Diagnostic value of MR imaging of parotid gland tumors

Poster No.: C-0500
Congress: ECR 2015
Type: Educational Exhibit
Authors: A. Gaja, S. Harguem, S. Bahi, I. Naccache, A. Ben Miled, N. Mnif; Tunis/TN
Keywords: Neoplasia, Sialography, Contrast agent-intravenous, MR-Functional imaging, MR-Diffusion/Perfusion, Salivary glands, Head and neck
DOI: 10.1594/ecr2015/C-0500

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.
As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.
You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.
Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.
www.myESR.org
Learning objectives

- Know the MRI techniques for the assessment of the intra-parotid gland masses.
- Analyze MR imaging findings to distinguish between benign and malignant parotid gland tumors and demonstrate its utility for predicting specific diagnosis.

Background

The pre operative diagnosis of parotid gland tumors is crucial as it influences not only prognosis but also treatment. In fact, the surgical approach and procedure is different for benign and malignant tumors. Local excision or superficial parotidectomy is performed to treat benign tumors; whereas, in the case of malignant tumors, the patient has to undergo total parotidectomy, a more difficult procedure with the surgical risk of facial nerve palsy.

MR imaging is the method of choice for the assessment parotid gland tumors. Thanks to its high contrast and spatial resolutions, it offers a good categorization of these tumors according to histological type.

Findings and procedure details

Discussion

Introduction

Parotid gland tumors are uncommon and represent approximately 3 % of head and neck neoplasms. About 80 % of all parotid masses are benign and the most common of these are pleomorphic adenomas.

MR imaging (MRI) is the method of choice for the characterization of parotid gland tumors. It authorizes a categorization of these masses into benign and malignant ones with a good correlation to histopathology.
Recently, new MRI techniques including dynamic contrast-enhanced MRI (DCE-MRI), diffusion-weighted MRI (DW-MRI) have shown promising results in the differentiation between benign and malignant gland tumors in addition to the static MR imaging.

**Parotid gland tumors: Histological types**

The big variety of histological types of parotid gland tumors makes them a major challenge for radiologists. The main histological types are listed in the following table (table 1).

**Clinical presentation**

The diagnostic approach for a suspected parotid gland tumor has to begin with patients review of past medical history and physical examination. The clinical presentation has to be known even if it is usually similar in malignant and benign ones.

In fact, Certain clinical symptoms, such a painful hard mass, facial nerve palsy and enlarged lymphatic nodes may suggest malignancy of the parotid gland tumor.

**MRI protocol**

The MRI protocol for the assessment of parotid gland tumors includes:

- T1 weighted spin-echo sequences in the transverse and coronal plans;
- T2 weighted Fast spin-echo sequence in the transverse and coronal plan;
- Diffusion-weighted (DW) sequence in the transverse plan with b values of 0 and 1000 s/mm²;
- T1-weighted spin-echo dynamic enhancement sequence in the transverse plane after administration of 0.2 mmol/kg of contrast media and with fat suppression:
  - SPGR 3D: 8 slices of 4 mm.
  - Small Fov : Max 28 cm
  - Matrice: 192 *192

Finally, T1-weighted spin-echo contrast enhanced sequence with fat suppression in the coronal plane.

**MR imaging findings:**
The analysis of the static MR images, dynamic contrast enhanced (DCE) and diffusion-weighted (DW) sequences allows the determination of:

1. Morphologic and static characteristics
2. The type and characteristics of DCE-MRI: low, intermediate and high enhancement and the type of enhancement curve
3. The signal in DW sequences and the apparent diffusion coefficient (ADC).

**Static MR imaging:**

The static MR imaging characteristics allows a determination of:

- The lesion location: Unilateral or bilateral; The location in the deep or the superficial lobe or both (figure1).
- The lesion growth pattern: focal, multifocal, diffuse (involving the entire parotid gland)
- The lesion margins: well defined, ill-defined, polylobulated margins, encapsulated character
- The appearance: homogeneous, heterogeneous on both pre- and post contrast sequences
- The signal intensity on T1 and T2 weighted sequences
- The extension to adjacent structures: subcutaneous tissue, skin, masticator space or mandible, bone invasion, meningeal infiltration...
- The presence of enlarged lymphatic nodes.

