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● *Original Contribution*

REAL-TIME QUALITATIVE ULTRASOUND ELASTOGRAPHY OF MISCELLANEOUS NON-NODAL NECK MASSES: APPLICATIONS AND LIMITATIONS

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Abstract—To evaluate real-time qualitative ultrasound elastography as an adjunct to conventional sonography for evaluation of non-nodal neck masses identified in routine clinical practice, 52 consecutive masses in 49 patients underwent both techniques. Lesion stiffness was graded visually on chromatic-scale elastograms from ES0-3 (low to high). Diagnosis was based on (cyto)pathology (11), corroborative cross-sectional imaging (18) or characteristic conventional sonography (23). There were 16 lipomas, 15 lymphatic/venous vascular malformations (LVVMs), six neurogenic tumours/neuromas, five thyroglossal duct cysts (TGCs), five (epi)dermoids, three abscesses, one second-arch branchial cleft cyst (BCC), and one soft-tissue metastasis. In general terms, lesion stiffness was high (ES2-3) for neurogenic tumours/neuromas, (epi)dermoids and metastasis, and low (ES0-1) for lipomas, LVVM, TGCs and BCC. Abscesses displayed variable stiffness according to fluid content. Technical limitations and artefacts of elastograms were identified. Data from real-time qualitative ultrasound elastography may be a useful adjunct to sonography for diagnosis of non-nodal neck masses (E-mail: aniltahuja@cuhk.edu.hk) © 2010 World Federation for Ultrasound in Medicine & Biology.

Key Words: **Ultrasound, Elastography, Neck, Masses, Diagnosis.**

INTRODUCTION

Non-nodal neck masses excluding salivary gland, thyroid gland and nodal aetiologies comprise a heterogeneous group of conditions including congenital and acquired cysts, infections, as well as benign and malignant neoplasms. Modern high resolution grey-scale ultrasound (US) combined with Doppler imaging is the first-line imaging investigation for these lesions due to its excellent spatial resolution, low cost, non invasiveness and widespread availability. Fortunately, many palpable masses have characteristic clinical features and typical sonographic appearances that are diagnostic, hence, tissue sampling is only necessary for a minority of lesions while ancillary cross-sectional imaging is reserved for tumour staging or evaluation of suspected deep extension.

Qualitative real-time US elastography is a comparatively novel technique, which is now available on conventional US systems with modified software. In US elastography, tissue elasticity is estimated by comparing local tissue displacements from ultrasonic signals before and after application of a compressive force. Under compression, stiff tissues show less deformation, or strain, than soft tissues. Reflecting the fact that malignant tissues are stiffer than their benign counterparts at many sites, increasing numbers of recent publications document the utility of US elastography to differentiate malignant from benign lesions in the breast, prostate, lymph nodes, liver, gastrointestinal tract, cervix and thyroid (Lyshchik et al. 2005; Taylor et al. 2005; Itoh et al. 2006; Saftoiu et al. 2006; Bae et al. 2007; Garra 2007; Janssen et al. 2007; Lyshchik et al. 2007; Rago et al. 2007; Thomas et al. 2007; Zhi et al. 2007; Alam et al. 2008; Asteria et al. 2008; Hong et al. 2009). Furthermore, a growing number of nononcological applications for this technique are being explored including for liver, renal, uterine, vascular and musculoskeletal disease (Garra 2007; De Zordo et al. 2009; Takahashi et al. 2009).

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To date, there have been no studies evaluating the utility of US elastography for the spectrum of neck masses encountered in routine practice, which was the purpose of the current study. Because thyroid, salivary and nodal masses are common pathologies that can be clearly identified as arising from these structures on conventional US, these warrant separate attention and, thus, were not included in the present study.

