-대한 구강·악안면방사선학회지 : Vol. 23, No. 2, 1993-

# EVALUATION OF THE DIAGNOSTIC IMAGING OF THE MALIGNANT TUMORS IN THE ORAL AND MAXILLOFACIAL REGION

## : COMPARISON OF CONVENTIONAL RADIOGRAMS AND MRI

Young-Mi Lee · Tae-Won Park

*Department of Oral and Maxillofacial Radiology, College of Dentistry, Seoul National University*

- CONTENTS -



## Ⅰ. INTRODUCTION

Malignant tumors of the jaws constitute up to 5% of malignant tumors in all sites of body. Ninty percent of oral malignant tumors are squamous cell carcinoma. Other forms of carcinoma, together with the malignant mesenchymal tumors account for the remaining 10%[1].

Definitive management of malignant disease depends upon the accurate determination of the extent of disease, complete excision of all abnormal tissue, and knowledge about patterns of disease spread. In order to obtain an accurate diagnosis, there have been well established imaging methods which include conventional radiography, panoramic radiography, directional tomography, and radionuclide scans, all of which carry significant limitations.

Nowadays, CT and MRI have been shown to be sensitive and have been well-established for

* 본 연구 논문은 1993년도 서울대학교 병원 임상연구비로 이루어진 것임

evaluation of the bony destruction and soft tissue extension of lesions in the oral and maxillofacial area[1,2,3,4]. Especially, MRI, which has no known biologic hazard, is capable of producing high resolution thin tomographic images in any plane and blocks of three-dimensional information[1,5]. Advantages of MRI are superior soft tissue contrast resolution with no beam hardening artifacts, visualization of blood vessels without intravenous contrast agents, and some information about the composition of the tissue. The limitations of MRI include long acquisition times, greater risk of motion artifact, patient claustrophobia, limited availability, and greater expense[1,6]. MRI dose not allow the recognition of histologic features and remains relatively nonspecific. Paramagnetic contrast agent such as gadolinium - DTPA (Gd-DTPA), which shorten T1 (spin-spin) relaxation times, can improve the inherent tissue contrast[1,7]. MRI is being used with increasing frequency in the evaluation of disease in head and neck orgin. The value of MR for imaging normal and pathological conditions in the area of oral cavity has been documented in recent publication[8,9,10]. Magnetic resonance contributes substantially to the imaging of this area by permitting better soft tissue contrast and by its capacity for producing multiplanar views[10]. However, no previous evaluation has been published to compare the diagnostic value of MRI with that of conventional radiogram with particular reference to the oral and maxillofacial region.

The purpose of this study is to compare conventional radiogram and MRI in their ability to detect malignant tumors in the oral and maxillofacial region to define the bony finding and extent of tumors.

## II. MATERIAL AND METHODS

Thirty-five patients with primary malignant tumors of oral and maxillofacial area were included in this retrospective study. All patients presented at the Seoul National Unversity Dental Hospital with such lesions between June 1988 and June 1993 and were taken with conventional radiogams (CR) and MRI examinations. There were 27 males and 8 females patients with 3.3 : 1 male predominance. Most patients(74.3%) were over 50 and the mean age was 53.3 years(Table 1). The mouth floor region was the most frequently involved area (8 cases), followed by alveolar ridge and gingiva (7 cases), retromolar trigone (6 cases), buccal mucosa (5 cases), tongue (5 cases), hard palate (2 cases), and maxillary sinus area (2 cases) (Table 2).

Histopathologic findings were obtained from either surgical or biopsy specimen treated with H-E staining at the Department of Oral Pathology, Seoul National University Hospital. The most common histopathologic finding was squamous cell carcinoma (29 cases), followed by osteosarcoma (2 cases). Remainings were mucoepidermoid carcinoma (1 case), adenoid cystic carcinoma (1 case), malignant lymphoma (1 case), and unidentified malignant tumor (1 case) (Table 3).

Conventional radiograms included intraoral radiogram (periapical and occlusal view), panoramic radiogram and extraoral radiogram. MRI studies were performed with two scanners (Goldstar spectro-20000, Goldstar Supertec - 5000). A spin-echo, multislice sequence was routinely used to obtain T1-weighted images and T2-weighted images. Examinations consisted of a sagittal T1-weighted scout view, axial T1- and T2-weighted sequences and coronal T1- or T2-weighted sequences depending on the anatomic area of interest. Contrast media, Gd-DTPA (Magnevist, Schering AG, Germany ; Dose 0.1 mmol/kg body weight) was used for almost patients.

