GE Healthcare

Advantages of CrossXBeam and SRI-HD imaging technology for the diagnosis of acute conditions of the abdomen

Edwin Cruz-Colon, Ph.D., CNMT, RDMS, RVT
Jorge Sarmiento, M.D.
Michael J. Washburn, Principal Engineer
Thomas J. Sabourin, Lead System Designer

Introduction

Acute abdomen is a very common clinical condition that may require immediate surgical attention. Some characteristics include localized or diffuse pain and the patient may experience a variety of signs and symptoms such as nausea, leukocytosis, and fever. Since more than 50% of all abdominal surgeries present an acute abdomen, the proper diagnosis of the origin is considerably important. An ultrasound examination is often used to make such a diagnosis. This paper examines the diagnosis of three common conditions of the abdomen including acute appendicitis, diverticulitis, and intussusception.

The following cases demonstrate how the use of new imaging technologies including CrossXBeam™, SRI-HD, and Coded Harmonics on the LOGIQ®9 ultrasound system increased the reliability and specificity of ultrasound in the diagnosis of acute conditions of the abdomen. (GE Healthcare, Wauwatosa, WI)

Technology

High-Definition Speckle Reduction Imaging

Ultrasound speckle is created by a complex interference of echoes made by reflectors spaced closer together than the resolution limit of the ultrasound system. The interference can be constructive and create bright spots, or can be destructive and cause dark spots. This random pattern of bright and dark spots is called speckle, and is inherent to ultrasound.

High-Definition Speckle Reduction Imaging (SRI-HD) addresses speckle by analyzing small regions of the image to determine if they contain mostly speckle or mostly anatomical features, and then processes them accordingly. The features are enhanced resulting in brighter, more continuous boundaries. By smoothing the speckle, variations in the echogenicity of various regions of the tissue are easier to see because the user's eyes are not distracted by the speckle variations. SRI-HD enhances the details while maintaining the image's integrity.

CrossXBeam

CrossXBeam is a spatial compounding technique of acquiring and combining ultrasound information in real-time to reduce speckle, clutter, and to improve the continuity of specular reflectors. This is accomplished by acquiring different but coplanar images and combining them in a way that reinforces true aspects of the data and reduces noise to form a single image. The coplanar images differ in that the beams used to acquire them are steered at different angles. In other words, the same slice of the target anatomy is insonated from different lines of sight. Altering the number of different steering angles for the coplanar images controls the amount of CrossXBeam applied to the image. The resulting contrast resolution of the CrossXBeam image can enhance the visualization of cystic boundaries, calcifications, biopsy needles, and the conspicuity of low contrast lesions.

Case 1

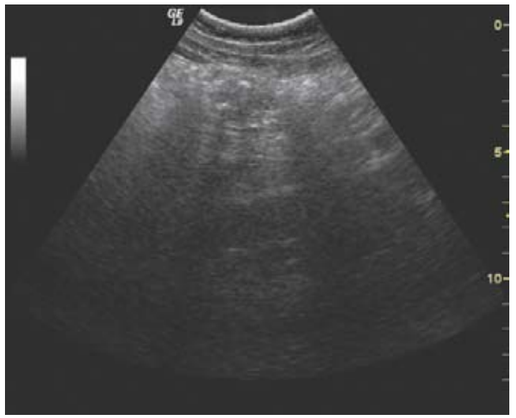
Background

Acute appendicitis is one of the most common indications for abdominal surgery in patients with acute abdominal pain. Appendicitis is a condition that is caused most commonly by obstruction of the appendix, resulting in inflammation and infection that can lead to perforation and an abscess in the abdominal cavity. While obstructed, the lining of the appendix continues its normal production of fluids. High pressures caused by a building up of fluids can result in inflammation, ulceration, and infection. Appendicitis can also be caused by nonobstructing processes such as bacterial and viral infections.[1] The appendix might not be normally visualized in routine ultrasound examinations mainly due to its small size, location, bowel gas interference, and beam aberation from numerous reflectors. Also, due to its variable location and shape, its detection, once inflamed, sometimes represents a challenge to the sonographer. However, the accurate detection and diagnosis of acute appendicitis by ultrasound results in a better prognosis and outcome for the patient. One of the findings that helps in the differentiation of a ruptured appendix is the presence of periappendiceal fluid collection.[2]

