Evaluation of MR imaging of tongue cancers in comparison with histopathological findings

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Abstract: The aim of this study was to evaluate the usefulness of magnetic resonance imaging for the preoperative measurement of depth of tumor invasion in 45 patients with tongue cancers. The depth of tumor area as determined by MR imaging was compared with the area where the tumor was really invading in the histopathological section prepared from the corresponding surgical material.

Lesion detectability was compared among the following 3 types of image: T1-weighted spin echo imaging, T1WI-group; T2-weighted spin echo imaging, T2WI-group; enhanced MRI-group. The T2WI-group showed highest accuracy in detecting the tumor among the three groups. In each sample the tumor area detecting in the histopathological tissue sections was measured and size reduction rate through histopathological processing was calculated. The depth of corrected histopathological tumor area was calculated by revising with reduction rate. The depth of corrected histopathological tumor area showed statistically significant correlation with the depth of tumor area of MRI. Type of growth, mode of invasion did not show any significant difference between the classified groups. The correlation coefficient between tumor depth of MRI and histopathology showed significant value in the case where lympho-plasmocytic infiltration was slight or none. On the other hand, the correlation coefficient was not significant in the case where lympho-plasmocytic infiltration was marked or moderate. The present result suggests that the depth of tumor area diagnosed by MRI well correlates with actual tumor depth in generally, however, careful diagnosis is required when stromal lymphocyte infiltration is strong.

Key words: tongue cancer, MRI, histopathological findings, The depth of tumor area, correlation coefficient.

Introduction

The tongue cancer is one of the most frequent cancers among all oral cancers. It can be diagnosed by inspection, palpation and by taking a biopsy from the tongue lesion. It is important to estimate the exact extension of the tumor in order to plan the most adequate treatment to each case of the tongue cancer.

Magnetic resonance (MR) imaging is considered to

be better for demonstrating soft tissue structures and surface and deep extension of tongue cancers than CT and other conventional diagnostic modalities¹⁻⁵⁾. In order to evaluate the accuracy of MR imaging for the diagnosis of the tongue cancer the preoperative measurement of the area of tumor invasion in MR imaging was compared with histopathological findings in each corresponding surgically resected material in this study.

Patients and Methods

We studied forty-five cases with squamous cell carcinomas of the tongue that underwent surgery at the department of oral and maxillofacial surgery in our university hospital during the period of January 1990 through May 2000. They were 31 men and 14 women, with ranging ages from 43 to 87 years with

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average age of 51.3 years old. T classification of each primary tumor was made according to UICC classification⁶⁾, which consists of 15 cases of T1, 18 cases of T2, 5 cases of T3 and 7 cases of T4. Type of growth of each primary tumor was classified into two types, either endophytic or exophytic by its macroscopic findings.

MR imaging was performed with a 1.5 Tesla superconductive unit (SMT-150, Shimadzu, Japan). In the following 3 types of image: T1-weighted spin echo imaging, T1WI-group (TR/TE=300~600/10~20 msec); T2-weighted spin echo imaging, T2WI-group (TR/TE=2000~3000/100~120 msec); enhanced MRI-group (Gd-DTPA, TR / TE=300~600 / 10~20 msec) lesion detectability was compared. In order to assess accuracy of MR imaging in tongue cancer ten control samples without a tongue cancer were used. They consist of 5 cases of salivary gland lesion and 5 cases of buccal mucosal lesion. Sensitivity, specificity and accuracy in detecting the tumor lesion were compared in three types of MR imaging. Then, MR imaging of the tumor was measured in depth (the depth of tumor area) in each case. The imaging type of borderline between normal and tumor area assessed in T2-weighted spin echo imaging, was classified into two groups: Clear type and Non-clear type.