The MR imaging characteristics of malignant tumors are reportedly irregular and poorly defined tumor margins, low signal intensity on both T1- and T2-weighted MR images, and tumor infiltration into deep surrounding tissues.

Thus, the role of this static MR imaging in the differentiation of benign and malignant tumors appears to be controversial, and some authors considerate that it is not discriminative to predict correctly benign or malignant disease, except the infiltration into deep structures.

**Dynamic contrast enhanced (DCE) MR imaging**

Dynamic contrast enhanced MR imaging improves the performance of MR imaging in differentiating benign from malignant parotid gland tumors and shows a high value in the characterization of the different histological types (especially pleomorphic adenoma, Warthin’s tumor and malignant tumors).

In addition to assessing whether or not the lesion enhance, DCE imaging can determine how far it extends, and precise areas that most enhance and which uptake curve.
Four types of curves were described by Yabuuchi et al who evaluated all different parotid tumors by using dynamic contrast-enhancement (DCE) and considering the time of peak (TIK) enhancement and the washout ratio (figure 2).

1. Type A (persistent): Pick of enhancement (>120s) with gradual enhancement suggesting benignancy
2. Type B (washout): Early peak of enhancement (#120s) and a high washout ratio (#30%)
3. Type C (plateau): early peak of enhancement (#120s) and a low washout ratio (<30%)
4. Type D: flat.

Using this classification:

Pleomorphic adenomas depict gradual enhancement pattern (type A)

Warthin's tumors as well as carcinomas can show the type B curve.

Type C can be found in high cellularity's pleomorphic adenomas or malignant lesions.

Lesions which show type D are usually benign.

**Diffusion Weighted(DW) MR imaging**

Parotid glands presents low ADCs values (0.8 x 10⁻³ mm²/sec) because of the protenaceous contents and the amount of adipose tissue.

Even if the ADC value is essentially related to the cellularity and doesn't reflect directly a potential malignancy or benignancy of a tumor, many studies showed that the assessment of DWI sequence with ADC calculation gives additional advantages in the differentiation between benign and malignant tumors.

In fact, The ADC maps show that more frequently, areas with a high ADC have significantly more benign tumors than malignant parotid tumors such as hypocellularepleomorphic adenomas which present ADC values usually higher than 1.8 x 10⁻³ mm²/sec.

For malignant tumors, the ADC was found to be significantly smaller in lymphomas than in carcinomas.

Yabuuchi et al showed that the combining of the assessment of DCE- MR imaging and ADC values increases significantly the differentiation between benign and malignant parotid tumors and proposed the following diagram for parotid gland tumors analysis (figure 3).
Most common features of parotid tumors on MRI

Benign Tumors

Pleomorphic adenomas (Figures 4-5)

Also known as benign mixed tumors. They account for 70-80% of parotid gland tumors and are especially common in the superficial lobe.

They usually occur in middle aged women who typically present with a smooth painless enlarging mass.

As they are called, pleomorphic adenomas are composed of various proportions of a mixture of both epithelial and myoepithelial (mesenchymal) tissues explaining its diverse histological and radiological presentation.

They appear as well circumscribed and encapsulated masses. However, the pseudocapsule is delicate and incomplete with microscopic extensions explaining the high risk of recurrence in the tumor bed after surgical treatment.

On MRI, pleomorphic adenomas are commonly well circumscribed masses with well defined and lobulated margins. They are homogeneous when they are small, whereas larger and growing tumors may be heterogeneous.

They are usually of low intensity in T1 weighted images and usually of very high intensity on T2 weighted images and often have a rim of decreased signal intensity representing the surrounding fibrous capsule.

Pleomorphic adenomas may contain calcifications and present cystic degeneration. The presence of calcification highly suggests pleomorphic adenoma as calcifications are rarely seen in other parotid tumors.

The DCE imaging shows usually a moderate and gradual enhancement (curve type A). DW sequence and ADC map show a high signal-intensity mass with an ADC value usually $> 1.8 \times 10^{-3}$ mm²/sec.

However, some pleomorphic adenomas with high cellularity with less-myxoid stroma can have a persistent TIC pattern (curve type C).