Table 1. Age and sex distribution

| Age | No. of patients(%) | | |
|---|---|---|---|
| | Male | Female | Total(%) |
| 0- 9 | 1 | 0 | 1 ( 2.9) |
| 10-19 | 0 | 1 | 1 ( 2.9) |
| 20-29 | 0 | 1 | 1 ( 2.9) |
| 30-39 | 2 | 2 | 4 ( 11.4) |
| 40-49 | 1 | 1 | 2 ( 5.7) |
| 50-59 | 9 | 1 | 10 ( 28.6) |
| 60-69 | 8 | 1 | 9 ( 25.7) |
| 70- | 6 | 1 | 7 ( 20.0) |
| Total(%) | 27(77.1) | 8(22.9) | 35 (100.0) |

Table 2. Regional distribution

| Site | No. of patients(%) |
|---|---|
| mouth floor | 8 ( 22.9) |
| alveolar ridge & gingiva | 7 ( 20.0) |
| retromolar trigone | 6 ( 17.1) |
| buccal mucosa | 5 ( 14.3) |
| tongue | 2 ( 5.7) |
| hard palate | 2 ( 5.7) |
| Total(%) | 35 (100.0) |

Table 3. Histopathologic classification

| Histopathology | No. of patients(%) |
|---|---|
| squamous cell carcinoma | 29 ( 82.9) |
| osteosarcoma | 2 ( 5.7) |
| mucoepidermoid carcinoma | 1 ( 2.9) |
| adenoid cystic carcinoma | 1 ( 2.9) |
| malignant lymphoma | 1 ( 2.9) |
| unidentified malignant tumor | 1 ( 2.9) |
| Total(%) | 35 (100.0) |

Table 4. Conventional radiographic findings

| Radiographic Finding | No. of patients(%) |
|---|---|
| diffuse bony destruction | 15 (42.9) |
| soft tissue shadow | 7 (20.0) |
| floating tooth appearance | 3 ( 8.6) |
| osteosclerotic change | 2 ( 5.7) |
| no change | 19 (54.3) |

Both CR and MRI were re-interpreted simultaneously and the results from each imaging modality were compared, especially in terms of the bony involvement of the lesions and its relationship to adjacent bone or soft tissue. Diagnostic accuracy of CR and MRI was also calculated.

## III. RESULT

### 1. Conventional radiographic finding

The most prominent radiographic finding was the destructive radiolucency with ill-defind irregular margin (16 cases). Other findings were soft tissue margins of the tumor above the lesion (7 cases), floating tooth appearance(3 cases), and sclerotic bony change(2 cases). There was no evidence of radiographic changes in the remaining 19 cases (Table 4).

### 2. MRI finding

MRI could detect from subtle tumor extension to large mass into the intrinsic musculature (23

Table 5. MRI findings

| MRI Finding | No. of patients(%) |
|---|---|
| soft tissue mass extension | 23 (65.7) |
| bone marrow involvement | 12 (34.3) |
| cortical bone destruction | 14 (40.0) |
| marrow infiltration with intact cortex | 1 ( 2.9) |
| fat plane obliteration | 19 (54.3) |
| lymph node involvement | 8 (22.9) |
| contrast enhancement | 15 (42.9) |
| osteosclerosis | 1 ( 2.9) |

Table 6. Tumor extension to the adjacent structure

| Area | No. of patients(%) |
|---|---|
| mouth floor | 8 (22.9) |
| masticator space | 5 (14.3) |
| parapharyngeal space | 2 ( 5.7) |
| ethmoid sinus | 1 ( 2.9) |
| infratemporal fossa | 1 ( 2.9) |
| submandibular gland | 1 ( 2.9) |
| nasal cavity | 1 ( 2.9) |

Table 7. Diagnostic accuracy

| MRI / CR | true | false | total(%) |
|---|---|---|---|
| true | 14 | 2 | 16 ( 45.7) |
| false | 13 | 6 | 19 ( 54.3) |
| total(%) | 27 (77.1) | 8 (22.9) | 35 (100.0) |

cases). Involvement of bone marrow space was characterized on T1-weighted images by low signal intensity tumor replacing the normal high intensity fat signal (12 cases). Cortical bone destruction was noted in 14 cases. A specific advantage of MRI over conventional radiogram was the detection of bone marrow infiltration with the cortex appearing intact, which occured in 1 case. Fat plane obliteration occured in 19 cases. Lymph node metastasis was presented in 8 cases. Marked contrast enhancement was produced in 15 cases by Gd-DTPA, allowing detection of tumors with a diameter as small as 4mm. Osteosclerosis was noted in 1 case (Table 5).