MATERIALS AND METHODS

Between October 2008 and January 2010, ultrasound elastography was performed for 52 consecutive focal cervical masses identified during routine sonography excluding masses within the thyroid gland, salivary glands or lymph nodes. The study population comprised 49 patients (29 women, 20 men) with mean age of 42.8 years (range 7–74 years). Institutional approval for this study had been obtained and informed consent was obtained per the WORLD Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects, 2008.

Patients initially underwent conventional neck US including color Doppler using a 5–12 MHz linear array transducer (Philips iU22, Philips Healthcare Nederland, Eindhoven, The Netherlands), which was performed by one of several radiologists experienced in neck ultrasound. Subsequently, elastography using a linear array 13.5 MHz transducer (Siemens Accuson Premium Edition with eSie Touch™, Siemens Healthcare, Erlangen, Germany) was performed by one of two radiologists (K.B., D.D.R) who also had approximately 1 year hands-on experience of performing elastography in the neck region. For the elastographic technique, patient and transducer positioning were identical to conventional US and elastograms were displayed in dual-mode superimposed and alongside grey-scale sonograms in real-time. An appropriate region-of-interest (ROI) was selected that included the lesion and some surrounding tissues. Intermittent gentle transducer compression and decompression along the beam axis was performed while observing the lesion to avoid out-of-plane or lateral transducer motions, which are causes of mistracking artifacts. Real-time elastograms were a color-coded graphic representation of the relative stiffness of structures within the selected ROI such that greyish purple indicated soft, green and yellow indicated intermediate stiffness, and red indicated stiff. The colourscale was automatically adjusted by the software for optimal separation of strain values within the selected ROI. The correct amount of compression was determined by manual adjustments such that surrounding tissues predominantly displayed an intermediate strain pattern, yellow or green, as opposed appearing over- or under-compressed, *i.e.*, red or gray/purple, respectively. Both static and moving cineloops of conventional US and elastography were acquired for analysis. Elastography took approximately 5 min per lesion.

Following elastography, a minority of lesions underwent US guided fine needle aspiration for cytology (FNAC) and/or excisional biopsy. The majority of lesions did not undergo tissue sampling due to their characteristic imaging appearances that will be discussed subsequently. Some patients also underwent additional cross-sectional imaging for diagnostic confirmation or to evaluate lesion extent.

Image interpretation

All relevant imaging studies were reviewed by the two radiologists (K.S.S.B., D.D.R.) who had performed elastography using consensus opinion. Reviewers were blinded to the original sonographic diagnosis when evaluating conventional sonography and elastograms but were aware of the clinical presentation. Lesion location and morphologic features were documented including size, margin regularity, echogenicity, presence of cystic change or calcification, and vascularity. In the absence of universally accepted scoring criteria, the elastograms were graded on a simplified 4-point scale (ES 0–3) (Table 1, Figs. 1–5) comparing the lesion to surrounding subcutaneous fat and/or other soft tissues excluding muscle. This scale was adapted from previous studies of thyroid US elastography (Lyshchik et al. 2005; Itoh et al. 2006; Rago et al. 2007; Asteria et al. 2008; Hong et al. 2009; Rubaltelli et al. 2009). However, differing from other studies, complete cineloop segments were scrutinized to obtain an overall impression of the stiffness of lesions during compression-decompression

Table 1. Elasticity grading system for cervical neck masses

Elasticity score	Overall impression	Elastographic appearance of the mass
ES 0	Softer than surrounding tissues	Mass contains purple areas compared with surrounding tissues that are displayed predominantly green, yellow or red. Lesion can be clearly delineated from surrounding tissues (Fig. 1).
ES 1	Soft as surrounding tissues	Predominantly green or yellow and is indistinguishable from surrounding tissues (Fig. 2).
ES 2	Mild stiffness	Predominantly yellow or green with few red areas comprising less than 50%. Mass is partially delineated from surrounding tissues (Fig. 3).
ES 3	Stiff	Predominantly red (over 50%) and is distinguishable from surrounding tissues (Figs. 4 and 5).