Oral Oncology (2007) 43, 940–947

available at www.sciencedirect.com

ScienceDirect

journal homepage: http://intl.elsevierhealth.com/journals/oron/

ORAL ONCOLOGY

Diagnostic value of dynamic contrast-enhanced MRI in the salivary gland tumors

Miki Hisatomi [a], Jun-ichi Asaumi [b,*], Yoshinobu Yanagi [b], Teruhisa Unetsubo [a], Yuu Maki [b], Jun Murakami [b], Hidenobu Matsuzaki [b], Yasutoshi Honda [a], Hironobu Konouchi [b]

[a] *Department of Oral and Maxillofacial Radiology, Field of Tumor Biology, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, 5-1 Shikata-cho, 2-chome, Okayama 700-8525, Japan*
[b] *Department of Oral Diagnosis and Dentomaxillofacial Radiology, Okayama University Hospital of Medicine and Dentistry, 5-1 Shikata-cho, 2-chome, Okayama 700-8525, Japan*

Received 2 October 2006; accepted 7 November 2006
Available online 25 January 2007

KEYWORDS
Pleomorphic adenoma;
Warthin tumor;
Mucoepidermoid carcinoma;
Adenoid cystic carcinoma;
DCE-MRI

Summary To evaluate the diagnostic value of dynamic contrast-enhanced MRI (DCE-MRI) in salivary gland tumors, thirty-five patients (47 lesions) who underwent MR examinations and were histopathologically diagnosed with salivary gland tumors in Okayama University Hospital, between April 1998 and March 2005, were entered in the present study. The parameters included CI_{max300} or CI_{max600}, which was the contrast index (CI) at maximal contrast enhancement upon 300 s or 600 s, and T_{max}, which was the time that corresponded to the CI_{max300}. Washout ratio (WR_{300} or WR_{600}) was defined as follows: $CI_{max300} - CI_{300s}/CI_{max300}$ or $CI_{max600} - CI_{600s}/CI_{max600} \times 100$ (%), where CI_{300} or CI_{600} was the CI at 300 s or 600 s after contrast medium administration. We obtained the following results from the analysis of DCE-MRI parameters; (a) The salivary gland tumors were categorized into three CI curve types according to T_{max} and WR_{300}; Pleomorphic adenoma; $T_{max} > 210$ s and $WR_{300} < 10\%$, Warthin tumor; $T_{max} < 60$ s and $WR_{300} > 40\%$, and malignant tumor; 60 s $< T_{max} <$ 210 s and 10% $< WR_{300} <$ 30%; (b) On the basis of the relationship between T_{max} and CI_{max} or WR, all pleomorphic adenomas were successfully differentiated from Warthin tumor lesions. Of the 20 pleomorphic adenomas, 18 (90.0%) were successfully differentiated from malignant tumors. All Warthin tumor lesions were successfully differentiated from pleomorphic adenomas and malignant tumors. Of 12 the malignant tumors, 11 (91.7%) were successfully differentiated from pleomorphic adenomas. All malignant tumors were successfully differentiated from Warthin tumors. Thus, DCE-MRI parameters are useful in diagnosing salivary gland tumors on the basis of the combined assessment of T_{max} and CI_{max} or WR.

* Corresponding author. Tel.: +81 86 235 6706; fax: +81 86 235 6709.
E-mail address: asaumi@md.okayama-u.ac.jp (J.-i. Asaumi).

1368-8375/$ - see front matter
doi:10.1016/j.oraloncology.2006.11.009

Introduction

Salivary gland tumors account for 5% of all head and neck tumors.[1] Histologically, the most common benign tumor is pleomorphic adenoma, followed by Warthin's tumor. The most common malignant tumor is mucoepidermoid carcinoma, followed by adenoid cystic carcinoma.[1] Biopsies of salivary gland tumors may be difficult and can lead to dissemination of the tumors, because they are often covered by normal mucosa, and biopsies are performed deep within the mucosa. In addition, it is often difficult to obtain a definite diagnosis from the biopsy, because salivary gland tumors show various histopathological features. However, it is important for surgeons to know preoperatively whether the salivary gland tumor is benign or malignant and the extent of the lesion, because this information strongly influences the surgical procedure. Therefore, preoperative imaging plays an important role in surgical planning.

