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The value of color Doppler imaging in the diagnosis of thyroid masses

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Abstract
The u /s examination was used early as 1955 to outline the thyroid gland abnormality, size of the gland, its consistency, if there is any nodular abnormality and its nature (solid or cystic) and to detect the occult malignancy and its recurrence. In our study the u/s with color Doppler technique is used in (94) patients with different thyroid lesions during the period of (12) months, pathological proof were obtained in (80) cases. According to our CD study the patterns of vascularity of the lesions are classified into four types, where it shows 87.5%, 94%, 63.6%, 98.6% sensitivity, specificity, PPV and NPV, respectively, for detection of malignancy. So it has been found that the conventional u/s in conjunction with CDI is considered as useful primary investigation tool in diffrential diagnosis of thyroid masses, being non invasive, simple, safe and time saving.

Keywords: CDI, PPV, NPV

Introduction
Ultrasonography is very sensitive in determining even subtle morphology changes [1]. The high frequency transducers currently provide both deep ultrasonic penetration up to (5 cm) and high definition images. The thyroid gland is one of the most vascular organs of the body as a result Doppler examination provides a useful diagnostic information in some thyroid diseases. To avoid the extensive use of fine needle biopsy or even unnecessary surgery, it would be useful to limit the number of patients submitted to invasive diagnostic procedures with the aid of non invasive easily applicable method by the use of color coded duplex u/s which permits the simultaneous real time display of soft tissue and blood flow and it is considered as a reliable method to detect solitary hot and hyperfused thyroid nodules.

Methods and Material
The study was carried out for (94) patients with different thyroid lesions, of those (72) were females, (22) males with the age ranging between (15 - 72) years. Data collections regarding the clinical presentation and the physical examination, results of other investigations if available (x-ray of the neck or chest, laboratory investigations: T_1, T_2 and TSH, radioactive isotope scanning). No specific preparation was needed, u/s with CDI was carried out using the available, Siemens, high resolution real time u/s machine, utilizing 7.5 MHz linear array probe. The patients were examined in the supine position with neck in slightly hyper extended position, the thyroid gland was examined in transverse and longitudinal sections. After detecting and delineating a thyroid mass, color flow box was applied exactly on the mass, moving the box by the track ball so that the mass being mostly within the field of color display. The sonographic features then described as well as of CDI: the size of the gland, size of the mass and its number, its echogenicity (isoechoeic, hypo or hyper echoeic) if there is cystic changes whether it has internal echo pattern. The outline of the mass (well defined or ill defined, with or without halo sign), any evidence of calcification within the gland, any mass effect on the adjacent structures (trachea and great vessels), any cervical lymphadenopathy. For CDI we recorded (vascularity of the whole gland, vascularity of the mass whether avascular, peripheral or central vascularity within the mass or both).Then thesongraphic diagnoses was compared with the result from cytological examination after FNA or postoperative histological examination.

Results
The total number of (94) patients were performed with various types of the thyroid lesions and were examined by u/s with CDI and the results of histopathological examination were obtained for (80) patients only, representing (85%) of the total number so only those patients were included in the statistical study. According to the CDI, the lesions were classified into four types of vascular patterns where:

Type 1: Complete absence of flow signal within the nodule, it was seen in (29) cases (36.05%) of all cases.

Type 2: Exclusive perinodular arterial flow signals, it was shown in (34) cases (42.5%).

Type 3: Intra nodular flow with multiple vascular poles with or without significant perinodular flow, it was shown in (11) cases representing (13.8%).

Type 4: Diffuse vascular where seen in (6) cases representing (7.5%).
Table (1) show the relative frequency of the vascular pattern studied by the CDI regarding the pathological diagnosed thyroid lesions.

Table 1: The relative frequency of four types of vascular patterns by pathological diagnosis of thyroid lesions.

Pathological diagnosis	Type 1		Type 2		Type 3		Type 4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
MNG	20	0.0	27	55.1	2	4.1	0.0	0.0	49	100
Malignancy	1	0.0	0	0.0	7	87.5	0.0	0.0	8	100
Solitary cystic	5	0.0	3	37.5	0	0.0	0.0	0.0	8	100
Folicullar adenoma	0	0.0	4	66.7	2	33.3	0.0	0.0	6	100
Diffuse toxic goiter	0	0.0	0	0.0	0	0.0	0.0	0.0	6	100
Solitry colloid	3	0.0	0	0.0	0	0.0	6.0	0.0	3	100
Total	29	36.05	34	42.5	11	13.8	6	7.5	80	100

Histopathological examination was done after surgical procedure for (56) cases, FNA cytology for (22) patients and only (2) patients had biopsies. The observed overall accuracy of clinical classification was (48%) only, where the difference between the clinical and u/s classification was statically significant as the great difference between them was in diffuse goiter as (34) cases of clinically diffuse enlargement of the thyroid gland on (27) cases were MNG by u/s ,in (4) cases were diffuse, and (3) cases showed solitary nodules. While high agreement between the clinical and u/s examination where in MNG as the accuracy of the clinical classification was (88.9%). Table (2) and (3) show there was the statically significant difference between the benign and malignant MNG and solitary nodular cases in the presence of type (3) vascularity which is regarded as a sign of malignancy, where the sensitivity, specificity, PPV and NPV of type (2) vascularity in the diagnosis of malignancy in MNG cases were (100%), (95.5%), (60%) and (100%) respectively while for solitary nodular cases they were (75%), (88.2%), (60%) and (93%) respectively.

