ORIGINAL ARTICLE

Role of Chest Computed Tomography in Head and Neck Cancer

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Objectives: To evaluate the role of chest computed tomography (CT) in patients with head and neck squamous cell carcinoma (HNSCC) and to determine the optimal timing and predictive factors for positive findings.

Design: Retrospective analysis.

Setting: Tertiary referral center.

Patients: Two hundred seventy screening chest CT scans performed in 192 patients with HNSCC during a 42-month period were reviewed.

Main Outcome Measures: The scans were categorized as new cases, follow-up cases, or recurrent cases. The results were classified as abnormal or normal. Scans of patients having a radiologic diagnosis of a malignant neoplasm of the lung or an indeterminate lesion were considered abnormal. Factors correlating with an abnormal chest CT scan or development of malignant neoplasm of the lung were analyzed, including the timing of imaging and the patients' clinicopathologic data.

Results: Seventy-nine scans (29.3%) were considered abnormal. The rate of an abnormal scan was significantly higher in the follow-up case group (44.2%) than in the new case group (14.2%) ($P<.001$). Ten of 15 indeterminate scans (66.7%) with small (<1 cm) solitary pulmonary nodules showed disease progression on subsequent follow-up scans, changing the patients' diagnoses to a malignant neoplasm of the lung. The predictive factors for development of a malignant neoplasm of the lung were initial N2 or N3 disease, stage IV disease, recurrent disease, and distant metastasis to another site.

Conclusions: Chest CT is recommended for high-risk patients, especially during the follow-up period. Intensified evaluation and management are mandatory for indeterminate small solitary pulmonary nodules because of the high rate of malignant neoplasms.

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THE DEVELOPMENT OF A MALIGNANT neoplasm of the lung, including distant metastasis and second primary cancer, is an important factor that limits the survival of patients with head and neck squamous cell carcinoma (HNSCC). The most common site of distant metastasis is the lungs,[1,2] with an incidence of 8% to 15% in clinical studies.[1-3] Primary lung cancers account for 23% of second primary tumors in patients with HNSCC.[4] Because the presence of a malignant neoplasm of the lung may alter the case management, evaluation of the chest condition is important for patients with HNSCC at the initial diagnosis and during the follow-up period.

Chest radiography is the most common screening tool for many patients with HNSCC, but its sensitivity for early chest lesions is far from satisfactory.[2,5-7] Chest computed tomography (CT) is a sensitive tool for the detection of pulmonary lesions.[5] However, routine screening by chest CT in patients with HNSCC is controversial, and the cost-effectiveness and optimal timing for this imaging are not clearly defined.[6,8-10] The objective of this study was to review the results of a screening chest CT in patients with HNSCC at Taipei Veterans General Hospital during a 42-month period. The rates of an abnormal chest CT scan at different times of imaging were analyzed. Possible predictive factors for the development of a malignant neoplasm of the lung were also explored to guide appropriate use of chest CT in the future.

METHODS

STUDY DESIGN

The computer database of Taipei Veterans General Hospital, Taipei, Taiwan, between February 1, 2002, and July 31, 2005, was searched for all chest CTs performed in patients with HNSCC. Patients with primary tumors originating at the nose, paranasal sinuses, or nasopharynx and patients with carcinoma of unknown primary site were excluded from this study. To explore the role of chest CT for

Table 1. Radiologic Criteria and Distribution of Abnormal Chest Computed Tomographic (CT) Scans

Radiologic Finding	No. of Scans
Malignant neoplasm of the lung	
Multiple mostly smooth and peripheral nodules (without clinical symptoms of infection)	49
Lesions with bony destruction	1
Mediastinal lymph nodes ≥1 cm	0
Solitary, spiculated, and centrally located lesions ≥1 cm	4
Indeterminate lesion[a]	
Small (<1 cm) solitary pulmonary nodules	15
Multiple air-space opacities with difficulty in distinguishing infectious processes from metastases radiologically	10

[a] All patients with indeterminate lesions had a follow-up CT scan 3 to 6 months later.

screening purposes, 1 or multiple scans of the same patient were included until any abnormal finding was found. Subsequent follow-up chest CT scans after an abnormal finding were excluded from statistical analyses in this study.

