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Evaluation of Solitary Thyroid Cold Nodules with Technetium-99m Sestamibi and Thallium-201

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ABSTRACT

This is a prospective study, including 54 patients with solitary cold thyroid nodules detected on the standard technetium-99m pertechnetate scintigraphy in the period between September 1999 and February 2001. All patients underwent thyroid ultrasonography, triple-phase thyroid scan with Technetium-99m pertechnetate (^{99m}Tc), Technetium-99m sestamibi (^{99m}Tc-MIBI) and thallium-201 (201TI) followed by fine needle aspiration cytology (FNAC). All patients, except those with thyroiditis, were subjected to surgery for histopathological diagnosis. Quantitative analysis was performed by drawing a region of interest (ROI) over the nodule and contralateral normal thyroid tissue. The lesion to normal thyroid (L/N) uptake ratio on early (ER) and late image (LR) were calculated. Based on histopathological examination, there were 19 patients (35%) with well differentiated carcinoma and 35 patients (65%) with benign lesions. The mean uptake L/N ratios for benign and malignant thyroid nodules were 1.25±0.47 and 1.56±0.24 in the early ^{99m}Tc-MIBI scan; 0.99±0.18 and 2.38±0.71 in the late ^{99m}Tc-MIBI scan. There was no statistical difference between the mean early L/N uptake ratio of benign versus malignant thyroid lesions using ^{99m}Tc-MIBI (p = 0.073). On the other hand, there was a statistically significant difference between the mean late L/N uptake ratios of benign versus malignant thyroid nodules using ^{99m}Tc-MIBI (p = 0.001). Also, there was no significant difference in the mean early L/N uptake ratios for thallium-201 scan between benign (1.29±0.41) and malignant nodules (1.35±0.17) (p = 0.133). A significant difference in the late thallium scan between the mean uptake ratio in benign (1.06±0.12) and malignant nodules (1.74±0.31) was noted (p = 0.01). to determine the threshold levels to differentiate between benign and malignant nodules, a receiver operating characteristic (ROC) analysis was applied. The mean uptake ratios of 1.31 and 1.48 for early and late ^{99m}Tc-MIBI scans and 1.23 and 1.34 for early and late 201TI scans were selected, respectively. Based on these threshold values, the sensitivity and specificity of early ^{99m}Tc-MIBI scan were 84.2% and 83.3%, whereas they were 89.5% and 90% for late ^{99m}Tc-MIBI. A lower sensitivity and specificity for early thallium-201 scan of 78.9%, and 66.7% and 84.2% and 86.7% for late thallium-201 were found. In conclusion, LR for ^{99m}Tc-MIBI and ^{201}TI studies were superior to ER in defferentiating malignant thyroid nodules. Also, LR of ^{99m}Tc-MIBI was more sensitive than that of ^{201}TI scan in diagnosis of benign versus malignant thyroid nodules.

Key Words: *Cold thyroid nodules - ^{99m}Tc-MIBI scan - Thallium - 201 scan.*

INTRODUCTION

Differentiated thyroid carcinoma is the most curable cancer. However, delay in diagnosis is associated with higher mortality **[16]**. Thyroid carcinoma is characterized by a non functioning or "cold" nodule detected in the technetium-pertechnetate (^{99m}Tc) scan **[23]**. In case of solitary cold thyroid nodule in the ^{99m}Tc scan, further studies are needed for proper diagnosis as the incidence of malignancy in solitary cold nodules ranges from 9% to 26%. Various diagnostic techniques have been successfully used in the clinical management of cold nodules. High-resolution ultrasonography provides a sensitive and non-invasive method for evaluating the thyroid nodules and is very helpful for guiding FNAC **[12]**. Fine needle aspiration cytology (FNAC) is the most acceptable diagnostic tool for distinguishing benign from malignant thyroid lesions **[1,25]**.