Pleomorphic adenomas have a small risk of malignant transformation into a carcinoma ex pleomorphic adenoma explaining the complete surgical resection.

Whartin's tumors (Figure 6)
Also known as papillary cystadenoma lymphomatosum. They represent the second most common benign parotid gland tumor after pleomorphic adenoma.

They typically occurs in the elderly (6th decade), in male and especially smoker ones. They are often bilateral and multi centric in 10-15% of cases and they are often located in the tail of the parotid gland.

Whartin’s tumors present as well-circumscribed lesions which may have a thin or incomplete capsule. They have typically an heterogeneous appearance with partly cystic, partly solid components.

On MRI, they present a low to intermediate signal with cyst containing cholesterol components containing focal high signal in T1 weighted images and usually a heterogeneous and variable signal intensity on T2 weighted images. The imaging features are non specific and differential diagnosis of pleomorphic adenoma or Whartin’s tumour may be impossible by conventional MRI.

Enhancement after contrast medium administration is often relatively poor, and usually shows a washout T1k pattern realizing a curve type B

The ADC value of Whartin's tumors was even smaller than that of malignant tumors (< 1.0 × 10^{-3} mm2/sec). This finding might be attributed to the intense lymphoid accumulation in the stroma and proliferation of the epithelial component leading to a decrease in the extracellular extra vascular space.

In the differential diagnoses of multiple lesions, metastases, lymphoma or inflammatory disease must be considered.

Malignant transformation is extremely rare in Warthin’s tumors. Some advocate surgical excision while others favour conservative management with follow up imaging.

**Lymphangiomas (figure 7)**

Lymphangiomas are congenital malformations of the lymphatic system occurring frequently in children. Infection or haemorrhage may occur. However in contrast to haemangiomas spontaneous regression is rare.

On MRI, lymphangiomas present cystic areas and thin septations, but also solid enhancing portions. Fluid-fluid interfaces with variable signal intensity depending on the duration of the bleeding can be seen and it is strongly favor the lymphangioma diagnosis.

**Other benign tumors**
Lipomas can easily be diagnosed thanks to their fat content signal intensities iso-intense to fat on all pulse sequences on MR imaging.

Other benign tumors, such as myoepitheliomas, oncocytomas, monomorphic adenomas, are relatively rare with a lack of typical imaging patterns.

**Malignant tumors**

**Muco-epidermoid carcinomas (figure 8)**

Muco-epidermoid carcinomas represent about 30% of parotid gland malignancies and are the most common malignant tumors in both children and adults.

The imaging features depend on the histological type. Low-grade lesions are well circumscribed, whereas high-grade lesions tend to have ill-defined margins and infiltrate surrounding tissues.

On MR imaging, low to intermediate signal intensity can be observed on both T1- and T2-weighted images.

These tumors metastasize primarily in the lymph nodes, bone and lung. Perineural tumor spread along the course of the facial nerve into the mastoid segment of the temporal bone has to be ruled out.

**Adenoid cystic carcinomas**

Adenoid cystic carcinoma are the second most common malignant neoplasm and accounts for 2-6% of parotid gland tumors.

They usually present as an infiltrating mass with a high propensity for peri-neural spread. Peri-neural disease can also present with 'skip' lesions distally in a nerve that seems to be normal.

**Lymphomas (figure9)**

Primary lymphoma of the salivary glands is rare and can only be diagnosed if there is no evidence of intra-or extraglandular nodal involvement. These lymphomas are considered as extra-nodal marginal zone B-cell lymphomas.
The incidence of salivary gland involvement varies between 1 and 8% of the patients with lymphomas. In the case of secondary lymphomatous involvement of the salivary glands, the parotid gland is involved in about 80%.

**Metastases (figure 10)**

Metastases are mainly observed in the parotid gland due to the presence of intra-glandular lymph nodes which drain the face, external ear, and scalp. Skin malignancies (melanoma, squamous cell carcinomas) are the most common primary tumors that metastasize to the salivary glands.

However, other malignancies, such as renal cell carcinomas, lung, breast and gastrointestinal carcinomas can also metastasize to the parotid gland or peri-parotid lymph nodes.