Two hundred seventy chest CT scans that were performed as part of tumor surveillance in 192 patients with biopsy-proven HNSCC were obtained during the 42-month period. According to the timing of the CT, the scans were divided into the following 3 groups: new cases (n=134), follow-up cases (n=52), and recurrent cases (n=84). Chest CT in the new case group was performed within 2 weeks before the initial treatment of HNSCC. The follow-up case group included scans performed in patients without evidence of relapse during the follow-up period. The median intervals between the diagnosis of the primary tumor and the chest CT were 8 months (range, 1-50 months) for the follow-up case group and 10 months (range, 2-70 months) for the recurrent case group. All chest CTs were performed using contiguous axial 5- to 8-mm section thickness through the lungs (LightSpeed and HiSpeed; GE Medical Systems, Milwaukee, Wisconsin) after intravenous administration of contrast medium. Conventional lung and mediastinal thoracic views were surveyed. Chest radiographs within 1 month before chest CT were available in 266 of 270 studies.

IMAGE INTERPRETATION

Radiology reports of all imaging studies were collected and further reviewed together by radiologists, oncologists, and head and neck surgeons (some of whom included the following authors, J.-C.L., Y.-B.H., P.-Y.C., T.-L.T., J.-L.H., Y.-F.W., and S.-K.T.). The initial results of the chest CT were classified as abnormal or normal. Abnormal results included a malignant neoplasm of the lung and an indeterminate lesion, as both findings contribute to possible modifications of case management. The radiologic criteria[2,6,11] and the patient distribution of abnormal chest CT scans are listed in **Table 1**. Scans demonstrating a radiologic diagnosis of lung metastasis or secondary primary lung cancer were included in the category of malignant neoplasm. Indeterminate lesions were considered benign if they were stable or decreased in follow-up scans. If indicated, the neoplastic nature of the CT results was confirmed by follow-up scan 3 to 6 months later or by pathologic findings on endoscopic or CT-guided needle biopsy. Images without any of the listed findings were considered normal.

During the study, the use of chest CT mainly depended on physician choice. Among 192 patients with HNSCC, 159 (82.8%) were advanced cases (stage III or IV) according to the 2002 American Joint Committee on Cancer staging system.[12] All patients underwent detailed history taking, physical examination, and comprehensive tumor surveys, including chest radiography, abdominal ultrasonography, and bone scintigraphy. Further investigation and consultation were arranged as necessary to ensure that patients had no other primary malignant neoplasms that had metastasized to the lungs. Medical records and radiology and pathology reports were reviewed, and the characteristics of 192 patients with HNSCC are summarized in **Table 2**.

Table 2. Characteristics of 192 Patients With Head and Neck Squamous Cell Carcinoma

Characteristic	Value
Sex, No. (%)	
Male	181 (94.3)
Female	11 (5.7)
Age, median (range), y	53 (33-87)
Tumor location, No. (%)	
Oral cavity	42 (21.9)
Oropharynx	30 (15.6)
Hypopharynx	83 (43.2)
Glottis	19 (9.9)
Supraglottis	18 (9.4)
T classification, No. (%)	
T1 or T2	74 (38.5)
T3 or T4	118 (61.5)
N classification, No. (%)	
N0 or N1	96 (50.0)
N2 or N3	96 (50.0)
TNM stage, No. (%)	
I or II	33 (17.2)
III or IV	159 (82.8)

DATA ANALYSIS

Statistical analyses were performed to determine the association between variables and an abnormal chest CT scan or development of malignant neoplasm of the lung. χ^2 Test or Fisher exact test was used for univariate analysis. Variables analyzed included timing of imaging, history of cigarette smoking, primary tumor location, T and N classifications, locoregional recurrence, and distant metastasis to another site. For patients with primary tumor treated by surgery, pathologic variables of the primary tumor or neck metastasis were analyzed where appropriate, including perineural invasion, lymphovascular permeation, surgical margin, and extracapsular spread (ECS) of neck metastasis. Multivariate analysis was performed using a logistic regression model and inclusion of the significant factors on univariate analysis. All analyses were performed using commercially available statistical software (SPSS version 12.0; SPSS, Inc, Chicago, Illinois).

RESULTS

CHEST CT

According to the radiologic criteria, 79 of 270 chest CT scans (29.3%) were initially considered abnormal, including 54 manifesting a malignant neoplasm of the lung (20.0%) and 25 manifesting indeterminate lesions (9.3%). All malignant neoplasms occurred within the lungs, and no isolated mediastinal lymph node metastasis was found.

