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Original Article

Role of strain elastosonography, B mode and color duplex ultrasonography in differentiation between benign and malignant axillary lymph nodes

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ABSTRACT

Aim and objectives: to evaluate diagnostic accuracy of combined gray scale, color Doppler and strain elastosonography in differentiation between benign and malignant axillary lymph nodes. *Methodology:* 50 patients with 60 enlarged axillary lymph nodes (20 male and 30 female), their ages ranged from 25 to 66 years with a mean of 37.4 years. Grey scale, color-power Doppler US and strain elastography were performed for all patient. *Results:* absent echogenic hilum, LS/TS ratio less than 2, transverse diameter more than 7, cortical thickness more than 3 mm, high RI were the most US patterns predictive of malignancy. Suspicious lymph nodes by elastography (Scores 3 and 4) were found in 45 (75%) lymph nodes with sensitivity 88.89%, specificity 66.67%; accuracy 83.33%. The best strain ratio cutoff of 2.3 with sensitivity 87.89% and specificity 65.67%; accuracy 82.3%. Rounded shaped, loss or compressed nodal hilum and suspicious elastography score (3 & 4) were the most predictive for malignancy with sensitivity 86.67% and specificity 93.33%; accuracy 88.33%. *Conclusion:* combined gray scale, color Doppler US and elastography improve diagnostic accuracy of conventional ultrasound alone in differentiation between benign and malignant axillary lymph nodes with sensitivity 86.67%, and specificity 93.33%; accuracy 88.33%.

1. Introduction

Lymphadenopathy refers to a condition affecting lymph glands of the body resulting in the lymph nodes that are abnormal in size, number or consistency. It can be either local or generalized [1].

Lymph node enlargement is a common sign of systemic inflammatory processes (sarcoidosis), infectious diseases (bacterial lymphadenitis, tuberculosis), autoimmune diseases, collagen vascular diseases and many other causes (silicone implants, tattooing) or resulting from malignant disease either by systemic lymphoid dissemination of a malignancy or lymphoma mainly non-Hodgkin lymphoma. Abnormal axillary lymph nodes are commonly caused by breast cancer, other primary tumors such as malignant melanoma, lung, stomach, or ovarian carcinomas can also cause axillary lymph nodes metastasis [2,3].

Tissue characterization of axillary lymph nodes was mainly assessed by fine needle aspiration, biopsy or excision of lymph nodes, however, sample error, increased health care costs and post excisional complications such as lymphedema and upper extremity dysfunction or discomfort are common disadvantages of these invasive techniques making them not sufficiently acceptable in the work-up of patients with lymphadenopathy [4,5].

According to non-invasive imaging techniques, Ultrasound is considered the method of choice in evaluating axillary nodes with moderate sensitivity and high specificity depending on morphologic characterization including size, shape, hilum and cortical thickness. Therefore, ultrasound remains the most suitable imaging method to assess axillary LNs, however, the diagnostic accuracy is still unsatisfactory. So, other technical advances as sonoelastography, tissue harmonic imaging and increasing frequencies are used nowadays for a better differentiation between benign and malignant lymph nodes [6,7].

Strain sonographic elastography is an ultrasound technique used to assess the relative mechanical elastic properties of soft tissue and, in particular, for imaging hard tumors within the human body qualitatively and semi-quantitatively. It has a great role in differentiating in cervical, axillary and inguinal nodal metastasis [8,9].

Abbreviations: CT, computer tomography; DCE, dynamic contrast enhancement; FNA, fine needle aspiration; MRI, magnetic resonance imaging; NPV, negative predictive value; PET, positron emission tomography; PPV, positive predictive value; REC, research ethics committee; RI, resistive index; SE, sonoelastography; SPSS, statistical package for the social sciences; US, ultrasonography

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Other imaging methods such as computer tomography (CT), magnetic resonance imaging (MRI), scintimammography and positron emission tomography (PET) were found to have insufficient role in evaluating axilla. Also they are highly priced and labor-intensive [9].

Nowadays, MRI used as a noninvasive modality for patients with breast cancer to preoperative grading the metastatic axillary lymph nodes which has high sensitivity and specificity. Diffusion-weighted MR imaging correlation with prognostic parameters is used for staging of breast cancer and monitoring of patient after therapy. In addition, DWI is used for the assessment of mediastinal, axillary, cervical, abdominal and pelvic lymph nodes [10,11].

Dynamic contrast enhanced (DCE) MRI may play role in the differentiation between benign and malignant lymph nodes also characterization of the malignant lymphadenopathy. The benign lymph nodes have lower DCE values than malignant ones and metastatic ones seen to have smaller DCE values than lymphomatous one [12].

The aim of this study is to evaluate the accuracy of SE added to conventional ultrasound in reliable characterization of indeterminate axillary lymph nodes to help in accurate staging of the malignant disease and thus having a role in therapy monitoring.

2. Patients and methods

2.1. Patients

50 patients (20 male, 30 female) presented with enlarged axillary lymph nodes by clinical examination (palpation) and B mode ultrasonography throughout the period from October 2015 to September 2017.