Nuclear medicine remains an important part of thyroidology, particularly in the diagnosis, treatment and follow-up of thyroid cancer **[13]**. Many investigators have attempted to differentiate benign from malignant thyroid nodules by means of thallium-201 (^{201}TI) imaging. ^{201}TI has a high sensitivity for diagnosis of malignant lesions, however the specificity is low as accumulation of ^{201}TI also occurs in some benign thyroid nodules. To increase the specificity of ^{201}TI, delayed scanning and quantitative criteria have been used by many investigators. It has been shown that the majority of malignant nodules demonstrated persistent delayed ^{201}TI uptake due to slower washout from malignant nodules compared with normal thyroid tissue and benign thyroid nodules [14,20]. ^{99m}Tc-methoxyisobutylisnitrile (MIBI) has been introduced for myocardial perfusion imaging as an alternative to ^{201}TI. Also, Technetium-99m sestamibi (^{99m}Tc-MIBI) has been shown to be taken up by many malignant tumours including thyroid malignancy [24]. High ^{99m}Tc-MIBI uptake increases the probability of diagnosis of malignant lesions, while decreased uptake excludes it [19].

The aim of this study is to investigate the value of early and late imaging of technetium-99m sestamibi and thallium-201 in conjunction with conventional technetium-99m pertechnetate scintigraphy in the differentiation between malignant and benign thyroid nodules.

PATIENTS AND METHODS

Patients:

Between September 1999 and February 2001, we carried a prospective study including 54 patients (21 males, 33 females) with solitary cold thyroid nodules diagnosed clinically and followed by ultrasonography and Technetium-99m pertechnetate scintigraphy. Thyroid scintigraphy with thallium-201 and ^{99m}Tc-MIBI were performed for each patient. Fine needle aspiration cytology (FNAC) was performed for all patients followed by surgery for histopathological diagnosis except in patients with thyroiditis. Surgical manouvers were affected by the histopathologic diagnosis obtained through FNAB. The scan findings in these patients were correlated with the final histopathological diagnosis.

Imaging:

Thyroid imaging was performed for 54 patients with the standard technique using 185 MBq technetium-99m pertechnetate in anterior view image starting at 20 minutes, collecting 500.000 counts using 128 x 128 matrix on a single head gamma camera with a high resolution parallel-hole collimator and with a 20% window. One day after ^{99m}Tc (half-life 6 hours), repeated scanning with thallium-201 (half-life 3 days) followed by technetium-99m methoxyisobutylisonitrile (^{99m}Tc-MIBI) 3 days later was carried out. ^{201}TI scintigraphy was obtained at 15 min (early image) and at 3 hours (late image) after intravenous injection of 74 MBq ^{201}TI. An anterior view image for a total count of 250.000 counts in both early and delayed images was taken. A dose of 370 MBq of ^{99m}Tc-MIBI was injected. The thyroid gland was imaged at 15 min (early image) and at 99 min (late image) following the injection, collecting 500.000 counts for each view for both tracer imaging.

Quantitative and statistical analysis:

For early image, a region of interest (ROI) was plotted around the thyroid nodule. A similar ROI was generated in the contralateral normal thyroid tissue. The lesion to normal (L/N) ratios for both early (ER) and late (LR) images were calculated by dividing the lesion count by normal thyroid count. This technique was performed for both ^{99m}Tc-MIBI and thallium-201 scans. A receiving operating characteristic (ROC) analysis was used to determine threshold level above which malignant thyroid nodules can be suspected.