Table 3. Correlation Between Timing of Imaging and Initial Results of 270 Chest Computed Tomographic (CT) Scans

	Chest CT Results, No. (%)			
		Abnormal		
Timing Group	Normal	Malignant	Indeterminate	Total
New case	115 (85.8)	10 (7.5)	9 (6.7)	**134**
Follow-up case	29 (55.8)	17 (32.7)	6 (11.5)	**52**
Recurrent case[a]	47 (56.0)	27 (32.1)	10 (11.9)	**84**
Total	**191** (70.7)	**54** (20.0)	**25** (9.3)	**270**

[a] Residual or recurrent locoregional disease.

Table 4. Final Results of 25 Indeterminate Lesions on Follow-up Chest Computed Tomographic Scans

	No. (%)		
Original Finding	Progression	Resolution or No Change	*P* Value
Small solitary nodule	10 (66.7)[a]	5 (33.3)	.01
Multiple air-space opacity	1 (10.0)[b]	9 (90.0)	
Total	**11** (44.0)	**14** (56.0)	

[a] Multiple nodules had developed in the follow-up scans.
[b] Malignant pleural effusion was proved in this case.

Besides chest lesions, additional findings were noted on 7 chest CT scans, including 4 liver, 2 adrenal gland, and 1 peripancreatic lymph node metastases. Seventy-five abnormal chest CT scans had antecedent chest radiography, but only 21 (28.0%) identified the lung lesions.

The correlations between the timing of CT and the results are summarized in **Table 3**. The rate of an abnormal scan was significantly higher in the follow-up case group (44.2%) than in the new case group (14.2%) ($P<.001$) and was comparable in the follow-up case group and in the recurrent case group (44.0%). Of 54 scans demonstrating a malignant neoplasm of the lung, histologic confirmation by endoscopic or CT-guided needle biopsy was obtained in 4 patients with a solitary lesion larger than 1 cm. Most of the scans in 49 patients with multiple pulmonary nodules on chest CT were considered radiologically unequivocal, and only 8 (16.3%) underwent biopsy for tissue confirmation. On subsequent clinical and radiologic follow-up, 2 CT scans were considered false-positive results because lesion regression was found without any systemic treatment.

CASE MANAGEMENT ALTERATIONS

Among 54 patients with the diagnosis of malignant neoplasm of the lung by initial chest CT, 45 patients (83.3%) had major alterations in their case management. Instead of curative treatment, 34 patients received chemotherapy alone, and 7 patients underwent chemoradiotherapy for palliation. Only 4 patients received aggressive wedge resection of malignant neoplasms of the lung followed by postoperative chemotherapy. The remaining 9 patients refused any treatment, although palliative chemotherapy was suggested. Excluding 2 cases with false-positive results, only 1 patient who received wedge resection and postoperative chemotherapy achieved ultimate disease control.

Among 25 patients with indeterminate lesions on initial chest CT, 2 underwent CT-guided biopsy, and both had histologically negative results. A follow-up chest CT was performed 3 to 6 months later in all 25 patients, and progression of the pulmonary finding was shown in 11 patients (44.0%), changing the diagnosis to a malignant neoplasm of the lung (**Table 4**). Initial indeterminate lesions manifesting as small solitary nodules had a significantly higher chance of developing into malignant neoplasm of the lung (66.7%) than indeterminate lesions manifesting as multiple air-space opacities (10.0%) ($P=.01$).

PREDICTORS OF A MALIGNANT NEOPLASM OF THE LUNG

Sixty-three of 192 patients with HNSCC (32.8%) eventually developed a malignant neoplasm of the lung. The median interval between the diagnosis of primary HNSCC and the development of a malignant neoplasm of the lung was 9.9 months (range, 1.7-59.7 months). Eighty-four percent of the malignant neoplasms of the lung developed within 2 years. Univariate analysis results for the development of a malignant neoplasm of the lung relative to clinicopathologic factors are summarized in **Table 5**. N2 or N3 disease ($P=.02$) and stage IV disease ($P=.03$) were significantly correlated with the development of a malignant neoplasm of the lung. Recurrent locoregional disease ($P<.001$) and distant metastasis to another site ($P<.001$) were also significant predictors for the development of a malignant neoplasm of the lung. Patients with a smoking history ($P=.09$) or with primary sites at the hypopharynx and supraglottis ($P=.07$) had a trend to development of a malignant neoplasm of the lung that was statistically nonsignificant. In multivariate analysis, recurrent locoregional disease, N2 or N3 disease, and distant metastasis to another site remained independent predictors for the development of a malignant neoplasm of the lung (**Table 6**).

