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The value of ultrasound harmonic imaging in the diagnostics of gall bladder concrements

Tissue harmonic imaging (THI) is a new imaging technique introduced in ultrasound imaging. Harmonic imaging is based on nonlinearity of tissue. In the harmonic imaging the fundamental frequency (usually 2 MHz) is generated by the transducer and the second harmonic frequency is received. The fundamental frequency is filtered out, the pure second harmonic is used to generate image (6, 10, 11).

Gall bladder concrements are very frequently seen in patients complaining about right upper abdominal pains. They are usually diagnosed in US, but in some case the diagnosis is difficult.

The aim of the study was to assess the value of harmonic imaging in US evaluation of gall bladder concrements.

MATERIAL AND METHODS

The material comprised 40 patients with gall bladder concrements diagnosed in US. In each patient supplementary US examination in the harmonic mode was performed. The examination was performed with the ultrasound apparatus Sonoline G50 by Siemens, equipped with C5-2 Curved Array Transducer and proper software enabling examination in the harmonic mode. The frequency of standard mode was 3.5 MHz. In harmonic imaging two fundamentals and two harmonic frequencies were used. The first fundamental frequency was 2.2 MHz with 4.4 second harmonic received. The second fundamental frequency was 2.6 MHz with 5.2 harmonic frequency. The quality of gall bladder images was assessed, as well as the visibility of the pathology. The presence of the reverberation and artifacts inside the gall bladder and in surrounding structures was noted on both, standard and harmonic images. The reflection of the echo from the concrements and the visibility and width of the acoustic shadow were also assessed.

RESULTS

In 21 patients the gallbladder stones were seen in US examination. In three of them the deposits were localized in the cervix of the gallbladder. In two of them in standard mode only the echo reflection was seen, and the acoustic shadow was seen only on THI images (Fig. 1). The lumen of the gall bladder was clearer in the harmonic mode, without artifacts visible on the standard image. In one patient the fibrotic gall bladder was found, contracted on multiple concrements. The diagnosis was made easier on harmonic images (Fig. 2). In other patients concrements were localized in the central part of the gall bladder. In seven cases the concrements were sharper and more distinctly visible on harmonic images (Fig. 3). In four patients in standard US mode the solitary deposits were found, while THI revealed multiple deposits in those patients.

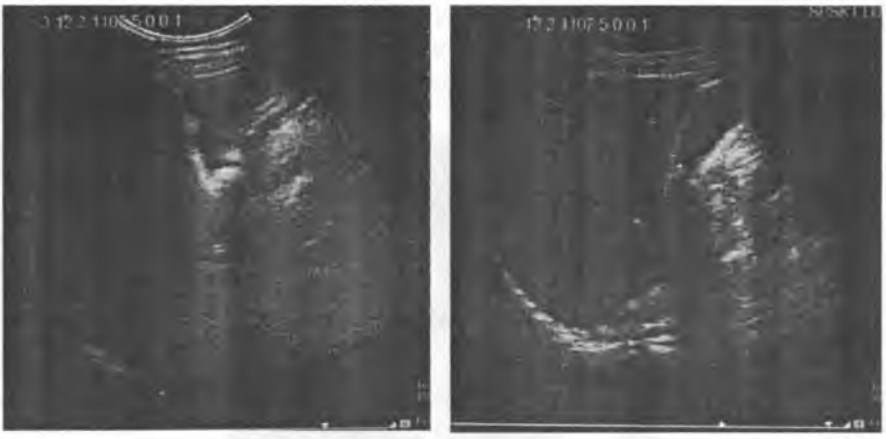

Fig. 1. Concrement in the gall bladder cervix. A – standard mode, only the reflection of the echo is seen; B – harmonic mode reveal both reflection of the echo and the acoustic shadow

Fig. 2. Fibrotic gall bladder contracted on multiple concrements (A – standard mode; B – THI)

