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CORRELATION BETWEEN ULRASOUND AND RADIONUCLIDE SCAN IN THE EVALUATION OF THE CLINCALLY SOLITARY THYROID NODULE

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SUMMARY

Ninety five patients clinically through to have a solitary thyroid nodule where examined scintigraphically and ultrasonographically. Pathological results were obtained in fifty two patients and correlated with functional criteria of the radionuclide, and the morphological criteria of the ultrasound. The results indicate that both imaging methods have sensitivity in detecting the lesion; ultrasound being more sensitive. Radionuclide provides important functional but limited anatomic information in comparison to those obtained from ultrasound. Both images lack the specificity in differentiating benign from malignant lesion, which can be increased significantly if combined with fine needle aspiration cytological study, and restricted for the high risk patient regarding scintigraphic and ultrasonic criteria of the lesion. Ultrasound is safe, reliable, easily repeatable and non invasive in comparision with scintigraphy.

Chapter one

Introduction

A thyroid nodule is a common clinical finding. The frequency of palpable nodules in clinical studies varies from 4% to 7 % and increase with age.[1]

There is a striking difference in the frequency of the thyroid nodules found clinicaly and at autopsy.

Today, the main indication for radionuclide scanning remains the evaluation of the clinically palpable thyroid nodules. The ability of the scanning to detecte such nodules (sensitivity) has been quite satisfactory: it is success in differenting between being from malignant disease however is less impressive; a hot nodule is considered virtually benign. A cold lesion on the other hand is more often encountered and has an incidence of carcinoma at 4 – 34 %.[2]

Ultrasonography has become an important asset in the evaluation of thyroid disease, when performed with a high – frequency transducer: it is highly sensitive in enabling the detection of even minute nodules, and differentiation cystic from solid lesions in over 90% of cases.[3]

Ultrasound evaluation of the thyroid nodules

The role of ultrasound is to detect and characterize thyroid nodule. It's size and location can be accurately assessed for initial evaluation and for follow up study. Masses as small as 3 mm can be demonstrated, and differentiation of cystic versus solid nodules is easily made by ultrasound.[11]

Solitary nodule

1- Cystic

True cyst is extremely rare; it shows the ultrasonic criteria of a benign cystic process (smooth posterior wall and increased sound transmission) its wall may be irregular and may contain internal echoes from hemorrhage.

Thyroid cyst may arise from degeneration of benign solid lesion of thyroid, appear with a thick wall and septation (complicated cyst). Incidence of malignancy in thyroid cyst about 1 %.

2- Mixed nodule

A nodule contain both cystic and solid element, there is quite a spectrum of such lesions, ranging from those that are nearly cystic to those that are nearly solid. The solid elements of these masses are usually less echogenic than the adjacent thyroid tissue but may be isoechoic or hyperechoic and may have a well defined boundering separating them from the adjacent thyroid tissue (halo or capsule), mostly due to haemorrhage or cystic change in a colloid nodule and adenoma, occasionally due to necrosis in carcinoma.[9,6]

3- Solid masses

Focal solid lesions apper to be well demarcated from the surrounding tissue by a capsule, the demonstration of which increase the likelihood that the lesion is benign. The solid lesion may range widely from total homogenicity to a very heterogeneous echo production. The strength of the echoes within a solid nodule may be an important clue to its nature, if the echoes are greater than or equal in echogenicity to those in the normal gland, the probability of that lesion is benign increases. Echoes within cancer are almost always reduced in strength relative to those in the normal gland. Solid lesions may due to colloid nodule, haematoma, adenoma, carcinoma, focal thyroiditis, metastasis and lymphoma.[9,7,8]

4- Lymph nodes

Enlarged lymph nodes occur quite commonly in the neck and can be difficult to distinguish clinically from the thyroid gland, sonographically they are of homogenous, but less echogenic than normal thyroid texture, lies lateral to the major vessels, mostly are benign and have an echogenic center. The presence of enlarged lymph nodes togather with a thyroid nodule is a good indication for malignancy.[12,13]

5- Poorly defined masses

Most of which due to thyroiditis, some type of adenoma or non specific goiter.

Some malignant tumors of thyroid (particularly medullary carcinoma) have had this appearance.[14,9]

6- Adenoma

It's the most common thyroid mass, typical sonographic appearances are:- a halo surroudinding echogenic mass denser than the remainder of the gland, a solid homogeneous mass with very few internal echo that can easily be confused with a cyst, and a densely echogenic lesion, egg – shell calcification may be seen.[15]

Evaluation of thyroid nodules by radionuclide scaning

Radionuclide scanning of the thyroid gland using ^{99m} Tc is the most important initial investigation, the purpose of which is to assess whether the palpable nodule(s) functioning or non functioning and whether there are any other nodules in the thyroid gland.[12]

There are three main results of the scan used in reference to the radionuclide scan.

a- Cold nodules

A cold nodule is defined as a palpable nodule which shows either no uptake of radionuclide or less uptake than the surrounding thyroid tissue, these lesions either solitary or multiple.