Histopathologic results were available in 85 patients who underwent surgery as the primary treatment of HNSCC. Pathologic factors of the primary tumor, including perineural invasion ($P=.64$), lymphovascular permeation ($P=.40$), and positive surgical margin ($P=.74$), were not predictive for the development of a malignant neoplasm of the lung. Fifty-two patients underwent neck dissection as part of their initial treatment, and pathologic cervical metastasis was found in 40 patients (19 without ECS and 21 with ECS). The incidence of a malignant neoplasm of the lung was significantly higher in patients with ECS (57.1%) than in those without ECS (26.3%) ($P=.04$). However, ECS remained a borderline predictor for the development of a malignant neoplasm of the lung ($P=.07$) by multivariate analysis in this subgroup of patients.

COMMENT

For patients with HNSCC, chest diagnosis is crucial and may influence their treatment plan. However, routine

yearly chest radiography has been shown by Shah and Applebaum[7] to contribute little to the overall survival in patients with HNSCC. In the initial 2 to 3 years of follow-up, intensive chest screening has been suggested at 4- to 6-month intervals rather than annually.[4] Chest CT is superior to radiography in sensitivity and adds little extra time and radiation dose (3-6 msv) when performed with neck CT.[10,13] However, chest CT is more expensive, and its indications vary widely as a screening tool for HNSCC. In the present study without strict guidelines, 70.7% of 270 chest CT scans showed normal findings. It is important to understand when and under which conditions chest CT will be cost-effective.

Chest CT performed at the initial diagnosis of primary tumors theoretically has the greatest effect on treatment planning. However, Keski-Säntti et al[8] and Tan et al[9] demonstrated limited usefulness of routine chest CT screening in patients newly diagnosed as having HNSCC. Our study also showed a low rate of an abnormal chest CT scan at the initial diagnosis. In contrast, a significantly higher rate of an abnormal chest CT scan was found in the follow-up period. Among 23 abnormal scans in the follow-up case group, 12 had antecedent normal CT scans at the initial diagnosis of their primary tumor. For more effective case management, chest CT during the follow-up period in high-risk patients should be emphasized.

Confirmation of the diagnosis of a malignant neoplasm of the lung theoretically should be supported by endoscopic or CT-guided biopsy. However, it is not always feasible in clinical practice. Brouwer et al[11] reported that pulmonary lesions were considered malignant if unequivocal radiologic findings were identified on chest CT or if progression of the lesions was demonstrated on a follow-up scan. In our study, lung biopsy was performed in only 8 of 49 patients (16.3%) with multiple and peripheral pulmonary nodules, as Mesurolle et al[14] and Ginsberg et al[15] demonstrated more than 90% malignant results in such lesions. However, 2 false-positive CT scans were encountered in the present study. Therefore, follow-up CT scans should be mandatory, although false-positive findings are rare. Lung metastasis and second primary lung cancer were categorized as a malignant neoplasm of the lung in this study. Differentiating between them in clinical practice is sometimes difficult for HNSCC, especially when the histologic diagnosis of pulmonary lesions is squamous cell carcinoma.[16] Advances in molecular genetic approaches may become efficient tools for the differential diagnosis in the future.[16]

Indeterminate lesions were common on chest CT in our study, and special attention should be paid to them. Based on the progressive change in follow-up scans, 44.0% of indeterminate lesions were eventually considered a malignant neoplasm of the lung. We also found that small (<1 cm) solitary nodules, which were usually resectable, carried significantly higher chances (66.7%) of being a malignant neoplasm. For patients with HNSCC, durable disease control has been reported in 34% of resectable pulmonary metastases after undergoing surgery.[17] However, under a close imaging follow-up policy, all patients with progression from small solitary nodules developed multiple pulmonary nodules, and their disease could only be managed with chemotherapy for palliation in the present study.