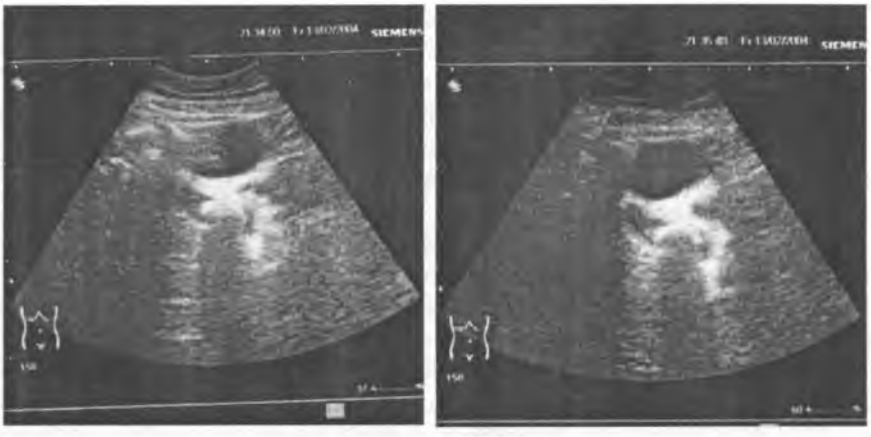

Fig. 3. The concrement in the gall bladder. The concrement is sharper on harmonic image (A – standard mode; B – THI)

In eight patients the acoustic shadow was more evident, wider and with sharper margins in the harmonic mode than on standard images. In five cases on standard mode the presence of inspissated bile was found in gall bladder apart from the deposits, but examination in the harmonic mode excluded the presence of bile sludge in four cases (Fig. 4).

Fig. 4. The concrement in the gall bladder in THI mode

DISCUSSION

Harmonic imaging is characterized by narrower beam cross-section than that of the fundamental frequency transmitted by the transducer. The reduced second harmonic beam width can lead to improved lateral resolution (6). The second harmonic has also reduced side-lobe levels resulting in reduction of image noise (1, 2,6, 10). Moreover, in harmonic imaging very close to the transducer very little harmonic is generated, thus the influence of reverberations in the superficial tissue layers is suppressed (1, 5, 6, 10, 11). In THI the use of lower frequencies for transmission facilitates the visualization of deep structures. The THI imaging mode may be helpful in obese patients (11).

Harmonic images are cleaner with higher contrast: this is especially useful in abdominal scanning (5). The minimum noise and clutter in harmonic mode reduces artifacts in liquid cavities, which appear much cleaner and darker on images. The tissue harmonic imaging is especially useful in the assessment of urinary bladder, gallbladder, large vessels and their pathologies. The assessment of liquid lesions, such as cysts, hydronephrosis, and ascites is easier in the harmonic mode (8, 9). The assessment of cysts and differentiation of true cysts and cystic tumors may be improved by the harmonic mode.

In the evaluation of urinary bladder most of the artifacts degrading bladder images are reduced, and its walls are much better outlined in the harmonic mode (3, 8, 9). Images of the lumen of vessels appear also with less reverberations artifacts and with a darker lumen on harmonic images. So vessel often can be easier to identify and cleaner (1, 8, 9, 11). The increase in contrast resolution can lead to more confidential assessment of abdominal and pelvic masses, particularly in obese patients, differentiating hyporeflective solid masses and cystic lesion (11).

Harmonic imaging can lead to a better analysis of tissue parenchyma and a better detection of lesion. The assessment of prominent renal columns may be easier in the harmonic mode, so THI may be helpful in differentiation with tumors. The pancreatic area is sometimes difficult to assess, with a poor contrast between fat and gland and, within gland, between healthy parenchyma and tumors. Some recent study showed that, for pancreas, harmonic imaging was significantly better than conventional sonography. Visualization of the pancreatic duct and the common bile duct was also

improved (8, 9, 11). The detection of focal liver lesion is often better in the harmonic mode, which can increase the liver-lesion contrast, leading to improved detection of hepatic lesions, particularly in patients with viral liver cirrhosis (7, 8, 9, 10, 11, 12).

The reduced artifacts result in clearer images of gall bladder lumen, which is usually filled with liquid. In the standard mode in some cases the inspissated bile is diagnosed, while examination in harmonic mode exclude this diagnosis. The false positive diagnosis of inspissated bile usually results from the presence of artifacts (8, 9, 11). The images of gall bladder concrements are more distinct. The deposits are sharper due to more intense echo reflection, and reduced level of artifacts and reverberations inside the gall bladder lumen. The higher frequency detected in the harmonic mode and reduced artifact facilitates visualization of the acoustic shadow, especially of small concrements and deposits localized in the gall bladder cervix. Some deposits are considered solitary in the standard US mode with one echo reflection and solitary acoustic shadow. In THI in such cases often multiple echo reflections are found, with multiple acoustic shadows, representing multiple concrements (8, 9).

