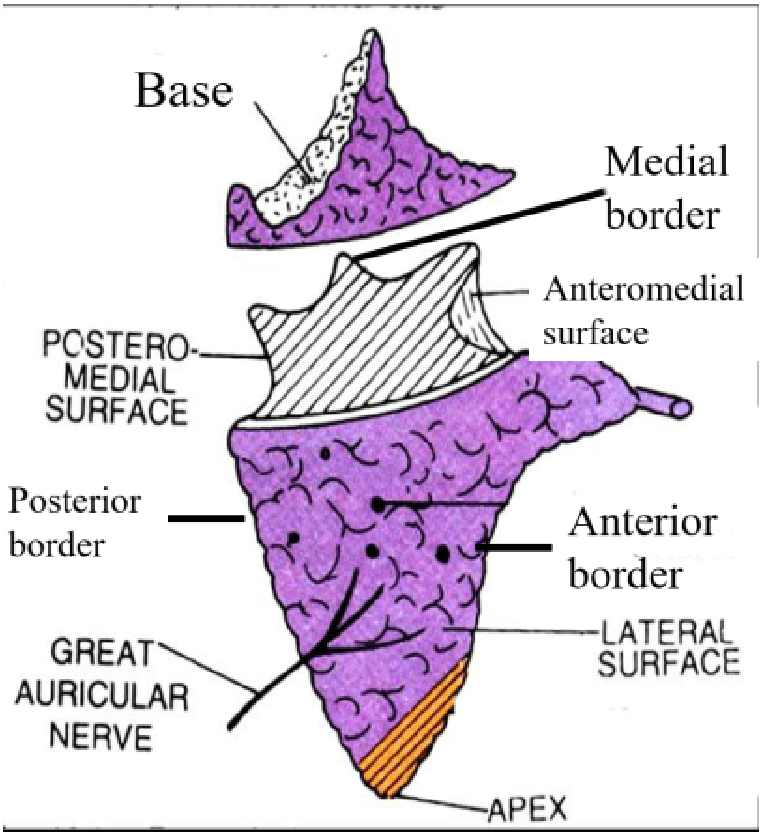

Figure (2): Diagrammatic view showing Gross features and relation of parotid gland ***(Thaaer, 2010).***

Parotid gland has three surfaces:

Superficial (lateral) surface: is covered (from superficial to deep) by skin, superficial fascia (containing the anterior branch of great auricular nerve, pre auricular (superficial parotid) lymph nodes, and platysma muscle fibers), superficial lamella of parotid fascia and deep parotid lymph nodes.

Anteromedial surface: is related to ramus of mandible, masseter, medial pterygoid, and lateral surface of temporomandibular joint and terminal branches of facial nerve.

Posteromedial surface: is related to the sternocleidomastoid muscle, posterior belly of digastric muscle, styloid process and muscles attached to it. The facial nerve enters the gland through this surface and external carotid artery is lodged in a groove in its lower part ***(O'Rahilly, 2008).***

The gland has three borders: Anterior, Posterior and Medial, the latter is related to lateral pharynx. structures emerging along the **anterior border** (from above downwards are):

- Zygomatic branch of facial nerve.
- Transverse facial artery.
- Upper buccal branch of facial nerve.
- Parotid duct.
- Lower buccal branch of facial nerve.
- Marginal mandibular branch of facial nerve.

Structures emerging along the posterior border are:

- Posterior auricular branch of facial nerve.
- Posterior auricular vessels ***(O'Rahilly, 2008)*** **(Fig 3).**

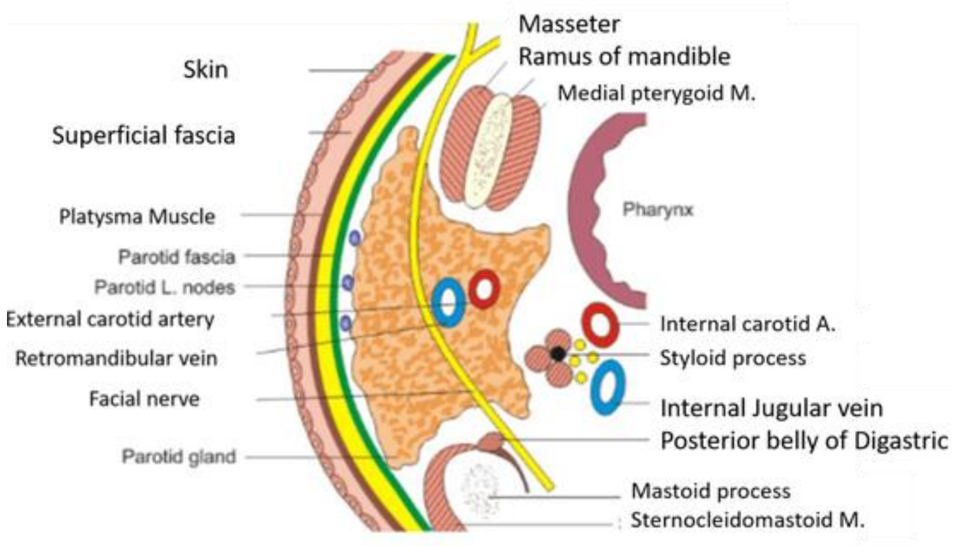

Figure (3): Diagrammatic view showing Relations of parotid gland ***(Thaaer, 2010).***

Parotid gland is surrounded by two capsules:

True capsule: form by condensation of the fibrous stroma of the gland.