After the surgery resected materials were fixed with 10% formalin and processed to make ordinary histopathological tissue sections. The tumor area

detecting in the histopathological sections was measured by depth (the depth of histopathological tumor area) in the corresponding slice to the preoperative MR image. Histopathological characteristics of these 45 cases of squamous cell carcinomas were classified in grade of differentiation⁷⁾, mode of invasion⁸⁾, stromal lympho-plasmocytic infiltration⁹⁾ and stromal desmoplastic reaction¹⁰⁾. These factors were weighed against the imaging findings.

Statistical analysis was performed by Mann-Whitney U test. A P-value equal to or smaller than 0.05 was considered significant. All calculations were performed using Stat View for Windows (SAS Institute Inc., North-Caroline, USA).

Result

The characteristics of the study sample were shown in Table 1, with the result of classification in grade of differentiation, mode of invasion, stromal lympho-plasmocytic infiltration, stromal desmoplastic reaction. Type of growth consists of 12 cases of exophytic type and 33 cases of endophytic type (Table 1). Lesion detectability of three types is illustrated in Figure 1. T2WI-group showed high value of 88.9% in sensitivity. In contrast, those of enhanced MRI-group and T1WI-group showed 75%, 64.4% respectively. Specificity was high in 90% with enhanced MRI-group, followed by T2WI-group showing 80%. Then,

Table 1 Relationship between clinical and histopathological characteristics and the imaging type of borderline.

Variable	Parameters	Number of cases	Clear type	Non-clear type	
Type of growth	Exophytic	12	8	4	P=0.0453
	Endophytic	33	11	22	
Differentiation (WHO)	Well	20	14	6	P=0.6214
	Moderate	22	5	17	
	Poorly	3	0	3	
Mode of invasion (Yamamoto, Kohama)	1	7	4	3	P=0.9415
	2	5	2	3	
	3	18	6	12	
	4C	11	5	6	
	4D	4	2	2	
Stromal lympho-plasmocytic infiltration (Anneroth)	1, 2	20	11	9	P=0.6407
	3, 4	25	8	17	
Stromal desmoplastic reaction	(+)	29	13	16	P=0.6333
	(-)	16	6	10	
					NS

Fig. 1 Sensitivity, specificity and accuracy of lesion detectability among three types of MR imaging.

Fig. 2 Relationship between the depth of corrected histopathological tumor area and the depth of tumor area of 3 types of MR imaging.

T2WI-group showed high value of 87.3% in accuracy.

In contrast, those of enhanced MRI-group and T1WI-group showed 78.6%, 65.5% respectively (Fig. 1).

The imaging type of borderline was analyzed with other clinical and histopathological characteristics. Differentiation, mode of invasion, storomal lymphoplasmocytic infiltration, storomal desmoplastic reaction did not show any significant difference in imaging type of borderline. However, endophytic type in type of growth of macroscopic findings was prone to Non-clear type image. Mann-Whitney U test revealed significant difference ($P=0.0453$) (Table 1).

Figure 2 shows the relationship between the depth of tumor area on the MRI and the depth of corrected histopathological tumor area. The correlation coefficient of T1WI group, T2WI group and enhanced MRI group showed value of 0.583, 0.678, 0.71 respectively.

The relationship between MRI and histopathological depth of tumor areas calculated by each regression equation was statistically significant in all three types of MRI ($P=0.0002$, $P<0.0001$). Figure 3 shows a correlation between the depth of corrected histopathological tumor area and the depth of tumor area classified by type of growth in T2WI group. Exophytic type showed higher value of the correlation

The relation with the type of growth .

Fig. 3 Relationship between the depth of corrected histopathological tumor area and the depth of tumor area on MRI classified by type of growth.

Fig. 4 The relation with the mode of invasion (Yamamoto & Kohama classification).

coefficient ($r=0.859$) ($P<0.0001$) than Endophytic type ($r=0.569$) ($P=0.0004$).

Figure 4 shows the relation with the mode of invasion (Yamamoto & Kohama classification). The mode of invasion was classified into two groups; Group 1: Type 1, 2, 3; Group 2: Type 4C, 4D. The correlation coefficient of group 1 and group 2 showed value of 0.645, 0.748, respectively. The both group showed statistically significant relationship ($P=0.0013$ and $P<0.0001$) between the depth of corrected histopathological tumor area and the depth of tumor area on the MRI.

