Comparison of CT with MRI for the Evaluation of the Juxta-Oral Tumor

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In the juxta-oral tumor, imaging study to localize the size and extent of the primary tumor is critical in the planning of surgery and radiation therapy. It is helpful to ensure adequate resection of tumoral margin, determine radiation field and improve patient’s prognosis. Twenty-six juxta-oral tumor cases included 13 cases of buccal mucosa carcinoma (CA), 10 cases of tongues and/or mouth floor CA, 1 case of tonsil CA, 1 case of palate CA and 1 case of maxillary sinus CA. The study group consisted of 24 men and 2 women, aged from 30 to 75 years (mean, 51.3 years). Twenty-four contrast-enhanced CT images and 26 MRI examinations with T1WI, T2WI and post Gd-DTPA images were performed. The T-staging of CT, MRI and post-operation pathological findings were recorded according to American Joint Committee on Cancer (AJCC) criteria.

Among 26 cases, the MRI gave an accurate staging in 22 cases (84.6%) and 13 out of 24 cases (54.2%) were staged correctly by CT scan. About the tumoral border delineation, the MRI is superior (13/24, 54.2%) or equal (11/24, 45.8%) to CT. The sensitivity for MRI to predict bony invasion by juxta-oral malignant tumors was 100%, the specificity was 83.3%, and the accuracy was 88.5%. The sensitivity for CT scan to predict bony invasion was 71.4%, the specificity was 88.2% and the accuracy was 83.3%.

MRI is more helpful than CT in evaluating the juxta-oral malignant tumors, especially the extent of tumor in the buccogingival and tongue region. The accuracy of T-staging in MRI for oral cancer is higher than CT. For the evaluation of bony invasion, contrast-enhanced CT is superior in demonstrating cortical bone invasion, while MRI is more sensitive in disclosing bone marrow involvement and perineural tumor spreading.

Key words: Oral cancer; CT; MRI

The most common type of head and neck tumor is squamous cell carcinoma, originating from the mucous membranes of the upper aerodigestive tract [1,2]. In oral cavity and oropharynx, squamous cell carcinoma accounts for 90% of cases of malignancy to affect this region [3,4]. In tumors of the tongue and mouth floor as well as oropharynx, imaging to localize the size and extent of the primary tumor is critical in planning surgery and / or radiation therapy because it is helpful to ensure adequate resection of tumoral margin, determine R/T field and improve patient’s prognosis [5,6]. The clinical assessment of local tumor around oral cavity can be made by palpation and inspection, but only the superficial lesion can be evaluated by this method; the tumor infiltration and invasion of deeper structures may not be appropriated [3,7] and submucosal growth may also occur beneath an intact mucosal surface [3, 8]. Magnetic resonance imaging (MRI) and computed tomography (CT) scan examinations have been used to evaluate juxta-oral tumors [9-13] in recent years. The CT has been demonstrated to be useful in evaluating juxta-oral tumors, but it has pitfalls because of low soft tissue contrast, beam hardening artifact and dental filling artifact; the MRI had been used to evaluate juxta-oral tumors because of its good soft tissue contrast, no beam hardening artifact and low dental filling artifact [1]. The purpose of this study is to use MRI for evaluation of juxta-oral malignant tumors and compare to contrast enhanced CT scan examinations, and then correlate with pathological T-staging. The final goal of this study is to ensure the
more accurate imaging modality to evaluate juxta-oral malignant tumors in order to improve prognosis of this disease

**MATERIALS AND METHODS**

From Jan. 1998 to Jul. 2000, we collected 26 juxta-oral malignant tumor cases, including 13 cases of buccal mucosa carcinoma (CA), 10 cases of tongue CA, 1 case of tonsil CA, 1 case of soft palate CA and 1 case of maxillary sinus CA (table 1). All the cases in our series were men except two women (case 7 and case 18). All the cases aged from 30 to 75 years and the mean age was 51.3 years old. Contrast-enhanced CT and MRI examinations were performed in all of our cases preoperatively except two cases that received MRI only.