**Images for this section:**

<table>
<thead>
<tr>
<th>Benign tumors</th>
<th>Malignant tumors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign epithelial</td>
<td>Pleomorphic adenoma</td>
</tr>
<tr>
<td>Benign non-epithelial</td>
<td>Warthin’s tumor</td>
</tr>
<tr>
<td></td>
<td>Oncocytoma</td>
</tr>
<tr>
<td></td>
<td>Myoepithelioma</td>
</tr>
<tr>
<td></td>
<td>Intraductal papilloma</td>
</tr>
<tr>
<td></td>
<td>Haemangioma</td>
</tr>
<tr>
<td></td>
<td>Lymphangioma</td>
</tr>
<tr>
<td></td>
<td>Lipoma</td>
</tr>
<tr>
<td></td>
<td>Mucoepidermoid carcinoma</td>
</tr>
<tr>
<td></td>
<td>Adenoid cystic carcinoma</td>
</tr>
<tr>
<td></td>
<td>Squamous cell carcinoma</td>
</tr>
<tr>
<td></td>
<td>Adenocarcinoma</td>
</tr>
<tr>
<td></td>
<td>Lymphoma</td>
</tr>
<tr>
<td></td>
<td>Malignant mixed tumors:</td>
</tr>
<tr>
<td></td>
<td>- Carcinoma ex pleomorphic adenoma</td>
</tr>
<tr>
<td></td>
<td>- Carcinosarcoma</td>
</tr>
<tr>
<td></td>
<td>- Metastasising pleomorphic adenoma</td>
</tr>
</tbody>
</table>

**Table 1:** Parotid gland tumors: histological types
**Fig. 1:** The parotid gland is theoretically subdivided by the facial nerve into superficial and deep lobes. Landmark definition for superficial and deep lobes taking account the hypothetical facial nerve path (on yellow). The facial nerve courses lateral to the retromandibular vein (red arrow). The vein is seen as a constant structure on cross-sectional imaging and is a useful marker for the location of the nerve.

![Diagram](image1)

**Fig. 2:** Delayed-enhanced MR imaging

![Diagram](image2)

**Fig. 3:** Diagram of parotid MR image analysis. In type A and D lesions, it is not necessary to refer to DW MR imaging results; however, in type B and C lesions, it is useful to refer to DW MR imaging results. When the ADC value is less than 1.4 x 10^{-3} mm²/sec in type C lesions or greater than 1.0 x 10^{-3} mm²/sec in type B lesions, the lesion should be treated as a probable malignancy.