Table 5. Univariate Analysis for Predictors of a Malignant Neoplasm of the Lung Among 192 Patients

Variable	Malignant Neoplasm of the Lung		*P* Value
	Normal	Abnormal	
Smoking history			
No	22	5	.09
Yes	107	58	
Tumor location			
Oral cavity, oropharynx, glottis	67	24	.07
Hypopharynx, supraglottis	62	39	
T classification			
T1 or T2	47	27	.39
T3 or T4	82	36	
N classification			
N0 or N1	72	24	.02
N2 or N3	57	39	
TNM stage			
I-III[a]	53	16	.03
IV	76	47	
Recurrent disease[b]			
No	106	28	<.001
Yes	23	35	
Distant metastasis to another site			
No	110	39	<.001
Yes	19	24	

[a] For grouping early and advanced diseases, we used stages I through II in this table, vs stages III through IV (as in Table 2).
[b] Residual or recurrent locoregional disease.

Table 6. Multivariate Analysis for Predictors of a Malignant Neoplasm of the Lung Among 192 Patients

Variable	Hazard Ratio (95% Confidence Interval)	*P* Value
N classification (N2 or N3 vs N0 or N1)	2.73 (1.31-5.68)	.01
Recurrent disease[a]	8.43 (3.89-18.26)	<.001
Distant metastasis to another site	4.35 (1.93-9.78)	<.001

[a] Residual or recurrent locoregional disease.

The evaluation and management of potentially controllable small solitary pulmonary nodules remain great challenges. Computed tomography–guided biopsy has been reported by Quint et al[18] to be a valuable tool for larger (5-30 mm) pulmonary nodules. However, biopsy of small indeterminate nodules is associated with low accuracy, and pneumothorax may occur.[19] Positron emission tomography with fludeoxyglucose F 18 (FDG-PET) has been advocated for high sensitivity.[20,21] However, it is not widely available and has been reported to be no more accurate in detecting a malignant neoplasm of the lung than chest CT.[20,22] Confirmation of abnormal findings on FDG-PET is necessary because false-positive results occur in 20% to 67% of cases.[20,21] When appropriate, aggressive surgical excision is another choice for definitive diagnosis and management.

Because the chance of disease control is low in patients with a malignant neoplasm of the lung at the initial diagnosis of HNSCC or after locoregional treatment failure, an abnormal chest CT scan can affect the treat-

ment plan and prognosis. For patients with HNSCC who develop unresectable malignant neoplasm of the lung, the treatment policy should mostly be palliative. Only for patients with potentially resectable malignant neoplasm of the lung should aggressive curative treatment at the primary site and the lung be considered for possible long-term disease control.[17,23]

Several limitations should be noted in this study. Although ECS had been reported as a predictor of distant metastasis,[24] we show its predictive value in only a small subgroup of patients with pathologic N disease or greater by univariate analysis. Further analysis in a larger study population whose initial treatment includes neck dissection is needed to clarify the relation between ECS and the development of a malignant neoplasm of the lung. Other limitations included selection bias in performing chest CT, the retrospective study design, and the limited follow-up period in some patients. Therefore, our results should be interpreted with caution. In the present study, CT was performed based on physician choice in patients with multiple unfavorable factors and with high likelihood of distant metastasis. A prospective study in consecutive patients with longer follow-up time is needed for more substantial results.

In conclusion, chest CT is recommended for high-risk patients, especially every 6 months for the first 2 years during the follow-up period, although its role is controversial for patients newly diagnosed as having HNSCC. High-risk patients include those with N2 or N3 disease, stage IV disease, or locoregional recurrence. For patients with indeterminate small (<1 cm) solitary pulmonary nodules, aggressive evaluation and management are imperative because of the high rate of a malignant neoplasm of the lung.

