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Original Article

Morphological Evaluation of Thyroid Nodules on Ultrasound

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ABSTRACT: OBJECTIVE: To evaluate different morphological appearances of thyroid nodules by using high frequency 7.5 MHz ultrasound along with Doppler ultrasound to provide criteria to characterize the nodule as benign or malignant. STUDY DESIGN: Non-interventional, descriptive study. SETTING: Department of ENT and Radiology, Dow University of Health Sciences and Civil Hospital, Karachi. DURATION: January 2011 to June 2012. PATIENTS AND METHODS: All adult patients who underwent ultrasound imaging either with palpable or non palpable thyroid nodules, were included in the study. Cases of any gender, aged between 20 – 65 years, having symptoms of goiter with or without palpable lump or nodule, pain or abnormal thyroid profile were included in the study. Biopsy proven and treated cases for thyroid diseases were excluded from the study. Main outcome measures were, presence of the abnormal clinical, laboratory and ultrasonic findings. Sonographic findings that are suggestive of potential malignancy are, size, shape (taller than wider), hypoechogenecity, microcalcfication, irregular or lobulated margins, presence of septae, and solid nodule. If any one of the above criteria was present it was considered as positive case for malignancy. In all such cases cytology and post operative histopathology were advised. Statistical analysis was done for descriptive purpose. Overall sensitivity, specificity, positive and negative predictive values of thyroid nodules, frequency and percentage analysis were carried out. RESULTS: Total of 85 patients were included in the study out of which, 56 (65%) were female and 29 (34.2%) were male. Palpable lump was observed in 70 (82%) patients, while other 08 (9.4%) had non palpable symptomatic lumps. In 07 (8.2%) patients, thyroid nodules were discovered incidentally on ultrasound neck for non thyroid ultrasonic examinations. Typical single solid nodules were observed in 35 (41%) patients, and 20 (23%) patients were with typical single cystic nodules. Multiple benign solid nodules were noted in 28 (21.1%) patients and in 02(2.35%) cases diffuse goiter was observed. Potential malignant features of shape and marginal irregularity, microcalcification, hetreogenicity and type I and II abnormal flow were observed in 10 (11.7%) patients, while 20 (23%) patients had typical sonological features of malignancy, i.e., taller than wider, irregular, heterogenecity, mural solid nodules with abnormal vascularity of type III and IV. All thyroid nodules (n=85) were further assessed by cytology or post-operative histopathology. Out of 30 potentially malignant cases, 24 were true positive for malignant cells, and 06 were false positive. Out of 55 potentially non-malignant cases, 52 cases were true negative, and 03 cases were false negative. Overall Ultrasound sensitivity of morphological characteristics is estimated to be 88.8% (24/30) and specificity to be 89.6% (52/55). Negative predictive value is calculated as 94.3% (52/55) and positive predictive value of 80.6 % (24/30). CONCLUSION: This study reflects that high frequency ultrasound is the alternative non-invasive modality to recognize benign and malignant features of thyroid nodules by their size, shape, margins, calcifications, solid mural nodules, septae and abnormal vascularity. Morphological characterization of thyroid nodule on ultrasound substantially reduce the number of unnecessary biopsies.
Key Words: Goiter, Doppler ultrasound, Histopathology, Neck lump, Thyroid nodule, Sonography.

INTRODUCTION: A thyroid nodule is an abnormal growth or lump in the thyroid gland. These growths can be benign or malignant. Fluid filled cyst or solid masses presenting as single nodule or multiple nodules. High frequency ultrasound scanning is the imaging modality of choice for thyroid masses. It is possible to detect thyroid nodules, especially those which are not palpable or difficult to diagnose clinically and are discovered incidentally on neck ultrasound. Thyroid ultrasonography may be used to differentiate benign from malignant nodule on the basis of certain characteristics features on ultrasonography[1,2]. Thyroid diseases are quite common, especially in those areas where iodine deficiency is present. The reported frequency of malignancy in thyroid nodules is 5%. It is important to diagnose it early, as thyroid cancers progress slowly. With early diagnosis and treatment, prognosis is much better with high survival rate[3,4]. With advancement and modification of ultrasound technology, rate of detection of thyroid nodules is increased[5,6]. Different studies were carried out since late 90's to assess the relationship of different features of thyroid nodules and potential malignancy[7,8]. American and European Thyroid Society of Radiologists have suggested different guidelines to mork benign or malignant thyroid nodules. These guidelines for thyroid nodule are still confusing[3,9]. Few authors believe in