Solitary cold nodules

A nodule may appear in any portion of the thyroid gland. Occasionally a nodule within the gland may be clearly defined on scan but not palpable. However, due to the frequency of variations in anatomic configuration, it is often difficult to detect peripheral cold nodules on scan findings alone.[19] The significant differential diagnosis of cold nodules is as follows.

a- Adenoma

Which either cystic (also referred to as colloid cyst) or solid.

b- Carcinoma

About 75% of all solitary cold nodules prove histologically to be either cystic or solid thyroid adenomas. The incidence of thyroid carcinoma in such cold nodules is about 20%.[20] Uncommon entities of solitary cold nodules are ; focal thyroiditis, infection(abscess), hemorrhage (frequently in adenoma), lymph node, Hodgkin's disease, metastasis, parathyroid adenoma.[19,20]

Histologically, the glands of patient with typical multinodular goiter may contain tissue resembling cancer. Multiple cold nodules may also be seen occasionally in patients having multifocal thyroiditis. A significant proportion of patients who are thought to have a solitary nodule on palpation are shown to have a multinodular goiter on scanning.

B- Neutral nodules

These are palpable nodules which on scan show uptake approximately equal to adjacent thyroid tissue. The differential diagnosis include

1- Adenoma

a- Functioning, non autonomous

b- Functioning, autonomous

2- Anatomic variant

3- Carcinoma (unusual)

Determination of autonomy from thyroid stimulating hormone (TSH) control may be easily accomplished by scanning following TSH suppression. nodules containing carcinoma may also take-up radionuclide.[21]

c- Hot nodules

A hot nodule is classically defined as a nodule with radionuclide uptake greater than the surrounding thyroid tissue. Differential diagnosis of such lesions includes:-

1- Autonomous thyroid tissue

a- Non toxic b- Toxic

2- Anatomic variant

3- Hyperfunctioning normal thyroid tissue (history of thyroiditis, radiation, surgery, or other result).

Scanning following the administration of exogenous TSH can distinguish autonomous nodules from the normal tissue.[22,16]

- **Role of radionuclide scan in diagnosis of thyroid carcinoma;**

While the radionuclide scan does not give absolute criteria to establish or exclude the diagnosis of thyroid cancer, it does have a very useful role in determining the probability that any specific lesion is a cancer. Its value is based on the fact that most malignant neoplasms accumulate little or no radioiodine and appear as non functioning (cold) or hypofunctioning (warm).[23,20]

Aim of Study

The aim is to study the correlation between the ultrasound and radionuclide scanning in assessment of thyroid nodule and to correlate the results to those of other studies regarding the same subject.

Chapter Two

Patients and methods

The study was carried out in the department of radiology, ultrasound units and nuclear medicine (N.M) department at Baghdad Medical city in one year period.

Total number of 95 patients; 78 females, 17 males, their ages ranged between 16 – 65 years, who where found to have a solitary thyroid nodule by palpation, were referred to the (N.M) department for the evaluation of thyroid function and for thyroid scanning.

Chapter three

RESULTS

Total number of (95) patients were presented clinically with solitary nodule, examined with radionuclide scan and ultrasound.

Table I shows the correlation of both techniques with the clinical finding. Radionuclide scanning demonstrated that(56 patients = 58%) of the total have more than one lesion. While ultrasound demonstrated that (66 patients= 69%) of the total have more than lesion, with (2 patients =2.1%) are normal. The difference in the number of detected lesion in both techniques were in (10) patients. The radionuclide scan results demonstrated that (82 patients = 86.3%) with a cold lesion, (56 patients= 58.9%) of them have multiple nodules, and (26 patients = 27.3%) have solitary nodule, (3 patients = 3.1%) found to be with a neutral lesion, (10) patients have hot lesions Table II.

The pathological examination with(F.N.A.) cytology were done to (52) patients. The total (52) patients have cold lesion and the correlation with the pathological results shown in Table III. (50 patients = 96.1%) of them shown to have a benign lesions. (2 patients = 3.5%) of them shown to have malignant lesions.

Correlation of the histopathological results by (FNA) of the total (52) patients, with the echo patterns of the lesions were summarized in Table IV. analysis of these results demonstrate that (5) patients have cystic lesion all of them are benign, 16 patients with a mixed nodule (93%) of them are benign and (6.2%) are malignant. 31 patients are found to have a solid lesions of different echogenicity, (5) patients of them found to have solid hypoechoic lesions, (4 patients=80%) of which are benign; (1 case = 20%) is malignant.

