

A comparative study of gallium-67 scintigraphy and computerized tomography in the diagnosis of head and neck tumors

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Purpose: To compare the effects of gallium-67 (Ga-67) scintigraphy with computerized tomography (CT) scanning in the diagnosis of head and neck neoplasm.

Materials and Methods: Eighty-three patients with neoplasm in head and neck underwent local CT scanning and Ga-67 scintigraphy preoperatively. The results were verified pathologically after operation.

Results: In total 43 cases of benign neoplasm according to pathological examination, 21 cases (42.5%) were identified using CT preoperatively, 36 cases (83.7%) were identified using Ga-67 scintigraphy. Significant difference can be found between Ga-67 scintigraphy and CT scanning in identifying the behavioral classification of tumors. The remaining 40 cases were malignant neoplasm, and 17 cases (42.5%) were identified or suspected to be malignant using CT scanning, while 37 cases (92.5%) were identified using Ga-67 scintigraphy. There was still significant difference between these two methods.

Conclusion: CT shows advantages in identification of tumor size, location, internal structure, and syntopy, while Ga-67 scintigraphy has advantages in identification of behavioral classification and metastasis of tumors. (Int Chin J Dent 2004; 4: 34-39.)

Clinical Significance: The results of this study demonstrate that Ga-67 scintigraphy is a useful clinical approach in tumor diagnosis, especially in identification of behavioral classification of tumors, that is, benign tumor or malignant one, and in judgment of metastasis.

Key Words: computerized tomography, diagnosis, gallium-67, head, neck, neoplasm.

Introduction

Computerized tomography scanning (CT) is an important tool in check and diagnosis of head and neck neoplasm, especially in identification of size, location and syntopy, which can provide surgeons with invaluable data and information. However, CT does not give satisfactory results in the identification of behavioral classification of neoplasm, that is, benign tumor or malignant one. Clinically, the behavioral classification of a tumor can be inferred from its position, whether it has an integrated membrane and if it invades surrounding tissues. Generally speaking, it is difficult to judge the behavioral classification of tumors before they invade surrounding tissues. Although some features such as ample blood supply, intrusion into surrounding tissues, damage of the blood vessels can be shown by CT images after injection of meglumine diatrizoate compound, clinicians cannot deduce the actual behavioral classification of tumors according to these features.

Recently, Ga-67-citrate imaging has been applied to differentiate the behavioral classification of head and neck tumors.¹ In malignant tumors, Ga-67 is absorbed to a high extent by tumor cells. After injection, Ga-67 is mainly bound to transferrin and becomes transferrin-Ga-67 complex.^{2,3} The complex is delivered to the tumors through capillaries with increased permeability. The complex then combines the receptors on the membrane of tumor cell and enters the tumor cell.^{4,5,6} This imaging method has a high sensitivity in the

diagnosis of malignant tumors.^{7,8,9} Undoubtedly, Ga-67-citrate imaging as a method of clinical examination showed a bright future in tumor diagnosis and the design of therapy strategy against tumor in early stage. This article compared Ga-67-citrate imaging with CT to observe its applied value in clinical practice.

Materials and Methods

Patients

From January 2000 to December 2002, 83 patients with head and neck neoplasm admitted to the department of Oral and Maxillofacial surgery at Qingdao University Medical College Affiliated Hospital were entered into this study. Fifty-one patients were male and 32 patients were female. The age ranged from 16 years to 83 years, and the average age was 48.2 years. The patients underwent examinations using CT scanning and Ga-67 imaging prior to surgery and the neoplasm specimens were identified pathologically after operation.

Appliances and Imaging Reagent

A single photon emission computed tomography (SPECT, Model DX, Sophy, Paris, France) equipped with a low energy all purposed collimator and a matrix of 93 keV energy peak with 20% centered energy windows was used. An average of 5.0×10^5 counts/image was selected. In addition, a CT (Model TF4800, Shimadzu Corp., Kyoto, Japan) and a magnetic resonance imaging system (Signa 1.5T MR/i, GE Corp., Waukesha, WI, USA) were used. Ga-67-citrate (Kexing Pharmacological Corp., Shanghai, P. R. China) was employed as an imaging reagent.

Methods

The patients were injected intravenously with Ga-67-citrate of 111-148 MBq. The post-anterior, right lateral, and left lateral position images were taken using the SPECT appliance 24, 48, and 72 hours after injection. The diameters of positive tumors (malignant tumors) were measured using the SPECT special software. At the same time, the diameter of tumors shown by CT and radiology were measured using the CT accessory ruler. Results of both measurements were compared. The images of the SPECT appliance were judged to be benign or malignant by two senior doctors according to the following accepted standards, and then were divided into benign group and malignant group according to the results of pathological examination. The comparison between the results of SPECT and CT were done simultaneously.