RESULTS

Between September 1999 and February 2001, a total of 54 patients (21 males, 33 females; mean age 41±11 years) had solitary cold thyroid nodules by thyroid scan and ultrasonography. Nineteen of 54 patients (35%) had well differentiated thyroid cancer, whereas the other 35 patients (65%) had benign lesions (18 follicular adenomas; 9 colloid goiters; 5 cysts and 3 thyroiditis). Based on ultrasound examination, the 19 malignant thyroid nodules showed 10 solid lesions (53%), 7 mixed (solid-cystic) lesions (33%) and 2 cystic lesions (14%). Also, ultrasound examination showed that out of 35 benign thyroid nodules [16 cystic lesions (46%), 13 mixed lesions (37%) and 6 solid lesions (17%)] were detected. The 19 cancerous nodules were cold on the ^{99m}Tc-pertechnetate scan, whereas in the early ^{99m}Tc-MIBI scan, 18 had warm nodules (95%) and one nodule (5%) had a normal uptake. On the other hand, in late ^{99m}Tc-MIBI scan all the 19 malignant lesions were warm with more retained radiotracer uptake. In ^{201}TI scan, 16 malignant lesions had warm nodules (85%) in early and late scanning and 2 had cold nodules (10%) in both early and late images. Only one malignant nodule had a normal uptake (5%) in early ^{201}TI scan, while it was warm in late ^{201}TI scan (Table 1 and Figs. 2,3,4). Out of 35 benign thyroid lesions, ^{99m}Tc-MIBI scan showed 11 cold nodules in early and late images (31%) [(5 cysts; 3 thyroiditis; 2 colloid goiters and 1 follicular adenoma)] and 4 nodules with normal tracer uptake (12%) (one follicular adenoma and 3 colloid goiters) in both early and late images. The other 20 benign nodules (57%) were warm in early ^{99m}Tc-MIBI (16 follicular adenoma and 4 colloid goiters). Nine of these 20 nodules had cold lesions (45%), 5 nodules (25%) had normal uptake while the other 6 warm lesions were still hyperactive in late ^{99m}Tc-MIBI scans (false positive results). In early ^{201}TI scan, 8 lesions (23%) were cold (5 cysts and 3 thyroiditis) and 5 benign thyroid nodules (14%) showed normal tracer uptake (4 colloid goiters and one follicular adenoma) with complete washout of radioactivity in late images. The remaining 22 benign thyroid lesions (63%) were warm (17 follicular adenomas and 5 colloid goiters) in early ^{201}TI images, while in late ^{201}TI images 7/22 lesions (32%) were cold and 6/22 nodules (27%) showed normal radiotracer uptake (Table 1).

Based on histopathological diagnosis, 28 out of 35 (80%) benign lesions and 15 out of 19 (79%) cancerous lesions showed true positive results in FNAC. On the other hand, FNAC had false negative findings in 7 patients with benign lesions (20%) and 4 malignant lesions (21%). The 4 false negative results in the malignant group were reported as follicular adenomas and the 7 false negative lesions in the benign group were follicular carcinomas in 4 lesions, thyroiditis in 2 lesions and a case of papillary carcinoma. The overall sensitivity of FNAC was 80%.

In early L/N ratio, malignant nodules showed higher ^{99m}Tc-MIBI than ^{201}TI uptake except in 4 nodules (3 follicular and one papillary carcinoma). However, late thallium uptake was higher than MIBI in only two nodules with papillary carcinoma. For malignant lesions, L/N ratio on the early thallium scan (ER) was 1.35±0.17 (range 0.88-1.64), whereas L/N on the late thallium scan (LR) was 1.74±0.31 (range 1.24-2.4). A significant difference was noted between early and late thallium ratios ($p = 0.025$). For ^{99m}Tc-MIBI scan, the median L/N ratio for malignant lesions was 1.56±0.24 (range 1-1.96) on the early scan and 2.38±0.71 (range 1.36-4.18) on the late scan. A significant difference was also noted between ER and LR of ^{99m}Tc-MIBI scan in malignant lesions ($p = 0.005$). In the thallium scan, the L/N ratio for benign lesions was 1.29±0.41 (range 0.67-2.27) on the early scan and 1.06±0.12 (range 0.69-1.33) on the late scan. For ^{99m}Tc-MIBI, the L/N for benign lesions was 1.25±0.47 (range 0.76-1.13) on the early scan and 0.99±0.18 (range 0.7-1.49) on the late scan. No significant difference was seen in L/N ratios on the early scans between benign and malignant lesions in either thallium ($p = 0.133$) or ^{99m}Tc-MIBI ($p = 0.073$) scans. In contrast, there was a significant difference between LR of benign and malignant lesions in thallium scan ($p = 0.01$) and ^{99m}Tc-MIBI scan ($p = 0.001$) (Table 2). All 19 malignant nodules showed higher radiotracer accumulation on the delayed than on the early ^{99m}Tc-MIBI scan (100%). Only 6 out of 35 benign nodules (17%) had false positive results with higher accumulation on the delayed ^{99m}Tc-MIBI scan; they were follicular adenomas in histopathologic analysis. On the other hand, 17/19 (90%) of malignant lesions (90%) showed higher accumulation of radiotracer on the delayed thallium scan, whereas, 9/35 benign lesions (26%) had false positive results and were follicular adenomas on histopathologic analysis. Of these 9 follicular adenomas, 6 had false positive results in both ^{99m}Tc-MIBI and ^{201}TI scans and the other 3 cases had false positive results in ^{201}TI scan only (Table 3).

