The use of real-time elastography in the assessment of gallbladder polyps: preliminary observations

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Aims and objectives

Real-time elastography is a dynamic technique that was developed to evaluate tissue elasticity objectively by measuring the degree of distortion (strain) under external force. It presents data in color-coded displays on top of the gray-scale sonographic image (1). Sonoelastography has been used as a diagnostic marker in clinical practice for different tissue types, including breast, thyroid gland, prostate, kidney, and liver (2-4). To our knowledge, however, there are no published reports of real-time elastography used for gallbladder (GB) polyps.

GB polyps affect approximately 4-5% of the adult population and they are often detected incidentally by sonography. The majority of GB polyps are benign and most commonly include cholesterol polyps or inflammatory polyps (5, 6). In rare cases, these lesions may be neoplastic, and they sometimes share the same appearance as benign polyps on sonographic examination (7). Current guidelines suggest surgical removal of polyps greater than 10 mm and follow-up with subsequent sonography for polyps smaller than 10 mm (5, 6). However, accuracy of the size criteria is limited since neoplastic polyps are also found in GB polyps less than 10 mm (8). Therefore, a novel diagnostic approach based on imaging characteristics other than size criteria is needed to guide decisions on whether to perform cholecystectomy. Because malignant tissues are usually harder, or less elastic, than benign tissues, we hypothesized that assessment of tissue elasticity might be useful for GB polyp characterization. The purpose of this study was to evaluate the feasibility of sonoelastography in GB polyps and to illustrate the elasticity properties of polyps.
Methods and materials

Patients

This prospective observational study was approved by the institutional review board, and informed consent was obtained from all of the reviewed subjects. Seventy four patients underwent sonography, including elastography of gallbladder polyps, within our institution. A polyp was defined on sonography as a lesion attached to the GB wall that was non-shadowing, non-mobile and hyperechoic to bile (5, 9). Patients were included in the study if they had any of the following: sonographic follow-up for at least 2 years, pathology report, or who were diagnosed on the basis of characteristic clinical and radiologic findings. Of these 74 patients, 21 were excluded due to insufficient follow-up or lack of a reference standard to establish diagnosis. The final cohort included 53 patients with GB polyps (32 women and 21 men; mean [± SD] age, 44.1 ± 10.6 years; range, 22-70 years).

Of these patients, 52 had a diagnosis of benign GB polyps. 40 patients with polyps (77%) had a sonography follow-up. The remaining 12 (23%) patients underwent cholecystectomy, and the histopathologic subtype was found to be cholesterol polyp in 9 cases and hyperplastic polyp in 3 cases. Additionally, we included one patient who had multiple metastatic lesions to the liver and lung with a polypoid lesion in the GB, which was accepted as a GB carcinoma.

Five patients had more than one polyp, and only the largest lesion was used for analysis; one of these patients had acromegaly.

Equipment and Scanning

Sonoelastography examinations were performed by one of two radiologists. These practitioners had 8-13 years of experience with conventional sonography and 2 years of experience in elastography. The patients underwent sonoelastographic examinations in the supine and left lateral decubitus positions during deep inspiration breath-hold after fasting for at least 6 hours, using a digital sonography scanner (Logiq E9, GE Medical System, Milwaukee, WI, USA) with a convex 2.8-5-MHz multifrequency transducer. B-mode and real-time elastographic images were simultaneously presented as a two-panel image, and the elastogram was displayed in a color scale that ranged from red (greatest strain, softest component), to green (average strain, intermediate component), to blue (no strain, hardest component) (10). Elastography scans were performed according to a standard protocol as follows: after identification of a GB polyp on a gray scale ultrasound image, real-time elastography was performed using the same probe while applying minimal pressure to the probe, since the GB itself receives pressure from the heartbeat (11); images were obtained only when optimal compression was in the 5-7-bar range (3); the scanning protocol was completed after confirming that several stable and reproducible images depicted almost the same color map of the polyp; static and
moving images were also recorded for later review; elasticity properties were decided in consensus by two radiologists.

Collected data were analyzed with SPSS version 16 software (SPSS Inc.). The numeric variables were expressed as either mean ± SD or number (percentage), where appropriate.
**Fig. 1:** Gray-scale (right panels) and color (left panels) examples of high-strain elastographic patterns that are entirely green on the elastogram. 43-year-old man with gallbladder polyp (arrow) identified as benign on follow-up sonography. Small arrows denote a three-layered artifact pattern.

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**Fig. 2:** Gray-scale (right panels) and color (left panels) examples of high-strain elastographic patterns with a mosaic of green, yellow and red on the elastogram. 47-year-old woman with gallbladder polyp (arrow) evaluated as a cholesterol polyp in pathologic examination. Small arrow denotes a three-layered artifact pattern.

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Fig. 3: Gray-scale (right panels) and color (left panels) examples of high-strain elastographic patterns with red and/or yellow on the elastogram. 42-year-old woman with gallbladder polyp (arrow) identified as benign on follow-up sonography. A three-layered artifact pattern is seen around the polyp.