Diagnostic Standard

Diagnostic standard was defined as follows: positive; the area of lesion had a higher intensity of Ga-67 than that of surrounding area or opposite salivary gland, TC/NC (tumor counts/normal counts) >1.15 , and negative (benign tumor); the area of lesion had the same intensity as the surrounding normal tissue, TC/NC <1.15 .

Statistics

The positive results of Ga-67 imaging and CT scanning were calculated using the chi-square test. The comparison of tumor sizes was calculated using the t-test.

Results

Comparison between Ga-67 Imaging and CT in Judgment on Behavioral Classification of Tumors

The analysis of benign tumors: 43 benign lesions were confirmed after operation, including 32 benign tumors (12 pleomorphic adenomas, 10 Warthin tumors, eight neurolemmomas, one ameloblastoma, and one fibroma) and 11 inflammatory lesions. The results of CT images showed that 21 out of 43 were benign tumors (48.8%), including six confirmed benign tumors and 15 suspected benign tumors. Twenty-two out of 43 (51.2%) could not be confirmed diagnostically using CT scanning. While Ga-67 imaging showed 36 out of 43 (83.7%) were negative which means that they were benign tumors, Ga-67 also showed seven out of 43 (16.3%) were positive which means that they were malignant but were identified as benign tumors after pathological examination (five pleomorphic adenomas and two chronic parotitis). The results are shown in Table 1.

Table 1. Comparison of Ga-67 scintigraphy and CT in the diagnosis of head and neck tumors.

Methods	Benign tumors			Malignant tumors		
	Cases	Coincident	Disagreement	Cases	Coincident	Disagreement
CT	43	21 (48.8%)	22 (51.2%)	40	17 (42.5%)	27 (57.5%)
Ga-67	43	36 (83.7%)	7 (16.3%)	40	37 (92.5%)	3 (7.5%)

Significant difference was found between CT and Ga-67 for both benign and malignant tumors ($p < 0.01$).

The analysis of malignant tumors: There were 40 malignant tumors (18 squamous cell carcinomas, five malignant pleomorphic adenomas, five adenoid cystic carcinomas, four malignant lymphomas, two adenocarcinomas, two mucoepidermoid carcinomas, and 4 metastatic carcinomas from lymph nodes of neck) identified using pathological examination. CT images confirmed five malignant tumors and suspected 12 malignant cases, total 17 cases (42.5%). The remaining 23 cases cannot be confirmed (57.5%) using CT. Thirty-seven cases showed positive images using Ga-67 imaging and confirmed to be malignant (92.5%), three cases showed negative (7.5%). Squamous cell carcinoma, lymphoma, lymph node metastatic carcinoma, and mucoepidermoid carcinoma showed 100% positive results using Ga-67 imaging while two malignant pleomorphic adenomas and one adenoid cystic carcinoma showed negative results (Table 1). A 41-year-old male patient, who had had a tumor in his left parotid gland for three months, was scanned using CT, which showed as an inflammatory lesion. However, results from the SPECT appliance showed a high accumulation of Ga-67 in the same area, which indicated that it was a malignant tumor. This Ga-67 imaging result was confirmed by pathological examination after operation (Figs. 1 and 2).

Comparison of the Image Characteristics of Ga-67 Imaging and CT Scanning

There was no significant difference between the two groups in the measurement of head and neck tumor size (Table 2). CT showed its obvious advantage in showing syncope and outline of tumor tissues,

especially its relations to main vessels. CT images can demonstrate clearly the internal structure of the lesions, such as liquefaction or abscess, while Ga-67 images cannot. Furthermore, a relatively large abscess will not be detected using Ga-67 imaging.

Table 2. Comparison of Ga-67 scintigraphy and CT in measuring size of head and neck tumors.

Size (mm)	Cases	Ga-67	CT	T-value	P-value
0.0-2.0	11	2.17 (0.51)	1.84 (0.26)	1.28	p>0.05
2.1-4.0	22	2.83 (0.41)	2.79 (0.28)	0.26	p>0.05
>4.0	10	5.74 (0.96)	6.73 (1.30)	1.76	p>0.05

Standard deviation (mm) in parentheses.