A receiver operating characteristic (ROC) analysis was used to determine the threshold level above which malignant thyroid nodules can be suspected. Based on this analysis, ER and LR levels were 1.23 and 1.34 for ^{201}TI and 1.31 and 1.48 for ^{99m}Tc-MIBI studies (Table 6 and Fig. 1). Using these threshold levels, the sensitivity and specificity of ^{201}TI study were 78.9% and 66.7% for ER; 84.2% and 86.7% for LR. On the other hand, the sensitivity and specificity of ^{99m}Tc-MIBI study were 84.2% and 83.3% for ER; 89.5% and 90% for LR (Table 6).

Clinically, the size of malignant nodules ranged from 1.0 to 5.5 cm in diameter. There was cervical lymph node enlargement in only 3 patients, all of whom had papillary thyroid cancer. There was no significant difference in the early and late L/N ratios for malignant lesions smaller or larger than 2 cm in both radiotracer studies (Table 4). Based on histopathological examination, 12/19 malignant lesions were proved to have papillary carcinoma (63%), whereas 7/19 malignant lesions had follicular carcinoma (37%). The mean ^{99m}Tc-MIBI ER and LR in papillary carcinoma were 1.6±0.18 and 2.38±0.6, respectively, whereas in thallium study, the early and late L/N ratios were 1.37±0.17 and 1.77±0.28, respectively. On the other hand, follicular cancer nodules showed early and late L/N ratios of 1.53±0.33 and 2.3±0.91 in ^{99m}Tc-MIBI scan and 1.26±0.23 and 1.67±0.38 in thallium scan, respectively. There was no statistical difference between papillary and follicular carcinoma in thallium-201 or ^{99m}Tc-MIBI uptake studies for early and late images ($p > 0.05$) (Table 5).

Table (1): Early and late ^{99m}Tc-MIBI and ^{201}TI uptake of 54 cold thyroid nodules.

Study	Malignant lesions			Benign lesions		
	Warm	Normal	Cold	Warm	Normal	Cold
Early ^{99m}Tc-MIBI	18 (95%)	1 (5%)	-	20 (57%)	4 (12%)	11 (31%)
Late ^{99m}Tc-MIBI	19 (100%)	-	-	6 (17%)	9 (26%)	20 (57%)
Early ^{201}TI	16 (85%)	1 (5%)	2 (10%)	22 (63%)	5 (14%)	8 (23%)
Late ^{201} TI	17 (90%)	-	2 (10%)	9 (26%)	11 (31%)	15 (43%)

Table (2): Quantiative early and late ^{99m}Tc-MIBI and ^{201}TI scanning in benign and malignant thyroid nodules.

Study	Malignant		Benign		*p* value
	Range	Ratio	Range	Ratio	
Early MIBI	1-1.96	1.56±0.24	0.76-1.13	1.25±0.47	0.073
Late MIBI	1.36-4.18	2.38±0.71	0.7-1.49	0.99±0.18	0.001
p value		0.005		> 0.05	
Early TI-201	0.88-1.64	1.35±0.17	0.67-2.27	1.29±0.41	0.133
Late TI-201	1.24-2.4	1.74±0.31	0.69-1.33	1.06±0.12	0.01
p value		0.025		> 0.05	

Table (3): Benign and malignant thyroid nodules with higher delayed than early uptake in ^{99m}Tc-MIBI and ^{201}TI scanning.