The CT examinations in our cases were performed with Picker CT scanner after 100 ml contrast medium IV injection. The scanning planes included axial scan with 4mm-slice thickness for oral cavity from skull base to hyoid bone and 8mm-slice thickness for neck. The coronal scan was also performed with 4mm-slice thickness in some cases. Both soft tissue and bone window setting were displayed for evaluation of soft tissue extension and bony invasion.

The MRI of oral cavity was performed with GE Signa 1.5 Tesla superconductive whole body MR scanner. The pulse sequences were selected as following: axial section spin echo (SE) T1WI (TR/TE/excita-

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**Figure 1.** Left retromolar CA (Path: T2) was staged correctly by both CT (T2) and MR (T2) staging. MR is superior to CT in tumoral border delineation. a. CT scan showed mild thickening of left retromolar trigone region (arrow). b. Axial section FSE T2WI showed high signal intensity tumoral lesion over left retromolar trigone region (arrow) with soft palate infiltration. c. Axial section post contrast T1WI with fat suppression showed left retromolar trigone region enhancing lesion (arrow).
tion, 450-500ms /10-16ms / 2), axial and coronal section fast spin echo (FSE) T2WI (4500-5500/80-95ms/3) with fat suppression, as well as post Gd-DTPA injection axial and coronal section SE T1WI with fat suppression. The slice thickness was 4 to 5 mm and the interslice gap was about 0.4 mm.

The CT and MRI imaging data were evaluated for the tumor border delineation and bony invasion by three neuroradiologists. The T-staging of CT and MRI were recorded according to American Joint Committee on Cancer (AJCC) criteria. After imaging study, the patients received operation for tumor resection as soon as possible. The pathological T-staging was also recorded according to the pathological findings under AJCC criteria. We compared the T-staging results among CT, MRI and pathological findings for detecting the sensitivity, specificity and accuracy of these two imaging modalities.

**RESULTS**

**Tumor staging**

Among 26 cases, the MRI gave an accurate staging in 22 cases (84.6%) (Fig.1). Three cases (cases 1, 2 and 4) were over staged that bony invasions (T4) were suspected by MR studies, but no definite evidence of bony invasion were detected by pathology. Although the bony invasion is not correct by pathology in case 1, the MRI T-staging was still as T4 due to the skin invasion. In case 2, the MRI under staged (MRI: T1, Path: T2) due to dental filling magnetic susceptibility artifact with field distortion.

Thirteen out of 24 cases (54.2%) were staged correctly by CT scan (Fig.1). One case (case 2) was over staged by CT scan (bony invasion was suspected by CT, but negative in pathology). Ten cases, included 3 cases (cases 20 to 22) from dental filling artifact, were under staged by CT due to poor soft tissue contrast (Fig.2).

**Tumoral border delineation**

In our series, the MRI delineated tumoral border extension superior or equal to computed tomography. In 13 out of 24 cases (54.2%), the MRI was superior to CT scan in the tumoral delineation and provided more information (Fig. 2, 3). In the other 11 cases (45.8%), the MRI was equal to CT scan examination in the tumoral border delineation (Table 1). Among these 13 case with inconsistent CT and MRI findings

<table>
<thead>
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<th>Case</th>
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<th>MRI</th>
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<td>MR=CT</td>
<td>BI:ethmoid sinus</td>
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TuE: tumor extend, BI: bony invasion, SI: skin invasion, MFI: mouth floor invasion, MS: maxillary sinus
cases, there were 8 cases that the T-staging of CT were correlated with that of MRI correctly, but one case the MRI over staged.

**Regional bony invasion**

The MRI predicted bony invasion in 11 cases that included 8 true positive cases (72.7%) (Fig. 3) and 3 false positive cases (27.3%). The MRI predicted no bony invasion in 15 cases that were all true negative (100%). The sensitivity for MRI predicted bony invasion by juxta-oral malignant tumors was 100%, and the specificity was 83.3%.

