MR Elastography of Salivary Gland Masses: Preliminary Results

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Introduction:

Salivary gland masses are histologically diverse and are an appreciable diagnostic imaging challenge as conventional MRI, computed tomography (CT) and ultrasound (US) can determine their presence, size and extent, but are suboptimal for determining histology. Published data on elastography in salivary tissue is limited to preliminary reports using ultrasonic methods (1-3), which have documented lower strain (equating to higher stiffness) of salivary neoplasms compared to normal parenchyma, and clustering of strain indices according to pathology(1). MR elastography estimates tissue shear modulus (equating to stiffness) by tracking shear waves produced in tissues stimulated by a mechanical oscillator. MRE has been explored at several body sites including the liver, breast, brain, heart, prostate and lungs (4-9). There is sparse published data for this technique in the head and neck (HN), which until now has been limited to the thyroid (10), tongue and tonsils (11). We have recently conducted a feasibility study of MRE in the HN using a customized mechanical driver and a novel MRE sequence based on gradient echoes and fractional encoding of the acoustic motion of tissues. The aim of the present study was to evaluate the potential utility of MRE for diagnosis of salivary gland masses.

Materials and Methods:

Subjects: Between August and November 2011, 9 patients (7 males, 2 females, mean age 51.8 years, range 18-73 years) with 9 salivary masses (8 parotid, 1 submandibular) diagnosed by needle cytology underwent MRE of the HN. These masses comprised 5 pleomorphic adenomas, 2 Warthin's tumours, 1 monomorphic adenoma and 1 myoepithelial carcinoma. Mean tumor size ± SD was 29.0±10.4mm. Local ethics board approval had been obtained for this study and all subjects provided informed consent.

MRE protocol: MR images were acquired on a 3.0 T scanner using a two-element flexible RF coil (SENSE Flex-M). A customized mechanical driver, originally designed for MRE of the liver (Philips, Hamburg, Germany), was positioned posterior to the neck. A gradient echo sequence was used to measure for each pixel the local acoustic wave displacements as three directional vector fields sampled eight times per 56Hz vibration period. Motion encoding was performed fractionally (q factor of 0.35) with a bipolar gradient pulse of 158Hz inserted between a 20° excitation pulse and the refocusing gradient echo, with an effective TE of 6.91ms. Acoustic frequencies of 28Hz, 56Hz and 84Hz were assessed consecutively but for succinctness, only the 56 Hz data is presented here. Sixteen axial slices were acquired with a 2mm isotropic spatial resolution. Reference anatomical images were acquired using a conventional, T2-weighted spin echo sequence with fat-suppression. Reconstruction was carried out using direct inversion of the wave equation and the measured acoustic displacements as input. Density of the tissues and vibration frequency were assumed to be constant.

Data and Statistical Analysis: Regions of interest (ROIs) were manually contoured for salivary masses and contralateral normal glands on T2-weighted maps and transferred to viscoelasticity maps (Fig.1, red and green ROIs show a salivary tumour and normal contralateral gland respectively). For each ROI, mean tissue elasticity (Gd), viscosity (Gi) and magnitude of shear modulus (stiffness) (|G*|) were obtained. Comparisons between mean indices of lesions and normal parenchyma across patients were performed using t-tests against a theoretical value of one (indicating identity between the parameter of the lesion and of the normal tissue). A p value <0.05 was used to indicate statistical significance.

Results:

MRE was successful in all patients. Salivary tumours had mean ± SD [range] Gd of 0.73±0.43 [0.33-1.45] kPa, Gi of 0.31±0.19 [0.08-0.64] kPa and G* of 0.83±0.47 [0.35-1.52] kPa. Normal parenchyma had mean ± SD [range] Gd of 0.54±0.30 [0.27-1.08] kPa, Gi of 0.18±0.12 [0.08-0.44] kPa and G* of 0.59±0.32 [0.29-1.21] kPa. For pooled data from all patients, there was no difference in the mean of absolute biomechanical values between tumours and normal tissue (p values=0.12-0.3). However, tumours had higher values compared to the contralateral normal tissue in the same patient, with normalized indices for Gd 1.34±0.37 (p=0.02), Gi 1.90±0.93 (p=0.02) and G* 1.41±0.37 (p=0.01) (Fig 2, * indicates statistically significant results).

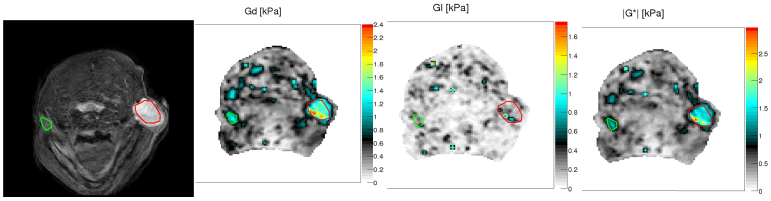

Fig. 1

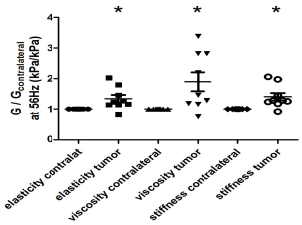

Fig. 2

Conclusion:

These preliminary results indicate that MRE is feasible for salivary masses and suggests that salivary neoplasms have higher normalized indices of viscoelasticity equating to higher stiffness than normal parenchyma. This study is ongoing and will be updated at the time of presentation with more detailed analyses with a larger sample size, analysis of different driver frequencies, and normative data using bilateral salivary glands from healthy volunteers. To our knowledge, there are no comparable published data so this work represents an important step in evaluating the potential of MRE at this site.

References:

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