Abstract
Objective. Our purpose was to evaluate the utility of the small region of interest (ROI) method to detect the architecture of cervical lymph nodes and the specificity of time–intensity curves for tissue present in cervical lymph nodes.

Methods. Specimens were taken from 17 lymph nodes of eight patients (ten sides of the neck) with oral squamous cell carcinoma who underwent dynamic contrast-enhanced magnetic resonance imaging (MRI) and neck dissection between 2005 and 2007 at our hospital. Two methods of constructing time–intensity curves were compared: the conventional method that uses relatively large ROIs, and a new method that uses small ROIs. Curves made with the small ROI method were then compared to histopathological findings for dissected lymph nodes.

Results. The small ROI method allowed differences in signal intensity to be discerned at the tissue level, which was not possible with the conventional large ROI method. Curves for normal lymphoid tissue tended to be type I, those for tumor cells tended to be type II, and those for keratinization/necrosis tended to be types III and IV, indicating that time–intensity curves can be specific to tissue type within lymph nodes.

Conclusion. The small ROI method was useful for evaluation of the architecture of cervical lymph nodes.

Key words Dynamic magnetic resonance imaging · small region of interest method · time–intensity curve
with histopathological findings for dissected lymph nodes.

Materials and methods

Patient population

Eight patients (ten sides of the neck) with histopathologically proven oral squamous cell carcinoma underwent dynamic contrast-enhanced MRI and neck dissection between 2005 and 2007 at our hospital. The lymph nodes were identified in all phases in these patients, and histopathological sections matching the MRI images were obtained from the lymph nodes. Specimens were obtained from 17 cervical lymph nodes (nine benign, eight metastatic). However, we excluded cervical lymph nodes in which the superimposition of motion artifacts caused by patient movement during imaging and deviations in measurement sites were noted.

Dynamic MRI and neck dissection were performed over 3–19 days (median, 10 days). Seven of the cervical lymph nodes were submandibular and ten were upper jugular lymph nodes. In addition, the primary tumor site was in the lower gingiva in two patients, the margins of the tongue in three, the upper gingiva in one, the buccal mucosa in one, and the mandible in one patient. The patient group comprised four men and four women, and their age at surgery was 24–80 years (median, 59 years).

Dynamic MRI image acquisition

MRI was performed with a 1.5-T unit (Intera Achieva 1.5T Nova Dual; Philips Medical Systems, Best, the Netherlands) with a Synergy Head/Neck coil or a SENSE-flex-S/M coil (Philips Medical Systems). Patients were held in place with straps and bands. The patient’s head was centered and immobilized with a fixation strap and band.

A dynamic study was performed by using the spin-echo method (repetition time, 415–829 ms; echo time, 10 ms; matrix size, 256 × 256; slice thickness, 5 mm; slice interval, 0.5–1.0 mm; field of view, 250 mm). Contrast medium for dynamic MRI was injected via the cubital vein at 2.0 ml/s, and images were acquired in 20 to 22 phases at 13.3- to 37.3-s intervals. The contrast medium was gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany).

Dynamic MRI evaluation

To draw the profile lines, a series of images, including those of the maximum cut surface of the lymph nodes, were selected from all dynamic MR images. Several profiles were manually drawn radially on the lymph nodes in all phases, to the extent possible, and the intensity over time was measured. One to four profile lines were drawn on each lymph node (median, two lines), and three to 25 plots (median, ten plots) were acquired automatically in accordance with the settings. The plot size on the profile line was 0.76–1.0 × 0.76–1.0 mm, and there were no gaps. The pixel size was 0.98 × 0.98 mm (Fig. 1A, B). Thus, 1–4 pixels were partially or fully included in each plot.

To select ROIs, a series of images, including those of the maximum cut surface of the lymph nodes, were selected from all dynamic MR images. ROIs were manually selected to include the entire lymph node in all phases. Intensity over time was measured.

To compensate for differences in signal intensity arising from different patients and to objectively evaluate the increase in signal intensity due to the contrast medium, the contrast index3 was calculated [contrast index = (signal intensity after contrast medium administration)/(signal intensity before contrast medium administration)], and time–intensity curves were created by the small ROI and large ROI methods (Fig. 1).

The period up to 90 s after intravenous injection of contrast medium was deemed the early phase, that from 90 to 180 s was deemed the middle phase, and that after 180 s was deemed the late phase. A contrast index ≥1.5 in the early phase was defined as a peak.3 The time–intensity curves were classified into four types in accordance with past reports27,11–16 and depending on the presence or absence of a peak and the washout rate after the peak: rapid initial enhancement followed by a rapid decrease in enhancement (type I), rapid initial enhancement followed by a gradual decrease in enhancement (type II), gradual increase in enhancement (type III), and no enhancement (type IV; Fig. 2). The washout rate of type I was ≥15%; and that of type II was <15%.

Histopathological evaluation

After the lymph nodes obtained by neck dissection were identified anatomically, they were fixed in neutral formalin solution, sectioned to match the dynamic imaging, and embedded in paraffin. Thin specimens thus prepared were stained with hematoxylin-eosin and examined microscopically (ECLIPSE 80i; Nikon, Tokyo, Japan). The lymph nodes were identified anatomically by consensus of one oral surgeon and two radiologists attending the lymph node dissection following neck dissection. Histopathological specimens were sectioned equally by the number of plots on profile lines on the lymph node in dynamic MRI images, and the time–intensity curves of the plotted sites and the histopathological findings for sites corresponding to the plotted sites were evaluated. Four histopathological findings were evaluated: normal lymphoid tissue, tumor cells, fibrous tissue, and keratinization/necrosis.

Statistical analysis

Statistical analysis was performed with JMP software for Windows version 6.0 (SAS Institute, Cary, NC, USA). Statistical significance was assessed using the likelihood ratio χ²-squared test. Values of P < 0.05 were considered to be significant.