ShearWave elastography in lymph nodes

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Purpose

Ultrasound (US) is the most useful and accepted modality for evaluating superficial lymph nodes (Ln). Due to the superposition of appearance between normal lymph nodes, reactive lymph nodes, lymphomas, and metastases histopathologic work up under ultrasound guidance is necessary to make a definitive diagnosis.

However, US-based new technologies have extended the opportunities for the differentiation of malignant from benign lymph nodes. The Shear Wave elastography (SWE) is an US-based technique that provides quantitative elastic information (in KiloPascals) on the basis of the shear wave propagation speed, thereby producing a real-time elastogram. SWE showed promising results in some superficial organs such as breast, thyroid (1-3). To date, the usefulness of SWE in lymph nodes has been studied in only few studies (4-6).

The aim of the current study is to correlate quantitative and qualitative patterns of Shear Wave elastography with histological status of lymph nodes in clinical routine practice.

Methods and materials

Subjects

133 consecutive patients (61 (46%) men, 72 (54%) women, mean age 61 +/-20) addressed for needle core biopsy under ultrasound guidance for lymph nodes or superficial nodules were prospectively included in this study. One target per patient was biopsied. Histology was obtained for all lesions.

The lymph nodes which were biopsied were localized in cervical area in 67 cases (50%), axilla in 37 (28%) and inguinal region in 29 (22%).

Conventional US and Elastography

Patients were examined using the Aixplorer (SuperSonic imagine®) with a superficial 10 MHz US probe.

Each target to be biopsied was analyzed on B mode and color Doppler according to morphological criteria:

- Presence or absence of a hilum
- The short-long axis ratio (S/L)
- Shape of the target: oval or round
- The vascular distribution: hilar type, peripheral.

At the time of examination, an experienced operator in US imaging of lymph nodes categorized each target as benign or suspicious.

If at least two of the following criteria were present, the Ln were categorized as suspicious: markedly hypoechoic, loss of hilum, hypervascularization.

**SWE elastography**

The SWE measurements were performed with no-to-mild compression: a thick layer of US gel was applied between the probe and the skin and no deliberate pressure was applied by the operator's hand on the skin.

On the SWE color map, a Region Of Interest (ROI) was manually delineated to include the maximum of the B mode hypoechoic part of the target. The ROI was placed away from borders and possible artifacts such as areas with increased stiffness due to transducer placement or pressure.

**Qualitative analysis**

An SWE elastogram is displayed in real time as a color-scale (SWE map): blue is soft, red is stiff.

A rim of stiff area around the target on the SWE color map (pixels colored in yellow to red) was noted if present.

**Quantitative analysis**

After selecting a ROI, SWE measurements (in KiloPascals) were provided by the system quantification tool (Q-Box):

- E Mean: the mean of the stiffness values of the pixels over the ROI
- E Max: corresponds to the maximum elasticity value over the ROI
- SD: was defined as the standard deviation of the elasticity values over the ROI. This parameter is related to the homogeneity of the elastogram.
For each target, three successive SWE measurements were completed at the time of the exam by the radiologist. The average of the mean elasticity value (E mean), the maximum elasticity value (Emax) and the standard deviation (SD) were calculated for each target.

**Results**

Histological specimen were:
- Benign lymph nodes: n= 50 (37%)
- Lymphomas: n= 54 (41%)
- metastases from carcinomas: n= 29 (22%)

*Conventional ultrasound assessment*

At the time of examination, the sensitivity, specificity of conventional ultrasound to differentiate benign from pathological Ln were 93%, 68% respectively.

The analysis of the conventional US criteria showed that the loss of hilum and the absence of central vessels were each significantly discriminant to differentiate carcinomas from other Ln (benign and lymphomas) (p<10^{-3}).

Table 1 summarizes the distribution of B mode and Color Doppler criteria in regard to the final histological diagnosis.