Table 2: The validity parameter of CD u/s features of malignancy (type (3) vascularity pattern) in patients with MNG.

Color Doppler	Histopathology		Total
	(+)VE (malignancy)/ (-)VE (benign)		
(+) VE (type 2)	3	2	5
(-) VE (type 2)	0	47	47
Total	3	49	52

Table 3: The validity parameters of CD u/s features of malignancy (type (3) vascularity pattern in patients with solitary nodule.

Color Doppler	Histopathology		Total
	(+)VE (malignancy)/ (-)VE (benign)		
(+) VE (type 3)	3	2	5
(-) VE (type 3)	1	15	16
Total	4	17	21

Discussion

The high sensitivity of the u/s was clearly seen in this study for the proper diagnosis of multinodular of clinically appearant diffuse or single nodule. Although nodular thyroid is common thyroid carcinoma is rare an accounts for less than 1% of all malignant neoplasms. So the majority of thyroid nodules are benign and the clinical challenge is to distinguish those few clinically significant cases and to identify those patients for home surgical excision is indicated. The nodular thyroid disease is more common with the multinodularity being more common than solitary. In this study (49) cases (94.23%) of MNG were benign and (3) cases (5.77%) were malignant, coarse calcifications was demonstrated in (2) cases, these findings were in agreement with Lagalla *et al* (1998) [4] and Ahuja and Metreweli (2000) [3] indicating benignity of the lesions. Of total (8) cases of malignancy (7) of them (87.5%) demonstrated type (3) pattern only (1) case (12.5%) shows type (1) pattern (avascular) and it was a follicular cell carcinoma and was considered as benign depending on CDI study.The malignant cases will MNG representing (37.5%) of total malignancy, one with papillary cell carcinoma, the other as Hodgkin's lymphoma, the 3rd case was follicular cell carcinoma. The case of Hodgkin's lymphoma of thyroid gland the conventional u/s showed multinodular hypo and isoechoeic nodules with thick and incomplete halo sign, CDI demonstrated highly intranodular vascularity (type 3) pattern figure (1) on the nodules, but because of multinodularity and longstanding condition and depending on other studies Ahuja (2000) [3] who stated that the case of lymphoma are usually hypovascular, so in this case study it was falsely diagnosed as a benign lesions. In this study the sensitivity of CDI in detecting malignant cases among the MNG was (100%) while specificity was (95.9%). Regarding the solitary thyroid nodules they were (21) cases of the total study sample, (8) cases are cystic either hemorrhagic or degenerative colloid nodule or follicular adenoma, although Ahuja and Metreweli (2000)[3] stated that (20_30%) of papillary cell carcinoma may be cystic. Actually all cystic thyroid lesions demonstrated some wall irregularity and internal degenerative or hemorrhage (more dense fluid present clinically as rapid growing nodule and often tender). From the (8) cystic lesions detected in this study (3) were colloid degenerative cyst, (5) cases were hemorrhagic cyst and all pathologically proved. Doppler study among the cystic lesions (5) of them were a vascular (type 1) and (type 3) shows scanty peripheral vascularity (type 2) and this agreement with the findings of Lagalla *et al* (1993) [4] and Ahuja *et al* (1996) [3]. For the solid nodules, the fundamental problem is to determine if it is benign or malignant, it is generally recognized that FNA cytology is the most effective method for diagnosis in addiction to radio nuclide scanning and sonography where the nodules are either hypo or hyperechoeic. In our study the total (7) solitary solid nodules were hypoechoeic (5) of them demonstrated (type 3) pattern (figure 1), (4) of them were proved to be malignant with other conventional u/s (illdefined, lake of halo sign, fixed during swallowing) and the other one was a case of hyper functioning follicular adenoma, the remaining (2) cases of solitary hypoechoeic nodules, (1) case was with pattern (1) vascularity proved to be malignant (follicular cell carcinoma) & it was falsely diagnosed as benign, while the other case with (type 2) vascularity and it was a case of follicular cell adenoma (figure 2). The other (3) isoechoeic nodules demonstrated (type 1) and (type 2) pattern while the hyperechoeic nodules were (2) cases showed type (1) pattern, all proved to be benign, all these in agreement with Solbiati *et al* [8], the pathological diagnosis of these hyperechoeic nodules was colloid nodules. The perinodular