### 3. Tumor extension

MRI was valuable in the evaluation of the tumor extension to the mouth floor (8 cases), masticator space (5 cases), parapharyngeal space (2 cases), ethmoid sinus (1 case), infratemporal fossa (1 case), submandibular gland (1 case) and nasal cavity (1 case) (Table 6).

### 4. Diagnostic accuracy

Conventional radiogram (CR) and MRI were equal to detect malignant tumor in 14 cases. MRI was superior to CR in 13 cases, and CR was superior to MRI in 2 cases. In 6 cases, both CR and MRI were not useful to diagnose lesions (Table 7). Diagnostic accuracy were 45.7% in CR and 77.1% in MRI.

## Ⅳ. DISCUSSION

Magnetic resonance imaging (MRI) is evolving into an effective tool with which to image the soft tissues of oral and maxillofacial region, its strength based on superior soft tissue contrast, excellent spatial resolution and multiplanar imaging capability. Additionally, MR images are less susceptible to degradation by dental amalgam[11] and are not affected by the dense bone of the skull base or mandible. These characteristics allow confident evaluation of oral and maxillofacial region pathology, providing detailed spatial anatomy and permitting a limited differential diagnosis[7-15]. MRI is the modality of choice for most malignant conditions relating to the jaw. MRI is able to detect subtle soft tissue lesions and to establish accuracy cortical bone invasion, despite an apparent intact appearance on conventional radiogram[1,7,10,17-22].

Prior to MRI, the radiologic examination of the oral cavity was principally relegated to the diagnosis of dental and bone abnormalities. Soft tissue masses that could not be completely visualized by direct inspection are evaluated radiographically largely for posterior extension or airway obstruction[22]. Plain radiography and panormic radiography have been extensively used to evaluate bone invasion by cancer.

Unlike x-ray techniques, which measure the attenuation of x-ray beams by Compton scattering and photoelectric absorption, the MRI signal is not related to electron density of tissues. Magnetic resonance is primarily a phenomenon that involves atomic nuclei. As used today, the element primarily examined in MRI is hydrogen, and since the hydrogen nucleus consists of a single proton, the term "proton" is used interchangeably with "hydrogen nucleus" in MRI. Proton MRI concerns itself with the distribution and binding of water nucleus around the body. Since water is present in all soft tissues, almost all areas of the body can be examined with MRI. A notable exception is compact bone ; however, bone marrow can be imaged quite well. Consequently, one of the main advantages of MRI over x-ray is its superior soft tissue differentiation[6]. In my study, degree of invasiveness, sharpness of lesion boundary and tumor homogeneity were better suited to evaluation on MRI than conventional radiogram, there was good evidence that MRI was useful in evaluation of bony involvement and mass extension by malignancy.

In 14 patients, both conventional radiogram and MRI were helpful to obtain accurate diagnosis (Fig. 1). CR is inferior to MRI in diagnosing of the actual tumor extension, but both CR and MRI had equal ability to detect malignancy.

The MRI studies provided information useful to diagnosis, but not present on plain radiographs, in 13 patients (Fig. 2). MRI depicted the extent of tumor in the soft tissues and bone marrow. The main criterion for diagnosis of benign tumor remains the preservation of tissue plane (that is, anatomic detail)[23]. The paramagnetic compound gadolinium-diethylenetriamine pentaacetic acid (Gd-DTPA) produces a decrease of both longitudinal(T1) and transverse(T2) relaxation times. Thus, in a T1-weighted images the signal intensity increases in a gadolinium-enhanced area[1,10]. Gadolinium can effectively separate tissues with markedly different histologic character and is useful to distinguish malignant from benign lesions of the tongue base or oropharynx[1,7]. The administration of Gd-DTPA also aids the determination of the tumor extent in the tongue base, pharyngeal wall, palate, and mouth floor[7,10,24]. In my study the administration of Gd-DTPA gave significant additional information in 15 of the 35 patients. The information was either on deep extension of the tumor or

on the submucosal spread. As with primary tumor staging, lymph node involvement with malignant tumor may be assisted by the use of Gd-enhanced MR[7]. At present, size is the best criterion for diagnosing abnormal lymph node[23,25,26,27]. Nodes of greater than or equal to 1.5cm size and/or with central inhomogeneity are considered malignant[7]. There were 8 cases which showed lymph node involvement with increased signal intensity on MRI.