Recently, magnetic resonance imaging (MRI) has been used in the diagnosis and definition of the extent of lesions in the oral and maxillofacial region because it is the most useful modality for analyzing the internal structure of lesions with its superior soft tissue contrast and multiplanar facility.[2–4] MRI has been effective in diagnosing salivary gland disorders and has some advantages over traditional techniques.[5,6] The MRI findings of salivary gland tumors have been described in a number of reports.[2,5–14] The infiltrative margin has been reported to reflect the high malignancy of the tumor.[8] In addition, it has been reported that the findings of low signal intensity and irregular lesion margins on T_2-weighted MR images indicate malignancy.[9,10] However, when salivary gland tumors have been discovered in small masses, the tumors do not exhibit characteristic features, such as lymph node metastasis or infiltrative margins, even if they are malignant tumors. Thus, MRI examination have not produced differential diagnoses of salivary gland tumors, and the reported sensitivities and specificities of these findings have been low and significantly overlapping.[5,11,12,15]

It has been reported that dynamic contrast-enhanced MRI (DCE-MRI) is useful for the differential diagnosis of some tumors, and many investigators have attempted to identify the differences between benign and malignant tumors, as well as to assess the malignancy of these tumors using dynamic MRI (10—13).[5–8,16,17] However, there have not been many reports concerning DCE-MRI of salivary gland tumors. In addition, the existing reports focused only on the T_{peak} for salivary gland tumors.[16,17] On the other hand, there has been only one study of dynamic MR imaging of salivary gland tumors that focused on some parameters of the time—signal intensity curve (TIC).[19] Those researchers concluded that the parameters derived from TICs under contrast medium-enhanced dynamic MR imaging correlate well with histopathologic findings. Thus, these parameters may be useful in diagnosing salivary gland tumors.

In the present study, we evaluated the diagnostic value of the parameters of contrast index curves (CI curves) on DCE-MRI of salivary gland tumors.

Materials and methods

Patient population and salivary gland tumors

Thirty-five patients (47 lesions) who underwent MR examinations and were diagnosed with salivary gland tumors in Okayama University Hospital between April 1998 and March 2005 were entered in the present study. All subjects gave their informed consent. Of these 35 patients, 20 (20 lesions) had pleomorphic adenomas, three (15 lesions) had Warthin tumors and 12 (12 lesions) had malignant tumors (7 mucoepidermoid carcinomas and 5 adenoid cystic carcinomas). The patient population of pleomorphic adenomas consisted of 16 females and six males ranging in age from 20 to 80 years old (mean, 43.8 years old). The primary site distribution of pleomorphic adenomas was as follows: palate, 10; submandibular gland, 2; parotid, 7; cheek, 1. The patient population with Warthin tumors consisted of one female (6 lesions) and two males (2 and 7 lesions) ranging in age from 70 to 77 years old (mean, 75 years old). The primary site distribution of the Warthin tumors was all parotid. The patient population with malignant tumors consisted of four females and seven males ranging in age from 29 to 72 years old (mean, 51.7 years old). The primary site distribution of the malignant tumors was as follows: palate, 3; sublingual gland, 6; maxilla, 2; tongue, 1.

MR imaging

The MR examination was performed on a 1.5 T unit (Magnetom Vision; Siemens, Erlangen, Federal Republic of Germany) with a CP head coil or a head-neck coil. Routine T_1- and T_2-weighted images were acquired with spin-echo and turbo spin-echo sequences with frequency-selective fat-suppression in the transverse and coronal planes, respectively. For DCE-MRI, 21 consecutive data sets were acquired for 315 s (14 s/1 scan) with three-dimensional fast imaging with steady state precession (repetition time/echo time/flip angle.5/2/25 degrees, 16 slices over 48 mm of slab thickness, resulting in an effective slice thickness of 3 mm). Frequency-selective fat-suppressed T_1-weighted images were immediately acquired as contrast-enhanced T_1-weighted images. Intravenous injection of a contrast medium (Omniscan syringe; Daiichi Pharmaceutical Co., Tokyo, Japan or Magnevist syringe; Nihon Schering, Osaka, Japan) was archived manually at a rate of approximately 2 ml/s through a 21-gauge butterfly needle inserted into a vein in the cubital fossa. The injection of a contrast medium started 6 s before the initiation of a second scan of 21 DCE-MRI data sets. The DCE-MR images were acquired repeatedly at 600, 615 s after the start of the injection of the contrast medium.

Data analysis

The region of interest (ROI) was drawn in the 2 or 3 size and/or shape within the solid area and the mean signal intensity (SI) was estimated. The mean SI on the ROI of each lesion was calculated using a workstation (Siemens). The contrast index (CI) was calculated as follows: CI = (SI (post-contrast) − SI (pre-contrast))/SI (pre-contrast). The