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Diagnostic value of capsule-like rim enhancement on magnetic resonance imaging for distinguishing malignant from benign parotid tumours

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Abstract. The purpose of this study was to clarify the diagnostic value of capsule-like rim enhancement (CLRE) on magnetic resonance imaging (MRI) for distinguishing malignant from benign tumours of the parotid gland. We retrospectively evaluated contrast-enhanced T1-weighted images of 100 patients with malignant and benign parotid tumours for the presence, completeness, and irregularity of CLRE and its maximum thickness. We investigated any correlation of imaging and histopathological findings for 51 cases showing CLRE with available histology. The presence and completeness of CLRE did not differ significantly between benign and malignant tumours. Malignant tumours had more irregular CLRE than benign tumours ($P < 0.05$). The mean CLRE thickness was significantly greater for malignant (2.4 mm) than benign tumours (1.4 mm) ($P < 0.0001$). The two types of tumour were most accurately distinguished using a cut-off value of 1.5 mm thickness. Histopathology demonstrated the general correspondence of thick CLRE on MRI in malignant tumours with thick but sparse fibrous tissue and infiltration of tumour cells and lymphocytes, whereas thin CLRE in benign tumours typically represented dense fibrous tissue without infiltration of tumour cells. CLRE was more irregular and thicker in malignant tumours than in benign tumours, which may be of help in differentiating them.

Key words: Salivary glands; Neoplasms – primary; MRI; Head/neck.

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Differentiating benign and malignant lesions of the salivary gland using magnetic resonance imaging (MRI) is important for selecting the appropriate surgical strategy. The more extensive surgery for malignancy involves removal of the entire salivary gland and surrounding lymph nodes, with the exception of malignant lymphoma which is successfully treated with radiotherapy and/or chemotherapy.

Characteristic findings of malignancy of the salivary gland include infiltration into

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adjacent structures and ill-defined borders on conventional MRI,[1–4] low washout in dynamic studies,[5–10] and a low apparent diffusion coefficient on diffusion-weighted imaging.[10–13] However, the overlap of such advanced findings among various tumours requires identification of additional predictive MRI features for accurate preoperative diagnosis.[7,10,11]

Researchers have distinguished benign and malignant tumours on conventional MRI by the capsule surrounding the tumours; this capsule is generally defined as a thin line of low signal surrounding the tumour on T1-weighted images and/or T2-weighted images.[14–17] Some have reported that entire encapsulation of the salivary tumour indicates benignancy,[14,15] while absent or incomplete encapsulation is a sign of malignancy,[16] while others have reported the presence of an intact capsule not to definitively exclude a low-grade malignancy.[17] Therefore in cases with complete encapsulation, additional features may be helpful in stratifying lesions into likely benign or likely malignant categories. Ishibashi et al.[15] recently noted rim-like enhancement as encapsulation and showed both irregular thickness and strong enhancement of the capsule to be more frequent in malignant than benign tumours of the parotid gland. We believe the capsules they describe may represent marginal rim-like enhancement of the tumour contents as well as histologically true fibrous tissue, because both of these should be indistinguishable by imaging alone. In the present study, therefore, we define capsule-like rim enhancement (CLRE) as a line or band-like enhancement around the tumour on contrast-enhanced T1-weighted images, which might include true fibrous tissue and/or marginal rim-like enhancing portions of tumours.

We retrospectively evaluated the presence, completeness, irregularity, and thickness of CLRE on conventional MRI of a larger number of malignant parotid tumours than investigated in the study by Ishibashi et al., as well as benign tumours, including cases that occurred prior to the availability of advanced MRI modalities such as diffusion-weighted imaging. We also investigated the corresponding pathology of those cases with available histological observations.

Materials and methods

Cases

We retrospectively evaluated the imaging and pathology findings of 100 consecutive patients with tumours of the parotid gland who underwent MRI and tumour resection in our hospital from January 1, 1999 through December 31, 2011. Fifty-five were female and 45 male and they were aged 16–88 years (mean age 56 years).