False capsule (parotid fascia): is formed by splitting of investing layer of deep cervical fascia (superficial layer of the deep cervical fascia). Its superficial lamina pass superficial to the gland, is thick and attached to inferior border of zygomatic arch. Its deep lamina passes deep to the gland, is thin and is attached to styloid process and tympanic plate. It also forms stylomandibular ligament (from tip of styloid process to angle of mandible) which separates parotid gland from submandibular gland ***(O'Rahilly, 2008).***

Parotid duct "Stensen's Duct"

Parotid duct is thick walled, 5cm long and 3mm wide. It is formed within the gland by joining of smaller ducts, emerges from the gland at the middle of its anterior border on the surface of masseter (a finger breadth below the zygomatic arch), runs forward and slightly downwards on the masseter and at the anterior border of masseter turns medially and pierces the buccal pad of fat, buccopharyngeal fascia, and buccinators muscle. It runs obliquely between the buccinators and oral mucosa (for 1cm.) before piercing the mucosa to open into the vestibule of mouth opposite to the crown of 2nd upper molar tooth ***(O'Rahilly, 2008).***

Structures passing through the parotid gland from **superficial to deep** are:

- **Facial nerve and its branches:** Facial nerve exits from stylomastoid foramen as a single trunk and enters the gland through the posterior-medial surface. Within the gland it divided into five terminal branches (temporal, zygomatic, buccal, marginal mandibular & cervical). The intra-glandular ramifying facial nerve is used by surgeons to divided the parotid gland in to 2 lobes lying on either side of the plane of the facial nerve. The large superficial lobe of the parotid is lateral to facial nerve and the small deep lobe lies medial to the facial nerve.

- **Retromandibular vein**: formed within the gland by union of superficial temporal and maxillary veins. It divides into anterior and posterior divisions in the lower part of the gland. Anterior division joins facial vein to form the common facial vein. Posterior division joins posterior auricular vein to form external jugular vein.
- **External carotid artery and its branches**: Enters the gland through the posteromedial surface and divides into two terminal branches; maxillary and superficial temporal within the parotid gland ***(O'Rahilly, 2008).***

Nerve supply

Parotid gland is supplied by:

- **Parasympathetic fibers (secret motor fibers):** stimulation of parasympathetic fibers stimulate production of watery secretion (rich in enzymes). Preganglionic parasympathetic fibers arise from the inferior salivary nucleus (in medulla oblongata) and pass in the Glossopharyngeal nerve which leaves the cranial cavity through the jugular foramen. It gives a tympanic branch which enters the middle ear cavity through tympanic canaliculus and participates in formation of tympanic plexus (over promontory). From the tympanic plexus lesser petrosal nerve arises which leaves the cranial cavity through foramen oval and synapses in the otic ganglion (present in the infratemporal fossa). The postganglionic fibers from the otic ganglion pass through auricle temporal branch of mandibular nerve and supply the parotid gland.

- **Sympathetic fibers:** Are mainly vasomotor and their stimulation produces thick sticky secretion. Preganglionic fibers arise from lateral horn of T1 spinal segment. They synapse in the superior cervical ganglion. The postganglionic fibers form a plexus around external carotid artery to reach the parotid gland.
- **Sensory fibers**: They carry general sensations from the parotid gland. Auricle temporal nerve carries the sensory fibers ***(O'Rahilly, 2008)*** **(Fig 4).**