Halo sign seen in 16% of benign lesion. Calcifications are seen in 6% of the benign lesions. Lymphadenopathy noted with 50% of malignant lesions and associated with 2% of benign lesions.

The differences in rate of detection the lesions in both imaging techniques, regarding the size of the lesion seen in the Table v.(3) of (27) of the lesions detected in ultrasonography are of less than 5mm size. While the smallest size of lesion detected in radionuclide study is 8 – 10 mm.

Table VI is showing the anatomical distribution of the lesion in both radionuclide scanning and ultrasound, right sided predominancy of the lesion seen in both techniques.

Table I: Correlation between clinical, US, radionuclide scan in detection of thyroid nodule in 95 patients.
(2) are normal excluded.

	Solitary No. %	Multiple No. %	Normal No. %
Clinical	95 100	0 0	56 58
Radionuclide	39 41	56 58	
US	27 28	66 69	2 2.1

Table II: Results of radionuclide scan of 95 patients.

Appearance	Total No. %	Solitary No. %	Multiple No. %
Cold	82 86.3	26 27.3	56 58.9
Hot	10 10.5	10 10.5	0 0
Neutral	3 3.1	3 3.1	0 0

Table I: Results of pathology(FNA) in Correlation to radionuclide scanng findings in 52 patients.

	Total	Benign No. %	Malignant No. %
Cold	52	50 96.5	2 3.5

Resut of cold nodule in FNA

Table ıv: Correlation between pathologic results obtained by (FNA) and ultrasonic criteria of the lesions in 52 patients.

Ultrasonic criteria	No.	Benign No.	%	%Total benign Cases(50)	Malignant No.	%	%Total malignant2
Cystic	5	5	100	10	0	0	0
Mixed nodule	16	15	93	30	1	6.2	50
Solid hyperechoic	18	18	100	36	0	0	0
Solid hypoechoic	5	4	80	8	1	20	50
Solid isoechoic	8	8	100	16	0	0	0
Halo sign	8	8	100	16	0	0	0
Well defined	30	30	100	60	0	0	0
ıı defined	22	21	95	42	1	4.5	50
Lymph node	2	1	50	2	1	50	50
Calcification	3	3	100	6	0	0	0

Table v: Correlation between US and radionuclide scan in relation to the size of lesion detected in 27 patients.

	Size of smallest lesion detected	No. of patients	% of Total 27
US	< 5mm	3	11
Radionuclide scan	8 – 10 mm	16	59

Table vı: Correlation between US and radionuclide scan in relation to the anatomical distribution of the lesion in 95 patients.

Site of the lesion	Radionuclide No.	%	US No.	%
Right lobe only	43	46.2	41	44.5
Left lobe only	28	30.4	26	28.2
Both lobes	20	21.7	23	25
Isthmus	1	1	2	2.1

Disagreement seen in 5 cases (5.4%)

Chapter four
DISCUSSION

The radionuclide studies have been for many years the most common used imaging method in the evaluation of nodular abnormalities of the thyroid gland. The role of the ultrasound in the diagnosis of the thyroid nodules is becoming increasingly important, mainly because of the excellent resolution of new equipments.

The criteria for correlation between ultrasound and radionuclide scan in evaluation of the thyroid nodule include the following.

4.1. Detection of the lesion

In this study 58% of the patient thought clinically to have a solitary nodule were detected to have more than one lesion (multiple) by radionuclide scanning. On the other hand 69% of those patients were found to have more than lesions in ultrasonographic study. This indicates that both images are more sensitive, than the physical examination in detection small thyroid lesion. In study of Christensen and Tibllin, the sensitivity of the clinical examination in detection of a nodule was 38%.[1]

Ten patients (9.5%) detected only in ultrasonic examination to have multiple lesions, as the ultrasound has more anatomical rewsolution to detect small lesion. A scintigraphically hypofunctioning or isofunctioning nodule may actually be non functioning. In contrary to ultrasound, scintigraphy is informative of the functionaly of the nodule.

The significance of detection of multinodularity decrease the probability of cold nodule being malignant from 15 – 25 % to 1 – 6%.[25] Approximately 20 – 25% of the lesions thought to be a solitary on radionuclide study were found to be multinodular on ultrasound[6]; (in agreement with our study).