Ratios	TI-201		MIBI	
	Malignant	Benign	Malignant	Benign
Higher LR	17 (90%)	9 (26%)	19 (100%)	6 (17%)

Table (4): Correlation of quantitative ^{99m}Tc-MIBI and ^{201}TI in relation to nodule size in 19 malignant thyroid lesions.

Size	No. (%)	Thallium-201		99mTc-MIBI	
		Early	Late	Early	Late
< 2 cm	8 (42%)	1.20±0.23	1.70±0.45	1.55±0.27	2.13±0.5
> 2 cm	11 (58%)	1.43±0.10	1.76±0.19	1.56±0.24	2.57±0.80
p value		0.123	0.182	0.154	0.077

Table (5): Correlation of quantitative ^{99m}Tc-MIBI and ^{201}TI in relation to histopathologic types.

Size	No. (%)	Thallium-201		99mTc-MIBI	
		Early	Late	Early	Late
Papillary	12 (63%)	1.37±0.17	1.77±0.28	1.60±0.18	2.38±0.60
Follicular	7 (37%)	1.26±0.23	1.67±0.38	1.53±0.33	2.30±0.91
p value		0.137	0.14	0.118	0.125

Table (6): Threshold levels, sensitivity and specificity of ER and LR for ^{99m}Tc-MIBI and ^{201}TI scans.

Study	Threshold level	Sensitivity %	Specificity %
ER MIBI	1.31	84.2%	83.3%
LR MIBI	1.48	89.5%	90%
ER TI-201	1.23	78.9%	66.7%
LR TI-201	1.34	84.2%	86.7%