<table>
<thead>
<tr>
<th></th>
<th>Benign Ln</th>
<th>Lymphomas</th>
<th>Metastases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oval shape</td>
<td>39 (78%)*</td>
<td>24 (44%)</td>
<td>9 (31%)</td>
</tr>
<tr>
<td>Presence of hilum</td>
<td>44 (90%)</td>
<td>32 (60%)</td>
<td>32 (24%)*</td>
</tr>
<tr>
<td>S/L ratio</td>
<td>0,43</td>
<td>0,57</td>
<td>0,62</td>
</tr>
<tr>
<td>Central vessels</td>
<td>37 (74%)</td>
<td>29 (54%)</td>
<td>4 (14%)*</td>
</tr>
</tbody>
</table>

*p<10^{-3}
Elastography assessment

Carcinomas

The metastases from carcinomas had the highest stiffness values (mean 32.2 Kpa (35.6); p<10^{-3}).

On SWE color map they appeared as significantly more heterogeneous than other Lns (mean SD 9.7 (6.7); p<10^{-3}). (Fig 1,2)

Diagnostic performance of quantitative and qualitative SWE

Table 2 shows the distribution of mean values of Emean, EMax and SD and qualitative parameter (rim pattern) in regard to the final histological analysis.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Benign Ln</th>
<th>Lymphomas</th>
<th>Metastases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean stiffness E</td>
<td>13.3 (9)</td>
<td>17.7 (13.8)</td>
<td>32.2 (35.6)*</td>
</tr>
<tr>
<td>Mean Max value E</td>
<td>23 (16.5)</td>
<td>35.9 (36.4)</td>
<td>57.5 (50.5)*</td>
</tr>
<tr>
<td>Mean standard deviation SD</td>
<td>3.7 (2.8)</td>
<td>6.2 (6.3)</td>
<td>9.7 (6.7)*</td>
</tr>
<tr>
<td>Rim pattern</td>
<td>8%</td>
<td>7%</td>
<td>48%*</td>
</tr>
</tbody>
</table>

*p<10^{-3}

The diagnostic performance of SWE (the combination of SWE stiffness measurements and qualitative rim pattern on SWE color map) was evaluated (statistical linear model):

- **To differentiate benign from pathological Ln** (i.e lymphomas or carcinomas) the sensitivity, specificity and accuracy were **82%, 81%, and 81.5%** respectively.
- **To differentiate benign Ln from lymphoma** the sensitivity, specificity and accuracy were **60%, 66%, and 67%** respectively.
The combination of Mean stiffness value (Emean) and Standard deviation (SD) showed sensitivity and specificity values of 72% and 66% respectively for differentiating benign Ln from lymphomas. (Fig 3)

Images for this section:

Fig. 2: Fig 2: SWE elastograms and B mode ultrasound of lymph nodes metastases from carcinomas. B mode showed hypoechoic round heterogeneous Lns. SWE color maps demonstrated the presence of a rim of stiff area around.

Fig. 3: Fig 3: Ln in the axilla area in color Doppler mode (a), SWE elastogram (b). Conventional US showed hypoechoic oval lesion with hilar hypervascularization. The Ln appeared homogeneously blue on SWE color map (Qbox: Emean= 8.4 Kpa; SD=1.9 Kpa). Histology: Follicular lymphoma
Fig. 1: SWE elastograms and B mode ultrasound of lymph nodes localized in the axilla (a) and in the inguinal area (b). B mode showed same hypoechoic pattern of the Lns with loss of hilum. The corresponding SWE maps showed that the hypoechoic part of the Lns was blue with corresponding Emean values (Qbox) of 10.4 Kpa for (a) and 5.2 Kpa for (b). Additionnaly, the Ln (b) showed a rim of stiff area around on SWE color map. Histology: a= Benign hyperplastic Ln; b= metastasis from colic carcinoma
Conclusion

Shear wave elastography showed promise as an adjunct to greyscale ultrasound examination in assessing lymph nodes.

SWE improved the specificity of B-mode ultrasound for differentiating benign from pathologic lymph nodes (from 68% to 81%) and provided objective informations for differentiating the LNs according to histology. Interestingly, carcinomas showed specific quantitative as well qualitative SWE characteristics (significant higher stiffness values, the presence of a rim of higher stiffness on SWE color map).

Personal information

References