In the 24 CT studies, bony invasions were suspected in 7 cases that included 5 true positive (71.4%) cases and 2 false positive (28.6%) cases. The CT scan predicted no bony invasion in 17 cases including 15 true negative (88.2%) cases and 2 false negative (11.8%) cases (Fig. 3A). The sensitivity for CT scan predicted bony invasion by juxta-oral malignant tumors was 71.4% and the specificity was 88.2%.

**DISCUSSION**

Squamous cell carcinoma (SCC) is the most common malignancy to affect juxta-oral region, accounting for 90% of cases [3, 4]. Knowledge of the extent of tumors of oral cavity and oropharynx is important in staging the tumor before surgical or radi-
However, it lacks the superior soft tissue contrast and multiplanar capabilities of MRI [1,3]. The MRI can provide a good anatomic delineation of primary tumors of the oral cavity and can supplement the information when screening for cervical lymphadenopathy. The extent of infiltration is well appreciated and invasion to adjacent structures can be identified [3]. CT is being rapidly replaced by MRI as the technique of choice for majority of lesions in the larynx, tongue, paranasal sinus, and parapharyngeal space [1, 20].

Bootz F. had studied 174 CT scans and 32 MRI examinations of oropharynx & mouth carcinoma and juxta-oral tumor staging therapy [14]. Clinical assessment of mucosal involvement by the primary tumor is far superior to assessment with CT scan and MR imaging [12,14,15]. On other hand, CT scan and MR imaging depict the deep extent of the disease and provide an objective estimation of the size of the tumor [14,15, 16]. The most accurate juxta-oral tumor staging comes when the clinical mucosal extent, based on visual and tactile observations, is matched with the radiographic evaluation of deep-tissue extent [7,17,18, 19].

CT examination has been demonstrated to be useful in evaluating the juxta-oral tumors with T2 stage or larger, and for assessing bony cortex invasion. [3,8,9,10]. However, it lacks the superior soft tissue contrast and multiplanar capabilities of MRI [1,3]. The MRI can provide a good anatomic delineation of primary tumors of the oral cavity and can supplement the information when screening for cervical lymphadenopathy. The extent of infiltration is well appreciated and invasion to adjacent structures can be identified [3]. CT is being rapidly replaced by MRI as the technique of choice for majority of lesions in the larynx, tongue, paranasal sinus, and parapharyngeal space [1, 20].

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he concluded that MRI is superior to CT in delineating tumor margins in 78% of patients. The T-staging based on clinical & CT findings was changed in only 5% of cases by MRI and the MRI is useful in T1-staged tongue base carcinoma. MRI rather than CT should be used when dental fillings obscure the region of interest [21]. Hermans R. et al in a retrospective comparative study also concluded that 60% of the tumors were better visualized with MRI and in 21% of the tumors, the supplementary information was acquired using MRI [22].

In our study, the accurate staging of MRI is 84.6% and is better than that of CT scan (54.2%). The accuracy of MRI is similar to the results studied by Steinkamp HJ (81%), but the accuracy of CT scan is much lower than that of Steinkamp study (77%) [23]. In tumoral border delineation, the MRI is superior to CT scan in 54.2% of our cases and MRI is equal to CT scan in 45.8% cases. In tumoral border delineation, none of our cases had the MRI findings inferior to CT scan findings. The results agreed with previous study. Most of our cases with incorrect CT-staging were due to dental filling artifact that causing poor soft tissue contrast. In our study, the MRI T-staging had corrected CT-staging in 8 cases (29%).