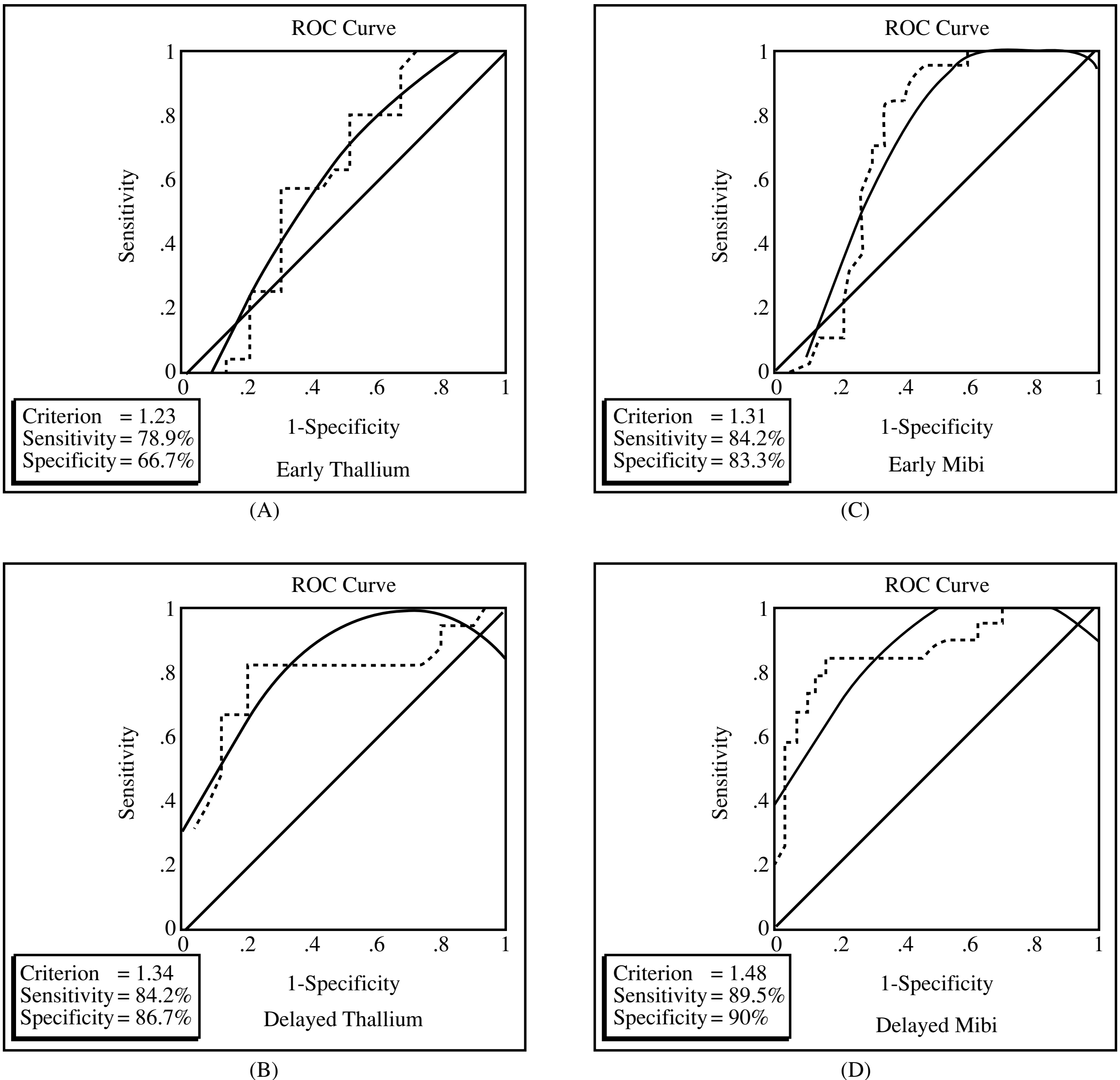

Fig. (1): Receiving operating characteristic (ROC) analysis of thallium and MIBI studies.

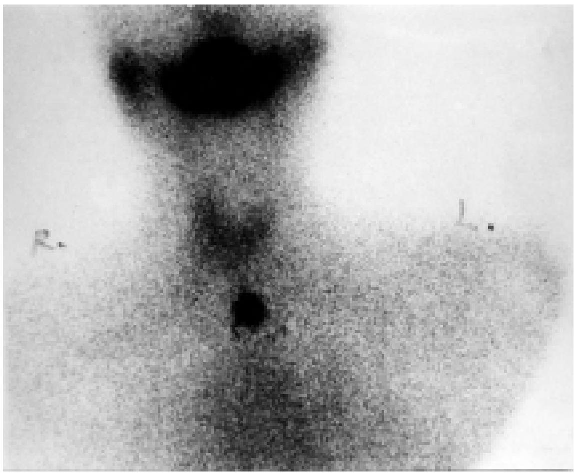

Fig. (2): Technetium-99m pertechnetate shows a cold nodule in the lower part of the left thyroid lobe.

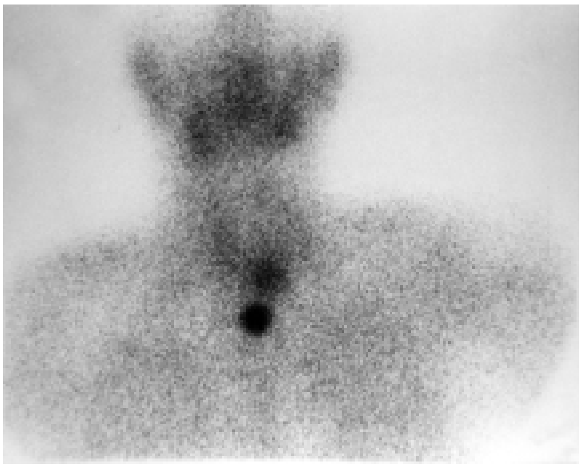

Fig. (3): Delayed ^{201}TI scan shows radiotracer accumulation in the previously described cold nodule.