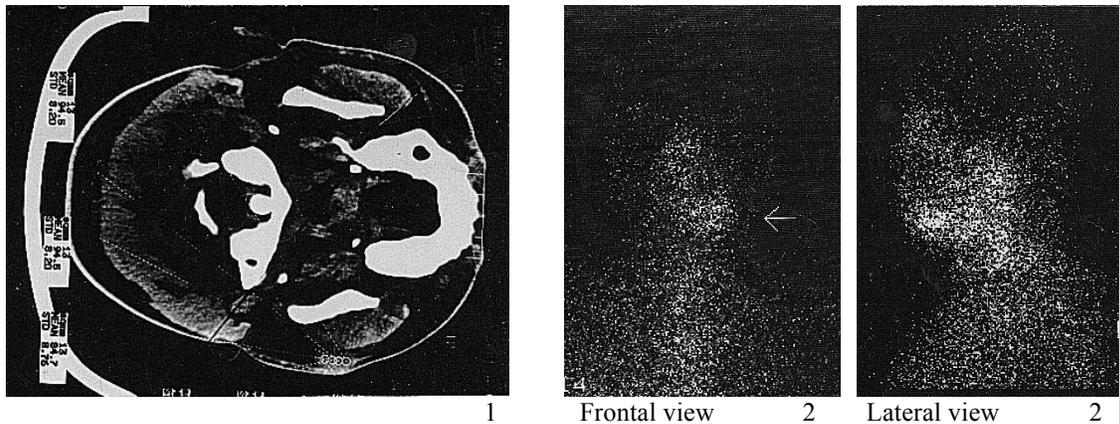


Fig. 1. CT showed left parotid gland benign tumor, and were diagnosed as malignant pleomorphic adenoma by pathological examination.

Fig. 2. Ga-67 showed malignant tumor of left parotid gland, were diagnosed as malignant pleomorphic adenoma by pathological examination.

Discussion

Judgment of Size, Morphology, Syntopy of Tumors

Both CT and Ga-67 imaging can indicate tumor size. No difference was found through using these two methods ($p>0.05$). However, a few tumors displayed different sizes when imaged by these two methods, which was related to the volume and position of tumors. If excessive amounts large/small tumors had been present, more obvious difference between these two methods would be detected.¹⁰ In general, CT had more advantages than Ga-67 imaging in respect to size, outline, internal structure and syntopy of tumors, especially to malignant tumors invading surrounding tissues. Therefore, CT scanning can help surgeons to determine the dissection range and make an appraisal of the operation risk.

Judgment of Behavioral Classification of Tumors

In our study, positive results were found in 92.5% malignant tumors, especially, in 100% squamous cell carcinoma and lymphoma, whereas false-negative results were also found in malignant pleomorphic adenomas and adenoid cystic carcinoma. Similar result was reported in Murata's study.¹¹ While only

42.5% malignant tumors can be showed by CT images. There was a significant difference in this study between these two methods.

The accumulation of Ga-67 can also be found in an inflammatory lesion.^{12,13} It is difficult to differentiate them from tumors,¹⁴ but if it is an inflammatory lesion the intensity of Ga-67 will reduce rapidly 48 hours after injection whereas it reduces slowly in tumors. We found that the imaging outline of the inflammatory lesion was indistinct and bigger than the actual lesion. In some cases, the duct of the gland was intensive and clear, while similar features were not found in malignant tumors. In the group of chronic inflammatory lesions, two out of 11 cases (18.2%) showed positive results, which was not a high rate. Hyperplasia of fibro-connective tissue, atrophy of gland and decrease of quantity and permeability of vessels in the negative growths can be identified by pathological examination. So, chronic inflammatory lesion in this study was not identified at a high positive rate as documents had reported.¹⁴

The five cases of pleomorphic adenomas also showed positive results and seven cases showed negative by Ga-67 images. Similar result was reported in Shinohara's study.¹⁵ Yoshikai et al.¹⁶ stated only pleomorphic adenomas showed positive Ga-67 imaging using the technique of DNA fluorescence staining, which was confirmed by pathological examination. This suggested that the active epithelial cell of pleomorphic adenomas might be responsible for the Ga-67 uptake, but the pleomorphic adenomas with many mesenchymal cells showed negative results. Therefore we should pay more attention to differentiating pleomorphic adenoma from malignant tumors.

Judgment of the Nature of Lymph Nodes of the Neck

Only 20% head and neck malignant tumors of cN0 stage were identified as lymph node metastasis using pathological examination after operation. If all the patients underwent surgery of the neck, about 80% of patients will be subject to unnecessary operation and suffer from the complications of an operation. Furthermore, radical neck dissection will cause patients shoulder syndrome.¹⁷ So, it is important to judge the metastatic conditions of the lymph nodes of the head and neck before deciding to operate. Ga-67 scintigraphy can give reliable information on the risk of recurrences in the soft tissues of the neck.¹⁸ In this study, positions and sizes of three lymph node metastatic carcinomas were identified using CT scanning, but the metastatic conditions of these lymph nodes cannot be identified positively. While all the three malignant tumors showed positive results in Ga-67 images, which were correlated well with pathological diagnosis. Clearly the Ga-67 imaging has more value in the diagnosis of the metastatic carcinoma.

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