There was a notable thing in my study that conventional radiogram was superior to MRI in 2 cases. A major reason for the overall failure of MRI in diagnosis was that calcification, ossification, and periosteal reaction were less easily evaluated than on plain radiographs. Calcification and cortical bone produce no signal on MRI. Small foci of calcification are not detected well by MRI, although larger foci are recognized as a signal void[1,16,23,28].

In 6 cases, both CR and MRI did not add available information to diagnose(Fig. 3). MRI is only valuable when there has been infiltration into muscle bundles or deep fascial planes[10,29]. Satisfactory image is obtained by recognition of tumor masses greater than 1.5mm in diameter[10]. Several authors have reported that mandibular involvement by oral cancer is estimated at 11% to 30%[1,30], but the difficulty in observing bone erosion on MRI is already well known and relates to the low signal intensity of cortical bones[31]. Mucosal abnormalities are detected best by clinical examination [23].

A more definitive evaluation of the accuracy of MRI in defining the boundaries of actual neoplasm and assessing the response to therapy must await additional studies with good radiographic-pathologic correlation. CR complement mandibular bone detail available from MRI. Nonetheless, we believe on the basis of our limited evidence that MRI, interpreted in conjunction with appropriate conventional radiographs, is the very useful modality of choice for most malignant conditions relating to the oral and maxillofacial region.

## V. CONCLUSION

Conventional radiogram(CR) and MRI finding of proven 35 malignant tumors in the oral and maxillofacial region were retrospectively compared to be of help in the diagnosis and treatment.

1. CR findings were diffuse bony destruction (42.9%), soft tissue shadow (20.0%), floating tooth appearance (8.6%) and osteosclerotic change (5.7%).
2. MRI findings were soft tissue mass extension (65.7%), bone marrow involement (34.3%), cortical bone destruction (40.0%), marrow infiltration with intact cortex (2.9%), fat plane obliteration (54.3%), lymph node obliteration (22.9%), contrast enhancement (42.9%) and osteosclerosis (2. 9%).
3. The MRI studies provided information, which was not present on CR, in the tumor extension to mouth floor, masticator space, parapharyngeal space, infratemporal fossa, submandibular gland, nasal cavity and lymph node involvement.
4. Diagnostic accuracy were 45.7% in CR and 77.1% in MRI. In 2 cases, CR was superior to MRI in detecting malignancy.