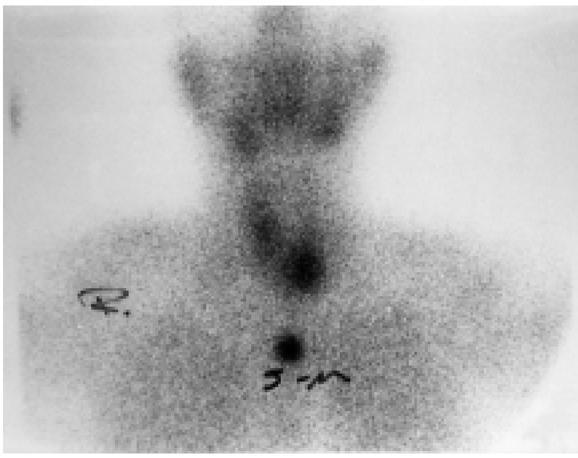

Fig. (4): Delayed ^{99m}Tc-MIBI scan shows intense uptake in the same nodule.

DISCUSSION

Various diagnostic techniques have been successfully used in the clinical management of cold thyroid nodules; however, the decision of treatment either by conservative or radical surgery is not always easy **[19]**. A detailed history and a careful physical examination are essential. Ultrasound cannot differentiate between benign and malignant nodules. Fine needle aspiration cytology has a limited value in differentiation of follicular adenoma and carcinoma **[18]**. Thallium-201 (^{201}TI) has a high affinity for diagnosis of malignant thyroid lesions **[14]**. Technetium-99m sestamibi (^{99m}Tc-MIBI) has been used in evaluation of thyroid lesions **[26]**.

In our study, there were 33 females (61%) and 21 males (39%). Also, Obradovic **[21]** showed that the presence of thyroid nodules is more frequent in women (91.3%). Similarly, Christensen et al. **[4]** proved that in patients with solitary cold nodules, 83% were females. Nineteen out of 54 patients (35%) with solitary cold nodules were proved to have differentiated thyroid cancer. This result was confirmed by the study of Diaconescu et al. **[7]**, where 25-30% of solitary cold nodules were malignant. Also, Sundram and Mack **[26]** showed that 24% of solitary cold nodules proved to have thyroid cancer. Furthermore, Okumura et al. **[23]** showed that 42% of patients with solitary cold nodules had malignant lesions. In contrast, Hung **[11]** stated that 19.9% of solitary cold nodules were malignant. Moreover, McCall et al. **[17]** showed that the incidence of carcinoma in patients with solitary cold nodules was 17%.

Based on ultrasound examination, 10 out of the 19 malignant thyroid nodules were solid (53%), 7 lesions were mixed (solid-cystic) (33%) and 2 lesions were cystic (14%). Similar data were reported by Cox et al. **[5]** using ultrasound examination of thyroid lesions and showed that 57% of solid lesions, 25% of complex lesions and 16% of cystic lesions were malignant.

In this study, 16/19 (85%) of malignant lesions and 22/35 (63%) of benign lesions were warm in early thallium-201 uptake than surrounding normal thyroid tissue. However, on early ^{99m}Tc-MIBI study, 18/19 (95%) of malignant and 20/35 (57%) of benign nodules were warm. In all patients, the malignant thyroid nodules showed higher uptake of ^{99m}Tc-MIBI and ^{201}TI in late scans than in early scans except in 2 nodules (10%) which showed lower thallium uptake in late scans. In contrast, benign thyroid nodules showed lower or normal uptake of ^{99m}Tc-MIBI and ^{201}TI in delayed than in early scans except in 6 nodules (17%) in ^{99m}Tc-MIBI study and 9 nodules (26%) in ^{201}TI study that had higher radiotracer uptake in delayed imaging which reflect false positive cases. Our findings were in agreement with those of Erdil et al. [8] who found that the malignant thyroid nodules showed higher uptake of ^{99m}Tc-MIBI and ^{201}TI especially in delayed images.

In this study, the mean L/N ratio in the early thallium study for benign lesions (1.29±0.41) was lower than that for malignant lesions (1.35±0.17) with no significant statistical difference (p = 0.133). In contrast, Erdil et al. [8] showed that the mean early L/N ratio of benign nodules (1.48±0063) was greater than that of malignant nodules (1.3±0.38). Also, Ohnishi et al. [22] showed that ER for malignant lesions was 1.38±0.27. In our study, ROC analysis showed that the threshold level for the early thallium scan was 1.23 with a sensitivity and specificity of 78.9% and 66.7%, respectively. The study of Erdil et al. [8] showed that the threshold level of 1.42 for the detection of malignancy had high sensitivity (85.7%) but low specificity (47.3%).