CONCLUSIONS

In the harmonic mode the level of artifacts generated by the body wall is reduced and contrast resolution is increased due to reduction in the noise level. The visualization of gall bladder is improved in the harmonic mode. The assessment of gall bladder stones in the harmonic mode is easier because: 1) images of the gall bladder lumen are clearer due to reduced level of artifacts; 2) the resolution and contrast between the concrements and the bile are increased; 3) the acoustic shadow is more evident on harmonic images.

Diagnosis of concrements localized in the gall bladder cervix is especially improved in the harmonic mode. Differentiation of solitary and multiple concernments is also facilitated by harmonic imaging.

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SUMMARY

The aim of the study was to assess the value of harmonic imaging in US evaluation of gall bladder concrements. The material comprised 40 patients with pathology of gall bladder diagnosed in US examination. 21 patients from this group with gall bladder concrements diagnosed in US was included into the study. In each patient supplementary US examination in the harmonic mode was performed. In three patients the deposits were localized in the cervix of the gallbladder. In two of them the acoustic shadow was seen only on THI images. In one patient the fibrotic gall bladder was found. In seven cases the concrements were sharper and more distinctly visible on harmonic images and acoustic shadow was more evident in eight. In five cases in the standard mode the presence of inspissated bile was found in gall bladder, but examination in the harmonic mode excluded the diagnosis in four of them. In the harmonic mode the level of artifacts generated by the body wall is reduced and contrast resolution is increased due to reduction in the noise level. The visualization of gallbladder is improved in the harmonic mode. The assessment of gallbladder stones in the harmonic mode is easier because: 1) images of the gall bladder lumen are clearer due to the reduced level of artifacts; 2) the resolution and contrast between the concrements and the bile are increased; 3) the acoustic shadow is more evident on harmonic images. Diagnosis of concrements localized in the gall bladder cervix is especially improved in the harmonic mode. Differentiation of solitary and multiple concernments is also facilitated by harmonic imaging.

Wartość harmonicznego obrazowania tkanek w diagnostyce ultrasonograficznej złogów w pęcherzyku żółciowym

Celem pracy była ocena wartości THI w ocenie złogów w pęcherzyku żółciowym. Materiał stanowiła grupa 40 pacjentów z rozpoznaną patologią pęcherzyka żółciowego w USG. 21 pacjentów z tej grupy z rozpoznanymi złogami w pęcherzyku włączono do badania. U każdego z nich wykonano uzupełniające badanie USG w trybie harmonicznym. U trzech pacjentów złogi było zlokalizowane w szyi pęcherzyka. U dwu z nich cień akustyczny był widoczny jedynie w THI. U jednego pacjenta rozpoznano marko-włóknisty pęcherzyk żółciowy obkurczony na złogach. W trybie harmonicznym złogi były wyraźniej widoczne w siedmiu przypadkach, a cień akustyczny szerszy i bardziej wyraźny w ośmiu przypadkach. U pięciu pacjentów w trybie standardowym podejrzewano obecność zagęszczonej żółci, ale obrazowanie harmoniczne wykluczyło jej obecność w czterech przypadkach. W trybie harmonicznym poziom artefaktów generowanych przez ścianę jamy brzusznej jest obniżony i rozdzielczość kontrastowa poprawiona dzięki obniżonemu poziomowi zakłóceń. Uwidocznienie pęcherzyka żółciowego jest lepsze w trybie harmonicznym. Ocena złogów w THI jest łatwiejsza, ponieważ: 1) obrazy światła pęcherzyka żółciowego są pozbawione artefaktów; 2) rozdzielczość kontrastowa między złogami a żółcią jest poprawiona; 3) cień akustyczny jest bardziej wyraźny na obrazach THI. Ocena złogów zlokalizowanych w okolicy szyi pęcherzyka żółciowego jest szczególnie poprawiona w trybie harmonicznym. Różnicowanie złogów pojedynczych i mnogich jest również łatwiejsze w THI.