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Short Report

Endoscopic Ultrasound Elastography in the Diagnosis of Pancreatic Cancer

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BACKGROUND

Palpation continues to be of great value in modern medicine, both practiced by doctors and as a technique for self-examination. But, palpation is limited to a few accessible organs, and the interpretation of the information sensed by the fingers is highly subjective. Recently, elastography has emerged as an option in several commercial ultrasound systems, and is starting to prove clinically valuable in many areas, particularly for example in assisting breast cancer diagnosis,[1] in guiding minimally invasive treatment of prostate cancer,[2] or assessing liver fibrosis in diffuse hepatopathies by the transabdominal approach.[3]

Endoscopic ultrasound (EUS) elastography is a recent imaging procedure used for the calculation and visualization of tissue elasticity during usual EUS examinations.[4] The method allows the assessment of elasticity distribution and shows differences in hardness between diseased tissue and normal tissue. EUS elastography can be accomplished real-time with state-of-the-art ultrasound systems, with the images being represented in transparent color superimposed on the conventional gray-scale B-mode scans. EUS elastography equipment includes a Hitachi 8500 ultrasound system with an embedded Sono-Elastography module (Hitachi Medical Systems Europe Holding AG, Zug, Switzerland), coupled with the EG 3830 linear endoscope or the EG 3630 radial endoscope (Pentax, Hamburg, Germany). Real-time EUS elastography can be thus performed with the conventional EUS probes, without any need for additional equipment that induces vibration or pressure. Due to its similarity with color Doppler examinations, EUS elastography is performed by using a two panel image with the usual conventional gray-scale Bmode EUS image on the right side and with the elastography image on the left side.

A region of interest (ROI) for the elastography calculations is manually selected and should include the targeted lesion, as well as the soft surrounding tissues. The ROI needs to be set to include sufficient surrounding tissue because elasticity values are displayed relative to the average strain inside the ROI. The system also displays a compression threshold which has to be set up between 3 and 4. To visualize tissue elasticity patterns, different elasticity values are marked with different colors (on a scale of 1 to 256) and the sono-elastography information is shown superimposed on the conventional gray-scale image.

The system is set-up to use a hue color map (red-green-blue), where hard tissue areas are marked with dark blue, medium hard tissue areas with cyan, intermediate tissue areas with green, medium soft tissue areas with yellow and soft tissue areas with red.

EUS elastography was already used in several studies for the characterization and differentiation of benign and malignant lymph nodes, with variable sensitivity, specificity, and accuracy, better than results obtained by conventional EUS criteria.[5]

MATERIAL AND METHODS

The aim of our study was to prospectively assess the accuracy of EUS elastography to differentiate between normal pancreas, chronic pancreatitis, and pancreatic can-

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cer. A postprocessing analysis based on specially designed software was used to analyze the EUS elastography movies by calculating hue histograms of each individual image. Furthermore, an extended neural network (NN) analysis based on mean hue histograms of the EUS elastography movies was tested to differentiate benign versus malignant EUS elastography patterns in a prospective, blinded and multi-center design study. EUS elastography was performed during the EUS examinations, with 2 movies of at least 10 seconds recorded onto the hard disk drive, embedded in the US system, to minimize variability and to increase repeatability of acquisition.

A 2-panel image with the usual conventional gray-scale Bmode EUS image on the right side and with the elastography image on the left side was used. The examination frequency during EUS elastography was usually set at 7.5 MHz (between 5.0 and 10.0 MHz). Each acquired movie was subjected to a computer-enhanced dynamic analysis by using a public domain Java-based image processing tool (ImageJ) developed at the National Institutes of Health, Bethesda, Maryland.

To minimize the human bias, all the postprocessing and computer analysis of digital movies was performed within the Information Technology Center, University of Medicine and Pharmacy of Craiova, with all programmers and statisticians were blinded to the clinical and pathologic information. Each EUS elastography movie, of approximately 10 seconds (125 frames), was transformed into numerical form, characterized by a single average hue histogram vector. Each individual value of the vector corresponded to the number of pixels of each color, in other words, to the number of pixels that correspond to each elasticity level, from 1 to 256. The data was further subjected to an extended collaborative neural networks (NNs) computing analysis in order to differentiate benign versus malignant patterns. The study group comprised 125 patients with focal pancreatic masses, which were included prospectively. Final diagnosis was based on positive cytology results obtained through EUS-guided FNA, final pathology results obtained after surgery, as well as typical imaging findings associated with minimum 6 months of follow-up.

RESULTS

The effectiveness of a collaborative computing system, based on a NN approach was assessed in order to provide a real-time decision support for the medical diagnosis. A thorough statistical benchmarking process and a weighted voting system were employed to identify the best NN models as reliable classifiers and to obtain the overall automatic diagnosis. Multi-layer perceptron (MLP) neural networks with both one and two hidden layers of neurons (three-layer perceptron and four-layer perceptron) were trained to learn how to classify focal masses as benign or malignant, and yielded an excellent testing performance, together with a high training performance.

Consequently, the accuracy of both MLP models was higher than 90%, in accordance with previously published data. However, the NNs approach might provide a very fast and accurate diagnosis, supporting and improving the human decision making, especially in difficult cases.

CONCLUSIONS

We strongly suggest that EUS elastography imaging offers complementary information added to conventional EUS imaging with minimal prolongation of the examination time, minimum costs, and no added morbidity or mortality.[6] The currently developed methodology, based on artificial NN processing of the EUS elastography digitalized movies, enables exploration and analysis by automatic means of large quantities of data to obtain an optimal prediction of the type of pancreatic lesions. The essential finding of our study was the improved testing performance of the NN approach compared with a simple ROC analysis when using mean hue histogram values. Future multicentric, randomized studies with adequate power will have to establish the clinical impact of machine-learning approaches for the differential diagnosis of focal pancreatic masses. Improvements of the software used and quantification of the EUS elastography information might also add to the increased accuracy of the results.

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