To improve the efficacy of ^{201}TI scintigraphy, delayed images have been used by many investigators [10,14,20]. In the present study, most of malignant lesions (90%) showed higher late than early thallium uptake; however, the main limitation is the false positive results in 26% of benign thyroid lesions which had higher tracer uptake in late ^{201}TI scans. In thallium study, there was a statistical difference in the late L/N ratio between benign (1.06±0.12) and malignant (1.74±0.31) lesions (p = 0.01). This finding was in agreement with the study of Erdil et al. [8] where the late L/N ratios on thallium scan for benign and malignant lesions were 1.11±0.33 and 1.61±0.62, respectively, with a statistically significant difference ($p < 0.01$). Using ROC analysis, the threshold level for delayed thallium study was 1.24 with a sensitivity and specificity of 80.9% and 73.6%, respectively. In our study using ROC analysis, the sensitivity and specificity of delayed ^{201}TI imaging were 84.2% and 86.7%, respectively, at the threshold level of 1.34 chosen by ROC analysis [8]. Similarly, Derebek et al. [6] demonstrated higher sensitivity (86%) and specificity (87%) for thallium-201 scintigraphy for differentiating benign from malignant thyroid nodules using early and delayed uptake ratios.

Double-phase ^{99m}Tc-MIBI scanning of the thyroid gland could be helpful in the preoperative assessment of patients with solitary cold thyroid nodules [2]. In our study, there was no statistical difference in ^{99m}Tc-MIBI scan for ER between benign and malignant nodules. Our findings are in agreement with those of Erdil et al. [8]. On the other hand, there was a significant difference in LR between benign (0.99±0.18) and malignant lesions (2.38±0.71) (p = 0.001). Similar data stated by Erdil et al. [8] showed a significant higher late MIBI uptake for malignant nodules (17.71±0.56) than for benign nodules (1.1±0.3) ($p < 0.001$).

In our study, following ROC analysis early and late threshold values of 1.31 and 1.48 for ^{99m}Tc-MIBI scan were selected. The sensitivities were 84.2% and 83.3% for ER ^{99m}Tc-MIBI, 89.5% and 90% for LR ^{99m}Tc-MIBI. A study of Erdil et al. [8] showed that the ER and LR levels for ^{99m}Tc-MIBI scan were 1.03 and 1.54, respectively. Using these values, there was a higher sensitivity (90.5%) with very low specificity (36.8%) for early scan and 61.9% and 94.7% for delayed scan.

^{99m}Tc-MIBI had a higher sensitivity and specificity as compared to ^{201}TI in detecting of the nature of thyroid nodules (p = 0.01 for sensitivity and 0.001 for specificity). The difference in sensitivity between ^{201}TI and ^{99m}Tc-MIBI may be related to the more metabolism-dependent uptake and slower release of ^{99m}Tc-MIBI from malignant thyroid nodules compared with ^{201}TI [3]. In contrast, Sundram and Mack [26] showed that the overall sensitivity of Tc-99m MIBI scan for evaluating solitary cold thyroid nodules was 79% and the specificity 80%. On the other hand, Földes et al. [9] and Kresnik et al. [15] reported that ^{99m}Tc-MIBI uptake was not specific for thyroid malignancy. Moreover, Nakahara et al. [20] found a higher delayed ratio with ^{201}TI than with ^{99m}Tc-MIBI.

In conclusion, the late ratio (LR) of ^{99m}Tc-MIBI and ^{201}TI scintigraphy is superior to early ratios (ER) in detecting malignant thyroid nodules. Also, LR of ^{99m}Tc-MIBI scan is more sensitive than that of ^{201}TI scan in differentiating benign from malignant thyroid lesions. So, proper diagnosis of solitary cold thyroid nodule using clinical findings and other investigation procedures especially quantitative ^{99m}Tc-MIBI scan before FNAC may be valuable in decision-making before surgical treatment.

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