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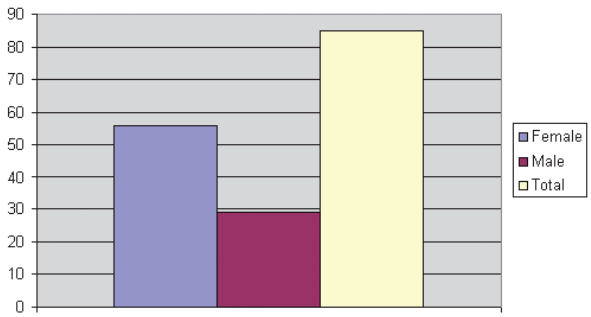
specific morphological pattern rather than individual or single feature to differentiate benign or malignant thyroid nodules[10, 11]. Ultrasound features indicative of malignancy are the presence of predominantly solid mass, hypoechogenecity, micro calcifications, abnormal vascularity, irregular margins and internal septations[12-4]. Some investigators prefer combination of features rather than single feature[11-2]. Although combination of features and overlaps of findings between benign and malignant are also found in some studies[6,15]. Sensitivity and specificity of ultrasound findings of thyroid nodule are also variable. In present study, we determined different morphological features of thyroid nodules on high frequency ultrasound by shape, size, margins, and numbers of nodules, presence of septae, hypoechogenecity, calcifications and abnormal vascularity. By combination of these ultrasonic features we can differentiate benign from malignant thyroid masses and recommend FNAC or biopsy in potentially malignant nodules only. This can reduce the number of unnecessary biopsies.

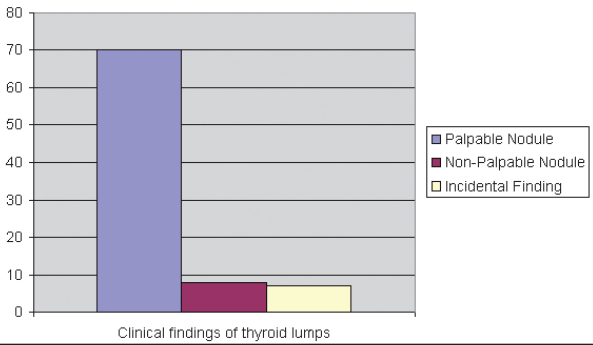
PATIENTS AND METHODS: This non-interventional, descriptive study was carried out at departments of ENT and Radiology of Dow University of Health Sciences and Civil Hospital Karachi between January 2011 to June 2012. All adult patients of any gender between the age of 20-65 years with the complains of neck lump and / or Thyroid related swelling with or with out palpable nodules with abnormal thyroid profile referred from department of ENT or General Surgery to radiology for ultrasound neck, were included in the study. Biopsy proven thyroid lesion and treated cases for thyroid diseases were excluded from the study. Ultrasound of thyroid was carried out by high frequency 7.5 - 12 MHz Zario Toshiba machine with linear array transducer and Doppler study was performed with gray scale B mode. Ultrasound examination of neck was carried out after taking detailed clinical history, informed consent and giving brief description of the examination. It was carried out by experienced sonologist adopting departmental scanning protocol. Transverse and longitudinal real time imaging of thyroid gland were performed. Ultrasound appearances of thyroid nodule was observed for size, shape, margins, hypoechogenecity, numbers, internal architecture i-e septae, solid nodule, calcification. Assessment of vascularity of each thyroid nodule was carried out by color Doppler ultrasound. These were ranked from 0-4 as follows; Type- 0-no visible flow Type-I as peripheral flow only, Type-II as predominantly peripheral with some central flow, Type-III as extensive internal flow with peripheral flow, Type-IV as central flow only, On the basis of above findings thyroid nodules were potentially classified as positive or negative. If one or more features were suggestive of malignancy, the nodules were classified as positive. If a nodule had no suspicious features, it was classified as negative (benign). Statistical analysis was performed for mean age, sex preponderance of nodule, frequency of different appearances of thyroid nodules, its vascularity, ultrasonic features of potentially malignant thyroid nodules, FNAC or post-operative biopsy. Positive predictive and negative predictive values of thyroid nodules, frequency and percentage analysis of benign & malignant findings were carried out. Sensitivity, specificity, Positive and Negative predictive values, and accuracy were calculated.

RESULTS: Total of 85 patients were included in this study, 56 (65.8%) were females and 29 (34.2%) were males (Table & Figure-1). Palpable lump was observed in 70 (82.4%) patients, while other 08 (9.4%) had non-palpable symptomatic lumps. In 07 (8.2%) patients, thyroid nodules were discovered incidentally on ultrasound neck for non-thyroid ultrasonic examinations (Table & Figure-2). Typical single solid nodules were observed in 35 (41%) patients, and 20 (23%) patients were with typical single cystic nodules. Multiple benign solid nodules were noted in 28 (21.1%) patients. Potential malignant features of shape and marginal irregularity, microcalcification, hetreogenicity and type I and II abnormal flow were observed in 10 (11.7%) patients, while 20 (23%) patients had typical sonological features of malignancy, i.e., taller than wider, irregular, heterogenecity, mural solid nodules with abnormal vascularity of type III and IV. (Table-3). All thyroid nodules (n=85) were further assessed by cytology or post-operative histopathology. Out of 30 cases 24 were true positive for malignant cells, and 06 were false positive (Table-4). Out of 55 cases, 52 cases were true negative, and 03 cases were false negative. Overall Ultrasound



Female	Male	Total
56	29	85

Table & Figure-1: Gender distribution.



