Advanced MRI Sequences (Diffusion and Perfusion): Its Value in Parotid Tumors

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Abstract

Introduction: Tumors of salivary glands constitute 3% of neoplasms of the body. Clinical signs and symptoms usually occur in tumors at advance stages. Dynamic-contrast-enhanced and diffusion-weighted MR sequences have been described as useful diagnostic tools in other locations. Our goal is to evaluate the utility of these techniques for parotid tumors.

Material and methods: We retrospectively reviewed the Parotid tumors operated by our department whit Dynamic-contrast-enhanced and diffusion-weighted MR sequences between 2012 and 2015. We correlate the results with the final histopathological diagnosis.

Results: From 44 parotid tumors studied, Warthin tumors were the most common (43%). They showed high enhancement and high washout in perfusion series, so as low ADC values. Pleomorphic adenomas (41%) are hyperintense tumors in T2, with moderate constant enhancement in perfusion and high Apparent Diffusion Coefficient values. It is not possible to establish consistent results for malignant tumors given their underrepresentation in this sample.

Conclusion: Advanced MRI techniques contribute to the differential diagnosis of parotid tumors. Perfusion is useful in diagnosis of Warthin tumors and Pleomorphic adenomas. There is greater overlap in other tumors, for which diffusion-weighted MR sequences can help in discriminating malignancies. Both malignancies and Warthins show low Apparent Diffusion Coefficient values.

Keywords
Diffusion weighted imaging, Dynamic-contrast-enhanced MRI, Parotid tumors
and signal increase 20% or more; type III (early rise with moderate contrast wash) time to peak less than 120 seconds, signal increase 20% or more and less than 30% of washout ratio; and type IV (early rise with high contrast wash), time to peak less than 120 seconds, signal increase 20% or more and washout ratio more than 30%.

Results

Patients and clinical characteristics

A total of 44 patients shown in Table 1 (24 males and 20 females); age 48.46 +/- 17.0 years (mean + standard deviation) with pathologically confirmed primary parotid lesions were included, consisting of 41 benign and 3 malignant lesions. Of the malignant entities there were three histological diagnosis: Mucoepidermoid carcinoma of high grade, Myoepithelial carcinoma of high grade and Squamous cell carcinoma (Table 1).

The most prevalent Benign Parotid Lesions were Warthin tumors (n=19), pleomorphic adenomas (n=18) and Oncocytomas (n=2).

<table>
<thead>
<tr>
<th>Table 1: Parotid tumors.</th>
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<tr>
<td>Benign</td>
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<td>Pleomorphic adenoma</td>
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<td>Whartin tumor</td>
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<td>Oncocytoma</td>
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<td>Basal cell adenoma</td>
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<td>Cystadenoma</td>
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<td>Malignant</td>
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<td>Mucoepidermoid carcinoma of high grade</td>
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<td>Myoepithelial carcinoma of high grade</td>
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<td>Squamous cell carcinoma</td>
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<td>Total:</td>
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Methods and Materials

We reviewed retrospectively the Parotid tumors operated in our Hospital by the department of Maxillofacial surgery between 2012 and 2015 with a total of 44 cases. The results obtained in the MRI were correlated with the histopathological diagnosis.

MRI Acquisition and Interpretation

MRI examinations were performed with a 1.5T system (Signa; GE Medical System, Tokyo, Japan) using a phased-array head and neck coil. In all cases, the MRI protocol included conventional sequences with 3 mm section thickness: T1 weighted imaging sequence, a T2 weighted imaging sequence and a T1 weighted imaging sequence after contrast injection. The contrast agent injected was 0.1 mmol/Kg of gadobutrol (Gadovist®).

DWI was performed with an echoplanar SE sequence with two b-values (0, 800). ADC values were obtained. Dynamic MR imaging was performed by using a gradient echo T1 sequence with fat suppression (LAVA). 24 acquisitions of 12 seconds scan time each were performed (total acquisition time 5 minutes). MR imaging were sequentially obtained before and every 12 seconds after contrast material administration.

Time-intensity curve (TIC) patterns were categorized as follows (Figure 1): Type I (slow and progressive rise), signal increase less than 20%; type II (moderate and progressive rise), time to peak was more than 120 seconds and signal increase 20% or more; type III (early rise with moderate contrast wash) time to peak less than 120 seconds, signal increase 20% or more and less than 30% of washout ratio; and type IV (early rise with high contrast wash), time to peak less than 120 seconds, signal increase 20% or more and washout ratio more than 30%.

Figure 1: Time-intensity curve (TIC) patterns.
Classification of time-signal intensity curves

We considered peak time of 120 s to be the optimal threshold because it most accurately discriminated between pleomorphic adenoma and other tumors. Next, we evaluated the WRs of all tumors. The optimal WR threshold was considered to be 30%, as this value most accurately discriminated carcinomas from other tumors. Using these thresholds, we classified the TICs into the following four types as we previously described.

Differential diagnosis of salivary gland tumors by time-signal intensity curve Table 3 shows the classification of the 44 salivary gland tumors based on TICs. All pleomorphic adenomas but 2 (16/18) showed Type I pattern, whereas Warthin tumors were either Type III (5/19) or Type IV (14/19). Two oncocytopmas were Type III (2/2). All carcinomas but 1 (2/3) showed Type III pattern. By contrast, the other case (a squamous cell carcinoma) presented a TIC type II pattern, characterized by moderate and progressive rise. Pleomorphic Adenomas are hyperintense tumors in T2 sequences, type II curves and high levels of ADC. On other side, Warthin tumors presented a TIC type III (26.3%) and type IV (63.2%) and low levels of ADC.