Figure 5 shows a correlation between the depth of corrected histopathological tumor area and the depth of tumor area classified by lympho-plasmocytic infiltration grade (Anneroth classification) in T2WI group. The lympho-plasmocytic infiltration grade was classified into two groups; Group 1: 1 (marked), 2 (moderate); Group 2: 3 (slight), 4 (none). The correlation coefficient of Group 1 was 0.304; on the other hand, that of Group 2 was 0.776. The significant correlation could not be recognized in Group 1 ($P=0.1920$). The regression equation of Group 2 was as follows: $Y=7.622+0.644X$ ($P<0.0001$). The result

The relation with the lympho-plasmocytic infiltration grade (Anneroth).

Fig. 5 The relation with the lympho-plasmocytic infiltration grade (Anneroth).

indicates the group of slight or none lympho-plasmocytic infiltration (Group 2) showed clear relationship between MRI and histopathology. However, the tumor depth in MRI may tend to show greater area than histopathological tumor depth in the group of marked or moderate lympho-plasmocytic infiltration (Group 1). Resected tissue materials reduce their size after formalin fixation and in histopathological section. These size reduction rates were measured in each sample. Actual depth of tumor area was calculated by revising histopathological tumor depth by each reduction rate and expressed as the depth of corrected histopathological tumor area.

Figure 6 shows an example of reduction rate of resected tissue by formalin fixation. In this sample (case No. 44) size of resected tongue tissue, 48×35 mm was reduced into 31×26 mm by formalin fixation and then 26×21 mm in histopathological section. The reduction rate (%) was calculated as follows: $100 \times \{ (48-26)/48 + (35-21)/35 \} \times 0.5$. The reduction rate of the case was 17%. Average reduction rate of all cases was 34.3%.

Figure 7 shows an example of well correlation between MRI and histopathology (Case No. 21). This cases was measured to 57×33 mm in tumor area by enhanced MRI. The resected material revealed to be 56×30 mm in tumor area, and then 43×23 mm in histopathological sections. The reduction rate was calculated as follows: $100 \times \{ (56-43)/56 + (30-23)/30 \} \times 0.5$. The

reduction rate of the case was 23%.

Figure 8 shows an example of poor correlation between MRI and histopathology (Case No. 40). The tumor size was measured to 18×13 mm in resected material, and $15 \text{ mm} \times 10 \text{ mm}$ in histopathological section. The reduction rate of the case was 20%. However, any type of MRI failed to detect the tumor in this specific case.

Discussion

In order to treat the tongue cancer, it is important to have accurate information on the size and extent of the tumor. Although the tongue is readily accessible for inspection and palpation, it is difficult to determine how deep the tumor extends⁶⁾. MR imaging is generally considered superior to CT and other modalities in demonstrating deep extension of tongue cancer¹¹⁻¹⁵⁾. Einspieler et al.¹⁶⁾ compared MR staging of lingual, oropharyngeal tumors in 11 patients with pathologic staging, showing 81.8% in diagnostic accuracy. They observed only each one case with over-and understaging in MR imaging. The present result indicates that T2WI-group showed high value of 87.3% in accuracy in detecting the tumor. In contrast, those of enhanced MRI-group and T1WI-group showed 78.6% and 65.5%. Superficial tumors could not always be detected with MR imaging, because tumor infiltration into the muscle bundle or deep

Fig. 6 An example of tissue size reduction during processing (case No. 44). The resected tissue 48mm×35mm was reduced into 26mm×21mm in histopathological section. Reduction rate of this case was 17%. Average reduction rate of all cases showed 34.3%.

facial plane may be necessary for detection¹⁷⁾. T2WI-group has been considered as optimal among the three types of MR imaging for tongue cancers^{18,19)}.