hypoechoeic halo sign which was thin and complete is seen in (7) cases of the solid solitary nodules, all were benign and this is in agreement with finding of other workers [2,9] while it could also be seen in 15% of the malignant nodules where the hypothesis that it represent the compressed normal thyroid parenchyma especially for rapidly growing thyroid cancers where this halo sign is thick > 2mm, irregular and incomplete. In this study this halo sign either avascular or hypovascular which is strongly suggestive of benign nodules represent blood vessels coursing around the periphery of the lesions. The other abnormality detected in this study was L.N adenopathy and this was seen in (2) cases which were proved to be malignant, of them was a case of recurrence of papillary cell carcinoma in a female aged (33) years with cervical lymphadenopathy and the thyroid gland was normal by gray scale u/s but the CDI study showed increase vascularity of the thyroid gland beside the enlarged homogenously hyperechoeic L.N. along the internal jugular vein, CDI demonstrated the capsular and hilar vascularity, this was in agreement with other studies [3, 5] . It has been reported that the combination of microcalcifications and intranodular flow signals can improve the sensitivity (85.3%) specificity (100%) and diagnostic accuracy (94.6%) in the differentiation between benign and malignant thyroid lesions. Regarding diffuse thyroid enlargement in this study and it was found in (6) cases, where u/s demonstrate diffused enlargement of thyroid lobes and the isthmus, hypoechocic in texture, CDI showed multiple small areas of intrathyroidal flow, these in agreement with the findings of other workers (Thyroid infero pattern) [11] and it is useful for evaluation of therapeutic efficiency. So the u/s with CDI offers one possible method that can help to reduce the number of unnecessary biopsies or surgery, besides it shows the encasement or by thrombosis of the adjacent vessels is highly suggestive of malignancy. The other study Spiezia *et al.* [12] stated the use of gelatos based u/s contrast agent (Levovist) followed by the CD or power Doppler evaluation provide useful and complementary information to differentiate benign malignant thyroid masses.

Conclusion

CDI provided additional advantages on the gray scale real time u/s for thyroid gland lesions :

1. More detailed analysis of the vascularity of the solid nodules so raises the possibility of malignancy even in MNG with the sensitivity (100%), specificity (95.9%), PPV (60%) while NPP (100%), while the values for solitary nodules were (75%), (88.2%), (60%) and (93%), respectively.
2. The autonomous changes in the MNG can be very accurately diagnosed as has been found in (4) cases of the total number.
3. Early detection of recurrence of thyroid tumor even the occult type, also for differentiation of metastatic lymphadenopathy of papillary cell carcinoma from the other head and neck malignancy.

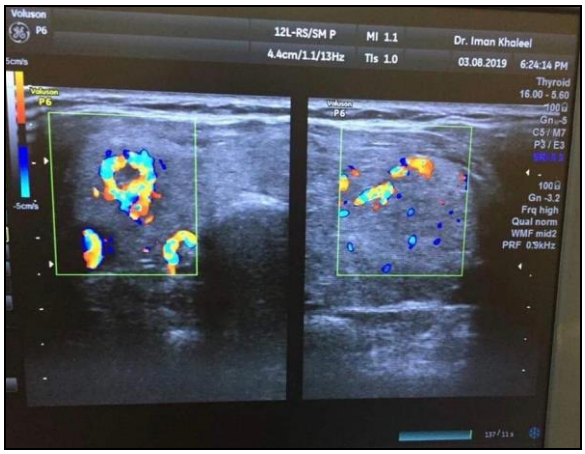

Fig 1: The case of Hodgkin's lymphoma of thyroid gland the conventional u/s showed multinodular hypo and isoechoeic nodules with thick and incomplete halo sign, CDI demonstrated highly intranodular vascularity (type 3) pattern**.**

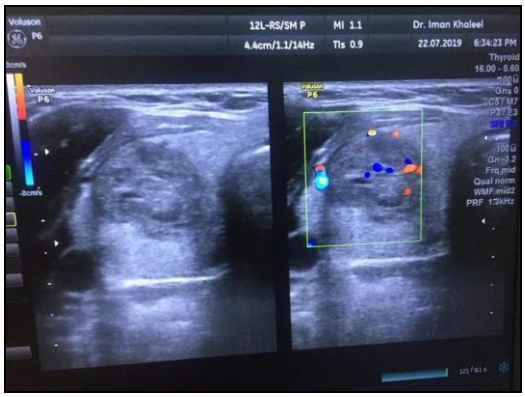

Fig 2: a solitary hypoechoeic nodule with type (2) vascularity proved to be a benign follicular cell adenoma.

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