Although CT is not as sensitive as MRI in tumoral border delineation, it is more reliable than MRI in the evaluation of discrete cortical involvement. However, the MRI is superior for the detection of bone marrow invasion [24,25]. The periosteum of the bone provides an effective barrier to tumor, with invasion occurring once the tumor has grown over the alveolar ridge [26,27]. The MRI detects more reliably the changes that occur within the marrow cavity than invasion by tumor can be reliably excluded by a negative MR examination, but a positive scan regarding maxillary involvement may indicate a need for CT scanning [1].

In our study, the sensitivity of MRI in detection of regional bony invasion is 100% and the specificity is 83.3%. The sensitivity of CT scan in detection of regional bony invasion is 71.4% and the specificity is 88.2%. The results of our study agree with the previous study which means patients with negative MRI scan, the role of CT is limited. A positive MRI scan is less meaningful, higher specificity may be gained by correlative CT imaging [1].

In conclusion, MRI is more helpful than CT in evaluating the juxta-oral malignant tumors, especially the extent of tumor in the buccogingival and tongue region. The accuracy of T-staging in MRI for oral cancer is higher than CT. For the evaluation of bony invasion, contrast-enhanced CT is superior in demonstrating cortical bone invasion, while MRI is more sensitive in disclosing bone marrow involvement and perineural tumor spreading.

**REFERENCE**

16. Hudgins PA, Gussack GS. MR imaging in the management of extracranial malignant tumors of the head and neck. AJR 1982; 159-161
17. Archer CR, Yeagry VL. Herbold DR. Improved diagnostic accuracy in the TNM staging of laryngeal carcinoma
using a new definition of region base upon CT. J Comput Assist Tomogr 1983; 7: 610-617
23. Steinkamp HJ, Maurer J, Heim T, Knobber D, Felix R. Magnetic resonance tomography and computered tomography in tumor staging of mouth and oropharyngeal cancer. HNO 19993; 41: 519-525
24. Lenz M, Skalej M, Ozdoba C, Bongers H Magnetic resonance tomography of the oral cavity, the oropharynx and the mouth floor: comparison with computed tomography. ROFO 1989; 150: 425-433
電腦斷層和磁振造影檢查影像在口腔癌病患的評估

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用影像檢查來對口腔腫瘤作定位和檢測腫瘤擴散範圍，在外科手術和放射治療的計劃上占有相當重要的地位，它能確切達到腫瘤的切除、決定放射治療範圍，進而改善病患預後的目的。本研究共有26例病患，包括13例口腔黏膜癌、10例舌癌、1例扁桃腺癌、1例軟顎癌和1例上顎竇癌。其中男性24位、女性2位，年齡由28歲至78歲（平均51.3歲）。有24名病患接受對比劑顯影電腦斷層檢查，全部26名病患均接受磁振造影檢查，檢查波序有T1為主、T2為主和注射顯影劑後影像。所有電腦斷層和磁振造影檢查影像以及手術後病理發現，均依照AJCC標準給予分期。影像檢查研究結果的分期，在對照手術病理分期發現，26例MRI檢查病患，有22例兩者分期相符占84.6%，而24例CT檢查病患則有13例占54.2%。針對腫瘤邊緣的界定，MRI比CT為佳的有13例占54.2%，兩者相同的有11例占45.8%。對於鄰近骨頸侵犯的偵測，MRI的敏感性達到100%、特異性為83.3%，而準確率為88.5%。在CT檢查的敏感性為71.4%、特異性為88.2%，而準確率則為83.3%。對於口腔癌，特別是口腔黏膜和舌頭部位腫瘤的分期，MRI比CT的準確性更高，尤其在腫瘤範圍的界定更為清楚。對鄰近骨頸組織的侵犯，雖然CT常能顯示骨皮質的破壞，但腫瘤對骨頭骨釦的浸潤性侵犯和沿脣神經途徑的擴散方面，MRI卻比CT較為敏感，也因此更增低MRI對骨頭侵犯的診斷率。在口腔癌病患MRI已有逐漸取代CT檢查，提供更詳盡診斷資料之趨勢。

關鍵詞：口腔癌；電腦斷層；磁振造影