Table 1. Histopathological diagnoses of parotid tumours.

Histological findings	Number of tumours
Malignant tumours	34
Mucoepidermoid carcinoma	7
Malignant mixed tumour	5
Salivary duct carcinoma	5
Malignant lymphoma	5
Squamous cell carcinoma	3
Acinic cell carcinoma	2
Epithelial myoepithelial carcinoma	2
Myoepithelial carcinoma	1
Adenocarcinoma	1
Carcinosarcoma	1
Basal cell adenocarcinoma	1
Sebaceous carcinoma	1
Benign tumours	66
Pleomorphic adenoma	44
Warthin tumour	15
Epithelial myoepithelioma	4
Basal cell adenoma	3
Total	100

Otorhinolaryngologists performed the surgeries, and a pathologist with 22 years of experience confirmed the pathology and diagnosis from haematoxylin–eosin-stained tissue sections and, when necessary, immunohistochemical studies. Table 1 gives details of the types of malignant and benign parotid tumours identified.

The local ethics committee approved this retrospective study, and our institutional review board waived informed consent.

MRI technique

MRI images were obtained using either of two 1.5-tesla superconducting units (Signa Horizon LX CVi, GE Medical Systems, Milwaukee, WI, USA; Intera Achieva Nova Dual, Philips Medical Systems, the Netherlands) with either quadrature head neck vascular or surface coil. Axial T1-weighted images were obtained using repetition time (TR) 460–646 ms, echo time (TE) 12–15 ms, and the spin echo (SE) technique. Fat-suppressed T2-weighted images were obtained using TR 3500–5500 ms, TE 90–95 ms, and the fast spin echo (FSE) technique. After intravenous injection of a gadolinium solution (0.2 ml/kg body weight Magnevist; Bayer Health Care, Osaka, Japan), fat-suppressed contrast-enhanced T1-weighted images were also obtained using the SE technique with a scanning delay time of 133–189 s after dynamic study. The section thickness of all axial images was 4 or 5 mm; the intersection gap was 0.5 or 1.0 mm. The acquisition matrix was 320 × 252–256, and field of view (FOV) was 21 cm × 21 cm.

Image analysis

All MRI images were coded and presented in random order to two oral and maxillofacial radiologists with 11 and 31 years of experience, who were blinded to the pathological diagnosis and clinical data. The two focused on possible contrast enhancement surrounding the parotid tumours on contrast-enhanced T1-weighted images; CLRE was defined as a line or band-like enhancement around the tumour.

After independent review, the two reviewers compared their findings and discussed the imaging findings, i.e., presence or absence, the completeness, and the regularity of rim enhancement. Initial disagreements in interpretation were resolved by consensus. They measured the rim enhancement with a sliding digital calliper at the point of maximum thickness on an axial pre-selected plane that cut approximately through the centre of the tumour (arrowheads, Fig. 1A and B). Measurement was avoided in regions with apparent mural nodules (arrow, Fig. 1B).

Data analysis

The χ^2 test was used to assess the significance of inter-group differences in frequency of CLRE presence, irregularity of thickness, and completeness of CLRE between malignant and benign tumours.

The mean measurement of the maximum thickness of CLRE obtained by the two reviewers was designated the final measurement. The relationships between the values obtained by the two reviewers were analysed by simple regression. The fit of the regression line was designed by calculating the adjusted R^2 value. We calculated the rate of measurement error (error/average) using the formula: error = $(\sum d^2/2n)^{0.5}$, where d is the difference between the two measurements and n is the number of samples.[18] The Mann–Whitney U-test was used to compare the thickness data of CLRE of all malignant and benign tumours, presented as the mean ± standard deviation (SD). The Kruskal–Wallis test was used to compare malignant tumours to three categories of benign tumour: Warthin tumour, pleomorphic adenoma, and all other benign tumours; this was followed by post hoc