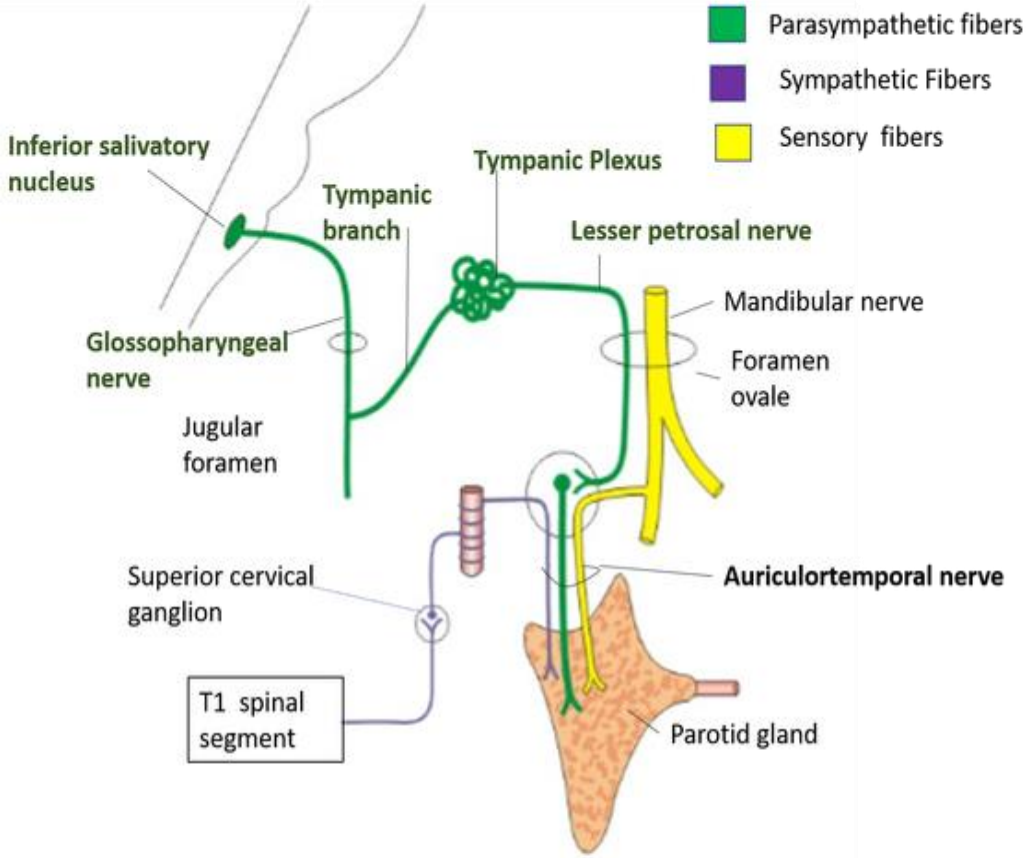

Figure (4): Illustration of sympathetic, parasympathetic and sensory nerve supply of parotid gland ***(Thaaer, 2010).***

Arterial supply

The transverse facial artery provides the gland’s main arterial blood supply. The superficial temporal artery gives off the transverse facial artery, which courses anteriorly between the zygoma and parotid duct to supply the parotid gland, parotid duct, and masseter muscle ***(Bhattacharyya and Navarrese, 1999)*** **(Fig 5).**

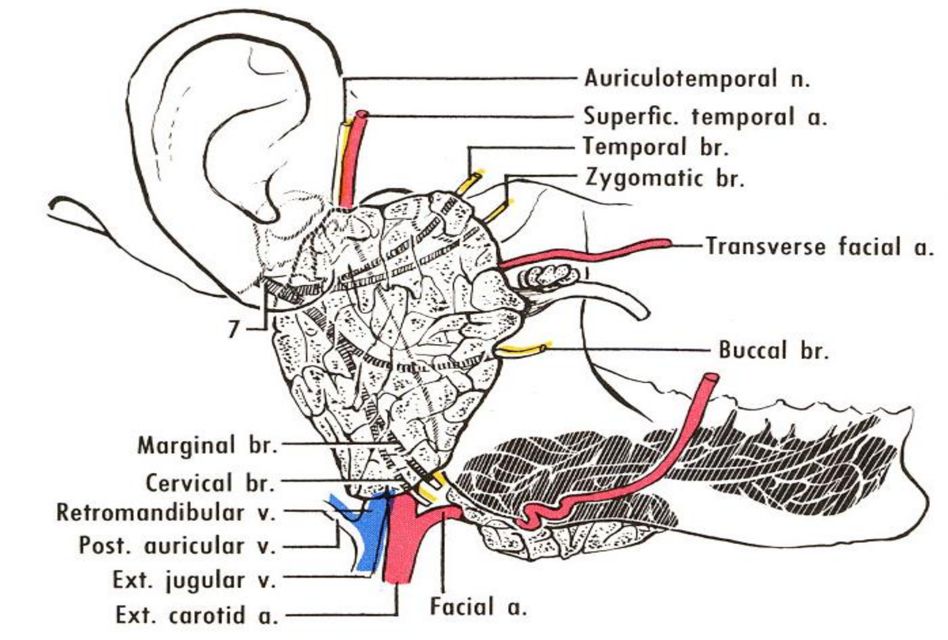

Figure (5): Diagrammatic view shows the arterial supply and venous drainage of the parotid gland ***(Thaaer, 2010).***

Venous drainage

Venous drainage is achieved via the retromandibular vein. It is formed by union of the superficial temporal and maxillary veins. Within the gland, it divides into anterior and posterior branches. The posterior branch joins the posterior auricular vein to form the external jugular vein. The anterior branch emerges from the gland to join the posterior facial vein to form the common facial vein ***(Bhattacharyya and Navarrese, 1999).***

Lymphatic drainage

Contrary to the lymphatic drainage of the other salivary glands, there is a high density of lymph nodes within and