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REFERENCES

1. León X, Quer M, Orus C, del Prado Venegas M, Lopez M. Distant metastases in head and neck cancer patients who achieved loco-regional control. *Head Neck*. 2000;22(7):680-686.
2. de Bree R, Deurloo EE, Snow GB, Leemans CR. Screening for distant metastases in patients with head and neck cancer. *Laryngoscope*. 2000;110(3, pt 1):397-401.
3. Alvi A, Johnson JT. Development of distant metastasis after treatment of advanced-stage head and neck cancer. *Head Neck*. 1997;19(6):500-505.
4. León X, Ferlito A, Myer CM III, et al. Second primary tumors in head and neck cancer patients. *Acta Otolaryngol*. 2002;122(7):765-778.
5. Ong TK, Kerawala CJ, Martin IC, Stafford FW. The role of thorax imaging in staging head and neck squamous cell carcinoma. *J Craniomaxillofac Surg*. 1999;27(6):339-344.
6. Houghton DJ, Hughes ML, Garvey C, et al. Role of chest CT scanning in the management of patients presenting with head and neck cancer. *Head Neck*. 1998;20(7):614-618.
7. Shah SI, Applebaum EL. Lung cancer after head and neck cancer: role of chest radiography. *Laryngoscope*. 2000;110(12):2033-2036.
8. Keski-Säntti HT, Markkola AT, Makitie AA, Back LJ, Atula TS. CT of the chest and abdomen in patients with newly diagnosed head and neck squamous cell carcinoma. *Head Neck*. 2005;27(10):909-915.
9. Tan L, Greener CC, Seikaly H, Rassekh CH, Calhoun KH. Role of screening chest computed tomography in patients with advanced head and neck cancer. *Otolaryngol Head Neck Surg*. 1999;120(5):689-692.
10. Houghton DJ, McGarry G, Stewart I, Wilson JA, MacKenzie K. Chest computerized tomography scanning in patients presenting with head and neck cancer. *Clin Otolaryngol Allied Sci*. 1998;23(4):348-350.
11. Brouwer J, de Bree R, Hoekstra OS, et al. Screening for distant metastases in patients with head and neck cancer: is chest computed tomography sufficient? *Laryngoscope*. 2005;115(10):1813-1817.
12. Greene FL, Page DL, Fleming ID, Balch CM, Haller DG, Morrow M. In: Fritz A, ed. *AJCC Cancer Staging Manual*. 6th ed. New York, NY: Springer-Verlag; 2002.
13. Arunachalam PS, Putnam G, Jennings P, Messersmith R, Robson AK. Role of computerized tomography (CT) scan of the chest in patients with newly diagnosed head and neck cancers. *Clin Otolaryngol Allied Sci*. 2002;27(5):409-411.
14. Mesurolle B, Mignon F, Meingan P, Domenge C, Vasile M, Sigal R. Head and neck cancer patients with pulmonary nodules: value and role of CT-guided transthoracic needle aspiration biopsies. *Head Neck*. 2003;25(11):889-894.
15. Ginsberg MS, Griff SK, Go BD, Yoo HH, Schwartz LH, Panicek DM. Pulmonary nodules resected at video-assisted thoracoscopic surgery: etiology in 426 patients. *Radiology*. 1999;213(1):277-282.
16. Geurts TW, Nederlof PM, van den Brekel MW, et al. Pulmonary squamous cell carcinoma following head and neck squamous cell carcinoma: metastasis or second primary? *Clin Cancer Res*. 2005;11(18):6608-6614.
17. Liu D, Labow DM, Dang N, et al. Pulmonary metastasectomy for head and neck cancers. *Ann Surg Oncol*. 1999;6(6):572-578.
18. Quint LE, Park CH, Iannettoni MD. Solitary pulmonary nodules in patients with extrapulmonary neoplasms. *Radiology*. 2000;217(1):257-261.
19. Wallace MJ, Krishnamurthy S, Broemeling LD, et al. CT-guided percutaneous fine-needle aspiration biopsy of small (≤1-cm) pulmonary lesions. *Radiology*. 2002;225(3):823-828.
20. Wax MK, Myers LL, Gabalski EC, Husain S, Gona JM, Nabi H. Positron emission tomography in the evaluation of synchronous lung lesions in patients with untreated head and neck cancer. *Arch Otolaryngol Head Neck Surg*. 2002;128(6):703-707.
21. Keyes JW Jr, Chen MY, Watson NE Jr, Greven KM, McGuirt WF, Williams DW III. FDG PET evaluation of head and neck cancer: value of imaging the thorax. *Head Neck*. 2000;22(2):105-110.
22. Hanasono MM, Kunda LD, Segall GM, Ku GH, Terris DJ. Uses and limitations of FDG positron emission tomography in patients with head and neck cancer. *Laryngoscope*. 1999;109(6):880-885.
23. Kuriakose MA, Loree TR, Rubenfeld A, et al. Simultaneously presenting head and neck and lung cancer: a diagnostic and treatment dilemma. *Laryngoscope*. 2002;112(1):120-123.
24. Puri SK, Fan CY, Hanna E. Significance of extracapsular lymph node metastases in patients with head and neck squamous cell carcinoma. *Curr Opin Otolaryngol Head Neck Surg*. 2003;11(2):119-123.