Of the 44 tumors, 3 were malignant tumors. One was a squamous cell carcinoma with type II curve and low levels of ADC. The other two were a mucoepidermoid low grade carcinoma squamous cell carcinoma and a Myoepithelial low-grade carcinoma both with type III curves and low levels of ADC.

Secondary to its low number of cases it was not possible to establish a correlation in malignant tumors. Low levels of ADC with hypointensity in T2 and ill-defined margins in MRI should avoid us about malignancy.

Discussion

Diagnosis of salivary gland tumors is critical in their treatment plan. Superficial parotidectomy, and other techniques which respect the facial nerve, are the most usual interventions for resection of the tumor with margins. In the case of malignancy, surgery sometimes has to include elective neck dissection in high-grade and high-stage tumors and resection of the facial nerve if its involved [6].

FNAB of the parotid gland is a minimal risk, fast and effective procedure that help the surgeon to distinguish between malignant and benign neoplasia’s. Even so, the role of FNAB remains controversial in the preoperative study of parotid lesions.

FNAB offers the possibility to risk-stratify patients and avoid surgery in those cases where it is not appropriate or unnecessary. Moreover, in patients where a benign pathology is suspected on FNAB, the facial nerve should be preserved.

The sensitivity and specificity of FNAB in distinguishing neoplastic from non-neoplastic disease in the parotid gland is reported to be between 79% and 100%, and between 71% and 100% respectively. The sensitivity and specificity of FNAB in distinguishing between benign and malignant neoplasia is between 33% and 100%, and between 67% and 100% respectively [7]. There are several difficulties to differentiate benignity and malignancy, or to define tumor grades due to insufficient specimens, sampling errors and the subjective opinion of the cytopathologist. Variability in diagnostic accuracy varies with operator experience and geographical location [8].

From these data, it is apparent that FNAB is a useful clinical tool with greatest benefit when performed by experienced operators and interpreted with all other clinical information.

Secondary to its high contrast enhance, its great resolution and possibility of establishing the relationship of
the facial nerve with the nearest structures, MRI is the best radiologic technique in salivary glands diagnosis.

Several MRI findings suggestive of malignancy in salivary gland tumors have been reported. These include ill-defined margins, infiltration into adjacent tissues and low signal intensity on T2 weighted images. Low to intermediate signal intensities on T2 weighted images reflect high-cellularity. The ill-defined margin reflects the invasive growth of tumor cells [9].

Classic MRI techniques result in considerable overlap between benign and malignant tumors in terms of imaging appearance. Christe, et al. [10] reported that the sensitivity and the specificity of the conventional MR images findings in predicting malignancy were 70% and 73%, respectively. As a result, the validity of conventional MRI in the differential diagnosis of salivary gland tumors is restricted.

In the last decades, the roles of functional MRI, such as DWI and DCE-MRI, have been assessed in head and neck neoplasms to improve this overlap between benign and malignant tumors.

The ADC, a quantitative parameter measured from DW-MRI, combines the effects of capillary perfusion and water diffusion in the extracellular extravascular space. Precise measurement of ADC is of great importance because it has been used to differentiate malignant from benign tumors [11], to discriminate malignant lymphomas from carcinomas [12], and to follow treatment re-

Figure 2: Pleomorphic Adenoma. a) Axial T1 weighted image; b) Post-contrast fat-suppressed T1 weighted image; c) ADC values; d) Diffusion-weighted image; e) Axial T2 weighted image; f) Post-contrast fat-suppressed T2 weighted image; g) Dynamic contrast enhanced image; h) Time-intensity curve.

Figure 3: Whartin Tumor. a) Axial T1 weighted image; b) Post-contrast fat-suppressed T1 weighted image; c) ADC values; d) Diffusion-weighted image; e) Axial T2 weighted image; f) Post-contrast fat-suppressed T2 weighted image; g) Dynamic contrast enhanced image; h) Time-intensity curve.
studies defined WR at 5 min after contrast administration, others defined it at 3-4 min. The WR thresholds reported in past studies include 10%, 20%, 30% and 40%. Furthermore, the optimal threshold of WR at 5 min was 30%, and this most accurately discriminated between malignant and Warthin tumors. Due to these parameters, we could find four different patterns, which has been previously reported.

In our study, all pleomorphic adenomas but 2 (16/18) showed Type I pattern (Figure 2), whereas Warthin tumors were either Type III (5/19) or Type IV (14/19) (Figure 3). Two oncocytomas were Type III (2/2). All carcinomas but 1 (2/3) showed Type III pattern (Figure 4). By contrast, the other case (a squamous cell carcinoma) showed a Type II pattern.

Conclusions
Dynamic MRI Studies such as DWI and DCE contribute to differential diagnosis of Parotid tumors. Perfusion is useful in the diagnosis of Warthin tumors and Pleomorphic adenomas, there is greater overlap in other lesions, for which the diffusion can help in discriminating malignancies. Both malignancies and Warthins show low ADC values. This fact together with hypointense signal in T2 and poorly defined margins should alert us of the possibility of malignancy.

Conflict of Interest
There is no conflict of interest.

References