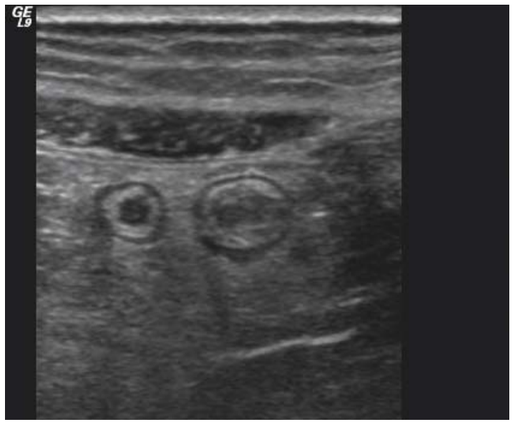
Clinical History

A 9 year-old female patient with acute right lower quadrant pain was taken to the emergency room with fever, leukocytosis, and rebound on the affected area.

A 3.5 MHz broad-band, multifrequency transducer is generally used to examine the abdomen. Although lower frequency transducers are necessary for visualizing deep anatomy, they suffer from decreased resolution when compared to higher frequency transducers. This scenario can make the differential diagnosis of acute abdomen challenging. High frequency matrix array transducers combined with Coded Harmonics help to increase contrast resolution, although penetration decreases slightly. Figure 1 A-B demonstrates the difference in image quality between low and high frequency transducers in the evaluation of this acute abdomen case.

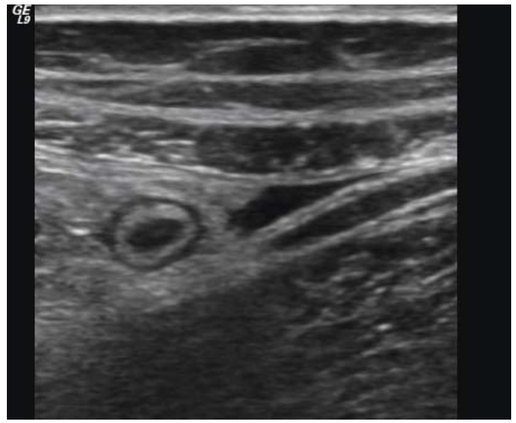


A

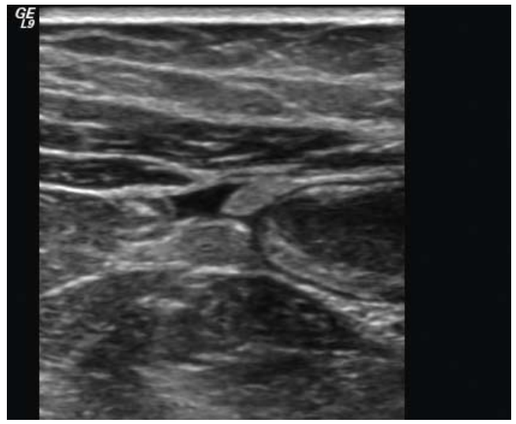


B

Figure 1A B
(A) A 3.5 MHz transducer shows no evidence of abnormaities in the RLQ.
(B) A higher frequency transducer (10.0 MHz) with the application of Coded Harmonics, SRI-HD, and CrossXBeam clearly depict an inflamed and tortuous appendix.

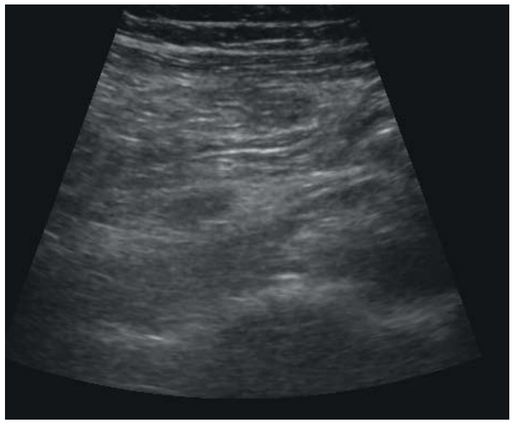


A

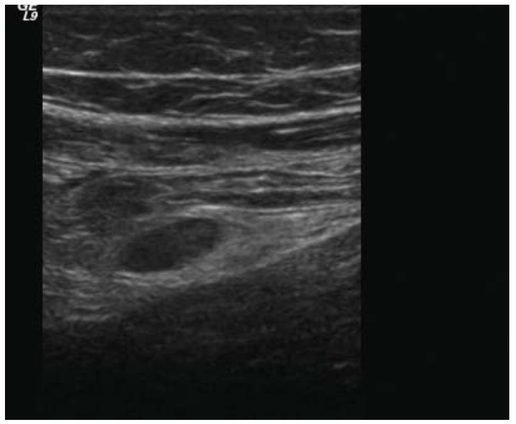


B

Figure 2A B
Axial scans of the RLQ revealed a small amount of free fluid surrounding the inflamed appendix and increased echogenicity of mesenteric fat.