## REFERENCES


1. Van Rensberg, L. J. and Nortjé, C. J. : Magnetic resonance imaging and computed tomography of malignant disease of the jaws. Oral Maxillofac. Surg. Clin. North Am., 4 : 75-111, 1992.
2. Ator, G.A., Abemayer, E., Lufkin, E.B., et al. : Evaluation of mandibular tumor invasion with magnetic resonance imaging. Arch. Otolaryngol. Head Neck Surg., 116 : 454-461, 1990.
3. Harnsberg, M.R. : The suprahyoid neck ; A spatial approach. Semin. US. CT. MR., 6 : 444-533, 1990.
4. Som, P.M., Shugar J.M.A. and Biller H.F. : The early detection of central malignancy in the post maxillectomy patient. Radiology, 143 : 509-516, 1982.
5. Longmore, D.B. : The principles of magnetic resonance. Br. Med. Bull., 45 : 848-871, 1989.
6. Makow, L. : Magnetic resonance imaging ; A brief review of image contrast. Radiol. Clin. North Am., 27 : 195-218, 1989.
7. Crawford, C.S., Harnsberger, R.H., Lufkin, R.B., et al. : The role of gadolinium-DTPA in the evaluation of extracranial head and neck mass lesions. Radiol. Clin. North Am., 27 : 219-242, 1989.
8. Mees, K., Vogl, T., Brauer, M., : Magnetic resonance imaging in otorhinolaryngology, Laryngol. Rhinol. Otol., 64 : 177-180, 1985.
9. Stark, D.D., Moss, A.A., Gamsu, G., Clark, O.H., Gooding, G.A., Webb, W.R. : Magnetic resonance imaging of the neck : Part I. Normal anatomy. Radioloy 150 : 447-454, 1983.
10. Vogl, T., Br ning, R., Greveor, G. : MR imaging of the oropharynx and tongue ; Comparison of plain and Gd-DTPA studies. J. Comput. Assist Tomogr., 12 : 427-433, 1988.
11. Hinshaw, D.B., Holahouser, B.A., Engstrom, H.I.M., Tjan, A.N., Christiansen, E.L., Catelli, W.F. : Dental material artifacts on MR imaging. Radiology, 166 : 777-779, 1988.
12. Dillon, W.P. : Application of magnetic resonance imaging of the Head and neck. Semin. US, CT, and MR, 7 : 202-215, 1986.
13. Dillon, W.P., Mill, C.M., Kjos, B., et al. : Magnetic resonance imaging of the nasopharynx. Radiology, 152 : 731-738, 1984.
14. Glazer, H.S., Neimeyer, S.H., Balfe, D.M., et al. : Neck neoplasms ; MR imaging. Radiology, 160 : 343-348, 1986.
15. Som, P.M., Braun, I.F., Shapiro, M.D., et al. : Tumors of the parapharyngeal space and upper neck ; MR imaging characteristics. Radiology, 164 : 823-829, 1987.
16. Aisen, A.M., Martel, W., Braunstein, E.M., et al. : MRI and CT evaluation of primary bone and soft tissue tumors. Am. J. Radiol., 146 : 749-756, 1986.
17. Han, J.S., Huss, R.G., Benson, J.E., et al. : Magnetic resonance imaging of the skull base. J. Comput. Assist Tomogr., 8 : 944-952, 1984.
18. Hoover, L.A., Wortham, D.G., Lufkin, R.B., et al. : Magnetic resonance imaging of the larynx and tongue base ; Clinical applications. Oto-Head Neck Surg., 97 : 245-256, 1987.
19. Lufkin, R.B., Larsson, S.G., Hanafee, W. : Work in progress ; NMR anatomy of larynx and tongue base. Radiology, 148 : 173-175, 1983.
20. Na, D.G., Han, M.H., et al. : MR imaging of oral cavity malignancy. J. Korean Radiological Society, 29 : 179-185, 1993.
21. Schaefer, S.D., Maravilla, K.R., Suss, R.A. : Magnetic resonance imaging vs computed tomography ; Comparison in imaging oral cavity and pharyngeal carcinomas. Arch. Otolaryngol., 111 : 730-734, 1985.
22. Unger, J.M. : The oral cavity and tongue ; Magnetic resonance imaging. Radiology, 155 : 151-153, 19 85.
23. Kassel, E.E., Keller, M.A., Kucharczgk, W. : MRI of the floor of the mouth, tongue and orohypopharynx. Radiol. Clin. North Am., 27 : 331-351, 1989.
24. Kilogore, D.P., Breger, R.K., Daniels, D.L., Pojunas, K.W., Williams, A.L., Haughton, V.M. : Cranial tissues ; Normal MR appearance after intravenous injection of Gd-DTPA. Radiology, 160 : 757-761, 1986.
25. Dooms, G.C., Hricak, H., Moseley, M.D., et al. : Characterization of lymphadenopathy by magnetic re-

sonance relaxation times ; Preliminary results. Radiology, 153 : 691-697, 1995.
26. Stark, D.D., Moss, A.A., Gamsu, G., et al. : Magnetic resonance imaging of the neck, Part I ; Normal anatomy. Radiology, 150 : 447-454, 1984.
27. Stark, D.D., Moss, A.A., Gamsu, G., et al. : Magnetic resonance imaging of the neck, Part II ; Pathologic finding. Radiology, 150 : 455-461, 1984.
28. Som, P.M., Bergeron, R.T., Curtin, H.O., Reede, D.L. : Head and neck imaging. 2nd ed, St. Louis, Mosby-Year book Inc., 407-466, 1991.
29. Wehrli, F.W., MacFall, J.R., Glouer, G.H., Grigsby, H., Haughston, V., Johanson, J. : The dependency of NMR image contrast on intrinsic and pulse sequence timing parameters. Magn. Reson. Imaging, 2 : 3-16, 1984.
30. Christianson, R., Lufkin, R.B., Abemayor, E., : MRI of the mandible. Surg. Radiol. Anat., 2 : 165-179, 1989.
31. Paling, M.R., Black, W.C., Levine, P.A. : Tumor invasion of the anterior skull base ; A comparison of MR and CT studies. J. Comput. Assist Tomogr., 11 : 824-830, 1987.

- 국문초록 -

# 구강영역 악성종양의 영상진단학적 평가

## : 방사선사진과 자기공명영상소견의 비교

서울대학교 치과대학 구강악안면방사선학 교실

이영미 · 박태원

저자는 1988년 6월 1일부터 1993년 6월 30일까지 서울대학교병원 치과진료부에 내원하여, 병리조직학적으로 확인된 구강악안면부 악성종양환자 35명의 방사선사진 소견과 자기공명영상 소견을 비교하여 다음과 같은 결론을 얻었다.