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Fig. 4: 50-year-old woman who was diagnosed with acromegaly due to a pituitary adenoma. Patient had multiple large gallbladder polyps, but patient refused surgery. Sonography follow-up over 2 years was performed, and the size of the polyps remained stable. Arrows denote polyps with a high-strain elastographic pattern on the elastogram. A three-layered artifact pattern is seen around the polyps.

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**Fig. 5:** 58-year-old man with lung and liver metastasis was evaluated with carcinoma from clinical and radiologic findings. Gray-scale (right panels) and color (left panels) examples of a low-strain elastographic pattern. Polypoid lesion (arrows) appears almost entirely stiff (blue, with some red and yellow) on the elastogram.

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**Results**

The mean size for benign GB polyps was 7.2 ±3 mm (range, 5-21 mm). The mean distance between the surface of the GB polyps and the skin surface was 45.1 ±7.7 mm (range, 27-60 mm).

All benign GB polyps on consecutive real-time elastographic images appeared as having a high-strain elastographic pattern. Elastographic images showed most GB polyps as a mosaic of green, yellow and red (28 out of 52, 53.8%), whereas the remaining polyps showed either entire green (12 out of 52, 23.1%) or red with partially yellow areas (12 out of 52, 23.1%) (Figs. 1-4).

In our study, only one patient had a GB polyp with low elasticity properties. The mean size for this polyp was 19 mm. The distance between the surface of the polyp and the skin surface was 41 mm. In this case, the elastogram showed a predominantly stiff (blue) appearance within the polypoid lesion, with minimal soft tissue areas (ranging from red to green) (Fig. 5). In this case, there were multiple metastatic lesions, and the patient died 10 days after sonographic examination. Although the histopathologic diagnosis in this case could not be confirmed, the polypoid lesion was evaluated as a GB carcinoma based on clinical and radiological findings.
Conclusion

Real-time elastography measures the degree of elasticity distribution within tissues under compression and is based on the principle that the softer parts of tissues deform more easily than the harder parts. Because many diseases correlate with changes in the mechanical properties of tissues, this technique has been successfully applied in detecting and assessing various pathologies of thyroid gland, breast, lymph nodes, major salivary gland, prostate, kidney, and liver (1-3, 11-16). However, to our knowledge, no study has been reported previously in the medical literature using real time sonoelastography to assess GB polyps. This study revealed that sonoelastography of GB polyps is a feasible and reproducible method.

With the increased use of sonography, GB polyps are often detected incidentally. Although most polyps are benign in nature, some early carcinomas show a similar appearance to benign polyps. Sonography has been used extensively in the pre-operative management of polyps, but this technique is generally not sufficient to differentiate between benign and malignant polyps, with the exception of advanced GB cancer (17, 18). On the other hand, the overall prognosis for GB cancer is extremely poor, with less than a 10% 5-year survival rate (6, 19). Current guidelines in the management of GB polyps are generally established on the basis of polyp size, which recommend sonography follow-up for polyps smaller than 10 mm and surgical intervention for those 10 mm or greater (5). However, this strategy may well produce increased patient anxiety and unnecessary follow-up examinations (6). Therefore, a novel diagnostic approach based on polyp imaging findings other than the size criteria can help in polyp characterization. We think that elastography can be useful in the characterization of GB polyps as a new technique, although there is insufficient data at present for this hypothesis.

In this study, all of the benign GB polyps, of various sizes, were characterized as having high elasticity properties. In addition, we found in the majority of cases three-layered areas (blue, green, and red) on the elastogram, which were usually observed in the dependent portion of the gallbladder, and/or around the polyp. This appearance is an artifact of elastography due to liquid in the lumen of the gallbladder (12). In our study, only one of the polyps was interpreted as having a low elasticity on the elastogram. Although the histopathologic diagnosis could not be confirmed, it was felt that patient had the diagnostic features of a GB carcinoma.

Our study had several limitations. First, the current study had only one case showing features of a malignant polyp, and pathologic correlation of the case was not provided. Second, elastography itself has certain limitations, including relatively high operator dependency, factors affecting the performance of elastography, such as size, depth, and density of the lesion, strain values containing variables with different degrees of compression and solid components affected by the lack of strain of the fluid portion (2, 3, 14, 20). Third, description of the elasticity pattern is a subjective method. Nevertheless,
a quantitative analysis of tissue elasticity of GB polyps might be useful for providing measurable thresholds.

In conclusion, real time elastography is feasible in patients with GB polyps. In our study, all benign GB polyps were evaluated as having a high-strain elastographic pattern. Due to the above mentioned limitations, however, we do not claim from the available data to have provided a full clinical investigation demonstrating the efficacy of elastography in the differential diagnosis of GB polyps. To evaluate the diagnostic performance of this method in GB polyps, larger-scale studies must be performed that include patients diagnosed as having malignant polyps, along with ideal histopathologic analysis.
References