A



B

Figure 3A B
Enlarged lymph nodes are noted. Image (A) shows an ill-defined mesenteric area with the use of a linear probe but without the application of the described image-improvement technology. Image (B) shows the improved image quality as a result of the layering of technology, namely the higher frequency probe, SRI-HD, CrossXBeam, and Coded Harmonics.

CrossXBeam with SRI-HD imaging technology helped to identify the presence of a small amount of fluid in the abdomen as seen in Figure 2 A-B. Enlarged lymph nodes, an associated, but non-specific sign of appendicitis, are also more clearly delineated when using this technology (Figure 3 A-B).

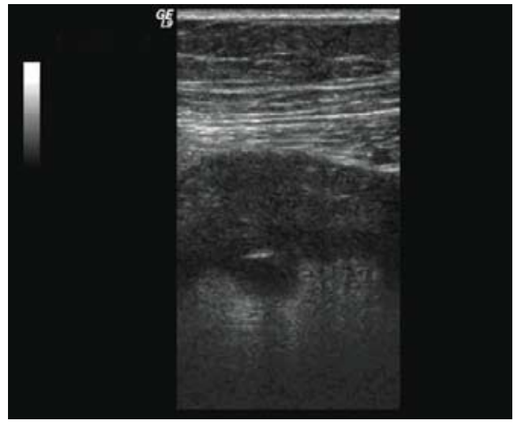
Case 2

Background

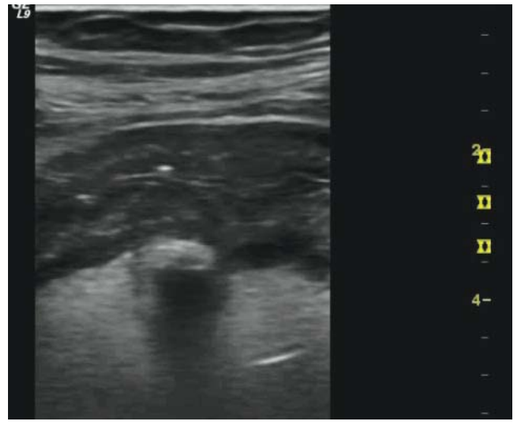
Diverticulitis is an inflammation in and around a diverticulum. The cause of diverticulitis is usually mechanical. The stagnation of fecal material (a fecalith) within the diverticulum may compromise blood supply to the thin-walled sac and render it susceptible to invasion by colonic bacteria, causing inflammatory erosion of the mucosal lining with perforation.[3] This sequence of events can involve perforation into the colonic wall, with the formation of an intramural abscess. Ultrasound diagnosis of diverticulitis as opposed to diverticulosis is more straightforward due to changes evident in the tissue, such as increased mesenteric echogenicity, small fluid collections, and aperistaltic, gas-free bowel loop.

Clinical History

A 57 year-old female patient was taken to an emergency care unit complaining of bloody stools, fever, severe LLQ pain, and increased white blood cell count. Upon examination, a non-compressible bowel segment was visualized in the left Iliac fossa. Figure 4 A-B shows the engorged bowel loop with an absence of gas and a protruded “mass-like” structure representing a diverticulum. The improved contrast resolution provided by CrossXBeam with SRI-HD aided in the differentiation of the diverticulum from the surrounding tissue.



A



B

Figure 4A B
Images obtained with a high-frequency 10.0 MHz probe. Engorged, hypoechoic and gas-free large bowel in the LLQ is clearly demonstrated with a protrusion of the posterior wall. Image (A) shows the demonstration of the diverticulum with harmonic imaging. Image (B) allows a better definition of bowel and surrounding tissue with the application of CrossXBeam and SRI-HD. This represents an inflamed diverticula in acute non-complicated diverticulitis. CrossXBeam allows for demonstrating the internal content of the diverticulum and the inflamed bowel loop.