![Diagram](image3)
Fig. 4: Pleomorphic adenoma of the right parotid gland in a 39-year-old woman. Transverse T1-weighted image shows a well defined hypointense mass in the superficial right parotid gland. (B) Transverse T2-weighted image shows a heterogeneously hyperintense mass surrounded by a hypointense capsule. (C-D) Transverse T1-weighted image obtained after contrast material administration shows moderate tumor enhancement realizing a curve type A. (E) DW image shows a high-signal-intensity mass. (F) The round cursor marks the ROI selected for measurement of the ADC value. The ADC value is $1.8 \times 10^{-3}$ mm²/sec. This diagnosis was confirmed by the anatomopathological analysis after surgical treatment.
Fig. 5: Pleomorphic adenoma of the right parotid gland in a 50-year-old woman. Transverse T1-weighted MR image shows a well-defined hypointense mass in the right parotid gland. Transverse T2-weighted MR image shows a heterogeneously hyperintense mass. A transverse T1-weighted post contrast enhanced MR image shows an early enhancement in the peripheral. The round cursor marks the ROI selected for signal intensity measurement at dynamic MR imaging that shows a plateau enhancement pattern (curve type C)(D). (E) DW image shows a high-signal-intensity mass. (F) The ADC value is $2 \times 10^{-3} \text{ mm}^2/\text{sec}$. If dynamic enhancement, only, had been used for interpretation, the lesion would have been diagnosed as malignant (curve type C); however, addition of the ADC value led to accurate diagnosis of the lesion as benign. The diagnosis of hypercellular pleomorphic adenoma was confirmed by the anatomopathological analysis after surgical treatment.
Fig. 6: Warthin’s tumor of the left parotid gland in a 58-year-old man. (A) Transverse T1-weighted MR image shows an intermediate signal intensity mass in the left parotid gland containing focal high signals. (B) Transverse T2-weighted MR image shows a hyposignal mass. (C) Transverse T1-weighted image obtained after contrast material administration shows a heterogeneous early enhancement. (D) The DCE imaging shows an early peak of enhancement with a washout pattern >30% (curve type B). (E) DW image shows a high-signal-intensity mass. The round cursor marks the ROI selected for measurement of the ADC value. (F) The ADC value is $0.9 \times 10^{-3}$ mm$^2$/sec. This diagnosis was confirmed by the anatomopathological analysis.
**Fig. 7:** Lymphangioma of the left parotid gland in a 40-year-old woman. (A) Coronal T1-weighted MR image with Fat sat shows a multilobulated hypointense mass including thin septations located in the inferior part of the left parotid gland. Axial (B) and coronal (C) T2-weighted MR image shows a highly hyperintense mass. (D) Coronal T1-weighted MR image with Fat after contrast media injection doesn't show a significant post contrast enhancement.
**Fig. 8:** Muco-epidermoid carcinoma of the right parotid gland presenting a low signal intensity on T1 weighted sequence and a heterogeneous signal on T2 weighted image. This lesion presents a high and heterogeneous enhancement after contrast medium administration. -Infiltration into deep surrounding tissues: sternocleidomastoid and digastic muscles, parapharyngeal and carotidian spaces.
**Fig. 9:** Lymphoma of the right parotid gland in a 10-year-old girl. (A) Transverse T1-weighted MR image shows an ill defined, diffuse, iso-intense mass in the right parotid gland. (B) Transverse T2-weighted MR image shows slightly hyperintense mass. (C) Transverse T1-weighted MR image after contrast material administration shows a highly heterogeneous enhancement with an early peak of enhancement and a low washout pattern (curve type c)(D). (E) The DW image shows a diffuse hypersignal mass in the right parotid gland with an ADC value of $0.4 \times 10^{-3}$ mm$^2$/sec (F). There is also a DW hypersignal in the controlateral parotid, palatine tonsils and lymphatic nodes. The diagnosis of lymphoma was confirmed by the anatomopathological analysis.
**Fig. 10:** Right parotid gland metastasis of a nasopharyngeal carcinoma (A-B) Transverse and coronal T1-weighted MR image shows a ill defined infiltrating hypointense mass in the right parotid gland. (C) Coronal T2-weighted MR image shows a heterogeneous mass. (D) A coronal T1-weighted image obtained after contrast media injection shows a highly heterogeneous enhancement.
Conclusion

The exact pre-operative evaluation of salivary gland tumors remains a major challenge. MR imaging is the method of choice in patients with palpable salivary gland masses to assess the exact extent of tumors, the invasion of neighbouring structures, perineural spread and lymph node staging.

The analysis of new MR techniques such as diffusion-weighted (DW) and dynamic contrast enhanced sequences combined to the other morphologic MRI criteria and clinical features offers a reliable differentiation between benign and malignant parotid tumors and a good approach of the different tumor entities.

Personal information

References

Diagnosing common parotid tumours with magnetic resonance imaging including diffusion-weighted imaging vs fine-needle aspiration cytology: a comparative study.
Dentomaxillofac Radiol. 2010 Sep

-Yabuuchi H, Matsuo Y, Kamitani T, Setoguchi T, Okafuji T, Soeda H et al
Parotid gland tumors: can addition of diffusion-weighted MR imaging to dynamic contrast-enhanced MR imaging improve diagnostic accuracy in characterization?
Radiology. 2008 Dec

-Yabuuchi H, Fukuya T, Tajima T, Hachitanda Y, Tomita K, Koga M.
Salivary gland tumors: diagnostic value of gadolinium-enhanced dynamic MR imaging with histopathologic correlation
Radiology. 2003 Feb
-Eida S, Sumi M, Sakihama N, Takahashi H, Nakamura T.

Apparent diffusion coefficient mapping of salivary gland tumors: prediction of the benignancy and malignancy.

AJNR Am J Neuroradiol. 2007 Jan