Palpable Nodule	Non-palpable Nodule	Incidental Finding	Total
70	08	07	85

Table & Figure-2 : Clinical findings of thyroid lumps.

Ultrasound Features		Frequency n=85	%
Shape	Taller than wider	25	29
	Wider than taller	40	47
	Round / oval	20	23
Margins	Circumscribed	37	36
	Microlobulated	26	30
	Irregular	22	25
Echogenecity	Cystic	20	23
	Solid	28	33
	Complex	37	43
Heterogeneity	Present	25	30
	Absent	60	70
No. of mass	Single	37	43.5
	Multiple	48	56.5
Calcification	Coarse	30	35
	Micro	20	23
	Absent	35	42
Vascularity	Central	18	21
	Peripheral	45	53
	Absent	22	26

Table-3 : Morphological features of thyroid lumps on ultrasonography.

Type of Nodule	Ultrasound Doppler	FNAC/Histopathology
Malignant	30	24
Benign	55	61
Total	85	85

Table-4 : Comparison of Ultrasound findings and histopathological findings (n=85).

sensitivity for morphological characteristics is estimated to be 88.8% and specificity to be 89.6%. Negative predictive value is calculated as 94.3% (52/55) and positive predictive value of 80.6 % (24/30) with accuracy of ultrasound to be 89.4% (76/85).

DISCUSSION: Thyroid nodules are quite common in Pakistan, either as palpable or non-palpable nodules. They may be discovered incidentally on high frequency ultrasound for other lesions of neck. Palpable nodules occur in 4-7% of population[16]. The prevalence of incidental discovery on sonography is13-67%[17]. Most of the thyroid nodules are asymptomatic and the patient only complains of the presence of lump. It may be incidental finding of nodules on cross sectional imaging performed for other reasons[8]. Normally, the healthy thyroid gland shows homogeneous echogenicity when compared with the surrounding muscle. Most thyroid nodules show hypoechogenicity when compared with the thyroid parenchyma. But this comparison does not provide much useful information. Hypoechogenecity is marked when compared with strep muscle for consideration of malignancy, as strep muscles are uniformly present in all patients. Therefore, it is used as the comparative standard for the determination of the echogenicity of solid nodules[1,12]. Micro-calcifications suggesting malignancy were defined as tiny, punctate hyperechoic foci which are 10- 100 µm sized, round- laminar crystalline calcified deposits, with or without acoustic shadows[18].

In this study we evaluated different morphological features of thyroid lump by non-invasive, easily available and cost effective modality. This avoid unnecessary advanced imaging modalities and interventional procedure like FNAC and biopsy. In present study different morphological ultrasonic criteria were assessed, which include shape (taller than wider), margins (regular, irregular), hypoechogenecity, heterogeneity, number (single, multiple), calcification (micro, macro or curvilinear) and vascularity (central, peripheral or both) on the scale of 0-4 as suggested in literature[19]. There is no single definitive criteria in the literature to label the lesion as malignant or benign. In a well defined, homogenous lesion with absent central vascularity, can be confidently reported as true benign nature of the disease and so avoiding FNAC or post operative biopsy. On the other hand, tissue growing against the soft tissue planes and taller than wider lesion signify aggressiveness of the disease[18]. Cystic with mural nodule, type III or IV vascularity and micro calcification are highly suspicious of malignancy and require biopsy to confirm the nature of the disease and to plan further management. Indeterminate or equivocal lesions with heterogenecity and complex cystic masses with mixed pattern of vascularity, microcalcfication and more hypoechoic nodules also need further evaluation by FNAC and post-operative histopathology. With availability of color Doppler ultrasound to assess the vascularity of thyroid nodule it has become established imaging tool to assess the malignancy on basis of vasculaity and its grading. Many authors believe that vascularity has good sensitivity and specificity index, when reporting as potential malignancy[2]. Sensitivity and specificity of vascularity of our study is comparable to other published studies[19,20]. In our study overall sensitivity, specificity, positive and negative predictive values of the ultrasound criteria of thyroid nodules are calculated by standard formulae in conjunction with histopathology report. The overall ultrasound sensitivity of morphological characteristics is 88.8% (24/27) and specificity of 89.6% (52/58). Negative predictive value is 94.3% (52/55), while positive predictive value is 77.6% (24/30) with accuracy of 76/85 (89.4%). These figures are also comparable with reported study by M. Yunus et.al.[21], where ultrasound sensitivity was calculated to be 92%, specificity of 73%, positive predictive value 65.7% and negative predictive value was 95.3%. This study described the frequencies of different ultrasound features, sensitivity, specificity, positive and negative predictive value and accuracy of ultrasound features in different thyroid nodules. These informations are utilized in the management plan that avoids unnecessary FNAC/ biopsies.

CONCLUSION: Ultrasound is sensitive, non-ionizing, easily available, simple and safe method to detect intrathyroid nodules. On the basis of different ultrasound features a thyroid nodule may be characterized as benign or malignant nodule. Although no single criteria is reliable but combined ultrasonic features help in predicting benign and malignant thyroid lesions. It saves economic burden and avoid unnecessary biopsies

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