4.2.Diagnostic criteria of the lesions

4.2.1 Radionuclide activity and ultrasonic echogenicity

In 86.3% of the patients, the radionuclide study revealed that the lesions are cold (non functioning) and 10.5% are hot (hyperfunctioning), about 3.5% of the cold nodule on fine needle aspiration (FNA) found to be a malignant. The hot nodules were not included in the pathological study, as a hot nodule is considered virtually benign.[26]

Correlation of echo patterns with pathological diagnosis demonstrated in tale ıv. out of (52) patients with (FNA) cytology (2 patients = 4%) have malignant lesions, (50patients = 96%) have benign lesions. Useful information can be obtained from analysis of relation of various ultrasonic feature to the correlated pathological results, 50% of the detected malignant lesion found to have more than one of the known echogenic criteria of malignancy (solidhypoechoic, mixed echogenicity, ill defined margine…etc). on the other hand most of the benign lesions are demonstrated with a benign echogenic criteria (100% with cystic consistency, hyperechogenicity or halo sign). In general, malignant lesion was found in 50% of lesions with a known echogenic malignant criteria. In comparison to 3.5% of the radionuclide malignant characteristic. Most

malignancy were found among hypoechoic nodule (63%).[6]

4.2.2. Size and volume of the lesions

Regarding the size of the lesions, in 27 patients we correlated between the two images. The smallest size of lesion demonstrated on ultrasound was about 5mm in dimension, in 11% of the patients. The smallest size we measured on scientigraphy was about 8 – 10 mm in size, in 59% of the patients.

This incompatibility between the two images due to the high sensitivity of the US and probably because of the usual irregularity of the outline of the lesion, and the overlapping of the low actively lesion with the normal actively tissue in some lesions in scintigraphy. The easier and most accurate measurements in ultrasound are that for the cystic lesion.

Sonography can reliably demonstrate lesions as small as 2 – 3 mm in diameter, where as the resolution of radionuclide imagning for lesions smaller than 1 cm is suboptimal.[27,20]

Measuring the depth of the nodule is performed well by ultrsonography.[28]

As the scintigraphy is a two dimensional representation of the spatial distribution of the radionuclide, in the gland and by adding the third dimension by means of US, it leads to a better functional and morphological classification of nodules by combining both techniques.[16]

Measuring the size of nodules repeatedly in patients left untreated is of great importance as growth of hypofunctioning noncystic nodule is an absolute indication for operation, besides the usefulness of documenting the size of nodules in patients receiving suppressive therapy.[20-16]

However the dimensions of the abnormalities detected by US have not shown any relation to the final pathologic diagnosis, as small papillary carcinoma may be identified by US because of associated large cervical adenopathies.

4.2.3. Consistency and other anatomical morphology

The most important contribution of ultasonography to clinical thyroidology lies in differentiating between solid and cystic solitary hypofunctioning nodules, which is of practical importance because completely cystic nodules only very rarely harbor malignancy. In this study the malignant lesions. On the other hand, the cystic lesions are 100% benign.

L.G Thi JS; J.D Weiner in thrie study found malignancy in 10% of the partially cystic and 23% of the solid nodules[16], combination with the scintigraphy is always necessary to compare the size of the hypofunctioning area with the size of the cystic part on US.

Concerning the anatomical distribution of the lesions as shown in table vı, disagreement in (5 patients = 5.4%) regarding the site of the lesion. Which indicates that sonography is more sensitive than radionuclide scan in determination of the exact location of the thyroid nodules (uni-or multifocal). This can be of considerable assistance for therapeutic decisions, especially when not all lesions are clinically palpable.

Sonography can separate intra from extra thyroidal abnormalities, such as lymphadenopathy, in these patients, sonography will demonstrate occult small neoplasm, usually papillary or mixed papillary and follicular tumor.[29,20-16]

Sonography can reliably separate individuals with thyroid hemiagenesis from unilateral non functioning thyroid lobe. In both cases radionuclide scan will demonstrate only one thyroid lobe.[20]

CONCOLUSION

A thyroid nodule is a common clinical finding more common in womaen than men.

Most of the nodules are scintigraphically cold and on ultrasound hypoechoic and pathologically bengin.

Both imaging modalitiies are more sensitive than palpation alone in detection of thyroid nodules,ultrasound being more sensitive, easies and free of contraindications.

The advantage of radionuclide scanning lie in the very likelihood that a hot nodule is invariably benign.

The primary use of ultrasound in thyroid nodule assessment is in its detection and the demonstration of its anatomical morphology. Neither the functional characteristics of the radionuclide image, nor the morphologic features of the ultrasound are able to differentiaate benign from malignant nodules with enough reliability in order to prefer one over the other. Therefore the use of cold theroid nodule with echogenic criteria of malignancy increase the preoperative specific diagnosis of such lesions significantly. In additionto that, the ultrasound is simple, non invasive, more availble and free of radiation hazard in comparison with radionuclide scanning, it can be helpful in cases in which scintigraph is not available, of inconclusive results, or is contraindicated (as in pregnancy)

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