Case 3

Background

Intussusception is another condition considered in acute abdomen cases. Intussusception occurs when one portion of the bowel slides into the next, much like the pieces of a telescope. When this occurs, it creates an obstruction in the bowel, with the walls of the intestines pressing against one another. This, in turn, leads to swelling, inflammation, and decreased blood flow to the intestines involved.[4]

Clinical History

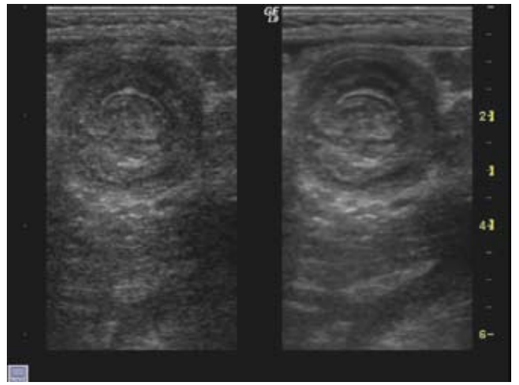
A 2 year-old female patient was evaluated due to continuous severe abdominal pain, jelly stools, and a palpable right quadrant "mass". The following images in Figure 6 A-G present the sequelae of bowel-between bowel, typically seen in intussusception. The use of CrossXBeam with SRI-HD, again, aided in the differentiation of tissue layers and helped in the diagnosis by providing improved contrast resolution, and better border definition.

A

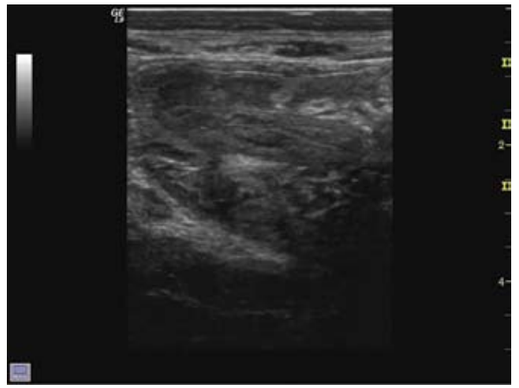
B

C

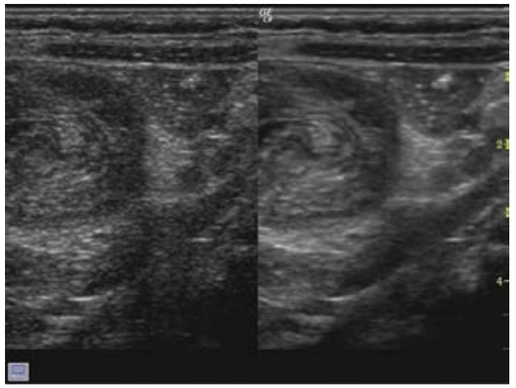
Figure 5A-C
(A) A volume-acquired section of large bowel showing at least two protruding diverticulae and an inflamed wall. (B) An aperture of communication between the diverticulum and bowel lumen is identified by a zoomed, high resolution image (arrow). (C) Once identified, it is easier to apply proven technologies such as power Doppler where a considerable increase in perfusion due to an active inflammation is observed.



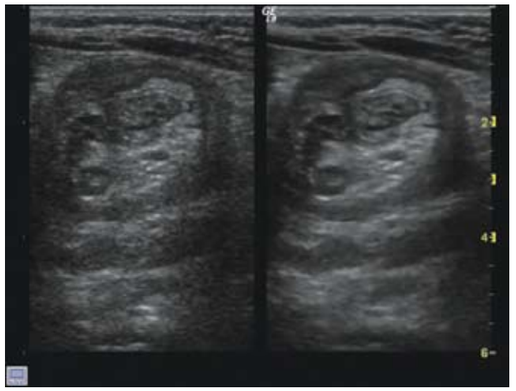
A/B



C



D/E



F/G

Figure 6A-G
These images show the comparison between using Coded Harmonics only (A, D, F) and the improved resolution when using Coded Harmonics with CrossXBeam and SRI-HD (B, C, E, G).

Conclusion

This report represents a series of cases of acute abdomen where conventional scanning techniques and technologies may fail to detect actual pathology. The combination of technologies such as SRI-HD, Coded Harmonics and high frequency CrossXBeam aids in the detection, characterization, and improved diagnosis of pathology. In the aim of a prompt and more specific diagnosis, SRI-HD in combination with CrossXBeam is a tool that should be used routinely in scanning anatomy where clear tissue contrast as well as layer and anatomy differentiation are required.

References

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Wauwatosa, WI 53226

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