Approval of Research Ethics Committee (REC) and informed written consent were obtained from all participants in the study after full explanation of the benefits and risks of the procedure.

2.2. Methods

All patients were subjected to the following:

1. Full history taking and clinical examination.
2. Real time Ultrasound and elastosonography:
   - Grey scale, color-power Doppler US and elastography were performed using a real time Ultrasound (Toshiba, Apilo 500, TUS-A500), using high frequency probe with frequency of 10 MHz.
   - **B mode ultrasound** was performed first for all lymph nodes followed by color/power Doppler study. Each lymph node is evaluated for **short axis diameter** (more than or less than 7 mm), **long axis/short axis diameter ratio which reflect nodal shape** (more than or less than 2)**, cortical thickness** (less than or more than 3 mm, or non available due to absent hilum)**, hilum** (preserved, compressed, absent or partially absent) and **vascularity** (present or absent, central or peripheral in distribution, number of vascular pedicle, low or high RI flow).
   - **All patients were evaluated by stain elastography:** the target lymph node was positioned at center of the region of interest box, we set the region of interest to exclude pectoralis muscles and axillary vessels, manual compression applied repetitively above the targeted nodule, the color scale ranged from red (ie, softest component) to blue (ie, hardest component), we assess color distribution in cortex and medulla of lymph nodes, the strain ratio of lymph node cortex was calculated with the best strain ratio cutoff value 2.3.
   - **Lymph node elasticity was classified on basis of a 4-point scoring system according to choi et al.** [13]**: a score of 1** was denoting absent or very small hard area, **a score of 2** was denoting hard area less than 45% of the lymph node, **a score of 3** was denoting hard area more than 45% of the lymph node, **a score of 4** was denoting hard area over the entire node with or without soft rim. **The lymph node with score 3 and 4 were classified as malignant lymph nodes, while lymph node with score 1 and 2 were classified as benign lymph node.**
3. Histopathological examination:
   - Histopathological examination of 60 axillary lymph nodes was done as standard reference.
   - Fine needle aspiration cytology and percutaneous core biopsy were done for 53 lymph nodes and surgical excision was done for 27 lymph nodes. The reasons of surgical excision were no nodal or representative tissue obtained with the preceding core needle biopsy and confirmation of the result of the preceding core needle biopsy.
4. Statistical analysis:
   - The data were collected, tabulated and statistically analyzed. All statistical analyses were computed with the Statistical Package for the Social Sciences (SPSS) Version 21. Descriptive statistic was performed in a form of number and percentage for qualitative data. Chi-squared test ($\chi 2$) was used to study the significance of association between ealstosonography of thyroid nodule and histopathology. Sensitivity, specificity and diagnostic accuracy of grey scale US, color Doppler US, elastography and combined US and elastography were calculated for diagnostic evaluation. P-value ≤ 0.05 was considered significant.

3. Results

The current study included 50 patients with 60 enlarged axillary lymph nodes, 20 (40%) of them were male while 30 (60%) of them were female, their ages ranged from 25 to 66 years with a mean of 37.4 years. The most affected age group was from 30 to less than 40 years (20 cases) representing 40% of the cases.

3.1. Pathological diagnosis

Histopathological examination of 60 axillary lymph nodes after fine needle aspiration cytology, core biopsy guided by ultrasonography and surgical excision revealed 45 lymph nodes (75%) with a pathological diagnosis of malignancy; 35 of them were non Hodgkin lymphoma and 10 were metastatic lymph nodes (invasive ductal carcinoma, invasive mammary carcinoma, papillary carcinoma). Fifteen lymph nodes (25%) were benign at histopathology comprised 5 non specific lymphadenitis and 10 reactive follicular hyperplasia.

3.2. Grey scale and Doppler ultrasound

Short axis or transverse diameter of the lymph nodes less than 7 mm was found in 17 lymph nodes (28.3%), on histopathology 7 of them were benign and 10 were malignant, transverse diameter more than 7 mm was found in 43 lymph nodes (71.7%), on histopathology 8 of them were benign and 35 were malignant.

Longitudinal diameter/transverse diameter ratio which reflect nodal shape as ovoid or rounded shaped was found more than 2 in 21 lymph nodes (35%), on histopathology 11 of them were benign and 10 were malignant, ratio less than 2 was found in 39 lymph nodes (65%), on histopathology 4 of them were benign and 35 were malignant.

Nodal hilum was classified as central echogenic fatty hilum, compressed or lost hilum. Central echogenic hilum was found in 17 lymph nodes (28.3%), on histopathology, 14 of them were benign and 3 were malignant. Lost hilum was found in 33 lymph nodes (55%), on histopathology, 1 of them were benign and 32 were malignant. Compressed hilum was found in 10 lymph nodes (16.7%), on histopathology, all of them were malignant.

Cortical thickness less than 3 mm was found in 17 lymph nodes (28.3%), on histopathology, 11 of them were benign and 6 were malignant. More than 3 mm thickness was found in 10 lymph nodes (16.7%), on histopathology, 3 of them were benign and 7 were