In general, squamous cell carcinomas of the tongue are usually moderately well differentiated and tend to spread along the tissue plane, vascular channels, or muscle bundle²⁰⁾. On T2WI-group the tumor of the tongue has higher signal intensity than that of normal tongue¹⁸⁾. A problem of T2WI-group is the overestimation of tumor size caused by surrounding edema and the disappointing tumor-to-fat contrast¹⁹⁾.

Edema often occurs with inflammation due to chemotherapy or irradiation. Although enhanced MRI-group is reported to be able to demonstrate many lesions with high sensitivity²¹⁾, that was inferior to T2WI-group in sensitivity in the present result. The present study revealed that T2WI showed the highest accuracy in detecting tumors among the three methods.

In the present study the relation between MR image and histopathologic findings was also examined.

The correlation coefficient was nearly high value in 3 types of MRI. The regression equation of all three types of MRI group showed statistically significant ($P<0.001$). Type of growth classified macroscopic

findings to endophytic or exophytic and mode of invasion classified by microscopic findings to grade 1, 2, 3, or 4C, 4D did not show any significant difference between the two groups. As for the result of the regression analysis of lympho-plasmocytic infiltration in interstitial tissue high correlation was recognized ($P<0.0001$) in the case where lympho-plasmocytic infiltration is slight or none (Group 2). The tumor depth area can be diagnosed considerably correctly by T2WI image. On the other hand, the correlation of tumor depth between MRI and histopathology was not statistically significant ($P=0.192$) in the case where lympho-plasmocytic infiltration is marked or moderate (Group 1). The present result suggests that diagnosis of tumor depth by MRI must be performed carefully in the case where lympho-plasmocytic infiltration is strong. Further analysis with large number of cases will be required to reveal the discrepancy.

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Fig. 7 This case was measured to 57×33mm in tumor area by enhanced MRI, and the resected material revealed to be 56×30mm in tumor area. The histopathological section showed 43×23 mm, showing well correlation with MRI and histopathology (reduction rate=23%) (Case No. 21).

Fig. 8 This case was measured to 18×13mm in tumor area by resected material. The histopathological section showed 15×10mm, however any type of MRI failed to detect the tumor (reduction rate=20%) (Case No. 40).

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舌癌における MR 画像診断と病理組織学的所見との比較検討

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要 旨

本研究は舌癌において腫瘍浸潤範囲を手術前に察知する上で MR 画像の有用性について 45 症例を用いて評価したものである。MR 画像上で計測した腫瘍浸潤の深さを手術で切除された当該症例の病理組織標本での実際の腫瘍浸潤範囲と比較検討した。腫瘍病変の描出能について T1 強調像, T2 強調像, 造影強調像の 3 タイプの MR 画像について比較検討を行った。これら 3 群の中では T2 強調像が腫瘍検出の点では最も高い精度を示した。次に, 各々の病理組織切片での腫瘍範囲を計測し, 病理組織標本の作製過程に伴う標本の縮小率を計算した。補正した病理組織学的腫瘍深達度はこれらの標本の縮小率を考慮して補正したものである。補正した病理組織学的腫瘍深達度は MRI 上での腫瘍深達度と統計学的に有意な相関が認められた。肉眼的な腫瘍発育様式, 組織学的な腫瘍浸潤様式では, その様式別に分類した各群間に有意差は認められなかった。一方, 間質におけるリンパ球・形質細胞浸潤が軽度ないし細胞浸潤なしの症例群においては MRI 上の腫瘍深達度と病理組織上の腫瘍深達度との相関係数は有意な値を示した。ところが, リンパ球・形質細胞浸潤が強度もしくは中等度の症例群では有意な相関は認められなかった。このことから MR 画像上で診断される腫瘍の深さは, 実際の腫瘍深達度と一般的にはよく一致しているが, 間質におけるリンパ球・形質細胞浸潤が強い場合には MR 画像上の腫瘍の深さの診断には十分な注意が必要であることが示唆される。

キーワード: 舌癌, MRI, 病理組織学的所見, 腫瘍深達度, 相関係数

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