1. 일반적인 방사선사진소견으로는 미만성의 골파괴가 15례 (42.9%), 연조직종괴의 음영이 7례 (20.0%), 부유치를 보인 경우가 3례 (8.6%), 골경화가 2례 (51.7%)로 나타났다.
2. 자기공명영상 소견은 연조직종괴가 23례 (65.7%), 골수침범이 12례 (34.3%), 피질골 파괴가 14례 (40.0%), 정상피질골에 골수침범이 1례 (2.9%), 지방층소실이 19례 (54.3%), 림파절전이가 8례 (22.9%), 조영증강이 15례 (42.9%), 골증식이 1례 (2.9%)였다.
3. 구강악안면부의 악성종양환자에 있어서, 방사선사진에서 관찰하기 힘들었던, 종양의 구강저, 저작근, 부인두강, 사골동, 측두하와, 악하선, 비강 등 인접조직으로의 침범여부 및 골파괴 정도와 림파절전이를 평가하는 데 자기공명영상은 도움을 주었다.
4. 정진율은, 방사선사진에서 35례중 16례로 45.7%였고, 자기공명영상에서는 35례중 27례로 77.1%로 자기공명영상의 정진율이 더 높았으나, 일반적인 방사선사진이 자기공명영상보다 더 우세한 경우도 2례 있었다.

주요어 : 구강영역, 악성종양, 방사선사진, 자기공명영상(MRI)

## EXPLANATION OF FIGURES

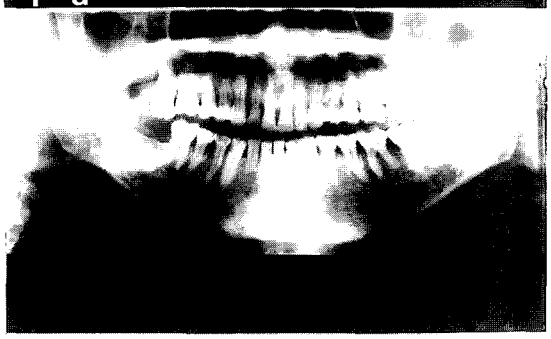
Fig. 1. 55-year-old man with squamous cell carcinoma in the left mandibular retromolar trigone. CR (a) showed diffuse bony destruction with soft tissue shadow. The tumor is hyperintense on axial T2-weighted MR images(b). Both conventional radiogram(CR, a) and MRI(b) were equal to detect malignant tumor.

Fig. 2. 63-year-old man with squamous cell carcinoma in the right mandibular retromolar trigone. Axial T2-weighted MR image(b) showed ill-defined hyperintense mass in the right mandibular retromolar area. MRI(b) was able to detect the tumor, not present on CR(a).

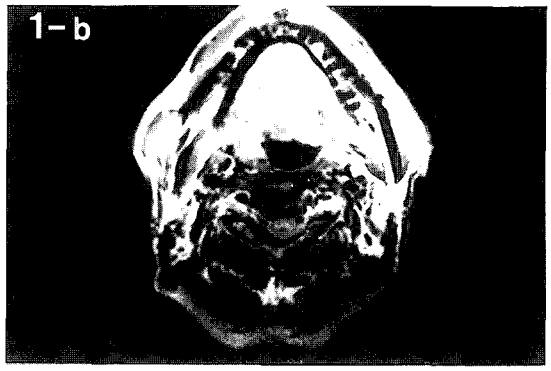
Fig. 3. 68-year-old man with squamous cell carcinoma in the tongue. Both CR(a) and MRI(b) showed intact appearance.

# 논문 사진부도

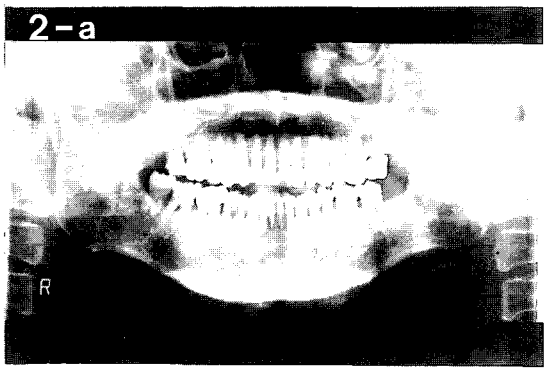
1-a



1-b



2-a




2-b

3-a

3-b